scour. Emphasis is placed on the special class of self-similar flows which, for wall jets, requires the ratio of the maximum-to-free stream velocities to be constant with streamwise distance. In this study, we consider values of this ratio from 0 to 0.8: the zero case corresponding to the challenging case of a wall jet developing in stagnant surroundings, a common occurrence in natural systems. The primary interest is the accurate prediction of the rate at which the jet expands into the surrounding environment, and the wall shear stresses that are the cause of severe scour associated with turbulent wall jets. We present comparisons with experimental data and with empirical correlations. These show that the second-order closure model succeeds in capturing many of the important features of this complex flow, including the separation of the points where the turbulent shear stress and the mean velocity gradients are zero. The wall shear stresses are also well predicted with this model but less so with the two-equation model. The implications of these results on the prediction of bed-load sediment transport will be discussed.

H12C MCC: Level 2 Monday 1330h

Coordinated Enhanced Observing Period (CEOP) I Posters *(joint with A, OS, GC)*

Presiding: **J O Roads,** Scripps Institution of Oceanography**; R Lawford,** NOAA

H12C-1006 1330h POSTER

A Simplified Land Data Assimilation Scheme (LDAS) for Assimilation of AMSR-E Data and Its Application to CEOP Reference Site: Mongolia

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Soil moisture controls the portioning of land surface heat fluxes into the atmosphere and influences the global and/or regional water cycle. However, improvement in the forecast skill of quantitative/qualitative soil moisture forecasts has been slow. This could be attributed to uncertainties in model physics, parameterization, and initial conditions. With the rapid increase of satellite data, the skill of quantitative/qualitative soil moisture forecasts is expected to be improved by using these data. This paper investigates the method of retrieving spatial distributions and temporal variations of key land surface variables such as soil moisture and soil and canopy temperatures from passive microwave radiance measurements by using the novel application of data assimilation. The Land Surface Scheme (LSS), which forms the heart of the data assimilation algorithm, is a bio-physically based Model (Simplified Biosphere Model2: SiB2) of soil, vegetation, and atmosphere interaction. Our Land Data Assimilation Scheme (LDAS) takes into account both model and observation uncertainties and provides dynamically consistent data product of land surface parameters. The satellite sensor Aqua/AMSR-E measurements, gathered over one of the CEOP reference site: Mongolia, are assimilated into the LSS using our LDAS. However, satellite observations of brightness temperatures are likely be available only over relatively larger spatial scales. In order to integrate spatial heterogeneity effects and pursue the optimal usage of large spatial scale satellite observations, we have introduced a simplified downscaling approach inside the LDAS. An assessment of the experiment results and the impacts of AMSR-E data and the data assimilation concepts in the modelling of land surface processes will be discussed.

H12C-1007 1330h POSTER

Model-Based Analysis on the Mountain-Valley Circulation in the CEOP Reference Site

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The mountain-valley circulation system in the Tibetan Plateau, one of the Coordinated Enhanced Observing Period (CEOP) reference sites, has been investigated. We set the target area around Naqu, which is located between the two mountain ranges running east to west in the north and the south. GEWEX Asian Monsoon Experiment-Tibet Intensive Observation Period of 1998 (GAME-Tibet IOP) data showed the diurnal variation of the convective activities and mountain-valley circulations. Wind from mountain to valley, accompanied by convection over the mountain range was observed during the afternoon while the wind direction changed at night with the mountain convection disappearing. At the same time, the convective precipitation areas moving from mountain to valley were observed by Doppler radar. Sometimes this convective precipitation system induced the vorticity. By using the atmosphere-land coupled regional model to investigate this phenomenon, we successfully clarified the mechanism of diurnal circulation going through the following steps. The convective clouds develop over the mountains encouraged by latent energy release. It leads to deep convective clouds with a high cloud bottom, while it also makes a huge amount of precipitation because of the relatively small saturation pressure. At the same time, these convections can bring down the westerly momentum in the upper troposphere with their downward stream. Then, this precipitation cools the surrounding air mass (by 2 to 4 K) by strong evaporation due to the relatively dry surrounding atmosphere. This significant amount of cold air mass under the cloud bottom induces a pressure gradient (meso-high) in the direction of the valley. As the wind blows from mountain to valley, lined convections are formed with cold air mass, with pushing up comparatively warm air mass in the valley. On the other hand, the contrast in the strength of westerly between inside and outside of the meso-high makes vorticity. For this validation, we made a comparison between the observation data and the simulation data. And these simulation data indicated pretty good correspondence with the observation data.

