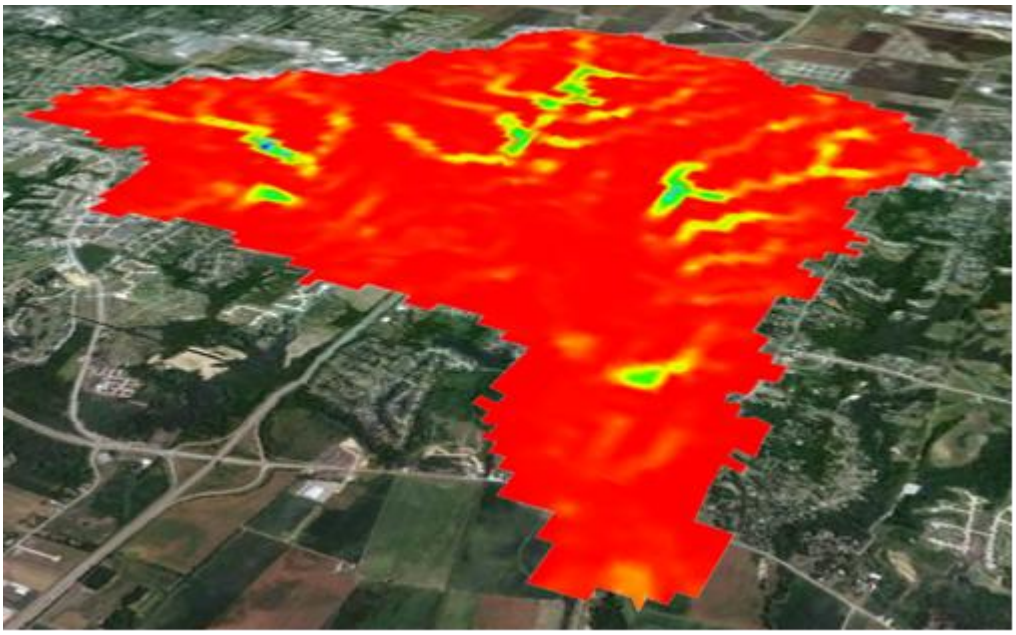
WMS 11.4 Tutorial

Snowmelt Modeling in GSSHA

Set up and run a snowmelt simulation in GSSHA



Objectives

Learn how to set up a simulation using the snow modeling capabilities within GSSHA. This tutorial, demonstrates how to accurately simulate snow accumulation, melting, and runoff within a watershed model using the data from the long term simulation tutorial.

Prerequisite Tutorials

- Long-Term Simulations in GSSHA

Required Components

- WMS Core
- GSSHA Model

Time

- 20–30 minutes

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1 Introduction

This tutorial will cover setting up and running a snow model simulation within GSSHA. It will begin with an existing project file. The snow model runs under long-term simulations and therefore correct hydrometeorological (HMET for short) data is required. Currently there are three snow models within GSSHA to choose from:

- Hybrid Energy Balance (Hybrid)
- Energy Balance
- Temperature Index (TI)

The Hybrid and TI snow models are the most commonly applied models. The TI model is the most accurate when calibration data in the form of snow water equivalent (SWE) is available. The Hybrid snow model is the default snow model and computes the amount of melt within the snow pack on an energy balance while also accounting for the heat transfer within the snow pack.

Melt-water moves both vertically and laterally through the snow pack, essentially delaying the water as it moves through the watershed. The melt-water flows through the snow pack and overland, and can be infiltrated or directly evaporated. Infiltration is limited due to frozen soil, simulated with a temperature index method.

By accurately simulating the accumulation and melt of the snow pack, as well as the melt-water transport, the GSSHA model can accurately replicate the response of watersheds where snow is a contributing factor.

2 Open an Existing GSSHA Project

This model has been set up to simulate approximately a year of data (Sept 2006–Sept 2007) for the Judy's Branch watershed, capturing the snow accumulation and melt within the watershed. This tutorial will demonstrate modifying the project and performing a long term simulation with snow included.

Open the WMS project file for the Judy's Branch watershed by doing the following:

1. Make the **2D Grid Module** active.
2. Select *GSSHA* **| Open Project File…** to bring up an *Open* dialog.
3. Browse to the *SnowModel**SnowModel*\ directory for this tutorial and select "longterm_snow.prj".
4. Click **Open** to import the project and close the *Open* dialog.

The project should appear similar to Figure 1.

