H12D-1017 1330h POSTER

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

Patrick E. Fritchel[1] ((775) 673-7442; fritchel@dri.edu)

Douglas P. Boyle[1] ((775) 673-7441; dboyle@dri.edu)

Joseph R. McConnell[1] ((775) 673-7348; jmcconn@dri.edu)

[1]Desert Research Institute, Division of Hydrologic Sciences, 2215 Raggio Parkway, Reno, NV 89512-1095, United States

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

Koray Kamil Yilmaz[1] (1-949-824-8823; yilmazk@uci.edu); Terri S Hogue[2] (1-310-794-4239; thogue@seas.ucla.edu); Kuo-lin Hsu[1] (kuolinh@uci.edu); Hoshin V Gupta[3] (hoshin@hwr.arizona.edu); Shayesteh E Mahani[4] (mahani@ce.engr.ccny.cuny.edu); Soroosh Sorooshian[1] (soroosh@uci.edu)

[1]Department of Civil and Environmental Engineering, University of California, Irvine, E/4130 Engineering Gateway, Irvine, CA 92697-2175, United States

[2]Department of Civil and Environmental Engineering, UCLA, 5732C Boelter Hall, Los Angeles, CA 90095-1593, United States

[3]Department of Hydrology and Water Resources, University of Arizona, 1133 E. North Campus Drive Harshbarger Bldg, Tucson, AZ 85721, United States

[4]International Center for Environmental Resources and Development, The City College of New York, New York, NY 10031, United States

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

James A. Smith[1] (609 258-4615; jsmith@princeton.edu); Andrew J. Miller[2]; Katherine Meierdiercks[1]; Mary L Baeck[1]; Peter Nelson[1]; Elliot Holland[1]; Jane Diehl[2]; Matt Ballantine[2]

[1]Dept. of Civil and Environmental Engineering, Princeton University, Princeton, NJ 08544, United States

[2]Dept. of Geography and Environmental Systems, University of Maryland, Baltimore County, Baltimore, MD 21228, United States

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

Thorsten 1 Wagener[1] (thorsten@hwr.arizona.edu)

Howard S Wheater[2] (h.wheater@imperial.ac.uk)

[1]University of Arizona, SAHRA, Department of Hydrology and Water Resources, Harshbarger Bldg., Tucson, AZ 85721-0011, United States

[2]Imperial College London, Department of Civil and Environmental Engineering, South Kensington Campus, London SW7 2AZ, United Kingdom

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

Changming He ((217)7214288; chm_he@yahoo.com)

Bill Hu ((702)8625438; hu@dri.edu)

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

Domenico Bau[1] (906-487-3097; dabau@mtu.edu)

Alex S Mayer[1] (906-487-3372; asmayer@mtu.edu)

[1]Department of Geological and Mining Engineering and Sciences, Michigan Technological University, 1400 Townsend Drive, Houghton, MI 49931, United States

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

Brent Thomas[1] (bthomas@ucla.edu)

William W-G Yeh[1] (williamy@seas.ucla.edu)

Ne-Zheng Sun[1] (nezheng@seas.ucla.edu)

[1]UCLA, Civil & Environmental Engineering 5731 Boelter Hall/Box 951593, Los Angeles, CA 90035-1593

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

H

been developed for solving these coupled advection-dispersion-reaction (ADR) problems. To make such a model a useful tool for assessment and design, however, both a model's structure and its parameters must be calibrated by observed data, and the reliability of the modeling parameters must be analyzed. The key to this process lies in identifying various reactive terms in the governing equations, such as adsorption and desorption, chemical decay or reaction, degradation by microorganisms, and adhesion to colloidal surfaces. A review of the literature shows that current research has several limitations, namely, that (1) the reactive procedure is often simplified as linear and equilibrium, (2) the functional form of the reactive term is often assumed to be known and that only a few constant parameters need to be identified, (3) the inverse problem is simply seen as a curve-fitting problem and solved by the traditional least squares method, and (4) most experiments and observations are in the lab scale. Many researchers have shown that the reactive processes in porous media are often nonlinear and kinetic and that their functional forms are often unknown. Moreover, the functional form of a reactive term obtained in the lab scale may not be appropriate for the field scale because of the physical and chemical heterogeneities of natural formations and the lack of observation data. Therefore, it is critical to develop a new methodology for identifying the various reactive terms in groundwater modeling. To this end, our research explores determining the structure of the reactive functionalities themselves based on available measurements. No a priori assumptions for the functional forms, such as linear versus nonlinear, are required. The procedure entails optimally constructing a series of polynomial basis functions to approximate the effects of the observed reaction behavior. This is accomplished through a coupling of genetic algorithms (GA) to sequential quadratic programming (SQP), which itself links to the ADR simulation model. A numerical example of the procedure is presented which demonstrates the GA/SQP progression along with the evolution of its concomitant parameter reliability.

