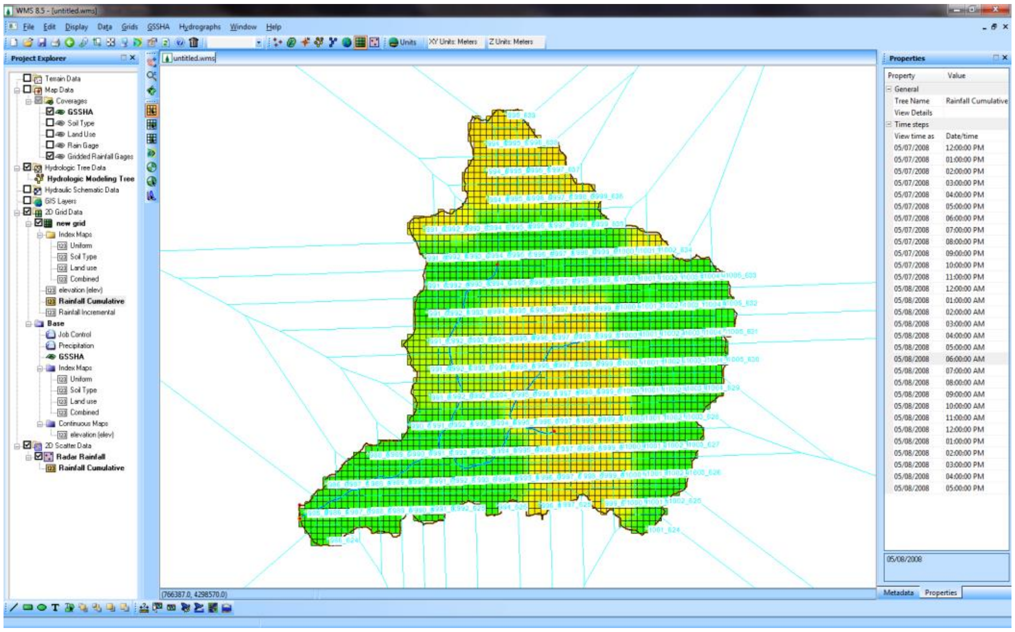
v. 10.0

WMS 10.0 Tutorial

GSSHA – Applications – Precipitation Methods in GSSHA

Learn how to use different precipitation sources in GSSHA models



Objectives

Learn how to use several precipitation sources and methods in GSSHA, including uniform rainfall, a rainfall hyetograph, rain gages with various interpolation methods, and NEXRAD RADAR rainfall data.

Prerequisite Tutorials

- GSSHA – Modeling Basics – Developing a GSSHA Model Using the Hydrologic Modeling Wizard in WMS

Required Components

- Data
- Drainage
- Map
- Hydrology
- 2D Grid
- GSSHA

Time

- 30-45 minutes

1 Contents

2 Introduction

In this tutorial, you will learn the different methods that precipitation data can be defined as storms in GSSHA. You will begin with an existing GSSHA project file. You will also see how NEXRAD data can be processed for GSSHA and view the difference in results while using various rainfall methods.

3 Open an Existing GSSHA Project

Open a WMS project file for Judy's Branch watershed.

1. In the *2D Grid Module* select ***GSSHA* | *Open Project File…***
2. Locate the ***Precipitation***, ***Personal***, ***Tables***, and ***Raw Data*** folders for this tutorial. If needed, download the tutorial files from www.aquaveo.com.
3. Browse and open the file ***Precipitation\base.prj***
4. Turn off the display of the Soil Type and Land Use coverages by unselecting them in the Project Explorer.

This model already has overland roughness, infiltration and channel routing options defined. We will not need to define or adjust these parameters, but will focus on exploring different methods for defining precipitation.

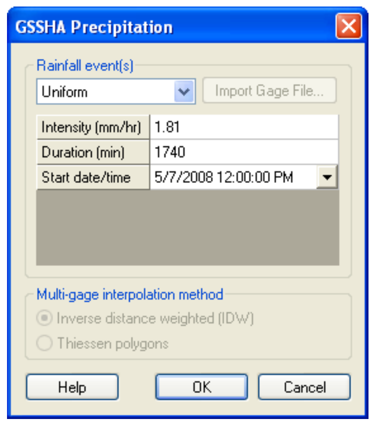
4 Using Uniform Rainfall

GSSHA has four different methods of defining rainfall precipitation. The method you use will be selected based on the availability of the data and purpose of the model. We will first use the uniform precipitation method, which generally is used to evaluate the initial set up of a model.

1. In the *2D Grid Module* select ***GSSHA* | *Precipitation***.
2. Under *Rainfall event(s)* select *Uniform.*
3. Enter 1.809 mm\hr for the intensity and *1740* minutes for duration. We are using total depth of 52.451 mm (2.065in) over a duration of 29 hours.

This precipitation depth is obtained from a real storm which we will use for comparison of the different methods. It was obtained from the NOAA site: (http:\\hdsc.nws.noaa.gov\hdsc\pfds\). The real storm total sums up to 2.065 inch over a duration of 29 hours.

