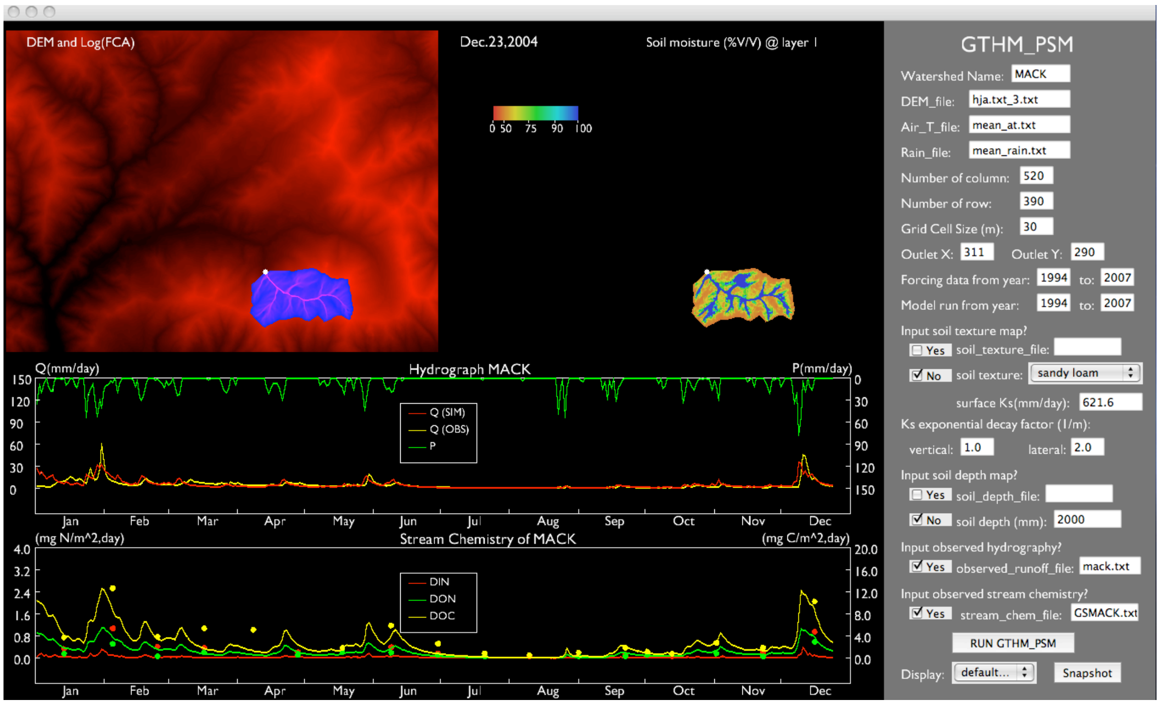
GTHM_PSM_GUI User's Manual

Version 1



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Description of GTHM

The Georgia Institute of Technology Hydrologic Model (GTHM) is a pixel based, hydrology-biogeochemistry coupled model with a graphical user interface (GUI). This model consists two modules: DEM processing module (pdem_gui) and a coupled hydrological and biogeochemistry model system (gthm_psm_gui). Pdem_gui treats flat and sink pixels in DEM, determine flow direction, and compute flow contribution area. Based on computed flow accumulation area and derived channel network, users can pick any outlet to delineate watershed. Gthm_psm_gui simulates soil water storage, surface runoff, subsurface runoff, baseflow, evapotranspiration, vertical drainage, vegetation dynamics and transport of biogeochemical variables (DON, DIN, and DOC). The required input data are air temperature, precipitation, soil texture, soil depth, and DEM data. There are only two parameters, which describe the exponential decay of saturated hydraulic conductivity with depth, needed to be calibrated. The GTHM is written in processing beta language.

How to run pdem_gui?

There are six steps for processing DEM data using pdem_gui code.

Setp1: To run pdem_gui, users first need to obtain DEM data from the USGS National Map Seamless Server (http://seamless.usgs.gov/website/seamless/viewer.htm). On the seamless web site, users can input the coordinate limits for extracting DEM data.

Step2: The downloaded DEM data from USGS seamless web site are in Arc Grid format and geographic projection. Users need to use ArcGIS to load DEM data and project the DEM data from geographic projection into UTM projection. User can use Fig.1 to pick the correct UTM zone for projection.