H12E-1024 1330h POSTER

Probably Approximately Optimal (PAO) Algorithm for Feature Subset Selection: Theory and Application in Canal Management Problem of Diversion Predictions

Saket Pande[1] (435-512-2995; saketpande@cc.usu.edu)

Mac Mckee[1] (mmckee@cc.usu.edu)

[1]Civil Engineering, Utah State University, 4110 Old Main Hill, Logan, UT 84322, United States

The following paper is an application of Probably Approximately Optimal (PAO) model selection to incrementally obtain optimal predictor subset to predict present day diversions into a canal. Local nature of non-parametric models is utilized to provide an efficient algorithm that searches for optimal feature (predictor) subset in n-dimensional feature space (when the cardinality of predictor set is n). The search is based on Probably Approximately Correct (PAC) learning, which ultimately yields a feature subset that is epsilon-optimal (or epsilon better than other feature subsets) with probability of error of at most delta after certain number of algorithm iterations (for some epsilon>0 and 0<delta<1). This PAO algorithm thus provides a feature subset, which is one of the epsilon-optimal feature subsets with probability of at least 1-delta after finite iterations. Thus epsilon-optimal feature subsets could be visualized as epsilon-equivalent best feature subsets and delta provides an upper bound on the error that we make in concluding that. The upper bound on the probability of error is distribution independent; however the algorithm must assume that the underlying joint distribution of inputs and outputs is invariant. The algorithm presented is not just limited to non-parametric models applied in management problems. It could easily be extended to any modeling environment to obtain one of the epsilon-equivalent best input sets with a probability of at least 1-delta.

H12E-1025 1330h POSTER

Two-Stage Parameter Estimation in Confined Costal Aquifers

Nien-Sheng Hsu (011-886-2-2362-1840; nsshue@ntu.edu.tw)

Dept of Civil Engineering, National Taiwan University, No.1, Sec.4, Roosevelt Road, Taipei 106, Taiwan

Using field observations of tidal level and piezometric head at an observation well, this research develops a two-stage parameter estimation approach for estimating the hydraulic conductivity (T) and storage coefficient (S) of a confined aquifer in a costal area. While the y-axis coincides with the coastline, the x-axis extends from zero to infinity and, therefore, the domain of the aquifer is assumed to be a half plane. Other assumptions include homogeneity, isotropy and constant thickness of the aquifer, and zero initial head distribution. In the first stage, fluctuations of the tidal level and piezometric head at the observation well are collected simultaneously without the influence of pumping. Fourier spectra analysis is used to find the autocorrelation and crosscorrelation of the two sets of observations as well as the phase vs. frequency function. The tidal efficiency and time delay can then be computed. The analytical solution of Ferris (1951) is then used to compute the ratio of T/S. In the second stage, the system is stressed with pumping and observations of the tidal level and piezometric head at the observation well are collected simultaneously. The effect of tide to the observation well without pumping can be computed by the analytical solution of Ferris (1951) based upon the identified ratio of T/S and is deducted from the piezometric head observations to obtain the updated piezometric head. Theis equation coupled with the method of image is then applied to the updated piezometric head to obtain the T and S values. The developed approach is applied to a hypothetical aquifer. The results obtained show convergence of the approach. The robustness of the developed approach is also demonstrated by using noise-corrupted observations.

