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Program & Abstracts

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Preface

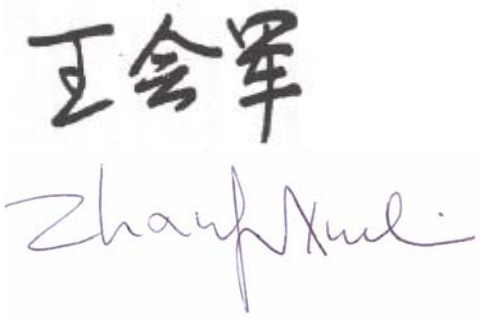
It is truly a great pleasure to welcome you all to this tenth in the series of the International Meetings on Statistical Climatology (IMSC), a series that has the simple objectives to provide a constructive environment for exchange between atmospheric scientists and statisticians and to promote good statistical practice in the atmospheric and climate sciences. The range of subjects spanned by the contributions, the number and disciplinary diversity of the participants, and their wide spread of geographical origins (we have received more than 200 abstracts from 40 countries located on 6 continents) all provide evidence of the important role that statistical analysis plays in climate research.

Many people and organizations contributed to the planning and execution of this meeting for which we are deeply appreciative. It is an impossible task for us to enumerate all of the people who should be thanked. Nevertheless, there are a few groups and organizations that we would like to single out for special thanks. The Meeting could not have taken place without the existence of, and the active encouragement and involvement of, both the Steering Committee and the Program Committee; the success and the quality of the meeting are our best thanks to them. We would also like to thank the Award Committee, chaired by Prof. Ian Jolliffe, for their effort in selecting this meeting's award recipients. The Institute of Atmospheric Physics (IAP) of the Chinese Academy of Sciences, and the German GKSS Research Center have provided generous financial support that has allowed us to offer assistance to keynote speakers, students, and several participants from developing countries. Finally, we would like to thank the IAP local organizing staff, led by Prof. Zhongwei Yan and Prof. Jiang Zhu, for their invaluable works in making the local arrangements for the meeting logistics.

We trust that the Meeting will be rewarding to you all and that it will draw you to the next IMSC that is planned for 2010, and we earnestly hope that you enjoy your visit to China to the full.

Most of presentations are available for download through the hyperlinks  ***in this on-line version of the abstracts book.***

Huijun Wang and Xuebin Zhang



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嘉賓樓
10th International Meeting on
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Invited Session: Spatial patterns of climate

Reduced Space Approach to Objective Analyses of Historical Climate Data Sets: Progress and Problems

Speaker: Alexey Kaplan

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Observed historical climate fields are characterized by comparatively precise data and good coverage in the last few decades and poor observational coverage in the earlier period. The technique of the reduced space objective analysis of such fields (i.e. estimating them in projections onto a low-dimensional space spanned by the leading patterns of the signal variability) is presented in the context of more traditional approaches to objective data analysis. Various versions of space reduction and covariance estimation techniques are reviewed. Outstanding problems and possible ways to overcome them are discussed.

Challenges of regional climate modeling and validation

Speaker: Douglas Nychka

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As attention shifts from broad global summaries of climate change to more specific regional results there is a need for statistics to analyze observations and model output that have significant variability and also to quantify the uncertainty in regional projections. This talk will survey some work on interpreting regional climate experiments. In large multi-model studies one challenge is to understand the contributions of different global and regional model combinations to the simulated climate. This is difficult because the runs tend to be short in length and with a limited number of ensemble members. We suggest some spatial models for the climate fields based on sparse approximations to the covariance matrix and derive an AN OVA like decomposition for the fields. The decomposition into main effects and interactions helps to isolate the effects of different models. The spatial models provide a rigorous framework for assessing statistical significance and comparing simulations to observed climate. This approach is illustrated for output from the PRUDENCE program and we also discuss the newer NARCCAP experiments for regional climate of North America.

Precipitation Extremes and Spatial Statistics

Speaker: Richard L. Smith

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In recent years an enormous literature has grown up documenting the increase in frequency of extreme climatic events of many types, and their conjectured association with anthropogenic causes of climate change. However, much of this literature has been relatively unsophisticated statistically, for example, calculating indices of climate change and looking for trends via time series and regression methods. The field of precipitation extremes is especially challenging statistically, since precipitation is defined by spatial as well as temporal scale, and climate model data is at a different spatial scale from rain gauge data. In this talk I focus on two applications where the application of spatial statistics is critical. The first concerns the estimation of trends in the extremes of long-term precipitation data, where spatial statistics is used to combine trends calculated at different locations and to define regional and national trends. The second application concerns the more specific problem of relating extreme value distributions calculated from point source (rain guage) data and gridded data, which is critical to characterizing the projection of future extremes from climate models.

Invited Session: Probabilistic estimates of climate sensitivity and other climate system parameters

New Diagnostics and Comparisons for Estimates of Climate System Properties from Climate Observations

Speaker: Chris E. Forest

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Two major challenges in estimating climate system properties (e.g., climate sensitivity and rate of deep-ocean heat uptake) from climate observations include: (a) the uncertainty in the historical climate forcings and climate observations, and (b) the uncertainty in the unforced variability of the climate system. Each of these poses a major challenge due to both the limited data available from either observations or climate model output and the required accuracy in the statistical algorithms. To address these issues, we have implemented a new estimation algorithm based on Bayesian methods to estimate the probability density functions for climates system properties. This is similar to model calibration algorithms in the statistics literature although here we use multi-variate patterns rather than scalar diagnostics to estimate the likelihood functions. We use a Bayesian approach that allows for the use of scientifically based information on the climate system properties to be used in the calibration process. The statistical model tackles the problem of dealing with multivariate diagnostics and incorporates all estimation uncertainties into the posterior distributions of the climate system properties. Additionally we obtain estimates of the covariance structure of the unforced variability of temperature change patterns. These results are critical for understanding uncertainty in future climate change and provide an independent check that the information contained in recent climate change is robust to statistical treatment. These results include uncertainties in the estimation of the multivariate covariance matrices for the first time.

Quantification of uncertainty in global temperature projections over the twenty-first century: A synthesis of multiple models and methods

Speaker: Reto Knutti

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The quantification of the uncertainties in future climate projections is crucial for the implementation of climate policies. Here I provide projections of global temperature change over the twenty-first century for the six illustrative, non-intervention SRES emission scenarios based on the latest generation of coupled general circulation climate models, and assess uncertainty ranges and probabilistic projections from various published methods and models. Short-term trends in global temperature are comparably well constrained and similar across all

scenarios. When considering evidence from different studies, long-term uncertainties are found to be larger than the ranges shown in previous IPCC reports, and also larger than captured in single models or methods. This is due to structural differences in the models, the sources of uncertainty taken into account, the type observational constraints used, and the statistical assumptions made. It is shown that assuming a time- and scenario independent relative uncertainty range for the future is a good approximation for the scenarios considered. The deviations from a constant relative uncertainty can be explained by the assumptions made in different methods, which all consider a subset of uncertainties in climate feedbacks, observed surface warming and observed ocean heat uptake, uncertainties in forcing, contributions of natural unforced internal variability, and natural forced variability by solar and volcanic forcing. Inclusion of uncertainties in carbon cycle feedbacks extends the upper bound of the uncertainty range by more than the lower bound.

Coherent treatment of model error and its implications for climate sensitivity

Speaker: Daithi Stone

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 Debate over the correct statistical framework to use, and Bayesian prior assumptions to make, has bedevilled efforts to reach consensus over the appropriate range of uncertainty in climate sensitivity. The crux of the problem is that we are dealing with a quantity that is non-linear in any conceivable observable climate variable, and the uncertainties are sufficiently large that arbitrary issues of statistical methodology have a substantial impact on headline conclusions. In Frame et al (2005) we proposed an approach to making the process more transparent by separating out the role played by data from the role of prior assumptions in estimating a distribution for climate sensitivity. If differences in prior assumptions are removed, the consensus on the relative likelihood of high versus very-high values for climate sensitivity is surprisingly good. Rather than resolving differences between rival estimates, as we hoped, our suggestion seems to have inflamed the debate still further. In this talk we will explain how the approach proposed in Frame et al (2005) generalises to a problem in which there are multiple underdetermined parameters, and show how it fits into the standard statistical framework of likelihood profiling. We will argue that the climate change detection and attribution community has, in effect, adopted a likelihood-profiling approach to date, which typically delivers more cautious estimates of uncertainty than a fully Bayesian subjectivist approach. The difficulty we face in assessments like that of the Intergovernmental Panel on Climate Change is that, if the same language is used to report likelihood-based results from attribution studies and subjective Bayesian probabilities for prediction studies, we will end up appearing more confident about the future than we are about the past. A logical solution would

be to adopt a different calibrated language to report subjective probabilities to that used to report likelihoods, but whether this could be accepted at this stage is a moot point.

Invited Session: Seasonal to Decadal Forecast

Slow Modes of Climate Variability and Seasonal Prediction

Speaker: Carsten S. Frederiksen

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The provision of skillful seasonal forecasts of temperature, rainfall and other climate variables has obvious potential benefits for countries whose economic activity is dependent on agriculture, tourism and other climate-sensitive industries. At extra-tropical latitudes, a substantial component of interannual variability of seasonal mean climate fields arises from variability within the season (i.e. intraseasonal variability). This 'intraseasonal' component is mainly contributed to by weather variability with time scale longer than the deterministic prediction period (about ten days) and therefore it is essentially unpredictable on seasonal, or longer, timescales. After removing this component from seasonal mean fields, the residual component is more likely to be associated with slowly varying external forcings (e.g. sea surface temperatures) and from slowly varying (interannual/supra-annual, slower than intraseasonal time scale) internal atmospheric variability and therefore, it is more potentially predictable at the long range. This component is referred to commonly as the 'slow' or 'potentially predictable' component.

Recently, the authors developed a methodology for estimating, from monthly mean data, spatial patterns, or modes, of the slow and intraseasonal components. This methodology provides a way to better identify and understand the sources of predictive skill as well as the sources of uncertainty in climate variability. Here, we illustrate this by applying the methodology to an analysis of New Zealand rainfall variability and the Southern Hemisphere and Northern Hemisphere 500hPa geopotential height field, often used to characterize the general atmospheric circulation. In particular, we show how the information obtained can be used to develop improved statistical seasonal forecasts of these two variables. The methodology for constructing the forecast schemes is based on determining predictors for the principal component time series of the dominant slow modes and then using these to construct a forecast of the climate field as a linear combination of the slow modes. We compare the skill of our statistical schemes with dynamical seasonal forecast models and show how our methodology can be used to analyse the sources of model predictive skill.

Statistical Methods in CPC Climate Forecast

Speaker: Peitao Peng

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 Although dynamical models have been increasingly used in climate forecast, statistical (or empirical) methods still have rooms to play, since dynamical models are far from perfect in their settings. This presentation will review the status of climate forecast in CPC and introduce some statistical methods used in operational forecast. Emphasis will be on the methods developed by CPC scientists, such as the optimum climate normal (OCN) and the constructed analog (CA). The OCN method, taking an average of latest years as the prediction for the coming year, has shown valuable skills in catching decadal or longer timescale variability. The CA method, approximating current state with a linear combination of historical sates and then carrying forward in time while persisting the weights assigned to each historical case, is skillful for forecasting sub-seasonal and seasonal variability.

In addition, our recent effort in consolidating forecasting tools will also be reported

Establishing non-trivial Skill in Seasonal Probability Forecasts: The Rise and Fall of Strawmen

Speaker: Leonard Smith

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 A clear demonstration of the utility for probability forecasts on seasonal time scales would significantly increase their attractiveness to decision makers who already use ensemble information on weather timescales. The challenges of robust evaluation of probability forecasts on seasonal scales are illustrated by contrasting the performance of simulation models with relatively simple data-based statistical models. Several challenges arise from the small-number statistics available for seasonal lead-times, multi-model multi-initial condition ensembles must be translated into probability density functions and evaluated based on only dozens of forecast-verification pairs; this is in contrast to the weather case where the forecast archive may consist of many hundreds of pairs. When the archive is small, and data are precious, false confidence in the forecasts is likely due to over-fitting and the poor assignments of weights to the various model structures. Three methods of weighting models ([i] equally, [ii]in/out selection which rejects some models completely while assigning equal weights to

those retained, and [iii] performance based weights) are considered, and illustrated in cases of small and large forecast archives. In the large archive case, robust results can be obtained by a wide variety of approaches. The case of seasonal forecasts requires more care. These issues are explored in both DEMETER forecasts and the ECMWF operational seasonal ensemble forecast, which are contrasted with probability forecasts from new dynamic climatology models, simple data-based statistical models which take account of the initial condition and relax towards the climatological dynamics. Suggestions for improving the design of future multi-model experiments are proposed, as are methods for the presentation of operational results to the numerate user community.

Invited Session: Climate Reconstruction

Significant noise

Speaker: G: Bürger

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 Noise is, by definition, insignificant. That means the following: Empirical statements, based on a set of data, are usually established by way of indirect proof, using the concept of a null hypothesis. The hypothesis is mostly of the form 'This result is based on pure chance', meaning that the data are merely the result of a random draw from some given, predefined distribution, that is: noise. From that distribution one derives the likelihood of the data and, if that likelihood is sufficiently low, the truth of the opposite which is then dubbed 'significant'. This kind of test has become folklore in climate science and belongs to the set of standard procedures and software by which results are produced.

Now the 'based on pure chance'-phrase has become quite controversial especially in the field of climate reconstructions, so that the same empirical relations are 'significant' for some and 'insignificant' for others. I think at least 3 independent ingredients can be identified that contribute to this controversy.

- Data and methods by which results are produced are often a complicated mix of various sources and procedures (proxies, type of regression, scaling, filtering).
- Many conventional tests use/rely on stationary statistics.
- The debate is heated and the respective opponents push the limits.

Climate research seems to be mired in this uncomfortable mix, and the challenge for the classical statistician seems overwhelming. Accordingly, my talk will not offer any fulminant solution but instead describe the state of my own bewilderment, not least about some of the most basic concepts of statistics.

Reconstruction Fidelity in Truncated EOF and RegEM Climate Field Reconstruction Methods

Speaker: Eugene R. Wahl

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 An important new technique for examining the fidelity of climate reconstruction methods is to test them experimentally in the context of three-dimensional climate system models (CSMs). The authors have utilized this technique with a long (AD 850-2000) run of the NCAR CSM to examine the Truncated EOF climate field reconstruction (CFR) method used by Mann, Bradley, and Hughes (MBH 1998, 1999). Experiments have been done using specially re-ordered (by year) cases to test the reconstruction method in extreme situations and in the calibration situation actually faced by MBH. Three notable results are: 1) the MBH version of Truncated EOF CFR is sensitive to the range of the full climatology of N. Hemisphere temperature present in the calibration period; 2) this inherent sensitivity leads to a relatively small, but real, loss of low frequency amplitude in the situation actually faced by MBH; and 3) extending the calibration period backwards from 1900 to 1850 reduces the amplitude loss to quite low levels, even though the size of the instrumental grid used in calibration would be reduced by more than a factor of four. The authors, along with M. Mann and S. Rutherford, have utilized the long NCAR run and the Erik run of the ECHO-G CSM to examine the Regularized Expectation Maximization (RegEM) CFR method. RegEM does not exhibit low frequency amplitude loss when reconstructing N. Hemisphere temperature under a variety of simulated noise, calibration length, and proxy richness situations. The authors also have done initial examinations of whole-field fidelity in the Truncated EOF CFR for the after-effects over Europe from large tropical volcanic events (using the long NCAR run). The model patterns are themselves highly like the real-world reconstructions produced by Fischer et al. (2007), both spatially and in terms of amplitude. Reconstructed pattern fidelity is good, but amplitude loss is again seen. This whole-field result hints that there could be situations in which pattern fidelity of the Truncated EOF CFR may be a more robust feature than fidelity of field mean values.

Evaluation of millennial proxy reconstruction methods

Speaker: Francis Zwiers

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A range of existing statistical approaches for reconstructing historical temperature variations from proxy data are compared using both climate model data and real-world paleoclimate proxy data. We also propose a new method for reconstruction that is based on a state-space time series model and Kalman filter algorithm. Two methods, one using a state-space modelling approach and the other the recently developed RegEM method, generally perform better than their competitors when reconstructing interannual variations in Northern Hemispheric mean surface air temperature. On the other hand, a variety of methods are seen to perform well when reconstructing surface air temperature variability on decadal time scales. An advantage of the new method is that it can incorporate additional, non-temperature, information into the reconstruction, such as the estimated response to external forcing, thereby permitting a simultaneous reconstruction and detection analysis as well as projection into the future. An application of these extension is also demonstrated in the paper.

Invited Session:

The Quasi-Biennial Oscillation with a Meridional Tripole Pattern Distribution in the Interannual Variability and Anomaly of Asian Summer Monsoon over East Asia

Speaker: Huang Ronghui

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In order to reveal the regularity of the interannual variability and anomaly of Asian summer monsoon over East Asia, the observed data of summer precipitation in China, the NCEP/NCAR and ERA-40 reanalysis data and the Empirical Orthogonal Founction (EOF) and the entropy spectral analysis methods are applied to analyze the interannual variations of summer monsoon (June-August) rainfall in China and water vapor transport fluxes over East Asia in this paper. The results show that there is an obvious oscillation with a period of two~three years, i.e., the TBO, in the interannual variations of summer monsoon rainfall in China, and the spatial distribution of this oscillation exhibits a meridional tripole pattern structure over East Asia. Moreover, it is also shown that this oscillation is closely associated

with the quasi-biennial oscillation in the interannual variations of the water vapor transport fluxes by summer monsoon flow over East Asia.

Furthermore, in order to understand the physical processes including the internal and external processes that influence the variability of Asian summer monsoon over East Asia, in this paper, the interannual variations of sea temperature in the surface and subsurface of the tropical western Pacific are analyzed by using the sea surface temperature (SST) data of the NCEP/NCAR reanalysis dataset and the sea temperature in the subsurface of the West Pacific along 137°E, JMA, respectively. From the analyzed result, it is revealed that there is also a significant quasi-biennial oscillation in the interannual variations of thermal state of the tropical western Pacific. And it is also shown that the quasi-biennial oscillation in the interannual variations of thermal state of the tropical western Pacific has a great impact on the Asian summer monsoon and the water vapor transport driven by the monsoon flow over East Asia. Besides, the influencing mechanism of the quasi-biennial oscillation in the interannual variations of thermal state of the tropical western Pacific on the interannual variations of Asian summer monsoon is discussed by using the teleconnection theory in this paper. The TBO with a meridional tripole pattern distribution in the interannual variability and anomaly of Asian summer monsoon over East Asia can be well explained from the East Asia/Pacific teleconnection pattern of circulation anomalies responding to forcing by the heating anomaly around the Philippines proposed by Nitta (1987), and Huang and Li (1987, 1988). And the teleconnection pattern of meridional wind anomalies along the westerly jet stream in the upper troposphere over East Asia also has an important influence on the meridional tripole pattern distribution.

Evidences and Modeling Study of Droughts in China during 4-2kaBP

Speaker: Wang Shaowu

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Documentary records indicated the predominance of drought in the period of 4-2kaBP, which covered the Xia (since 2070BC), Shang (since 1600BC), and West Zhou (1041-771BC) Dynasties and so forth. Drying up of the rivers, disasters with droughts were recorded in a series of historical documentations, such as Chronicles on Bamboo Clappers, Book of Odes, Chinese Encyclopedia, and so on. Palaeo-environmental data; pollen, peat, TOC, $\delta^{13}C$, and magnetic susceptibility provided high-resolution records of climatic humidity in thousands years ago. Droughts have predominated in China 4-2kaBP according to the

palaeo-environmental data from south of Northeast, North, to the east of Northwest China, and over the eastern Plateau, corresponding to the intensification of summer monsoon over the East Asia. The latter may caused by the increase of insolation over land area of the Northern Hemisphere, which depended on the precession. Droughts were simulated well by the AGCM under the orbital forcing.

Climate and Infectious Disease: New Challenges and Opportunities

Speaker: Mark L. Wilson

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 Climate has been associated with transmission of many infectious disease agents, but rigorous analysis of risk patterns is not straightforward. Weather and climate variables alter transmission dynamics in various directions and through different pathways, depending on the type of microbe, its natural reservoir, and mode(s) of transmission. Disease expression following infection also may be indirectly affected. Impacts can be linked to seasonal variation with different disease-dependent time-lags, or to extreme events. Risk has been assessed at scales ranging from microclimate to global indices, but in most cases has not been carefully investigated with more complex, multi-level statistics that consider influences of strain variation, immunity, socio-economic or behavioral risks, and adaptation. Examples of research analyzing space and/or time patterns of climate and infectious diseases will be presented to illustrate various epidemiologic and ecologic results. In addition to describing associations, longer-term efforts are aimed at developing forecasts that might serve as early warning of outbreaks. Opportunities for climatologists and epidemiologists to collaborate will be explored.

Invited Session: Climate Extremes

Spatial characterization of extreme meteorological events; climate and weather effects

Speaker: Dan Cooley

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 Meteorological data are generally spatial and our goal is to characterize the spatial nature of extreme meteorological events. To do so, one should characterize the spatial effects due to both climate and weather. The climate effects are characterized by the marginal distribution associated with a particular location, while the weather effects would be characterized by the dependence found in the observations. Unfortunately, the recorded data are a result of both climate and weather effects and it is not straightforward to separate the two, especially with extreme data.

Recently there have been several characterizations of the climatological variation of extremes. These have been hierarchical models which have an assumption that the data are conditionally independent given the climatological dependence. There has also been separate work in how to describe the spatial dependence in extreme weather events and how to perform spatial prediction for extremes. These weather problems all assume that the climatological variation has already been accounted for. Thus, to this point, the weather and climate problems have been dealt with completely separately.

This talk will illustrate the difficulties in modeling weather and climate extremes. The climatological dependence problem will be illustrated by a project which describes the risk of extreme precipitation for a region of Colorado (USA). The weather dependence problem will be illustrated by a project which performs spatial prediction. Finally, an ongoing project will be presented in which the conditional independence assumption is clearly violated and how we are attempting to characterize the climatological dependence.

Probabilistic Event Attribution of the United Kingdom Autumn 2000 Floods

Speaker: Pardeep Pall

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 The United Kingdom floods of Autumn 2000 occurred during the wettest autumn in England & Wales since records began in 1766, causing widespread damage and an estimated insured loss of 1.3bn pounds.

Whilst it has been noted that such types of event might become more likely under global warming, it is impossible to directly attribute this specific event to anthropogenic emissions of greenhouse gases. It is, however, possible to attribute the contribution (if any) of anthropogenic greenhouse gas emissions to the risk of such a magnitude of event occurring at that time. We do this using a Probabilistic Event Attribution methodology -- in a manner similar to that previously used for the European Summer 2003 heatwave, but now accounting for the more variable nature of precipitation.

We compare an Industrial Autumn 2000 climate which includes the effects of atmospheric greenhouse gases for that time, and an analogous Non-industrial climate had there been no emissions of these gases over the 20th century. These climates consist of very large ensembles of weather simulations generated using a high spatio-temporal resolution global atmospheric climate model. We find that the Industrial climate is able to capture observed Autumn 2000 levels of precipitation, and that approximately 20-30% of the risk of this precipitation is attributable to the aforementioned greenhouse gases. This conclusion is, however, very dependent on the characteristics of sea surface temperatures input to the Non-industrial climate being compared against.

Such an assessment may have implications for providing insurance to properties built in floodplains and, notably, requires very large ensembles of simulations for such an extreme event. Given recent debates over the contribution of anthropogenic climate change to the risk of extreme weather events, future development of an operational Probabilistic Event Attribution system would have many advantages.

Combining climate models for probabilistic of climate change: statistics and heuristics

Speaker: Claudia Tebaldi

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In the last few years what have been called 'ensembles of opportunity',i.e. output from similar experiments run by different climate models, arebecoming increasingly easy to come by, and increasingly rich in the amountof data they provide.

In this talk I focus on ensembles of global coupled climate models.It has been shown over and over that no model is 'the best model' and projections that are synthesized from the ensembles promise to be more reliable, and to offer a better representation of the uncertainties involved in future climate change, than anything that can be gathered from single model experiments.There are challenges, though, besides opportunities, in optimally combining multi-model ensembles. How to measure and account for differentperformance in representing observed climate; how to quantify interdependencies among models, how to deal with increasingly different models when it comes to the representation of auxiliary processes, e.g. the carbon cycle. Not to mention the pre-existing challenges of designing experiments able to

balance the demands of resources between intra-model ensembles and the sampling of a representative set of scenarios.

I will focus on some work by myself and co-authors that tackles the quantification of uncertainty in regional climate projections. I want to exemplify through this approach not only issues, shortcomings and open questions, but also the most promising directions in which this kind of statistical analyses should be taken next.

Parallel Sessions：Climate Data Homogenization and Climate Trend/Variability Assessment

Time series analysis of daily rainfall variability and extreme events

Speaker: Bohloul Alijani

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The amount and variability of precipitation characteristics, especially extreme events, are very important for most of the developmental purposes in dry and semi-dry climates. Iran being located in dry climates suffers from extreme events of daily rainfall every year. This research has tried to investigate the frequency and intensity of these extreme events with the help of some indices such as annual rain amount and rain days, maximum one day precipitation, the frequency of rain days exceeding the 75th, 90th, 95th, and 99th percentiles and the amount of rainfall due to these events during the existing data period (1961-2004) for Tehran station. The data were processed by Man Kendal randomness and trend tests and linear regression models.

The results showed a positive trend in all indices among which only annual rain days trend was significant at α =0.05. Although the amount and frequency of rainfall showed increasing trend during study period, but at the same time the increasing share of the extreme events indicates some irregularity in the precipitation pattern of the station. The final conclusion of the study is that the rainfall does not show any significant change but its internal irregularity has increased. This creates problem for planners and sustainable development of the area.

Key words: climate change, daily rainfall, climate hazards, rainfall variability, rainfall trend.

Observed changes in July-August precipitation and temperature extremes over China

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Using daily station data over China, we studied the trends, inter-annual and decadal variations in July-August (hereinafter JA) precipitation and temperature extremes, and probed into possible association between precipitation and temperature. Our results show that except for the precipitation intensity, which show consistent increase trends over most part of China, other extreme precipitation indices show positive trends along the Yangtze River valley and negative trends over North China for the last 50 years, there's no significant trend for China as a whole. Extreme temperature indices based on daily minimum temperature show coherent increasing trend, which is corresponding to the global warming. Daily maximum temperature is mostly affected by precipitation, significant decrease trends were found along mid-low Yangtze River valley. For China as a whole, the dominant increase of daily extreme temperature occurred after 1990s. Besides long-term trend, JA precipitation and temperature extremes also show significant decadal variations. The DTR (diurnal temperature range) and ETR (extreme temperature range) tend to decrease over most part of China, they experienced a decadal shift starting from late 1970s. The difference (1980-2001 mean minus 1958-1979 mean) spatial pattern of extreme temperature and precipitation indices is consistent with their long-term trends. The probability of cold nights (warm nights) is lower (higher) after 1980s than before.

Changes of winter extreme rainfall over Southwest Western Australia and the linkage to the Southern Annular Mode

Speaker: Yun Li

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Southwest Western Australia (SWWA) is an austral winter rainfall dominated region. Since late 1960s, rainfall over SWWA has experienced a substantial drying trend with a winter rainfall decrease of some 25%, putting further constraints on water resources in an already dry area. The decline is manifest as a reduction of high-intensity extreme rainfall events. There

has been vigorous debate as to what is forcing the drying trend, i.e., whether it is driven by secular forcings such as increasing atmospheric CO2 concentration or whether it is part of multidecadal variability. Previous results from greenhouse warming experiments suggest that the SWWA rainfall shows a drying trend with an increasing mid-latitude mean sea level pressure (MSLP) under increasing atmospheric CO2, which is expressed as an upward trend of a dominant atmospheric circulation mode in Southern Hemisphere called Southern Annual Mode (SAM) or the Antarctic Oscillation (AAO).

We present our recent results on statistical modeling winter extreme rainfall over SWWA and its associated changes with the SAM. The possibility of the rainfall reduction being a part of multidecadal variability was discussed by using outputs of the CSIRO Mark 3 climate model in an experiment without CO2 forcing. Our results offer the qualified support for the argument that the SAM may contribute to the drying trend.

This work was supported by the Indian Ocean Climate Initiative of the Western Australian state government, and CSIRO WfHC Flagship-Climate Program.

Estimation and Extrapolation of Climate Normals and Climatic Trend

Speaker: Robert E. Livezey

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WMO-recommended 30-yr normals are no longer generally useful for the design, planning, and decision-making purposes they were intended. They not only have little relevance to the future climate, but are often unrepresentative of the current climate. The reason for this is rapid global climate change over the last 30 years that is likely to continue into the future. It is demonstrated that simple empirical alternatives already are available that not only produce reasonably accurate normals for the current climate but also often justify their extrapolation several years into the future. This result is tied to the condition that recent trends in the climate are approximately linear or have a substantial linear component. This condition is generally satisfied for the U. S. climate division data, but will also have wide applicability globally. One alternative, Optimum Climate Normals (OCN) are multi-year averages not fixed at 30 years like WMO normals, but adapted climate record by record based on easily-estimated characteristics of the records. The OCN works well except with very strong trends or longer extrapolations with more moderate trends. In these cases least squares linear trend fits to the period since the mid-1970s are viable alternatives. An even better alternative is the use of hinge fit normals, based on modeling the time dependence of large-scale climate change. Here, longer records can be exploited to stabilize estimates of modern trends. Related issues are the need to avoid arbitrary trend fitting and to account for trends in studies of ENSO impacts. Given these results we recommend that (a) the WMO and national climate services

address new policies for changing climate normals using the results here as a starting point, and (b) NOAA initiate a program for improved estimates and forecasts of official U. S. normals, including operational implementation of a simple hybrid system that combines the advantages of both the OCN and the hinge fit.

Changepoint Detection in Multinomial Logistic Regression with Application to Sky-Cloudiness Conditions in Canada

Speaker: QiQi Lu

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Detecting changepoints in a sequence of continuous random variables has been extensively explored in both statistics and climatology literature. There is little, however, for studying the case with multicategory response variables. For instance, the sky-cloudiness condition in Canada is reported in tenths of the sky dome and has 11 categories (0 for clear sky, 1/10 for one tenth of sky covered, and 10/10 for overcast). To model and homogenize such a multinomial variable, this paper develops an overall likelihood-ratio test statistic in an ordinal logistic regression model setting. A method of partitioning of the overall test statistics is also proposed to enable one to test the changes in the individual categories. This technique is applied in the analysis of the real cloudiness data.

A cloud-based reconstruction of surface solar radiation trends for Australia

Speaker: Manuel Nunez

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Despite its importance to climate change, reliable and calibrated measurements of solar radiation are available only after 1992 for Australia. In this study we extend the data base by developing a cloud-based solar radiation model and extending the data set back from 1967 to 2004. Results show no significant change in the majority of stations, although slightly more than one quarter of the stations report a significant decrease of solar radiation with a maximum of just less than one percent per decade. Trend analyses also detect an upturn in many of the

southern stations in the late eighties which appear to relate to changes in middle and high cloud cover.

This work was supported by Western Australian state government projects: Indian Ocean Climate Initiative and Strategic Research Fund for the Marine Environment.

Patterns and trends in severe storm environments using re-analysis data

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Severe storms cannot be resolved well by climate models because they occur at too fine of a scale and because of limitations in the capabilities of climate models. We therefore examine the changes in frequency of large-scale conditions conducive to severe storms with respect to space and time.

This presentation addresses three issues. First, using previously published results, the relationships between moderately high levels of convective available potential energy (CAPE J/kg) and vertical shear (m/s) and the occurrence of observed convective storms are reviewed. This review supports the use of high values of the product of CAPE and shear as a proxy for severe convective events, but cautions about the ability of this information to discern storm types.

Second, to gather information over a greater domain of space and time, CAPE and shear are calculated from the NCEP/ NCAR reanalysis data set using the Skew-t/Hodograph Analysis and Research Program (SHARP) yielding data on an approximately 2-degree square grid, 4 times daily from 1958 through 1999. The CAPE, shear and their product (CAPE*shear) are summarized statistically and graphically. Statistically significant trends are identified using general linear models fit to annual and monthly summaries of this data set. Issues associated with multiple comparisons are addressed using a method that limits the false discovery rate. Results show that in select regions significant changes in the frequencies of high CAPE*shear events have occurred over the last 40 years.

Third, the distribution of the product of CAPE and shear are heavy tailed, with large values being relatively rare. Therefore, the generalized extreme value distribution is well suited to model the tails of high values. In our work we model these extremes using the spatial extension of the extRemes toolkit. Initial results are consistent with empirical extreme values,

and show promise for analyzing trends in extremes of this large-scale indicator of smaller-scale severe weather activity. Both approaches to analyzing the data may be extended to allow inferences to be made regarding the frequency of convective storms under future climate change scenarios.

Spatial Variation of Thunderstorm Rainfalls in the Northwest of Iran

Speaker: Ali Akbar Rasuly

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Thunderstorm rainfall is considered as a very vital climatic factor because of its significant effects and often disastrous consequences upon people and the natural environment in the Northwest of Iran. Thus, the purpose of this study was to analyze the spatial variation and distribution of thunderstorm rainfall in the region, between 1951 and 2005. Previous studies have found that thunderstorm rainfalls are most frequent in the spring and summer normally at the late afternoon and early nights. They occur primarily over the southwest of the study area and mountains, and less frequently over the lowland interior of region. It was suggested that environmental factors, such as synoptic weather systems and the physiographic parameters may control thunderstorm occurrence and its associated rainfall distribution.

Accordingly, a specific attention was paid to the patterns of the spatial variation of thunderstorm rainfall during the warm months over a long time-span (55 years), using data from 16 synoptic stations. Mathematically, the gamma functions (beta and alpha values) and Pearson's Exponential Type 3 were consequently applied to data available for describing and summarizing of the probability distribution of daily thunderstorm rainfalls across the region. Additionally, to distinguish the details of major thunderstorms environment, a few NOAA and TRMM satellites images, a number of synoptic charts and rainfall amounts observed during certain large events have been compared.

A Comparison of Various Changepoint Detection Techniques for Climate Data

Speaker: Jaxk Reeves

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A serious problem for climate data researchers is the detection of changepoints in climate series. Detection of such changepoints (typically caused by man-made interventions such as relocation of a temperature station, new recording instruments or techniques, etc.) is very important, since quantification of long-term trends, such as possible global warming, can not be done with any degree of reliability until artificial changepoints are removed from the series of interest. The field of climate research is replete with numerous ad-hoc methods for detecting changepoints, with relatively little statistical justification for most. This presentation attempts to categorize these methods statistically and to indicate the situations in which each might be appropriate or optimal. Most results presnted will pertain to analysis of classical annual temperature series, which can reasonably be modeled with independent normally distributed error innovations. Some results concerning suggested procedures when these assumptions are violated, as in the case of correlated errors, will also be discussed.