4. Change the starting date as 05\07\2008 12:00:00 PM and click *OK.*



4.1 Changing the Job control

Since the rainfall will last for 29 hours, the total simulation time should be adjusted so that all runoff from the watershed will be captured.

1. Select ***GSSHA* | *Job Control.*** Then change the total time to 2880 mins (2 days). Make sure the simulation time step is 10 sec.
2. Click *OK.*

4.2 Save and Run the Model

We have now defined the uniform precipitation. Next we will save and run the model.

1. Select ***GSSHA* | *Save Project file…***
2. Save it as ***Personal\Precipitation\Uniform.prj.***
3. Select ***GSSHA* | *Run GSSHA….***

4.3 Visualization

1. Once GSSHA has finished running, click *Close*

2. You should have noticed that there is no runoff. This is because the rainfall intensity was small and all of the rain got infiltrated.
3. If you look at the Summary file, it should have shown that all the amount of precipitation that fell into the watershed got infiltrated.

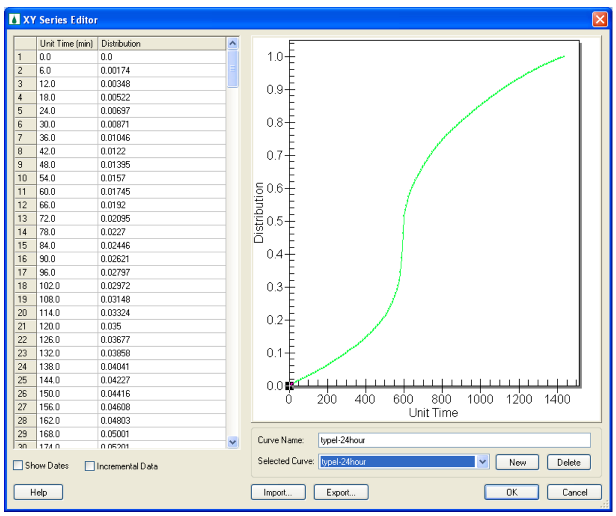
5 Using A Design Storm Hyetograph

Here we will see how typical rainfall distribution can be defined in GSSHA. We will be using the SCS synthetic rainfall distribution applied to the same total depth of 52.451mm (2.065in). In a similar fashion an actual temporal distribution could be defined if available. The actual temporal distribution of this storm will be used in the next section.

You can keep using the same GSSHA project and just change the precipitation method. Once the new precipitation has been defined, we will save the project with different name and run it.

5.1 Define the rainfall

1. Make sure you are in the *2D Grid* Module 
2. Select ***GSSHA* | *Precipitation.*** In the precipitation dialog, select *Hyetograph* for the Rainfall event(s) option.
3. Click on the *Define Distribution* button.
4. In the *XY Series Editor* dialog, select ***typeI-24hour*** for the *Selected Curve* option. See the following figure.



5. Click *OK.*
6. Enter **52.451 mm** for the *Average depth* field and make sure that the *Start date* is set to 05\07\2008 12:00:00 PM.
7. Click *OK.*

5.2 Save and Run the Model

We have now defined the hyetograph method of defining precipitation. Next we will save and run the model.

1. Select ***GSSHA* | *Save Project file…***

2. Save it as ***Personal\Precipitation\Hyetograph.prj.***
3. Select ***GSSHA | Run GSSHA….***

5.3 Visualization

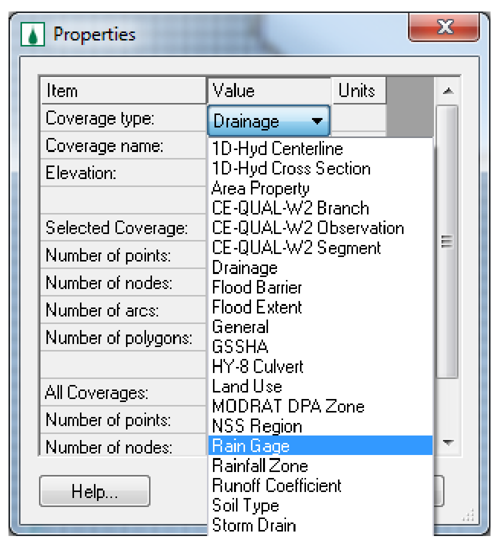
1. Once GSSHA has finished running, click *Close*
2. View the results (Hydrograph at the outlet).
3. For comparison, export the hydrograph ordinates as you did before and copy\paste in the spreadsheet ***tables\RainfallMethods.xls*** under column *Type I.*
4. Close the plot window(s) when you are done copying.
5. Note the difference in the outlet flow hydrograph when comparing the *uniform* and *hyetograph* methods.
6. In the summary file, you can see exactly how much of water from the precipitation got infiltrated and how much was drained out from the watershed in the form of an outlet hydrograph.

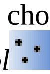
6 Using Rain Gages with the Inverse Distance Weighted Method of Interpolation

For this next simulation we will see how rain gages can be used to define precipitation in GSSHA. We will be using four gage locations in the vicinity of the Judy's Branch watershed; namely Belleville, Carlinville, Carlyle and St. Louis Airport gages.