H12E-1026 1330h POSTER

Optimal Observation Network Design for Parameter Structure Identification in Groundwater Modeling

Li-Fang Chang[1] (lifang@ucla.edu)

Ne-Zheng Sun[1] (nezheng@seas.ucla.edu)

William W-G Yeh[1] (williamy@seas.ucla.edu)

[1]UCLA, Department of Civil and Environmental Engineering, 5731 Boelter Hall, Los Angeles, CA 90095, United States

This research develops a methodology for optimal observation network design for parameter structure identification in groundwater modeling. The design is formulated as an integer nonlinear programming problem. The design objective is to minimize experimental cost subject to data sufficiency requirement. By incorporating the data sufficiency requirement as a constraint in the optimization model, the proposed methodology quantitatively unifies observation network design, model structure identification and model application reliability. Because the optimal design is predicated on parameter values, which themselves are to be estimated before performing the experiments, it is extremely important to utilize and integrate prior information into the design problem. In this study, we use a geostatistical simulation method to generate a large set of realizations for the real parameter field according to the available prior information. For each realization, we solve the integer nonlinear problem and find the minimum cost design that satisfies the data sufficiency requirement. After solving the design problems for each of the realizations, we analyze the overall results. We calculate the probability of a potential observation well location that has been chosen from all the realizations. Additionally, we analyze the reliability of providing sufficient data for each given cost. The criterion used to select the observation well location is to maximize a norm of the information matrix. We use the variational method (the adjoint state method) to compute the sensitivity coefficients which form the information matrix. When the parameter structure is unknown, the adjoint state method is highly efficient in computing the sensitivity coefficients for each of the computation nodes.

H12E-1027 1330h POSTER

Optimization Of Fuzzy Programming For Reservoir Operation

Fi-John Chang[1] (886223639461; changfj@ntu.edu.tw)

Yu-Chen Chiu[1] (r90622008@ntu.edu.tw)

Li-Chiu Chang[1] (d8762003@ms87.ntu.edu.tw)

[1]Fi-John Chang, No1, Sec4, Roosevelt Rd., Dept.of Bioenvironmental Systems Engineering, National Taiwan University, Taipei, TW 10617, Taiwan

The framework of this study includes a fuzzy programming and three optimization algorithms for reservoir operation. The fuzzy programming theorem is adopted to construct a suitable set of objective function and constraints of reservoir operation, while the optimization methods are used for searching long-term operation histograms. The optimization methods include the genetic algorithm (GA), the simulated annealing (SA), and a hybrid module, the annealing genetic algorithm (AG). The Shi-Man reservoir, Taiwan, is used as a case study. Its observed monthly inflow data in three different hydrological conditions are implemented to investigate the model performances through different optimization approaches. The degree of satisfactory, Generalized Shortage Index (GSI), and total shortage amount are the criteria for evaluating the model's performance. For the purpose of comparison, the current used M-5 operation rule is also performed. The results demonstrate that all three optimization algorithms (i.e. GA, SA, and AG) do come out better performances, in terms of larger satisfactory and smaller GSI and total shortage amount, than the current used M-5 operation rule in all the cases, while the annealing genetic algorithm has the greatest capability and highest efficiency for optimizing the fuzzy programming model in reservoir operation.

H12E-1028 1330h POSTER

Web-Based Model Visualization Tools to Aid in Model Optimization and Uncertainty Analysis

Jay Alder[1] (1-909-263-0873; jalder_ucr@hotmail.com)

Ann van Griensven[1] (annvg@mail.ucr.edu)

Thomas Meixner[1] (1-909-787-2356; tmeixner@mail.ucr.edu)

[1]University of California, Department of Environmental Sciences University of California, Riverside, CA 92521, United States

Individuals applying hydrologic models have a need for a quick easy to use visualization tools to permit them to assess and understand model performance. We present here the Interactive Hydrologic Modeling (IHM) visualization toolbox. The IHM utilizes high-speed Internet access, the portability of the web and the increasing power of modern computers to provide an online toolbox for quick and easy model result visualization. This visualization interface allows for the interpretation and analysis of Monte-Carlo and batch model simulation results. Often times a given project will generate several thousands or even hundreds of thousands simulations. This large number of simulations creates a challenge for post-simulation analysis. IHM's goal is to try to solve this problem by loading all of the data into a database with a web interface that can dynamically generate graphs for the user according to their needs. IHM currently supports: a global samples statistics table (e.g. sum of squares error, sum of absolute differences etc.), top ten simulations table and graphs, graphs of an individual simulation using time step data, objective based dotty plots, threshold based parameter cumulative density function graphs (as used in the regional sensitivity analysis of Spear and Hornberger) and 2D error surface graphs of the parameter space. IHM is ideal for the simplest bucket model to the largest set of Monte-Carlo model simulations with a multi-dimensional parameter and model output space. By using a web interface, IHM offers the user complete flexibility in the sense that they can be anywhere in the world using any operating system. IHM can be a time saving and money saving alternative to spending time producing graphs or conducting analysis that may not be informative or being forced to purchase or use expensive and proprietary software. IHM is a simple, free, method of interpreting and analyzing batch model results, and is suitable for novice to expert hydrologic modelers.