Some Features of Instrumental Period Rainfall and Wet Season Fluctuations over Different River Basins of India

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In recent years a new perspective has been added to hydrological investigations of India with the launch of the most ambitious Master Plan 'Interbasin Water Transfer –Interlinking of Rivers of India'. The plan is intended to utilize the country's water resources to the fullest extent practicable by transferring water from the surplus basin to deficit areas. One of the important issues to be addressed amicably in the planning process of the program is the impact of global changes, particularly global warming, on the rainfall fluctuation over different basins of the country. Long period basin-scale rainfall data is expected to provide vital information to this plan. The drainage system of the whole country can be divided into 11 major and 36 minor river basins, and the west coast drainage system which is a combined drainage area of 25 small rivers. Longest instrumental area-averaged monthly, seasonal (winter JF, summer MAM, monsoon JJAS, post-monsoon OND, July-August, June-August, October-November and May-November) and annual rainfall series have been developed for each of the 11 major and 36 minor basins as well as the west coast drainage system using highly quality-controlled data from well spread network of 316 raingauges. For the period

1901-2005 with complete data of all stations the area-averaged series has been prepared from simple arithmetic mean of the gauges in the particular basin, and for period prior to 1901 (sometimes going back to 1813) with lesser observations the series is constructed by applying established objective method. For the whole country the different rainfall series could be developed for the period 1813-2005. For the different basins the starting year of rainfall data is as (ending year is always 2005): major basins The Indus 1844; The Ganga 1829; The Brahmaputra 1848; The Sabarmati 1861; The Mahi 1857; The Narmada 1844; The Tapi 1859; The Godavari 1826; The Krishna 1826; The Mahanadi 1848 and The Cauvery 1829; minor basins Chenab 1891; Beas 1853; Satluz 1844; Yamuna 1844; Ramaganga 1844; Gomati 1844; Ghaghara 1844; Gandak 1848; Kosi 1870; Mahananda 1837; Chambal 1844; Sind 1860; Betwa 1844; Ken 1844; Tons 1844; Son 1842; Tista 1869; Brahmaputra 1848; Dhansiri 1871; Wainganga 1844; Wardha 1826; Penganga 1865; Godavari 1844; Indravati 1871; Krishna 1836; Bhima 1826; Tungabhadra 1837; Luni 1856; Surma 1848; Kasai 1831; Damodar 1829; Subarnarekha 1848; Brahmani 1871; Penner 1813; Palar & Ponnaiyar 1853; Vagai 1846 and The West Coast Drainage System 1817. Important statistical characteristics of the rainfall series are reported. Annual rainfall quintiles are used as threshold to categorize yearly rainfall condition for the particular basin as meteorologically very dry, moderately dry, normal, moderately wet and very wet. Distinct epochs in annual rainfall fluctuations over the whole country and the different basins are identified.

The area-averaged monthly rainfall sequence have been used to document climatology and fluctuation of the wet season (starting date, ending date and duration) over the whole country, 11 major river basins, 36 minor river basins as well as the west coast drainage system. Objective criterion ‘continuous period with rainfall greater than 50 mm every month’ was applied on yearly data to identify the wet season. Starting date is marked in the first month of the consecutive months, each with rainfall greater than 50 mm, by linear interpolation up to which from the beginning of the month 50 mm rainfall is expected. And the ending date is marked by linear interpolation in the last month of the consecutive month from which up to the end of the month 50 mm rainfall is yet to occur. The mean (±1σ) of the starting date, ending date and duration of the wet season for the whole country are as: 29 May (±11days), 12 October (±13days) and 136 days (±18days). According to Fisher’s g-statistic test distribution of the starting date, ending date and duration follows the Gaussian (or normal) law.

The mean (±1σ) of the starting date (MSD), ending date (MED) and duration for 11 major river basins are tabulated. The g-statistic test suggested that parameters of the wet period for different major basins are near-normal.

The parameters of the wet season for 36 minor basins and west coast drainage system have also been determined following similar procedure and their climatological and fluctuation characteristics studied. Visibly the time series of different wet season parameters for all the cases examined is homogeneous and random.

Sequential change point analysis using Bayesian criterion

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Climate change is becoming a major issue all over the globe due to its wide spread impacts on various socioeconomic sectors across the regions. It may also render significant changes in the climate variability leading to abrupt climate regime shifts that can have considerable impacts at various temporal and spatial scales. The identification of such regime shifts (or “the change points” in the climatic time series) may help us translating these impacts to adaptation and mitigation policies. Change point detection models (CPDMs) are useful in detecting abrupt changes in the climatic variability. In essence, a CPDM employs a measure on stability and persistence of a statistical model of the climate and its variability. The problem to detect and identify a climatic regime shift can be formulated with respect to many statistical parameters such as mean and variance. The most prevalent models are CPDM with respect to the mean of a variable.

This paper presents a comparative study of two of such methods, one each to the changes with respect to mean (Model-1) and to variance (Model-2) respectively. Both models resolve the change point detection problem quite well. Model-1 is sequential change point analyzer and uses student-t test to detect the changes in the fit of the distribution based on mean of the segment. Model-2 uses Bayesian Information Criterion (BIC) to identify the changes in the variances in the time series. However, it is shown that Model-2 is more robust to the presence of outliers than to changes in mean. In fact Model-2 is computationally more efficient as well.

Homogenization of daily air pressure, temperature and precipitation series for Southern Moravia in the period 1848–2006

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Homogenization of daily meteorological series is a difficult task. Several kinds of problems have to be taken into consideration in the course of homogenization: selection of a proper homogenization method with regard to the data used, creation of reference series, completion of missing values, annual course of adjustments and others. We present an attempt to create a homogeneous series of daily air pressure, temperature and precipitation readings in the area of Southern Moravia (Czech Republic) from 1848 to 2006. Tools for converting daily precipitation series to be normally distributed were adopted. In case of air temperature and precipitation, other characteristics such as monthly and annual number of days above given thresholds (0°C, 5°C, 10°C, 15°C for temperature, ≥ 0.1, 1.0, 5.0, 10.0 mm for precipitation) were investigated and mutually compared.

Because of presence of a noise in the series, statistical homogeneity tests give their results with some portion of uncertainty. Using various statistical tests along with various types of reference series made it possible to increase considerably the number of homogeneity tests results for each tested series and thus to assess homogeneity more reliably. Two basic approaches were adopted: (i) homogenization of monthly series and projection of estimated smoothed monthly adjustments in annual variation of daily adjustments and (ii) homogenization of daily values in individual months and direct estimation of daily adjustments, again smoothed by low-pass filter. Differences in results obtained from these two approaches are further discussed.

The series were prepared, quality checked and homogenized by means of AnClim and ProClimDB software (www.climahom.eu).

Basic methodological questions of homogenization and the MASH procedure

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The MASH (Multiple Analysis of Series for Homogenization) iterative procedure is a relative method and depending on the distribution of examined climate element additive or multiplicative model can be applied. In the earlier program system the following subjects were elaborated for monthly series: series comparison, break point (changepoint) and outlier detection, correction of series, missing data complementing, automatic usage of meta data and a verification procedure to evaluate the homogenization results. The new version was developed further for daily data: homogenization, quality control and missing data complementing.

As we see it, the basic methodological questions of homogenization are as follows: comparison of series, break point detection and correction of shifts. In general the relative

homogeneity principle is used to remove the unknown climate change signal since we have no information about the shape of this signal. This means that the climate data series are compared mutually in order to detect the inhomogeneities and to correct the series. The possible errors are type one error i.e. detection of false inhomogeneity and type two error i.e. neglecting real inhomogeneity. The significance and the power of the procedures can be defined according to the probabilities of these errors.

The methodology of comparison of series is related to the questions as reference series creation, difference series constitution, multiple comparison of series etc. This topic is very important for detection as well as for correction, because the efficient comparison of series can increase both the significance and the power. The development of efficient methods can be based on the examination of the spatial covariance structure of climate data series.

The next question is the methodology for multiple break points (changepoint) detection. One of the possibilities is to use penalized likelihood methods based on the Bayesien model selection. Different criteria, penalty terms (e.g. AIC, BIC) may be applied according to the assumed a priori probabilities. However the significance level of these methods is questionable. Another possibility is to use hypothesis test methods for this purpose. At the MASH a hypothesis test procedure has been developed, as we want to avoid the type one error that is the damage of data series.

The third question is the methodology for correction of series. Almost all the methods use the maximum likelihood estimation for the correction factors at the detected break points. The MASH procedure is an exception because the correction factors are estimated on the basis of confidence intervals.

Summarily, the philosophy of MASH is as follows: cautious break points detection and correction in order to decrease the probability of type one error, but using optimal series comparison for decreasing the probability of type two error that is increasing the power.

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Trend Analysis of Extreme Climatic Indices in Iran using Extreme Climate Index Software (ECIS)

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In recent years, extreme events (droughts, floods, heat waves) and climate –related hazards take the heaviest toll on human life and exert high damage costs in Iran. In this study, the behavior and the frequency of extreme events are investigated using extreme climate index software (ECIS).The ECIS is a code under MATLAB includes several subroutines, such

as Homogen Data, Gap, Index, Statistic and Return Period for calculating extreme indices , their trends and the return period of climatic extreme indices. The geostatistical methods such as weighting with inverse distances and the Kriging methods are used for interpolations and data production. In ECIS, the trends is calculated on the basis of daily series of temperature and precipitation observations from 16 synoptic stations in Iran in the period 1951-2005.The indices are selected from the list of climate change indices recommended by CLIVAR.Results indicate that the symmetric warming in the tails of most indices is seen over most regions of Iran except in the northwest region. Also, results show that the frequency of warm (cold) extreme indices is increased (decreased) and the precipitation extreme indices vary depending upon geographic location. Finally, the observed changes in indices of climate extremes show that a large proportion of Iran was increasingly affected by a significant change in climate extremes and the frequency of extreme events is increased.

Keywords: Trend, Extreme Event, Climate Index, Frequency.

Trend analysis of agrometeorological and meteorological indices of climate change in several climatic regions of Iran

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To detect the possible occurrence of climate change it is necessary to define a set of agrometeorological indices, derived from the climatic data that are capable of indicating the consequences of climate change on crop production. In this study, maximum and minimum daily air temperatures (Tmax and Tmin), mean daily air temperature (Tmean) and total daily rainfall data in a 40 years period (1961-2004) of five synoptic stations, namely Tehran, Tabriz, Zahedan and Bushehr were collected. These stations represent different climates of Iran based on Koppen climatic classification. The collected data were used to calculate extreme temperature and rainfall values including the magnitudes of the lower (1st, 5th, 10th) and upper (90th, 95th, 99th) percentile threshold values for each year and number of days below the lower threshold values and above the upper threshold values, date of first autumn frost, AF (day), date of last spring frost, SF (day) and length of frost free period LFF (day). Besides, number of frost days, rainy days, snowy days and annual rainfall amounts were derived using the monthly data obtained from the Islamic Republic of Iran Meteorological Organization (IRIMO). In case of Bushehr station, based on its climate, (Desert climate) frost dates and numbers of snowy days were not included in the analysis. All time series have been checked for normality with the Kolmogorov-Smirnov test. Time trends for all variables were analysed using parametric and nonparametric techniques (Least squares linear regression, Pearson, Spearman and Kendall's τ-significance test).

Among the study stations Tabriz (temperate humid climate) showed significant negative trend in rain thresholds, number of frost days and annual rainfall amounts. Bushehr (Desert climate) showed significant positive trend in upper percentile of daily rainfall amount and number of rainy days. Zahedan (Steppe climate) showed significant negative trend in number of frost days, annual rainfall amounts and number of lowest percentile of rainfall and positive trends in length of frost free period and number of highest percentile. Tehran (As the other example of Steppe climate) also showed significant positive trends in length of frost free period, date of first autumn frost and number of highest percentile of rainfall data and negative trend in number of frost days, date of last spring frost and lower thresholds of rain. In general, most of the selected stations showed significant positive trend in extreme temperatures especially minimum daily air temperature thresholds which might be an indication of an overall warming trend. In both Steppe climatic stations the length of frost free period was increased.

Keywords: Climate change, Extreme values; Frost dates; Frost free period; Rainfall; Temperature

Penalized maximal t-test, penalized maximal F-test, and the RHtestV2 software package for climate data homogenization

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The penalized maximal t-test (PMT) and the penalized maximal F-test (PMFT) have recently been developed, which greatly alleviate the problem uneven distribution of false alarm rate and detection power of two commonly used changepoint tests. On the basis of the PMT and PMFT being embedded in a recursive testing algorithm, the software package RHtestV2 has been developed (in both R and FORTRAN) for detecting, and adjusting for, multiple changepoints (mean-shifts) that could exist in a data series that may have first order autoregressive errors. The time series being tested may have zero-trend or a linear trend throughout the whole period of data record; its lag-1 autocorrelation (if any) is empirically accounted for. A good homogenous time series that is well correlated with the base series may be used as a reference series. However, detection of changepoints is also possible with the RHtestV2 package when a good homogenous reference series is not available. This presentation will focus on the recursive testing algorithm, the usage of the RHtestV2 functions, and the procedure in climate data homogenization with the RHtestV2 software package.

Penalized maximal t-test for detecting undocumented mean change

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In this paper, a penalized maximal t-test (PMT) is proposed for detecting undocumented mean-shifts in climate data series. PMT takes the relative position of each candidate changepoint into account, to diminish the effect of unequal sample sizes on the power of detection. Monte Carlo simulation studies are conducted to evaluate the performance of PMT, in comparison with the most popularly used method, the standard normal homogeneity test (SNHT). An application of the two methods to atmospheric pressure series recorded at a Canadian site is also presented.

It is shown that the false alarm rate of PMT is very close to the specified level of significance and basically evenly distributed across all candidate changepoints, while that of SNHT can be up to 10 times higher than the specified level for points near the ends of series and much lower for the middle points. In comparison with SNHT, consequently, PMT has higher power for detecting all changepoints that are not too close to the ends of series, and lower power for detecting changepoints that are near the ends of series. On average, however, PMT has significantly higher power of detection. The smaller the shift magnitude Δ relative to the noise standard deviation σ , the greater the improvement of PMT over SNHT. The improvement in hit rate can be as much as 14-25% for detecting small shifts ($\Delta < \sigma$) regardless of time series length, and up to 5% for detecting medium shifts ($\Delta = \sigma \sim 1.5\sigma$) in time series of length $N < 100$. For all detectable shift sizes, the largest improvement is always obtained when $N < 100$, which is of great practical importance, because most annual climate data series is of length $N < 100$.

Penalized maximal F-test for detecting undocumented mean-shift

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In this study, a penalized maximal F-test (PMFT) is proposed for detecting undocumented mean-shifts that are not accompanied by any sudden change in the linear trend of time series. PMFT aims to even out the uneven distribution of false alarm rate and detection power of the corresponding unpenalized maximal F-test that is based on a common trend two-phase

regression model (TPR3). The performance of PMFT is compared with that of TPR3 using Monte Carlo simulations and a climate data series.

It is shown that, due to the effect of unequal sample sizes, the false alarm rate of TPR3 has a W-shape distribution, with much higher-than-specified values for points near the ends of the series and lower values for points between either of the ends and the middle of the series. Consequently, for a mean-shift of certain magnitude, TPR3 would detect it with a lower-than-specified level of confidence and hence more easily when it occurs near the ends of the series than somewhere between either of the ends and the middle of the series; it would mistakenly declare many more changepoints near the ends of a homogeneous series. These undesirable features of TPR3 are diminished in PMFT by using an empirical penalty function to take into account the relative position of each point being tested. As a result, PMFT has notably higher power of detection; its false alarm rate and effective level of confidence are very close to the nominal level, basically evenly distributed across all possible candidate changepoints. The improvement in hit rate can be more than 10% for detecting small shifts ($\Delta \leq \sigma$, where σ is the noise standard deviation).

Observed Temperature Trends in Colorado

Speaker: Klaus Wolte

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Colorado ranges from around 1200m in elevation to well over 4000m. While many of the original high-elevation mining camps also recorded temperature and moisture as early as a century ago, continuous station records rarely precede the 1930s, or 'Dust Bowl' era. This analysis documents the temperature trends of those stations that are deemed most reliable by the Colorado State Climatologist' Office, stratified by new 'Climate Division', by season, by varying base periods (from 30- to 100-year), by statistical significance, by elevation, and in relation to simultaneous precipitation trends. While recent warming trends are large and alarming (especially in spring), longer-term trends are not always upwards, highlighting the need to understand the warmth of the 1930s in particular.

Parallel Sessions：General Contribution

The Survey of 1 to 5 day rain fal in Tehran County based on Markof Chain model Second stage

Speaker: Mojgan Afshar

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The Survey of 1 to 5 day rainfall in Tehran County based on Markof Chain model

Second stage Mojgan Afshar, Ph.D in Natural Geography, Iran, Tehran, Research and Science Campus Fardin Saberi, Master Degree,Iran, Tehran, Azad University, Central Branch

In order to Statistically and Synoptically Analyze and predict the sequence of 1 to 5 day rainfall in Tehran County during the cold period, rainfall in Mehrabad, Doshan Tappeh, Karaj, Abali, Hamand Absard and Aminabad Stations during the statistical period of years 1985-2004 were daily provided from the country meteorology organization. For determining and predicting the rainfall sequences, the Second grade Markov Chain model was used. At first, the frequency of wet (days 0/1 milimeter or more rainfall) and dry days (less than 0/1 rainfall) based on their sequence were classified and the frequency of every sequence was individually studied. Then the possibility of occurrence of each sequence monthly and during the six cold months was calculated. The most frequency of wet days throughout all months except November was attributed to Abali station and the least was related to Aminabad station. March and October were in order the wettest and driest months in Tehran county.

The varieties of deep rainfall in all stations were completely obvious. The most and the least dry years were in order related to Karaj (12 years) and Doshan Tappeh (9 years). The year 1995 in Tehran county was defined as the driest year. After determining the sequences, the survey of effective pressure patterns causing county rainfall on 10th to 13th of December 1995 as a four day wet period in the driest year of the survey period was synoptically analyzed. For this reason, the maps of sea level pressure and 500 hp as well as maps of direction and the speed of wind and special humidity in level 700 hp were used.

In synoptical survey, it was recognized that the most important sources of wetness in Iran are red sea and Adan gulf which Coincidence of these wetness sources with Soudi Arabia and Persian Gulf has caused the more transition of wetness into Iran and Tehran.

Key words: rainfall, wet and dry sequences, Markov Chain Model, drought, synoptical analysis.

On the verification and comparison of extreme rainfall indices from climate models

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 Interpreting model precipitation output (e.g., as a grid-point estimate vs. as an areal mean) has a large impact on the evaluation and comparison of simulated daily extreme rainfall indices from climate models. We first argue that interpretation as a grid-point estimate (i.e., corresponding to station data) is incorrect. We then illustrate impacts of this interpretation vs. the areal-mean interpretation in the context of rainfall extremes. Using a high resolution (0.25x0.25 degree) gridded CPC daily US unified precipitation dataset as idealized perfect model gridded output, both 30-year return levels of daily precipitation (P30) and a simple daily intensity index are substantially reduced when estimated at coarser resolution than when estimated at finer resolution. The reduction of P30 averaged over the conterminous US is about 9, 15, 28, 33, and 43% when the data were first interpolated to 0.5x0.5, 1x1, 2x2, 3x3 and 4x4 degree grid boxes, respectively, before the calculation of extremes. The differences resulting from the point estimate vs. areal mean interpretation are sensitive to both the data grid size and to the particular extreme rainfall index analyzed. The differences are not as sensitive to the magnitude and regional distribution of the indices. Almost all IPCC AR4 models underestimate US mean P30 if it is validated with P30 estimated from the high resolution CPC daily rainfall observation. On the other hand, if CPC daily data is interpolated to various model resolutions and then calculate the P30 before comparison (more correct in our view), about half of the model show good agreement with observations while most of the remaining models tend to overestimate the mean intensity of heavy rainfall events. A further implication of interpreting model precipitation output as an areal mean is that use of either simple multimodel ensemble averages of extreme rainfall or inter-model variability measures of extreme rainfall to assess the common characteristics and range of uncertainties in current Atmosphere/Ocean General Circulation Models (AOGCMs) is not appropriate if simulated extreme rainfall is analyzed at model's native resolution. Owing to the large sensitivity to the assumption used, we recommend that for analysis of precipitation extremes, investigators interpret model precipitation output as an area average as opposed to a point estimate, and then ensure that various analysis steps remain consistent with that interpretation.

Unsupervised machine learning techniques for studying climate variability

Speaker: Alexander Ilin

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 We present applications of several techniques intensively studied recently in the machine learning community to exploratory analysis of global climate data. The considered techniques are related to rotating principal components using various statistical criteria. The proposed algorithms use modeling assumptions plausible for the global climate system and they are closely related to the method called independent component analysis (ICA). The proposed exploratory algorithms follow a common framework, which allows for finding underlying signals with properties of interest. The algorithms are iterative, alternating between estimating the important structure of extracted signals and using this structure to find new signal estimates.

The proposed algorithms are applied to analysis of the daily global data from the NCEP/NCAR reanalysis project. The first example presents how using only the assumption of prominent interannual variability allows for finding the component capturing El Nino-Southern Oscillation (ENSO): The time course of the most prominent component is a good ENSO index and the corresponding spatial patterns have many features traditionally associated with ENSO. Interestingly, the second component extracted from the dataset combining the three variables somewhat resembles the derivative of the ENSO index. It is also possible to capture how the effect of ENSO changes depending on the time of the year using a slightly modified technique.

Several other algorithms with applications to the same climate dataset are presented. One technique finds a meaningful representation of the slow climate variability as combination of trends, interannual quasi-oscillations (including ENSO), the annual cycle and slow changes in seasonal variations. This can be achieved by a similar technique which emphasizes slow behavior of time signals prominent on distinct timescales. Another approach is to analyze fast weather variations and find components in which such variability has significant behavior in a slow timescale. For example, it is possible to find fast varying components whose intensity of variations has been slowly increasing over the last decades.

There are lots of possible directions in which this research can be extended. For example, one can study slow climate changes, nonlinear effects such as interactions between phenomena (similar to ENSO-annual cycle interactions), spatially evolving phenomena, climatic effects on ecology, economy etc. It might also be possible to learn the dynamics of some climate phenomena for making prediction of their evolution. We developed a relevant algorithm which allows for finding groups of components with shared dynamics and predictable time course.

The same algorithmic framework could be used for implementing new tools for discovering significant regularities in the climate. The new directions can be motivated by the type of features which might emerge during exploratory data analysis or can be based on expert knowledge.

Multi-resolution analysis on the relationship between summer rainfall over North China and Australian winter rainfall

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Summer rainfall over north China results from the advance of the East-Asian summer monsoon which is closely linked with the Australian winter monsoon. Recent research has indicated that the interaction between these two monsoon systems can affect both the East-Asian summer rainfall and Australian winter rainfall. There is also evidence showing that the observed boreal summer rainfall variability over north China is similar to the austral winter rainfall variability (in particular drying trends) over southwest Western Australia (SWWA). This has attracted significant interest and attention to study the relationship between summer rainfall over North China and Australian winter rainfall, particularly in terms of possible causes and policy options in response to the rainfall decrease.

We present results on multi-resolution analysis on the relationship between summer rainfall over North China and Australian winter rainfall. Our results suggest that there is significant positive correlation at level 0.05 in the low frequency base-line drift of rainfall variability between summer rainfall over North China and SWWA winter rainfall. The positive correlations are also found at various larger scales (lower frequencies), but not in the small scale (high frequency) noise in the rainfall variability.

This work is supported by an Australian government bilateral climate change partnership project (with the People's Republic of China) called "Research on Rainfall and Climate Change in both China and Australia".

The dominant dynamical mode under an increase in CO2 concentration

Speaker: Jin-Song von Storch

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 A 50-member ensemble is produced with the ECHAM5/MPI-OM model to study dynamical modes under an increase in CO2 concentration. The mode with the largest spatial scale is found over and in the Southern Ocean. It is essentially zonally symmetric. An increase in CO2 concentration produces a temperature increase in the Southern subtropics and consequently a strengthening of the meridional temperature gradient. The latter leads to changes in the midlatitude westerlies and the surface zonal wind stress. The wind stress changes strengthen the northward Ekman transports that transport the cold polar water into the midlatitude Southern Ocean, whereby further maintaining the meridional temperature gradient. The relation of this mode to the Antarctic Oscillation, the dominant Southern Hemispheric mode under the control condition (i.e. pre-industrial CO2 concentration), is studied in the phase space spanned by the leading EOFs.

Verification of Biomass Burning Aerosols by Using GOES-12

Speaker: Jian Zeng

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Biomass burning impacts the climate system on local, regional and global radiation budget. High aerosol concentrations caused by biomass burning outbreaks are able to provoke damaging impact on human life. An algorithm has been developed to automatically detect aerosols and track long-range transport of smoke plumes associated with biomass burning. Two major schemes are applied in the algorithm, the source scheme and the pattern recognition scheme. This algorithm combines GOES observations of fire hot spots with aerosol optical depth maps in the source scheme to find the smoke aerosols most possibly caused by the fire sources. Secondly apply the pattern recognition technique to identify smoke plumes that drifted away from the source region. Once the optical depths due to smoke aerosols are separated from other types of aerosols, they are converted to smoke concentrations using mass extinction coefficient of 7.8 m2/g and assuming that aerosols are confined to the lowest 5 km of the atmosphere. The algorithm was applied to the biomass burning episodes during September 1-15, 2006 and evaluated using Ozone Monitoring Instrument (OMI) absorption aerosol optical depth product and HYSPLIT model analysis. We will present algorithm description, evaluation, and its potential impact on climate.

Parallel Sessions：Downscaling

Evaluation of a regional climate model regarding statistical characteristics of daily precipitation and sensitivity to physical parameterizations

Speaker: Susanne Bachner

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The use of Regional Climate Models (RCM) for scenario simulations of the future climate has become possible in the last years. For a careful interpretation of the scenario simulation results, the models should be evaluated with respect to their ability to reproduce statistical characteristics of daily precipitation. This is done here for the regional climate model CLM, developed by the German Weather Service and several institutes in Germany. Especially since the question of increasing extremes in a changing climate becomes more important, characteristics other than mean values have to be evaluated in more detail. In this study, we focus on summer precipitation in Germany.

Eleven different summer seasons have been modelled, forced by ERA40 reanalysis, and have been analyzed regarding different statistical precipitation characteristics like e.g. the frequency distribution and characteristics of heavy precipitation. A comparison is made to station data of the German Weather Service at a daily and seasonal time scale.

Furthermore, the uncertainty related to the physical parameterizations in the CLM is addressed with an ensemble of simulations using different options in the physical package. The evaluation strategy and the main results will be presented. Characteristics which are averaged over larger areas and several summers are captured quite well, but the interannual variability and spatial structure show quite some differences. The model uncertainty due to physics is not negligible, where the largest sensitivity is found by the changes in the convection scheme.

Addressing climate model uncertainty in stochastic downscaling applications

Speaker: Richard E. Chandler

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 Downscaling techniques are widely used to convert the outputs from gridded numerical climate models to the temporal and spatial scales required for hydrological applications. Increasingly, however, it is being recognized that projections of future climate can differ widely between climate models. It is therefore necessary to account for climate model uncertainty in any downscaling exercise. Here we suggest that a hierarchical statistical model, implemented in a Bayesian framework, provides a logically coherent and interpretable way to think about climate model uncertainty in general, which can be applied to downscaling studies in particular. The ideas are illustrated by considering the generation of future daily rainfall sequences at a single location in the UK, based on the outputs of four different climate models under the SRES A2 emissions scenario. The technique could in principle be used in conjunction with any appropriate stochastic downscaling method; in our application, the downscaling is based on Generalised Linear Models for daily rainfall.

On the variation of temperature and precipitation in the 20th century and its scenarios under various CO2 concentration in China

Speaker: Youmin Chen

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 Impacted by monsoon climate environment, the variation of temperature and precipitation has its exceptional characteristics. We applied CRU dataset (1901-2000) and ECHAM5 model output (2001-2100) to analyze the variation of temperature and precipitation in China. The first 100-years are considered as the observed variation and the second 100-years are the projected scenarios. All the datasets are in the grid with 0.5/0.5 lat/lon and the area weighted averages are calculated with the region as a whole. It is found that the temperature increased by 0.7 degC in the 20th century, and the latest trend reach up to 6 degC/100-years (1982-2002); the scenario shows that the temperature increase by a variety of from 3.7 to 5.6 degC in the 21st century. There is no significant trend for precipitation both in the 20th century and in the future scenarios. The temperature and precipitation mainly show negative correlation before 1965, after which there is a significant positive relationship, which may means that with the climate warming in China, the precipitation could increase. Based on CRU dataset, the whole area shows increasing temperature except for Sichuan basin, where the temperature is decreasing. However, temperature trends manifest a great variety at

different time periods. There are negative temperature trends from 1945 to 1970; all other time periods show positive trends. In addition, several abrupt changes in temperature were detected respectively in the year 1937, 1913, 1986 and 1949.

An Automated Synoptic Weather Typing and Its Applications to Climate Change Impact Analyses

Speaker: Chad Shouquan Cheng

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The synoptic weather typing approach has become popular in evaluating the impact of climate on a variety of environmental problems. One of the reasons is its ability to categorize a complex set of meteorological variables as a coherent index and to facilitate to link with high-impact weather analyses. In a series of studies, an automated synoptic weather typing was developed using principal components analysis, average linkage clustering procedure, and discriminant function analysis to classify daily weather types. Meteorological data used in the weather typing usually include hourly/six-hourly surface observations of air temperature, dew point temperature, sea-level air pressure, total cloud cover, and west-east and south-north wind velocities. The weather typing approach was validated using an independent dataset (1/4–1/3 of the total years) that was randomly selected.

This talk will focus on development and validation of the synoptic weather typing and its applications to a variety of high-impact weather analyses, such as freezing rain, heavy rainfall, high air pollutant levels, and extreme temperature/air pollution-related premature mortality. In addition, this talk will summarize how the weather typing was applied, using downscaled GCM climate change scenarios, to project changes in frequency and magnitude of future high-impact weather events.

Answering questions about empirical downscaling methodologies

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 Answering questions about empirical downscaling methodologies

The increasing demand for regional scale climate change projections, and the increasing availability of empirical downscaling products, raise important questions about the role and influence of methodology choice on the derived projections. There are a wide range of applied downscaling methods in the literature, and which seek to accommodate the components of deterministic and stochastic variance in the local climate response to large scale forcing. In general the methods fall into one of two approaches; using some form of scale transfer function to capture the deterministic component and then adding the stochastic element, or alternatively using a technique such as a weather generator conditioned in some form to accommodate the deterministic large scale forcing.

We compare two such methodologies which have matured and been used to provide regional scenarios for a broad range of end user applications. The two approaches are used to project climate change for four locations that present a challenge due to location and complex local features. The four locations span Africa and include tropical and higher latitudes, coastal and inland regions, and complex topography.

Does nonlinearity bring an improvement in statistical downscaling of daily temperature?

Speaker: Radan Huth

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 The aim of the contribution is to evaluate the potential gain in the performance of statistical downscaling due to introduction of nonlinearity into the transfer functions. This issue has not been resolved so far. The nonlinearity is introduced in two different ways: (i) by using artificial neural networks (ANNs), namely the multilayer perceptron architecture, and (ii) by stratification of the dataset by a classification of circulation patterns, the linear method being built in each class separately. The study concerns daily maximum and minimum temperatures in winter at eight European stations differing in their geographical and climatological settings, spread from Ireland to Russia and from northern Finland to Spain. The predictors are the 500 hPa heights and 850 hPa temperature defined in a network covering whole Europe and a large part of the neighbouring Atlantic Ocean. The performance of the methods is quantified in terms of correlations between the downscaled and observed values. Other measures of correspondence, such as mean absolute error or root mean square error, lead to identical

results. We demonstrate that the nonlinear methods bring an improvement, although rather marginal, to the sub-optimal linear methods, such as the linear regression of predictor's principal components. The best linear method, multiple linear regression of gridpoint values, is however not surpassed by any nonlinear method. The performance of the best nonlinear method, ANN with gridpoint values as predictors, is fairly close to the linear method, but in general is slightly worse. The classification does not improve the fit between the downscaled and observed values either. In addition to the correspondence measures, we evaluate the downscaled temperature in terms of temporal and spatial autocorrelations and statistical distributions. ANNs are the only method capable of reproducing at least some deviations of the statistical distributions from normality. Spatial autocorrelations are best reproduced by the classification-based methods, whereas the temporal autocorrelations are best captured by the linear methods. Taken together, the linear regression of gridpoint values appears to be the method whose performance is closest to the optimum.

Detection and simulation of extreme rainfall in a topographically complex region

Speaker: Chris Lennard

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 Annually, extreme rainfall causes millions of dollars worth of damage and regularly displaces thousands of people in Cape Town, South Africa. Forecast skill for extreme precipitation in the region is generally poor thus an accurate, qualitative forecast is necessary. An empirical technique is presented for the identification of weather systems associated with extreme rainfall as are results from high resolution simulations of these storms.

Regression Procedures and Their Applications to Climate Change Impact Analyses

Speaker: Qian Li

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 In a series of climate change impact studies, many regression procedures were applied to construct the simulation models for various high-impact weather analyses, including daily rainfall occurrence and amount, freezing rain occurrence, streamflow volume, air pollution concentration, and extreme temperature/air pollution-related premature mortality. The regression procedures include binomial and multinomial logistic regression, orthogonal regression, robust regression, autocorrelation correction regression, stepwise regression, and nonlinear regression. In addition, these regression analyses were employed to develop downscaling transfer functions for various meteorological variables.

This talk will focus on the selection of appropriate regression methods to conduct different climate change impact analyses and to develop/validate the simulation models. In addition, the use of regression procedures in downscaling GCM climate change scenarios and deriving hourly station-scale future climate scenarios will be summarized.

Issues for Use of Climate Models to Assess Future Impacts and Develop Adaptive Strategies: Cautions for IPCC WGs 1 and 2

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 Take-Home Messages:

1. Impact assessment and scenario development must approach climate model output far more critically, conducting expert and thorough historical record validation of all critical aspects of the problem as a first mandatory step.

Otherwise the assessments or scenarios may be worthless or, worse, misleading.

2. Model validation needs greater research attention, both to meet user needs under (1) and to sensitize modelers to deficiencies.

Currently, model validation is grossly inadequate.

3. More attention needs to be paid to the development of credible mesoscale (to avoid downscaling compromises) global coupled models that correctly treat the full spectrum of variability.

Downscaling (whether statistical or with nested models) is inherently flawed.

Discussion:

Global climate change will not be uniform either geographically or seasonally. Associated changes will not only be in temperature means but in its variability, both intraseasonal and interannual, in the means and variability of precipitation, winds, etc. and in the risks of high impact weather types and events. It is rare that a policymaker, adaptive planner, or resource manager concerned with climate sensitive issues or sectors should not have a critical interest

in this granularity of change, certainly at a minimum the seasonal and geographic distribution of changes in the mean temperature and precipitation; changes in the mean annual global surface temperature are of no practical interest to anyone by themselves.