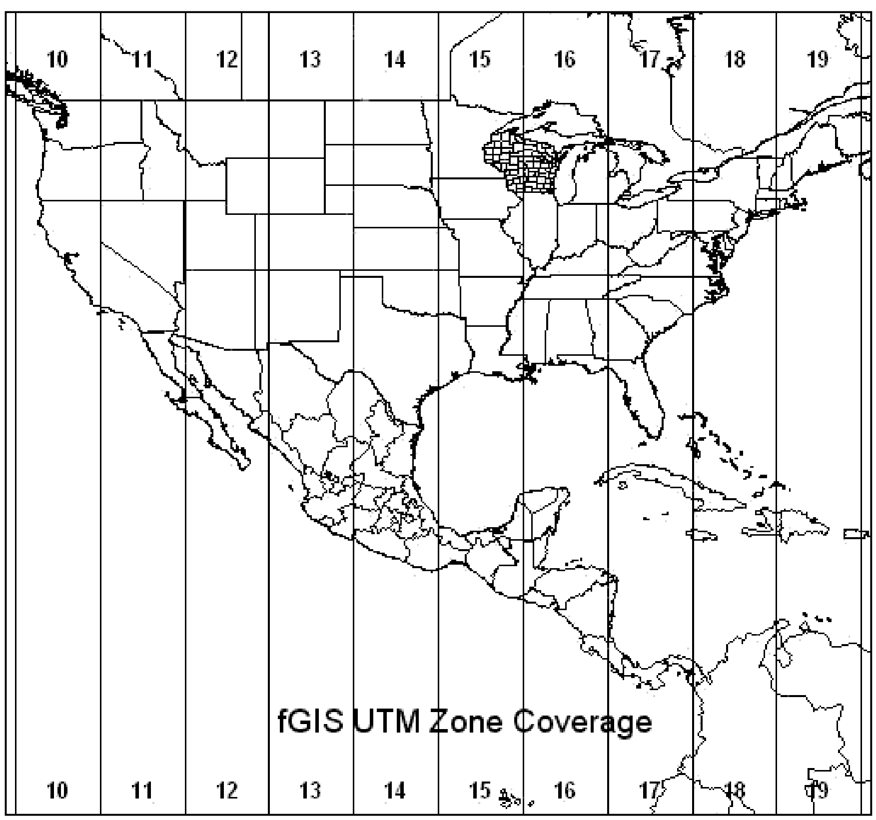

Fig.1

Step3: Export DEM grid file in UTM projection to an ascii text file using ArcGIS. Re-format the text file according to the format: {{z(i,j) for (j=1:ncol)}, for(i=1:nrow)}. Where z(i,j) is the elevation at (i,j), i and j are row and column indices, nrow and ncol are numbers of rows and columns.

Step4: Run pdem_gui.pde. On the pdem_gui interface, type in DEM_file name in DEM_file textbox, fill in number of column, number of row, grid cell size in meter. Click "Process DEM" button. During processing DEM, all flat or sink pixels are shown as green dots. Once all flat or sink pixels are removed, flow contribution area (FCA) at each pixel is computed and displayed. One the screen, one message will tell user that the process DEM is saved and the file name of the processed DEM.

Step5: Click "Pick Outlet" button. Then use mouser o pick a pixel from screen. Once you click the mouser, location of the pixel and the FCA value associated with the pixel will be printed out on the screen. This information can help user to pick the correct outlet for watershed delineation.

Step6: After pick the correct outlet, user can click "Delineation" button. The delineated watershed will be displayed. If user think the delineated watershed is correct, then the DEM processing procedure is done. Otherwise, user can click "Pick Outlet" and repeat Step 5 and Step 6, till users find the correct outlet.

How to run gthm_psm_gui?

1. Input file and parameters

Step1: To run gthm_psm_gui, users must have three input files: 1) processed DEM data (i.e., output from pdem_gui), 2) daily air temperature (in °C) data, and 3) daily precipitation (in mm/day) data. The data formats of air temperature file and precipitation file are the same, i.e., one-D array of air temperature, or rainfall rate in mm/day. The daily air temperature and precipitation data must start from January 1, and end in December 31. There are three textboxes on the GUI which user must enter: 1) input DEM file name in DEM_file textbox, 2) input air temperature file name in Air_T_file textbox, and 3) input precipitation file name in Rain_file textbox. Users also need to enter a name in the Watershed Name textbox.

Step2: There are five textboxes associated with DEM information on the GUI need to be filled in: 1) Number of columns, 2) Number of row, 3) Grid Cell Size(m), 4) OutletX, and 5) OutletY. Users have these DEM information from running pdem_gui code.

