H31C-0263 0830h POSTER

Infiltration Into Sandy Alluvial Deposits: Effects of Moisture-Dependent Anisotropy?

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An infiltration transport experiment was undertaken in a heterogeneous sandy alluvial deposit adjacent to and above a vertical exposure. Water containing red followed by blue food coloring was ponded on the surface using a square infiltrometer measuring 0.46-m on a side. The advancement of the dye and wetting front on the vertical face was photographed several times throughout the infiltration event. After infiltration was stopped, vertical slices were excavated at regular intervals to the midpoint of the infiltrometer providing the ability to observe the tracer in a quasi three-dimensional manner. While initial infiltration of the red dye enhanced the ability to observe wetting front patterns, sequential infiltration of the two dyes resulted in color contrast providing the ability to observe internal flow field behavior. The red dye front significantly lagged behind the wetting front. Dye fronts also exhibited significantly more complication than did the wetting front suggesting a less diffusive process. Lateral spreading of both wetting and dye fronts were twice that of the vertical indicating a pronounced effect of horizontal layering. Assuming homogeneity of the deposits, three-dimensional numerical simulations of the infiltration process were conducted. Results of the simulations indicated that the model with isotropic conductivity-pressure relations overestimated the vertical movement of the wetting front. Similarly, a model assuming constant hydraulic anisotropy did not adequately capture the evolution of the observed wetting front. The simulation, based on a model with moisture-dependent anisotropic conductivity relations, however, produced moisture distributions that appear to be in a good agreement with the observed distributions.

H31C-0264 0830h POSTER

The Effect of Compaction on Moisture Characteristic Curves of Compactible Soils Measured in a UFA

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The objective of this study was to develop and test methods to allow the use of the Unsaturated Flow Apparatus (UFA) for characterization of hydraulic properties of compactable soils often encountered in vadose zone environments. Use of the UFA in this application is limited by compaction of the soil under the applied centrifugal force. The UFA significantly reduces the time required to reach moisture equilibrium by applying driving forces thousands of times greater than natural driving forces for unsaturated flow through sample cores. However, the centrifugal force will also cause some soils to compress in the instrument, significantly changing the macropore volume distribution and thus the moisture characteristic curve. Moisture characteristic curves of undisturbed soil cores were measured both by traditional methods and in the UFA. Changes in pore volume distributions were estimated using X-ray micro-focus tomography (XMT) both before and after adjustment of the moisture content. Using a mathematical model, compaction of the pores at each UFA rotational speed can be accounted for and an original uncompacted macropore volume distribution can be estimated. This uncompacted macropore volume distribution can then be used to predict the moisture characteristic curve of the original soil, greatly shortening the time necessary to complete these measurements.

H31C-0265 0830h POSTER

The Effect of Fluid Properties on Field-Scale Anion Transport During Intermittent Unsaturated Flow

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Laboratory-scale experiments suggest that the properties of hypersaline fluids may influence transport behavior, to extent of finger formation, though an interaction between fluid and hydraulic properties. Yet, the importance of these mechanisms to field-scale transport is largely unknown, thereby limiting the accuracy of contaminant transport predictions. To assess the importance of these interactions in field-scale solute transport, tank leaks were simulated by performing a series of injections, using solute-free and hypersaline waters, in two consecutive years. Starting in May 2000, five 4000-L injections of Columbia River water were made with no-flow periods occurring every 3-5 days. The third injection contained 1000 ppm of Br^- and a suite of isotopic tracers. In May 2001, the experiment was repeated with five 4000-L injections of saturated sodium thiosulfate containing 2500 ppm of Cl^- with no-flow periods occurring every 3-5 days. Water content distributions were measured by neutron probe in 32 wells (18 m deep) arranged in a concentric pattern extending to 16 m in diameter. Water extracts from soil cores were analyzed for anions including Fl^-, Cl^-, Br^-, NO_3^-, PO_4^{2-}, SO_4^{2-}, and $S_2O_3^{2-}$. Differences in the location of the wetting and solute fronts were apparent with the magnitude dependent on fluid constitution. Resident concentration profiles were generally asymmetric with a large mass occurring at 5-7 m, and a smaller mass at 10-12 m. Fine-textured layers at 6 and 11 m caused a substantial increase in lateral solute convection and confined longitudinal spreading to 12 m, except at one location where solute was detected at 16 m. The locations of multiple peaks were coincident with the finer-textured lenses, emphasizing the need to consider local-scale textural discontinuities in conceptual models of field-scale transport at the Hanford Site. Results show no evidence of fingering due to fluid properties.

