H52E MCC: 130 Friday 1330h

Hydroclimatology of Large Northern Watersheds: From Observation to Modeling II *(joint with B, OS, GC)*

Presiding: **D Yang,** University of Alaska, Fairbanks**; M Serreze,** University of Colorado

H52E-01 1335h INVITED

The Pan-Arctic Water Budget: Major Challenges and Opportunities

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The Arctic system and its water cycle are believed to play a central role in regulating Earth's climate and biogeochemistry. The Arctic is also experiencing rapid environmental change, several elements of which are associated with the hydrological cycle. This presentation describes a synthesis study of the pan-Arctic water cycle and its role in global change. An Expanded Arctic Regional Integrated Monitoring System (E-RIMS) is currently under development to link an existing, near real-time hydrological monitoring system for the pan-Arctic landmass and atmosphere (Arctic-RIMS) to an Arctic Ocean and sea ice component. On the terrestrial side, E-RIMS produces time-varying aerological and land surface water budgets including river and icemelt inputs to the Arctic Ocean. For the ocean, freshwater fluxes from the atmosphere and land are used in concert with observed mass, heat and momentum forcings to drive a coupled ocean-sea ice-atmosphere model. The linked models are being used to examine the origin of freshwater fluxes in the atmosphere and landmass and how water is then partitioned between solid (sea ice) and liquid forms in the ocean. E-RIMS will also track freshwater transport off the shelf, downward below the mixed layer, and laterally toward the straits leading to the North Atlantic Ocean. An overview of the principal elements of E-RIMS will be discussed, and an early application of the system to estimate closure of the pan-Arctic water budget will be presented. The role of such studies in the broader context of the new Arctic-CHAMP Hydrology effort at NSF is also discussed.

H52E-02 1350h

Main results obtained by the Siberia Regional Project of GAME

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GAME(GEWEX Asian Monsoon Experiment) selected one of their field experiment site in Siberia. Importance of this area was, first, its large area on Eurasia, second, potential effect of fresh water supply to the Arctic Ocean, thirdly, this region is one center of the recent intense warming. In order to progress the study, we set up the following objectives. 1) Clarify the physical processes of the land-surface/atmosphere interacting system. 2) Clarify the characteristics and variability of regional energy/water cycle. 3) Obtain the climate trend and land-surface change during the past 50 years. 4) Improve and develop atmospheric and hydrological models 5) Collection and archive of regional ground based/satellite data. 6) Establishment of observational network for long-term variation study, and development of hardware. The 1st phase of the study was 1996-2001, and from 2002 to 2004, 2nd phase emphasizing on integration is continued. Among the drainage in Siberia, Lena River was selected and following main results were obtained. (1) Land surface processes at three local sites: Heat water exchange study was made at three sites (Tundra: Tiksi, Flat taiga:Yakutsk, Mountaineous taiga:Tynda) for multiple years. They all showed strong influence of frozen ground (permafrost) to the heat/ water balance at patch scale. Snow cover had strong influence to hydrological process at Tundra and Mountaineous taiga, but it was masked at Flat Taiga. In Flat taiga, rhythm of heat flux to atmosphere is regulated strongly by foliation of leaves. Grassland (called alas) in comparison with nearby forest show different seasonal progress of fluxes, higher evaporation and low sensible heat at small young alas, and lower evaporation at vastly cultivated alas. Inter-annual variation of evaporation seem to be small in the Flat taiga forest compared with Tundra, although soil moisture show strong inter-annual variability, mainly due to the result of active function of the trees. In dry years trees used the soil moisture at deep depth. (2) Land/surface atmosphere interaction at flat taiga: According to the aircraft observation of heterogenous land surface at 100km scale including Lena River, distribution of low level heat/water fluxes (100m) show complex pattern influenced by characteristics of boundary layer and local circulation. (3) Precipitation recycling: Stable Isotope analysis show the seasonal change in the character of precipitation recycling, weaker in the early summer and stronger in late summer (August) in this area. (4) Hydrological models sensitivity tests: Hydrological models were developed applicable to the large drainage, and result showed that drainage is more sensitive to change in precipitation than to air temperature. (5) Development of automated year-round observation system: Automated observation system made success in acquiring year-round meteorological and ground surface data at the three local observation sites

