Texas A & M University and U.S. Bureau of Reclamation

Hydrologic Modeling Inventory (HMI)

Model Description Form

December 21, 2008

Name of Model

Branched Lagrangian Transport model BLTM

Model Type

The BLTM is a general-purpose transport model for unsteady flow in a system of one-dimensional channels. It routes any number of constituents. Reaction kinetics are contained in a single subroutine which can be easily modified to fit a particular application. The model comes with three reaction kinetics subroutines, a simple first order decay of each constituent, a temperature model, and the reaction kinetics found in the EPA QUAL2E water quality model.

Model Objective(s)

To route chemically interacting dissolved constituents through a series of inter connected one-dimensional channels.

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Model Structure or Mathematical Basis

The BLTM routes any number of interacting dissolved constituents through a system of bi-directional, one-dimensional open channels. Flow hydraulics must be supplied externally, normally by a flow model such as the DAFLOW model. The convective-diffusion equation is solved using a Lagrangian reference frame that minimizes numerical dispersion. It can, therefore, be used to route sharp concentration gradients such as occur in an estuary.

Model Parameters

The only model parameters are the dispersion coefficient and coefficients which define the chemical inter-actions. Each constituent is assumed have one zero order reaction and to react with itself and each other routed constituent as a first order reaction with an equilibrium concentration at which the reaction ceases. This allows the user to define $N + 2N^2$ reaction coefficients, where N is the number of constituents being routed, to define the interactions. Any coefficient can be a function of external variables such as solar radiation, internal variables such as depth or velocity, or the concentration of any routed constituent such as temperature of dissolved oxygen concentration.

Spatial Scale

The model has been used to route constituents in rivers of all sizes, as well as flume flows. The largest river system modeled is the Mississippi River basin form Iowa to the Gulf of Mexico.

Temporal Scale

Typically the models is operated with a 1-hour time step, but the time step depends entirely on the scale of the system. Generally it is operated using a daily time step when simulating transport in the Mississippi River and with a very short time step when routing the dye concentration just downstream of an instantaneous dye dump into a small stream.

Input Data Requirements

Input data includes the flow hydraulics including the discharge, flow area, top width, and tributary inflow at each node for each time step. This information is typically supplied to a file by a flow model such as DAFLOW, BRANCH, or FEQ. In addition a time series of the concentrations of each routed constituent is needed for each inflow point and a time series of any external meteorological or other information that may be used to compute the reaction coefficients. The dispersion coefficient and all reaction coefficients must be defined for each subreach of the model.

Computer Requirements

The BLTM model operates under DOS on any 286, or better, machine. Depending on the application, only 640K of memory and 1.5mb of disk space are required.

Model Output

The BLTM model produces concentration output at user specified locations and time intervals. In addition for each time step and location {it supplies} the model can provide the parcel number, volume, time it entered the branch, and a tabulation of the concentration when it entered the branch and the changes that have occurred as a result of dispersion, tributary inflow, and each chemical reaction.

Parameter Estimation / Model Calibration

Calibration generally begins with assuring that the flow velocity provided by the transport model is representative of the actual velocity in the river. When using the DAFLOW model to supply the hydraulics, the water velocity can be adjusted independently of the hydraulic calibration. Once the timing is correct the dispersion coefficient is calibrated and finally the reaction rate coefficients are adjusted such that the computed and observed time series of concentrations agree.

Model Testing & Verification

The model has been tested against theoretical solutions and numerous sets of field data.

Model Sensitivity

Model sensitivity depends strongly on the constituent being routed. When routing a nearly conservative substance, such as dye, timing (transport velocity) is usually the most important variable followed by the dispersion coefficient. When the constituents are strongly interactive, the reaction coefficients are generally the most significant variables.

Model Reliability

Model stability and repeatability are excellent.

Model Application/Case Studies

The following are references to reports for projects that have used the BLTM model.

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