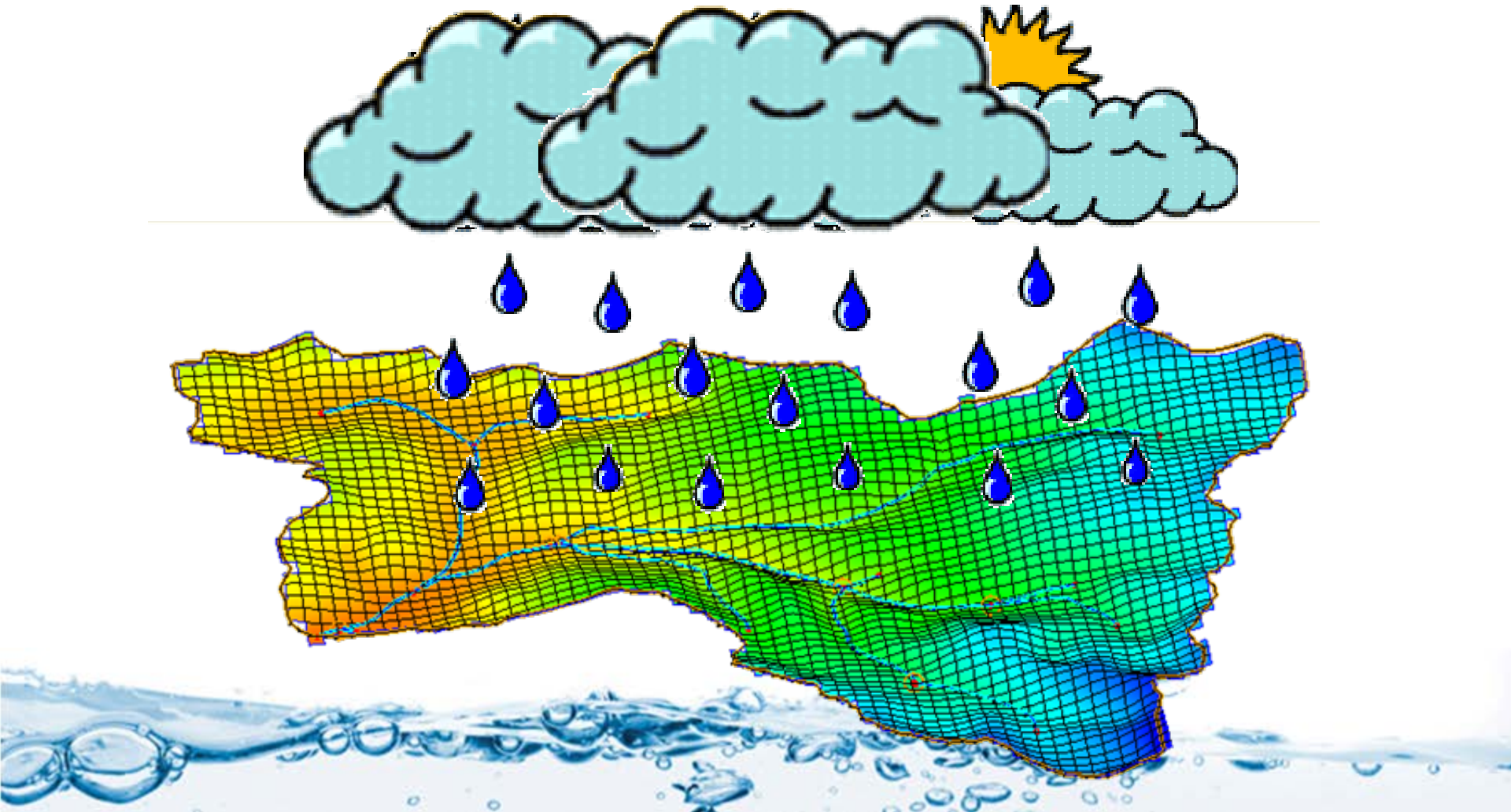
Rainfall methods in GSSHA



Precipitation Types

- Uniform rainfall
- Spatially uniform, temporally varying
- Spatially and temporally varying

Uniform Rainfall

- Specify uniform precipitation under global parameters
  - start time
    - year
    - month
    - day
    - hour
    - min
  - rate (mm/hr)
  - duration (min)

Spatially Uniform Temporally Varying Rainfall

- Specified in WMS as a single gage rainfall
- Time series data is entered as X and Y data
- Uniform time spacing is specified by the user
- Time series data can be imported or exported
- Useful for simulating "standard" storm events

Spatially and Temporally Varying Precipitation

- File built external to WMS
- Specify gage locations and rainfall rate with non-uniform time spacing
- Multiple formats for entering rainfall

Gage Data Input File

- Card based input file
  - EVENT - Storm ID
  - NRPDS - # of time distributions in the event
  - NRGAG - # of gages for event
  - COORD – rain gage coordinate
    - One for each gage (NRGAG)
  - Rainfall source card
    - GAGES – accumulation (mm) at end of period
    - RADAR – rates (mm/hr) at the end of the sampling period
    - RATES – rates (mm/hr) at the beginning of the sampling period
    - One for each time period (NRPDS)

Example Gage Input File

- EVENT "Event of 30 June 1995- rainfall stops on July 1st"
- NRPDS 5
- NRGAG 3
- COORD 205150.0 4750212.0 "center of radar pixel #1"
- COORD 205045.0 4750104.0 "center of radar pixel #2"
- COORD 205320.0 4751173.0 "center of radar pixel #3"
- RADAR 1995 06 30 22 56 0.00 0.00 0.00
- RADAR 1995 06 30 23 18 10.75 2.25 5.80
- RADAR 1995 06 30 23 39 21.16 1.80 41.50
- RADAR 1995 06 30 23 57 12.13 20.90 20.70
- RADAR 1995 07 01 00 09 11.71 16.50 2.30

Rules for Single Event Gage Rainfall

- In a given EVENT, the rainfall data source type (GAGES, RADAR, RATES, ACCUM) may NOT change.
- If only one gage is present, rainfall interpolation is impossible. The location of the gage is irrelevant and the gage coordinates are ignored. Rainfall is applied uniformly in space. This provides a means to apply a temporal distribution of rain in a spatially uniform fashion. Such temporally varying, spatially uniform rainfall distributions are commonly used in flood frequency analysis, i.e. TP40.
- A separate line with its own time of recording is used to input each instance of rainfall, allowing varying temporal resolution rainfall data to be input. This feature is particularly useful when using radar-rainfall estimates, since the temporal resolution can vary considerably.
- The finest temporal resolution of GSSHA rainfall input is 1 minute. Rainfall rates change on integer minutes. Seconds are not allowed in the time field.
- The COORD card must be followed by the easting and northing of the rain gage. Easting and northing must be in coordinates in the same frame of reference as the header of all ASCII GRASS input maps. If the gage and map coordinates are not in the same system, the gages will not be placed at the correct location in relation to the watershed.
- If used, the optional strings must be enclosed in double quotes "like this"
- Tabs or spaces are used to delimit the file. DO NOT USE COMMAS.
- To improve readability, line feeds are allowed in the data file.