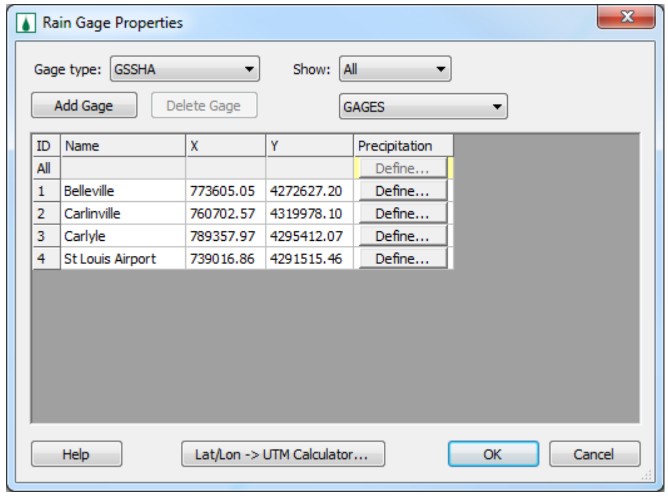
6.1 Creating gages

1. Right click on Coverages in the Project Explorer and select *New Coverage*
2. Change the type of the coverage to *Rain Gage* and click *OK* which will add coverage on the data tree under coverages



3. Click on the Rain gage coverage and choose *Create Feature Point Tool* . Click on the white area just outside your watershed boundary so that it will be easier to locate and make sure you are not too far away from the watershed. This will add a rain gage to the watershed. Create 3 additional gages surrounding the watershed. Do not worry about the exact location of the gages for now. We will edit their coordinates in the next step.
4. Choose *Select Feature Point\Node tool*  and double click any of the 4 gage that you just created.

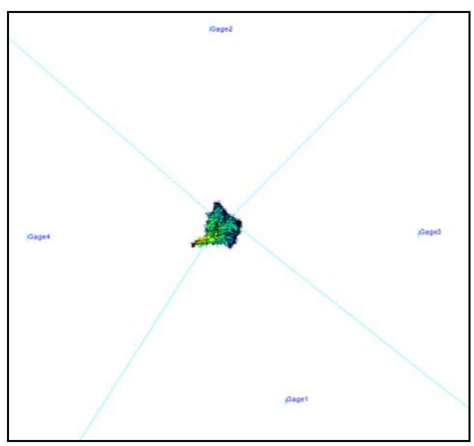
5. In the Rain Gage properties dialog, make sure the *Gage Type* is set to *GSSHA* and select *All* for the *Show* option.



6. Edit the coordinates and the names of each gage as shown in the following table.

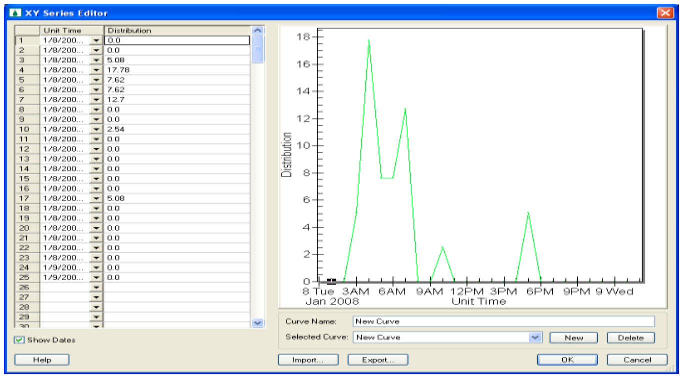
Gage name	Change gage name to	X	Y
Gage1	Belleville	773605.05	4272627.20
Gage2	Carlinville	760702.57	4319978.10
Gage3	Carlyle	789357.97	4295412.07
Gage4	St Louis Airport	739016.86	4291515.46

7. If you move *Rain Gage Properties* dialog to one side, you can see how WMS automatically draws Thiessen polygons (see the following figure).

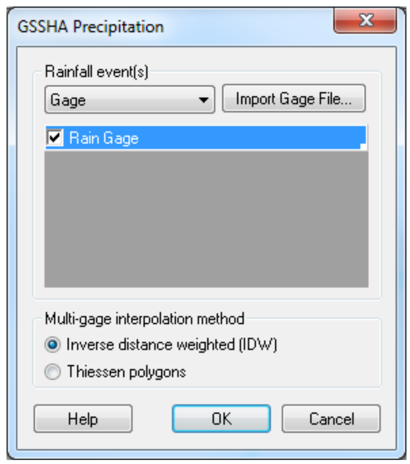


8. On the *Rain Gage Properties* dialog, click on the *Define…* button for *Belleville* gage which will open the XY Series editor window. In the XY Series Editor make sure the option *Show Dates is toggled ON.*
9. Open the spreadsheet ***RawData\JudysBranch\RealStorm.xls*** which has hourly precipitation records for these gages.
10. Copy and paste the columns with date and incremental distribution for *Belleville* to the XY series editor. Be sure to paste the time data into the

Unit Time column and paste the incremental precipitation values under the *Distribution* column. Your XY Series will look something like this:



11. Click *OK*
12. Repeat the same process for all other gages.
13. Once done, click *OK* to close the Rain gage property dialog.
14. Switch to the 2D Grid Module and select ***GSSHA | Precipitation***.
15. Select Gage under Rainfall event(s) option and it will bring Rain Gage in the list. Check on to select Rain Gage.