Unfortunately, state-of-the-art climate models that credibly produce the historical trace of the global mean annual temperature also credibly reproduce at best the geographic distribution of mean temperature trends in some, but not all, seasons. Major deficiencies remain in historical simulations of some aspects of mean temperature changes and all aspects of mean precipitation changes, while little or no attention has been paid to validation of variability, extremes, etc. and their changes. The ability of these models to credibly treat much of the latter depends on their ability to reproduce the form, seasonality, and variance of the phenomenon that constitute the dominant controls on weather systems and their variability. These phenomena minimally include ENSO, the MJO, the NAO, and monsoons. Since no climate model has been shown to collectively and correctly treat all of these it is unlikely that any model can currently and credibly address variability or risks of high impact events. Because of these and other deficiencies, downscaling (whether statistical or dynamical) based on perfect model approaches cannot be a productive approach to scenario development in almost all instances. Correction approaches are problematic as well because of data limitations and the inherent non-stationarity of climate change.

Snow Trends in Northern Spain: Analysis and simulation with statistical downscaling models

Speaker: Maria R. Pons

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In this study we consider a database of binary snow observations (occurrence or no occurrence) in a set of stations from the Spanish National Meteorological Institute (INM) over Northern Spain. A previous quality analysis has been performed based only on the length of missing periods and the stations with less than 10% of missing data in the period 1957-2002 were selected for the study. In the first part of the work a trend analysis is performed regarding the annual number of days in which snow occurred, obtaining in some stations a significant decreasing trend in approximately the last 15 years.

Secondly, the connection of snow with large-scale fields simulated by a General Circulation Model (GCM) is analyzed using statistical downscaling methods (in particular analog and weather typing techniques). On the one hand, we validate the probabilistic predictions using Relative Operating Characteristics (ROC) curves. However, due to the low

climatological annual frequency of snow occurrence (around 6% in average), appropriate thresholds for the predicted probability have been calculated for each station to obtain deterministic predictions which can be validated with 2x2 contingency tables (for instance, typical values for HIR are around 60% whereas FARs are around 2%). Using this technique the annual number of days with snow is correctly simulated for the different stations, reproducing the observed trends. These results are based on cross-validation studies, in which a window around each of the predicted dates is removed in the analysis.

In order to check the possible extrapolation of statistical downscaling to climate change studies, the following experiment was conducted: the last 15 years of data –in which the decreasing trend was observed- were tried to simulate using the remaining 30 years as the training period to develop the statistical model. Some promising results are reported.

Relationship between large-scale circulation and North American extreme precipitation in observations and model simulations

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Almost all statistical downscaling approaches assume that the relationship between observed large-scale predictors and regional/local scale predictants will remain valid in the future. This assumption is rarely validated. Using simulations conducted with three GCMs (CCCma CGCM3, NCAR-CCSM3, and MIROC), we examine if such assumption holds for the relationship between large-scale circulation and extreme winter precipitation in North America. We found that the dominant spatial patterns in the observations and the simulations are similar. We also found that modelled extreme precipitation responses to the circulation patterns are different from that observed. The model simulated relationship between extreme precipitation and large-scale circulation for the 20th century continues to hold for the 21st century.

Parallel Sessions：Climate Change Detection and Attribution

Application of Granger Causality Test to Detection and Attribution of Climate Change

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The presence of natural climate variability means that the detection and attribution of anthropogenic climate change is a statistical ‘signal-in-noise’ problem. Several statistical methods for detection and attribution of climate change have been developed. Here ‘Granger causality’ tests are applied to this issue.

‘Granger causality’ tests -- or more correctly perhaps, Granger non-causality tests -- are statistical tests of ‘causality’ in the sense of determining whether lagged observations of another variable have incremental forecasting power when added to a univariate autoregressive representation of a variable. Granger causality is a technique for determining whether one time series is useful in forecasting another. Ordinarily, regressions reflect ‘mere’ correlations, but Clive Granger, who won a Nobel Prize in Economics, argued that there is an interpretation of a set of tests as revealing something about causality.

A time series X is said to Granger-cause Y if it can be shown, usually through a series of F-tests on lagged values of X (and with lagged values of Y also known), that those X values provide statistically significant information on future values of Y.

The test works by first doing a regression of ΔY on lagged values of ΔY. Once the appropriate lag interval for Y is proved significant (t-stat or p-value), subsequent regressions for lagged levels of ΔX are performed and added to the regression, provided that they are significant in and of themselves , and add explanatory power to the model. This can be repeated for multiple ΔX 's (with each ΔX being tested independently of other ΔX 's, but in conjunction with the proved lag level of ΔY). More than 1 lag level of a variable can be included in the final regression model, provided it is statistically significant and provides explanatory power.

Several climatic variables, such as CO2 concentration in the atmosphere, solar black point, Atlantic oscillation, East-Asian monsoon etc. are used for testing temperatures in China and in Beijing by means of Granger causality test. The plausible connections between these variables and temperatures in China and in Beijing are revealed. We focus on an impact of the CO2 concentration on temperatures in China and in Beijing; the cause of delay of temperature change in China to global warming is explained. Thus it is proved that the Granger causality test is able to use to detection and attribution of climate change. Besides, Granger causality test can reveal relationships among different meteorological elements, so it is capable for screening the predictors for a predictant.

Detection of urban warming in recent temperature trends in Japan

Speaker: Fumiaki Fujibe

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The contribution of urban effects on recent temperature trends in Japan was analyzed using data at 561 stations for 27 years (March 1979- Feb. 2006). Stations were grouped according to the population density in an area of 3km radius. In comparison to the group of stations with low population density (<100 people per sq. kilometer), the highly populated group (>=3000 people per sq. kilometer) shows an anomalous trend of 0.12 C/decade during the 27 years. Even the weakly populated group (100-300 people per sq. kilometer) has an anomalous trend of 0.04 C/decade, which is significant at the 5% level. This result indicates that a careful analysis of urban effects is required in using temperature data in Japan for researches in climatic change.

A hierarchical Bayesian model for climate change detection and attribution

Speaker: Tianshu Ma

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Two different Bayesian approaches have been used for climate change detection and attribution. One is to use Bayesian methods to make inferences about posterior distribution of regression coefficient, or scaling factor β, that is obtained from a conventional optimal fingerprinting approach. The other is based on Bayes factor to compare two probability models which assign different values about β. Detection and attribution can be inferenced by finding the most likely model and its corresponding parameter. Earlier work related to the first method uses a mixture 2-modal normal distribution a priori. While this method is computationally easy to implement when simulations from one GCM are used, it is not straightforward to extend to multiple GCMs due to the difficulties in the selection of prior distribution. Here, we propose a

more general procedure, a hierarchical approach , that can be applied for both single and multiple GCMs simulations.

In the single GCM case, earlier studies (e.g. Berliner 2003, Lee et al. 2003) estimate prior distribution parameters empirically using long simulations of an EBM. We use a normal distribution as our prior for β and a second flat prior distribution based on a hyperparameter, eliminating the need to use a model to obtain such estimation that could be affected by the performance of the EBM. Detection and attribution is inferenced based on the posterior distribution of β. In the multi-model case, all GCMs are treated equally because there is no obvious reason to suggest a particular GCM is superior to other GCMs. We compute one scaling factor β for every GCM separately. These scaling factors are then considered as a sample from a common population with the hyperparameter which is then inferenced.

Our methods have been applied to simulations with observed anthropogenic forcing changes from several GCMs including CGCM1/CGCM2, HadCM2, HadCM3, and PCM to assess the causes of 20th Century temperature changes over the globe. Results indicate that the observed global temperature changes during 1900-1949, 1910-1959, and 1950-1999 may be attributed to the effect of combined greenhouse gases and sulfate aerosols.

Multi-Model Bayesian Climate Change Assessment for Regional Surface Temperatures

Speaker: Seung-Ki Min

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A Bayesian approach is applied to the observed regional and seasonal surface air temperature (SAT) changes using single-model ensembles (SMEs) with the ECHO-G model and multimodel ensembles (MMEs) of the IPCC AR4 simulations. Bayesian decision classifies observations into the most probable scenario out of six available scenarios: CTL (control), N (natural forcing), ANTHRO (anthropogenic forcing), G (greenhouse gas), S (Sulfate aerosols), and ALL (natural plus anthropogenic forcing). Space-time vectors of detection variable are constructed for six continental regions (North America, South America, Asia, Africa, Australia, and Europe) by combining temporal components of SATs (expressed as Legendre coefficients) from two or three subregions of each continental region.

Bayesian decision results show that over most of the regions observed SATs are classified into ALL or ANTHRO scenarios for the whole 20th century and its second half. N and ALL scenarios are decided during the first half of the 20th century, but only in the low latitude region (Africa and South America), which might be related to response patterns to solar forcing. Overall seasonal decisions follow annual results, but there are notable seasonal dependences which differ between regions. A comparison of SME and MME results demonstrates that the Bayesian decisions for regional-scale SATs are largely robust to inter-model uncertainties as well as prior probability and temporal scales as found in the global results.

Detection of Human Influence on pan-Arctic Precipitation

Speaker: Seung-Ki Min

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The Arctic and the northern sub-polar region are critical areas for climate change. The fluctuation of regional fresh water inflow to the Arctic Ocean modulates the deep ocean circulation and thus exerts strong influence on global climate. This region also warms faster under global warming. By comparing observations to simulations from 22 coupled climate models, we detect anthropogenic influence in the space-time precipitation patterns over the northern high-latitude (north of 55N) lands during the second half of the 20th century. The detection is also robust to the removal of Arctic Oscillation related variability in the observed precipitation. This regional-scale precipitation detection result represents a new and strong evidence that human activity has contributed to the pan-Arctic climate change.

Impact of carbonaceous aerosols on attributable warming and future prediction

Speaker: Toru Nozawa

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Impacts of historical changes in carbonaceous aerosols on past attributable warming and future prediction are investigated using an optimal fingerprinting method (Allen and Stott,

2003) with a series of numerical simulations performed by a coupled ocean-atmosphere general circulation model (CGCM) called by MIROC. Observationally constrained attributable warming in the 20th century is similar to that estimated with the other CGCMs (Stott et al., 2006) if the historical changes in carbonaceous aerosols do not considered in MIROC as in the other CGCMs. When we consider historical changes in carbonaceous aerosols, on the other hand, observationally constrained attributable warming increases and uncertainties in attributable anthropogenic signals become larger. Scaled future prediction gets more uncertainties when we use scaling factors estimated with carbonaceous aerosol forcings. This implies that the other process, such as carbon cycle, atmospheric chemistry, dynamical vegetation, etc. might also have significant impact on the past attributable warming and the scaled future prediction.

Robustness of climate change signals in near term predictions up to the year 2030

Speaker: Hideo Shiogama

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 This is the first study to examine whether human contributions to changes in extreme temperature indices have larger amplitudes than natural variability in near future (up to 2030) climate prediction. We performed 10 runs of the initial condition perturbed ensemble of a coupled atmosphere-ocean general circulation model. In the near future, over most land areas, all 10 runs show agreement in predicting more frequent occurrences of warm nights and warm days, and less frequent cold nights and cold days, suggesting that human influences in them have become larger than natural variability. Area weighted fraction of grid boxes where all runs agree the direction of changes over the land is little sensitive to ensemble sizes (for warm nights, 96% and 93% for 4 runs and 10 runs, respectively). It was also suggested that the changes in the frequency of warm and cold extremes are mainly due to shifts in seasonal mean temperatures. Additionally snow cover affects the frequency of cold extremes in some areas.

Extending attribution studies: postage stamps for the world

Speaker: Dáithí Stone

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Studies of the detection and attribution of climate change are progressing beyond the question `Have we influenced the climate?' and starting to address the question `How does the current climate differ because of our influence?' The subtle but important difference between these two questions means that different assumptions are required when addressing them. Are these assumptions contradictory? This talk will discuss these questions through a comparison of observed continental surface temperature trends with those from a multi-model ensemble of historical simulations including only natural external forcings and an ensemble including both anthropogenic and natural forcings.

Consistency of observed winter precipitation trends in northern Europe with regional climate change projections

Speaker: Hans von Storch

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Often it is claimed that the recent changes in northern European climate are at least partly anthropogenic even though a human influence has not yet been successfully detected. Hence we investigate whether the recent changes are consistent with regional climate change projections.Therefore, trends in winter (DJF) mean precipitation in northern Europe are compared to human induced changes as predicted by an ensemble of four regional climate model simulations.

The patterns of recent trends and predicted changes match reasonably well as indicated by pattern correlation and the similarity is very likely not random. However, the model projections severely underestimate the recent change in winter precipitation by 50 to 80\%. That is, the signal-to-noise ratio of the anthropogenic precipitation change is either rather low or the presently used simulations are significantly flawed in their ability to project changes into the future.

European trends contain large NAO-related signals, of which a major unknown part may be unrelated to the anthropogenic signal. Therefore, we also examine the consistency of recent and projected changes after subtracting the NAO signal in both the observations and in the projections. It turns out that even after the removal of the NAO signal, the pattern of trends in the observations are similar to those projected by the models. At the same time, the magnitude of the trends is considerably reduced and closer to the magnitude of the change in the projections.

Detection of external influence on trends of atmospheric storminess and northern oceans wave heights

Speaker: Xiaolan L. Wang

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The atmospheric storminess (as inferred from geostrophic wind energy) and ocean wave heights have increased in the cold seasons over the past half century in the high-latitudes of the northern hemisphere (especially the northeast North Atlantic in boreal winter), and have decreased in more southerly northern latitudes. This study shows that these trend patterns contain a detectable response to external forcing (i.e., both natural and anthropogenic forcing). The signal of external influence is found to be strongest in the winter hemisphere, that is, in the northern hemisphere in January-February-March and in the southern hemisphere in July-August-September. However, the magnitude of the estimated response to the forcing, which was obtained directly from climate models in the case of geostrophic wind energy and indirectly via an empirical downscaling procedure in the case of ocean wave heights, is significantly less than the magnitude of the observed changes in these parameters.

Detection of Human Influence on 20th Century Precipitation Trends

Speaker: Xuebin Zhang

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Human influence on climate has been detected in surface air temperature on global, continental and some sub-continental scales, in sea level pressure, in free atmospheric temperature, in tropopause height, and in ocean heat content. While precipitation change is highly relevant to the impacts of climate change, large scale precipitation changes have not previously been detected and attributed to human influence. A key reason for this is that perhaps because compensating increases and decreases in different regions of the globe reduce the global average signal. Models suggest that while anthropogenic forcing should have caused a small increase in global mean precipitation, it also is expected to induce a latitudinal redistribution of precipitation with moistening at high latitudes, drying in sub-tropical latitudes, and perhaps a shift of the ITCZ. Here we compare the changes in the pattern of 20th century land precipitation observations averaged in latitude bands to precipitation changes simulated by fourteen climate models. We show that the influence of anthropogenic forcing on observed zonal mean precipitation changes can be detected and that these changes cannot be explained by internal climate variability or the effect of natural forcing. We estimate that anthropogenic forcing contributed substantially to observed increases in precipitation in the northern mid-latitudes, to drying in the northern subtropics and tropics, and to moistening in the southern deep tropics and subtropics. The observed changes, which are larger than estimated from presently available model simulations, have significant implications for ecosystems, agriculture, and human health.

An assessment of regional record-breaking statistics in annual mean temperature

Speaker: Eduardo Zorita

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Different datasets of global mean surface air temperature show consistently increasing values for the past 50 years. Since 1990, a large number of record warm years was detected: the 12 warmest years since 1880 have all occurred after 1990. The probability p of the event E of finding at least 12 of the largest values of a sequence of 126 random numbers (years 1880 to 2005) on the last 16 places (year 1990 to 2005) is 9.3·10–14. However, annual mean surface air temperatures show serial correlations even in the absence of variations of external forcing. Two null-hypothesis have been used to calculate the probability that such series of

warm record years may arise by chance in stationary, but serially correlated, series: an auto-regressive process of order 1 and long-memory process. The parameters of these processes are estimated from the observed data, using the complete record or just part of it. The resulting probabilities, estimated by Montecarlo realizations, hover over 10-4 to 10 -3.

A similar analysis has been performed for the annual temperature averaged in each of the 26 regions defined by Giorgi and Bi (2005), derived from the HadCRU3 data set. Some of these series start earlier than 1880. The autoregressive parameter is estimated for each of these series, as well as the number of warmest years occurring in 1990-2005. The probabilities of these number of record years arising by chance under this null-hypothesis varies widely. For some regions, it is as high as 0.1, but for other regions, notably East Asia and Alaska, they are remarkably small, of the order of 10-6, indicating that for these regions the late series of warm years would lie even more clearly outside the range of random fluctuations than for the global annual temperature.

Parallel Sessions：Process Studies

The study on Anomalous Atmosphere-Ocean Currents and the Propagation Mechanism for Warm Signal of Sea Temperature

Speaker: Changrui

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Because of the sparse observation over the Ocean, the important problems about the characteristics of the ocean currents and their relationship with the sea temperature anomaly during El Niño events are still not completely resolved, although there already have been a few researchers focused their attentions on this field. In order to deeply investigate the truth behind the puzzles from a new way, this research is based upon the Simple Ocean Data Assimilation (SODA) dataset from 1971 to 2000 and the NECP/NCAR reanalysis dataset from 1980 to 2000, which are of high resolution and long time scale. Therefore, from the departures point of view, the variations of zonal wind and ocean currents as well as the propagation features of the sea temperature signal during El Niño events have been investigated by composite analysis. In this research, special emphasis is placed on the two main types of El Niño events: the middle-pattern of El Niño and the east-pattern of El Niño. According to the amplitude of the sea surface temperature anomaly and its characteristics of propagation, the 1982/83, 1991/92 and 1997/98 events are composite for the middle-pattern of El Niño event and the 1972/73 and 1976/77 events for the east-pattern of El Niño event. The results show that:

1, In the middle-pattern of El Niño event(the anomalous warm water appears first in the western of 120°W) and the east-pattern of El Niño event(the anomalous warm water appears first in the eastern of 120°W), there is a significantly eastward propagation of the strongest western wind anomalies over the western equatorial Pacific Ocean. Besides, the positive (negative) equatorial surface current anomalies are associated with the enhanced (weakened) western wind anomalies. The response of the ocean currents to the zonal wind anomaly has a high correlation with the intensity and the characteristics of the propagation of the zonal wind anomaly. In the middle-pattern of El Niño event, the western wind anomalies are relatively stronger, which is favorable for the eastward movement of the positive equatorial surface current anomalies over the western Pacific. Therefore, the intensity of such El Niño event is relatively stronger.

2, In the middle-pattern of El Niño event, over the western Pacific, the anomalous down-welling of the equatorial ocean currents caused by the convergence of surface zonal currents anomalies suppresses the up-rush of the deep cold water, leading to the warm surface water, which also moves eastward with the eastward propagation of the anomalous down-welling.

3, In the east-pattern of El Niño event, the anomalous down-welling of the equatorial ocean currents caused by the convergence of surface zonal currents anomalies over the western Pacific Ocean does not move eastward, and the formation of warm water is relevant to the regional (120°W east) anomalous down-welling of the equatorial ocean currents caused by the convergence of surface zonal currents anomalies, which suppresses the up-rush of the deep cold water. This is considerably different from the feature in the middle-pattern of El Niño event.

Detecting annual cycle in the modes of low-frequency circulation variability

Speaker: Radan Huth

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Modes of low-frequency variability of atmospheric circulation in the extratropics are commonly detected by rotated principal component analysis (PCA) of monthly or seasonal means. PCA is usually performed on monthly or seasonal, not annual basis. However, we were faced with the task of creating time series of the variability modes that would be equidistant in time with the time step of one month. In this contribution, we compare two approaches to this task: the first one consists in performing PCA for each month separately (monthly PCA), similarly to Barnston and Livezey (1987), whereas in the other, PCA is conducted for all monthly data together (annual PCA). All the analyses are based on 500 hPa heights from the NCEP/NCAR reanalysis. The disadvantage of monthly PCA is that only two modes can be traced throughout the whole annual cycle: it is the North Atlantic Oscillation

(NAO) and the West Pacific Oscillation (WPO), which in the warm season turns into the Subtropical Zonal (SZ) mode. Moreover, parts of variability are attached to the modes rather randomly, which makes their comparison between months difficult. Monthly PCA is therefore hardly applicable to producing equidistant time series of the variability modes. Since the variability of atmospheric circulation is larger in winter than in summer, results of annual PCA are potentially biased towards stronger influence of winter. Therefore, we weighted each month by its standard deviation, thus giving all months equal influence in the analysis. However, the results of weighted and unweighted PCA differ only in the order of the modes, not in their shapes. Of the 13 modes detected, only 2 are strongest in summer; all the others dominate in winter. Annual PCA does not succeed in distinguishing the winter and summer positions of at least some modes; it detects the 'annualy average' modes, whose position is generally similar to, but not coincident with, their winter position. In conclusion, a search for on optimum method of detection of the variability modes with a monthly resolution is still open.

Harmonic Analysis on Low Latitudinal Climatological Wind Field

Speaker: Liping Li

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A scheme of Fourier analysis on monthly wind field is put forward. 850hPa, 200hPa climatological wind fields in low-latitude zone from 30°S to 30°N and Asia are investigated. The results show that it has providesd a series of valuable information. 1) Climatological wind fields is characterized by low dimension and low order, whose module square is centered upon the first few (3~5) wave components. 2) The most important 0 wave component characterizes the configuration of mean zonal trade winds. For 850hPa wind field, trade winds are more extensive then the edge of westerlies all the year around; the highest trade winds in the Northern and Southern Hemispheres and the thermal equator, matching along with hemispherical Hedley cell centers and the common ascending leg, move northwardly and southwardly approximately together with the seasons. For 850hPa wind field, easterlies and westerlies are also important in the whole year, but the former is weaker than the latter obviously. The seasonal movement of the tropical easterlies, towards north and south, shows clear hemispherical variations. 3) More than 80 percents of the steady wave module square are centered upon the first few couples of wave components (from the first to forth wave for 850hPa and form the first to third wave for 200hPa), which show the main circulation system of the steady wave. The first couple, whose module square fitting rate is much larger than others, displays the equatorial Walker cell and the seasonal movement of the intertropical

convergence zone (ITCZ). The third and the second couples are the second most significant in January and July respectively.

Key words: Fourier harmonic analysis; low latitudinal climatological wind field; In the complex field

Links between cyclonic activity and precipitation

Speaker: Piero Lionello

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Mid-latitude cyclones have important effects on the environment as they are associated with rain, winds, waves, surges and even landslides, and they are linked to timing and magnitude of the extreme weather events. This study concentrates on precipitation events over Europe during the second half of the 20th century and on their link to cyclone position and intensity, both at global and at daily scale. Data for the analysis of the cyclones are provided by the ERA-40 (ECMWF Re-Analysis) dataset for cyclone and sea level pressure variability and by CRU (Climate Research Unit, Univ. of East Anglia) and ECA (European Climate Assessment, hosted at Royal Netherlands Meteorological Institute, KNMI) for monthly and daily datasets, respectively. Spatial distribution of the correlation between cyclone activity and precipitation and links between spatial variability of their trends are discussed. Signals are particularly consistent over Northern Europe where both cyclone activity and precipitation present a positive trend.

The Interdecadal Variation of the Equatorial Pacific SST and its Relationships with the Southern and Northern Oscillation

Speaker: Jingbei Peng

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Northern Oscillation Index (NOI) is the index of climate variability based on the difference in sea level pressure (SLP) anomalies of the Ship N which was in the Northeast

Pacific and Manila, Philippine, in a climatologically low SLP region. SLPs at these two observation sites have a strong negative correlation. NOI reflects the oscillation between the North Pacific Subtropical High and Tropical Low Pressure Belt. It is roughly the north Pacific equivalent of the Southern Oscillation Index (SOI), and highly correlated with SOI and the sea surface temperature anomalies (SSTA) in the tropical Eastern Pacific on the interannual scale.

The interdecadal variability of SSTA in Niño 3 (Niño-3) that measures the variability of the tropical Pacific SSTA, and its relationships with the interdecadal variability of NOI and SOI were studied by using ICOADS dataset and observations. Niño-3, NOI and SOI experienced climatic abrupt changes in the mid-1970s. The increase of Niño-3 after mid-1970s indicated a notable basin-wide warming in the Pacific Ocean, while NOI and SOI shifted from positive phases of the interdecadal variation to the negative phases. The abrupt jumps of NOI and SOI were leading the variation of Niño-3.

In spite of the long-term trend, Niño-3, NOI and SOI shared the same interdecadal-scale periods dominated by positive and negative values, suggesting substantial climate shifts on a roughly 12~15-year 'cycle'. After filtering, the interdecadal variations of NOI and SOI showed different characteristics. Before mid-1970s, NOI and SOI were weaker and out-phase. After mid-1970s, they were stronger and in-phase. The lag-relation revealed that SOI leaded Niño-3 by about 7 months, and NOI by 10 months, the strongest correlation coefficients were weaker before mid-1970s. After mid-1970s, SOI leaded Niño-3 by 4 months with stronger correlation, and the same as NOI. The long-term and the interdecadal variations of SOI and NOI may explain the interdecadal variation of Niño-3.

The Unsteadiness of NH Stationary Wave

Speaker: Ning Shi

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 In this paper, a concept of stationary wave unsteadiness is presented and elucidated in terms of the framework of Lorenz circulation decomposition, which illustrates the variability of zonal wave components of stationary wave relative to the intensity of stationary waves on monthly weather map. Based on the Lorenz circulation decomposition method, the degree of unsteadiness for the global (local) stationary wave is defined, and then used to analyze the stationary wave unsteadiness on the latitude band 30-60N, where the stationary wave intensity of northern hemisphere 500-mb geopotential height, as is well known, is significantly strong. The following results are obtained: 1) The degree of unsteadiness characterizes the space-time variance of global stationary waves in 30-60N belt, and the location of unsteady belt advances southward and then retreats northward in the course of seasonal march. Steady

stationary waves occur in mid-latitude band in winter and subtropical area in summer. Specifically, these are associated with the major troughs of East Asia, North America and a weaker Europe trough in winter and a relatively steady subtropical high system in summer. A high value center for the degree of unsteadiness appears at 35N in spring and 50N in summer, which might be caused by the interannual variation of stationary waves, particularly variations in association with the strength and zonal migration of stationary waves. 2) The degree of unsteadiness for the local stationary wave clearly shows a zonal asymmetry. The steady zones are always located in areas controlled by strong troughs or ridges of stationary waves, whereas the unsteady ones are in the areas where the stationary wave intensity is weak. The degree of unsteadiness for local stationary waves in the subtropics is stronger in winter than in summer, and the reverse is true in the mid-latitude region. Over the local North American continent, the degree of unsteadiness is slightly less than 1 in summer, indicating that the stationary wave in this region is more steady than that over other mid- and high latitude region. As a contrast, North European is the most unsteady area for stationary wave, as represented by a high value of degree of unsteadiness locally, both in summer and winter. The summertime distribution of degree of unsteadiness shows a rather complicated structure in overall. 3) From North China to the Northwest Pacific, there is a high value of degree of unsteadiness in summer, with its center located to the east of Heilongjiang Province, which impacts northern part of China including Northeast China, North China and Northwest China. From the macroscopic point, it, therefore, can explain why these areas become a vulnerable climate zone in summer. It is obviously that the degree of unsteadiness is an intrinsic characteristic of stationary waves, and it can be regarded as being of the same importance as the intensity and energy-spectrum structure of stationary waves for the study of the general circulation system.

Parallel Sessions：Climate Reconstruction

On the loss or preservation of externally forced climate variability in climate field reconstructions

Speaker: Caspar M. Ammann

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Because future climate change will be strongest at regional scales - in particular with regard to the hydrologic cycle, it is important that we understand how radiative forcing can

affect climate variability at that spatial scale. An extended record is required for a cleaner separation of naturally occurring variability from changes that are linked to the recent anthropogenic influence on climate. Additionally, to raise confidence in regional climate predictions, it is important to test if hypothesized links between forcings and response are indeed systematic over time, and possibly even the same over multiple time scales. Climate field reconstructions (CFRs) based on high-resolution proxy networks provide a way of extending the often short instrumental record. Significant progress has been made in recent years in understanding the properties and skills of reconstructions on a global or hemispheric mean scale. In preparation for assessments of future regional scale climate and its predictability, it is now crucial to investigate how much of regional climate is driven by external forcing and what components are simply due to internal, unforced variability. Solar activity changes over decadal to millennial time scales and short lived, interannual volcanic effects on climate offer our only way of testing such links. Successful preservation of the forced structures in climate response to external forcing is therefore crucial, particularly given the fact that during the short calibration period natural forcing factors were confounded by increasing anthropogenic disturbance. This contribution employs coupled climate model output to test how much of externally forced climate signals are preserved in field reconstructions, and how much information could be lost or compromised by the short calibration or underlying assumptions of stationarity.

Reconstruction of the Past 100-Year Weather Variation in Europe

Speaker: Youmin Chen

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The historical climate is reconstructed in the aspects of temperature, precipitation, radiation, humidity, vapor pressure deficit, and so on, which will be used for ecosystem modeling as the climate forcing. The daily variations are based on REMO daily dataset from 1971 to 2000; the monthly summaries are based on the CRU dataset from 1901 to 2002. Canonical correlation analysis (CCA) is used for monthly anomaly reconstruction from CRU to REMO datasets; and the weather generator-like technique is used for reproducing daily variability. We employ auto-regression method to generate time series based on the time coefficient of principle component (PC) so that spatial relationship between spatial grids and different variables will be preserved through PC projection. One of the augments is the selection of the distribution of the random number, which is expected to have the similar distribution as the residuals after the auto-regression estimation. The reconstruction result has the characters that monthly data is consistent with CRU dataset and daily variability is consistent with REMO dataset; and that the relationships between grids and variables are preserved. That is obviously important for reconstruction of the variables in a specific domain, as the ecosystem modeling often required.

A multiple surrogate data study of reconstruction skills

Speaker: Bo Christiansen

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 Reconstruction methods may differ in many details but they basically rely on a statistical relationship between proxy data and observations. However, the statistical properties and robustness of such methods are not well known which has led to the current vivid discussion about the quality of published reconstructions. Of particular concern has been the methods' ability to catch low frequency variability.

In this paper we will present a systematic study of reconstruction methods. The methods include both global-mean reconstructions, field reconstructions based on Principal Components and Canonical Correlation Analysis, and the regularized EM algorithm.

Based on a climate simulation of the period AD 1500-2000 with the ECHAM4/OPYC3 Ocean-Atmosphere General Circulation Model we use a novel technique to generate an ensemble of surrogate fields with the same temporal and spatial characteristics as the original modelled surface temperature field. This technique also allows us to control the strength of the decadal-multidecadal variability in the surrogate fields. We apply the reconstruction methods to each member of the ensemble of surrogate worlds: we train the reconstruction method on a subperiod (defining the set of surrogate proxies by degrading a number of gridbox timeseries) and reconstruct the remaining years. The multi-world approach will allow us to make statistical robust estimates both of the mean properties of the different reconstruction methods and their statistical variance and significance.

Meiyu since 1736 over Middle-Lower Reaches of Yangtze River

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The Starting and Ending dates, the length series and precipitation of Meiyu were reconstructed in the Middle-Lower Reaches of Yangtze River during 1736-1911, using Yu (rainfall)-Xue (snowfall)-Fen (approximately 0.32cm)-Cun (approximately 3.2cm) records in the Qing dynasty, based on the climatic feature of Meiyu. And the Meiyu characteristics were analyzed since 1736, joint with instrumental precipitation data. The strength of the East Asian Summer Monsoon (EASM) and related rainband location were speculated, based on the relationship between the length of Meiyu and the index of the EASM. The results shows that: The starting and ending dates and the length of Meiyu all have significant annual-decadal change, particularly, the length of Meiyu has inter-decadal variations with 20-30 year and 40 year, and century scale variation, except for the inter-annual variation with 2 years and 7-8 year. The periods of 1736-1770, 1821-1870, 1921-1970 are characterized by the shorter length of Meiyu, strong EASM, and the rainband related to EASM is located in the North China and South China, but the periods of 1771-1820, 1871-1920 and 1971-2000 are characterized by the longer length of Meiyu, weak EASM, and the rainband is located in the Middle-Lower Reaches of Yangtze River easily.

Coherence of climatic reconstruction from historical documents in China by different studies

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Much effort has been spent in the last few decades to reconstruct the climate over China using a variety of historical documents. However, the results are not always the same. To address the quality of the reconstruction work,the coherence of 14 reconstructed temperature series, which are derived from historical documents by different studies,is expounded. And the comparison between the reconstructed temperature series derived from historical documents and natural archives is also conducted. It is found that the temperature series by different studies are highly correlated. The closer the reconstructed regions are, the higher their relation is, which suggests that the regional differences of climate change are responsible for the differences of reconstructed temperature series. And the 30-year temporal resolution might be reasonable for temperature change study by using Chinese historical documentary data. The similarity between the results based on historical records and natural evidence is also demonstrated. On the basis of the validation of the reconstruction work with historical documents, the synthesized temperature series for last 500 and 1000 years are achieved.

Linear and non-linear reconstruction from tree-ring series and written documents and the problem of low frequencies and missing data

Speaker: Guiot, Joel

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Climatic reconstructions for the last millennium based on long tree-ring series and, when available, on historical written documents, have several crucial problems related, to the calibration (linear or non-linear methods, stationarity and range of the climatic variable), the validation of the estimates (availability of independent data, method), the variability amplitude of the extrapolation and the low frequency component of the reconstructed signal. Various methods have been proposed as well for the pre-processing of the low frequency component of the tree-ring series (standardization) than for the calibration method or the post-processing of the reconstructions. We illustrate our discussion with examples taken from our own works (reconstruction of temperature in Europe and summer PDSI in the Mediterranean region) that we compare with approaches found in the recent literature (Mann et al, 2005; Rutherford et al, 2005; Burger et al, 2006 …). We will propose some solutions for the various problems pointed out. So non linear calibration techniques such as analogues methods and artificial neural network are useful for reconstructing the full range of the climatic variables and to perform in presence of missing data (it is compared to the regularized expectation maximization (RegEM) method). A combination of cross-validation and bootstrap technique is useful for a robust validation. The treatment of the tree-ring series trend by using a flexible regional growth curve is also a good solution for saving low frequencies in the reconstructed climatic series. Finally we propose that, in the future, the use of inverted process models is an integrated approach able to deal with most of the problems discussed in the talk.