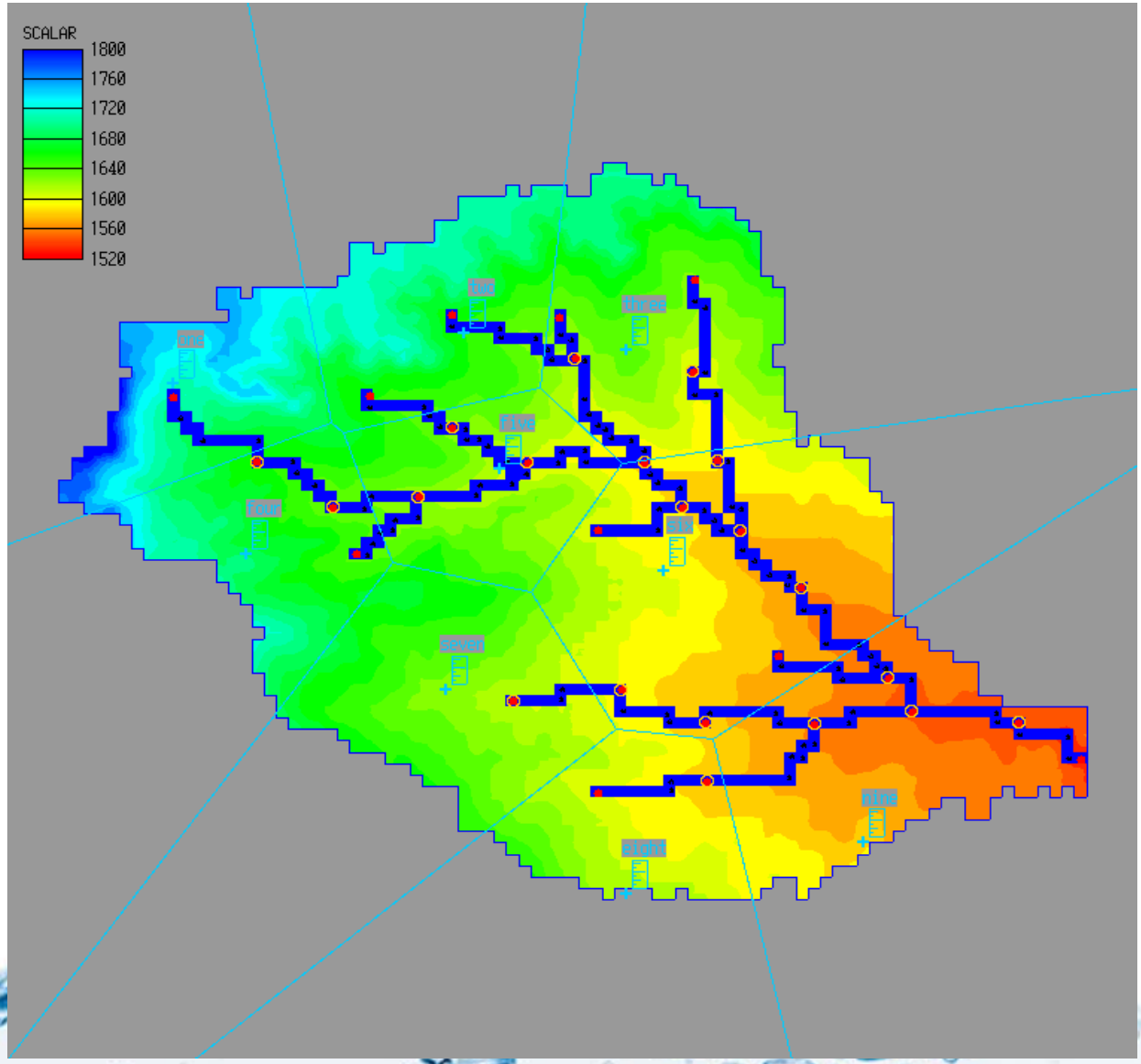
Guide for Rain Gage Selection

- GSSHA is very sensitive to rainfall input. Poor input data will result in poor model solutions.
- For best results multiple rain gages should be located inside the watershed.
- For convective storms, research indicates very poor correlation between gages more than 50 km apart.
- Include NEARBY gages outside the watershed.
- Input the finest temporal resolution possible.
  - If one gage has finer resolution than others use the data from that gage and repeat the data form the other gages.

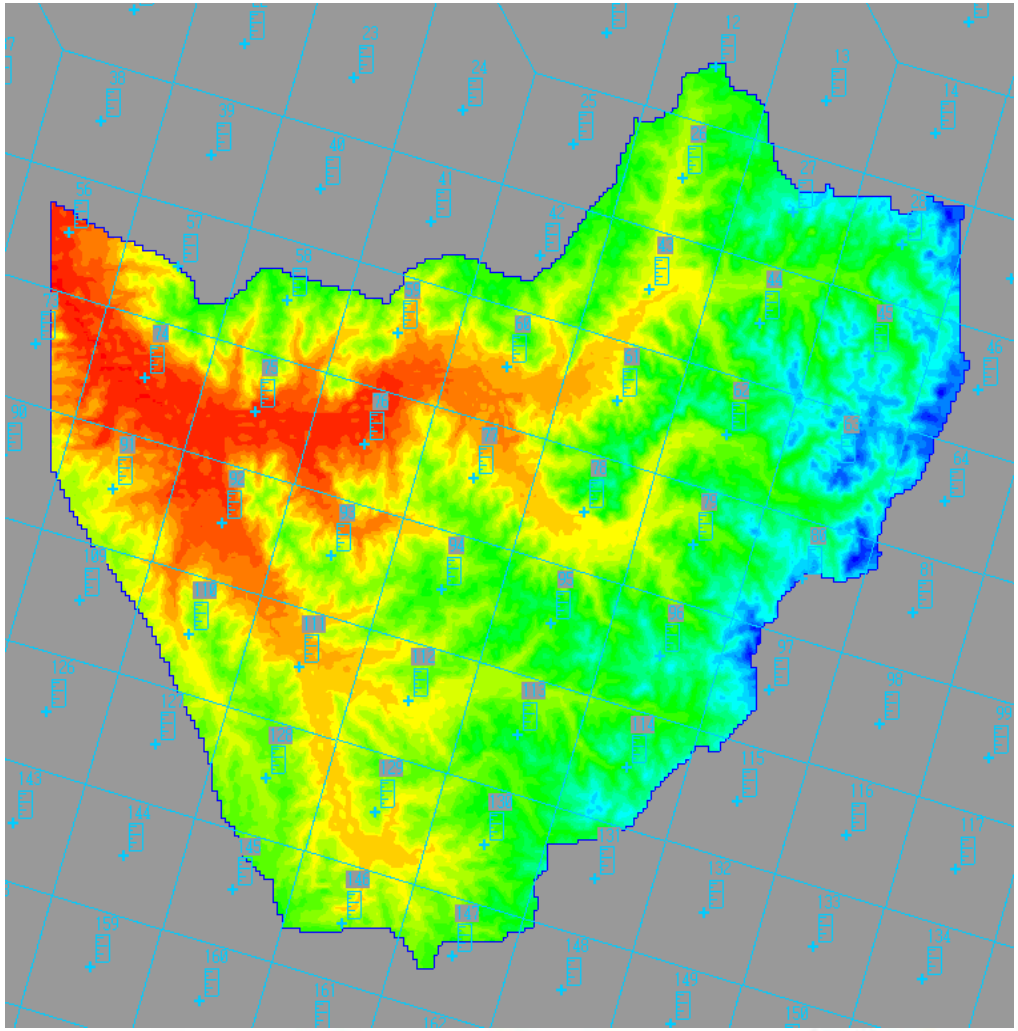
Spatial Distribution

- Thiessen polygon
- Inverse distance squared weighted
- Thiessen polygons can be used to represent radar rainfall.