16. Select *Inverse Distance Weighted (IDW)* for the interpolation method.
17. *Click OK*

6.2 Save and Run Model

We have now defined the IDW method of interpolation for the gages to define the precipitation. Next we will save and run the model.

1. Select ***GSSHA | Save Project file…***
2. Save it as ***Personal\Precipitation\IDW.prj.***
3. Select ***GSSHA | Run GSSHA….***

6.3 Visualization

1. Once GSSHA has finished running, click *Close*

2. View the results (Hydrograph at the outlet).
3. For comparison, export the hydrograph ordinates and copy\paste to the spreadsheet ***Tables\RainfallMethods.xls*** under the column *IDW*.
4. See the difference in the outlet flow hydrograph in using the three different precipitation methods tested so far.

6.4 Using Rain Gages with the Thiessen Polygon Method of Interpolation

For this simulation we will use the same gages for precipitation, but with the Thiessen Polygon interpolation method.

1. Switch to the *2D Grid Module* and select ***GSSHA | Precipitation***
2. Leave everything the same other but change the *Interpolation method* to *Thiessen Polygons* and click *OK.*

6.5 Save and Run Model

We will save and run the model.

1. Select ***GSSHA | Save Project file…*** Save it as ***Personal\Precipitation\ Thiessen.prj.***
2. Select ***GSSHA | Run GSSHA….***

6.6 Visualization

1. Once GSSHA has finished running, click *Close*
2. View the results (Hydrograph at the outlet).
3. For comparison, export the hydrograph ordinates and copy\paste into the spreadsheet ***Tables\RainfallMethods.xls*** under the column *Thiessen.*
4. See the difference in the outlet flow hydrograph using the different precipitation methods.

6.7 Using NEXRAD Rainfall Data in GSSHA

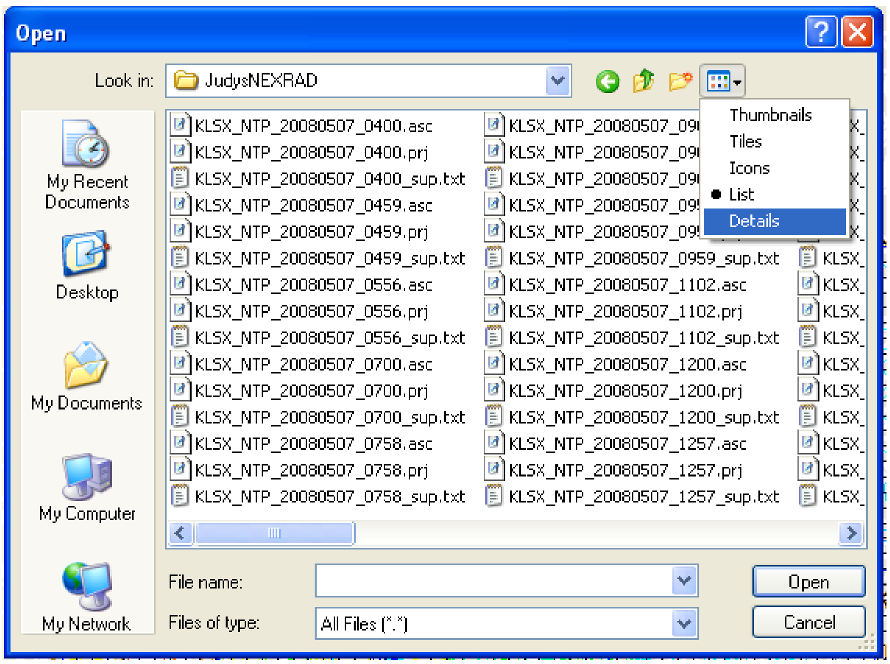
In this section, you will see how NEXRAD rainfall data can be used in GSSHA. You will begin with an existing GSSHA project file. You will see how NEXRAD data can be processed for GSSHA and view the difference in results between using gage-based and distributed rainfall.