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URL: http://vadose.pnl.gov

H31D MC: Hall D Wednesday 0830h

An Integrated Approach to Hydrologic Research and Applications: A Session in Honor of Dr. John Schaake I

Presiding: **Q Duan,** NOAA/NWS; **S Sorooshian,** University of Arizona

H31D-0266 0830h POSTER

Back to Baltimore - Hydrology and Hydrometeorology of Flooding in an Urban Environment

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John Schaake's urban hydrology studies in Baltimore have played an important role in management of urban drainage basins. In this paper, we examine flood response in the Baltimore metropolitan region using high-resolution radar rainfall estimates and a distributed hydrologic model. Analyses focus on organized convective systems during the warm season. These events become an increasingly important element of regional flood hydrology with urbanization. Model analyses are used to characterize flood response in terms of land use and cover, structure of the natural and storm water drainage system, and space-time variability of rainfall. Drainage basins range in area from 2 to 20 km 2 and reflect diverse land cover properties and development histories. Particular attention is given to Dead Run, Gwynns Falls, Moores Run, Minebank Run, White Marsh Run and Baisman Run.

H31D-0267 0830h POSTER

Development of Operational Hydrologic Forecasting Capabilities

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Two obstacles limit the use of Numerical Weather Prediction (NWP) model output in hydrologic prediction systems. First, meteorological forecasts from current-day NWP models are laden with biases. Secondly, NWP model forecasts at the space/time scales used in hydrologic models are unreliable. Both of these obstacles can be overcome through statistical downscaling using Model Output Statistics (MOS), where the development of empirical relationships between grid point values of NWP output (e.g., vertical velocity, total column precipitable water, static stability) and observed data (e.g., maximum temperature at a point location) provide a statistical correction of NWP forecasts. However, statistical intervention using MOS is difficult to apply in practice because operational modeling centers continually update ("improve") forecast models. Such frequent updates ensures a state-of-the-art forecasting system, but severely degrades the utility of archived forecasts from previous versions of the NWP models.

The National Oceanic and Atmospheric Administration (NOAA) Climate Diagnostics Center (CDC), in collaboration with the Climate Research Division of SCRIPPS, is generating a re-forecast data set using a fixed version (circa 1998) of the NCEP operational NWP model. In this study, we statistically downscale the forecast archive to improve model forecasts of precipitation and temperature, and assess the benefits of a fixed version of the NWP model for hydrologic predictions. Results from cross-validated prediction experiments show that statistically downscaled forecasts of precipitation and temperature are free of systematic biases, and of higher skill than the raw NWP output. These downscaled NWP forecasts are used as input to hydrologic models in select river basins in the contiguous United States, and the performance of the NWP-based forecasts is compared against the National Weather Service (NWS) Extended Streamflow Prediction (ESP) procedure. Hydrologic forecasts made using statistically downscaled fixed NWP output were significantly more accurate, both in terms of deterministic and probabilistic forecast skill, than hydrologic forecasts made using the NWS ESP approach. Forecast improvements were most pronounced in snowmelt-dominated river basins, where short-term variations in runoff are more strongly influenced by variations in temperature than variations in precipitation. Hydrologic forecasts based on raw (uncorrected) NWP output were of similar accuracy, and in some cases worse, than the NWS ESP forecasts. For the purposes of hydrologic prediction, it is preferable to use an older fixed version of the NWP model with a long archive of forecasts than to have a current state-of-the-art NWP model that includes no forecast archive at all.