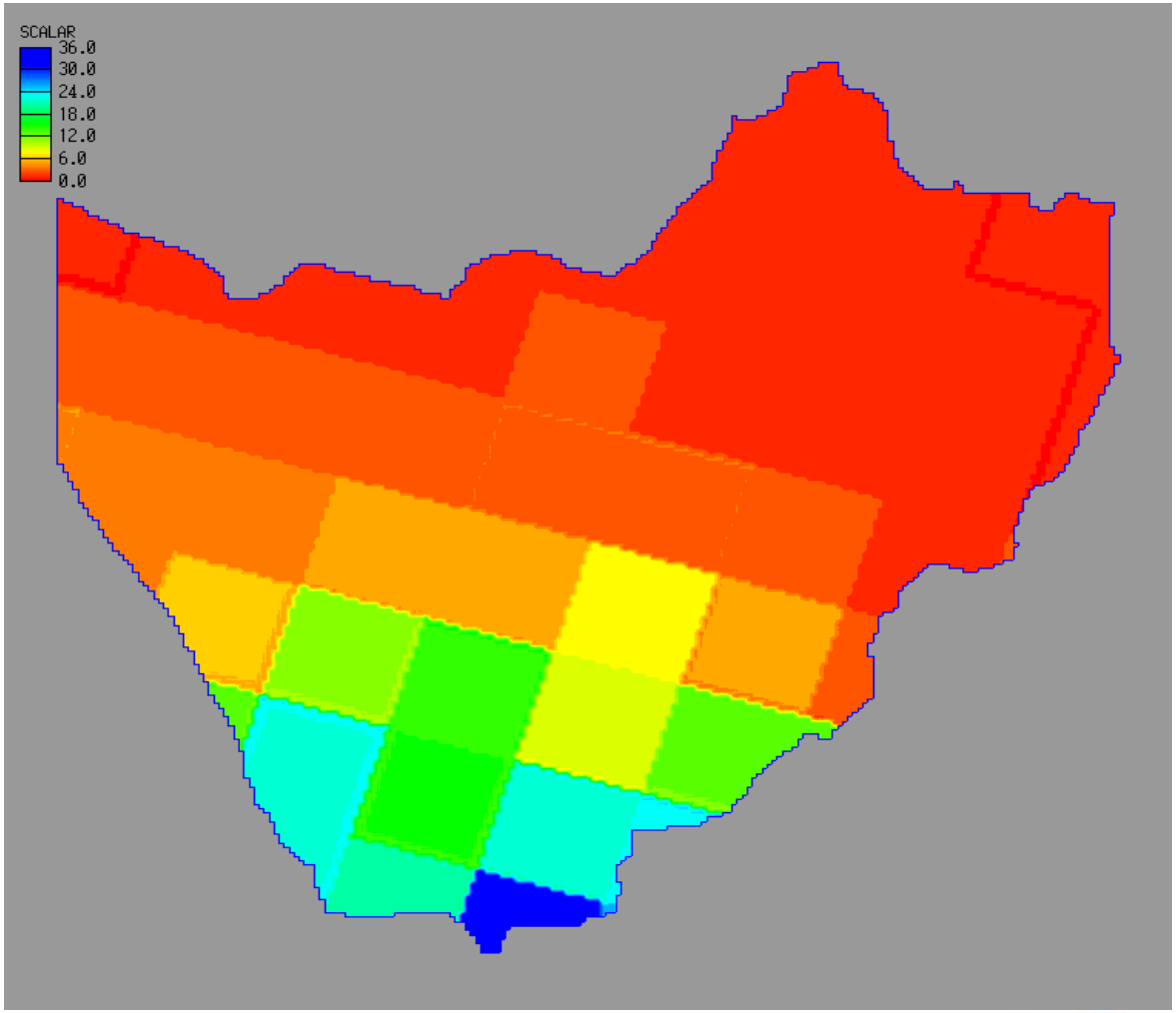
Rain Gages with Thiessen Polygons



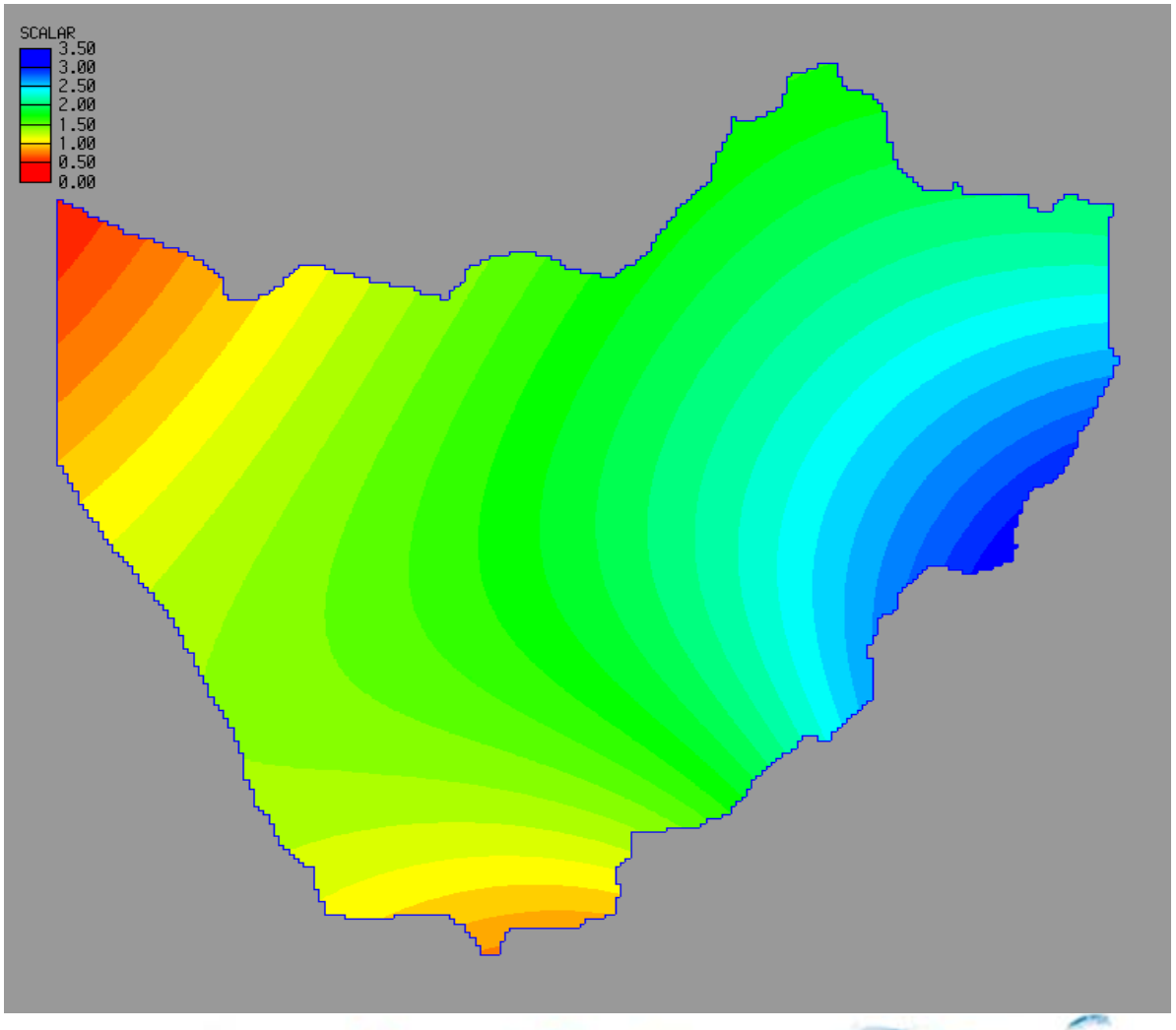
NEXRAD Radar Distributed with Thiessen Polygons