URL: http://water.ucr.edu/IHM/

H12E-1029 1330h POSTER

Investigating Optimal Land-Use Patterns for Nonpoint Source Pollution Control Using an Integrated Hydrological and Land-Use Optimization Model

In-Young Yeo (614-292-9811; yeo.13@osu.edu)

Steven I. Gordon (614-292-4132; gordon.1@osu.edu)

Jean-Miche Guldmann (614-292-2257; guldmann.1@osu.edu)

The aim of this study is to develop an optimal land-use pattern to reduce nonpoint source pollution at the watershed outlets. This study takes an innovative approach to evaluate the land-use patterns with regards to nonpoint source pollution by coupling a hydrological model and a land-use model. With an assumption that the degree of nonpoint source pollution is positively correlated with the volume of surface runoff, the goal is to find the land-use pattern with a minimal runoff volume. A hydrological simulation model is developed with a modified SCS curve number method. Using a spatially explicit SCS curve number, the geographical impacts of land uses are analyzed. Then an optimization technique is integrated to evaluate different land-use patterns and their response to the rainfall runoff events, and to search for the optimal land-use pattern. By integrating these two methods, we are able to uncover the optimal land-use patterns, which would reduce the peak runoff rate by 15-20 % with 1-, 2-. 5-, and 10-year storm. The model results provide site-specific land-use guidelines and identify critical areas for conservation. The proposed model is applied

to the southwestern basin of Lake Erie, Old Woman Creek Watershed (OH).

H12E-1030 1330h POSTER

Effect of Medium Characteristics on Optimal Remediation Design: Sorption and First-order Decay Rate

Nak-Youl Ko[1] (+82-2-873-3647; fuu@netian.com)

Dong-Kyu Park[1] (+82-2-873-3647; ecolede1@hanmail.net)

Kang-Kun Lee[1] (+82-2-880-8161; kklee@snu.ac.kr)

[1]Seoul National University, School of Earth and Environmental Sciences, College of Natural Sciences, Seoul National University, NS80, San 56-1, Shinrim-9dong, Kwanak-ku, Seoul 151-747, Korea, Republic of

Optimal remediation design using the pump and treat method is obtained for a hypothetical contaminant transport with natural attenuation represented by first-order decay and sorption. The total pumping volume is set to the decision value. Simulation-optimization method is used to minimize the total volume and find optimal pumping locations. When the first-order decay rate becomes higher, less pumping volume is required but the pumping wells stay at the same positions. The location of pumping wells is on the centerline of domain and down-gradient region from highly contaminated zone. First-order decay rate has influence on the portion of the pumping rate; the lower decay rate causes the higher pumping rate is to be assigned. The sorption also influences on the optimal design. More pumping rate and pumping wells are required when the sorption effect increases. Most of additional wells are located on highly contaminated zone.

H12F MCC: 3022 Monday 1340h

Observations and Modeling of Land Surface Hydrological Processes III

(joint with A, B, C)

Presiding: **V Lakshmi,** University of South Carolina**; A Cahill,** Texas A&M University

H12F-01 1340h

Assessment of Scale-Dependent Runoff Generation Mechanisms in TOPLATS and Noah-router

David J Gochis[1] (3034972809; gochis@rap.ucar.edu)

Hatim Sharif[1] (sharif@ucar.edu)

[1]National Center for Atmospheric Research, 3450 Mitchell Lane, Boulder, CO 80307, United States

Until recently, contemporary land surface models neglected the realistic treatment of runoff. However, the decreasing scale at which land surface models are being applied necessitates the inclusion of lateral surface and subsurface runoff in order to properly close local water budgets. In this study we compare two, distinct, offline land surface models that have been dynamically coupled to runoff schemes. Comparisons of simulated runoff volumes, land surface fluxes, soil moisture states are made using TOPLATS, which uses the conceptual runoff formulation of TOPMODEL and Noah-router', which uses an explicit dynamical approach. Particular emphasis is placed on assessing the differences in runoff production zones and runoff generation mechanisms (i.e. infiltration and saturation excess and exfiltration) between the two models. Scale dependent behavior of the models is also explored by comparing runoff generation processes when the models are run at different grid scales typical of contemporary rainfall-runoff models.

