overall increase in the evapotranspiration for all scenarios. Faced with these conditions, water companies are planning for less reliable groundwater resources within an overall risk-based approach to managing future water supply and demand.

H23F CC: 520 A Tuesday 1330h

Advanced Methods for Probabilistic Hydrometeorologic Forecasting III

Presiding: **J Demargne,** NOAA Hydrology Laboratory; **A Pietroniro,** National Hydrology Research Center

H23F-01 1330h

Ensemble streamflow forecasting in snowmelt-dominated river basins

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We are undertaking a detailed study to improve both the accuracy and probabilistic information content of streamflow forecasts in the Colorado River basin. Our two main research objectives are: (1) Development and evaluation of methods to assimilate station-based measurements of snow water equivalent into the NWS River Forecast System; and (2) Development and evaluation of methods to produce forecast inputs on time scales of days through to seasons. For forecast lead times up to two weeks, our experimental forecasting methods have significantly higher skill than the operational methods used by the NWS. On seasonal time scales, our experimental forecasting methods add skill over the operational methods, especially in the lower Colorado River basin where ENSO signals are strong. Further, in specific cases, assimilation of SNOTEL measurements of snow water equivalent are found to improve streamflow forecasts.

H23F-02 1345h

Probabilistic Hydroclimatic Forecasts based on MultiModel Ensembling

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Seasonal forecasts of precipitation/streamflow are essential for the management of water supply systems as well as for developing various strategies of crop management in rain fed agriculture. However, climatic forecasts from different General Circulation Models (GCMs) and statistical models can differ significantly across these models, thereby necessitating the development of methodologies that focus on optimal combination of model ensembles. IRI dynamical climate forecast system pursues such an approach to develop IRI Net Assessment Forecast. In this study, we develop a similar approach to develop multimodel ensembles of streamflow forecasts conditioned on climatic indices. The methodology obtains multimodel streamflow ensembles through an iterative weighting scheme. The performance of the multimodel ensemble is compared with the skill of individual model based approach.

H23F-03 1400h

Towards Operational Probabilistic Quantitative Precipitation Estimation Using NEXRAD

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Large uncertainties associated with the operational quantitative precipitation estimates produced by the U.S. national network of WSR-88D radars known as NEXRAD are well-acknowledged. These uncertainties include both systematic and random effects of numerous sources. Quantitative description of the precipitation estimation errors would help the U.S. National Weather Service (NWS) forecasters in making operational decisions on issuing forecasts and warnings on flooding potential. It would also help the commercial sector and other agencies that use the rainfall products in making risk-based decisions. Currently such information is not available. The authors describe a comprehensive plan of introducing probabilistic quantitative precipitation estimation into the operational NWS environment. The plan focuses on radar-based estimates and includes research and development, experimental, and implementation components. The authors discuss three different possible approaches with their merits and problems. They recommend one of the approaches based on a parameterization of radar-rainfall errors taking into account space and time scale, range, seasonal, synoptic and climatic dependencies. They discuss details of the resources required and the implementation feasibility.