Snapshot of Rainfall Intensity

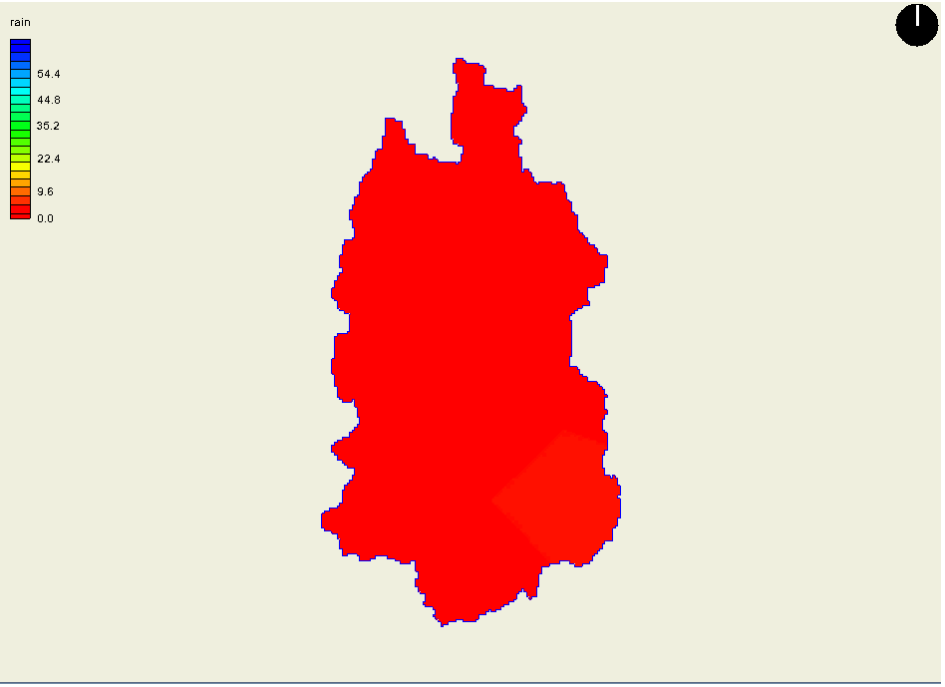


Inverse Distance Weighted Rainfall

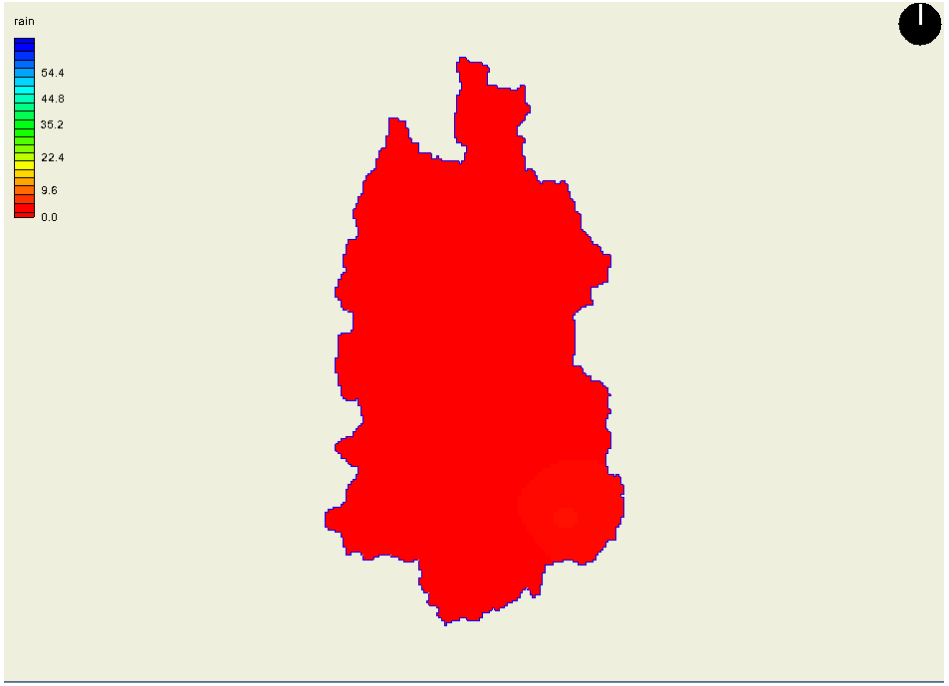


Rainfall Distribution Comparison

Theissen Polygon



Inverse Weighted Distance



Plant Interception

- Rainfall is intercepted by vegetation before reaching the land surface.
- Two parameter interception model
  - Initial volume of rainfall
  - Fraction retained of rainfall falling after satisfying initial storage