The 'Hockey Stick' and the 1990s: A Statistical Perspective on Reconstructing Hemispheric Temperatures

Speaker: Bo Li

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 The short instrumental record of about 100-150 years forces us to use proxy indicators to study climate over long time scales. The climate information in these indirect data is embedded in considerable noise, and the past temperature reconstructions are therefore full of uncertainty, which blurs the understanding of the temperature evolution. To date, the characterization and quantification of uncertainty have not been a high priority in reconstruction procedures. Here we propose a new statistical methodology to explicitly account for three types of uncertainties in the reconstruction process. Via ensemble reconstruction, we directly obtain the distribution of decadal maximum as well as annual maximum. Our method is an integration of linear regression, bootstraping and cross-validation techniques, and it 1) accounts for the effects of temporal correlation of temperature; 2) identifies the variability of the estimated statistical model; and 3) adjusts the effects of potential overfitting. We apply our method to the Northern Hemisphere (NH) average temperature reconstruction. Our results indicate that the recent decadal temperature increase is rapidly overwhelming previous maxima, even with uncertainty taken into account, and the last decade is highly likely to be the warmest in the last millennium.

Deconstructing Reconstruction

Speaker: Matthew R. Schofield

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 The study of climatological data is inhibited by the availability of data. Inference about the climate over the past hundreds or thousands of years cannot be based on direct observations, which are only available for the past century or two. To obviate this problem proxies with many more observations, such as isotopes, tree rings and ice cores are used to predict the past climate.

Using tree rings as an example, we stress the importance of modeling the unobserved climate process in terms of a selection of scientifically driven pre-specified models. The methods we suggest allow all uncertainty to be explicitly included in the model, which may substantially effect the conclusions obtained. If time permits, an example will be given.

Pseudo-proxy tests of the regularized expectation maximization (RegEM) method and their implications for real-world climate field reconstructions of the last millennium

Speaker: Jason E. Smerdon

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 Several pseudo-proxy tests of the regularized expectation maximization (RegEM) method are now documented in the literature. The differences in current applications hinge on the regularization method used within the RegEM algorithm to estimate the regression coefficients and error covariance of the linear regression model. We test several of these regularization methods using pseudo-proxy networks from millennial integrations of the GKSS ECHO-G and the NCAR CSM General Circulation Models (GCMs). We demonstrate that one form of RegEM using ridge regression is sensitive to the chosen standardization interval of instrumental and proxy data. Previous tests of this method that used output from the CSM millennial integration standardized the data matrix using information prior to the instrumental period. The inclusion of such information yields reconstructions with minimal systematic biases, but the approach makes such pseudo-proxy tests irrelevant for real-world applications. RegEM reconstructions using ridge regression and standardizations confined to the instrumental period yield warm biases and variance losses at low frequencies in both ECHO-G and CSM pseudo-proxy tests. We further explore additional regularization schemes in RegEM, as they are related to published approaches. We explore selection criteria for regularization parameters and test the performance of derived reconstructions in terms of their ability to reproduce hemispheric averages and spatial variability. Results indicate a more nuanced interpretation of the RegEM method than what is currently presented in the literature, as well as the need for a more systematic evaluation of the method.

North western temperature during Song and Yuan Dynasty (960-1368AD) in China

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The extent of the Medieval Warm Period (MWP) from 900AD to 1300AD, was occurred in the periods of Wudai-Song-Yuan Dynasty, when the temperature is warm as Holocene Megathermal in many parts of the worlds. Although the exact timing and duration of warm periods may have varied from region to region, the relatively warm conditions during MWP have been generally accepted by the climatologist. For example, Chinese scholars have been studied the magnitude and timing for MWP by the historical documentary evidence of phonological events and cold/warm records, the results were expressed that the 930-1310 was warming, and particularly in the periods of 930s-1100s and 1200s-1310s, the temperature may have passed the 20 century warming. However, the temperature reconstruction in North Western of China from the evidences of tree-ring, ice core and lake sediment showed inconsistent results with Eastern China for MWP, which includes the surface temperature reconstruction only reached the mean value and no significant MWP, even the periods of 1000-1050, 1150-1350 were cooling placed in the past 1000 years; and the timing with 1200-1400 was behind 300 years than Eastern China.

Here, we analyzed the cold/warm magnitude, and calculated the temperature in North western, covering Gansu, Shanxi, Ningxia and part of Henan, based the evidence of the abnormal snow and frost records, to assess the temperature level during the past 1000 years. The results showed that the temperature has three obvious stages during 960~1368, which included the 962-1110 cooling, the1111-1260 warming, and the 1260-1368 cooling lower than 962-1110. And only the cooling event of the last stage, 1260-1368 was compatible with the trend in Eastern China.

Underlying dynamics of glacial millennial-scale climate transitions derived from ice-core data

Speaker: Frank Kwasniok

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A method for systematically deriving simple nonlinear dynamical models from ice-core data is proposed. It offers a tool to integrate models and theories with paleoclimatic data. The method is based on the unscented Kalman filter, a nonlinear extension of the conventional Kalman filter. Here, we adopt the conceptual model of stochastically driven motion in a potential that allows for two distinctly different states. The parameters of the model, that is, the shape of the potential and the noise strength are estimated from a Greenland ice-core record. The data reveal that during glacial times the potential is asymmetric and degenerate: there is one stable cold stadial state and one indifferently stable warm interstadial state

Spatio-Temporal Variability of the Sea Surface Temperature of the Gulf of Guinea and Its Implication for Coastal Precitation in Nigeria

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This study described and discussed the spatio-temporal variability of the sea surface temperature (SST) of the Gulf of Guinea and its implication for the coastal precipitation in Nigeria between 1950 and 1998. The specific objectives of the study include: (a) examining the spatio-temporal variability in the mean annual sea surface temperature over the Gulf of Guinea between 1950 and 1998; (b) examining the spatio-temporal variability in the mean mid-summer (July, August and September) sea surface temperature over the Gulf of Guinea between 1950 and 1998; (c) identifying the areas of the Gulf of Guinea in which the sea surface temperature is below the latitudinal average over the period of study; (d) identifying the areas of the Gulf of Guinea in which the sea surface temperature temporal variability is above the latitudinal average over the period of study; and (e) discussing the implications of the pattern of the variability of the sea surface temperature in the Gulf of Guinea for coastal precipitation in Nigeria. The data used for the study are the mean monthly SST at specific locations in the Gulf of Guinea. The data were obtained from the International Research Institute for Climate Prediction. The specific locations where data were collected to represent the Gulf of Guinea are Longitudes 100W, 80W, 60W, 40W, 20W, 00, 20E, 40E, 60E, and 80E and Latitudes 50N, 30N, 10N, 10S, 30S, and 50S.

The statistical analytical procedures employed to summarise and make inferences on the data include: (a) K-means cluster analyses; (b) Coefficient of variation; and (c) Integrated Land and Water Information System (ILWIS) software (version 3.2 Academic). The K-means cluster analysis was employed to classify the SST into groups. The coefficient of variation was used to determine the degree of the SST variability over time, while the ILWIS was employed to map the spatio-temporal variability in the SST.

Results from the study reveal that the SST of the Gulf of Guinea is generally colder between Longitudes 80W and 20E. The temperature anomaly which appears most noticeable during the months of July-August-September is also discernible in the average annual pattern. This area of the SST anomaly was also observed to experience the greatest inter-annual variability longitudinally. The results also show that while SST generally decreases from the north to the south and from east to the west, variability value generally increases from the

north to the south and from east to the west. The observation thus shows that the areas of relatively colder SST are those having the higher variability values.

The study concluded by noting that, although the inter-annual variability in the SST of the Gulf of Guinea as observed in this study, is generally low, it appears to greatly perturb the rainfall-producing systems of West Africa in general and Nigeria in particular. Its most prominent effects are: (i) the chilling effect at the coast-thereby acquiring negative buoyancy, and later the warming over the land (which at this time of the year is warmer than the sea) - thus acquiring positive buoyancy to effect convection at some distance inland; (ii) the southwesterlies are strengthened by the upwelling effect of the ocean water in the Gulf of Guinea (i.e. localized high pressure offshore). This is believed to inhibit precipitation around the coastal area; and (iii) the static stability, brought about by colder SST in the Gulf of Guinea that prevent the development of convection and thus responsible for the 'little dry season' in southwestern Nigeria during the months of July-August-September.

The impact of climate change on frost occurrences across the Murray-Darling Basin

Speaker: B. Timbal

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 This study focuses on quantifying both the effect of mean and variance changes in the impact of climate change on extremes, looking at one particular case. The area of interest is the Murray-Darling Basin, which is covered by an important network of climate stations with long daily records. This is an important agricultural area strongly impacted by frost. Furthermore, frost occurrences are observed during winter months with a frequency from 30% in the mountainous South-East to less than 1% in the North and Western part of the basin. In order to study the combined effect of the mean warming and variance effect, estimates of the mean warming for minimal temperatures are derived from Direct model outputs (DMO) using climate model simulations archived in the IPCC AR4 database, using differences between simulation of the climate of the 20th century and of the 21st century forced with different emission scenarios. The mean anomalies are applied to observed series and compared with results obtained using a downscaling technique developed for daily temperature extremes (Tmin and Tmax) in the region and applied to the same IPCC AR4 simulations. In this study, the DMO and downscaled temperature series estimate of frost occurrences for the current climate are compared to evaluate the benefits of using a statistical downscaling method for local climate extremes. Furthermore, the impact of emissions scenarios on frost occurrences are compared between DMO and downscaled series to evaluate the importance of reproducing the observed probability density function of local temperature in order to infer future changes for climate extremes. Finally, the contribution of the mean and variance effect across the range of climate simulations is assessed and the importance of the variance effect is evaluated.

Iterative Interpolation of Daily Precipitation Data for Alberta, Canada

Speaker: QINGFANG DAI

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Climate physics shows that topographic precipitation is related to atmospheric circulation patterns and climate dynamics. These patterns may be reflected statistically by empirical orthogonal functions (EOFs). In this research, we take the elevations into account and use EOF-interpolation method to develop Hybrid 2.0, the next generation of hybrid interpolation method based on the initial data derived from Hybrid 1.0. The method to be developed will first calculate a climatology surface as the mean of 1961-1990 data. Climate anomalies will be interpolated by EOF-interpolation to retain the spatial variance. Finally, the nearest-station regression will be applied to retain the temporal variance. With this developed method, we interpolate daily precipitation data onto grids for Alberta, Canada. The accuracy of the final result of Hybrid 2.0 is assessed with cross-validation and compared to that of Hybrid 1.0.

Recent Rainfall Trends in Agro-Ecological Zones of Zambia

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Agriculture sector contributes approximately 15% to Zambia's GDP. About 80% of farming households in Zambia are subsistence farmers who depend on rains for crop production. In recent years, significant rainfall deficits at critical stages of crop growth have frequently led to serious shortfalls in crop production. This paper attempts to characterize the nature of drought in Zambia.

40 years(1960-2000) of daily rainfall data obtained from selected stations of the Department of Meteorological services of Zambia have been classified in the following classes: class1 (0-0.5mm), class2(0.5-5mm), class3 (5-10mm), class4 (10-25mm)and class5 (>25mm). Trend analysis is done for (i) annual number of days in each of the classes from 2 to 5 (ii) annual number of rainfall days (sum of days in classes 2 to 5) (iii) annual rainfall amounts for

the Agro_ecological zones of Zambia. The analysis shows that in Agro-ecological zone 1, low intensity rainfall events are increaing and intense rainfall events are decreasing. In Agro-ecological zone 2 low and moderate rain events are decreasing and intense rain events are increasing. The annual rain events in Agro-ecological zone 1 are increasing at the rate of 0.629 events/year and decreasing in Agro-ecological zone 2 at the rate of 0.33 events/year. The annual rainfall amounts in Agro-ecological zone 1 and 2 are decreasing at the rate of 1.038 and 3.269 mm/ year respectively.

Variability of Rainfall in Connection with the 3 - 5-Day Wave in Northern Africa in summer

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A composite method is used to determine the spatial pattern of the westward propagating 3 - 5-day waves and the associated rainfall anomalies in northern Africa in summer, throughout the period 1981-90. The rainfall anomalies increasing (decreasing) is associated with the cyclonic (anticyclonic) circulation and negative (positive) geopotential height anomalies. The waves increase rainfall in the band of latitudes 7.5°- 15°, around the ZCIT mean position in summer, with a maximum near the Fouta-Djallon in Guinea and decrease rainfall north of 15° and south of 7.5°. The rainfall anomalies increasing or decreasing depends on the waves activities. For example in 1981 where the waves were active, the rainfall anomalies composited were positive in the whole studied area, with strong values while in 1982 and 1983 where they were weak, the rainfall anomalies composited were negative south of 10°.

Consideration of Drought at the Aji-chai Basin

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Climatic change is one of the natural characteristic of the atmospheric cycle that causes abnormality and fluctuations in the trend of climatic parameters such as precipitation and heat. Atmospheric abnormalities are very intensive in the most parts of the world and resulting

disturbance in the natural ecosystems. Droughts are the symbols of climatic changes and are accounting as natural damages affecting the human life and ther living creatures.

In this study climatological drought at the Aji-chai basin was studied using SPI index. For this propose climatalogical data of the selected stations (Tabriz, Ahar, Sarab, Bostanabad Ligvan) were used to study drought conditions for 3, 6 and 12 months time periods, the results shows that drought are appearing in the short time periods with short time duration but longtime droughts are also have the longtime durations.

In the Aji-chai basin the number of short time droughts are more than longtime. Ones in which duration of the longtime droughts comparing with short time droughts are more. All of the selected stations are facing to 3, 6 and 12 months gentle to moderate droughts and there are no intensive or very intensive drought in the studied stations.

Keywords: Drought, Ajichai, SPI, GIS.

The quantitative survey of drought effects on the barley yield in Eastern Azarbayjan by classical statistical ways

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The growing season climatic parameters; especially, rainfall plays the main role to predict the yield production. Therefore the main objective of this research was to find out some possible relations among meteorology parameters and drought indexes with the yield using classical statistical methods.

To achieve the objective, meteorological parameters such as; precipitation, the average of maximum temperature, the average of minimum temperature, the average of temperature, the sum of temperatures more than 10º,evaporation,the water vapor pressure ,the average of wind speed, the sunshine .and the drought indexes such as; Percent of normal Index, Standard Index of Annual Precipitation Index, Hydrothermal Index, Nguyen Index, Transeau Index, Standardized Precipitation Index, Shashko moisture drought Index, Rainfall Anomaly Index were evaluated in terms of normality and their mutual influences. Then the correlation analysis between the barley yield and the climatic parameters and drought indexes have been examined .the results of this study showed that among the drought indexes, Nguyen Index , Transeau Index , Rainfall Anomaly Index and Standardized Precipitation Index (SPI24) are

more effective for prediction of barely yield. It is also found that the multivariate regression are better than the univariate regression models.

Finally, all the obtained regression models were ranked based on statistical indexes(R, RMSE and MBE). This study showed that the multivariate regression model including wind speed, sunshine, temperature summation more than 10, precipitation and Nguyen index is the best model for prediction yield production in Miane. Average wind speed and Nguyen index were recognized to be the most effective parameters for yield production in the model.

The Evaluation of Climatic Factors that Effect Climate in Azarbayjan by Method of Principal Component Analysis

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The region studied here includes: Ardedil, east and west Azarbayjan provinces located in the north west of Iran. In this research nineteen synoptic Stations with relative distribution have been chosen. The data gathered Monthly during 1971 to 2005.

These research is done by using principal component analysis (PCA) method an also varieties such as wind speed, seasonal precipitation, relative humidity at 3, 9, 15 synoptic time and average daily temperature and the highest, lowest daily average temperature and also the average of dew point, and the maximum precipitation in the north west of Iran has been discussed, in order to determine the effective varieties and principal component analysis (PCA) on the climate of Azarbayjan. The effects of every chosen variety based on the importance and choosing the places of every station show same factors. The conclusion of this research includes the analysis of main factors in every stations and areas. In data analysis, drawing diagrams and maps several software such as: ArcView, Minitab, SPSS, Arc info and Excel, have been used.

Key words: precipitation, temperature, dew point, Relative humidity, Principal Component Analysis, North West Azarbayjan.

Climate Risk Management in North-East of Iran By Statistical Downscaling Direct on GCMs Output

Speaker: Sina Samadi

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In climate change studies the global circulation models of Atmosphere (GCMAs) enable one to simulate the global climate, with the field variables being represented on a grid points 300 km apart. Unfortunately, the most recent generation of general circulation models (GCMs) still has serious problems when modeling over Iran. However, these models are able to reproduce the main patterns of atmospheric circulation, such as those derived from a principal component analysis of the sea level pressure anomaly field. GCMs Models are benefit for detecting Climate change and zone on a special parameter. Even if global climate models in the future are run at high resolution there will remain the need to 'downscale' the results from such models to individual sites or localities for impact studies. A Statistical Model (SM) has been developed to downscale large scale predictors given by Global Climate Models (GCMs). This is a complementary approach to the dynamical modeling of regional climate change using high resolution nested models. It allows bridging the scale difference ("downscaling") between coarse grid Coupled Atmosphere-Ocean GCMs and the finest temporal and spatial scales required for regional and environmental impact studies of climate changeGeneral Circulation Models (GCMs) indicate that rising concentrations of greenhouse gases will have significant implications for climate at global and regional scales. Less certain is the extent to which meteorological processes at individual sites will be affected. So–called "downscaling" techniques are used to bridge the spatial and temporal resolution gaps between what climate modelers are currently able to provide and what impact assessors require. Many downscaling techniques have been developed in recent years, all having in common the need to establish statistical links between the large-scale circulation and the observed data at a local or regional scale. We know several centers in the world are producing climate data in deferent scenarios. So, choose the best one that is suitable in selection area and then use them for detecting change in climate parameters is the main propose of this paper. In this paper, we try to find correlation between observed data and models outputs to find the best one for downscale monthly precipitation over the North-East of Iran. We use SDSM tools for that changing scale. It was found that the precipitation characteristics (mean, variance, and empirical distribution) were better reproduced by the downscaled results than by the GCM direct output. With using Precipitation parameter constructed for the future (2005–2050) in SPI (Standard Precipitation Index) we could detect climate change in this region for future and it will improve climate risk management.

Keyword: Climate Change, Downscaling, , GCM, Management, SDSM, Risk

Analysing decadal rainfall perfomance in Uganda

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The generation of climatological and weather information that can be applied in advising the planners and decision makers mostly involves data analysis, after which most appropriate inferencing can be done.This paper will look at the ten day rainfall analysis for Uganda for the past ten years, using accumulated decadal rainfall data.Data from a total of 16 active synoptic stations across the country, has been analysed whereby accumulated ten day rainfall graphs have been generated.

A Preview of Iran`s Climate Using SIAP Method

Speaker: Behrooz Sari Sarraf

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In the existing study, we have used the precipitation records of synoptic stations of Iran for a long term period, after retrieving the data and applying homogenity tests.Using the SIAP equation, we have drawn zoning map of IRAN based on standardized values and the coefficient of variation of precipitation have been studied and finally the coefficients of variation map of Iran has beenstudied and finally the coefficients of variation map of Iran has been prepared.

According to the results obtained, in the years 1966 and 1973 all over Iran has experienced droughts and since 1995 until 2001 a very long desiccation in most parts of Iran has dominated.

Key words:Zoning, Drought,coefficient of variation,Siap

Analyzing of synoptic intence showers over the southern part of ARAS River

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The main goal of the current study was to examination of some of distinguished intense rainfalls using six synoptic station data in the southern part of Aras River.To achive our main goals, the data from six station including Makoo, Khoy, Ardabil,Parsabad, Ahar, and Gholfa from 1986 t0 2003 was used.By taking advantage of synoptic maps it was found that some type of shower rains could be resulted of consequence effect of interring cold front upcoming to the study areas.In this regard two synoptic station Skew_T maps have been analyzed.The final result shows that in the study area some intense showers could be produced from the local thunderstorm as well. Key Words: southern part of Aras River ,intense shower,Skew-t Map

Indian Monsoon Rainfall and its relationship with El-nino/Southern Oscillation Index (SOI) Over India during 1940- 2000

Speaker: C.V.Singh

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The interannual fluctuations in the Southern Oscillation Index (SOI) and their relationship to the Indian monsoon rainfall (June-September) have been studies for the period 1940-2000 covering 340 stations all over India (in figure 1. each stations contains the seasonal average rainfall of five neighbors stations). The monsoon rainfall is significant correlated with the southern oscillation index (June-September) 0.65. The large positive southern oscillation indexes are positively correlated with the flood years, while the negative southern oscillation indexes are correlated with the drought years. In this study, we have taken the flood/drought and El-Nino years separately and find their relationship with SOI. It has been observed that mostly drought occurs, when Southern Oscillation Index value is negative. It has also been noticed that there is a good correlation ship with El-Nino and drought years (57%). The Spectrum analysis is also carried out on monsoon rainfall and Southern Oscillation Index

separately (SOI) and it is concluded that they are highly correlated in the period range 2-2.5 years to 4-6 years and 5.5-6.0 years respectively. It has also been observed that the climatic anomalies such as drought in India and El-Nino off the coast of Peru are linked with the Southern Oscillation (Walker circulation)

Kew Words: Monsoon rainfall, Southern Oscillation Index, El-Nino, Climatic fluctuations

Parallel Sessions：Forecast

Verification of Climate Predictions

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WEATHER VERIFICATION: Verification of climate predictions is based on the considerable methodology that has been developed to verify weather forecasts. Thus, first the methodology for weather forecasts is reviewed.
PURPOSE: Forecasts are verified for two purposes (1) Diagnostic verification- to give forecasters feedback to improve their forecasts by removing bias, etc. (2) Quantify utility to build user edibility (the probability a user thinks that they are correct)
TYPES OF FORECASTS
QUANTITATIVE: a specific value from a continuous variable e.g. 50deg. C
PROBABILITY FORECAST: a forecast plus the uncertainty that it will occur expressed as a probability.
A probability forecast can be used to optimize utilty of a forecast by minimizing expected loss or allowing for an alternate action: e.g. go on picnic but take an umbrella.
CATEGORY FORECASTS: a well defined event e.g.rain or no rain or a temperature below freezing.

RANKED CATEGORIES results from a continuous variable divided into categories by a set of thresholds e.g. temperature 0><10> <20probability forecasts of ranked categories are important in that as categories become smaller it becomes a probability density forecast verification scores area STATISTIC OF THE FORECASTS. And as Ed Tuftee (1983) points out all statistics are used to answer the question “compared to what? To answer this question a knowledge of the SCORE VARIABILITY is needed: His variability can only come from (1)Considerable past experience with the score or*2) Use of a Normative (theoretical) model. The Normative model most used by statisticians is the independent CASES MODEL WHICH ASSUMES EACH CASE IS INDEPENDENT FROM ALL OTHERS. This assumption is often

chosen since it completely defines the variability of cases and hence the verification score. The trouble is that weather is highly correlated in time and space thus having much less variability then the independent normative model indicates. The effect of correlation can be incorporated by using randomly SIMULATED VERIFICATION: generated forecasts and observation with known correlation.

SYNTHETIC VERIFICATION is the closed form result which would occur from a series of simulated verifications and thus an explicit form shows the effects of skill, event climate probability and other factors on a verification score and one easily programmed simulation of correlated forecasts and verifying observation is the TRANSNORMAL model which generates multivariate normal deviates which are then transformed into weather variables via their cumulative distribution. The transormal model can relate with closed form expressions quantitative, category and probability forecasts

CLIMATE PREDICTIONS differ from weather forecasts in several ways instead of being for a single location at one time, they are often valid for a large region and an extended valid time thus they are often expressed as distributions. Plus generally because of longer lead times, they generally have lower skill and accuracy. Gringorten (1952) proposed an S score to verify probability density forecasts. Plus synthetic verification indicates it is quite sensitive to low skill forecasts.The S score was able to show that one year ahead seasonal temperature analog forecasts forecasts produced by ETAC had significant improvement over chance.

CFARC MODEL a global extension of the transnormal model generates weather forecasts and observation on a global scale thus providing a normative model for judging significance of such things as widely separated telaconnections and global climate change.

CLIMATE CHANGE VERIFICATION: By using observations from one period as a prediction of a later period, climate change can be verified. We note from experience that the climate is always changing thus the question: has the climate changed is trivial since the answer is always Yes! The real question is has the climate changed in an important manner?

A Glossary of over 28 verification terms is included. For example:

skill: takes into account the difficulty of the forecast in accessing the ability of a forecaster or forecast method. Skill attempts to compare verification of easy forecasts with hard forecasts. Generally, accuracy will be lower when: 1. the forecast event is rare, 2. data is sparse or missing, or 3. the weather situation is complex; it does not fall into an easily recognized pattern. See Skill Score.

2 ROC

Verification methodology using Relative Operating Characteristics (ROC), is derived from signal detection theory. This methodology is intended to provide information on the characteristics of systems upon which management decisions can be taken.(WMO2000)

Skill Score, SS: Is a generalized form to convert any score into a fractional improvement over some standard. Thus: SS = [S(f) - S(s)] / [S(p) - S(s)] where S(f) is a any score based on forecasts, S(s) is the score based on a standard such a persistence or climatology or chance , and S(p) is the perfect score. For forecasts better then the standard, SS has the range [0, 1] with 0 when forecasts have the same accuracy as the standard and 1 when when forecasts are∞the forecasts are perfect. SS is negative with range to - less than standard. When the perfect score is zero as in the Brier score or MSE, it simplifies to: SS= 1 - S(f)/S(s). WARNING: When the denominator can become small, skill scores are subject to considerable variability.

See Heidke Skill Score. Ref. Heidke (1926) and Murphy (1976).

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WMO (200) Standardised Verification System (SVS) for Long-Range Forecasts

Integrated seasonal climate forecasts for South America

Speaker: Caio Coelho

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Seasonal climate forecasts are forecasts of the expected climatic conditions in the forthcoming 3-6 months. These forecasts are currently produced using empirical (statistical) and dynamical (physical) models. Given the availability of these two modeling approaches one might question the feasibility of producing a single and well calibrated integrated forecast that gather all available information at the time the forecast is issued.

This talk will illustrate how empirical and dynamical coupled model rainfall seasonal forecasts for South America are currently being integrated (i.e. combined and calibrated) using a Bayesian approach know as forecast assimilation. Empirical forecasts are produced using a simple multivariate regression model that uses the previous month Pacific and Atlantic sea surface temperature as predictors for South American rainfall of the following three month season. Dynamical forecasts are from the European Seasonal to Inter-annual Prediction (EURO-SIP) coupled multi-model system composed by ECMWF, UK Met Office and Météo-France. Such an empirical-dynamical multi-model integrated system is part of EUROBRISA (A EURO-BRazilian Initiative for improving South American seasonal forecasts). Preliminary results of rainfall seasonal forecasts for South America produced by each model and by the integrated system together with skill assessment measures, which indicate regions where forecasts have best quality, will be presented.

The Roles of Ensembles in Climate Modelling

Speaker: Hailiang Du

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Ensemble simulations play a central role in climate modelling, both in terms of model improvement and decision support. Their effectiveness in this role is shown to vary with how various uncertainties are sampled and with what the ensemble itself is interpreted to represent. Experimental design will vary with the goal of the experiment, indeed the division of resources between sampling distributions of initial conditions, parameterizations, model structures and forcing scenarios will vary with the questions to be addressed. The impact of each type of uncertainty and the importance of ensembles in each case will be shown with examples from the archives of the IPCC and climateprediction.net, as well as illustrative statistical models.

These issues and options for designing ensemble experiments are addressed in several settings, one being the statisticians. Traditional vehicle for sampling experiments: the selection of balls from a collection of urns. Current experimental designs place restriction on the use of ensembles of simulations for either decision support or model improvement. The aim is to illustrate approaches which exploit ensemble based experiments to gain maximum value from climate simulations, given finite resources and imperfect models.

Climateprediction.net

Speaker: Nick Faull

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Climateprediction.net is a simulation project harnessing the power of idle PCs to forecast the climate of the 21st century. In collaboration with the BBC, we asked volunteer members of the public to download a climate model from the project website and to run it locally on their PC. Each model forms a single member of a massive, perturbed physics ensemble in the world's largest climate forecasting experiment. As well as discussing the design of the experiment, we present some of our first results.

Statistical characterization of ensemble prediction systems: Application to the DEMETER ensemble

Speaker: Jesús Fernández

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A novel approach is presented to characterize and graphically represent the spatiotemporal evolution of ensembles by means of a simple diagram. The study focuses on the evolution of perturbations, defined as differences between each ensemble member and a control member. The lognormal character of these perturbations suggests a characterization in terms of the first two moments of the logarithmic transformed values (the log-perturbations). On one hand, the mean is associated with the spatially-averaged exponential growth in time. On the other hand, the variance accounts for the inhomogeneous and localized spatial growth component.

We introduce the MVL (Mean-Variance of Logarithms) diagram to intuitively represent the interplay and evolution of these two magnitudes. We show how this diagram uncovers useful information about the spatiotemporal dynamics of the ensemble by appling it to the analysis of the multimodel ensemble for seasonal forecasting developed in the EU-project DEMETER.

The diagram shows aspects of the initialization procedure and the internal dynamics of the models, which cannot be easily assessed by other means.

Spatiotemporal Rainfall Predictive Model using ANN and Storm Data Sets. Case Study: Bogotá City, Colombia

Speaker: Carlos F Gaitan

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Developing an accurate spatiotemporal rainfall predictive model is a challenging task in atmospheric sciences and a great need for mayor capital cities like Bogotá, Colombia. Within the hydroinformatics discipline, several models were developed at either spatial or temporal scale for predicting the precipitation at the city for a storm event. This work aims at showing a new model using Artificial Neural Networks (ANN) and precipitation data sets gathered at thirty six rain gauges; in order to develop the model, the city map was divided with an equally spaced grid, over which were located the rain gauges; the temporal resolution of the model was defined on a quarter hour. The model was trained to predict the next two expected values for each cell of the grid, using the available data of the neighboring cells and the early period information; before beginning the training instances of the model and in order of obtaining appropriate patterns, a proper statistical characterization of the data sets was advanced, in particular spatiotemporal linear and non-linear correlations. The type of calibrated ANN is the multilayer perceptron trained with the delta generalized rule. Results suggest that the ANN-based model applied for the study zone perform well for almost all the grid cells and that such performance basically depends on both topological features of the nets and correlation structures among point precipitation data sets.

A new interval-based method for seasonal forecast validation: Application to DEMETER in Perú and Spain

Speaker: Jose M. Gutierrez

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In this work we describe a simple statistical method to validate seasonal forecasts, comparing them with random predictions. This method provides an estimation of the statistical significance of the skill and, hence, allows us to find out predictable situations where the seasonal system significantly outperforms a random forecast. We also analyze the advantages of post-processing the predictions with some appropriate statistical downscaling method. The technique is applied to precipitation and temperature forecasts considering two regions with different seasonal behavior: Peru (in the tropics) and Spain (mid-latitudes). Results show high predictability over Peru during El Niño periods. Here, the use of a downscaling method clearly improves the forecast skill. Over Spain the forecast signal is much weaker, but some predictability related to El Niño and La Niña events is found.

Finally, some sensitivity studies are presented. On the one hand, we compare raw station data with high resolution gridded interpolated data. On the other hand, different temporal aggregation patterns are used for the analog downscaling method (daily, weekly and monthly), comparing the different results obtained.

For this work we have used data from the DEMETER multimodel project.

Tests for evaluating rank histograms from ensemble forecasts

Speaker: Ian Jolliffe

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Rank histograms are often plotted in order to evaluate the forecasts produced by an ensemble forecasting system - an ideal rank histogram is `flat'. It has been noted previously that the obvious test of `flatness', the well-known $\chi 2$ goodness-of-fit test, spreads its power thinly and hence is not good at detecting specific alternatives to flatness, such as bias or over/under-dispersion. Other tests, which focus their power and are therefore more successful in detecting such alternatives, will be discussed and illustrated.

The talk will emphasise new tests, which decompose the overall $\chi 2$ statistic, but the Cramér-von Mises family of tests will also be described.

Empirical probabilistic seasonal forecasts for Canada

Speaker: V. Kharin

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A method for constructing empirical deterministic and probabilistic seasonal forecasts in Canada is proposed. The performance of the empirical forecasts is evaluated and compared to the performance of a multi-model ensemble of seasonal hindcasts produced with four global numerical models. Special attention in developing and validating empirical forecasts is paid to avoiding artificial skill enhancement. The 20th century empirical seasonal hindcasts of near surface temperature in Canada are best skillful in colder seasons for time leads up to several months. Little skill is found in transient seasons. One-month lead empirical seasonal forecasts are competitive to the corresponding numerical model seasonal forecasts. Seasonal precipitation hindcasts in Canada are not very skillful.

Regime predictability in an atmospheric model or analogue prediction revisited

Speaker: Frank Kwasniok

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Predictability properties of atmospheric flow are diagnosed and analysed empirically using nonlinear signal processing techniques. The notion of predictability is relaxed from accurate prediction of individual trajectories to a coarse-grained view in which only probabilities of visiting certain regions of state space or regimes are forecast. The regimes and a probabilistic model of the transitions between them are determined simultaneously by fitting a hidden Markov model to a data set of the system. Then regime predictability is examined as a function of initial condition using the Markov model; states with particularly high or low regime predictability are identified. States with high regime predictability are characterized by a large projection of their posterior distribution of regime membership onto the slowliest decaying eigenmode of the Markov model. Predictability information is refined by using an analogue model of the regime posterior. The method bears the potential of improving prediction by combining dynamical models of the system with the present statistical model. The ideas outlined above are applied to the classical Lorenz system as well as an atmospheric model with realistic variability and teleconnection patterns.

Insights from a Skill Analysis of the First Decade of Long-Lead U.S. Three-Month Temperature and Precipitation Forecasts

Speaker: Robert E. Livezey

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The first ten years (issued starting in mid-December 1994) of official, long-lead (out to one year) U. S. three-month mean temperature and precipitation forecasts are verified using a categorical skill score. Through aggregation of forecasts over overlapping three-month target periods and/or multiple leads, we obtain informative results about skill improvements, skill variability (by lead, season, location, variable, and situation), skill sources, and potential forecast utility. The forecasts clearly represent advances over zero-lead forecasts issued prior to 1995. But our most important result is that skill hardly varies by lead-time all the way out to one year, except for cold-season forecasts under strong El Nino or La Nina (ENSO) conditions. The inescapable conclusion is that this lead-independent skill comes from use of long-term trends to make the forecasts and we show that these trends are almost entirely associated with climate change. However, we also argue that climate change is not yet being optimally taken into account. All other skill in the forecasts comes from exploitation of strong and predictable ENSO episodes for winter forecasts, out to 6.5-months lead for precipitation and beyond 8.5-months for temperature. Apparently other sources of skill supported by existing research, including predictability inherent in weaker ENSO episodes and interactive feedbacks between the extratropical atmosphere and underlying surfaces, do not materially contribute to positive forecast performance. Compared to strong ENSO and climate change signals, other sources are too weak, unreliable, or poorly understood to detect an impact. Another consequence of the clear attribution of skill is that often-observed high regional/seasonal skills imply that the forecasts can be unambiguously valuable to a wide range of users. With these findings, steps (some immediate) can be taken to improve both the skill and usability of official long-lead forecasts.