6.8 Importing NEXRAD Rainfall Data

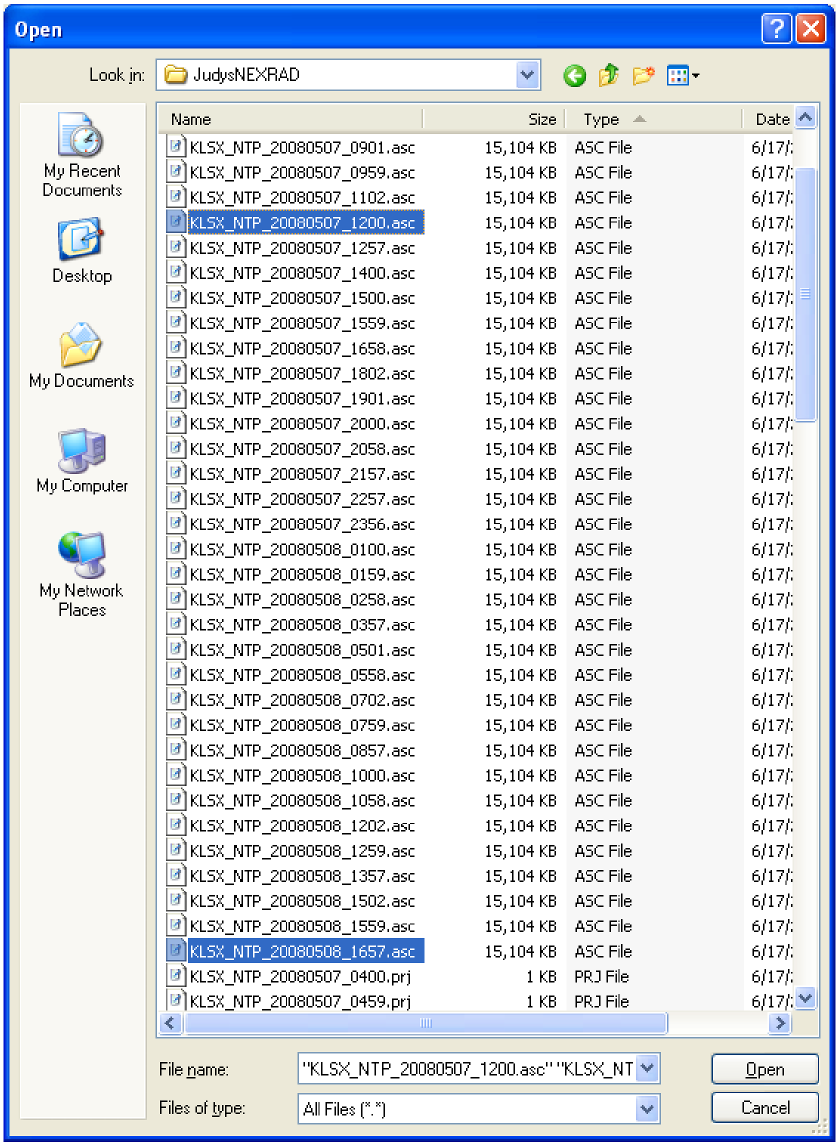
NEXRAD rainfall datasets have already been downloaded for this watershed. For information on how to obtain your own radar rainfall datasets, see http:\\www.xmswiki.com\index.php?title=GSDA:Obtaining_NEXRAD_Radar_Data_from_NCDC

1. We will keep working with the same model. Check off the display of *Rain Gage Coverage* by unselecting it on the project explorer. Zoom to GSSHA coverage (Right click GSSHA coverage and select *Zoom to Layer*).

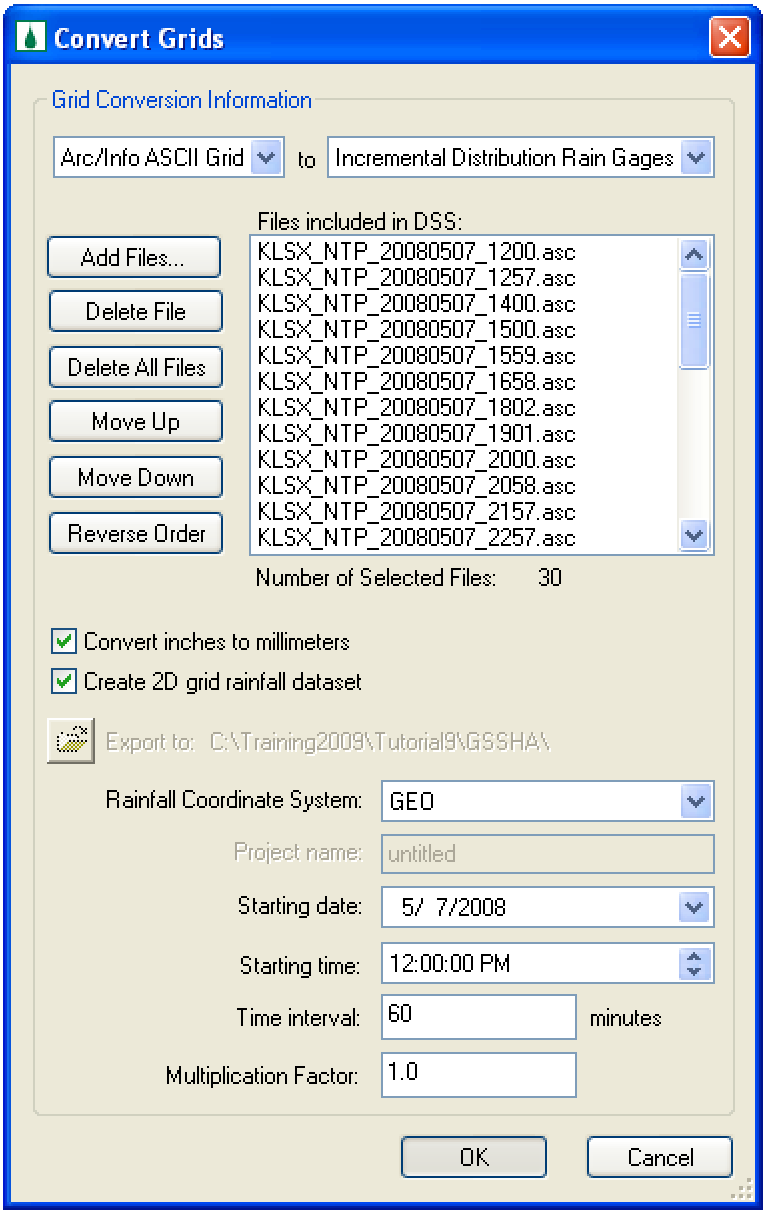
2. In the *2D Grid Module*  select ***GSSHA | Precipitation***. Under *Rainfall event(s)* select *Nexrad Radar*
3. Click on *Import Radar Data…* button which will open the *Convert Grids* dialog
4. In the *Convert Grids* dialog, make sure that *Grid Conversion Information* is set to *Arc\Info ASCII Grid* to *Incremental Distribution Rain gages*
5. Click the *Add Files…* button and browse to ***RawData\JudysBranch\Nexrad*** In the Open file browser, change the View Menu to *Details* (See following figure)