Inputs for Interception

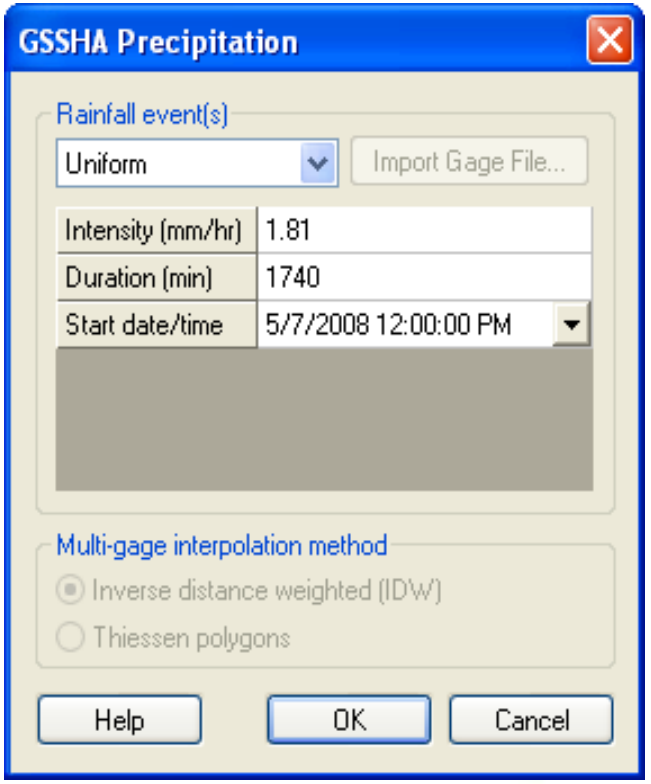
- Index map and mapping table
- Index map derived from vegetation coverage
- Mapping table contains values of
  - Initial storage volume (mm)
  - Fraction retained after satisfying initial storage

Applications

- Uniform rainfall most useful for initial model set up and trouble shooting
- Real watershed simulations are conducted with multiple gage, temporally varying rainfall
- Radar rainfall estimates can be useful when good gage data are not available
- Currently exploring the use of satellite data for remote regions

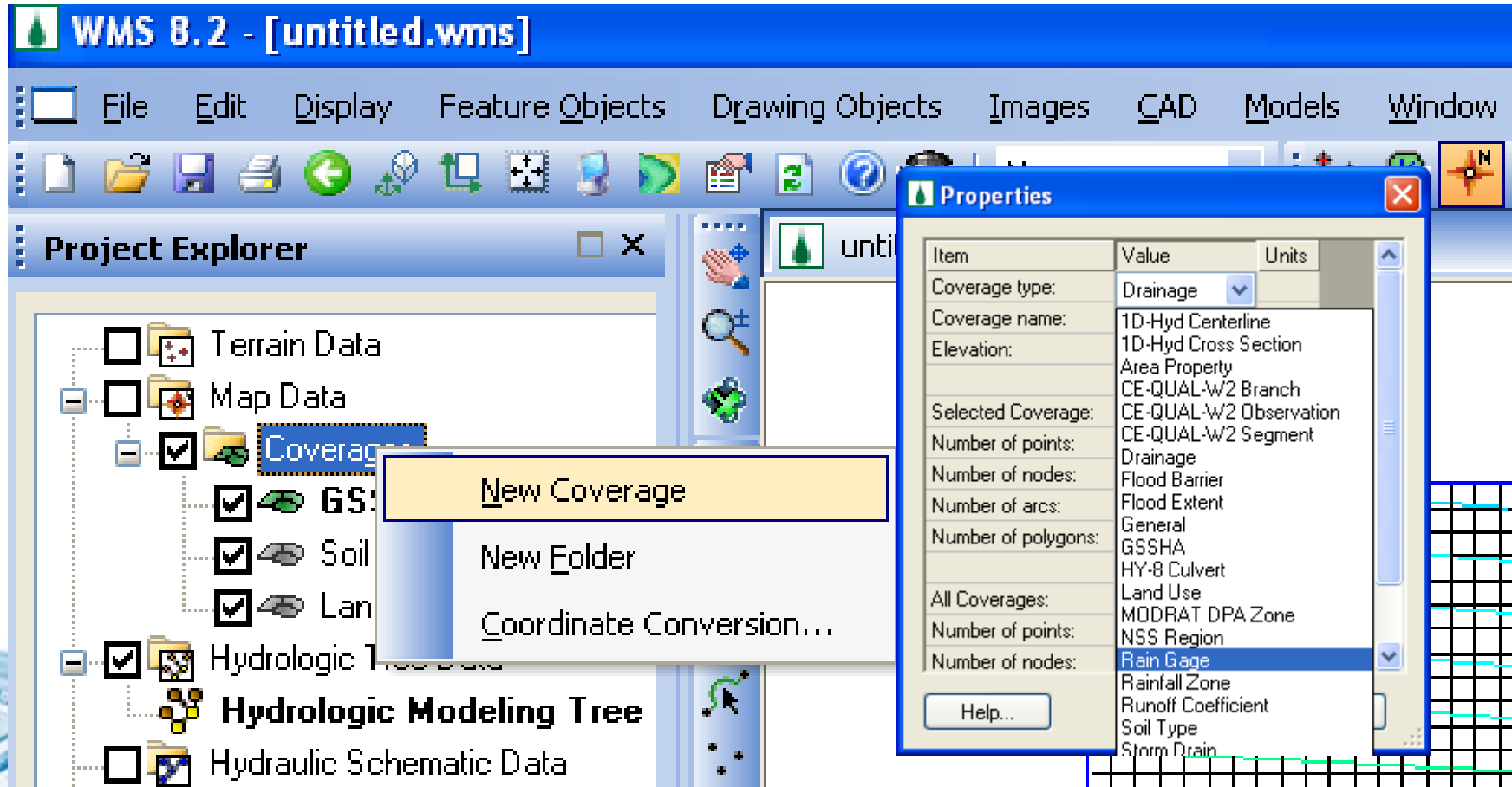
Uniform Precipitation

- The rainfall depth is uniformly distributed over time and is assumed to have same intensity all over the watershed
- Intensity: mm/hr
- Duration: min