H12C-1008 1330h POSTER

US CONTRIBUTIONS TO THE COORDINATED ENHANCED OBSERVING PERIOD (CEOP) AND THEIR BENEFITS TO US WATER CYCLE RESEARCH

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The USA is a major contributor to the World Climate Research Programme's Coordinated Enhanced Observing Period (CEOP). Many US scientists are engaged in the project because they are convinced of the project's value for longer-term climate studies. The facilities of DOE, NASA and NOAA feature in US contributions to CEOP data set development. Through support from NOAA and NASA, UCAR is playing a major role in data processing and data set development. In return for these contributions, US scientists now have access to large international data sets that did not previously exist or were difficult to access. The use of these data sets for Water and Energy Simulations and Predictions and Monsoon system studies are already underway. These efforts will contribute to the Climate Change Science Program's (CCSP) Water Cycle theme, GEWEX Americas Prediction Project and NOAA's emerging Intraseasonal to Interannual Prediction (ISIP) program. The systems being developed through this process will advance some of the goals of the Water Cycle theme within the Integrated Global Observing Strategy (IGOS) Partnership. However, there will be many more opportunities for creative use of these data sets. The purpose of this presentation is to increase awareness of the US contributions to CEOP; to provide interested scientists with information on how to access these data sets and to obtain feedback on additional uses of these unique global data sets.

H12D MCC: Level 2 Monday 1330h

Hydrologic Predictions in Ungauged Basins: PUB I Posters *(joint with NG)*

Presiding: **T Wagener,** University of Arizona**; D Schertzer,** Laboratoire de Modélisation en Mécanique, Université Pierre et Marie Curie

H12D-1009 1330h POSTER

Regional Flood Frequency Equations: What Level of Complexity is Rational?

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The "single-return-period" prediction equation of the log-log multivariate regression form in which a peak discharge of a specific return period is related to one or more watershed and meteorologic characteristics is the most frequently used regional flood frequency procedure in the US for ungaged, unregulated rural streams. Equations are developed for a region that is identified as homogeneous based on underlying hydrologic/meteorologic and geologic/soil properties. The number and type of explanatory variables used in regression equations vary. For example, most regional regression equations developed by the US Geological Survey and compiled into "The National Flood Frequency Program," are based on watershed characteristics such as: drainage area, mean basin elevation, and channel slope. Other explanatory watershed variables used include parameters such as: storage area of lakes/ponds, forest cover, channel length, basin shape, high elevation index. Climatic characteristics present in some of the equations consist of mean annual rainfall, rainfall amount for a specified duration, mean annual snowfall and/or minimum mean January temperature. The development of GIS based models, such as ArcHydro or Watershed Modeling System, has created an opportunity to easily produce extensive sets of hydrologic parameters that could be investigated as possible predictors of T-year discharges. As a result, prediction equations tend to be even more complex than they used to be. However, based on our results, it appears that such equations may actually generate less accurate flood estimates than very simple equations that include only one or two predictors. Equations are highly sensitive to uncertainties (errors) in explanatory variables, both in calibration and in prediction mode. Based on our study for several watersheds in Utah we'll try to answer the question on how much complexity in prediction equations is really rational.

H12D-1010 1330h POSTER

A new GIS-based routing scheme for hydrological models

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The development and application of a new GIS-based routing scheme for hydrological models are presented in this paper. The new approach differs from previous methods in four aspects: (1) it computes the flow direction continuously from 0° to 360° and allows runoff to leave each grid from any angle between 0° to 360° rather than from only one of the eight directions (i.e., 0°, 45°, 90°, 135°, 180°, 225°, 270° and 315°) which allows the new GIS-based routing scheme to be able to represent efficiently effects of different spatial and temporal resolutions of the digital elevation model (DEM) data on river network routing; 2) it considers impacts of land cover/use change on overland and river routing dynamically; (3) it advances the early routing methods by fully coupling it with a hydrological distributed model to consider runoff re-infiltration; and (4) it corrects the flow directions at the boundary grids of a watershed by taking the advantage of DEM data at a finer spatial resolution. The new routing scheme

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is being applied to the watersheds of the Blue River and Illinois River at Watts, Oklahoma, which represent two different watershed shapes, by fully coupling it with the Three-Layer Variable Infiltration Capacity (VIC-3L) model, and the simulated streamflow will be compared to the observed and those simulated by other routing methods. Uncertainties associated with the new routing scheme and a typical 8-direction routing scheme on streamflow simulations will be investigated. Although the routing scheme presented here is implemented into the VIC-3L model, it can be easily applied to other hydrological models at any space-time scales.