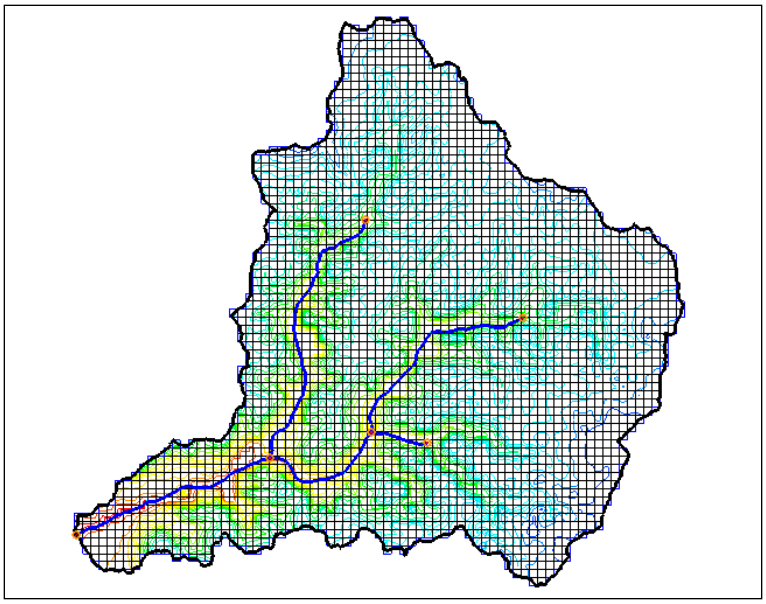

Figure 1 Initial GSSHA project

3 Setting up the Snow Model Simulation

After having defined a long term simulation, setting up a snowmelt model requires the correct input. The snowmelt parameters can be defined using the *Snowmelt options* button in the *GSSHA Job Control* dialog. This section shows how to set up snowmelt data after defining a long term simulation.

1. Select *GSSHA* **| Job Control…** to open the *GSSHA Job Control Parameters* dialog.
2. On the far right, select **Edit parameter...** next to the *Snowmelt options* to open the *GSSHA Snowmelt Options* dialog.
3. For *Hydraulic conductivity of the snow pack*: enter “0.00555” m/s.
4. Turn on *Dry adiabatic lapse rate* and enter “**-**5” deg C/km.
5. For *Elevation of HMET gage*: enter “140.0” m.
6. Turn on *Base temperature to begin melt* and enter “5” deg C.
7. Keep all the other parameters at their default values and select **OK** to close the *GSSHA Snowmelt Options* dialog.
8. In the *GSSHA Job Control Parameters* dialog, select **Output Control** to open the *GSSHA Output Control* dialog.
9. Scroll to the bottom of the *Gridded datasets* list and turn on *Snow water equivalent*.
10. Click **OK** to close the *GSSHA Output Control* dialog.
11. Click **OK** to close the *GSSHA Job Control Parameters* dialog.

These steps told GSSHA to:

- Write temporal and spatial snow water equivalent data (in meters) to a storm water equivalent file

- Begin melt of the snow pack at 5.0 deg C
- Simulate the melt-water from the snowpack as flow through the snowpack
- Account for orographic effects by lowering the temperature as elevation increases

It is important to note that the hybrid snow model is automatically activated when temperatures drop below 0 deg C and either precipitation or an existing snowpack are present. Output for the snow model is only activated when the option to export the Snow water equivalent gridded dataset is turned on. The hydraulic conductivity of the snow pack (in this case, 0.00555 m/s) gives the rate at which the flow moves through the snowpack. The default value for the temperature at which snow melts is 0 deg C, unless otherwise specified in the base temperature to begin melt (in this case 5.0 deg C). The GSSHA model assumes a 0.0 deg C/km dry adiabatic lapse rate (no change in temperature with elevation) unless the dry adiabatic lapse rate option and the elevation of the HMET gage are defined.

4 Save and Run the Model

With the snowmelt parameters defined, it is time to save and run the GSSHA model.

1. Select *GSSHA* | **Save Project File** to open the *Save GSSHA Project File* dialog.
2. Enter “snowmelt_final.prj” as the *File name* and click **Save**.
3. Select *GSSHA* **| Run GSSHA** to open the *GSSHA Run Options* dialog.
4. Accept the setting and click **OK** to close the *GSSHA Run Options* dialog and to bring up the *Model Wrapper* dialog.

The model will take several minutes to complete running.

5. When the model has finished running, click on the **Close** button to close the *Model Wrapper* and WMS will read in the output.

5 Viewing the Results

To visualize the snow-related results, do the following:

1. Select *Display* **| Display Options** to open the *Display Options* dialog.
2. Select *2D Grid Data* from the list on the left.
3. Turn on the *Contours* option.
4. Select **OK** to close the *Display Options* dialog.
5. In the Project Explorer, right-click on “  snow_water_equivalent” under the “  snowmelt_final (GSSHA)” folder and select **Contour Options** to open the *snow_water_equivalent Contour Options* dialog.
6. Make sure the *Contour Method* drop-down box is set to “Color Fill”.
7. Check the *Specify a range* option in the lower left corner of the dialog box.
8. Set the *Min* to “0.01” and leave the *Max* at the value given.
9. Uncheck the *Fill below* option for the *Min* value.