H31D-0268 0830h POSTER

Implementation of the AFWA AGRMET Solar Radiation Scheme in GLDAS

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In order to improve our understanding of the space-time structure of the land-atmosphere interaction on a global scale, a high-resolution, near-real-time, Global Land Data Assimilation System (GLDAS) is being developed at NASAs Goddard Space Flight Center and NOAA NCEP. It is within the GLDAS objectives to utilize the remotely sensed and in situ observations to derive a high-resolution global surface solar insolation field for the land surface models forcing. The solar radiation package (Shapiro, 1987) in the AFWA AGRMET model suite is ideal in generating such field in near real-time.

This study introduces the methodology and application of the sited solar radiation model. The model is implemented globally on two 1/8 mesh polar stereographic grids, for the northern and southern hemispheres, at about 48 km resolution true at 60 degree latitude. The AFWA RTNEPH 3-hourly cloud analysis (Hamill, 1992) and the SNODEP daily snow analysis will provide input information in near real-time. Those cloud and snow analysis are based on satellite and conventional observations, and are used to calculate the atmospheric transmissivity and reflectivity, and surface albedo. The implementation of using the AGRMET solar radiation in GLDAS will be demonstrated. The comparison between the calculated solar fluxes, the SURFRAD ground observations, the NESDIS GOES satellite estimates, and the NCEP operational regional and global model predictions, will be also presented.

URL: http://ldas.gsfc.nasa.gov

H31D-0269 0830h POSTER

A Hybrid Architecture of Neural Networks for Daily Streamflow Forecasting

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Streamflow forecasting has always been a challenging task for water resources engineers and managers and the major component of water resources system control. For years numerous techniques have been suggested and employed for streamflow forecasting. Computational Neural Networks (NNs), which are capable of recognizing hidden patterns in data, have recently become popular in many hydrologic applications. In this study, hybrid NN is developed for one step ahead forecasting of daily streamflow. Radial Basis Function (RBF) composed of a group of Gausian functions is used in conjunction with Self-Organizing Feature Map (SOFM) used in data classification. RBF transfers those classified input variables into the desired output estimate.

Eight years of daily rainfall, streamflow, and temperature in Salt River basin were used for calibration and validation. Since 60%-80% of the water supply produced by the basin comes in the form of snow, further consideration of the existing time delay of snow melting process in the basin to the watershed outlet is important. Therefore two separated settings were considered in this simulation: the first one only includes several short-term daily rainfall and streamflow in the input sequence; the second setting, on the other hand, includes a longer time period (three-months) of temperature data sequence.

Various statistical analyses, such as root mean square error, bias estimate, noise to signal ratio, and correlation coefficients of estimates and observations, were done to evaluate the forecast models. The preliminary results show that the accuracy of the model once considering the long-term effect of the snowmelt is conspicuous with respect to short-term effect. The effectiveness of the proposed and current operational models is evaluated.

H31D-0270 0830h POSTER

Spatial and Temporal Variability of Soil Moisture and Relations to Monsoon Precipitation

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Soil moisture controls land-atmosphere energy and water exchange by determining the partition of radiative energy absorbed on the ground surface into sensible and latent heat fluxes and by providing available water for evapotranspiration. Thus, it is an important factor for the development of monsoon precipitation. This study investigates the spatial and temporal variability of soil moisture in the East Asian monsoon region and relations to precipitation anomalies using a combination of observation analysis and numerical modeling. Soil moisture and precipitation data, obtained from measurements in China and from simulations with the NCAR regional climate model (RegCM), were analyzed using various techniques. A number of experiments were also conducted under the forcing of initial soil moisture anomalies. There is large soil moisture variability at regional scale, though its spatial pattern at continental scale is basically determined by climatology. It is shown in many cases that the largest soil moisture occurs in a zone from the southwestern to northeastern China, rather than in the southeastern China. Sensible heat flux has similar spatial patterns to soil moisture. Significant changes occur during spring, when the regime of dry soil extends from the northwestern to northern China and, in the same time, sensible heat flux increases rapidly in the northern China. Evaporation also has the dependence on climatological regimes. Its spatial and seasonal variability, however, is more closely related to monsoon precipitation. The area of large evaporation shifts northward to the central China from spring to summer, following the movement of the summer monsoon rainfall regime. Soil moisture situation in spring has substantial effects on the surface energy balance and summer monsoon circulation. A dry spring results in larger sensible heat transport into the atmosphere and intensifies the East Asian summer monsoon by increasing land-ocean thermal contrast. The heating results in a tendency of anticyclonic circulation in the mid-troposphere and depression of mid-latitude trough system. These effects are observed over a number of months, providing evidence for the importance of soil moisture to the atmospheric variability at seasonal scales. There are special patterns in precipitation changes in response to soil moisture anomalies in the East Asian monsoon region. When spring soil is drier, summer precipitation is overall reduced in the region where non-convective rainfall contributes to precipitation the most. In contrast, rainfall within the summer monsoon rainbelt is increased.

