

## H71C-0824 0830h POSTER

## Understanding Controls on Historical River Discharge in the World's Largest Drainage Basins

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Long-term (20 year) river discharge records from 30 of the world's largest river basins have been used to characterize surface hydrologic flows in relation to net precipitation inputs, ocean climate teleconnections, and human land/water use patterns. Comparisons of paired station records at upstream and downstream discharge locations within each major river basin suggest that the relatively 'natural' discharge signals represented in upstream discharge records are sustained in the downstream station records for nearly two-thirds of the drainage basins selected. River basins that showed the strongest localized climate control over historical discharge records, in terms of correlations with net basin-wide precipitation rates, are located mainly in the seasonally warm temperate and tropical latitude zones, as opposed to river basins located mainly in the higher latitude zones (above 45 degrees N). Ocean climate indices such as the NINO1+2 and NINO3+4 correlate highly with historical interannual patterns in monthly river discharge for only four of the selected discharge station records, namely on the Amazon, Congo (Zaire), Columbia, and Colorado (Arizona) rivers. Historical patterns of cropland development and irrigated areas may explain the weak climate correlations with interannual patterns in monthly river discharge rates for at least one-third of the major river drainages selected from the historical discharge data set.

URL: <http://www.ahpcrc.umn.edu/nasa-umn/>

## H71C-0825 0830h POSTER

## Hydrological and climatological impacts of the North Atlantic Oscillation in Norway and Sweden

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The North Atlantic Oscillation (NAO) has a discernible impact on the availability of water in reservoirs used for hydropower production in Norway. The NAO signal in precipitation is much weaker in Sweden, because the Kjolén mountains in Norway block the passage of much of the precipitable water into Sweden. However, temperature in both countries is highly correlated with the NAO index. Hydrological and climatological impacts of the North Atlantic Oscillation (NAO) in Norway and Sweden are discussed, as well as the impact of the NAO on the supply and demand of hydropower.

## H71C-0826 0830h POSTER

## Use of extended daily hydroclimatological records to assess hydrologic variability in the Pacific Northwest

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The National Climatic Data Center (NCDC) has recently created digital archives of daily climatological data (primarily precipitation and daily temperature maxima and minima) for the continental U.S. going

back to the beginning of the instrumental records. Previous electronic archives were typically available only back to about 1948, with a few stations digitized back to the 1930's. As a result, most long-term hydroclimatological simulations have been limited to the second half of the 20th century. Reasonably good station coverage for the Pacific Northwest is now available back to at least 1915, which represents a 35-year extension of the available driving data for hydrologic model simulations. These long records, and the hydrologic simulations (e.g., of soil moisture, snow water storage, and runoff) derived from them make possible a better understanding of hydrologic variability in the 20th century. Of particular interest in the Pacific Northwest are hydrologic simulations of the severe droughts in the 1930s and 1940s. Using the newly available data merged with the previous archive, we have created a 1/8 degree data set of precipitation, temperature, and derived radiative forcings and other surface variables needed to drive the Variable Infiltration Capacity (VIC) macroscale hydrology model over a Pacific Northwest domain consisting of the Columbia River basin and coastal Washington and Oregon. Records of naturalized streamflow for the Columbia River at The Dalles, OR are available for this same period, and these observed data are compared to simulated streamflow from the VIC simulations to evaluate the quality of the new data in comparison with the data previously available from 1948-1999. The raw data are also compared to a smaller number of higher quality HCN data records in an effort to identify temporal inhomogeneities or other biases in the data. From the new analysis, we assess implications of the longer derived records to our previous assessments of interannual and interseasonal variability in key hydrologic variables such as snowpack and soil moisture storage.