H52E-03 1405h

The Large-Scale Hydro-Climatology of the Terrestrial Arctic Drainage System

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The large-scale hydro-climatology of the terrestrial Arctic drainage system is examined, focusing on the period 1960 and onward. Special attention is paid to the Ob, Yenisey, Lena and Mackenzie watersheds, which provide the bulk of freshwater discharge to the Arctic Ocean. Station data are used to compile monthly gridded time series of gauge- corrected precipitation (P). Gridded time series of precipitation minus evapotranspiration (P - ET) are calculated from the moisture flux convergence using NCEP reanalysis data. Estimates of ET are obtained as a residual. Runoff (R) is obtained from available discharge records.

For long-term water-year means, P-ET for the Yenisey, Lena and Mackenzie is 16 to 20 percent lower than observed runoff. In the Ob the two values agree within 9 percent. Given the uncertainties in P-ET, we consider the atmospheric and surface water budgets to be reasonably well closed. Compared to the other three basins, the mean runoff ratio (R/P) is lower in the Ob, consistent with the high fraction of annual precipitation lost through ET. All basins exhibit summer maxima in P and minima in P-ET. Summer P-ET in the Ob is negative due to high ET rates. For large domains in northern Eurasia, about 25 percent of July precipitation is associated with recycling of water vapor evapotranspirated within each domain. This points to a significant effect of the land surface on the hydrologic regime.

Variability in P and P-ET has generally clear associations with the regional atmospheric circulation. A strong link with the Urals trough is documented for the Ob. Relationships with indices of the Arctic Oscillation and other teleconnections are generally weak. Water year time series of runoff and P-ET are strongly correlated in the Lena only, reflecting extensive permafrost. Cold-season runoff has increased in the Yenisey and Lena. This is most pronounced in the Yenisey, where runoff has also increased sharply in spring, decreased in summer, but has increased for the year as a whole. The mechanisms for these changes are not entirely clear. While they fundamentally relate to higher air temperatures, increased winter precipitation, and strong summer drying, we speculate links with changes in active layer thickness and thawing permafrost.

H52E-04 1420h INVITED

Issues in Application of Macroscale Hydrology Models to High-Latitude Domains

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The representation of high-latitude land surface processes in coupled land-atmosphere-ocean models has received increasing attention with recognition of the importance of the Arctic to global climate. The recently completed Arctic Hydrology Model Intercomparison Project (Phase 2(e) of the Project for Intercomparison of Land-Surface Parameterization Schemes PILPS 2(e)) identified several shortcomings with many of the current generation of land surface schemes when applied to the Torne-Kalix River basin of Scandinavia. These included difficulties in representing the end-of-season snowpack, which at high latitude mostly represents a balance between precipitation accumulation and sublimation. Errors in sublimation, and hence in spring snow accumulation, propagate through the annual water balance. Errors in sublimation were found to strongly affect annual net radiation, as models with (artificially) high sublimation generally had low sensible heat. A calibration experiment for four small subcatchments showed that model parameters that control storage of moisture in the soil column or on the land surface via ponding can strongly influence the seasonal distribution of runoff, but have relatively little impact on annual runoff ratios. New parameterizations for the Variable Infiltration Capacity (VIC) land surface scheme have been developed to address model deficiencies identified in PILPS 2(e). The dynamic nature of wetland extent in low-gradient arctic watersheds is now represented through an energy balance lake and wetland algorithm. Representation of evaporation from open water areas increases predictions of summer evaporation in arctic coastal areas by up to 60 %. An algorithm to represent topographically induced sub-grid variability in wind speed and blowing snow sublimation has also been implemented. Predicted sublimation from blowing snow represents approximately 25 to 50 % of winter snow precipitation in northern Alaska tundra regions. Preliminary results for large arctic river basins are presented which illustrate implications of the new parameterizations.

