The Texas A&M University and U.S. Bureau of Reclamation Hydrologic Modeling Inventory (HMI) Questionnaire

December 19, 2009

This document is the Texas A&M University (TAMU)-U.S. Bureau of Reclamation (USBR) Hydrologic Modeling Inventory (HMI) Questionnaire. Your response to this questionnaire will provide the basis for the HMI on-line database accessed through the HMI Web page. Modelers can interactively obtain information about your model through this Web-enabled model inventory complete with search capabilities. The information you provide will hopefully foster wider interest in your model. A designated contact will be explicitly acknowledged and posted within the HMI Web page database.

Given more and more applications of GIS and remote sensing techniques to hydrologic modeling, water resources and watershed management, the Subcommittee on Hydrology has recently set up a workgroup to organize and publicize information on GIS applications in the fields of hydrology and hydraulics. This scope has been expanded to include related water quality, watershed management, and ecological sciences GIS applications. This work is intended to make information on GIS applications in hydrology and hydraulics more generally available. This questionnaire is also designed to gather limited but key information about a particular GIS application in order for a potential user to decide if the application fits his/her computer system, data requirements, and physical system to be modeled.

These applications should be public domain and supported by user documentation. Availability on the Web is not necessary if the application can be distributed on CD ROM or through e-mail requests. If a short abstract, fact sheet, or technical paper is available on the application, please attach a copy. Please respond this email before **22 January, 2010**.

Name of Model, Date, Version Number:
MMA 10/26/2009 1.100

Contact (with e-mail, web site, and/or phone number):
Eileen Poeter epoeter@mines.edu

Brief Description:

The Multi-Model Analysis (MMA) computer code can be used to evaluate results from alternative models of a single system using the same set of observations for all models. As long as the observations, the observation weighting, and system being represented are the same, the models can differ in nearly any way imaginable. For example, they may include different processes, different simulation software, different temporal definitions (for example, steady-state and transient models could be considered), and so on. The multiple models may be calibrated by nonlinear regression or another method. Any calibration needs to be completed before application of MMA.

MMA can be used to rank models and calculate posterior model probabilities. These can be used to (1) determine the relative importance of the characteristics embodied in the alternative models, (2) calculate model-averaged parameter estimates and predictions, and (3) quantify the uncertainty of parameter estimates and predictions in a way that integrates the variations represented by the alternative models.

There is a lack of consensus on what model analysis methods are best, so MMA provides four default methods. Two are based on Kullback-Leibler information, and use the AIC (Akaike Information Criterion) or AICc (second-order-bias-corrected AIC) model discrimination criteria. The other two default methods are the BIC (Bayesian Information Criterion) and the KIC (Kashyap Information Criterion) model discrimination criteria. Use of the KIC criterion is equivalent to using the maximum-likelihood Bayesian model averaging (MLBMA) method. AIC, AICc, and BIC can be derived from Frequentist or Bayesian arguments. The default methods based on Kullback-Leibler information have a number of theoretical advantages, including that they tend to favor more complicated models as more data become available than do the other methods, which makes sense in many situations.

Many applications of MMA will be well served by the default methods provided. To use the default methods, the only required input for MMA is a list of directories where the files for the alternate models are located.

Evaluation and development of model-analysis methods are active areas of research. To facilitate exploration and innovation, MMA allows the user broad discretion to define alternatives to the default procedures. For example, MMA allows the user to (a) rank models based on model criteria defined using a wide range of provided and user-defined statistics in addition to the default AIC, AICc, BIC, and KIC criteria, (b) create their own criteria using model measures available from the code, and (c) define how each model criterion is used to calculate related posterior model probabilities.

The default model criteria rate models based on model fit to observations, the number of observations and estimated parameters, and, for KIC, the Fisher information matrix. In addition, MMA allows the analysis to include an evaluation of estimated parameter values. This is accomplished by allowing the user to define unreasonable estimated parameter values or relative estimated parameter values. An example of the latter is that it may be expected that one parameter value will be less than another, as might be the case if two parameters represented the hydraulic conductivity of distinct materials such as fine and coarse sand. Models with parameter values that violate the user-defined conditions are excluded from further consideration by MMA.

Ground-water models are used as examples in this report, but MMA can be used to evaluate any set of models for which the required files have been produced.

MMA needs to read files from a separate directory for each alternative model considered. The needed files are produced when using the sensitivity-analysis or parameter-estimation mode of UCODE_2005, or the equivalent capability of another program.

MMA is constructed using modules and conventions for data-exchange files from the JUPITER API, and is intended for use on any computer operating system. MMA consists of algorithms programmed in Fortran90, which efficiently performs numerical calculations.

Model Type: Statistical

Model Objective(s): Multi-model ranking, averaging and evaluation

Model Structure or Mathematical Basis: Using regression and prediction data from underscore files produced by UCODE or their equivalent. MMA calculates and tabulates model character using model evaluation criteria and other measures.

Spatial Scale Employed in the Model: Any scale.

Temporal Scale Employed in the Model: Any scale.

Input Data Requirement: Regression and prediction output of one or more models from underscore files produced by UCODE or their equivalent. Input describing the location of those models and the user selected option for the model evaluation.

Model Output: Model rankings and model averaged parameters, predictions and their uncertainty given multiple calibrated models of the same system.

Input Data Format: ASCII text files and using a GUI from the USGS

Output Data Format: ASCII text files

Parameter Estimation/Model Calibration: Not applicable

Model Testing and Verification: The model has been compared to manual calculations.

Model Sensitivity: Not applicable

Model Reliability: Excellent. Results have been checked by THE USGS and review is available in Ground Water:

> **MMA: A Computer Code for Multimodel Analysis (p 9-12)**
> Ming Ye
> Published Online: Nov 16 2009 4:18PM
> DOI: 10.1111/j.1745-6584.2009.00647.x

Model Application/Case Studies:

Platform/Operating System: Any platform on which Fortran can be compiled and executed. PC, UNIX, LINUX, MAC

Programming language and software: Fortran

Web-based or desk-top application? Desk-top

Is the application flexible to couple with external programs and user created executables? Yes it reads the output of other models and processes it.

Are system and user documentation available? (Web site)
Yes: http://water.usgs.gov/software/lists/groundwater/

Are example applications available? (Web site)
Yes: http://water.usgs.gov/software/lists/groundwater/

Is there a user group or hotline-type support? (Website)
No. Rapid replies are provided by epoeter@mines.edu and mghill@usgs.gov