H12D-1011 1330h POSTER

Water Level Changes on the Central Amazon Floodplain Measured with Interferometric JERS-1 SAR Data

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The central Amazon floodplain is marked by non-channelized, diffusive flow conditions that prohibit the use of typical in-situ gauging methods for estimating discharge (e.g., rating-curves). In fact, gauging stations are located only on the mainstem and major tributaries, but not in the adjoining floodplains. Logistics and costs prohibit the installation of floodplain gauges, thus predictions of floodplain storage and subsequent discharge evolve from models, such as Muskingum methods, or from remote sensing. Interferometric processing of SIR-C SAR data has previously been used to demonstrate that water levels across the central Amazon floodplain are not horizontal, as assumed in a Muskingum model based approach. Yet, the interferometric SIR-C data exists only for a very brief, 24-hour period, and the method requires a "double-bounce" radar pulse travel path typical of flooded vegetation. Interferometric processing of JERS-1 SAR data over flooded forests of the floodplain provides net changes in water levels during the 44, 88, etc. day orbital repeat cycles. Interferometric coherence during these repeat-cycles is poor, but visible fringe patterns exist, even in unfiltered interferograms. Measured changes in water levels generally agree with channel gauges at Itapeau, Beruri, and Manacapuru, but within-floodplain fluctuations are not planar. Preliminary interpretation of the interferometric data suggests that during early rising water, inundation appears first as a patchwork bordered by small floodplain channels, whereas at mainstem peak stage, floodplain flow appears to subparallel the mainstem.

URL: http://www.icess.ucsb.edu/˜alsdorf/

H12D-1012 1330h POSTER

Time Series Analysis of In-situ Gravity Data in the Context of Hydro-meteorological Variability

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The Global Geodynamics Project (GGP) began in 1997 to record the earth's gravity field with high accuracy at a number of worldwide stations using superconducting gravimeters (SG). This data is being used in an extensive set of studies of the earth, ranging from global motions of the whole earth to the gravity effects of atmospheric pressure and groundwater. The new generation in-situ gravimeters and NASA's Gravity Recovery and Climate Experiment (GRACE) promise the possibility of tracking the movement of the water on and beneath the earth surface. Detecting hydrological effect on gravity time series is not only interesting for geodynamic or geophysical researches, but also promising for the hydrologists, in closing the water balance. Therefore a research programme was started with the general aim to investigate the possibility of detecting the variations in river basin water storage from both in-situ and satellite gravity measurements. The first part of the research is to deal with in-situ gravity data. To assess the hydrological effect on time variation in in-situ gravity signals water balance models can be used to trace hydrological changes in time in the vicinity of the station. The water balance model obviously has to deal with all relevant hydrological processes in the area. As a first step towards the construction of the hydrological model time series analysis is applied to available hydro-meteorological and gravity data. The data used in this analysis is from Moxa Geodynamic Observatory in Germany and it includes precipitation, ground water, air pressure and temperature, wind speed, and humidity along with gravity residuals. This paper describes first results of this analysis and draws conclusions about theoretically detectable hydrological effect on gravity signal and practical requirements for model building.

H12D-1013 1330h POSTER

MOPEX Workshop Results Revisited

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A complementary program to the Prediction in Ungauged Basins (PUB) program is the Model Parameter Estimation Experiment (MOPEX). The primary goal of MOPEX is to develop techniques for the *a priori* estimation of parameters in land surface parameterization schemes in atmospheric models and in hydrologic models. A recent MOPEX workshop evaluated the use of *a priori* estimated parameters in eight hydrologic models. A data set of mean areal precipitation, temperature, and potential evapotranspiration was provided for each of 12 basins located predominantly in the southeastern United States. While workshop results provided valuable insight to some problems in *a priori* parameter estimation within and among models, additional questions remain. Using additional data sets for the 12 basins, alternative parameter estimation techniques are being evaluated to compare the use of distributed values of precipitation and temperature to the use of mean areal values in the original study. Also, the magnitudes of the uncertainty in streamflow prediction resulting from errors in the meteorological variables and their distribution are being compared with the magnitudes of uncertainty associated with errors in parameter estimates of basin physical characteristics. The U.S Geological Survey's distributed-parameter watershed model PRMS was one of the eight models used in the MOPEX workshop and is the model being used to conduct these further studies. Results of this investigation are presented.