Step3: There are four textboxes associated with time step: 1) start year of forcing data, 2) end year of forcing data, 3) start year of model run, and 4) end year of model run.

Step4: Users can have two options to input soil texture information for running the GTHM_PSM_GUI. 1) If users have a soil texture map over the study watershed and want to use that map for simulation, they need click "Yes" checkbox under the line of "Input soil texture map?”, and enter the file name in the soil_texture_file textbox. The soil texture file should be in the same format, same resolution, same projection, and same spatial extent as the DEM file. The soil texture file actually stores soil texture ID based on the following lookup table: sand=1, loamy sand=2, sandy loam=3, loam=4, silt loam=5, sandy clay loam=6, clay loam=7, silty clay loam=8, sandy clay=9, silty clay=10, clay=11. 2) If users don’t have a soil texture map, they need to click ‘No” checkbox and choose one soil type for the whole watershed from drop-down list. Once they pick one soil type, the associated soil saturated hydraulic conductivity will popup in the surface Ks textbox. User can also change Ks by entering value in this Ks textbox.

Step5: Users can have two options to input soil depth information. 1) If users have a soil depth map over the study watershed and want to use that map for simulation, they need click “Yes” checkbox under the line of “Input soil depth map?”, and enter the file name in the soil_depth_file textbox. The soil depth file should be in the same format, same resolution, same projection, and same spatial extent as the DEM file. The units of soil depth is meter. 2) If users don’t have a soil depth map, they need click “No” checkbox under the line of “Input soil depth map?”, and enter one soil depth value (in meter) for the whole watershed in the soil depth textbox.

Step6: If users have observed daily streamflow data, they can load the data and plot the observed hydrograph. To load observed hydrograph, users need click “Yes” checkbox under the line of “Input observed stream hydrograph?” and enter the observed runoff file name in the observed runoff file textbox. The data format of the observed runoff is the same as the air temperature data or the daily precipitation data.

Step7: If users have observed stream chemistry data, they can load the data and plot the observed stream chemistry. To load observed stream chemistry data, users need click “Yes” checkbox under the line of “Input observed stream chemistry?” and enter the observed chemistry file name in the observed chemistry file textbox. The data format of the observed stream chemistry is as follows: DON(time), DIN(time), DOC(time). The units of DON, DIN and DOC are gN/(m^2day), gN/(m^2day), and gC/(m^2day), respectively.

2. Run the model

After users fill in all required textboxes, they can click “RUN GTHM_PSM” button to start running the model. Users can select any display option from the 11 “Display” drop-down lists:

1) “menu” showing menu;

2) “default-layer1” showing time series plots of precipitation, simulated runoff and observed runoff (if users input the observed hydrograph), simulated DON, DIN, and DOC losses, and observed DON, DIN, and DOC losses (if users input the observed stream chemistry) in the bottom panel, and DEM and simulated soil moisture at layer 1 in the top panel;

3) “default-layer2” same as the default-layer1, except the top-right panel showing the simulated soil moisture at layer 2;

4) “default-layer3” same as the default-layer1, except the top-right panel showing the simulated soil moisture at layer 3;

5) “default-layer4” same as the default-layer1, except the top-right panel showing the simulated soil moisture at layer 4;

6) “soil moisture” showing simulated soil moisture images in four layers

7)”biogeochemistry” showing simulated biomass, soil carbon change, and soil moisture of whole soil column images

8) “time series” showing the time series plots of biomass, air temperature, soil carbon, DON loss, DIN loss, and DOC loss;

10) “annual plot” showing the time series plots of annual biomass, npp, DON loss, DIN loss, and DOC loss;

11) “ nitrogen pool” showing the simulated nitrogen images in four layers

3. Output

3.1 Without click any button, there is one output file saved in the same folder as the model. The output file is called out_xxxx.txt, where xxxx is the watershed name entered by users. This file records simulated runoff, DON loss, DIN loss, and DOC loss at the outlet from start year of model run to the end year of model run.

3.2 Without click any button, during the end of each simulation year, one snapshot is saved as a tiff image. The image file is called out_xxxx_year.tif, where xxxx is the watershed name entered by users.

3.3 Users can also take snapshot at any time step by clicking “Snapshot” button.

3.4 Users can also make a movie. To start a movie, users need to click “Movie ON” button. Once this button is clicked, a solid white square will appear on the bottom left corner. To finish the movie, users need to click “Movie OFF” button. Once this button is clicked, the solid white square on the bottom left corner will disappear, and the movie is created and saved as movie_xxxx.mov, where xxxx is the watershed name entered by users.