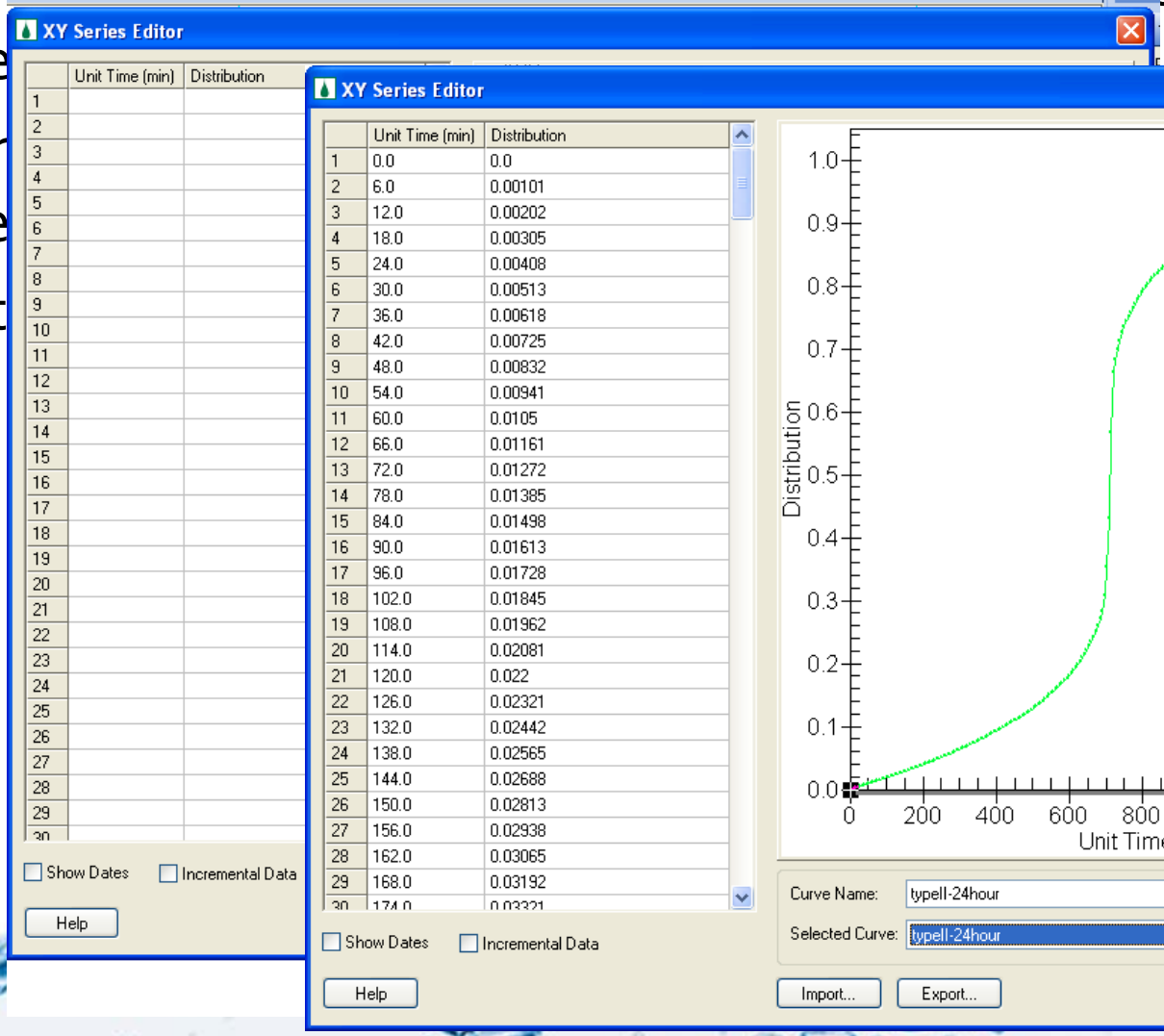
Using Gages

- Multiple gages can be used but each gage must have the same temporal distribution of rainfall
- Rain gage coverage is created