H31D-0271 0830h POSTER

Integrating Numerical Groundwater Modeling Results With Geographic Information Systems

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Many different types of data are used to create numerical models of flow and transport of groundwater in the vadose zone. Results from water balance studies, infiltration models, hydrologic properties, and digital elevation models (DEMs) are examples of such data. Because input data comes in a variety of formats, for consistency the data need to be assembled in a coherent fashion on a single platform. Through the use of a geographic information system (GIS), all data sources can effectively be integrated on one platform to store, retrieve, query, and display data. In our vadoze zone modeling studies in support of Los Alamos National Laboratory's Environmental Restoration Project, we employ a GIS comprised of a Raid storage device, an Oracle database, ESRI's spatial database engine (SDE), ArcView GIS, and custom GIS tools for three-dimensional (3D) analysis. We store traditional GIS data, such as, contours, historical building footprints, and study area locations, as points, lines, and polygons with attributes. Numerical flow and transport model results from the Finite Element Heat and Mass Transfer Code (FEHM) are stored as points with attributes, such as fluid saturation, or pressure, or contaminant concentration at a given location. We overlay traditional types of GIS data with numerical model results, thereby allowing us to better build conceptual models and perform spatial analyses. We have also developed specialized analysis tools to assist in the data and model analysis process. This approach provides an integrated framework for performing tasks such as comparing the model to data and understanding the relationship of model predictions to existing contaminant source locations and water supply wells. Our process of integrating GIS and numerical modeling results allows us to answer a wide variety of questions about our conceptual model design:

- Which set of locations should be identified as contaminant sources based on known historical building operations?

- Which locations need to be assigned different infiltration rates based on physiographic and hydrologic setting?

- Which regions of the Laboratory are likely problem areas based on the hydrostratigrahphy, infiltration rate, and location of contaminant sources?

By integrating GIS technology with 3D numerical modeling techniques, we provide an effective means to analyze, store, and view a wide range of data, which has proven useful for modeling groundwater flow and transport. An example presented in this study is a 3D flow and transport model for the vadose zone beneath Los Alamos canyon in northern New Mexico, the site of past contaminant releases by Los Alamos National Laboratory.

H31E MC: Hall D Wednesday 0830h

Hydrology and Water Resources

Presiding: **H F Lins,** U.S. Geological Survey

H31E-0272 0830h POSTER

Geostatistical Regional Flood Analysis

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A general framework and methodological approach is developed to perform regional flood analysis using space-time techniques. A nonparametric method is combined with L-moments, geostatistical and GIS techniques to perform a regional flood analysis. A nonparametric method provides at-site flood characteristics and means to delineate homogeneous regions. L-moments are then employed to test regional homogeneity. Geostatistical methods are used to quantify spatial characteristics in the GIS environment. Annual maximum and partial duration data for Central and Eastern Canada were used for the numerical calculations. It was found that the regional spatially-explicit method developed in this study results in improved accuracy and physical understanding of flood generating phenomena on a regional basis.

H31E-0273 0830h POSTER

A NEW METHOD OF CURVE-FITTING FOR HYDROLOGIC FREQUENCY ANALYSIS

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The essence of the hydrologic frequency analysis is to estimate the probabilities of hydrologic events occurred rather than to determine the magnitudes of the events by some artificially regulated values of probabilities. The traditional vertical curve fitting (VCF)