H12D-1014 1330h POSTER

Summary of MOPEX workshop results and plan for next phase experiments

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The primary goal of the international Model Parameter Estimation Experiment (MOPEX) is to develop improved approaches to estimation of parameters of hydrologic models that can be applied to ungaged areas. Three workshops have been convened including the second workshop held in Tucson, Arizona, April 8-10, 2002 and the third workshop held in Sapporo, Japan, July 7-9, 2003.. The workshops were designed to bring together interested US and international hydrologists and land surface modelers to exchange experience in developing techniques for a priori estimation and calibration of hydrologic model parameters. Participants of the MOPEX project were given data for 12 basins selected in the Southeastern United States and were asked to carry out a set of numerical experiments using a priori parameters as well as calibrated parameters developed for their respective hydrologic models. The results from the workshopa are summarized in this presentation. Attempts are made to understand the differences in the results from different models. Also presented are the planned next phase MOPEX experiments. Additional US and international basins will be included in the new experiments. The emphasis in this phase will be on detailed analysis of the parameter estimation techniques from different modeling groups. A forth workshop is planned in Paris in July, 2004 to discuss the experiment and analysis results.

H12D-1015 1330h POSTER

Estimation of Annual Runoff Statistics in Ungauged Basins with Parsimonious Evaluation of Climatic Indices

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Relations between climatic parameters and hydrological variables at the basin and the regional scale are investigated using climatic classifications as synthetic indices representing the average annual water budget. Precipitation, temperature and net radiation are the climatic variables required for evaluating the climatic indices in the formulations proposed by Thornthwaite, Emberger and Budyko. The spatial distribution of these variables has been studied in the 10,000 km2 territory of the Basilicata region (Southern Italy), to evaluate the possibility of their indirect estimation. Precipitation and temperature data was available for several stations within the region, and measures of global radiation were available for few stations in a reasonable number of years. Simple, yet robust, literature methods for estimation of net radiation were adopted, to limit the ground data requirement to temperature and relative heliophany, which was replaced by average measures of cloudiness from remote sensing. Consequently, the climatic indices considered can have an approximate evaluation using only data of elevation, latitude and cloudiness. The above-mentioned climatic indices were evaluated over a grid of resolution of about 1 km. Lumped climatic indices computed on the gauged basins available in Basilicata were found to be clearly related to mean and variance of the measured annual runoff series. The Budyko index was the best in terms of symmetry of the frequency distribution, sensitivity to aridity and quality of the correlation with the moments of the annual runoff. To further substantiate the potential of synthetic climatic information to support a regional hydrologic studies, the NOAA-AVHRR normalized difference vegetation index (NDVI), obtained with the maximum value composite technique, has been compared to the above estimates of climatic indices. Dependency of the vegetation phenology from the energy and water budget support the connections found between NDVI and the estimated climatic indices. These initial results indicates that there are good premises in the task of reducing the dependence of climatic mapping in a region from ground data, with the possibility of reducing the importance of the measure of precipitation.

H12D-1016 1330h POSTER

Channel Slope From SRTM Water Surface Elevations in the Amazon Basin

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A lack of hydrologic observations exists globally, particularly for large rivers in remote, non-industrialized regions. Considering the combined global decline in gauging stations as well as a prohibitive cost in increasing gauges to a reliable number for discharge prediction, remote sensing observations are both a necessary and efficient means for measuring certain hydraulic variables. Remote sensing observations allow for an unparalleled spatial scale and consistency in temporal acquisition. The Shuttle Radar Topography Mission (SRTM) digital elevation model (DEM) provides an initial means of measuring surface water elevations. Typically, open water flowing in channels yields specular radar pulse travel paths, however a roughened water surface can allow for partial radar return to the antennae. These water surface elevations combined with associated distances can be used to determine channel slope, which is an important component of the Manning equation and ultimately can be used to predict river discharge. Distance along each channel was extracted from the SRTM DEM by first determining flow vectors for each pixel from evaluation of the surrounding eight pixels, and then by linking the vectors. The resulting water slopes were calculated for the area from 0S-8S, 72W-54W. The Amazon mainstem was found to have a slope of 3.26 cm/km upstream of Manaus, while the slope is only 0.64 cm/km for the reach downstream of Manaus. The Tapajos slopes ranged from nearly flat near the mouth (0.29 cm/km) to a greater slope (17.57 cm/km to 11.47 cm/km) in the middle and upper reaches respectively, which are drained from a higher relief region. The Japura, Branco, Ica, and Madiera tributaries drain relatively higher relief regions and have slopes that range from 4.79 to 3.65 cm/km. The Purus and the Negro are more moderate with slopes of 3.09 cm/km and 2.47 cm/km respectively. These values are consistent with topographic relief and show that channel surface slopes can be measured on a vast spatial scale from SRTM provided that water surfaces are roughened. These slopes will be used in conjunction with depth values attained from nautical charts (for the mainstem Amazon) and width measurements obtained from classifications of JERS-1 low water data to estimate discharge of the Amazon and its major tributaries.