## H71C-0827 0830h POSTER

## Multiyear Estimates of Evaporation from a Watershed

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Estimates of the evaporative losses from the Walnut River Watershed in Kansas were made with the parameterized subgrid scale (PASS) model and applied in an evaluation of the hydrological balance for the five-year period 1996-2000. The PASS model uses routine, spatially sparse surface meteorological data and satellite remote sensing data to calculate surface evapotranspiration rates over extended areas. The PASS model is observationally driven, makes use of extensive parameterizations of surface properties and processes, and does not rely on mesoscale meteorological models. Heterogeneities in surface conditions are spatially resolved to an extent determined primarily by the satellite data pixel size. For the period of the 1997 Cooperative Atmosphere-Surface Exchange Study field experiment at the Walnut River Watershed, estimates of vertical moisture fluxes from PASS agreed well with surface-based and aircraft-based eddy covariance measurements. Current work focuses on simulation of the water balance over the Watershed area of about 5000 square kilometers for a period of five years, in part to evaluate and study interannual variability. Surface vegetative conditions were described by analysis of biweekly, composite, 1-km-resolution NDVI (normalized difference vegetation index) data products. Radar-based estimates of precipitation estimates were obtained from the regional forecast center. Preliminary results indicate that estimates of accumulated soil moisture loss by evapotranspiration match fairly well with the soil moisture loss inferred roughly from precipitation and stream gauge measurements.

## H71C-0828 0830h POSTER

## Representing interannual variability in daily rainfall sequences

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Many traditional methods of daily rainfall generation assume that the daily rainfall depends exclusively on the rainfall that occurred in the past one, two, or

three days, an assumption that results in an underrepresentation of variability at longer time-scales. For example, the variability of seasonal and annual totals produced by these approaches is known to be lower than the respective observed values. Such reduced variability effects the representation of sustained droughts and years having low rainfall, features that are of great interest in catchment planning and management. We present an approach for stochastic generation of rainfall that does not suffer from the problems noted above. Rainfall is modeled using a two-step approach. The first step consists of generating a series of rainfall occurrences that patterns the day-to-day, inter-seasonal, and inter-annual variability observed in the historical rainfall occurrence record. Once the rainfall occurrence is generated, the next step consists of generating the rainfall amount on each day designated as wet. Both rainfall occurrence and rainfall amounts are modeled assuming a combination of an order-one Markovian dependence, along with selected discrete aggregate conditioning variables representing seasonal, annual and inter-annual aggregate values. Nonparametric statistical methods are used to formulate both simulation models. The approach is applied to daily rainfall from Sydney and Melbourne, Australia, and the performance of the approach is demonstrated by presentation of model results at daily, seasonal, annual, and inter-annual timescales. The resulting generated sequences provide a better representation of the variability associated with droughts and sustained wet periods than was previously possible.

## H71D MCC: Hall C Sunday 0830h

## Drought Analysis and Prediction II Posters (joint with A, GC)

Presiding: J Valdes, University of Arizona; J Salas, Colorado State University

## H71D-0829 0830h POSTER

## The Geographical Distribution and Recurrence Characteristics of Drought - A Global Perspective

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Various indices based on observational data are used to assess the geographical distribution and relative frequency of occurrence of drought events around the globe for the period 1950-1998. Droughts of various intensity, duration, and spatial extent are considered. The results indicate that, despite variability among the different indices, there appears to be preferred regions around the globe for recurrent drought events. In addition, some of these regions map onto areas typically affected by ENSO (with seasonal precipitation anomalies of like "sign") suggesting some potential predictability. The integration of real time global drought monitoring with seasonal forecasting efforts at the IRI will be briefly described in the context of probability of drought persistence.

## H71D-0830 0830h POSTER

## Circulation patterns associated with droughts over southern Africa

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The paper highlights the circulation patterns associated with droughts that have demonstrated the vulnerability of the socioeconomic development of around 200 million people from 14 the Southern African Development Community (SADC) countries to the vagaries of the climate system. The recent, apparently perennial droughts juxtaposed with floods across southern Africa have to be seen against the background of advances made by the scientific community in the understanding of the global ocean-atmosphere system. The paper seeks to contribute to such advances science is making in order to make humankind benefit from the knowledge science has provided. The data used in the analyses include actual rainfall from the SADC countries and those from the United States NOAA (NCEP/NCAR Reanalysis) data banks.