A Multiple Linear Regression Model for the Seasonal Prediction of Rainfall over Peninsular India

Speaker: Lorna R. Nayagam

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The present study attempts to develop a linear multiple regression model to predict the summer monsoon rainfall over Peninsular India (PIR). Correlation between PIR and several global parameters were found and areas having 99% significance were selected as indices. The consistency of the relationship between these indices and PIR was checked by doing a 15-year sliding window correlation (significant at 5% level). Twenty indices were used as the input and 5 predictors were selected by the stepwise regression method. The predictors are Zonal wind at 925hPa (jan), 700 hPa (mar), 200 hPa (jan), 100hPa (apr), and 30 hPa (feb) over different spatial locations. These 5 predictors were used to develop the linear regression model. The model has been trained for a period of 24 years (1977-2000). The model has a multiple correlation of 0.944 and coefficient of determination of 89.2%. The VIF analysis of all the parameters that is retained in the stepwise regression have values less than 2 indicating an insignificant level of multicollinearity and has a Durbin Watson value of 2.247.The model performance was assessed for 5 years (2001-2005) using statistical measures such as RMSE, BIAS and ABSE. The model has a RMSE of 13 %, BIAS of 3.62% and ABSE of 10.26% of long-term average. Climatological predictions were also made and found that RMSE, BIAS and ABSE are 15.73%, -11.52% and 13.83% of long term average, respectively.

Determination of Threshold for Binary Forecast

Speaker: Keon Tae Sohn

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There are many binary forecasts like heavy rain in weather forecast system. Threshold is needed to generate a binary forecast based on the probablisitic forecast model. This study is performed via Monte-Carlo simulation to propose a guidance on the choice of skill score to find the optimal threshold for binary forecasts.

In Monte-Carlo simulation, 40 patterns which consist of 5 distribution modes, 4 occurrence rates and 2 variation models, are generated by random variate sampling. Varying threshold from 0 to 1, binary forecasts are generated by the threshold and the results are summarized in 2x2 contingency tables. And skill scores (Heidke skill score, hit rate, true skill statistic, threat score, etc) are computed to find the threshold which maximizes a skill score separately. As

results, the guidance on the determination of threshold for binary forecast is proposed for each pattern.

Using this guidance, the heavy snow forecast in Korea is considered as a case study.

Effects of daily MOC fluctuations on long-term MOC predictability

Speaker: Jin-Song von Storch

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The first continuous assessment of the Atlantic meridional overturning circulation (MOC), achieved within the framework of the UK Rapid Climate Change Program, indicates strong MOC variability on timescales of about a few weeks. A large part of this variability results from or is related to the wind stress forcing. Assume that this MOC variability is not predictable beyond a few weeks, its presence will significantly limit the long-term MOC predictions which owe their skill to the slow ocean dynamics. To quantify this limitation, daily and yearly MOC time series generated by the ECHAM/MPI-OM model are used to test two null hypothesis: one addresses the existence of the slow dynamics and the other the strength of the variability generated by the slow dynamics relative to the low-frequency white-noise extension of the unpredictable short-term fluctuations. The analysis is carried out for different frequency ranges by decomposing the variances in frequency domain. It is found that the model slow dynamics start to operate on timescales longer than two to three years and the variance generated by the slow dynamics can only be over and above the low-frequency white-noise extension of the unpredictable noise when considering timescales longer than 20 years. The result suggests that when predicting the MOC by initializing the ECHAM/MPI-OM model using an ocean analysis, a long initialization time period, preferably longer than 20 years, is required to capture the state of slow dynamics at the initial time.

On the reliability of ENSO dynamical predictions

Speaker: Youmin Tang

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In this study, ensemble predictions were constructed using two realistic ENSO prediction models and using stochastic optimals. By applying a recently developed theoretical framework, we have explored several important issues relating to ENSO predictability including reliability measures of ENSO dynamical predictions; and the dominant precursors that control reliability. It was found that prediction utility (R), defined by relative entropy, is a useful measure for the reliability of ENSO dynamical predictions, such that the larger the value of R, the more reliable a prediction. The prediction utility R consists of two components, a dispersion component (DC) associated with the ensemble spread, and a signal component (SC) determined by the predictive mean signals. Our results show that the prediction utility R is dominated by SC.

Using a linear stochastic dynamical system, we further examined SC and found it to be intrinsically related to the leading eigenmode amplitude of the initial conditions. This finding was validated by actual model prediction results, and is also consistent with other recent work. The relationship between R and SC has particular practical significance for ENSO predictability studies, since it provides an inexpensive and robust method for exploring forecast uncertainties without the need for costly ensemble runs.

Comparison of Information-based Measures of Forecast Uncertainty in Ensemble ENSO Prediction

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In this study, we have applied information theory to investigate the reliability of El Nino Southern Oscillation (ENSO) predictions from 1981-1998. Several recently proposed information-based measures, including relative entropy (R), predictive information (PI), predictive power (PP) and mutual information (MI), were explored for quantifying prediction reliability. It was found that the MI is a good indicator of overall pedictability. When it is large, the prediction system has high predictability whereas small MI often corresponds to a low

prediction skill. The R and PI have a nearly identical average (over all predictions) as should be the case in theory.

Comparing the different information-based measures reveals that R is a better predictor of prediction reliability than PI and PP, especially when correlation-based metrics are used to evaluate model predictability. A ``triangular relationship'' emerges between R and the model skill, namely that when R is large, the prediction is likely to be reliable whereas when R is small, the prediction skill is much variable. A small R is often accompanied by a relatively weak ENSO variability. The possible reasons why R is superior to PI and PP as a measure of ENSO forecast reliability will also be discussed.

Seasonal Climate Forecasts for the Southwestern U.S.

Speaker: Klaus Wolter

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New and improved climate divisions can be used for the statistical prediction of climate anomalies (here: precipitation) in the interior southwestern U.S. After initial success with simple ENSO composites, the lack of clear-cut ENSO phases around 2000-2001 prompted further exploration with other well-known teleconnection indices. Stepwise linear regression was chosen as the most straightforward statistical technique to test and develop prediction equations.

Seasonal forecasts were trained on station data for the Water Years 1951 through 1999. This includes the implementation of a statistical ensemble approach that uses five different base periods, bias-corrected for its performance within the 49-year record. After some experimentation, publicly issued forecasts started in late 2001, and were continually updated monthly on the internet (http://www.cdc.noaa.gov/people/klaus.wolter/SWcasts/). Since the original data training period ended in September 1999, there will be almost eight years of verification data available by August 2007.

Seasonal forecast skill for the interior southwestern U.S. appears to be linked not only to ENSO (and its various 'flavors'), but also to SST regions further afield (Indian Ocean) as well as closer to the U.S. (eastern subtropical Pacific and Caribbean). Other useful predictors include northern hemispheric teleconnection patterns, and antecedent regional precipitation anomalies. Verification skill for the last eight years exhibits large regional and seasonal variations, but has remained positive for all seasons, in contrast with official Climate Prediction Center forecasts for this region. This presentation highlights the regions and seasons with the highest skill, and reports on possible contributors to this skill.

Parallel Sessions：Simulation tools for weather generation and risk assessment

High resolution simulation of weather sequences for binary events with Generative Classifiers

Speaker: Rafael Ancell

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Different generative classifiers have been used to develop a probabilistic model for the simulation of high resolution spatially distributed weather sequences for binary events. The main difference between discriminative and generative classifiers is that discriminative classifiers directly model the posterior probability, and the generative ones first model the joint probability distribution to get the posterior, taking into account the relationships among the different attributes given some kind of available evidence. Generative Classifiers provide us a simple method for generating stochastic weather in a spatially consistent manner. Instead of simulating values independently for each variable (as in standard weather generator methods) we simulate spatial realizations taking into account the constraints imposed by the dependencies among the atributes. This work illustrates the application of this methodology in the case of discrete variables (precipitation), though a similar scheme is also applicable to the continuous case.

The study has been carried out over a small area with 42 locations in Northern Spain, and both extreme and normal precipitaion events have been considered. The validation of the results is based on the RSA (ROC skill area). Three generative classifier models are evaluated: naive Bayes, augmented naive Bayes, and general probabilistic models (Bayesian networks), in different nowcasting, forecasting and climate problems. Finally we show that, in the forecasting situation, the spatial dependencies do not provide any additional information to the simple naive Bayes when an estimation of the atmospheric state (numerical weather prediction) is given. However, these dependencies become very important in the nowcasting and climate paradigms, i.e. when some kind of evidence, other than the atmospheric state, is considered.

Using multi-site stochastic downscaling to understand regional precipitation variability and trends across southern Australia

Speaker: Stephen P. Charles

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 A stochastic downscaling framework based on a nonhomogeneous hidden Markov model (NHMM) identifies how regional precipitation changes are related to large-scale atmospheric forcing. The NHMM stochastically simulates multi-site, daily precipitation conditional on large-scale atmospheric forcing. When driven by observed atmospheric predictors, from NCEP/NCAR Reanalysis, the NHMM is able to reproduce the statistical properties of daily, intra-seasonal, inter-annual and inter-decadal multi-site precipitation for several regions across temperate, mid-latitude southern Australia.

Although originally proposed as a tool for climate change projection, we highlight the benefits of using such stochastic downscaling models for 'forensic climatology' – to understand the drivers of significant decreases in both variability and amount of precipitation experienced across southern Australia in recent decades. Links to detection and attribution research, and other recent investigations into how these changes relate to hemispherical circulation, will also be discussed.

Improving the simulation of extreme events by stochastic weather generators

Speaker: Richard W. Katz

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 Stochastic weather generators are used for a number of purposes, including disaggregation of climate forecasts and statistical downscaling of the output of climate change experiments. Although entire sequences of daily weather are usually required, in many applications it is extreme weather events (such as high precipitation amounts) that are particularly important. Although much is known about the characteristics of extreme weather events (e.g., the apparent heavy upper tail of daily precipitation amount), such information is seldom explicitly taken into account in conventional stochastic weather generators.

One approach to stochastic weather generation is resampling. This approach is nonparametric, with the advantage that the shape of the distribution of a weather variable is not assumed a priori. However, it has the disadvantage that no value outside the span of the

data can ever be generated. In fact, conventional resampling algorithms, such as the standard form of bootstrap, fail for the maximum value of a sample or when the underlying distribution is heavy-tailed. Such limitations of the resampling approach are demonstrated in this talk by example.

The alternative approach to stochastic weather generation is parametric. This approach involves a formal stochastic model for time series of daily weather variables (e.g., a Markov chain model for precipitation occurrence). Because the parametric distributions (e.g., gamma) typically used cannot produce a heavy tail, precipitation extremes can be underestimated by a substantial amount.

Furrer and Katz (2007) proposed a generalized linear modeling (GLM) technique for parametric stochastic weather generation. The GLM technique and its extensions are used in this talk to explore how the simulation of high precipitation amounts can be improved. In particular, the substitution of a stretched exponential (or Weibull) distribution, instead of the gamma, for the upper tail of daily precipitation amounts can be readily incorporated into the GLM approach. Extreme value theory has established that such a distribution can produce an apparent heavy tail. Requiring an extension of the GLM framework is the technique of fitting a mixture of two Weibull distributions to daily precipitation amount. The results suggest that the simulation of extreme precipitation events can be substantially improved, with a stochastic model that remains fairly parsimonious.

Reference

Furrer, E.M., and R.W. Katz, 2007: Generalized linear modeling approach to stochastic weather generators. Climate Research (in press).

Atmospheric dust dispersion from disking operation: near-field simulation

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This paper presents a dynamic random-walk model which simulates the field-scale PM10 (particle m) dust dispersion from an agriculture operationμmatter of diameter ≤10

(disking). The major inputs are the mean wind speed (wind friction velocity, u*) and direction in the simulation period, atmospheric stability, and source strength (g/s, or particle numbers/s). In each time step (usually dt <0.1 s determined by the wind speed and stability) of the model simulation, 3 instantaneous wind velocities (x, y and z directions) are produced randomly based on mean wind speed and atmospheric stability. Then, the wind velocities drive each particle to fly. The particle deposition algorithm judges if a particle is deposited based on the particle settling speed and the wind speed when it touches the ground surface. The particle concentration in 3-D can be obtained at any instant time by counting the particle numbers in a unit volume. The time resolution of the outputs can be less than 1 s and the spatial resolution can be smaller than 1 m. Simulations from this model were compared with measured dust concentration data which were obtained by a Lidar (Laser radar) for disking operations. The model accuracy is acceptable.

Stochastic modeling of regional variability in the summertime precipitation over the southwestern U.S.

Speaker: Jingyun Wang

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The regional variability in the summertime precipitation over the southwestern U.S. is studied using stochastic chain-dependent models generated from 70 years of station-based daily precipitation observations.

To begin, the temporal-spatial structure of the summertime precipitation over the southwestern U.S. is analyzed. Three spatial cluster techniques are used to identify the regionalization of anomalous seasonal rainfall frequency, intensity, and the overall rainfall amounts. Four optimal clusters are identified for all three variables. The seasonal frequency and seasonal precipitation clusters show coincident four-corner spatial structure but the intensity distribution clusters show a slightly different orientation. Next, the regional variability in the seasonal precipitation associated with year-to-year variations in the rainfall-characteristic variables -- the occurrence, the coverage, and the rainfall intensity of regional rainfall events -- are studied. Regional chain-dependent models -- comprising a previous-dependent occurrence chain, an empirical rainfall coverage distribution, and an empirical rainfall amount distribution -- are constructed over each sub-regime and are integrated to simulate the regional daily precipitation evolution. Studies results indicate that more than 55% of the observed inter-annual variance of the seasonal precipitation in a given

region can be explained by the random evolution of the stochastic models, i.e. about 45% of the observed seasonal-mean rainfall variance lies outside of the regional chain-dependent model's capability (which is termed the "potentially predictable" variance). In addition, only a small fraction of observed years (between 10% to 20% over a given sub-regime) contain seasonal-mean precipitation anomalies that contribute to this potentially-predictable variance.

Next, the influences of the various component sub-processes – rainfall occurrence, rainfall coverage, and rainfall intensity – upon the overall precipitation anomalies are analyzed. Study results indicate that year-to-year variations of all three can produce rainfall anomalies in a given year. However year-to-year variations in coverage have the greatest impact upon seasonal rainfall anomalies in each region. Finally, the influence of regional rainfall variations on precipitation anomalies at single station is analyzed. Study results indicate that the regional chain-dependent models can capture more than 60% of the station-based variance in the summertime precipitation. In addition, 70% of the seasonal precipitation variance at a given station is accounted for by regional variability and only about 30% of the variance is contributed by local processes.

A study of daily precipitation in North China using generalized linear models

Speaker: Yi Wang

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Daily precipitation series for North China during 1961-2004 was analyzed with generalized linear models (GLM). A two-stage approach was adopted. Firstly, the pattern of wet and dry was fitted using logistic regression; secondly, the precipitation amount during wet days was fitted under gamma distribution. The regional daily precipitation sequence was simulated by incorporating significant large-scale climate indices and interactions between predictors (e.g. seasonal effect, rainfall autocorrelation and persistence).

The results suggested most influential factors affecting precipitation in North China, as listed below.

(1) North Pacific pattern (NP): a striking negative correlation exits between annual wet days in North China and the NP index. The positive phase of the NP pattern is associated with less annual wet day numbers in North China. The NP also influences the summer rainfall intensity in North China. The positive (negative) phase of NP corresponds to deficient (excessive) rainfall.

(2) The Arctic Oscillation (AO): this pattern is found to be significantly correlated with the summer precipitation amount in North China. A larger AO index corresponds to weaker precipitation.

(3) Large-scale circulation at 500hPa height: the Asian zonal circulation in JJA is negatively correlated with both the precipitation occurrence and severity. Another influential factor is the Subtropical High in the Western Pacific (SHWP) in summer: the stronger the SHWP is the larger the number of rainy days in North China.

(4) East Asian Summer Monsoon: A lower EAP (East Asian-Pacific Pattern) index, indicating weaker East Asian monsoons, corresponds to less summer precipitation in North China. In addition, when onset of South China Sea summer monsoon (SCSM) is early, the rainfall is rich and persistent.

Parallel Sessions: ENSO and Monsoon

The preparation of the colza suitability map using statistical analysis and GIS

Speaker: Hamed Adab

Hamed Adab

Abstract In this paper, 10 environmental data items including climatic and physical variables for colza cultivation collected from 24 sample farmlands in Sabzevar township within the period of agricultural year 2004-2005 and then required statistical analysis carried out for the selected farmlands in order to select the significant linear multiple regression procedures including enter, stepwise and backward in connection to colza yield . After selecting backward procedure as the best model, four environmental condition variables including degree-day, mean temperature, slope and EC of used groundwater extracted as necessary variables for zonation of suitable areas in the whole the study area. Then the spatial maps of the selected variables were prepared and the zonation map of suitable areas for cultivation of colza was prepared using GIS functions. The results show that the appropriate regions for cultivation of colza are located in the plain region in Sabzevar. Toward the border of the plain, suitability conditions of colza cultivation is degrading. Keywords: Colza, Sabzevar, linear multiple regression, Geographical Information System (GIS).

Multi-scale analysis of the surface energy balance during the corn growing season, and a new reason for energy unclosed

Speaker: Jianxia Guo

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Field measurement data collected from the agricultural and meteorological test station of CMA, 2004, was employed to investigate the energy balance problem during the entire corn growing season. Analysis was performed for the entire growing season, 10-day, diurnal, and

on instantaneous time scales, respectively. The statistical regression slope of turbulent energy fluxes (sensible and latent heats) against available energy (net radiation, less the ground heat flux) is 75.79% for the entire corn growing season, which indicates a lack of closure of 24.2%. The imbalance is greatest during nocturnal periods. The regression slope of daytime data is 89% during the 10 days of mid-June, and gradually decreases to 67% during the 10 days of early October, showing the seasonal decrease of energy closure with the corn growth. The diurnal cycle of the energy utilizing ratios show that the energy closure in afternoons is better than mornings. The instantaneous energy utilizing ratios are mainly concentrated within the range of 0~1, but there also exist a number of values outside this range even during the daytime. The latent heat is the main energy consumption form on all scales. The heat storage term from the energy balance equation, may exceed the sensible heat in as long as seventy days, which suggests it should not be omitted from the energy balance analysis of the corn field. There are phase differences that exist in the diurnal cycle of the energy components. The phase of the heat storage term is often shifted to earlier times with respect to the net radiation. We explore the lagging effect of turbulent fluxes as a new reason for failing to obtain the energy closure. Results show that the energy closure ratios are improved on all time scales when turbulent fluxes are lagged by 30 minutes to the available energy. As well as not only the ratio points outside the range of 0~1, but also the earlier phase of the heat storage term are improved in some degree.

Effects of land cover change on East Asian summer monsoon variability

Speaker: Eungul Lee

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The East Asian Summer Monsoon (EASM) is a tropical/subtropical monsoon covering eastern China, the Korean peninsula, Japan, and the adjacent marginal seas. The region of the EASM in this study will be 20°~50°N and 110°~145°E. We have shown in previous research (Lee et al., in press) that there exist two components to the EASM, a northern component and southern component, which are differentiated because they have different causal relationships with heat sources in the surrounding oceans. Each component of the EASM can be skillfully predicted by these causal relationships.

We wish to build on the previous research of Lee et al. and our proposed research will address the following questions: (1) How do land factors affect the strength, seasonality, and sub-seasonal variability of the EASM; (2) How do land and ocean factors interact to determine these properties for the EASM; (3) whether statistical models using a combination of land cover and ocean heating factors skillfully predict EASM precipitation; (4) whether models of the

sub-EASMs behave differently when land factors included; and (5) Do the statistical models based on observational data have good agreement with climate model simulations and can these climate models elucidate the physical mechanisms governing monsoon strength and seasonality.

Spatial correlation, Empirical Orthogonal Function (EOF), and composite analyses will be used to demonstrate the relationships between the EASM and the surrounding land surface factors such as density of vegetation cover, snow cover, soil moisture, and irrigation extent. Multivariate linear and non-linear regressions using stepwise methods will be applied to create the forecast models for the EASM. These will be compared against EOF analyses for consistency. Observed relationships affecting the EASM will also be compared with results from general circulation model experiments in order to illuminate the physical mechanisms involved.

Seasonal Prediction of Rainfall over Peninsular India using a Principal Component Regression Model

Speaker: Lorna R. Nayagam

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The aim of the study is to develop a principal component regression model to predict the summer monsoon rainfall over Peninsular India (PIR). Correlation between PIR and several global parameters were found and those areas having 99% significance were selected for making indices. The consistency of the relationship between these indices and PIR was checked by doing a 15-year sliding window correlation (significant at 5% level). Seven indices having high correlation were selected. Indices are relative humidity at 925hPa (apr), specific humidity at 850hPa (apr), sea level pressure (may), zonal wind at 100 hPa (apr), 30 hPa (feb), 70 hPa (jan) and meridional wind at 10 hPa (jan) over different spatial locations. PCA is done using these seven indices, for the period 1977-2005. Six components with eigen value greater than two which explains the maximum variance were selected for further analysis. A multiple linear regression model was developed using these components for the period 1977-1998. The model has a multiple correlation of 0.917 and coefficient of determination of 84 %. The VIF analysis of all the parameters that is retained in the model have values less than 2 indicating an insignificant level of multicollinearity and has a Durbin Watson value of 1.54. The model performance was assessed for 7 years (1999-2005) using statistical measures such as RMSE, BIAS and ABSE. The model has a RMSE of 6.71 %, BIAS of 0.13% and ABSE of 5.28% of long-term average. Climatological predictions were also made and found that RMSE, BIAS and ABSE are 16.75%, -14.08% and 14.52% of long term average, respectively.

Key words:- principal component regression, Climatological predictions, multiple correlation

Long Range Forecasting of Monsoon Rainfall over Peninsular India for Recent Years

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This study attempts to develop a linear multiple regression model to predict the summer monsoon rainfall over Peninsular India (PIR) for recent years. Correlation between PIR and several global parameters were found and areas having 99% significance were selected as indices. The consistency of the relationship between these indices and PIR was checked by doing a 15-year sliding window correlation (significant at 5% level). Nineteen indices were used as the input and 3 predictors were selected by the stepwise regression method. The predictors are Zonal wind at 700Pa (mar), 200 hPa (Jan) and 10 hPa (Feb.) over different spatial locations. These 3 predictors were used to develop the linear regression model. The model has been trained for a period of 23 years (1981-2003). The model has a multiple correlation of 0.908 and coefficient of determination of 82.5%. The VIF analysis of all the parameters that is retained in the stepwise regression have values less than 2 indicating an insignificant level of multicollinearity and has a Durbin Watson value of 1.82.The model was assessed validated for 4 years (2004 -2007). The model has a RMSE of 7%, BIAS of 0 and ABSE of 5.98% of long-term average, for the training period. Climatological predictions were also made and found that RMSE, BIAS and ABSE are 15.42%, 3.37% and 11.69% of long term average, respectively.

Monitoring and defining El Ni?o/Southern Oscillation behaviour with an enhanced Multivariate ENSO Index (MEI)

Speaker: Klaus Wolter

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 This talk addresses the need for an internationally acceptable ENSO index that allows for the global definition of ENSO events under operational, near-realtime conditions. The MEI appears uniquely qualified to fulfill this need. It was originally defined as the first Principal Component of six atmosphere-ocean (COADS) variables in the tropical Pacific basin. Here we describe a new effort to expand the MEI concept to include both satellite (OLR) and subsurface data. Since these data sets are only available for the last two+ decades, it will be necessary to extend and blend the new MEI time series with the original MEI to allow for historical analyses prior to 1979. On the other hand, long-term trends in MEI-related climate data will have to be removed in order to separate 'Global Change' from ENSO signals.

Parallel Sessions：Spatial statistics

Interactions between dust clouds and meningitis epidemics in the Sahel: a geostatistical study

Speaker: Béatrice Augereau

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 Meningitis due to meningococcus may cause severe epidemics in Africa: 200,000 cases and 20,000 casualties in 1996 for the whole Sahel zone; in 2007 there were over 20,000 cases reported for Burkina Faso. The priviledged hypothesis in the present study is that of a link between dust clouds and the start of an epidemic. The meningitis data in the present study (1992-2003) stems from health centers in different regions of Mali. The dust clouds in the Sahel were identified by processing images from the Meteosat geostationary satelite. The spatial and temporal co-occurences of meteorological events and meningitis epidemics have

been analysed with geostatistical tools taking account of delay effects between the former and the latter.

The present work prepares the ground for Meteosat Second Generation (MSG) studies, which will rely on data with a better space-time coverage and with more climatological parameters, like e.g. temperature and humidity, whose sudden variations in pre-monsoon periods are important factors. Eventually this could yield to the development of derivate products providing forecasts of meningitis in the Sahel, leading ultimately to a better planification of vaccination campaigns.

Estimation of the missing data by principal components analysis

Speaker: L. Benaichata

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From observation to the use, weather data must be treated and checked before final use. One of the problems met is the missing data displayed in many datasets from weather station. Thus, we try to solve this problem by using one of the methods of Eigenvectors called Principal Components Analysis (PCA). he work consists in testing the method on a matrix with a logical in its data. The method is compared with two others, Regression substitution and EM estimation.Apparently the PCA method reconstitutes the missing data perfectly and better. However, the method is applied to a climatic file which contains precipitation data from weather stations belonging to the same region from the statistical point of view. Results are particularly encouraging showing the effectiveness of the method.

Spatial interpolation of daily precipitation in China: 1951-2000

Speaker: Deliang Chen

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Climate research relies heavily on good quality instrumental data. So far relatively little efforts have been made to create gridded climate data for China. This is especially true for high resolution data that can be used to study regional climate variability and to validate regional climate models. This work focuses on gridding of daily precipitation in China over the last 50 years. Daily precipitation data of China from 726 stations during 1951 and 2000 are interpolated to a high-resolution 18km*18km spatial grid system covering the whole country. A 0.5o*0.5o block interpolation is then obtained by averaging the grid nodes falling in each block. Among commonly used interpolation methods, ordinary kriging (OK) based on seasonal semi-variogram is chosen because it shows the best and the most robust performance in cross validation (CV). OK shows better results than those from Inverse Distance Weighting (IDW) method, the second-best method. Excluding the 126 stations (17% of 726 stations) in the northwest arid area, the daily, monthly and annual relative mean absolute error (RMAE) established by CV for the other 600 stations is 58%, 26% and 13% respectively. A close look at the results for tropical China shows that the interpolated results have a relatively high reliability there.

Applications of Bayesian Networks in Climate

Speaker: Jose M. Gutierrez

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Probabilistic networks are an efficient datamining tool which provides a compact and simple probabilistic representation of information. This technique can deal with a large number of variables (discrete or continuous) extracting only the relevant dependencies among them. These dependencies are graphically depicted using a directed acyclic graph (for the Bayesian Networks case) which is easy to understand and interpret. The graph defines a decomposition of the high-dimensional probability density function into a set of low-dimensional local distributions (marginal or conditional). Although this technique is well known in different fields (genomics, machine learning, etc.), just a few applications have been described in climate.

In this work we present some applications of Bayesian networks in climate from a data mining point of view. We work with a database of observations in a network of stations over the

Iberian Peninsula and with the corresponding gridded atmospheric patterns generated by a numerical circulation model. As a first step, we study the efficiency of standard learning algorithms to obtain directed acyclic graphs representing the spatial dependencies among the variables included in the database. The resulting graphical models are applied to different problems including climate analysis and weather forecast allowing also to easily perform sensitivity studies. Just to mention a couple of examples, in the climate case, the agreement between the graphical representations learned from observed and simulated (by a general circulation model) records gives us an idea of the model's ability to capture the observed climatology. On the other hand, Bayesian networks can also be used to obtain the posterior probability of an event in the stations' network given a predicted state of the atmosphere as evidence.

Space-time Modeling of Biomass Burning and Regional Aerosols in Southeast Asia

Speaker: Tao Shi

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Scientists and policy makers have become increasingly concerned about the implications of the consistent brown haze covering Southeast Asia in terms of human health and climate change. The emergence of this haze is due to increased atmospheric concentrations of carbonaceous aerosols, which are generated by anthropogenic activities including both slash-and-burn agriculture and fossil fuel combustion.

Our research focuses on determining the relative contribution of these two types of emissions to the total aerosol burden over the region. We propose a space-time Bayesian model for regional carbonaceous aerosol composition and concentration, given atmospheric circulation processes and observed fire occurrence. Our model synthesizes a variety of types of data including remote sensing imagery, output from atmospheric transport models, and estimates of biomass emissions for various vegetation types.

This is joint work with Prof. Kate Calder (Statistics, OSU), Prof. Darla Munroe (Geography, OSU), and Prof. Ningchuan Xiao (Geography, OSU). This project is supported by NASA Land-Cover/Land-Use Change program.

Construction and applications of 2-d digital filters for separating spatial scales

Speaker: Hans von Storch

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An algorithm for deriving 2-d isotropic digital filters, which approximates a given response function, has been derived. These filters are used to examine the performance of regional atmospheric models on different spatial scales. One application is related to the identification of added value of simulations with such models as compared to driving global models, another for the identification of smaller storms, in particular typhoons and polar lows.

Parallel Sessions：Climate and Industry

Multi-scale analysis of the surface energy balance during the corn growing season, and a new reason for energy unclosed

Speaker: Jianxia Guo

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Field measurement data collected from the agricultural and meteorological test station of CMA, 2004, was employed to investigate the energy balance problem during the entire corn growing season. Analysis was performed for the entire growing season, 10-day, diurnal, and on instantaneous time scales, respectively. The statistical regression slope of turbulent energy fluxes (sensible and latent heats) against available energy (net radiation, less the ground heat flux) is 75.79% for the entire corn growing season, which indicates a lack of closure of 24.2%. The imbalance is greatest during nocturnal periods. The regression slope of daytime data is

89% during the 10 days of mid-June, and gradually decreases to 67% during the 10 days of early October, showing the seasonal decrease of energy closure with the corn growth. The diurnal cycle of the energy utilizing ratios show that the energy closure in afternoons is better than mornings. The instantaneous energy utilizing ratios are mainly concentrated within the range of 0~1, but there also exist a number of values outside this range even during the daytime. The latent heat is the main energy consumption form on all scales. The heat storage term from the energy balance equation, may exceed the sensible heat in as long as seventy days, which suggests it should not be omitted from the energy balance analysis of the corn field. There are phase differences that exist in the diurnal cycle of the energy components. The phase of the heat storage term is often shifted to earlier times with respect to the net radiation. We explore the lagging effect of turbulent fluxes as a new reason for failing to obtain the energy closure. Results show that the energy closure ratios are improved on all time scales when turbulent fluxes are lagged by 30 minutes to the available energy. As well as not only the ratio points outside the range of 0~1, but also the earlier phase of the heat storage term are improved in some degree.

A Decision Tree Classification with Correlation-based Feature Selection for Decision Making in Conducting the Cloud Seeding Operations

Speaker: Lily Ingsrisawang

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The northeastern part of Thailand is an arid region with varied rainfall. To enhance the precipitation in this area, a number of cloud seeding operations have been conducted by the Royal Rain Making Project. Since there is no assurance for the success of cloud seeding operations, it is important to determine or forecast the success rate before any operations are conducted. Several climate factors, precipitation records and prediction results from the cloud models such as the Great Plains Cumulus Model (GPCM) are normally used in making the decision on whether the cloud seeding operation will be successful or not. This study presents a two-step supervised learning framework to improve the forecasting performance on the success rate of cloud seeding operations. First, we perform a correlation-based feature

selection to eliminate the irrelevant features and find a subset of features that give the maximal separation between success and failure in the operations. Second, we apply C4.5, a decision tree induction algorithm, with the selected discriminative features for building a classifier for predicting success or failure in the cloud seeding operations. Using the real data collected in the northeastern part of Thailand from the Royal Rain Making Regional Center during 2004-2006, our framework yields the accurate and interpretable classifier, reaching 91.2% accuracy. In addition, the decision tree can be converted and extracted to a rule set to improve forecast and facilitate decision making for conducting the weather modification activities or cloud seeding operations.

Uncertain Climatic Land of Africa

Speaker: Gordon Ondiek Nyabade

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The beautiful and most resourceful land of Africa is daily faced with uncertainty in her climatic conditions.Each country and especially countries constituting East and Southern Africa region most people live in rural areas and depend on subsistence agriculture for their livelihoods. In the region land degradation occurs mostly from soil erosion, chemical degradation (loss of nutrients, depletion of organic matter and acidification) and biological depletion. Other factors which contribute to land degradation in the region include compaction from overgrazing of rangelands, uncontrolled burning and improper cultivation of steep slopes, alternating flooding and crusting, salinization and pollution which all combine to cause degeneration of the fragile ecosystems covering large expanses of the region.

Landscapes devoid of vegetative cover deeply incised by gullies that are difficult to reclaim, characterize large land expanses in the region classified as drylands. The portions classified as sub-humid or humid (highlands and wetlands) are prone to rapid soil loss from flash floods or periodic flooding. With a cycle of 2-3 and sometimes 5-6 years, droughts that have occurred in the region for over a century, worsen the land degradation problem making land management a formidable task particularly during the critical moisture deficient periods. Differing land tenure systems combined with high poverty and low literacy levels common among the rural population complicate land management process.

Low technological capacity, poor governance, poorly conceived management policies and their implementation further complicate land management issues. Technology development, technology transfer and low adoption rates further exacerbate the situation. Pressure on the land and competition for land is of main concern throughout the region. Governments in the region as well as private organizations (including the numerous NGOs operating in the region), some communities and individuals (including researchers and academicians) have all identified the need to conserve land and reverse degradation to restore its productivity and improve the quality of life for those who depend on it for their livelihoods.

The paper examines the nature and causes of land degradation in the region, linking it to population characteristics, land ownership, low technological capacity, poverty, poor governance, low literacy and inappropriate land management practices. The paper points out that numerous interventions targeted at reducing poverty and improvement in land resource management have not achieved their targets due to lack of coordination, rigidity and imposition which culminated in failure of the interveners to recognize and incorporate indigenous knowledge and peoples?preferences and/or indigenous age-old land management strategies. Linkages to trade and unequal market access that encourages poverty and unwise use of the land resources are discussed. Adopting people centered interventions is recommended together with smart partnerships between the participating partners both from the north and those from the south. Solutions will largely depend on willingness to change and sharing information that will guide appropriate regional action. The region faces an enormous challenge part of which is to come up with viable solutions that will reverse the degradation of land and manage it sustainably

Estimating barley yield by means of drought indexes and climatic parameters in Eastern Azerbaijan using Artificial Neural Network

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The growing season climatic parameters; especially, rainfall plays the main role to predict the yield production. Therefore the main objective of this research was to find out possible relations among meteorology parameters and drought indexes with the yield using Artificial Neural Network.To achieve the objective, meteorological parameters such as; precipitation, the average of maximum temperature, the average of minimum temperature, the average of temperature, the sum of temperatures more than 10,evaporation,the water vapor pressure ,the average of wind speed, the sunshine and the drought indexes such as; Percent of normal Index, Standard Index of Annual Precipitation Index, Hydrothermal Index, Nguyen Index, Transeau Index, Standardized Precipitation Index, Shashko moisture drought Index, Rainfall Anomaly Index were evaluated in terms of normality and their mutual influences. Then the correlation analysis between the barley yield and the climatic parameters and drought indexes have been examined .the results of this study showed that among the drought indexes, Nguyen Index , Transeau Index , Rainfall Anomaly Index and Standardized Precipitation Index (SPI24) are more effective for prediction of barely yield. In this research, ANN model is recommended for monitoring and predicting agricultural drought.