6. Click on the *Type* column heading to sort the files by Type
7. Select the **last** time grid which is *KLSX_NTP_20080508_1657.asc*



8. Hold the *Shift* key and select the **starting** time grid which is *KLSX_NTP_20080507_1200.asc*
9. Click *Open*
10. In the Convert Grids dialog, toggle on the option *Convert inches to millimeters* (if it is not already on)
11. Toggle on *Create 2D grid rainfall dataset* option.
12. Change the *Starting date* to 05\07\2008 and the *Starting time* to 12:00:00 PM.
13. Make sure that the time interval is 1 hour (60 min) (See the following figure)



14. Click *OK* to save the grid file. It will take some time to create the gages for the NEXRAD rainfall method.
15. After a couple of minutes the conversion process will complete and a summary file will open up (Following figure) showing the date\time and rainfall depth (mm) at each time interval.
16. Review and close the summary file

NEXRAD RADAR DATA SUMMARY REPORT

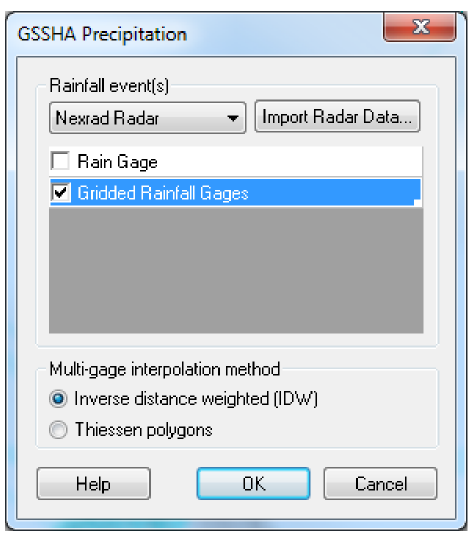
Basin Average Hyetograph

Date & Time	Time (min)	Incremental Depth (mm)	Cumulative Depth (mm)
05/07/08 12:00:00	0.000000	0.000000	0.000000
05/07/08 13:00:00	60.000000	5.371954	5.371954
05/07/08 14:00:00	120.000000	0.000000	5.371954
05/07/08 15:00:00	180.000000	0.000000	5.371954
05/07/08 16:00:00	240.000000	0.000000	5.371954
05/07/08 17:00:00	300.000000	0.000000	5.371954
05/07/08 18:00:00	360.000000	0.000000	5.371954
05/07/08 19:00:00	420.000000	1.182414	6.554368
05/07/08 20:00:00	480.000000	6.525172	13.079540
05/07/08 21:00:00	540.000000	0.000000	13.079540
05/07/08 22:00:00	600.000000	1.532759	14.612299
05/07/08 23:00:00	660.000000	0.000000	14.612299
05/08/08 00:00:00	720.000000	0.000000	14.612299
05/08/08 01:00:00	780.000000	5.109195	19.721494
05/08/08 02:00:00	840.000000	0.000000	19.721494
05/08/08 03:00:00	900.000000	0.656897	20.378391
05/08/08 04:00:00	960.000000	0.000000	20.378391
05/08/08 05:00:00	1020.000000	0.000000	20.378391
05/08/08 06:00:00	1080.000000	0.000000	20.378391
05/08/08 07:00:00	1140.000000	2.408621	22.787011
05/08/08 08:00:00	1200.000000	0.000000	22.787011
05/08/08 09:00:00	1260.000000	0.000000	22.787011
05/08/08 10:00:00	1320.000000	0.802874	23.589885
05/08/08 11:00:00	1380.000000	3.722414	27.312299
05/08/08 12:00:00	1440.000000	9.926437	37.238736
05/08/08 13:00:00	1500.000000	6.641954	43.880690
05/08/08 14:00:00	1560.000000	4.963218	48.843908
05/08/08 15:00:00	1620.000000	1.313793	50.157701
05/08/08 16:00:00	1680.000000	0.000000	50.157701
05/08/08 17:00:00	1740.000000	0.000000	50.157701