H12D-1017 1330h POSTER

Evaluation of a Hydrologic Model of the Rio Grande Using a Long-Term Dataset of Land Surface Fluxes and States

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Researchers at the Desert Research Institute (DRI) are conducting SAHRA-related research aimed at (1) understanding the spatial and temporal distribution of snow and water balance above the mountain front and (2) developing and calibrating both operational and physically based numerical models that can be used to predict the quantity and timing of runoff in semi-arid regions where the majority of runoff originates in the seasonal snow pack. Unfortunately, observations of hydrologic variables (precipitation, streamflow, evapotranspiration, snow water equivalent, etc.) are sparse in the semi-arid regions of the western United States and, therefore, the evaluation of model accuracy (usually in terms of streamflow) is often very limited. However, comparisons of model output with newly developed high-resolution estimates of hydrologically based land surface fluxes and states may provide insight to model accuracy in areas with little or no observed information. In this study, we apply a hydrologic model to the Rio Grande (above El Paso, TX) and compare the model output to a dataset of estimated land surface fluxes and states. Specifically, the USGS Precipitation-Runoff Modeling System (PRMS), within the Modular Modeling System (MMS), is applied to the watershed at a daily time step with a spatial resolution of 1/8 degree. Many of the model parameters are derived directly from spatial information describing important hydrologic characteristics of the watershed (e.g., soils, vegetation, slope, aspect, etc.) using existing empirical relationships. Model estimates of land surface fluxes and states (e.g., streamflow, groundwater flow, evapotranspiration, snow water equivalent, soil moisture, etc.) are compared with a long-term dataset of land surface fluxes and states from a variety of different sources. From these comparisons, we hope to gain a better understanding of the role of basin scale, grid resolution and some of the uncertainties associated with current prediction methods - all important issues presented within the Prediction in Ungauged Basins (PUB) initiative.

H12D-1018 1330h POSTER

Evaluating Satellite-based Rainfall Estimates for Basin-scale Hydrologic Modeling

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The reliability of any hydrologic simulation and basin outflow prediction effort depends primarily on the rainfall estimates. The problem of estimating rainfall becomes more obvious in basins with scarce or no rain gauges. We present an evaluation of satellite-based rainfall estimates for basin-scale hydrologic modeling with particular interest in ungauged basins. The initial phase of this study focuses on comparison of mean areal rainfall estimates from ground-based rain gauge network, NEXRAD radar Stage-III, and satellite-based PERSIANN (Precipitation Estimation from Remotely Sensed Information using Artificial Neural Networks) and their influence on hydrologic model simulations over several basins in the U.S. Six-hourly accumulations of the above competing mean areal rainfall estimates are used as input to the Sacramento Soil Moisture Accounting Model. Preliminary experiments for the Leaf River Basin in Mississippi, for the period of March 2000 - June 2002, reveals that seasonality plays an important role in the comparison. There is an overestimation during the summer and underestimation during the winter in satellite-based rainfall with respect to the competing rainfall estimates. The consequence of this result on the hydrologic model is that simulated discharge underestimates the major observed peak discharges during early spring for the basin under study. Future research will entail developing correction procedures, which depend on different factors such as seasonality, geographic location and basin size, for satellite-based rainfall estimates over basins with dense rain gauge network and/or radar coverage. Extension of these correction procedures to satellite-based rainfall estimates over ungauged basins with similar characteristics has the potential for reducing the input uncertainty in ungauged basin modeling efforts.