H52E-05 1435h INVITED

An assessment of simulated water balance for the Yenisey, the Lena, and the Amur River basins in an AMIP 2 simulation

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Streamflow, which integrates the response of the land surface to atmospheric forcing over large areas, is a useful diagnostic to assess the performance of land surface schemes over large spatial scales. Observed runoff and streamflow data for three high-latitude continental-scale river basins (the Yenisey, the Lena, and the Amur) are used to assess the performance of the Canadian land surface parameterization scheme (CLASS), when operated within the Canadian Centre for Climate modeling and analysis (CCCma) general circulation model (GCM) at 3.75^{o} resolution.

Results are used from the 17 year (1979-1995) AMIP 2 simulation made with the CCCma atmospheric GCM in which lower boundary conditions of observed monthly sea surface temperatures (SSTs) and sea-ice concentrations are specified. Estimates of evapotranspiration obtained using atmospheric water balance, and soil moisture obtained using the VIC-2L hydrological model, are also used to assess the CLASS water balance simulations. Runoff generated by CLASS is routed via a flow routing scheme to obtain streamflow at the mouth of the rivers.

Comparisons with observations of streamflow, and estimates of evapotranspiration and soil moisture, suggest that despite the large spatial scale (≈3.75^{o}) at which the CLASS land surface scheme is operated within the GCM the simulated annual cycle of evapotranspiration, streamflow, and soil moisture compare reasonably well with observation-based estimates. However, there remain discrepancies in the mean annual water balance quantities. The GCM simulated precipitation is slightly higher (≈8-14%) than observation-based estimates for these river basins. Model-simulated runoff is lower (≈12-26%) than observations and simulated evapotranspiration is higher.

H52E-06 1450h INVITED

High Latitude Soil Moisture Observations to Study Climate Variations and to Evaluate Climate Models

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Soil moisture is an important variable in the climate system. Understanding and predicting variations of surface temperature, drought, and flood depend critically on knowledge of soil moisture variations, as do impacts of climate change and seasonal climate forecasting. An observational data set of actual in situ measurements is crucial for model development and evaluation, and as ground truth for remote sensing. The Global Soil Moisture Data Bank is a web site (http://climate.envsci.rutgers.edu/soil_moisture) dedicated to collection, dissemination, and analysis of soil moisture data from around the globe, and is a resource for the remote sensing, climate modeling and climate analysis communities. We currently have soil moisture observations for over 400 stations from a large variety of global climates, including from the former Soviet Union, China, Mongolia, India, and the US, but not many from high latitude locations. We will describe two examples of different uses of these data sets. We have used the data to examine the impact of explicitly including frozen soil in land surface models on the partition of snow melt into runoff and infiltration, as a continuation of analysis of the PILPS Phase 2(d) experiment in Valdai, Russia, and to examine the role of soil moisture in serving as a memory for snow cover anomalies to influence the Asian summer monsoon. We find that inclusion of frozen soil is important for accurate simulations of soil temperature, but not as important for soil moisture in high latitudes, since the soil tends to be saturated and there is insufficient capacity for a large influence on infiltration. There is no evidence for soil moisture serving as snow cover memory.