Drought and its ecological effects in central of Gilan –south western of Caspian sea

Speaker: Ramezani Gourabi, Bahman

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I compared the changing of precipitation (Drought) with growth of tree ring index (TRI) in the cental of Gilan at a statistical period (1995-2003). The research method this paper is field work and using from cut wood and capture of wooddisk and prapering in the laboratory and counting of TRI yearly with comparing precipitation rate in this same time (anaual, monthly) with correlation method. Result of this research showed that drought or deficit of rain has direct relationship with growth tree ring index ((TRI) diameter incremeter in Popolar trees and has prefer that with irrigation on time could will low risk of destroy.

Key words: Drought, Gilan, Popolar trees, Tree Ring Index (TRI)

A model of potential natural vegetation

Speaker: Matteo Zampieri

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A number of vegetation dynamical models already exist, but they are affected by uncertainties related to the high degree of parameterization of the involved processes.

Here, as an alternative, a diagnostic model of potential natural vegetation, based on cluster analysis of high resolution datasets of observed vegetation distribution and climate, is proposed.

The model reliability is discussed and it is showns how it can be applied for reconstructing spontaneous vegetation distribution in areas where it has been replaced because of anthropic action. Further, it can be coupled to climate models in order to take into account the feedback of dynamical vegetation to the atmosphere and it can be be used to infer past climate from paleo-vegetation datasets.

Special AMS Session：Verification of Climate Forecasts

Diagnostic and user-focused verification of seasonal and climate forecasts: Extensions from weather forecast verification methodologies

Speaker: Barbara G. Brown

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In recent years, the weather forecast verification community has given a lot of attention toward development of verification approaches that provide more meaningful information about forecast performance than can typically be obtained using traditional verification measures (e.g., RMSE, Brier Skill Score). In part, the movement toward these new approaches has been driven by a desire to identify and understand which aspects of a forecast are performing well or poorly (e.g., to feed back into model improvements). In addition, this focus has been driven by the need to provide more meaningful information regarding forecast quality to forecast users (e.g., to aid in decision making). Both of these motivations also have relevance in the seasonal and climate prediction community.

More specifically, new verification methods have been developed that consider attributes of spatial forecasts that are of relevance either for a particular user or a broad spectrum of users. While heretofore much of the effort toward development of these methods has focused on weather forecasts, similar approaches would be equally applicable for evaluating the performance of seasonal predictions, and for examining the abilities of global and regional climate models to replicate current (or previous) climate conditions. Differences between climate/seasonal forecasts and weather forecasts that must be taken into account when applying these methods will be discussed, and examples of the types of methods available and how they might be applied to climate forecast verification will be presented. In addition, the concept of user-focused verification will be discussed in a more general context.

Locality and the Ranked Probability Score

Speaker: Simon Mason

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The ranked probability score and its corresponding skill score are widely used metrics of the quality of forecasts of weather and climate that are expressed as probabilities of three or more ordinal categories.The ranked probability score considers the ordering of the categories so that for two forecasts with equal probabilities assigned to the observed category, a better score will be achieved by the forecast that gives higher probabilities to nearby categories. It is argued here that when considering the mathematical quality of forecasts as opposed to their social or economic value, the credit given to probabilities assigned to categories close to the observed category ('distance') is an undesirable feature of the ranked probability score because we have no knowledge of what the actual probabilities are for these categories for any specific case. The reliability of the probabilities assigned to the categories that did not verify can be tested only over a set of forecasts by considering the observed relative frequencies of verifications within these categories conditional upon the forecast probabilities assigned.It is thus inappropriate to give credit for 'near-misses' in the context of probabilistic forecasts. A desirable feature of a scoring metric is that of 'locality': the forecast is scored only on the basis of the probability assigned to what actually occurred. The ranked probability score does not have this feature. Alternative scores include the quadratic and the logarithmic scores, but the latter is to be preferred since the former does not generalise to continuous forecasts (infinite number of categories).

Verification of Seasonal to Secular Climate Forecasts

Speaker: David Stephenson

Professor David Stephenson
University of Exeter, UK

Verification is a key aspect in developing good scientific forecast systems. Without reliable procedures for forecast evaluation, we are unable to judge whether a forecasting system is better than just chance or whether a new forecasting system is really an improvement compared to previous schemes.

Climate forecasts pose particular problems for forecast verification. Small sample sizes and non-stationarity due to long-term trends can make verification scores extremely unreliable and uninformative and put serious limits on how well we can assess such types of forecast.

This talk will discuss various issues that affect the verification of climate forecasts and will present simple statistical models for understanding verification of climate forecasts on lead-times from seasons to centuries

Verification of Climate Forecasts (Discussion)

Speaker: Ian Jolliffe

Beyond Ensembles: The Application and Improvement of Climate Simulations

Speaker: Leonard Smith

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Climate models are large nonlinear dynamical systems which insightfully but imperfectly reflect the evolving weather patterns of the Earth. In the theory of nonlinear dynamical systems, the concept of shadowing is employed to describe the ability of one mathematical system to admit trajectories which remain close to the trajectory of another mathematical system, as the two evolve in time. This idea is generalised to the case where we have one mathematical dynamical system and observations of a physical system. Recent applications to operational weather models are used to justify the likely applicability of this approach in the climate context. Ensemble experiments sample the various uncertainties and inadequacies of the available models, and yield useful information on model behaviour. The high dimension of the model-state spaces and our ignorance of how to to sample the space of model structures limit our ability to improve and interpret our models using the ensemble approach.

These limits are highlighted, from the decision makers perspective, with figures from the 2007 IPCC Summary for Policy Makers. Our ability to address the needs of decision makers via ensemble experiments is discussed, and contrasted with the information which could be extracted from shadowing experiments. In the climate context, shadowing experiments identify pseudo-orbits of the model over relatively well-observed historical periods (say, 1950-2006).

Poster Session

Detected shift of Mediterranean cyclone tracks using the ERA-40 database

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Midlatitude cyclones are analyzed on a selected region covering most part of southern Europe and the Mediterranean Sea (i.e., 35-50°N, 10°-25°E). On the base of mean sea level pressure fields of the ECMWF (European Centre for Medium-range Weather Forecast) Reanalysis Dataset (ERA-40), detailed evaluation of the Mediterranean cyclones is accomplished for the period between 1957 and 2002 on a 1-degree horizontal resolution grid. Cyclone centers are identified using anomaly fields, and then, the paths of these mid-latitude cyclone centers are tracked with a 6-hour time step (using 00 UTC, 06 UTC, 12 UTC, and 18 UTC). Decadal, annual, and seasonal statistical analysis of cyclone tracks includes the study of the genesis, the frequency and the activity of the Mediterranean cyclones, as well, as the variability of cyclone tracks. The results suggest that the cyclone frequency in the entire Mediterranean region increased in summer and autumn, and decreased in winter and spring. A special belt-shape area is identified, which plays a special role in cyclogenesis, and also, the cyclone tracks often remain within this belt. An overall decreasing trend is detected in winter and spring in the entire Mediterranean belt, while cyclone frequency increased in autumn. The largest positive and negative trend coefficients are identified in summer.

Regional climate change expected by the end of the 21st century in Central/Eastern Europe

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The results from coarse resolution global climate models (GCM) can only be considered as a first-guess of regional climate change consequences of global warming. Regional climate models (RCM) nested in GCMs may lead to better estimations of future climate conditions in the European subregions since the horizontal resolution of these RCMs is much finer than the GCMs. In this poster, RCM outputs from the completed PRUDENCE project are summarized for the Carpathian Basin (located in Central/Eastern Europe). Composite maps of expected change in temperature and precipitation are generated using the RCM simulations (with 50 km spatial resolution) for the periods of 2071-2100 and 1961-1990. Furthermore, uncertainty of

the regional climate change is represented by the standard deviation of the simulated changes. Furthermore, the potential use of regional climate model RegCM3 developed by Giorgi et al. in ICTP is discussed. This RCM is a 3-dimensional, sigma-coordinate, primitive equation model, and has been adapted at the Department of Meteorology, Eotvos Lorand University with 10 km horizontal resolution and 23 vertical levels.

Future changes of extreme events over Korea in regional projection

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IPCC has sent a clear message that warming of the climate system is unequivocal and most of the observed warming is attributable to human activities. For the next two decades, a warming of about 0.2C per decade is projected for a range of SRES emission scenarios. At the end of 21st century, global mean surface temperature is projected to increase by 1.1-6.4C due to the projected increases of greenhouse gas concentrations in the atmosphere. Large-scale forcing arising from global warming may locally change the precipitation distribution over complex terrain regions such as the Korean Peninsula. To understand possible future surface climate change over Korea, regional climate change projection is produced from MM5. The boundary condition is from the coupled climate model ECHAM4/HOPE-G simulation based on the IPCC SRES A1B scenario. In regional projection, temperature and annual rainfall amount will increase by 4C and 17% over the Korean Peninsula in the end of 21st century. Hot extremes and heavy rainfall events will continue to become more frequent.

Multi-scale statistic and dynamic model for annual streamflow of the Yangtze River at the Three Gorges Dam in China

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A novel multi-scale analysis method, Empirical Mode Decomposition (EMD),is used to analysis the annual streamflow of the Yangtze River at the three Gorges Dam in China. The results shows that:(1) The annual streamflow of the Yangtze River at the three Gorges Dam can be decomposed into four timescales quasi-periodic oscillations including a 3 year signal, a 7 year signal, a 13 year signal and a 54 year signal, as well as a trend. With each contributing ration of the quasi-periodicity discussed, the 13 year and the 54 year timescale oscillation is the most prominent.(2)Using the model for annual streamflow of the Yangtzs river at the three gorges dam based on EMD, the predictions of streamflow from 2001 to 2004 are tried and show good effects. The relative errors of model 1 and model 2 are less than 12.5% and 2.4% respectively.(3)Five years prediction in advance of annual streamflow for the Yangtze River at the three Gorges Dam shows that the annual streamflow will be less in the future two years, then rise again in the third and forth year, up to the year 2012 the greater streamflow comparing to that in 1998 will probably occur. The results of the study provide a valuable information for operating and managing the Three Gorges hydro-power station.

Climate Change in the Siberian High and Its Relationship to the East-Asian Monsoon

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The Siberian high is a large scale system of the Northern hemispheric circulation, which dominants other systems, such as the circulation over the Eurasia, the East-Asian Monsoon, the Meiyu over the Yangtze River. The study of climate change in the Siberian High has been carried out and presented in this paper.In order to understanding the interannual to interdecadal variations of the Siberian high, the index I of the Siberian high for 1873—2000 was calculated using the NCEP/NCAR reanalysis data, the index I is a mean of the sea level pressure (SLP) for all network points covering 40—55°N, 90E—110°E.The climate change in the Siberian high in winter was investigated. Its linear trend is almost at zero, it means the variation in the Siberian high in winter oscillated around an average since 1873. There were three oscillations during 1873 to 2000, the averaged oscillation period is about 40yr. The minimum of the Siberian index I during 1873 to 2000 is 1025.1 hPa in 1917, but the maximum is 1038.1 hPa in 1967. There were two periods with a low pressure during 1913—1922 and 1988—1998 respectively. But there was one period with a high pressure during 1966—1974, but the pressure values are not so high. The interdecadal variation was investigated too. The result shows that the interdecadal variation of the Siberian index is significant.In order to model the climate change in the Siberian high in winter, a new approach of time series analysis is carried out, it is called a data-based self-memoried (DASM) model. Self-memoried principle of dynamic system is briefly described, then the DASM model is presented as well. The DASM

model has been applied to the series of the Siberian high index and demonstrated its ability for fitting and forecasting.Besides, the relationship between the Siberian high in winter and the East-Asian summer monsoon was studied. The synchronization between the Siberian high in winter and the East-Asian summer monsoon existed before 1925, after that the variations of both the Siberian high in winter and the East-Asian summer monsoon were quite different, the East-Asian summer monsoon became weaker.

Long-term Probabilistic Forecast and T* Distribution

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Models are great tools to test ideas. Their usefulness, however, depends on their ability to simulate the current reality and predict the future. In this study, I show that a statistical model based on a new t*-distribution of station temporal data is capable of predicting the probability of any future outcome to exceed a specific value using only the currently available sample statistics assuming a normal random variable. In an air quality management application, the model has demonstrated categorically an average success rate of over 80% both in simulating the current ozone non-attainment areas and forecasting the rate of future violation of the 8-hour ozone National Ambient Air Quality Standards in the U.S. for up to 12 years. While the predictability of deterministic climate models is still limited by large uncertainties, the probabilistic forecast by this model provides a promising alternative in assessing the climate impact on environment for decades.

Spatial Drought Reconstruction Based On Point-By-Point Regression

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The paleoclimate reconstruction of climate fields is often considered a joint space-time estimation problem where the predictand climate field, typically on a regular grid, is reconstructed simultaneously from an irregular predictor network of paleoclimate proxies. In dendroclimatology, there is a rich history of doing this as far back as 1971. In so doing, sea level pressure, temperature, precipitation, and drought fields have been successfully reconstructed from tree-ring networks using a variety of reduced space multivariate regression methods. While such methods can work well, they are also difficult to diagnose because the network of predictors is contributing jointly to the reconstruction of the climate field in a potentially very complicated way. Thus, why a reduced space multivariate method might fail to skillfully reconstruct certain areas of a climate field might be impossible to identify and correct

for without negatively impacting other parts of the field. This would appear to be especially the case in reconstructing precipitation and drought fields that have a lot of relatively small-scale spatial variability in them. To avoid this problem in reconstructing gridded Palmer Drought Severity Indices (PDSI) over North America from tree rings, and to use only those tree-ring chronologies that are likely to have true drought signals in them, a method of point-by-point regression (PPR) was developed and extensively tested. PPR reconstructs each grid point of PDSI separately from all others using principle components regression analysis. As constructed, PPR has total control over which tree-ring predictors are used at each grid point through two steps that determine the selection of candidate predictors: a search radius for locating likely predictors of PDSI and a screening probability that identifies those predictors within the search radius that are likely to contain statistically useful information about past drought. This predictor selection process is applied at each grid point in the reconstruction of the PDSI field such that not all tree-ring predictors are used to reconstruct drought at all locations of the grid. Thus, the PPR method operates locally within the possibly overlapping limits of the search radius used. Even though PPR does not theoretically guarantee the preservation of the joint space-time variability of the PDSI field because of its point-wise method of estimation, tests reveal that the inherent spatial patterns of drought variability over North America are faithfully preserved in the PPR-reconstructed field.

High resolution modeling of the monsoon circulation in the Indian Ocean

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Results on the monsoon circulation in the Indian Ocean simulated with a σ-coordinate ocean model developed at the Institute of Numerical Mathematics, the Russian Academy of Sciences is presented. The model has a horizontal resolution of 1/8°×1/12° and contains 21 σ-layers of uneven thickness. Realistic bottom topography and land geometry are used. The numerical experiments were carried out for 15 years starting from the Levitus climatology for January and monthly mean climatic atmospheric forcing from the NCEP reanalysis data. The annual cycle of the surface and subsurface currents and temperature and salinity fields were analyzed. The model reproduces well the Summer Monsoon and the Winter Monsoon currents and their time evolution and spatial structures. The Somali Current is adequately modeled. During the Summer Monsoon, the velocities of the current exceed 2 m/s, while the total mass transport is approximately 70 Sv. The model results show that a reversal of the Somali Current from the northern direction in the summer to the southern direction in the winter is accompanied by the generation of anticyclonic eddies, which drift westward owing to the β-effect and dissipate either near the Somali shore or in the Gulf of Aden. The monsoon variability of the equatorial surface current and equatorial subsurface countercurrent system

are analyzed. It is shown that these currents are generated predominantly by the zonal component of wind stress, in which the half-year harmonic dominates. This leads to the fact that the equatorial surface current also changes its direction with a half-year periodicity almost in phase with the wind. The oppositely directed subsurface compensational countercurrent changes its direction with a time lag of approximately one month. Gradient currents, which appear in the Bay of Bengal due to the riverine runoff, make an important contribution to the circulation. This effect manifests itself especially strongly in the summer during the peak of the Ganges River runoff, which transports fresh turbid waters. The principal features of the large-scale quasi-stationary gyre structure of the Indian Ocean such as the Great Whirl, Socotra high, and Laccadive high and low are simulated.

The Study of the Impacts of Meteorological Parameters on the Air Quality Index in the Esfahan City

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Air is the certain composition of different gases. If the percent of these compositions be changed which has been harmful effectiveness on human health or alive things,it be called air pollution. For numerising the quality of air and reporting it to common, Air Quality Indices were been used thus pollution standard index is one of these indecies. A standard Air Quality Index changes the density of surface pollutants to a dimentionless number. This index classified by 50 units that each number expresses the especial condition of air quality by Good, Moderate, Unhealthy and very Unhealthy words. The goal of this investigation is stuying the effect of meteorological parameters on Esfahan Air Quality Index by Isfahan Meteorological Weather Station, Environmental Organization Stations. So, first of all we calculated air quality index by special software during 1383-1385. Because of Ozone is very important for determining Air Quality Index so we studied it during 1995-2005.For determining the effectes of meteorological parameters on Air Quality Index we used the meteorological data on surface and 13 standard upper levels. Calculations expressed that Maximum Temperature, Average Temperature, Total Solar Radiation and surface Pressure have strong effects on Total Ozon measurments. Dioxside Nitrogene in spring and summer, Dioxside Sulfure in autumn and winter had maximum values. Dencity of Carbonmonoxide changes with trafic pattrern and man activities and its values upper than other pollutants. Dencity of Pulb and Cadmium changes with traffic pattern. Particular Matter in dry days had upper levels in compare of wet days and more than half of them had about 0.1 micrometere diameter. Normalised Residual Mass Curve of Total Ozone showed that Ozon fluctuations decreses in recent years. Upper level meteorological parameters had strong effect on Ozon especially temperature in 50 milibar level. Total ozone in spring had high valuse and in winter had low values. We calculated the statistical relationships between Air Quality Index and meteorological parameters on surface and upper standard levels. Calculations showes that relationships between Total Ozone and Total Sun Radiation is more than Sunny Hours.Termal Island Effect on Isfahan city due to consuming

energy and termal saving ability of asphalt and structural materias caused that isfahan minimum temperature .0.1 c and miximum 3 c upper than upper than perimeter .Air quality in Azadi and Bozorgmehr squares were more than Lale square which shows the role of urban transportation in decreasing air quality in some days. We draw synoptic maps in surface and 500 milibar levels a day before pollutant episode, during pollutant days and one day after pollutant episode by Grads. software and classified the occured patterns in these days. Duration of pollutant days in Esfahan City were in one, three, five, seven, seventheen, nineteen and twenty three days period. Synoptic maps showed that presence of high pressure syclones with pressures upper than 1025 milibar on North, Westnorth or Eastnorth of Iran (North of Caspian Sea, Gafghaz, Siberia and Oral Lake) are essential factor for bad air quality in Esfahan city. Sometimes these conditions due to the formation a local high pressure syclon that air pollution intencify and reach to critical limits. At this time in the upper upper level usually a teraghf formed on Mediterane Sea, Black Sea, Iraq or in the Northwest of Iran when a ridge were about west of Iran. Due to this time weather subsides from upper level and air descends which causes the dencity of pollutants on the surface increased. In addition, when high pressure cyclones are presenc, the movement of air through inside of syclone with low speed which limits the scattering of pollutant in horizontal area. This phenomena causes the polluted days be continued. So in these days we must cotrol the issuing of pollutants from sources by different ways that each way must be done by related organizations. Some of these activities are: using instruments for monitoring and controlling the volume of polume from industries stacks, development of urban green space, correcting some passage and altitude of urban buldings, development of public transportation, development of the tecnology of automobile production.

Key words:Air Quality Index(A.Q.I), Meteorological Parameter,Total Ozone , Atmospheric Pollutant Model , synoptic System .

Statistical Analysis of temporal variation of rainfall and evapotranspiration in several meteorological stations of Iran

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The methods for estimating temporal variation of evapotranspiration and rainfall are useful tools for irrigation scheduling and regional water allocation. The purpose of this study was to determine the probability, trend of seasonal, annual rainfall and evapotranspiration in some meteorological stations of Iran for the last 50 years. Reference crop evapotranspiration (ETo) was calculated from Penman–Monteith equation using meteorological data measured from 11

stations in Iran. The amount of seasonal, annual ETo and rainfall trend were determined by Mann–Kendall test analysis during 1953s–2003. The data was then subjected to statistical tests to determine the probability distributions that best fit them. Suitable probability distributions were selected from among the Normal, Log-Normal, Gumbel Extreme Value Type I, Gamma and Logistic distributions. Seasonal and annual rainfall and ETo at 80, 50 and 30 percent probability levels were determined. The results showed that there is not any significant trend for seasonal and annual rainfall and evapotranspiration in all of station. And so, The probability analysis of data shows that variability of evapotranspiration and rainfall are so much, therefore determining return period of this data are useful for rainfed irrigation. The results of this analysis can be attributed to expansion of irrigation areas and agricultural management.

Keywords: climate change, rainfall, Reference crop evapotranspiration, probability analysis, trend

Error Detection and Checking of Inhomogenities Basing on the Metadata in Uganda Climatological Dataset

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Climate data is a key aspect of statistical climatology, more so, today, when climate change amplitude is super imposed on climate variability, there is a dire need of well managed quality data to prove that climate change is not a myth but a reality. WMO together with the climate scientist are keen to see that artificial deviations within the climate data must be dealt with, hence the need for data homogenization. In his opening speech, at the FOUTH SEMINAR ON HOMOGENISATION AND QUALITY CONTROL IN CLIMATOLOGICAL DATABASES (Budapest Hungary WMO_TD No.1236 2004), Yadowsun Boodhoo observed that, homogenization of the climate data is not within the reach of all member countries. In this regard, this paper seeks to address issues pertaining to uncertainties within the climate datasets which was written out of the quality control work done during the HYDROCLIMATIC STUDY(2003) in Uganda. The detection of errors in climatological data sets, the checking of inhomogenities basing on metadata and design of quality control measures were undertaken during an inter-disciplinary study carried out by Uganda Meteorological Department (UMD) in collaboration with the Water Resource Management Department (WRMD). There were 597 rainfall and 50 temperature stations which were digitized using CLICOM software that generated 16,363 and 1,500 records of rainfall and temperatures respectively, spanning the years 1902 to 2003.Different types of errors and their relationship were identified. Checking logics (nature of checking algorithm) were employed both by automatic computer programs and manual checks. The check tests used varied in accordance with the characteristic of logical operations, the element and the type of data being checked, daily, monthly or annual

data type and also suspicious zeros. Suspicious values were compared to their neighbors and the meta data available was checked to prove the worthiness of the record. In respect of data quality, correlations for AWS data was compared with manual data to see if it can be used to complete the missing data in the series for Namulonge Reaseach station and Ebtebbe where the AWS stations have been place in the same site with the manual stations.Ultimately because of the new quality control techniques used in this study, confirmed consistent extreme values of rainfall were identified. Confirmed inconsistent records were also identified. Inhomogenities were discovered in Mbarara, Buvuma and within estates stations who had abruptly changed management.

Analyze Effect Factors and Research Forecasting Method of the Annual Water Consumption in Beijing City

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In this paper, the partial least squares model is used to analyze the relationship between the annul water consumption and its influencing factors in Beijing. It is found that the annual water consumption in testing year can be forecasted more precisely when the sample time between forecast object and factors is staggered by 3 years. As the equation confirmed, the future value of factors should be forecasted for restrict of samples' length. The factor samples are forecasted by AR model. At last, through the determinate equation and the forecasted factors, the annual water consumption from 2003 to 2010 in Beijing can be forecasted. It turns out the definitely increasing trend of the annul water consumption in Beijing from 2003 to 2010.

Forecasting Schemes of the Reservoir's Monthly Runoff Volume Based on the Wavelet Analyze

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The wavelet theory is used to analyze some reservoir's monthly runoff volume. Based on the decomposed approximate and detailed coefficients, model is established with BP network. The result of show that the model with the method of wavelet analyze and BP network is better and valuable.

The study of the Urban Heat Island in Nanjing city

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The urban heat island (UHI) intensity in Nanjing, has been particularity investigated using the temperature data measured at three urban and one suburb station form 1960 to 2005, including annual, mensal, day-by-day temperature of average, highest, lowest, and four times(02:00, 08:00 , 14:00, 20:00) a day. The thesis adopts three sorts UHI statistical methods to analyze the character of the UHI. The conclusion can be drawn as following: (1) The UHI intensity boosts up with the developing of city, and also gives more prominent presentation on annual lowest temperature than on annual highest temperature and annual average temperature. (2)The seasonal variety of UHI intensity is obvious: strong in spring, weak in autumn and winter. (3) The UHI intensity in Nanjing is lower than other large city, the peak value is between 0□ and 3□. When the daily temperature is lowest, the UHI intensity is stronger. (4) The temperature of four times reflects an obvious day and night variety of UHI intensity with the maximum intensity appears at 02:00 and the minimum at 14:00. (5)The UHI intensity exponent increases holistically reduce in 1960s, arrive at lowest in 1970s, increases again form 1975.

"Attribution of changes in extreme weather risk: a study of the European Summer 2003 Heatwave"

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In 2003 the average summer temperature in continental Europe exceeded the 1961-1990 European summer mean by 2.3K. Many regions experienced a large number of deaths due to

the elevated temperatures, and attribution studies have determined that human activity have at least doubled the risk of such a heatwave compared to pre-industrial times. However, other, non-linear processes could also have amplified summer 2003 temperatures: feedbacks between reduced cloud cover and precipitation and reduced soil-moisture may have prevented the usual convective disruption of the high pressure system. This study will build on previous attribution work by attempting to further isolate the change in risk of the heatwave due to anthropogenic influences. A large ensemble of the ECMWF IFS model will be performed at higher resolution than previous studies, with improved simulation of land surface processes.

Seasonal Rainfall Prediction for the Tropical Pacific Region

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Research has shown that short term global climate fluctuations, such as those related to the El Nino Southern Oscillation (ENSO) phenomenon, play a dominant role in the climate variability in the tropical Pacific region. Because the demand for climate information in the tropical Pacific region has risen in the last decade, the PEAC (Pacific ENSO Application Center) Climate Teleconference and the Southern Pacific Island Climate Teleconference have been held monthly to support the decision making processes undertaken in the tropical Pacific region for water resource management, fisheries management, agriculture, natural disaster mitigation strategies, and other climate sensitive sectors. The climate teleconferences also set up a bridge to exchange the climate information for the scientists from US, Australia, New Zealand, and Pacific island nations. Both dynamic and statistical forecasting tools are examined for the seasonal rainfall forecast for the tropical Pacific region in the climate teleconferences. An objectively consolidated seasonal rainfall forecast scheme for the tropical Pacific region is developed recently through the support of the NOAA PRIDE (Pacific Region Integrated Data Enterprise) project. The future plan and opportunities, e.g., NOAA Climate Test Bed (CTB) and Pacific Climate Information System (PaCIS), for improving the climate prediction skill for the tropical Pacific region will also be discussed.

Development and analysis of a daily high resolution grid over Spain (1950-2003)

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Gridded climate data sets have the advantage of producing a historical set of consistent and regularly distributed observations, and are a very useful tool for validating numerical weather prediction models. In this work, a new 0.2º spatial resolution (~20Kms) observational grid for precipitation and extreme temperatures (maximum and minimum) has been developed, built-up from the Spanish National Meteorological Institute (INM) data network: 3500 rain gauges and 850 thermometric stations. Both networks have a daily temporal coverage from 1950 to 2003.

Firstly, commonly used interpolation methods –such as kriging, kernel-based methods, angular distance weighting and thin plate splines- have been compared, using different aggregation time scales: daily, weekly and monthly. In this work we show how the performance of the different methods depends on the aggregation time scale.

Secondly, in order to explore the utility of the grid, an analysis of the climatology, trends and teleconnections with El Nino-Southern Oscillation (ENSO) and North Atlantic Oscillation (NAO) has been performed.

Projection of future heat wave mortality rates using regional climate model predictions

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As the frequency and intensity of heat waves are projected to increase in the 21st century, mortality associated with extreme high temperatures is a major health impact under climate change. This poster presents projections of future heat wave mortality in two European cities, London, United Kingdom and Budapest, Hungary using predictions from the Hadley Centre Regional Climate Model (RCM).

The past relationships between daily mortality rates and observed meteorological variables in London (1993-2003) and Budapest (1992-2001) are modelled using a generalized additive model (GAM). It is shown that the mortality rates in both cities exhibit annual cycles,

modified by effects of air temperature and humidity. Systematic errors in the RCM are identified by comparing its simulation of present-day climate with observations. After correcting such biases, changes in summer mortality rates in the 21st century are projected using the GAM developed with the air temperature and humidity predicted by the RCM.

East Asian Summer monsoon changes in the MIS 3 Stage recorded from the western South China Sea

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The climate of Marine Isotope Stage 3 (MIS 3) was extremely variable on a millennial timescale, characterized by Dansgaard–Oeschger (DO) events and Heinrich (H) events. In this work, sediments from the upper part of Core 17954-2, located at the upwelling area off the Vietnam coast in the western SCS, was analyzed to uncover how the rapid climate changes in this region responded to that in high-latitude region of the Northern Hemisphere during MIS 3, by discussing the changes of surface sea temperature (SST), depth of thermocline (DOT) and primary productivity with AMS14C dating and stable oxygen isotope analysis on the basis of analysis of planktonic foraminifera species.The records of planktonic foraminifera in Core 17954-2 responded to rapid climate events in the records of GISP2. Besides, there were more changes similar to these observed in this work.. In certain of IS events, the conditions of low SST, shallow DOT and high productivity implied upwelling taking place when it was warm. It was estimated that East Asian Monsoon enhanced during these warm events. On the other hand, three stages showed in some indexes also supported a concept that enhanced East Asian summer monsoon could influence this region.

Wavelet Based Fractal Analysis of El Niño Episodes

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Fractal widely exists in nature, and has been developed both in theory and application. Self-organized criticality (SOC) is one possible explanation for fractal behavior. The temporal-spatial fractal characters of sea surface temperatures (SSTs) have been documented in many articles. El Niño event may be a result of the phenomena of SOC. However, how El Niño affects the fractal characters of SST? Can we show the adequate features of SOC for the El Niño events? In this study, we applied discrete second-order Daubechies wavelet transform method using the HadISST data sets from 1870-2005. We examined the SOC features for El Niño event on the scale of Quasi- Biennial-Oscillation (QBO). The results confirmed that QBO was important for El Niño event, and represented that some El Niño events are due to the result of SOC on the timescale of QBO, especially after 1990. Hence, SOC also offered a statistical explanation for El Niño event, in addition to the variant physical explanations. Moreover, we found that there were two distinct periods, i.e. 1894-1923 and 1978-2000, during which the trend of the oscillation of ENSO-event-index well meets with that of fractal dimension, i.e., Hurst coefficient “H”. The inverse trends between ENSO-index and “H” were normally due to the influence of La Niña events. The mechanisms of El Niño and La Niña events may be certain distinct in the inner mechanisms. This study may help understanding of El Niño phenomena, and will help for forecasting of El Niño.

Global average surface temperature anomalies with COBE-SST

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For the purpose of monitoring the global warming, Japan Meteorological Agency has so far estimated operationally the long-term change of global average surface temperature anomalies with both observed data at meteorological stations and the historical SST analysis (COBE-SST).The result shows that the global average surface temperature has been rising at a rate of about 0.67˚C per 100 years since 1891.The standard error of the globally and annually averaged temperature time series is also computed to be around 0.08˚C for these few decades.

Multi-timescale Analysis, Reconstruction and Estimation for Global Sun Solar in January and North Hemispherical Temperature Anomalies Data

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Assumed that climate change is a period signal only changed with time, and a composition of multi-timescale signals without regard to the affect of other physical factors, such as sunspots, radiation etc., then each periods of climatic data can be decomposed by EMD method and the model can be built using nonlinear minimization procedures to reconstruct this climate data. Further, the future climate change can be estimated by using this model. The experimentations on two different real time series, global sun solar in January and North hemispherical temperature anomalies data from NOAA.CDC., indicate that this method is able to get very good fit results. Therefore, the method used in this paper show great promise for revealing patterns in historical data.

Key Words: Climatic Time Series; Empirical Mode Decomposition(EMD); Data Reconstruction

Long-term climatology of droughts in the Limpopo Province of South Africa

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This paper examines the nature of long-term climatology of droughts in the Vhembe District of the Limpopo Province in South Africa. One of its focus areas is the assessment of the long-term rainfall characteristics in the district to determine changes over time, frequency and duration of dry spells. Drought is described as a severe event, therefore the frequency of occurrence and intensity need to be explained by using criteria that distinguish normal dry spells from real drought. The study examines the geographical variability of dry spells in the area and analyses seasonal drought in detail to reveal its frequency, spatial coverage, and persistence.

The required data in this study is the area rainfall, obtained from South Africa Weather Service (SAWS). All station data were intercorrelated to produce blocks of highly correlating sites. All the blocks were subjected to principal component analysis (PCA) to determine their homogeneity in space. Rainfall data for 40 years (1960-1999) were used. Standardized Precipitation Indices (SPIs) was employed to determine the statistical rarity of drought episodes, drought onset, intensity and cessation.

From rainfall time series, abnormally extended dry spells and consecutive long dry spells are precursors of drought. The SPI detects negative values that indicate less than median precipitation, and if they persists to reach SPI value of -1.0 or less it is a sign of occurrence of drought. Findings of this research demonstrate the nature of the long-term climatology of drought in Limpopo Province and are of use in agriculture, water resource management, drought monitoring and early warning and also in formulating drought policies.

Rescue of historical climate data: Compilation of a new historical data-base for Germany

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The sequence of disastrous floods and unusual hot summer in the last decade result in growing scientific interest in studies in changes in extreme weather and climate events. For the assessment of changes in climate extremes, high resolution, gap free long-term observational records are needed. However, in the majority of the countries, and also in Germany, such climate data are rare. In this contribution an overview will be given about efforts, which have been made in the rescue of historical climate data in Germany. Presented are the digitalization and quality control techniques as well as homogenisation methods of the daily climatic records.