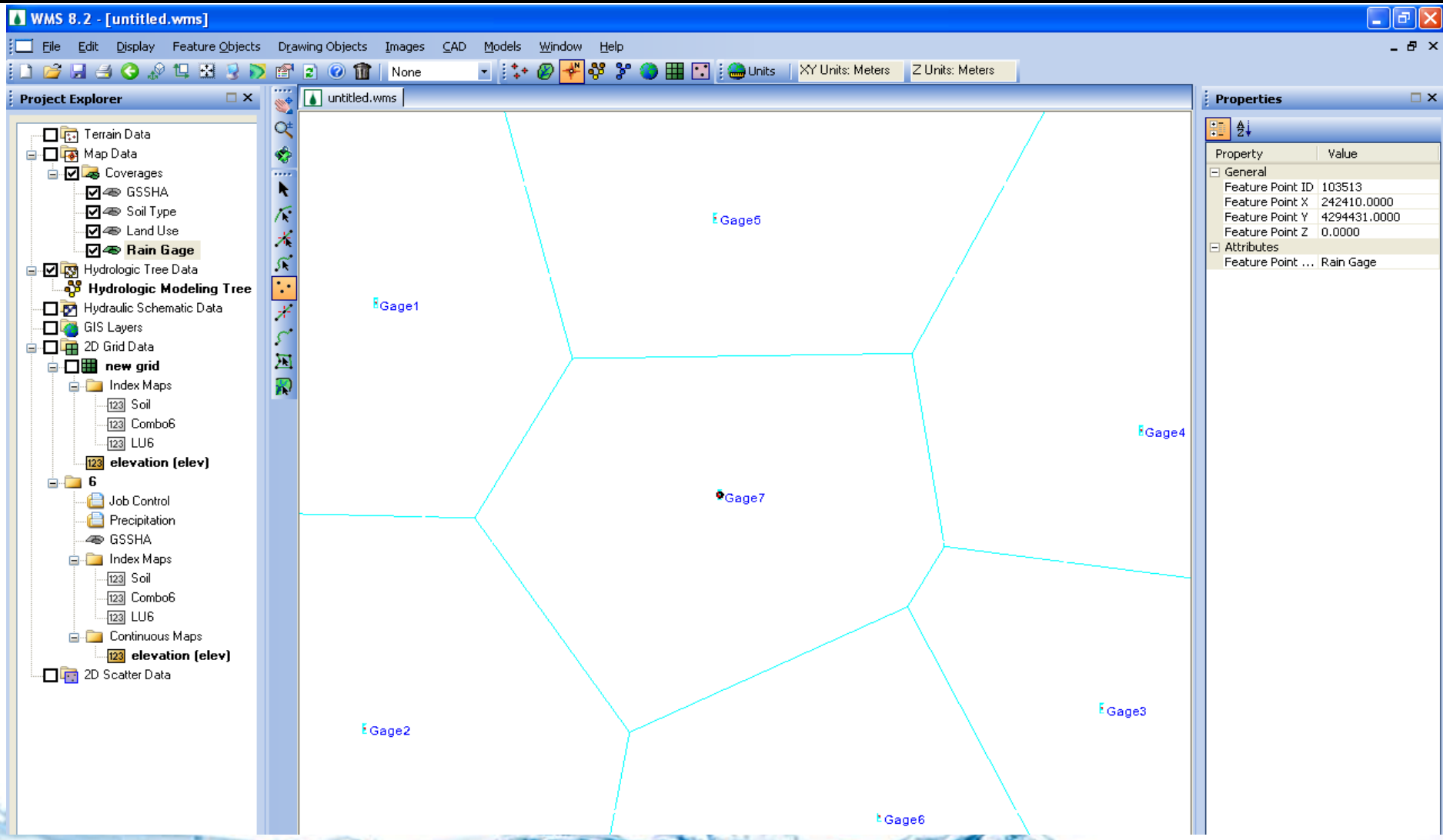


Using Hyetograph

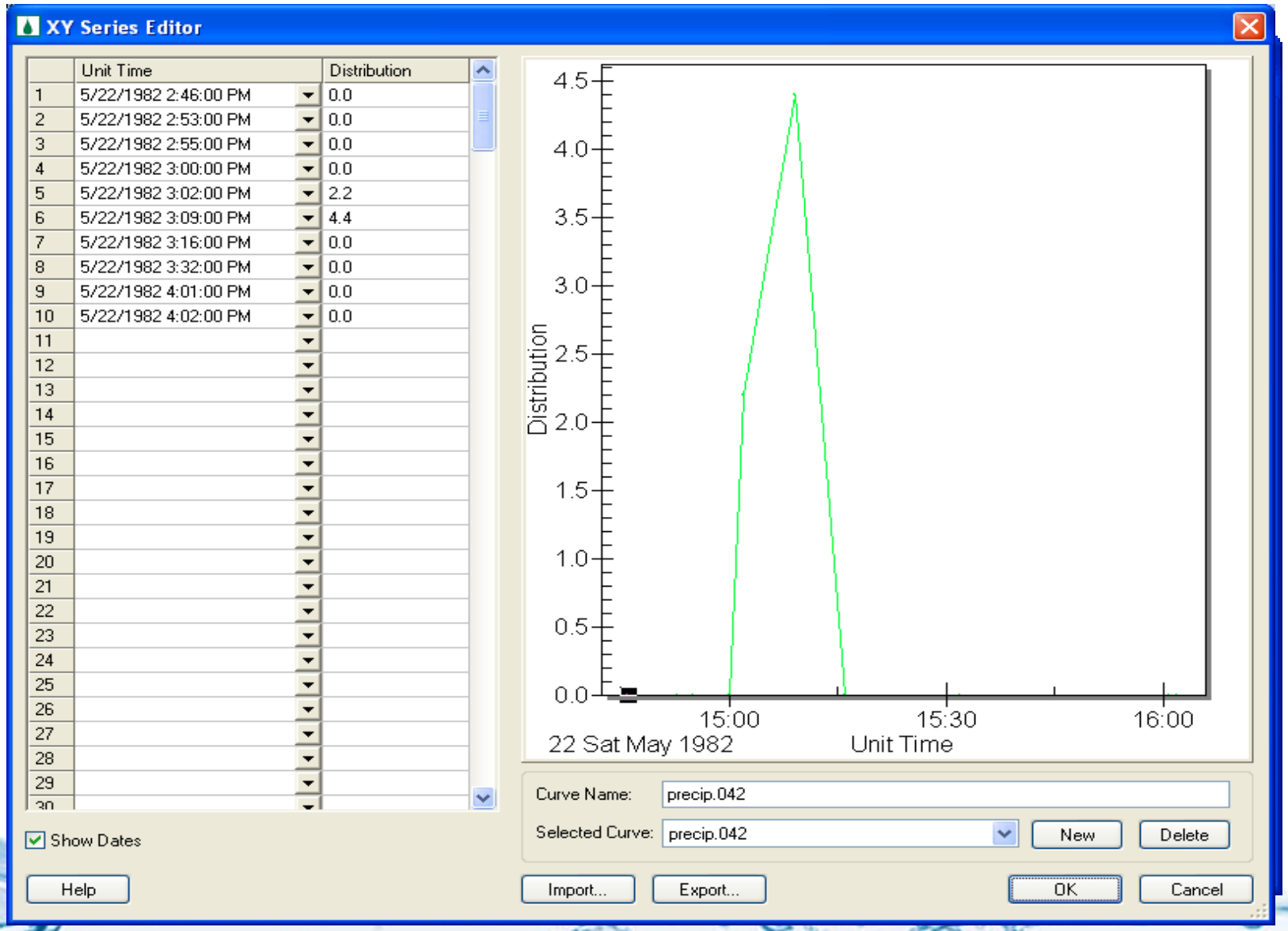
- This option is useful if the normalized temporal distribution is available
- The distr
storm de
- This met



Using Gages

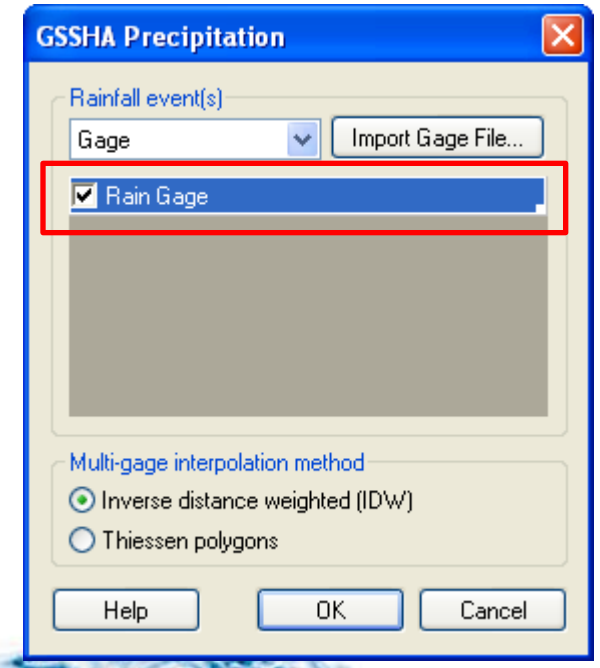

WMS 8.2 - [untitled.wms]
File Edit Display Feature Objects Drawing Objects Images CAD Models Window Help
None
Units
XY Units: Meters
Z Units: Meters
Project Explorer
Terrain Data
Map Data
Coverages
GSSHA
Soil Type
Land Use
Rain Gage
Hydrologic Tree Data
Hydrologic Modeling Tree
Hydraulic Schematic Data
GIS Layers
2D Grid Data
new grid
Index Maps
Soil
Combo6
LU6
elevation (elev)
6
Job Control
Precipitation
GSSHA
Index Maps
Soil
Combo6
LU6
Continuous Maps
elevation (elev)
2D Scatter Data
untitled.wms
Gage5
Gage1
Gage4
Gage7
Gage3
Gage2
Gage6
Properties
Property
Value
General
Feature Point ID 103513
Feature Point X 242410.0000
Feature Point Y 4294431.0000
Feature Point Z 0.0000
Attributes
Feature Point ... Rain Gage

Using Gages


XY Series Editor
Unit Time
Distribution
1 5/22/1982 2:46:00 PM 0.0
2 5/22/1982 2:53:00 PM 0.0
3 5/22/1982 2:55:00 PM 0.0
4 5/22/1982 3:00:00 PM 0.0
5 5/22/1982 3:02:00 PM 2.2
6 5/22/1982 3:09:00 PM 4.4
7 5/22/1982 3:16:00 PM 0.0
8 5/22/1982 3:32:00 PM 0.0
9 5/22/1982 4:01:00 PM 0.0
10 5/22/1982 4:02:00 PM 0.0
Show Dates
Help
Distribution
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
15:00
15:30
16:00
22 Sat May 1982
Unit Time
Curve Name: precip.042
Selected Curve: precip.042
New
Delete
Import...
Export...
OK
Cancel