The paper briefly looks at the regional climatology of the SADC countries, which shows that rains fall within the period October during one year to March of the following year. Most of the damaging droughts have tended to occur during January to March. Thus, the more detailed analysis of the circulation characteristics has a focus of composite of these months.

A few recent drought years are selected for analyzing of the dynamical structures of the regional circulation patterns and the tropical ocean and global atmosphere. These tended to coincide with El Niños. However, the selected years include the recent drought during the 2001/2002 rainfall season, which occurred in a neutral El Niño-Southern Oscillation (ENSO) phase. There emerged significant similarity between rainfall anomaly variability and the ENSO signals. The many parameters of the atmosphere showed consistent characteristics in different drought years. The regional circulation patterns associated with droughts show similarities in both active and neutral ENSO years.

The study also shows how possible generators of the climate anomalies can be grouped together. Thus the diagnosis of the various fields contributes to developing a framework for providing skillful predictive tools in order to minimize the vulnerability of the region to the extremes in the variation of the climate system.

#### H71D-0831 0830h POSTER

##### An Examination of the Spatial and Temporal Patterns of Agricultural Drought in the Canadian Prairies

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Palmer's Moisture Anomaly Index (Z-index) was used to characterize the frequency, severity, and spatial extent of growing season agricultural drought events for 43 crop districts across the Canadian prairies during 1920-1999. The crop districts were divided into five relatively homogeneous regions based on a cluster analysis of the Z-index values. Drought statistics were calculated and analysed for each of the drought regions. The single most severe growing season drought on the Canadian prairies occurred in 1961. This drought covered more than 86% of the study region and had a mean severity (Z-index) of -5.67. Other severe growing season droughts occurred in the Canadian prairies (in order of severity) in 1988, 1929, and 1937. The results demonstrated that the severity and spatial extent of droughts on the Canadian prairies are strongly correlated indicating that more severe drought events tend to affect larger areas. The most drought prone crop districts experienced moisture conditions unsuitable for crop production approximately one out every six growing seasons. The spatial analysis revealed the existence of several preferred spatial patterns of drought. The temporal analysis verified the presence of coherent drought periodicities (in particular quasi-2, 4, and 10-15 year oscillations).

#### H71D-0832 0830h POSTER

##### Hydroclimatic Variations and the Spatial Scales of Drought Severity in the Interior Western United States

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In the semi-arid interior west, watershed health and drought severity depend on the overlapping scales of climatic variations (and associated snow, temperature, warm season precipitation anomalies), vegetation stress, and streamflow volumes. Consequently, diagnosis and assessment of drought must account for these hydroclimatic and ecological indices and their year-to-year variations. Based on historical streamflow records, high-resolution vegetation indices, and climate data, we investigate the spatiotemporal variations in runoff efficiency and drought probabilities. The proposed framework provides a fresh perspective on drought characterization, monitoring, and prediction for water resources management, drought planning, fire risk, and resource allocation.

#### H71D-0833 0830h POSTER

##### An Aggregate Drought Index (ADI) to Quantify Drought Severity Across Multiple Time Scales

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A multivariate, principal-component based index is introduced to quantify the severity of droughts. The Aggregate Drought Index (ADI) describes the meteorological, hydrological, and agricultural aspects of drought on a climate-divisional basis, using fluctuations in the values of five variables associated with the hydrologic cycle and available water: precipitation, evaporation, streamflow, reservoir storage, and soil moisture. Additionally, the ADI considers the snow water content of snowpack reserves (for months and regions where appropriate). The ADI is computed as the first principal component of the observational dataset, where the principal components are determined using a correlation-based approach. Index computations are performed separately for each of the twelve months, such that the signal is not biased by the differing hydroclimatologies of distinct months. The twelve series are ordered chronologically, and the basic monthly chronology is extended to produce time series of drought across 3, 6, 12, 24, 36, 48, 60, and 72 month periods. Drought severities over multiple time scales are presented for three California climate divisions during the minimum period of 1975-2000. A methodology is also presented for the routine, real-time computation of current ADI values.