H12D-1019 1330h POSTER

Extreme Floods in Urban Drainage Basins

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Flooding in urban drainage basins is controlled by the interplay of a wide range of hydrologic, hydraulic and hydrometeorological processes. From the hydrometeorological perspective, the distribution of extreme rainfall rates at "short" time scales and "small" spatial scales is of fundamental importance for urban flood response. The hydrologic response of urban drainage basins is complicated by: 1) alterations to the drainage network, especially through the storm drain system of an urban drainage basin, and 2) alterations to the infiltration properties of a basin through detention basins and impervious cover. The hydraulic properties of urban stream channels are profoundly influenced by bridges, channelized reaches, detention basins and channel stabilization projects. Hydraulic properties of an urban stream channel are also altered by the river itself as it adapts to the changing hydrologic response of a drainage basin. We examine the hydrology, hydraulics and hydrometeorology of extreme floods in urban drainage basins based on observations from one of the most densely monitored urban regions, the Baltimore metropolitan area. The Baltimore Ecosystem Study (BES), which is a component of the NSF LTER program, has provided the backdrop for development of an exceptional observational base for examining urban flooding. Analyses are motivated by two problems of prediction for ungaged basins, development of flash flood forecasting techniques for ungaged urban basins and estimation of the T-year floodplain in ungaged urban basins.

H12D-1020 1330h POSTER

Calibration and Regionalisation of Rainfall-Runoff Models

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Current rainfall-runoff models require the calibration of at least some key parameters to yield reliable predictions of the continuous response of catchment systems. Recent years have seen considerable advances in the understanding of this calibration, or, better, parameter estimation, process. Examples are the recognition that estimates of parameter (and therefore prediction) uncertainty should be standard in any hydrological study, the fact that more information can be retrieved from rainfall-runoff time-series using multi-objective approaches, and the realization that model structural uncertainty is larger than has generally been assumed so far. While these findings are considered in state-of-the-art parameter estimation in gauged catchments, they have so far only found very limited recognition in the modeling of ungauged catchments. However, these issues are central to the regionalisation of rainfall-runoff models. This paper examines their effect on the regionalisation process, based on a case study using ten catchments located in the southeast of England. The consequences of parameter and model structural uncertainty are demonstrated and new approaches to consider these effects are introduced.

H12E MCC: Level 2 Monday 1330h

Optimization for Model Calibration and Management in Water Resources III Posters *(joint with NG)*

Presiding: **S Sorooshian,** University of California, Irvine**; C Shoemaker,** Cornell University

H12E-1021 1330h POSTER

Using SSC method and GA to optimally design tracer test for estimation of conductivity distribution

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The design of tracer test will acutely affect the accuracy of conductivity estimation, and the geophysical structure plays a very important role in determining the tracer test design. By combining the inverse method, Sequential Self-Calibration method (SSC) and Genetic Algorithm, we developed an efficient way to search the optimal tracer test design to estimate the conductivity distribution under different kind of geophysical structure.

H12E-1022 1330h POSTER

Analysis of the impact of soil heterogeneity on optimal policies for groundwater remediation

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Typical groundwater remediation problems involve the design of the number, location and flow rate schedule of pumping and injection wells. Simulation models combined with optimization models are used to rank alternatives while considering management objectives, e.g. minimizing remediation cost and/or maximizing cleanup efficiency, and constraints, e.g. the maximum permissible concentrations at selected compliance sites. Mostly due to both high computational effort required and lack of data, the simulation models often are based on simplified 2D homogeneous hydrogeologic settings. The purpose of this work is to investigate how simplifying hypotheses may affect the final optimal remediation policy. In particular, the analysis addresses the case of a heterogeneous layered aquifer versus an homogeneous one with an equivalent (lumped) hydraulic conductivity. To simulate groundwater flow and contaminant transport, use is made of a fully 3D finite element unsaturated flow model along with a particle tracking transport code. The flow and transport code is then coupled to a genetic algorithm model to optimize the specified objective function. The problem considered is the remediation of a hypothetical aquifer-contaminant system using pump and treat. The objective is to minimize the cost of the remediation system. The cost function is a nonlinear function of decision variables (pumping rates) and state variables (hydraulic heads and contaminant concentrations). Constraints include limits on hydraulic head and the contaminant mass remaining in the aquifer at the end of the remediation. The results of homogeneous and heterogeneous simulations are compared in terms of cost and values of the decision variables.

H12E-1023 1330h POSTER

Identification of Complex Reactive Transport Processes in Groundwater Modeling

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The study of innovative technologies for groundwater and soil remediation requires modeling complicated physical, chemical and biological processes in the subsurface. In recent years, various numerical models have

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