H12F-02 1355h

Estimation of Drainage and Evapotranspiration from Time Series of Soil Moisture, Potential Evaporation, and Precipitation

Guido D Salvucci[1] (617-353-8344; gdsalvuc@bu.edu)

Marisa Gioioso[1] (mgioioso@bu.edu)

[1]Boston University, 675 Commonwealth Ave., Boston, MA 02215, United States

A previous study demonstrated that the dependence of soil water outflow on soil moisture can be estimated by averaging precipitation conditioned on soil moisture. The methodology is non parametric and relies only on the assumed stationarity of the soil moisture time series. Here we present a method for partitioning out the evapotranspiration component of total outflow. One goal is to structure the model with as few assumptions about model form as possible. for example we set evapotranspiration efficiency to increases monotonically with moisture and to be concave down, while the net drainage (capillary rise to or percolation from the root zone) is made to depend on moisture in a concave upward fashion. The functions used to represent these behavior are piecewise continuous polynomials or line segments. After generating a set of feasible partitions using a linear programming technique, we evaluate the relative likelihood of each by estimating the entropy of the time series of soil water storage that results from integrating the fluxes. We show that the entropy of the series is proportional to the likelihood that the increments that make it up come from a stationary process, and use this as a basis for model selection. We also estimate the growth of variance of the time series, and decompose this into an equilibrium process (that saturates with time due to a negative correlation among increments) and an error process which (for white noise model, measurement and sampling errors) leads to a random walk term. A unique feature of the method is that it does not fit model predictions to soil moisture, but instead evaluates the stationarity of the running series of soil water storage values implied by the partitioning. Because of this feature the method can be driven with indices of soil moisture (like brightness temperatures) rather than site-specific water contents.

H12F-03 1410h

Towards a unified approach for remote estimation of chlorophyll-a in both terrestrial vegetation and turbid productive waters

Giorgio Dall Olmo[1] (gdall@calmit.unl.edu)

Anatoly A. Gitelson[1] (gitelson@calmit.unl.edu)

Donald C. Rundquist[1] (drundquist1@unl.edu)

[1]University of Nebraska-Lincoln, 113 Nebraska Hall, Lincon, NE 68588-0517

The photosynthetic pigment chlorophyll-a is an indicator of biomass and productivity of both terrestrial and aquatic ecosystems. Numerous medium specific, independent techniques to extract information on chlorophyll-a concentration from reflectance have been developed. However, the differences and similarities of methods for extracting chlorophyll-a amounts from reflectance spectral data collected over different types of media (e.g. water bodies and plant leaves) have not been compared and generalized. Recently a conceptual model, relating remotely sensed reflectance and pigment content in higher plant leaves has been developed. The model was devised to isolate the absorption coefficient of the pigment of interest from reflectance spectra using three spectral regions. The model allowed accurate estimation of chlorophyll content in leaves and leaf area index in crops. In this study we tested the applicability of the model to retrieve chlorophyll-a concentrations from reflectance spectra of turbid productive waters. We tuned the conceptual model according to the optical characteristics of the aquatic medium, and accurately predicted chlorophyll-a concentrations in water bodies over a wide range of optical conditions (chlorophyll from 7 to 194 mg m^{-3}; total suspended matter from 0.1 to 214 mg L^{-1}; absorption coefficient of dissolved organic matter from 0.7 to 2.3 m^{-1}). Three spectral bands (the red, red edge and near infrared) were used in the model, which accounted for 94% of the variance ($p<0.0001$) of chlorophyll-a concentrations measured analytically. In the range of chlorophyll variation from 7 to 194 mg m^{-3}, the root mean square error (RMSE) of chlorophyll-a estimation was less than 11 mg m^{-3}. The model was validated by independent data set yielding a RMSE of chlorophyll-a prediction lower than 13 mg m^{-3}. Our results provide evidence that this technique may be considered as a general solution, independent of the type of medium, for assessing chlorophyll concentration in optically deep media using remotely sensed data.