URL: http://climate.envsci.rutgers.edu/soil_moisture

H52E-07 1525h INVITED

Changes in Permafrost Dynamics and Their Hydrologic Implications over the Russian Arctic Drainage Basin

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Recent studies indicate that runoff over the Siberian arctic drainage basin in the past several decades has increased 25 to 90 percent during the cold season (October-April) and there is an imbalance between runoff and precipitation minus evaportranspiration (P-ET). The cause of the imbalance between runoff and P-ET, and the increase in winter runoff, is poorly understood. It is hypothesized that changes in the active layer and permafrost dynamics may play a key role in the recent changes in the Arctic hydrologic regime. In this paper, we document permafrost distribution and near-surface permafrost temperature and active layer thickness over the past few decades, and their impact on the hydrologic cycle over the major Siberian river basins. Over the Ob river basin, less than 10 percent of the total area is underlain by permafrost; mainly sporadic and isolated patches. The impact of permafrost on runoff may be minimal compared to the impact of permafrost on other rivers. Approximately half of the total area of the Yeniser river basin is underlain mainly by discontinuous, sporadic, and isolated permafrost. Permafrost in the Yenisei basin should be more sensitive to thawing and melting of excess ground ice, and thickening of the active layer would contribute an extra source of runoff. More than 90 percent of the total area of the Lena river basin is underlain by permafrost in the Lena river basin, of which continuous permafrost accounts for more than 90 percent. Our study indicates that mean annual soil temperature at 40 cm depth has increased about 0.9 to 1.0 degree C from 1930 to 1990 over the Russian Arctic and subarctic regions. The increase is more pronounced from 1970 to 1990. Increase in the near-surface soil temperature leads to degradation of permafrost and thickening of the active layer. Ground-based measurements over the Lena river basin indicate that active layer thickness has increased about 30 cm during the past two decades. Based on related ground ice data and information, thawing of 30 cm of the active layer would produce sufficient water to account for the imbalance between runoff and P-ET. Thickening of the active layer delays the freeze-up date and therefore partly explains increased runoff during winter months. We will also present historical variations in the timing, duration, areal extent, and thickness of the active layer over the study area.

H52E-08 1540h

Variability of Snow Ablation: Consequences for Runoff Generation at the Process Scale and Lessons for Large Cold Regions Catchments

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The supply of water to large northern catchments such as the Mackenzie and Yukon Rivers is dominated by snowmelt runoff from first order mountain catchments. In order to understand the timing, peak and duration of the snowmelt freshet at larger scale it is important to appreciate the spatial and temporal variability of snowmelt and runoff processes at the source. For this reason a comprehensive hydrology study of a Yukon River headwaters catchment, Wolf Creek Research Basin, near Whitehorse, has focussed on the spatial variability of snow ablation and snowmelt runoff generation and the consequences for the water balance in a mountain tundra zone. In northern mountain tundra, surface energetics vary with receipt of solar radiation, shrub vegetation cover and initial snow accumulation. Therefore the timing of snowmelt is controlled by aspect, in that south facing slopes become snow-free 4-5 weeks before the north facing. Runoff generation differs widely between the slopes; there is normally no spring runoff generated from the south facing slope as all meltwater evaporates or infiltrates. On the north facing slope, snowmelt provides substantial runoff to hillside macropores which rapidly route water to the stream channel. Macropore distribution is associated with organic terrain and discontinuous permafrost, which in turn result from the summer surface energetics. Therefore the influence of small-scale snow redistribution and energetics as controlled by topography must be accounted for when calculating contributing areas to larger scale catchments, and estimating the effectiveness of snowfall in generating streamflow. This concept is quite distinct from the drainage controlled contributing area that has been found useful in temperate-zone hydrology.

H52E-09 1555h

Characteristics of snow accumlation over northern Eurasia

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The snow depth climatology, trends, and temporal and spatial variability over northern Eurasia are examined using the historical Soviet Daily Snow Depth data for the time period of 1936-95. Also, trends in starting and ending dates of snowfall season over the study region are revealed. The teleconnections of the northern Eurasia winter snow depth to sea surface temperatures and summer monsoon rainfall over Southeast Asia are explored.