#### H71D-0834 0830h POSTER

##### A hydrological-climatological-ecological drought severity index

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Droughts are studied either from a pure climatological perspective (precipitation deficit), hydrological perspective (low streamflow) or ecological perspective (low vegetation). This paper intends to study droughts and their occurrences using a hydrological model of the soil layers complete with infiltration, runoff, evaporation and temporal evolution of the soil moisture. We propose a new method of integration of precipitation, soil moisture, streamflow, water table and vegetation information into an integrated hydrological-climatological-ecological drought severity index. However, several roadblocks exist for such a coupled index. Water table information (if available) is very sparse and these are influenced by withdrawals. Vegetation data is available via remote sensing and is very seasonal. Precipitation is highly variable in space and has this has to be factored in the index calculation. This paper will provide a framework for such a complex and complete integration.

#### H71D-0835 0830h POSTER

##### Analyzing Drought From Paleo-Reconstructions Of 7-Day Low Flow In The Hudson River Basin

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The annual 7-day low flow in a stream is a measure of the dry season conditions in a stream. Consequently, it is a useful indicator for multi-year droughts. Here, we first present the application of a Generalized Linear Model in a Bayesian Hierarchical Modeling Framework for reconstructing the annual 7-day low flow series at 5 locations in the Hudson River Basin using 11 regional tree ring chronologies. This technique directly provides estimates of the posterior probability distribution of each reconstructed streamflow value, considering model parameter uncertainty. Given these reconstructions, we examine the frequency and recurrence attributes of extreme droughts in the region and their potential connections to known low frequency climate modes.

#### H71D-0836 0830h POSTER

##### A Local Forecast of Land Surface Wetness Conditions, Drought, and St. Louis Encephalitis Virus Transmission Derived from Seasonal Climate Predictions

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We present an ensemble local hydrologic forecast derived from the seasonal forecasts of the International Research Institute (IRI) for Climate Prediction. Three-month seasonal forecasts were used to resample historical meteorological conditions and generate ensemble forcing datasets for a TOPMODEL-based hydrology model. Eleven retrospective forecasts were run at a Florida and New York site. Forecast skill was assessed for mean area modeled water table depth (WTD), i.e. near surface soil wetness conditions, and compared with WTD simulated with observed data. Hydrology model forecast skill was evident at the Florida site but not at the New York site. At the Florida site, persistence of hydrologic conditions and local skill of the IRI seasonal forecast contributed to the local hydrologic forecast skill. This forecast will permit probabilistic prediction of future hydrologic conditions.

At the Florida site, we have also quantified the link between modeled WTD (i.e. drought) and the amplification and transmission of St. Louis Encephalitis virus (SLEV). We derive an empirical relationship between modeled land surface wetness and levels of SLEV transmission associated with human clinical cases. We then combine the seasonal forecasts of local, modeled WTD with this empirical relationship and produce retrospective probabilistic seasonal forecasts of epidemic SLEV transmission in Florida. Epidemic SLEV transmission forecast skill is demonstrated. These findings will permit real-time forecast of drought and resultant SLEV transmission in Florida.

#### H71E MCC: 130 Sunday 0830h

##### Observations and Modeling of Land Surface Hydrological Processes II (joint with GC)

Presiding: V Lakshmi, University of South Carolina; T Cahill, Texas AM University

#### H71E-01 0835h INVITED

##### Soil Moisture Experiments 2003 (SMEX03)

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A series of large-scale soil moisture field experiments have been conducted over the past decade. These have been successful at addressing a broad range of science question, focusing technology development and demonstration, and providing educational experiences for undergraduate and graduate students. Soil Moisture Experiments 2003 (SMEX03) will focus on satellite based soil moisture products. The NASA Aqua and Japanese ADEOS-II Advanced Microwave Scanning Radiometer (AMSR) Programs are committed to developing and providing daily soil moisture products. This is the first time that this challenging task has