The *Contour Options* dialog box should look like Figure 2:

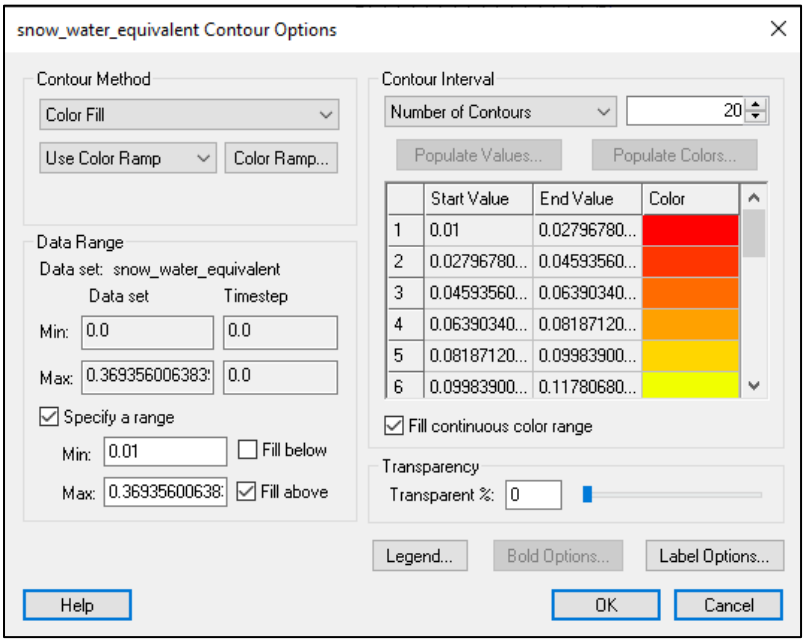

Figure 2 Contour Options dialog

10. Select **Legend…** to open the *Contour Legend Options* dialog.
11. Turn on the *Display legend*.
12. Click **OK** to close the *Contour Legend Options* dialog.
13. Click **OK** to close the *snow_water_equivalent Contour Options* dialog.
14. With “ snow_water_equivalent” still selected, click on the time steps that appear in the *Properties* window (normally to the right side of the WMS screen).
15. Use the arrow keys on the keyboard to toggle through the time steps.

Notice the snow water equivalent contours varying as the time steps change. Notice the following:

- See initial snow water around “10/17/2006”.
- The initial snow pack will start to melt around “11/07/2006”.
- The snow pack begins to accumulate once again and major melting becomes evident from “4/10/2007” through “5/13/2007”.

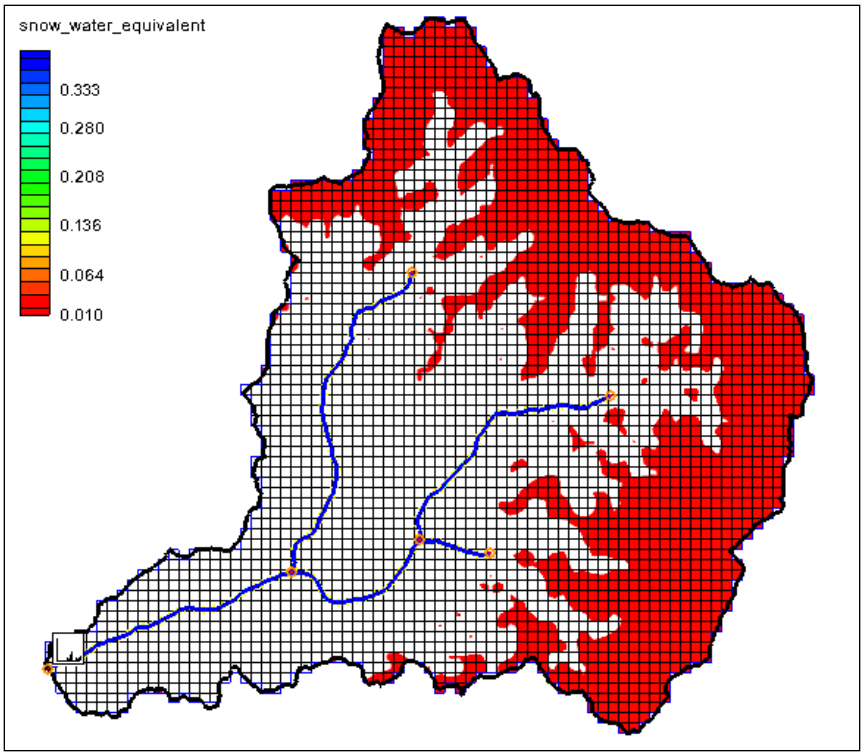

Figure 3 Snowmelt at time step 11/07/2006

6 Conclusion

This concludes the Snowmelt Modeling in GSSHA tutorial. More options exist for modeling snow, such as the Temperature Index snow model, but these options were not examined in this tutorial. For more information on advanced snow modeling capabilities please see the GSSHA wiki site (http://www.gsshawiki.com).

Continue experimenting with WMS or exit the program.