H12F-04 1425h

A Complementary Evaporation Approach to Scalar Roughness Length Estimation

Richard Crago[1] (570-577-1094; rcrago@bucknell.edu)

Raphael W. Crowley[1] (rcrowley@bucknell.edu)

[1]Bucknell University, Department of Civil and Environmental Engineering, Lewisburg, PA 17837, United States

The difference between momentum and scalar roughness lengths has been well-established both theoretically and experimentally. Accurate experimental estimates of the scalar roughness length require knowledge of the actual scalar concentration at the surface, which is rarely known and is generally poorly defined for vegetation canopies. However, estimates of the scalar roughness length for water vapor can be made using the advection-aridity model for evaporation for cases in which the evaporation is known. These estimates require no knowledge of surface characteristics except the momentum roughness length. Based on the complementary relationship between actual and potential evaporation, the advection-aridity equation is only likely to be valid under conditions of minimal advection. Data from a grassland site at CASES-97, collected by Russell Qualls (University of Idaho), were screened to ensure that only data representing minimal advection conditions were retained. The scalar roughness length for water vapor was determined from the advection-aridity equation, and its dependence upon land surface characteristics was investigated.

H12F-05 1440h

Precipitation and Radiation Forcings in Off-line Assimilation of Soil Moisture

Stephane Belair ((514) 421-7220; stephane.belair@ec.gc.ca)

Meteorological Service of Canada, 2121 Trans-Canada N., Suite 500, Dorval, Que H9P1J3, Canada

In order to facilitate the eventual inclusion of space-based remote sensing data in operational soil moisture assimilation, an off-line surface assimilation system is currently being developped at the Meteorological Service of Canada (MSC). In this new system, our best estimates for atmospheric forcings, i.e., precipitation, downwelling radiation (solar and infrared), low-level air temperature, humidity, and winds, are used to drive the Interactions Soil-Biosphere-Atmosphere (ISBA) land surface scheme. The behavior of this new system was compared with the strategy currently used operationally at MSC, which is based on a statistical interpolation that relate model-errors on low-level air temperature and relative humidity to errors in soil moisture. Results show that improving precipitation forcings (obtained from NEXRAD Level III data) slightly alters the evolution of soil moisture, with non-negligeable impacts on 2-m air temperature and relative humidity. Another sensitivity experiment indicates that, at least for the case examined in this study, reasonably large changes to downwelling solar radiation did not modify much the evolution of soil moisture, but had a significant impact on low-level air characteristics. The implications of these results for future soil moisture assimilation will be discussed at the conference.

H12F-06 1455h

Impact of Mesoscale Surface Heterogeneity on Larger Scale Precipitation and the Surface Water and Energy Balances

Matei Georgescu[1] (732-932-3891; matt1@cep.rutgers.edu)

Christopher P Weaver[1] (weaver@cep.rutgers.edu)

[1]Rutgers University - Center for Environmental Prediction, 14 College Farm Road, New Brunswick, NJ 08901

High-resolution summertime simulations that capture storm-scale dynamics over many diurnal cycles and over several 100 x 100 km2 regions are conducted over the central United States using the Regional Atmospheric Modeling System (RAMS). The focus is on two different synoptic regimes in order to quantify the impact of clouds and precipitation associated with atmospheric dynamical systems on soil moisture and surface fluxes, both domain averages and spatial heterogeneity: one where large-scale dynamic forcing is strong and one where it is weak. The evolution of the surface water and energy balances controls mesoscale circulations that subsequently impact future convection and precipitation. This mesoscale surface heterogeneity is both relatively static (i.e., resulting from land cover and topographic features) and time-varying (i.e., resulting from spatial variability in rainfall and hence soil moisture). Control simulations, validated against observations, including rainfall, soil moisture, and surface fluxes, show that RAMS has the ability to capture the relevant processes during both synoptic regimes. The three-way interaction between large-scale atmospheric dynamics and precipitation, surface-forced mesoscale circulations, and the surface water and energy balances over multiple diurnal cycles controls the overall hydrologic evolution within the model domain. An improved understanding of this linkage is important for improving our ability to model hydrologic processes on basin scales.