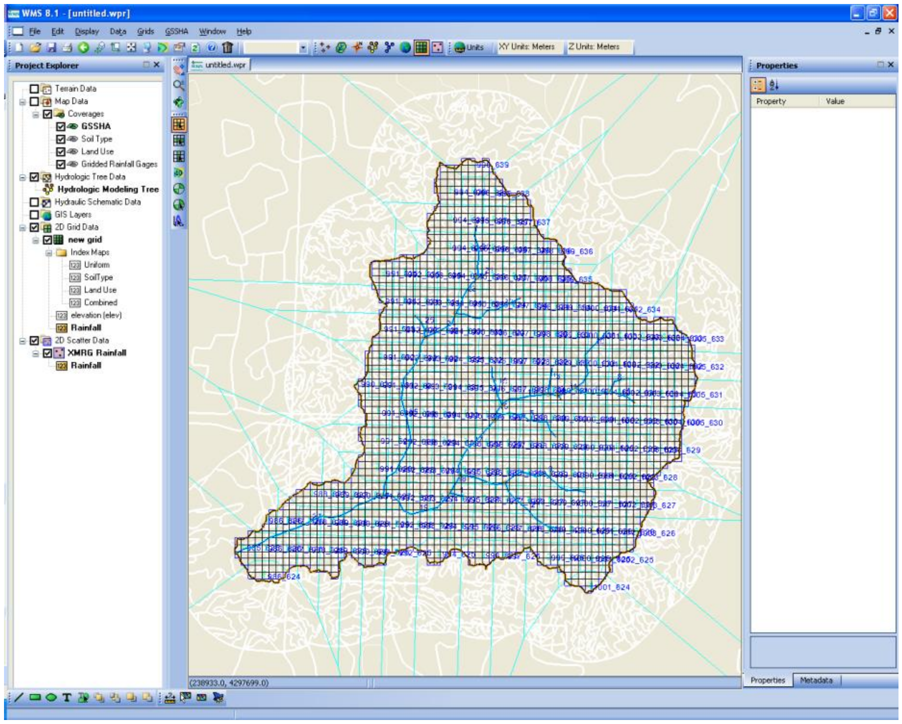
Total Storm Duration: 1740.000000 min
Total Storm Depth: 50.157701 mm

You should now see many gages covering the watershed and a network of polygons joining the gages. You should also notice a new Gridded Rainfall Gages coverage in the coverage tree.

17. The GSSHA Precipitation dialog will appear after the completion of the conversion process. Toggle on the *Gridded Rainfall Gages* option and click *OK*.
18. In the *GSSHA precipitation* dialog make sure that you toggle off the Rain Gage coverage and the change the interpolation method back to IDW.



19. The WMS window should look similar to the following figure.



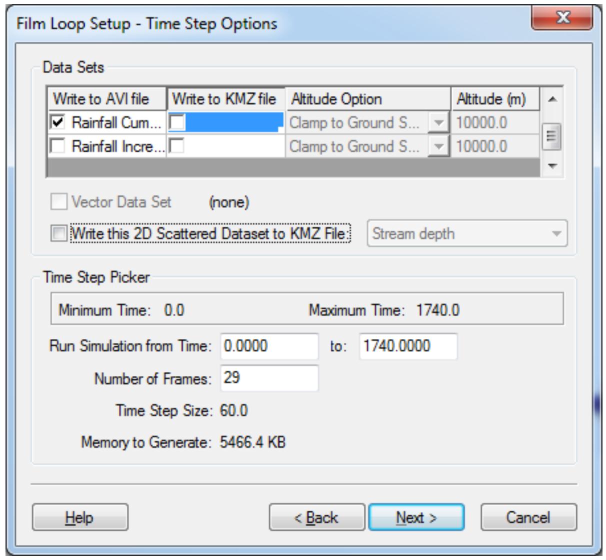
6.9 Visualizing Meteorological Data

Before continuing, let us visualize the gridded rainfall data.

1. Toggle off the display of *Gridded Rainfall Gages* by unselecting it in the project explorer.
2. Right click on *Rainfall Cumulative* on the data tree under 2D Grid Data and select *Contour Options…*Select *Color Fill* for the *Contour Method.* Click *OK*
3. With the down arrow key on your keyboard, step through the time steps in the properties window on the right sidebar to see how the precipitation varies.

There are two rainfall datasets, one is incremental and the other is cumulative. You may choose to view the incremental rainfall data set in the same way you viewed the cumulative data set. Whichever dataset is selected will be used to create the film loop.