Annual and seasonal precipitation trend investigation in central region of Iran using non-parametric methods

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In this paper annual and seasonal precipitation trends of some 48 meteorological stations of central region of Iran during the (1971-2000) period were investigated using Mann-Kendall and Sen's Estimator Slope non-parametric methods. Results show that the application of these two methods is almost similar. the Sen's Estimator Slope method showed better performance where the number of zero in the time series of data was considerable. The results showed a significant negative trend in both test in some of the time series. But no significant positive trend for both test was confirmed. Since the number of series with significant trend comparing with series without any trend was small, therefore a general trend can not be attributed to the region.

Keywords: precipitation trend, Non-parametric methods, Mann-Kendall, Sen's Estimator Slope, Iran

Long-range correlations of ERA-40 temperature data: Geographic patterns and height dependence

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Global temperature data from six pressure levels (1000hPa, 850hPa, 600hPa, 400hPa, 200hPa, 100hPa) of the ERA-40 re-analisys data bank (temporal resolution of 6 hours, covered interval of 45 years, spatial resolution of 2.5°×2.5° lat/long) are analyzed in order to quantitatively characterize correlation properties.The method of detrended fluctuation analysis (DFA) is exploited, which has proven useful in revealing the extent of long-range correlations in various time series.The temperature records exhibit long-range temporal power-law correlations extending up to several years for all grid points.The correlation exponent's geographic distribution is quite complex at the lowermost pressure level 1000hPa, but it reproduces the spatial patterns detected for the observational data (e.g. several thousands of terrestrial daily temperature records from the Global Daily Climatology Network, GDCN).At higher levels the modifying effects of the surface are weaker, the spatial distribution of exponent values becomes much smoother. Near the equator (between 15° S and 15° N) the level of correlations is strong, inside the 30°-60° band exhibits a local minimum and towards the poles it becomes higher again on both hemispheres. This geographic pattern is similar to the distributions observed for some other meteorological parameters, e.g. the correlation exponent for ozone concentrations.These results can serve as useful testbed for validating globally coupled numerical ocean-atmosphere models.

Interpolation methods of weather generator parameters

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Stochastic weather generators (WGs) are used to provide observed like synthetic weather series. The synthetic series may be generated for both present and changed climate conditions and serve typically as an input to various weather dependent models (e.g. crop models and rainfall runoff models). A stochastic single site 4 variate daily weather generator Met&Roll is used here. Met&Roll uses Markov chain (order = 1 to 3) to model precipitation occurrence, Gamma distribution to model precipitation amount and first order autoregressive model to model solar radiation and daily extreme temperatures.

The main aim of the paper is comparison of methods of interpolating of WG parameters from stations to sites with non existing or incomplete historical observations. Three interpolation techniques were tested: kriging or co kriging run from ArcGIS, neural networks and weighted nearest neighbours. Kriging is an advanced geostatistical procedure that generates an estimated surface from a scattered set of points with z-values. Weighted nearest neighbours interpolator defines the interpolated value as a weighted average from the surrounding stations using a bell shaped distance based weight. Neural networks are sophisticated techniques (generally non-linear), capable of modelling extremely complex functions.The performance of the interpolation techniques is examined in two ways: (i) accuracy of interpolation of individual WG parameters is assessed in terms of the Root Mean Square Error and Reduction-of Variance of individual WG parameters. (ii) Climatic characteristics derived from the synthetic series produced by the interpolated weather generator are compared with those derived from the series produced by WG calibrated with the site specific observed weather data. The experiments are based on 1961-90 weather series from a set of 125 Czech stations and a stress is put on precipitation characteristic (parameters of Gamma distribution, parameters of the first-order Markov chain, some extreme precipitation characteristics).

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Intra-seasonal Variability of Indian Monsoon Precipitation in Coupled Climate Model Simulations and Projections under IPCC AR4

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The intra-seasonal variability of the Indian monsoon rainfall plays a dominant role in deciding the seasonal strength of the monsoon. The Indian monsoon is known to exhibit two dominant periodicities of intra-seasonal oscillations 30-60 days and 10-20 days on the spatial scale of entire landmass. In this paper the nature and intensity of these dominant periodicities have been studied on smaller spatial domains during all-India droughts and floods. The high resolution data 1o x 1o latitude/longitude over Indian domain for the recent period of 1951-2003 provided by India Meteorological Department have been used in this analysis. The powerful tools of mathematical statistics (thoroughly discussed by Storch and Zwiers, 1999) are applied to analyse the daily rainfall time series of high resolution data over Indian domain. The multi-taper spectrum analysis method (Ghil et al, 2002) has been applied to identify the periodicities over four homogeneous regions. This method shows that 30-60 days periodicity is dominant over west coast and central India during droughts while the floods are characterized by high frequency oscillations (Kulkarni et al, 2007) To examine the time variability of dominant periodicities over these four regions, wavelet analysis has been applied to daily time series over every grid for each of all-India drought and flood years. The average spectrum shows that over west coast the 30-60 days oscillations are dominant in later half of the season, August-September during all-India droughts while during floods they dominate at the end of the season, September (Kulkarni et al, 2006). Over Central India 30-60 days oscillations are dominant in the vital months of the season, July and September during droughts The space-time variability of two most dominant modes of ISV of Indian monsoon is studied by applying Empirical Orthogonal Function (EOF) technique to the 53 spatial patterns of explained variance by these two modes. The most dominant pattern explains 23.6% (30-60 days mode) and 11.5% (10-20 days mode) variance. The corresponding principal component time series reveal that both the oscillations have weakened after 1975. Kripalani et al (2007) have shown that only 6 coupled climate models under IPCC AR4 (cccma_cgcm3.1, cnrm_cm3, mpi_echam5, miroc3_medres, miroc3_hires and ukmo_hadcm3) are able to simulate the seasonal mean monsoon precipitation over India reasonably well. We are trying to examine the capability of these models to simulate the characteristics of intra-seasonal variability of Indian monsoon precipitation which are discussed above. Also the intra-seasonal variability in future will be studied in SRES projection scenarios. The work is under progress and the results will be presented at the conference.

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Statistical analysis of definiteness of selected climate classifications from a view of climate change

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More climate classifications are used for different fields of economy, especially in agriculture and forestry. Among specialists arises the question, what changes of climate regions borders will occur in association with climate change. Presentation deals with problem of uncompromisingness of Quitt's regional climate classification which is frequently used in the Czech Republic. Statistical evaluation of uncompromisingness of climate regions in 0.5 km squares is presented. Capabilities of using of fuzzy sets methods for computerized creating of digital maps of similar climate classification are discusses, too. Results show that the discussed type of the climate classification is unambiguous from the principle and it is not suitable for climate change studies. Koeppen's classification is discussed from above mentioned view, too.

The structure of predictability in a quasigeostrophic atmospheric model

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The local predictability of planetary atmospheric flow is investigated in the framework of a three-level quasigeostrophic (QG) model with realistic climatological mean state and variance pattern as well as Pacific/North America and North Atlantic Oscillation teleconnection patterns. Local predictability is quantified by instantaneous and finite-time Lyapunov exponents and

vectors. The variation of local predictability across state space is examined. The study also aims to infer predictability information in geographical rather than spectral space. To this end, local growth exponents are calculated from the Lyapunov vectors and their time evolution. Moreover, a local Lyapunov vector dimension is introduced to measure the dimension of the space spanned by the leading Lyapunov vectors locally in geographical space.

The methodology of cluster-weighted modeling is used to derive a probabilistic model of the first Lyapunov exponent conditioned on the leading empirical orthogonal functions (EOFs) of the QG model. This approach allows the identification of regimes in the large-scale circulation that tend to be associated with large or small finite-time Lyapunov exponents as quantified by a regime-weighted mean Lyapunov exponent.

Projected change in mean and extreme climate over Korea

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We present an analysis of a simulated climate projection covering the period 1971-2080 over the Korean Peninsula with a regional climate model (RegCM3) using a one-way double-nested system. The mean climate state as well as frequency and intensity of daily extreme events are investigated at various temporal and spatial scales, with a focus on surface air temperature and precipitation.In order to obtain confidence of future climate projection, we first evaluated the reference scenario (1971-2000) against a dense observation network over the Korean territory. The RegCM3 successfully simulates the fine scale structure of the temperature field due to topographic forcing but it shows a systematic cold bias mostly due to an underestimate of maximum temperature. The frequency distribution of simulated daily mean temperature agrees well with the observed seasonal and spatial patterns. In the summer season, however, daily variability is underestimated. The RegCM3 simulation adequately captures the seasonal evolution of precipitation associated to the East Asian monsoon. In particular, the simulated winter precipitation is remarkably good. Although summer precipitation is underestimated, area-averaged time series of precipitation over Korea show that the RegCM3 agrees better with observations than ECHO-G both in terms of seasonal evolution and precipitation amounts. Heavy rainfall phenomena exceeding 300 mm/day are simulated only at the high resolution of the double nested domain. Projected changes in both temperature and precipitation fields provide strong evidence that East Asia including the Korean Peninsula undergoes a more warmer and wetter climate regime in response to the intensification of the summer monsoon and weakening of the winter monsoon.

The magnitude of the change signals both in mean and extremes of temperature and precipitation in response to anthropogenic forcings is more pronounced in 2051-2080 compared to the period of 2021-2050 as GHG concentration increased. The temperature exhibits a positively persistent trend throughout whole period increasing by 3.2°C for 2070s while precipitation is characterized by pronounced interdecadal variations, with gradual amplification of the fluctuation range. During wet period, the summer monsoon is intensified due to stronger southeasterly flow, favorable for advection of lower level warm and moist air from the Pacific Ocean. A significant increase (decrease) of hot (frost) spells is found along with increasing (decreasing) of maximum (minimum) temperature. The frequency distribution of daily precipitation during 2051-2080 indicates heavy rainfall over 400 mm/day, suggesting the possibility of increasing frequency of flood events. Wet spells of long periods tend to be more frequent as well, accompanied with an increase of precipitation amounts

Trend Indicators of Atmospheric Climate Change based on Reanalyses and Global Climate Model Scenarios

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The upper troposphere-lower stratosphere (UTLS) region is re-acting particularly sensitive to climate change. Thus, changes of the thermodynamic state of this part of the atmosphere, especially variations of its key parameters, are promising candidates for the monitoring and diagnosis of climate change.

This study aims at revealing optimal atmospheric climate change indicators with respect to radio occultation (RO) measurements, which feature high accuracy, long-term stability, and global coverage. As a first step, due to the currently limited time length of RO observations, we investigate 'proxy' climatologies from reanalyses and global climate model runs. We use two reanalysis data sets and three representative climate models with two representative scenarios for the IPCC 4th Assessment Report serving as multi-decadal datasets out to year 2050. The datasets are systematically explored for finding the most robust and sensitive trend indicators by testing pre-defined potentially useful atmospheric parameters such as refractivity, geopotential height, temperature, and specific humidity. These key climate variables were chosen since they are provided by RO measurements with highest accuracy.

Temporal characteristics of trends are analyzed on the basis of a seasonal resolution. Different investigated spatial domains (e.g., northern/southern hemisphere, tropics, mid-latitudes, as well as UT, LS) allow a mapping of regions, which are particularly suitable for trend indicators.

Least squares fitting of a linear trend provide parameter estimates (slope, intercept) and interval estimates (standard deviations of the parameters). The significance of the trend is derived for an estimate of the signal to noise ratio (SNR). Sensitive and robust indicators need comparatively low residual variance and favorable SNR for all scenarios of the multi-ensemble database.

First results for optimal UTLS trend indicators of climate change, including the most promising parameters and their spatio-temporal characteristics, will be presented.

Bayesian Detection and Attribution of Climate Change on a Region of Northeast Asia

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In this study, we performed that climate change signal detection and attribution were studied for the surface air temperature in a region of Northeast Asia (100-150°E, 20-60°N). We use a Bayesian fingerprints methodology to compare annual data from ERA40 reanalysis and MRI coupled atmosphere-ocean general circulation model. It is exemplified with ERA40 reanalysis data from 1961 to 2000 as an observation, 1% a year CO2 increase experiment to doubling with realizations. A Bayesian fingerprint analysis of the evidence for anthropogenic climate change in the Northeast Asian region surface air temperature observations is described with changes in a climate change scenarios.Our findings are shown that there is a statistically significant anthropogenic climate change in the Northeast Asian surface air temperature change over the past four decades (1961 - 1970, 1971 - 1980, 1981 - 1990, and 1991 - 2000) and there is a evidence for attribution assessments to represented in our fingerprints and specific definition of the attribution region.

Stochastic downscaling of climate model outputs for continuous hydrological simulation

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There is increasing recognition that, in hydrological problems such as flood risk assessment and management, it is desirable to simulate catchment processes over extended time periods. Such 'continuous simulation' requires the ability to generate long sequences of rainfall data, at an appropriate spatial and temporal scale, for input to hydrological models of catchment response. Moreover, for medium and long term planning it is necessary to account for climate change. This talk will describe research at UCL and at Imperial College London, which aims to provide the UK with a national capability for the generation of future rainfall sequences at daily and subdaily time scales. The methodology exploits information from numerical climate models, while recognising that there are questions regarding the ability of these models to represent rainfall at scales of hydrological relevance. The work falls into two parts. First, generalized linear models (GLMs) are used to parameterise relationships between observed daily raingauge data and large-scale atmospheric variables that are represented reasonably well by the climate models. It is shown that GLM simulations are able to reproduce closely the properties of historical rainfall sequences, including measures of interannual variability and extremes. In the second stage, relationships are identified between rainfall properties at different temporal scales; these relationships appear invariant over a wide range of different climatic conditions (represented by different months of the year and different locations), and hence enable the properties of subdaily rainfall sequences to be deduced from those of daily sequences in an altered climate that is

The seasonal characteristic of ChangSha's climate warming

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This article statistics the air temperature data of ChangSha monthly,the results are found:1.The air temperature of ChangSha has been rising in more than half century.2.The characteristic of elevated temperature exist a notable seasonal difference in ChangSha,which is distinct in spring,but is unclear in summer.3.The climate warming of ChangSha is stand out in the recent 10 years.

Rainfall and Synoptic characteristics of the flood discharge events at Xin'anjiang, eastern China, during the 1980s-1990s

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Rainstorms in eastern China tended to be more frequent and enhanced after the 1970s. Subsequently there were quite a few flood discharge events during the 1980s-1990s at the Xin'anjiang Reservoir and Hydropower Station, which supplies electricity and water for the area including Shanghai and Hangzhou, eastern China. A study of the rainfall and synoptic characteristics in the region for the years of flood discharges was carried out, in order to help improving the reservoir management. Daily precipitation data of surrounding stations and the ERA-40 reanalysis data for the rainy season (April-July) of 4 flood discharge years were analyzed. A common feature for the flood discharge years was revealed that the accumulated daily rainfall kept positively anomalous (above climatological mean level) since mid-April, followed by some unusually heavy rainfall process in late June just before the decision-making for flood discharge. The Meiyu period was longer than usual for the 4 years. Anomalously westward expansion of the Subtropical High in the western Pacific and early burst of the Asian summer monsoon might have played a role in forming the anomalous rainfall process in eastern China.

The Analysis and Study on Mesoscale convective Cloud Clusters and the Torrential Rains of the Middle Yangtze River During Meiyu Season

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Main conclusions in this paper are in the following:
(1)According to the concrete situation of Yangtze River,from the basic feature of mesoscale

convective cloud clusters when they develop vigorously,this paper gives a definition to it. It comes to several statistical conclutions by investgating the whole process from starting to disappearing of mesoscale convective cloud.

(2)Raising a new point about the origin of the mesoscale convective cloud clusters,it is considered that the fundamental reason which causes the mesoscale convective cloud clusters is heating in local and dry layer;rather than upper trough or surface front.

(3)Analyses show that 74% mesoscale convective cloud clusters can cause torrential rains of the middle Yangtze River during meiyu season,44% torrential rains of the middle Yangtze River during meiyu season are caused by mesoscale convective cloud clusters.So to do well in the torrential rains of the middle Yangtze River during meiyu season,the analysis of mesoscale convective cloud clusters is essential.

The Study of The Effect of Dongting Lake on The Temperature

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Abstract:According to the climatic datas about 101 stations of Hunan province from 1951 to 1980,and the datas hour by hour from part of observational stations in Hunan, in climatic and meteorologial term,in macroscopic and microcosmic term,this paper analyses the effect of Dongting Lake on the temperature,coming out:1.The effect of Dongting Lake on the daily variation of air temperature is very obvious,Yueyang is by the east of the Dongting Lake,its daily maximum temperatures appear at 17 in average,even meteorologists in the lake district have not perceived this definitely before;2.The extreme maximum temperature of Dongting Lake district is lower than surrounding regions,and its extreme minimun temperature is higher than surrounding regions;3.The mean annual maximum temperature of Dongting Lake is lower than surrounding regions,and its mean annual minimum temperature is higher than surrounding regions,the data is about 1□;4.The daily range of temperatures of Dongting Lake are smaller than other regions in Hunan province;5.The high-temperature days and low-temperature days of lake district are fewer than others.

The Study of Reasons of Drought of Northwestern Region of Iran

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The prevailing climate on our country is due to its location in dry and semi-dry district, as a result, drought is the commonest phenomenon in this country. One of the drought and climatologic drought's definitions is as follow. If the precipitation is less than average during long-term period, it is called drought. The drought of northwestern of Iran which is due to the shortage of precipitation has caused starvation and poverty.First, the research framework, theoretical principle, and study of precipitation fluctuations, trend, temperature, humidity, wind, evapotranspiration of stations are under study. Then the precipitation correlation between stations and precipitation and temperature correlation with respect to altitudes have been studied. In order to determine the reasons of drought in the region which is under study, primarily, the fluctuations of time, frequency and degree of drought as per Z score have been examined which prove in statistical and synoptic network that due to simultaneous drought in region in terms of severity, weakness frequency, time, location at different stations are different. And later on study of reasons of drought with regard to the pattern movement of general circulation of climate with Tel connection which results in changing in pattern pressure in region and movement of circumpolar western line and blocking systems by benefiting from normal distribution probability the return period 2,5,20,100,1000 were determined and the occurrence of probability in distribution %20 & 80% was calculated and return period with 5-year drought range and 5-year humid period range.

Quantifying Uncertanties Associated With Climate Variaiblity and Climate Change Studies: the Cox´S Semiparametric Approach

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A wide range of probabilistic approaches have been used for assessing climatic risks and associated uncertainties: multiple linear regression (Martis et al, 2002), logistic regression (Nichols, 1984; Lo et al, 2007), nonparametric approaches based on empirical cumulative distribution functions (Maia & Meinke, 1998; Maia et al, 2004), among others.

In this paper, we quantify risks by using probability of exeedance curves (PECs) and propose the use of the proportional hazards model (also referred to as Cox model - Cox, 1972; CPH model) to investigate the influence of continuous (e.g. oceanic/atmospheric indexes) or categorical predictors (e.g. classes derived from El Niño/Southern Oscillation) on these risks.

CPH model is widely used in medical analyses of survival data that examine the effect of explanatory variables on survival times. This allows the ranking of risk factors and quantitative assessments of their impacts. These methods are well established in medical research and used routinely for risk assessment in medical studies (e.g. Finkelstein et al, 1993; De Lorgeril,

1999; Smith et al, 2001; Gibbons, 2002) where data are rarely normally distributed and often incomplete. To our knowledge, this study is the first using the CPH framework to analyse the linkage among oceanic/atmospheric indexes and climate risks. This constitutes a major step towards better quantification of climate related uncertainties in climate variability and climate change studies.

Some of the advantages of using the CPH model include:

a) the method was developed to accommodate censored data (incomplete information) without the need to balance the data set thereby discarding potentially valuable information;b) in contrast to ordinary least squares multiple linear regression or logistic regression, CPH model does not require assumptions regarding the type of underlying probability distributions; proportionality of hazards is the only assumption necessary for CPH model, and even this can be relaxed via an appropriate generalization;c) it overcomes the problem of having to estimate probabilities of exceedance for each threshold in order to compose a PEC, a limitation of the logistic regression approach as used in Lo et al (2007);d) when compared with the nonparametric approach used by Maia et al (2007), CPH framework is superior because it allows investigating simultaneously influences of many predictors on risks; the contribution of each 'candidate' can objectively be evaluated via likelihood tests;e) methods for assessing uncertainties of PEC (and therefore uncertainties of risk estimates) are readily available. These methods have well established theoretical basis (Kalbfleisch and Prentice, 1980);

We demonstrate the adequacy and usefulness of the proposed approach by analysing the influence of two oceanic/atmospheric indexes on the onset of monsoonal wet season at Darwin, Australia, as suggested by Lo et al (2007): the Southern Oscillation Index (mean of the July and August monthly SOI values) and the first rotated principal component (SST1) of large scale Sea Surface Temperatures anomalies (Drosdowsky and Chambers, 2001).

When applied to grided data, the CPH approach allows objective spatial assessment of either individual or joint influences of such predictors on risks. Mapping the coefficients of the Cox model (which express the magnitude of the predictor's influence) and p-values resulting from likelihood tests provides a complete descriptive and inferential assessment of predictor influence on the risks under investigation. Once the strongest predictors are selected at a location, probabilities of exceeding any particular threshold (preferably within the range of observed data) can be estimated for any combination of predictor values. The resulting risk estimates and their respective uncertainties provide valuable information for decision making in climate sensitive industries.

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The Dominant Indian Ocean Dipole Influence on Southeastern African Seasonal Rainfall Variability

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Southern Africa is semi arid and hence is characterized by high seasonal rainfall variability. Therefore the region is very vulnerable to recurring floods and droughts, with recovery taking ages to attain once the climate related disaster occurs. This makes reliable early warning schemes very essential in this region if mitigatory efforts are to be fully realized. However, this is not possible without a sound knowledge of the processes that control southern African seasonal rainfall. This study uses observational data on the Indian Ocean Dipole (IOD), El Nino Southern Oscillation (ENSO) and Zimbabwe seasonal rainfall to show that the recently discovered IOD is not only a simple additional climatic mode, which also influences southern African seasonal rainfall, but is significantly dominant over ENSO. Simple statistical methods including partial correlation and composite techniques are employed in order to unravel this relationship. Zimbabwe seasonal rainfall is mostly sensitive to the positive phase of the IOD, which induces very severe rainfall deficits. On the other hand, an ENSO warm event only induces rainfall deficits in the company of a positive IOD event. At the same time, an ENSO warm event is unable to influence seasonal rainfall deficits over the sub region, if it does not co-occur with a positive IOD event. This discovery is noteworthy as it contradicts the convectional knowledge which links ENSO warm events to droughts over southern Africa.

Climate Prediction Techniques for Small Scale Farmers Using Daily Rainfall Data in Southern Province - Zambia

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Background

In Zambia 80-90% of staple food production currently comes from rain-fed farming systems. Southern Province (SOUTHERN PROVINCE) of Zambia, which was once the maize belt. Of the country draws much interest for climate change and adaptation to suitable farming practices. High poverty levels, HIV/AIDS and rampart food shortage resulting from high rainfall variability are major concerns especially for the vulnerable small-scale farmers. These farmers are increasing migrating to the northern parts of Zambia citing climate change as the cause. Recent studies, which were carried out using daily rainfall for selected stations show no evidence of climate change but indicates high variability of climate in the region. Food

household shortages were mainly attributed to lack of poor farming practices. A decentralised agro meteorological section of the Department of Meteorology in Southern Province has been working with small farming communities to help them understand issues related to weather and climate since 1995.

Approach and Achievements

The small farming community, in Southern Province has been sensitised to be in constant touch with the Department of Meteorology (Climatology) and work closely and apply the knowledge provided judiciously. The package included; short and long term forecasts, rainfall observations, crop-weather reports, bulletin production and any other relevant and useful information during growing season from October to March. Further details from the study of climate in Southern Province include planting dates, start and end of the season, planting opportunities, choice of seed, risks of dry or wet Southern Province spells within growing season. Meetings, workshops before and after each season have been used as platform to share climate issues. Drama, plays, leaflets and faces to face discussions in English and local languages have been instrumental.

Linkages with international scientists in climate helped to facilitate training and studies in Climatology of Southern Province. NGOs, government have stared addressed the concerns by adopting crop diversification and other practices to achieve food security. Investment in rain harvesting techniques is taking off.

Southern Province is the only one decentralised to this level worldwide. This is an opportunity to sell the idea and practicability of the model to other parts of the world.

Statistical Analysis of variation and precipitation trend in arid region, central IRAN

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Precipitation is important element which affect climate condition and climate change .Increase or decrease trends of rainfall may be sign of climate changes.In this research study, in order to recover probable local climate changes, time series of monthly and annual precipitation in arid region,central iran considered.It has been studied of synoptic stations during of province center the statistical period from 1951 to 2003 .Statistical studies of climate change usually analyze homogeneity , trend and jump in the climate series. In this study, homogeneity of mentioned climatic series was tested by cumulative deviations and run test.Trend was tested by different parametric and non-parametric tests consist of Mann-Kendal, correlation coefficient Pearson, t-student and Spearman tests .Precipitation trend in Zahedan was decreasing and it had significant trend. Jump in series was tested by LEVEN test (Compare of Two Variances) . The aim of analyzing time series is determination of long-term behavior of observation data finding changes model to use for engineering designs and other projects.

The Relation Between PCA and SOM in Processing of Multivariate Datasets

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The contribution is focused on the comparison of two different methods of robust pattern variability identification. Well-known method of Principal Component Analysis (PCA) is compared to a relatively new technique based on Artificial Intelligence – Kohonen Self Organizing Maps (SOM). Kohonen SOM is a 2-layered neural network with radial units organized typically (but not necessarily) in a 2-dimensional output layer (topological map). Kohonen networks use the unsupervised learning algorithm which attempts to locate clusters in the input data. In contrast to PCA, SOM is a non-linear method.The performance of SOM was tested on PCA-preprocessed synthetic datasets that were derived from monthly fields of NCEP/NCAR 500 hPa geopotential level reanalyses, 1950-2003, from the region 90˚W-50˚E, 10˚N-80˚N. As the zonal distances between neighboring grid points decrease poleward in the geographical grid, the data were transformed to more “regular” grid with each grid point representing similar area. Then, anomalies from 1961-1990 means were calculated for each grid point and each month and data were pre-processed by means of PCA. The 1st component represents “zonal” pattern connected with the annual course of geopotential heights, the 2nd component corresponds to NAO and the 3rd one to EA pattern. Next, 3 testing (synthetic) datasets were reconstructed from selected leading principal components; „1-D“ dataset from the first component only, “2-D“ dataset from principal components 1-2 and “3-D” dataset from principal components 1-3. Those datasets were then mapped onto 2-dimensional Kohonen SOMs with 20 nodes (5x4 nodes).The results indicate that for “1-D” dataset SOM maps the only principal component along the longer side of SOM map, for “2-D” dataset, two principal components are mapped along diagonals of the SOM. Those results are similar to PCA with the only difference in their non-linearity. For “3-D” dataset some “dimensionality reduction” is needed to map the “3-D” dataset onto 2-dimensional SOM. As the mapping is intrinsically non-linear and results are categorical (clusters), this case is similar to “categorical 2-dimensional non-linear Principal Component Analysis”.

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Probabilistic Climate Change Predictions Applying Bayesian Model Averaging

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This study explores the sensitivity of probabilistic predictions of the 21st century surface air temperature (SAT) changes to different multi-model averaging methods using available simulations from the Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report (AR4). A way of observationally-constrained prediction is provided by training multi-model simulations for the second half of the 20th century with respect to long-term components. The Bayesian model averaging (BMA) produces weighted probability density functions (PDFs) and we compare two methods of estimating weighting factors: Bayes factor (BF) and Expectation-Maximization (EM) algorithm. It is shown that Bayesian weighted PDFs for the global mean SAT changes are characterized by multi-modal structures from the middle of the 21st century onward, that are not clearly seen in arithmetic ensemble mean (AEM). This occurs because BMA tends to select a few high-skilled models and down-weight the others. Additionally Bayesian results exhibit larger means and broader PDFs in the global mean predictions than the unweighted AEM. Multi-modality is more pronounced in the continental analysis using 30-yr mean (2070-99) SATs while there is only a little effect of Bayesian weighting on the 5-95% range. These results indicate that this approach to observationally-constrained probabilistic predictions can be highly sensitive to the method of training, particularly for the later half of the 21st century, and that a more comprehensive approach combining different regions and/or variables is required.

Linking atmospheric circulation to daily rainfall patterns over the territory of Bulgaria using Hidden Markov Models

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Non-homogenous hidden Markov Models (NHMMs) have found widespread application in meteorology and hydrology in Australia and New Zealand, North and South America, e.g., in studies of climate variability or climate change, and in statistical downscaling of daily precipitation from observed and numerical climate model simulations. However, the NHMM methodology has not been yet employed for similar purposes in Europe. The NHMM links large-scale atmospheric patterns to daily precipitation data at a network of rain gauge stations, via several hidden (unobserved) states called the “weather states”. The evolution of these states is modeled as a first-order Markov process with state-to-state transition probabilities

conditioned on some indices of the atmospheric variables. Due to these weather states the spatial precipitation dependence can be partially or completely captured. In the present study various NHMMs are used to relate daily precipitation at 30 rain gauge stations covering broadly the territory of Bulgaria to synoptic atmospheric data. At each site a 40-year record (1960-2000) of daily precipitation amounts is modeled. The atmospheric data consists of daily sea-level pressure, geopotential height at 500 hPa, air temperature at 850 hPa and relative humidity at 700 hPa (subset of NCEP-NCAR reanalysis dataset) on a 2.5° x 2.5° grid covering the Europe-Atlantic sector 30°W–60°E, 20°N–70°N for the same period. The first 30 years data are used for model fitting purposes while the remaining 10 years are used for model evaluation. Detailed model validation is carried out on various aspects. The identified weather states are found to be physically interpretable in terms of regional climatology. A comparison is also made between the NHMM and classical at site two-state first-order non-stationary Markov stochastic daily precipitation model, conditional on a summary of 5 pseudotemps (based on all atmospheric variables in NCEP-NCAR reanalysis dataset) surrounding the territory of Bulgaria.

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Bridging the gap between simulated climate and local weather

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Data from global and regional climate models usually refer to grid cells and are, hence, basically different from station data. This particularly holds for variables with enhanced spatio-temporal variability like precipitation. On the other hand, many follow-up modelling study require atmospheric data with the statistical characteristics of station data in order to simulate for instance realistic surface runoff or erosion rates.

Here, a dynamical-statistical tool is presented to derive virtual station data from regional climate model output in tropical West Africa. This weather generator incorporates daily gridded rainfall from the model, an orographic term and a stochastic term, accounting for the chaotic spatial distribution of local rain events within the model grid box. Total sums and the probability density function of daily precipitation are adjusted to available station data.It is also assured that the generated data are still consistent with other model parameters like cloudiness and atmospheric circulation. The resulting virtual station data are in excellent agreement with various observed characteristics, which do not enter explicitly the weather generator. algorithm. This holds for the mean daily rainfall intensity and variability, the relative number of rainless days and the scaling of precipitation over different time scales.

Comparison of past and future trends of extreme climate indices for Central/Eastern Europe

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Several climate extreme indices are analyzed and compared for the Carpathian basin (located in Central/Eastern Europe) following the guidelines suggested by the joint WMO-CCl/CLIVAR Working Group on climate change detection. These climate extreme indices are determined on the basis of daily maximum, minimum and mean temperature values, and daily precipitation amounts. The statistical trend analysis includes the evaluation of 27 extreme indices, e.g., the numbers of severe cold days, winter days, frost days, cold days, warm days, summer days, hot days, extremely hot days, cold nights, warm nights, the intra-annual extreme temperature range, the heat wave duration, the growing season length, the number of wet days (using several threshold values defining extremes), the maximum number of consecutive dry days, the highest 1-day precipitation amount, the greatest 5-day rainfall total, the annual fraction due to extreme precipitation events, etc. In order to analyze the past trends, daily meteorological observations are used to calculate the time series of extreme temperature and precipitation indices for the 31 selected stations for the 20th century. Because of the lack of century-long meteorological time series, the analysis focuses mainly on the second half of the 20th century. However, the analysis is extended for the entire century in case of some stations, where sufficient data was available. The results suggest that similarly to the global and continental trends, regional temperature of Central/Eastern Europe got warmer during the second half of the 20th century. Furthermore, regional intensity and frequency of extreme precipitation increased, while the total precipitation decreased in the region and the mean climate became drier. In case of the future trends (2071-2100), daily values of meteorological variables are obtained from the outputs of various regional climate model (RCM) experiments accomplished in the frame of the completed EU-project PRUDENCE (the horizontal resolution of RCMs is 50 km). Both scenarios A2 and B2 are used to compare past and future trends of the extreme climate indices for the Carpathian basin.

Past climate reconstruction for the Carpathian basin using documentary sources

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In order to cover several centuries of the past climate, various proxy data series play an essential role since regular meteorological observations being reliable started only in the 1800s. Among many others, the proxy climate sources include the historical documentary data. Written documentary sources can be used to evaluate the occurrence, duration and geographical location of climatic events of the past centuries when no or only scarce instrumental time series are available. For the Carpathian basin (located in Central/Eastern Europe), Antal Réthly (a Hungarian climatologist of the 20th century) collected historical documents in their original form containing meteorology-related information into the 2500-page-long book series, titled 'Meteorological events and natural disasters in the Carpathian basin'. In order to facilitate the detailed analysis of this documentary collection, a special code system using hierarchical subclasses has been defined. The applied code system distinguishes three main categories of climate information: temperature, precipitation and wind related events, containing about 3800, 10000, and 1300 information items, respectively. Furthermore, the three level subclass system involves 10 second-level classes and 61 third-level classes. In case of temperature related documents, reports on cold conditions dominate (65%), while in case of wind related events, most of the archive records mention the strength. Precipitation information takes 66% of the total collection and the most often reported event is the 'rain', which can be explained by the source types (many estate records and account rolls) and by the agricultural importance of water. Other frequent classes of precipitation are 'thunderstorm', 'hail', 'flood', and 'drought'. Besides the event classification, the coded database contains full geographical information about the location of the meteorological events (e.g., settlement, geographical coordinates, and subregion identification). Spatial and temporal distribution of precipitation, temperature, and wind related climate events and extremes have been investigated using both settlement and subregional scales. Geographical distribution of extreme climate events has been mapped. Decadal, annual, and seasonal time series have been analysed for the Carpathian Basin, and compared to other reconstructed temperature and precipitation index time series from other geographical locations in Central/Eastern Europe.