H52E-10 1610h

Hemispheric-scale Snow Cover Climatologies Derived From Satellite Remote Sensing

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During the past thirty-five years much important information on Northern Hemisphere snow cover has been provided by the NOAA weekly snow extent charts derived from visible-band polar orbiting and geo-stationary satellite imagery. This product represents the longest single time series of any geophysical product obtained from satellite and is available from NSIDC as the Northern Hemisphere EASE-Grid Weekly Snow Cover and Sea Ice Extent Version 2. Because of the ability to penetrate clouds, provide data during darkness and the potential to provide an index of snow depth or water equivalent, passive microwave satellite remote sensing can greatly enhance snow measurements based on visible data alone. It is now possible to monitor the global fluctuation of snow cover over a twenty-three year period using passive microwave data (Scanning Multichannel Microwave Radiometer (SMMR) 1978-1987 and Special Sensor Microwave/Imager (SSM/I), 1987-present). We present a recent NSIDC prototype data set of microwave-derived mean monthly snow water equivalent. While other satellite-derived snow extent data are available, they are regional in scale, limited in time period and often do not represent consistent data processing techniques. The launch of the NASA EOS platforms of Terra in December 1999 and Aqua in May 2002 provide new and enhanced opportunities for mapping of snow at the global scale. Both Terra and Aqua carry a MODIS (Moderate Resolution Imaging Spectroradiometer) which provides snow maps at an unprecedented 500 m resolution. The Aqua platform also carries the AMSR-E (Advanced Microwave Scanning Radiometer-EOS) which has approximately double the spatial resolution of SSM/I and will be providing passive microwave-derived snow water equivalent at the global scale beginning in 2003. Because there are clear advantages, and corresponding disadvantages, in applying only visible or passive microwave methods to snow mapping, we are currently developing a blended product which combines the respective advantages of the two sensors while simultaneously reducing their limitations.

H

H52E-11 1625h

Signal of vegetation variability found in large-scale evapotranspiration as revealed by NDVI and assimilated atmospheric data

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The vegetation activity strongly influences the atmosphere. Especially, the transpiration from the vegetation of extensive forests plays an important role in the water and energy cycle in the climate system. It was revealed that the seasonal cycle of the evapotranspiration (ET) has close relationship to that of the Normalized Difference Vegetation Index (NDVI) (Suzuki et al., 1998, Journal Meteorological Society of Japan, **76**, 663–671). This study focused on the interannual change of the NDVI, which is derived from NOAA/AVHRR measurement, and that of the ET, which was estimated from gridded atmospheric datasets.

Monthly global NDVI data were acquired from the Pathfinder AVHRR Land (PAL) data. The ET was estimated by so-called "atmospheric water budget method," that is, a method for estimating the ET from the precipitation and water vapor divergence/convergence in the air column on each grid cell of the gridded atmospheric data. This study used 2.5 × 2.5 degree spatial resolution atmospheric data created by the National Centers for Environmental Prediction (NCEP), and gridded (2.5 × 2.5 degree) precipitation data provided by the CPC Merged analysis of Precipitation (CMAP) etc.

The time series of the NDVI and ET monthly anomalies from their monthly mean was calculated for each grid cell from 1982 to 2000, and they were compared. In general, positive correlation prevails over the terrestrial area except for some deserts and tropical rain forest regions. Especially, high positive correlation coefficients were found over the high latitude Eurasia and semi-arid regions in Africa and North America.

This result possibly demonstrates that the ET interannual variation contains an apparent signal due to the vegetation variability. Further results of analyses in term of the time series of the NDVI and ET in some specific regions in northern high latitudes will be introduced.