H23F-04 1415h

Wavelet-Based Evaluation of Rainfall-Runoff Models

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Objective functions (e.g. the Nash-Sutcliffe efficiency index) are crucial to the inter-comparison of rainfall-runoff models with different process representations and parameterisations. They are also routinely used as the target of model optimisation and as the parameters used to describe model uncertainty under different parameter sets. The problems of objective functions are well-established, as individual functions may require one or more of: (a) a mean error of zero; (b) a distribution of error that is Gaussian (either before or after some form of transformation); (c) an error series that is not autocorrelated; and (d) an error series that is homoscedastic (i.e. the variance of the error does not change as a function of time). Unfortunately, there are good reasons why these four requirements do not hold. This largely relates to the fact that hydrological processes are influenced by a number of scales of variation (from the storm event through to seasonal variation in soil moisture conditions). The associated error series therefore integrates errors due to a range of time scales and magnitudes of variability (e.g. high magnitude, short duration error in the prediction of a flood peak will be superimposed upon low magnitude, long duration error due to inadequate evapotranspiration treatment). These errors will also be inter-correlated (i.e. the magnitude of flood peak error will depend upon the magnitude of evapotranspiration error). In this paper, a method for addressing this problem is developed and evaluated. This is based upon disaggregation of the error series using a time-frequency localisation based upon wavelet analysis. Wavelet analysis measures the fit of a data series to a wavelet basis function with a range of scales and at all time periods. Thus, it yields the characteristic time scale of a phenomenon present in a data series at all time periods. This paper develops and evaluates a continuous wavelet transform for disaggregating observed runoff data and predictions from a modified form of the classical TOPMODEL. Use of the cross-wavelet spectrum and phase coherence allows explicit identification of when model predictions diverge from observations and the associated time scale over which this occurs. The paper shows that such divergence can be hidden by more conventional objective functions and so provides an additional explanation of possible causes of model equifinality.

H23F-05 1430h

Appraisal of Forecast Value for Groundwater Resources Management

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Seasonal climate forecasts present an opportunity to increase the efficiency with which water resources are managed. However, the probabilistic nature of forecasts poses challenges to potential users and complicates evaluation of the forecasts' quality and value. In this study we use Bayesian decision modeling to evaluate the performance of a seasonal precipitation forecast. We generate an optimal decision map by which probabilistic categorical forecasts are re-categorized and evaluated. In this way, forecast performance is assessed not in terms of the observed climate state but rather in terms of the decision indicated by the forecast. Preposterior analysis via stochastic dynamic programming is used to determine the expected value of the forecast. The application setting is the Palar River basin in Tamil Nadu, India, where demand for water exceeds economically available resources leading to income loss, economic displacement and environmental degradation. Instead of targeting forecasts for use by farmers, we propose that water managers use forecasts to set economic parameters to signal the expected availability of water in the coming season. The economic signal promotes efficient use of water while mitigating the farmers' personal risk of forecast-based decisions.

H23F-06 1445h INVITED

Seasonal to Interannual Hydroclimatic Prediction: From Identification of Dynamics to Multi-Attribute Forecasts

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Dynamical and Statistical Models for seasonal to interannual forecasts of key hydroclimatic state variables have been explored in recent years. Many authors report success based on typical performance metrics. Thus, a casual external observer may feel that we are at the verge of a breakthrough in hydrologic prediction, and hence in water resource management. This talk explores this notion, with particular regard to the multi-scale (time and space) nature of hydrologic fluxes, and of the management variables and styles that the water resources community has become accustomed to. A conceptual framework for the nascent predictive science of hydroclimatology is developed and exemplified. Aspects of the dynamics that need to be understood, and a unifying estimation/inference framework are proposed.

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H24A CC: 520 C Tuesday 1530h

Coupling Microbial Activity, Water Flow, and Solute Transport in the Subsurface I *(joint with B)*

Presiding: **J E Smith,** McMaster University; **M Rockhold,** Pacific Northwest National Laboratory

H24A-01 1530h

Effects of Diffusion Fragmentation and Spatial Constraints on Soil Microbial Diversity

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Evidences show unparalleled microbial diversity at very small scale in soils as compared with aquatic habitats (oceans) - soils contain numerous genotypes per unit volume. Yet the causes of such abundance remain largely unknown due to our limited understanding of relationship between soil microbes and their environment and interaction among microbial populations. We developed a conceptual model for the role of habitat heterogeneity, induced by physical constraints and fragmentation of diffusion pathways on abundance and coexistence among microbial genotypes. The model simulates competition between two microbial cultures with different key growth and diffusion (motility) properties within a soil domain. Diffusion-reaction equation is used to simulate nutrient capture, growth and spreading of the microbial population. Spatial constraints according to soil pore sizes are introduced to limit maximum microbial volume within a specific soil volume. In the absence of spatial constraints, only one of the