Prediction of Monsoon rainfall over Peninsular India using parameters over Arabian Sea and adjacent seas

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This study aims to connect different meteorological and oceanographic parameters over the Arabian Sea and adjacent seas with the summer monsoon rainfall over Peninsular India. Correlation between Rainfall and several global parameters were found and those areas having 99% significance were selected for making indices. To check the consistency of the relationship between these candidate predictors and the predictant, a 15-year sliding window correlation (significant at 5% level) was done. Nine indices having high correlation were selected. Indices are relative humidity at 925hPa (Mar and May), sea surface temperature (Dec), zonal wind at 925 hPa and 850 hPa (Mar), air temperature at 925 hPa (Mar and May), surface sensible heat flux (Mar) and meridional wind at 700 hPa (Jan) over different spatial locations. PCA is done using these nine indices, for the period 1975-2003. Seven components that explain the maximum variance were retained for further analysis. A multiple linear regression model was developed using these components for the period 1975-1997. The model has a multiple correlation of 0.84 and coefficient of determination of 71.2 %. The VIF analysis of all the parameters that is retained in the model have values less than 2 indicating an insignificant level of multicollinearity and has a Durbin Watson value of 1.856. The model performance was assessed for a period 1998-2003. The model has a RMSE of 8.6 %, BIAS of 0% and ABSE of 7.2% of LPA. For the test period this becomes 23.68%, 18.13% and 4.86% respectively. Climatological predictions were also made and found that RMSE, BIAS and ABSE are 8.7%, 7.07% and 7.57% of LPA respectively.

Statistical downscaling of a specific weather pattern for rainfall forecast using techniques of artificial intelligence

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A statistical downscaling procedure derived from artificial neural network (ANN) and fuzzy logic (FL) were development to generate quantitative forecasts of daily rainfall to specific weather patterns. Weather pattern methods involve linking observational station data to given weather classification schemes. In this case the classification is subjective and a specific weather pattern namely SACZ-ULCV pattern was selected. This weather pattern is the interaction between the upper level cyclonic vortices (ULCV) in the vicinity of Northeast Brazil and South Atlantic Convergence Zone (SACZ). This interaction is associated with severe rainfall and thunderstorms over Southeastern of Brazil. The SACZ-ULCV pattern is well simulated by regional Eta model of Center for Weather Forecasts and Climate Studies (CPTEC) in Brazil, for this reason the outputs of this model to period from December, January and February of 2000-2003 were used to generate statistical downscaling. The predictors were the dynamical meteorological variables of Eta model related to SACZ-ULCV and surface

rainfall as predictand. Additionally, was constructed another experiment but in this case, it was considered all summer period, that is, other summer weather type besides of SACZ-ULCV pattern were included. Forecast experiments were conducted for 12 major urban centres in the S.Paulo region. Several statistics are calculated to examine the performance of different experiments. Generally it was observed that a good rain forecast performance were associated with well-defined events, in this case when was only considered the downscaling to SACZ- ULCV pattern (i.e., the forecast should be better when the rainfall is predominantly generated by similar dynamical process). The results generated by the model neural presented a good performance in the forecasts. When it was compared with the FL technique showed very close results to the generated by ANN. The obtained results suggest that FL technique can be applied for forecast applications. On the other hand, the downscaled precipitation is more realistic than the precipitation simulated by Eta model.

Palavras-Chave: Downscaling Estatístico, Previsão de Chuva, Redes Neurais Artificiais, Lógica Fuzzy

Determining Africa Socio-Economic Challenges to Climate Sensitivity: the Need to Work Together

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The primary objective of the paper is how climate sensitivity can be properly evaluated over the West Africa sub-region whose socio-economic survival is largely agro-based, a sector most sensitive to weather and climate variability. Having reviewed the sources of statistical problem confronting climatology which is found to be deeply rooted in the complexity involved in detecting climate variability which often leads to great apprehension especially on the part of farmers and water resources managers concerning their expectations in the near term, and its attribution to some certain influences coupled with the method currently used to tackle these problems, the paper opined that the possibility of adopting adequate response to present and anticipate future scenarios to these anomalous changes through exchange of expertise ideas and concepts must be given priority attention if the relevant anticipated United Millennium Development Goals (MDGs) must be met for the continent.

To achieve this, the understanding of the role and interaction between climate and the socio-economic elements sensitive to it must carefully be analyzed empirically using advance but relevant statistical techniques for case study situations. From this, it is believed that synthesized results and insights will evolve which will help put in place policies to address the challenges of future scenario within a specific framework. Such a synergetic outcome is what the paper sought to appraise.

A GEV fit to Annual Temperature Extremes in Argentina: a Study of the 1976-77 Climate Shift

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Temperature extreme events are one of the most studied extreme events since their occurrence has a huge impact on society. In this study we fit a GEV distribution to annual temperature extremes in Argentina by the method of maximum likelihood estimation with the aim of studying the influence of the 1976-77 climate shift on the frequency of occurrence of temperature extreme events. A Kolmogorov-Smirnov goodness-of-fit test is performed in order to study whether the GEV distribution fits the observed annual temperature extremes satisfactorily. The bootstrapping technique is used to determine the critical value of the K-S statistic.Based on daily data, four different annual extremes are defined: the highest maximum (minimum) temperature of the year, and the lowest maximum (minimum) temperature of the year. The spatial distribution of return values of annual temperature extremes in Argentina for the period 1956-2003 shows that while maximum temperature (Tx) is expected to be greater or equal to 32℃ at least once every 100 years throughout the country -reaching values even higher than 46℃ in the central regions-, minimum temperature (Tn) is expected to exceed 16℃ -reaching 30℃ in the central and northern regions-. Cold annual extremes show larger gradients across the country, with Tx being lower than 8℃ at least once every 100 years, and Tn lower than 0℃ every two years with values even less than -10℃ in the southeastern part of the country.However, the frequency of occurrence of climatic extremes has changed throughout the globe during the twentieth century. Changes in return values of annual temperature extremes due to the climatic shift of 1976-77 in six long-term data sets are analysed. The lowest Tx of the year is the variable in which the shift 1976-77 is less noticeable. In most of the stations there is a decrease in the probability of occurrence of the highest Tx if we based our study on the more recent epoch, while the frequency of occurrence of the highest Tn enlarges. The most noticeable change in return values due to the shift 76-77 is seen in Río Gallegos where the 10-yr return value for the highest Tn increases from 13.7℃ before 1976 to 18.6℃ after 1977.

Impact of ENSO PHASES on Amazonia Seasonal Rainfall

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The influence of ENSO events on the probabilistic seasonal rainfall anomalies over the Brazilian Amazonia is analyzed. Composites of seasonal rainfall tercils, observed at 30 climatological stations during the 5, 8 and 11 most significant events of El Ninõ and La Niña between 1950/51 and 2000/01, were used to characterize the ENSO phases typical impacts over the regional rainfall. The probabilities of below, near and above-normal seasonal rainfall associated with El Niño and La Niña events, in a 3x2 contingency tables, were obtained using a test based on the hypergeometric distribution. The El Niños major impact in Amazonia was observed in the Austral Summer (DJF), when the events were in their mature phases. In these cases, they were significantly associated with below-normal rainfall in the Central and Northern part of the region, simultaneously and lagged by 1 and 3 months. In their typical developing (SON) and decreasing phases (MAM) the El Niños were respectively associated with 3 and 1-month lagged below-normal rainfall in Central Amazonia. La Niñas during their typical developing phases (SON) were significantly associated with above-normal rainfall in the beginning of the rainy season in the Central and Eastern part of the region. La Niñas in JJA were significantly associated simultaneously and 1 and 3-month lagged above- normal rainfall in the rainiest period of the year in the North-Western part of the region. There is a remarkable asymmetry in the effects of both events, related to the seasons (phases) and extent of significant impact. The high ENSO predictability and its great impact over Amazonia rainfall provide a significant source of predictability of seasonal rainfall variability in the region.

Climate Data Homogenization and Climate Trend/Variability Assessment

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Global system climate control gives a great importance to the preparation of long-term similar climatic data of high quality. During the operation of meteorological system in Armenia observations took place in 123 weather-stations. Periodically some stations were closed and new ones were opened. About 30% of stations have 60 or more years, 10% - 70 or more years and 5 stations more than 100 years observation series. Today 43 synoptic services work.All data are divided into 3 parts:

- Data in machine-readable form (data on machine-readable bearer)
- Data on paper (tables, maps, texts etc.)
- Data on the photos (microfilms, microfiches, microprints)

For creating historical data of base a whole series of problems are solved.

• Rescue of historical data, recording data using modern technologies.

• Forming of historical data in united size (format).

• Forming of metadata of appropriate stations.

• Elimination of heterogeneity in meteorological variable connected with the changes in methodic of observation and processing and changes of devices.

• Providing with ability of regular replenishment of current information.

During the formation of historical series the problem of filling the lack of meteorological data, which evenly appeared in different periods of creating archives, is solved (during overwriting of information from punched card to magnetic tape, during overwriting from old magnetic tape to modern technical methods).

For the formation of historical data in united size (format) and of metadata special attention is paid on the control of the quality of data and elimination of heterogeneity. The cause of heterogeneity in data is changes in methodic of observation (change of quantity of term of observation), replacement of devices, changes in methodic of processing data of observation.There are no program methods for homogenizing historical series in Armenia on this stage, but it is very important. It is handmade.

Starting from aforesaid it becomes clear that for integrated solving of the problem of homogeneous data formation, it is important to eliminate heterogeneity in the series of meteorological elements connected with the changes in the methodic of observation and processing, changes of devices, etc.

The KMA Ensemble Prediction System : the impact of Ensemble size increase

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The Ensemble Prediction System (EPS), based on the breeding method with the global spectral (KMA GDAPS) model was on operation at March 2001 at KMA. Since the revised GDAPS (T426L40) was implemented for operation, the EPS has also been constructed with T213L40M32 version at 00 and 12 UTC in July 2006.

The global spectral model with the slightly different initial conditions run 17 times included the control forecast at 00 UTC and 12UTC. And then we have 32 members from the 12hourly

time lag. Both perturbed analysis and control analysis are projected to 24 hours with the model, and the departures from the control analysis at 24 hours are scaled down to the norm of initial perturbations. For effective ensemble spread, we designed that 12h-evolved perturbations were rotated by using the Factor Rotation. Then the rotated perturbations were re-evolved for 12 hours.

In this study, the effect of horizontal resolution and ensemble size on the performance of the KMA EPS assessed for the forecasts of 500hPa geopotential height, 850hPa temperature, and 850hPa wind speed. The overall conclusion is that the skill score of the KMA EPS increases with increaseing numbers of ensemble members in terms of BSS, ROC, ROSSS, CRPSS. Increasing the model resolution has small but positive impact on EPS performance for ensemble configurations with the same number of members. But, an ensemble size increase improves the average skill of the ensemble mean after forecast day 5.

Arctic heat spells - a case study of the warm spring 2006 at Svalbard

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In April 2006 a long-lasting heat spell occurred in Svalbard, in the North Atlantic region. It was statistically considered as a very extreme event, with temperatures up to 4 standard deviations above the mean April surface temperature for the period 1961-1990. Observations from Svalbard Airport are compared with simulation output from 10 different coupled General Circulation Models from the Fourth Assessment Report of Intergovernmental Panel on Climate Change. The mean temperature in heat spell in April 2006 is similar to the expected mean surface temperature late in the 21st century. An anti-cyclone created a blocking effect South-East of Svalbard, caused the heat spell. With the present climate, the return period of the April 2006 heat spell is estimated to be 70.8 years. A climate change under enhanced atmospheric greenhouse-gas concentrations will increase the frequency of heat spell in this region, and thus reduce the return period.

West African Weather Systems in the Development of Tropical Cyclones

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Tropical cyclones have their origins from areas of low atmospheric pressure over warm waters in the tropics or subtropics. We have carefully studied the interconnection between the West African Weather Systems (WAWS) and their subsequent development into Tropical Cyclones.

Between 2004 and 2005, we studied the interconnection and the teleconnection between the WAWS and the various occurrences of Tropical Cyclones and their eventual development into Hurricanes. We noted that critical synoptic characteristic and the environmental properties of the Systems; the thermodynamic conditions of the storms trajectory and the conditions of the ocean are all closely linked. It is therefore believed that proper understanding and monitoring of these systems will play a very vital role in early detection of potential WAWS that may develop into Tropical Cyclones and even Hurricanes. More practical issues will be presented.

It was recorded that over the period 1992-2001, weather and climate-related disasters especially those of Tropical Cyclones origin killed about 622 000 people, affected more than two billion, left millions more homeless, devastated arable land and spread diseases.

Intense Precipitation Events in the Reanalysis Datasets over the Asia

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Recently, many studies for occurrance trends of intense precipitation have been conducted based on both observational data analysis and model simulation in association with the global warming. Basically detection of such trends should be based on the long-term surface observation, but there is a problem that its distribution is not homogeneous and localized geographically. On the other hand, estimation based on satellite observation is homogenous spatially. However, its temporal coverage is limited for just recent ten years for daily base products. As another available data sources, there are atmospheric reanalysis datasets, which are useful because they provide not only precipitation but also other quantities with spatial homogeneity and physical consistency although reanalysis datasets may suffer from artificial trends due to changes in observational input data.In this study, statistical characteristics of intense precipitation events in reanalysis datasets are examined by comparison with newly produced observational gridded precipitation data for India and China.The annual index for intense precipitation used in Takahashi, K. et al (2006) as well as annual precipitation calculated from each reanalysis dataset, especially the latest product JRA-25, shows significant correlation with observation at one percent level.

Relationship Between Ensemble Mean Square and Ensemble Mean Skill in Four Climate Models

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In this study, we investigated the reliability of ensemble prediction of the El Nino and Southern Oscillation (ENSO) and the Arctic Oscillation (AO), using four different climate models and various ensemble schemes. Several important issues related to climate predictability, including reliability measures and dominant precursors that control the reliability, were addressed. It was found that the ensemble mean (EM) square is a useful measure for the reliability of both the ENSO and the AO dynamical prediction.The relationship between EM^{2} and the prediction skill depends on the measure of skill. When correlation-based measures are used, the prediction skill is likely to be a linear function of EM^{2}, i.e., the larger the EM^{2} the higher skill the prediction; whereas when MSE-based (mean square of error) metrics are used, a ``triangular relationship'' is suggested between them, such that when EM^{2} is large, the prediction is likely to be reliable whereas when EM^{2} is small, the prediction skill is highly variable.

In contrast to ensemble numerical weather predictions (NWP), the ensemble spread in the ensemble prediction of these climate models was found to have little connection with the prediction skill. This is probably due to a small variation of ensemble spread in the climate models which may be associated with the intrinsic nature of ensemble climate predictions. The predictability of these models can be characterized fairly well using a Gaussian framework with constant variances.

A Methodology in Predicting the Influence of Climatic

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Weather interacts with components of agricultural production system. An understanding of these interactions is essential in formulating crop production strategies.On one hand, it is difficult to establish quantitatively this complex interaction with some reasonable degree of reliability. The most feasible approach is to conduct long-term experiments involving continuous cropping and subject to analysis to generate rational or statistical relations.On the

other hand, crops react differently to climatic parameters at various stages of development and these responses are usually manifested in the final yield of the crop, hence not only reliable climatological data for the whole season is needed but it is also essential to know the temporal distribution of a climatological variable at each growth stage.In the context of studying the influence of a single weather parameter over a given period, effect on yield was determined by dividing the growth period into seven-day periods. Such analysis based on weekly weather data determined the effect of seasonal variation of weather factors more accurately than monthly weather data using the prediction equation

Intelligent data processing center (IDPC) of climate and rural development in Iran (case study: sistan region)

Mortaza tavakoli

Geography department; Zabol University; jihad square; zabol; sistan – balochestan province ; IRAN .

As we know climatology has a location essence with in reason of self subjective and can be use from principles of others field's science. One of the most dimensions climatology is applied that has value in planning and development special for rural. The sistan region is located in east of Iran and that's region have special conditions. Such as: wind; sun shine; dust; moisture; rain; evaporation and temperature. This region has 120 days violent wind in the year. These conditions imposed circumstance in the field of subsistence and activity for rural development. Furthermore in this region haven't any data processing center; the environmental conditions can be multiplier inflexibility in decision making. This research doing with use of questionnaire and SWOT technique. The result of research showing that provide intelligent data processing center is need for rural development in sistan region.

Key words: applied climatology; intelligent data center; rural development; climate conditions; statistical SWOT technique; sistan region.

Climatic jumps in precipitation extremes in association with recent drying process in North China

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Changes in climate extremes, particularly in association with the drying jumps (stepwise changes) in North China during the second half of the 20th century, were analyzed based on daily rainfall data from 329 stations during 1954-2000. Rainfall extremes defined in different

ways were considered. Four zones, from the north to the south in the east half of China, were divided according to the different features of climatic jumps. A significant jump signal in summer rainfall happened in the late 1970s and early 1980s, almost simultaneous over these four zones. Increasing jumps are found over the Northeast and Yangtze-Huai area, while decreasing jumps over North China and the South to Yangtze River. In North China, another decreasing jump happened in the mid-1960s. The step-wise decreases of rainfall in North China have caused severe droughts with widespread concerns.

For North China, rainfall amount was categorized into six grades with fixed intervals: rainstorm, heavy rain, moderate rain, light rain, trace rain and no-rain. The number of each grade rainfall days in summer was examined. The larger the grade is, the more similarity is between the changes of the number of the grade rainfall days and the overall rainfall amount. Particularly, there was a decreasing jump in the 1960s, clearly for the series of total rainfall amount and the number of rainfall days for rainstorm but unclearly for others; the decreasing jump in the 1980s appeared in all series except that of light rain.

For relative extremes defined against a climatological seasonal cycle at each station, the extreme rainfall frequency and strength in North China also experienced two decreasing jumps, a weak one in the mid 1960s and a strong one in 1979-1980. However, the proportion of the extreme rainfall amount to the annual rainfall amount exhibited different trends, without significant jumps. The increasing proportion of extremes since the 1980s suggested more extreme rainfall events under an overall dryer background in recent decades than before. The interannual variability of the frequency and that of the extreme strength are similar. Changes in atmospheric circulation such as the East Asian summer monsoon were analyzed to explain the typical drying process in North China.

Water vapour transport from the tropical Atlantic and summer rainfall over tropical southern Africa

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An EOF analysis of the onshore flow of moisture along the west coast of southern Africa using NCEP-DOE AMIP II Re-analyses suggests two dominant modes of variability that are linked to (a) variations within the South Atlantic anticyclone (b) the intensity of the flow that penetrates from the tropical Atlantic. The second mode, referred as the Equatorial Westerly mode, contributes the most to moisture input from the Atlantic onto the subcontinent at tropical latitudes.

Substantial correlations in austral summer between the Atlantic moisture flux in the tropics and rainfall over the upper lands surrounding the Congo basin suggest the potential role played by this zonal mode of water vapour transport.

Composites for austral summer months when this Equatorial Westerly mode had a particularly strong expression, show an enhanced moisture input at tropical latitudes that feeds into the deep convection occuring over the Congo basin. Sustained meridional energy fluxes result in above normal rainfall east and south of the Congo belt.

During years of reduced equatorial westerly moisture flux, a deficit of available humidity occurs in the southern tropics. A concomitant eastward shift of deep convection to the southwest Indian ocean and southeastern Africa, leads to below normal rainfall over the uplands surrounding the Congo basin.

Regional scale and downscaled climate projections for Croatia

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In order to estimate climate projections for Croatia, the synthetic meteorological series was created by the stochastic weather generator (WG) Met&Roll, which was designed by Dubrovský, both for present climate and different climate change scenarios. The WG parameters were derived from the long time series (1949–2004) for the Zagreb-Maksimir station in the NW continental part of Croatia. The WG Met&Roll provided the synthetic meteorological series of daily data of global solar radiation (SRAD), maximum (Tmax) and minimum (Tmin) air temperatures and precipitation amount (PREC). Precipitation occurrence was modelled by the first-order Markov chain model and precipitation amount by the Gamma distribution. The standardised deviations of SRAD, Tmax, and Tmin from their means were modelled by the first-order autoregressive model, separately for the days with and without precipitation (wet and dry days). As the purpose of the weather generator produces data which are statistically similar to the observed data, the results of validation of the WG Met&Roll are presented as follows:

- The coefficients of skewness and kurtosis for the synthetic and observed SRAD for dry days and Tmin differ the most from normally distributed variables in winter months;
- Discrepancies between the synthetic and observed deviations of the mean value and standard deviation derived from the SRAD and Tmin values are the greatest in April for wet days;
- A shape parameter of the Gamma distribution for the observed and synthetic series of PREC shows the greatest deviation in August;
- Among all correlations between three variables, only the correlation between SRAD and Tmin is negative;

- Monthly ratios of synthetic and observed standard deviation differ from 1 the most for PREC in October and March and for SRAD in February.

The WG Met&Roll preserved well some features of the stochastic structures of daily meteorological series, but the discrepancies were found in reproducing the shape of the distributions of SRAD and PREC.The climate change scenarios were prepared by the pattern scaling technique using the global climate models (ECHAM4/OPYC3, HadCM3 and CSIRO-Mk2). Scaling factors used in this study were for the middle emission scenario and intermediate climate sensitivity (the increase in global mean temperature of 2.5°C) for the years 2050 and 2100. Using the climate change scenarios, the WG Met&Roll was applied to generate a 99-years synthetic meteorological series representing the changed climate.In the current climate the linear trend analysis of four meteorological elements in the NW part of Croatia over the 56-year period showed the significant positive linear trend only in Tmin (0.4°C/10 ys) which started in the late 1980s.In the future climate all climate change scenarios at the end of the 21st century projected an increase: in SRAD 3–7%, in Tmin around 3°C and in Tmax 3–4°C. A slightly increase in PREC (2%) has been shown only in the climate change scenario using the global climatic models HadCM3. Others climate scenarios showed a decrease in PREC for 8%. The results from the climate change scenarios lead to an increase in weather stability in the NW continental part of Croatia.

Climate change impact on the increase of forest fire risk on the Croatian Adriatic coast

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The Croatian part of the Adriatic coast and the islands with the predominantly Mediterranean climate are at high risk of forest fires that inflict serious damage on the agricultural sites and forestland in summer months. Summer in this region is characterized by dry spell, high air temperature and long-lasting insolation duration. The goal of this study is to establish the regional impact of climate change on the potential greater danger of forest fires on the Adriatic area.Monthly severity rating (MSR), as one of the products of the Canadian Forest Fire Weather Index System, is an index for the potential risk assessment of forest fires. The input meteorological data for the MSR assessment include the air temperature, relative air humidity, and wind speed in the warmest part of the day, at 12 UTC, and the daily amount of precipitation. In the warm season, from May to September, the secular variations of MSR were analyzed using the long-term series of Crikvenica (1891–2005) and Hvar (1867–2005), stations which represent the northern and middle Croatian coast and islands. The mean value of warm season air temperature is 20.9°C for Crikvenica and 22.4°C for Hvar. The mean amount of precipitation for the same season is 471 mm for Crikvenica and 194 mm for Hvar. Due to higher mean air temperature and lower precipitation amount in Hvar than in Crikvenica, the MSR values are about three times greater in the mid-Adriatic related to the northern.The

analysis of the secular linear MSR trend for Crikvenica and Hvar as well as the application of non-parametric Mann-Kendall rank test indicate an increase in the MSR for both stations in all months of the warm season except in May, where slightly negative trend was noticed for Hvar. Significant monthly increase (confidence level is 0.05) in the MSR were observed for Crikvenica for all months of the period considered and for Hvar only for June and July. This increase is particularly important for June, as it indicates the possibility of the earlier onset of the forest fire season on the Adriatic area.The analysis also showed that higher risk for forest fire has been spread from the middle Adriatic to the northern, especially in July and August. The reason for that is the significant increase in the mean monthly air temperature and decrease in the monthly precipitation amount in summer months.

Fitting a power law model for low frequencies of ERA40 air temperature spectra

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The question of which statistical model best describes the low frequency behavior of climatic variables is an important one that relates to the predictability of such variables and to confidence intervals for detecting trends and periodicities. Dating from the seminal papers of Hasselmann over 30 years ago, the dominant model for climatic spectra has been an autoregressive model of the first order (AR1). But more recent studies indicate that geophysical time series do not always follow the AR1 or at least that it is not superior to an alternative power law approximation. We investigate the spatial distribution of ERA40 air temperature power law exponents estimated by means of five different statistical methods: detrended fluctuation analysis (DFA), Geweke Porter-Hudak estimator, Gaussian semiparametric estimator, and multitapered versions of the last two. We also test the sensitivity of these spatial distributions to filtering of various climatic modes of variability, such as linear trend, QBO, ENSO, etc. We find that the DFA method is particularly non-robust in the presence of periodic signals, and that for all these methods significant power exponents are concentrated in the tropical troposphere and the subtropical stratosphere. We present preliminary evidence that links the tropical power exponents to ENSO and the subtropical stratospheric power exponents to volcanic forcing.

Impact of Long-Range Correlations on Trend Detection in Total Ozone

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Total ozone trends are typically studied using linear regression models that assume a first order autoregression of the residuals (so-called AR(1) models). We consider total ozone time series over 60S-60N from 1979-2005 and show that most latitude bands exhibit long-range correlated (LRC) behavior, meaning that ozone autocorrelation functions decay by a power law rather than exponentially as in AR(1). At such latitudes the uncertainties of total ozone trends are greater than those obtained from AR(1) models, and the expected time required to detect ozone recovery correspondingly longer. We find no evidence of LRC behavior in southern middle and high sub-polar latitudes (45-60S), where the long-term ozone decline attributable to anthropogenic chlorine is the greatest. We thus confirm an earlier prediction based on an AR(1) analysis that this region (especially the highest latitudes, and especially the South Atlantic) is the optimal location for the detection of ozone recovery, with a statistically significant ozone increase attributable to chlorine likely to be detectable by the end of the next decade. In northern middle and high latitudes, on the other hand, there is clear evidence of LRC behavior. This increases the uncertainties on the long-term trend attributable to anthropogenic chlorine by about a factor of 1.5, and lengthens the expected time to detect ozone recovery by a similar amount (from ~2030 to ~2045).

Crytic Period Analysis Model of Hydrological Process Based on Herteroskedasticity Test and Its Application

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The hydrological process is very complicated, which is influenced by both deterministic and stochastic factors. It is difficult to analyze its critic period, because hydrological time series is probably characterized by herteroskedasticity. To find out the cryptic period, a model is put forward as follows: (1) to apply zero-mean-value to the data, to have ADF stationary test for the sequence and to develop the corresponding AR(p) model, and then to have ARCH effects test and white noise test for residual series, (2) for the time series unfit for ARCH test, to

transform the logarithm to reduce the herteroskedasticity, and then to repeat the step (1) until they pass through ARCH test and stationary test, (3) to determine the component of the prime period by periodogram analysis, and to put forward three kinds of tests to determine significance level of the prime period. According to the new model, the naturalized streamflows from 1784 to 1997, from Alaer and Xinquman gaging Station are analyzed respectively. When reducing their herteroskedasticity, AR(4) Model and AR(2) Model are developed respectively. It is concluded that the naturalized streamflows in the two stations have the same cryptic period of 42.7 years.

Examining the Oceanic Fresh Water Flux in the NCEP Reanalyses and Global Models

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Seasonal and interannual variations of global oceanic precipitation and evaporation generated by the NCEP CDAS, CDAS2, GDAS, GFS AMIP runs, and the CFS coupled simulations have been examined and compared with those of the observations from CMAP and GSSTF2. In general, large-scale distribution and seasonal variation patterns of global oceanic precipitation, evaporation and fresh water flux are relatively well re-produced by the NCEP reanalyses and the climate models. Systematic differences, however, are observed in the magnitude of the precipitation and evaporation compared to the CMAP and GSSTF2. For instance, both the precipitation and the evaporation in the CDAS2 are over-produced, while their differences (fresh water flux) are in general agreement with the observations over tropical and sub-tropical oceans. Interannual variability of precipitation and evaporation associated with the ENSO, NAO, AO and PNA is reasonably well captured in the reanalyses and model simulations examined here. Quantitative agreements between the reanalyses and the observations, however, are less desirable, especially over tropical oceans. Monthly anomaly correlation between the NCEP reanalysis 2 (CDAS2) and observation is less than 0.4 for both precipitation and evaporation over most of the global tropical oceanic regions. Further work is underway to examine the surface wind, temperature, humidity and other related atmospheric and oceanic fields to better understand the differences with the observations and among the reanalyses and model simulations.

Impact of Urban Expansion on Regional Temperature Change in the Yangtze River Delta

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Based on non-radiance-calibrated DMSP/OLS nighttime light imagery from 1992 to 2003, urban land area statistical data, meteorological data and land surface temperature data retrieved by MODIS and NOAA/AVHRR data, the urbanization influence on regional climate trend of temperature in the Yangtze River Delta was analyzed. Conclusions are as follows: □There is a significant urbanization process from 1992 to 2003 in the Yangtze River Delta. Four city clusters of Nanjing-Zhenjiang-Yangzhou, Suzhou-Wuxi-Changzhou, Shanghai and Hangchow Bay form a zigzag city belt. The increase rate of year average air temperature in city-belt is 0.28-0.44□/10a from1991 to 2005, which is far larger than that of non-city-belt. □The urban heat island (UHI) effect on regional average air temperature in different seasons is summer>autumn>spring>winter. □The UHI intensity and the urban total population logarithm are creditable correlated. □The UHI effect made the regional year average air temperature increased 0.072□ from 1961 to 2005 and 0.047□, and the year maximum air temperature increased 0.162□ and 0.083□ from 1991 to 2005, all these indicates that the urban expansion in the Yangtze River Delta from 1991 to 2005 may be regarded as a serious climate signal.

Detecting Inhomogeneity in Daily Climate Series Using Wavelet Analysis

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Daily meteorological observations have increasingly been used in the study of climate extremes. However, the long-term homogeneity of daily data remains questionable, due to untraceable changes in observing system or subjective data processing. Early studies of

homogeneity were mainly concerned with long-term mean values (and hence adjustments of level jumps). Conventional statistics may help identify unusual changes in variance but don't indicate the right way of adjustment regarding variability across different timescales. For daily series, the shortest timescale variability, daily variability, is sensitive to changes in local observing systems and hence may influence homogeneity more than longer-term large-scale variability may do.

A wavelet method was applied to detect inhomogeneities in a few well-established long-term daily temperature series back to the 18th century, which have been 'homogenized' with conventional approaches. Various types of problems remaining in the series were revealed. As these inhomogeneities deal with daily and weather timescale fluctuations, their existence will seriously influence analysis of changes in climate extremes deduced from the daily data.

By analyzing inhomogeneities with regard to specific timescales, the present results not only have importance for understanding issues in conventional climate data processing, but also imply potential for developing more comprehensive methods of homogenization for long-term daily climate series, in order to improve analysis of climate extremes based on daily data.

Changing Trends of Climate in Jiangsu Province during 1961 to 2000

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Abstract: Based on the meteorological data, observed in 63 meteorological stations of Jiangsu Province from 1961-2005, variation trends of average temperature, precipitation and sunshine percentage in recent 45 years are studied. The results show that, annual average temperature in Jiangsu Province presents a significant increase, that is, the temperature increases slightly in the summer while obviously in the other three seasons; the temperature raises the most in the winter and has the largest contribution to the annual temperature rising. Precipitation decreases significantly in the autumn while increases obviously in the winter, but the variations of annual precipitation, the precipitation in the spring and the summer is not so significant; extreme precipitation amount and its frequency appears an obvious increase in the summer, and the intensity of extreme precipitation in the autumn decreases apparently. Annual sunshine percentage and sunshine percentage of the four seasons have some decrease generally; the annual sunshine percentage and the sunshine percentage in the summer and winter reduce obviously.

Key words：average temperature ；precipitation；sunshine percentage；changing trends

Calibrating and evaluating reanalyses surface temperature bias by topographic correction

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Based on the observed daily surface air temperature data from 597 stations over continental China and 2 sets of reanalysis data (NCEP/NCAR and ERA-40) during 1979 - 2001, the altitude effects in calibrating and evaluating reanalyzed surface temperature errors are studied. The results indicate that accuracy of interpolated surface temperature from the reanalyzed grid point value or the station observations depends much on the altitudes of original data. Bias of interpolated temperature is usually in proportion to the increase of local elevation and topographical complexity. Notable improvements of interpolated surface temperature have been achieved through "topographic correction", especially for ERA-40 reanalysis, which highlights the necessity of removal of "elevation–induced bias" when using and evaluating reanalyzed surface temperature.

A Statistical Prediction of the Seasonal Mean Circulation and a Comparison with Dynamical Ensemble Prediction using NCEP's CFS

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Reanalysis data and a recently developed variance decomposition approach are applied to statistically predict seasonal mean 500hPa geopotential height anomalies in both the Northern and Southern Hemisphere. The statistical prediction is compared with the dynamical ensemble prediction of the National Center for Environmental Prediction's coupled Climate Forecast System. (CFS). Generally speaking, the statistical scheme produces a lower prediction error than the dynamical prediction scheme. Using a combined spatio-temporal correlation measure, we find that the CFS dynamical predictions have slightly higher skill

compared to the statistical predictions in Northern Hemisphere, but slightly lower skill in the Southern Hemisphere.

However, because coupled general circulation models have the potential to simulate the contemporaneous air-sea interactions, they have the potential to predict the seasonal mean circulation patterns forced by such interactions. By contrast, statistical prediction relies on a lagged SST or circulation index relationship, which precludes the prediction of modes for which contemporaneous interactions are important. Here, we provide two striking examples: the boreal winter western Pacific oscillation and the austral winter meridional wave train. Their inter-annual variations are successfully predicted by the dynamical model, but could not be included in the proposed statistical prediction scheme due to a lack of lagged predictors.

A Statistical Prediction of the Seasonal Mean Circulation

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Reanalysis data and a recently developed variance decomposition approach are applied to statistically predict seasonal mean 500hPa geopotential height anomalies in both the Northern and Southern Hemisphere. The statistical prediction is compared with the dynamical ensemble prediction of the National Center for Environmental Prediction's coupled Climate Forecast System. (CFS). Generally speaking, the statistical scheme produces a lower prediction error than the dynamical prediction scheme. Using a combined spatio-temporal correlation measure, we find that the CFS dynamical predictions have slightly higher skill compared to the statistical predictions in Northern Hemisphere, but slightly lower skill in the Southern Hemisphere.However, because coupled general circulation models have the potential to simulate the contemporaneous air-sea interactions, they have the potential to predict the seasonal mean circulation patterns forced by such interactions. By contrast, statistical prediction relies on a lagged SST or circulation index relationship, which precludes the prediction of modes for which contemporaneous interactions are important. Here, we provide two striking examples: the boreal winter western Pacific oscillation and the austral winter meridional wave train. Their inter-annual variations are successfully predicted by the dynamical model, but could not be included in the proposed statistical prediction scheme due to a lack of lagged predictors.

To explore an optimal climate decision-making method suitable for medium-sized reservoir management

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Made full use of climate resources，dispatched water level (volume) of the reservoir, and played reservoir's economic benefit in fighting the drought and generating electricity, reservoir operation decisions that must be resolved was currently an important issue .According to weather and economic principles, applyed continuous function for extreme methods, used related economic parameters of yangquan reservoir, Based on reservoirs climate the best activation patterns were established, which could achieve remarkable results for reservoir optimization activation with a scientific basis.

Key words: climate applications；reservoir operation；mothod study；optimal decision