H52E-12 1640h

Origin of Measured Precipitation on Alaskas North Slope

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Although annual precipitation (250-300 mm) on the North Slope of Alaska would place this area in a semiarid classification, significant individual events occur. For example, in July 1999 over 100 mm of rain fell during a 50-hour period and in August 2002 over 60 mm fell in a 20-hour period. These major events are of great importance as they often lead to catastrophic actions reshaping stream channel morphology and causing destruction of roads and other civil structures. Questions regarding how these precipitation events may be changing in frequency or intensity in response to a changing climate are of critical importance. Knowing the source of typical and atypical events may enable improved projections. As the surrounding Arctic Ocean is ice-covered with some open leads almost the entire year (open ocean possible along the coast from mid-July to mid-September) the question is, what is the source of precipitable water for both winter and summer events. By combining field measurements from the Kuparuk River basin with storm tracks just prior to the local event, we are able to determine the origin and pathway of this water. Preliminary results indicate storm tracks may be separated using meteorological analyses, satellite image analyses and stable isotope analyses (d18O and d2H). It appears the major events initiate in the North Pacific or Bering Sea, picking up some water in the Chukchi and Beaufort Seas as they move generally northward along Western Alaska and then from west to east across Alaskas North Slope, avoiding the major mountain ranges.

URL: http://www.uaf.edu/water/projects/NorthSlope/northslope.html

H52E-13 1655h

Preliminary Findings From the First Year of the USGS Yukon River NASQAN Study

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The Yukon River, located in northwestern Canada and central Alaska, drains an area of more than 330,000 square miles, making it the fourth largest drainage basin in North America. The Yukon River is being studied from 2001 to 2005 as part of the U.S. Geological Survey's National Stream Quality Accounting Network (NASQAN) program. A number of constituents are being measured during this study and include sediment, major ions, trace elements and nutrients, dissolved and particulate carbon, and mercury. Five water-quality sites have been established in the basin. Three are located along the main stem of the Yukon River: at Eagle, near Stevens Village, and at Pilot Station; and two at major tributaries - the Tanana River, and the Porcupine River.

Data from the first year of the study (October 2000 to September 2001) indicate large differences between the Tanana and Porcupine Rivers. Both basins are approximately the same size, 25,600 square miles and 29,500 square miles respectively, but glaciers cover about 6 percent of the Tanana River Basin whereas the Porcupine River Basin contains no glaciers but is underlain by permafrost. Runoff from the Tanana River Basin was 13.8 inches while runoff from the Porcupine River Basin was 7.8 inches. Approximately 25 million tons of suspended sediment were transported by the Tanana River while approximately 3 million tons of suspended sediment were transported by the Porcupine River.

Suspended sediment loads transported past the Yukon River gages at Eagle (near the Canada-U.S. border), near Stevens Village, and Pilot Station (near the mouth) were 44, 52, and 89 million tons respectively. These suspended sediment loads suggest that the Yukon Flats area (located between Eagle and Steven Village) may not be a depositional area for sediment. At all sites, concentrations of nitrogen are less than 1.0 mg/L although phosphorus concentrations are greater than 0.1 mg/L. Dissolved organic carbon concentrations peak at the beginning of the runoff season and gradually decline at all sites.

H52F MCC: 120 Friday 1330h

Advances in Information Fusion Technologies in Hydrological Sciences I

Presiding: **W Illman,** University of Iowa**; T Yeh,** University of Arizona**; D Tartakovsky,** Los Alamos National Laboratory

H52F-01 1330h

Quantifying Uncertainty in the Geochemical Model of a Soil Solution

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Sensitivity/uncertainty analysis is commonly used in hydrological modeling, but its use in geochemical and reactive transport models is rare. In this study, the process of identifying, quantifying and minimizing uncertainties encountered in developing a soil solution geochemical model is illustrated using field chemical analyses. Stochastic models are used to quantify uncertainties in model parameters, particularly those associated with Fe-oxide solubility. Uncertainties in aqueous species stability constants, mineral log(K)'s, as well as in solution composition were addressed. Fe-oxide mineral solubility was only sensitive to a few aqueous speciation constants, so uncertainties in the remaining 66 constants used in the aqueous model could be ignored. The analyses indicated that soil solution composition might be controlled by reactive phases, not thermodynamically stable ones. Fe solubility distributions arising from sensitivity/uncertainty analyses showed that the only Fe-oxide consistent with all the measurements was ferrihydrite, and that goethite and Al-substituted goethite have overlapping solubility ranges in these sediments. The preferred conceptual model and the resulting average solution composition will be used as the initial condition in reactive transport models for a set of field experiments.