4. In *2D Grid Module*  select ***Data* | *Film Loop…***
5. Select the option to *Create New Filmloop* and specify the folder where you want to have the animation saved (***Personal\Precipitation/precip.avi)***, check off the option to *Export to KMZ (Google Earth)* and click *Next*
6. Toggle on either *(Rainfall Cumulative)* or *(Rainfall Incremental)* and toggle off all other datasets.
7. Toggle off the option to *write to KMZ file.*
8. Toggle off the option to *Write 2D scattered Dataset to KMZ file.* See the following figure



9. Click *Next*
10. Click *Finish*. WMS will now a few moments to create and save the animation file. The animation will start playing as soon as the saving process is complete.

6.10 Save and Run the Model

We have now imported the NEXRAD rainfall into GSSHA and copied the data into the Gridded Rainfall Gages coverage. Next we will save and run the model.

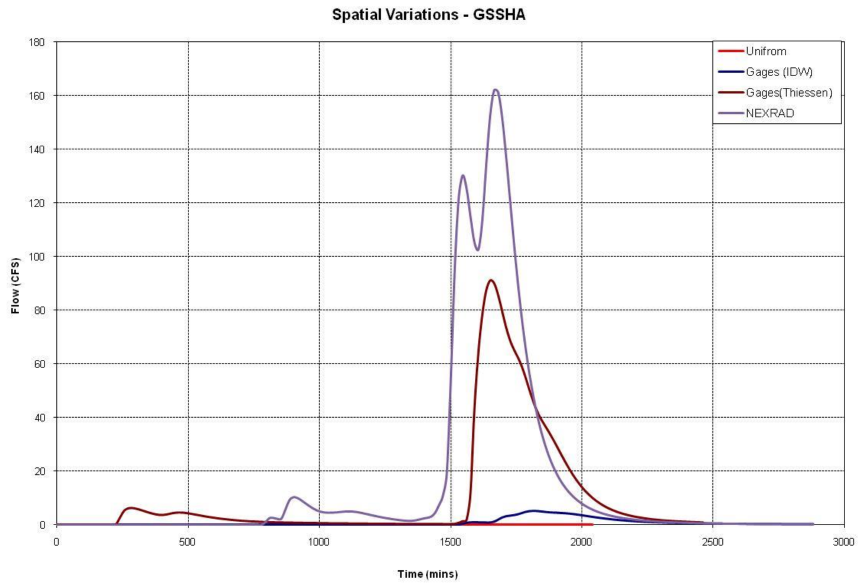
1. Select ***GSSHA* | *Save Project file…***
2. Save it as ***Personal\Precipitation\nexrad.prj***.
3. Select ***GSSHA* | *Run GSSHA….***

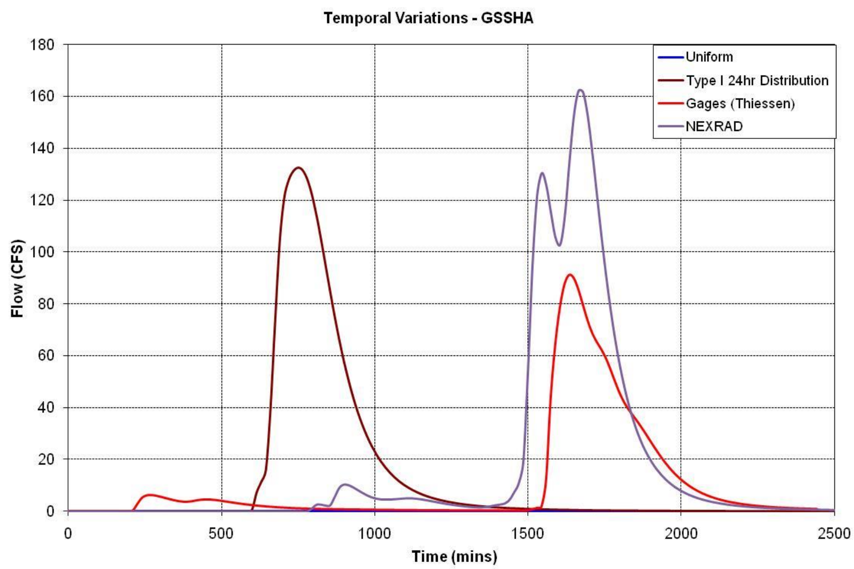
6.11 Visualization

1. Once GSSHA has finished running, click *Close*
2. With the *Select Hydrographs* tool  selected, double-click on the hydrograph icon to view the runoff hydrograph at the watershed outlet
3. For comparison, export the hydrograph ordinates and copy\paste in the spreadsheet ***Tables\RainfallMethods.xls*** under the column *NEXRAD.*
4. See the difference in the outlet flow hydrograph in using different precipitation methods.
5. You may export the animations to Google Earth (Optional).

6.12 Summary

Open up the comparison spreadsheet and compare the results from different precipitation methods.


Spatial Variations - GSSHA
Unifrom
Gages (IDW)
Gages(Thiessen)
NEXRAD
Flow (CFS)
Time (mins)


Temporal Variations - GSSHA
Uniform
Type I 24hr Distribution
Gages (Thiessen)
NEXRAD
Flow (CFS)
Time (mins)