H52F-02 1345h

Ensemble Approaches to Hydrologic Data Assimilation

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Ensemble (or Monte Carlo) methods provide an especially flexible and efficient way to merge diverse sources of hydrologic information. The ensemble approach is based on state and measurement equations that relate noisy observations to the uncertain hydrologic quantities of primary interest. Approximate statistical descriptions of the system states are constructed by repeatedly solving these equations for different error source realizations. Various methods can be used to derive state estimates from these sample statistics. In this paper we show how ensemble estimation algorithms are related to reduced rank filters and illustrate some of the advantages of the ensemble approach with a soil moisture data assimilation problem.

H52F-03 1400h

The Central Roaring Fork Valley, Colorado Hydrologic System on a Watershed Scale: An Integrated, Interdisciplinary Hierarchical Modeling Approach Using Intergraph GeoMedia and Voxel Analyst

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The Central Roaring Fork Watershed, part of the Colorado River Basin, comprises the towns of Aspen, Basalt, and Snowmass Village, Colorado, 4 major ski resorts, and streams that are designated as Blue Ribbon trout fishery. The study area is urbanizing rapidly, including increased reliability on drinking water wells and individual sewage disposal systems (ISDS). The impacts to recreation, drinking water supplies, and the riparian/wetland environment may reach the point of noncompliance for TMDLs in surface waters and drinking water standards. The purpose of this study is to use existing data to develop a watershed-based, hierarchical analysis and an integrated conceptual model, focused on ground water, to aid in characterization of potential contaminant migration pathways from various urban sources, such as ISDS's.

The complex hydrologic system is characterized using hierarchical systems analysis of multidisciplinary data, including climate, vegetation, surface water, topography, anthropogenic activities, soils and geomorphology, and geology. The hydrogeologic units are delineated spatially as a 3-dimensional framework where significant permeable layers or major conduits for ground-water flow are identified, and hydrogeologic properties of the units are estimated using available data. The hydrogeologic framework solid block model is then created in Intergraphs GeoMedia and Voxel Analyst to analyze and visualize the Central Roaring Fork watershed system. This complex hydrogeologic model consists of 5 unconsolidated hydrogeologic layers, 3 bedrock hydrogeologic layers, and several major fault systems. The hydrologic system is then characterized with respect to both surface water and ground water subsystems. Significant groundwater flow, discharge and recharge areas, and the relationship of these areas to the surrounding terrain and areas of potential environmental impact are assessed with respect to the entire system using GeoMedia and Voxel Analyst. The analysis will allow a comprehensive, complex mathematical model to be constructed and provide a framework for a raster-based GIS decision-analysis tool for future management and decision-making by the Pitkin County Stakeholders.

H52F-04 1415h INVITED

Dynamic Data Integration Using Streamline Models

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Recent developments in petroleum reservoir characterization and in the management of uncertainty have lead to the ability of the industry to routinely generate large multimillion-cell detailed geologic models. Reconciling such high-resolution models to dynamic reservoir behavior (transient pressure and tracer response, multiphase production history) still remains an outstanding challenge because of the high computational costs associated with the solution of large inverse problems. Streamline-based flow simulation models can offer significant potential in this regard.

In this presentation we will exploit an analogy between streamlines and seismic ray tracing to develop an efficient formalism for dynamic data integration into high-resolution subsurface models. Utilizing concepts from the asymptotic ray theory in seismic and diffusive electromagnetic imaging, we will generalize the streamline approach to incorporate transient pressure, tracer and multiphase production response during subsurface characterization. Data integration will be carried out in a manner analogous to seismic tomography and waveform imaging by first matching the arrival time and then the amplitude of the production response. Several field examples from the oil field and environmental applications will demonstrate the practical feasibility of the approach.

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A structured approach to Bayesian data fusion

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