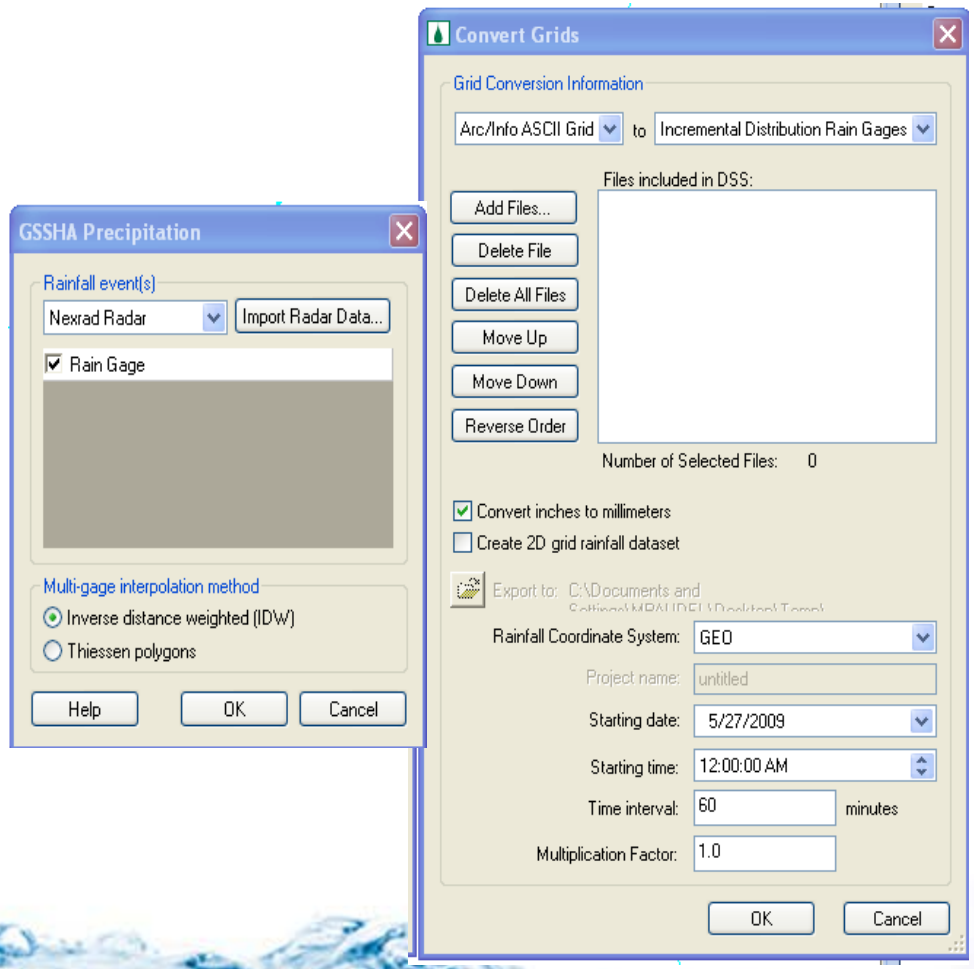
Using Gages

- Once all the gages are defined, we need to go back to GSSHA | Precipitation and select "Rain Gage" coverage to be used to get the gage information

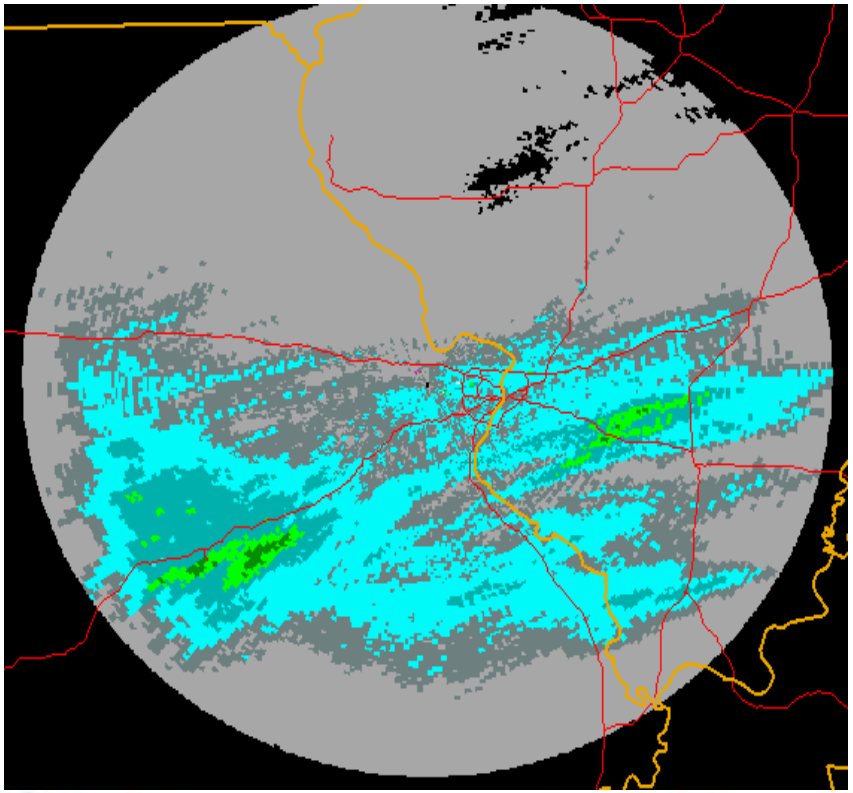


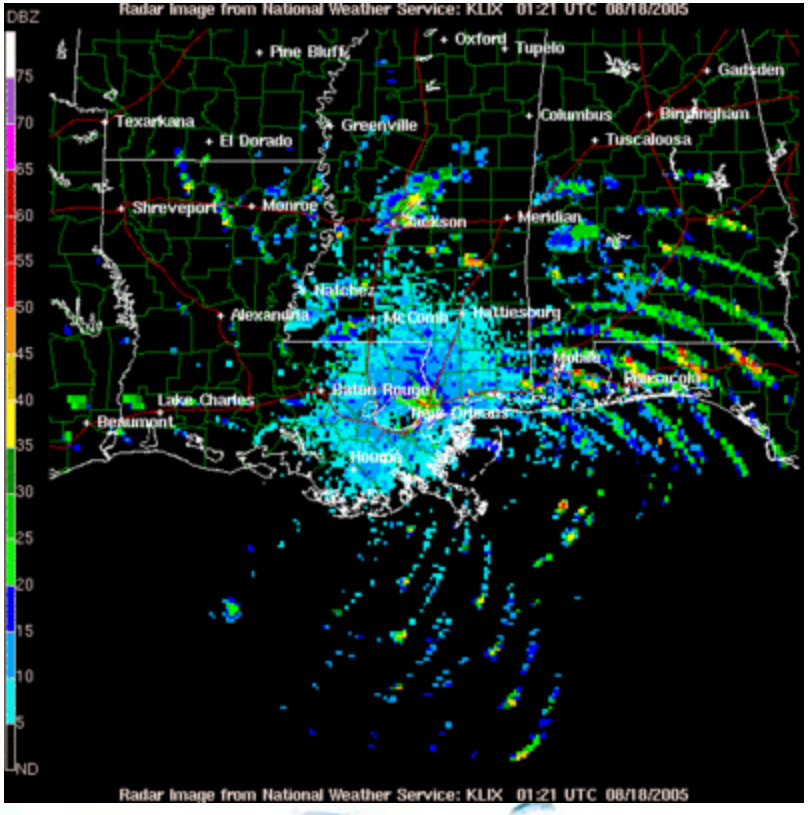
Using NEXRAD Radar data

- NEXRAD radar data is used to define the spatially and temporally varying rainfall
- It involves more computation compared to previous methods.
- This will be discussed in more detail next.



NEXRAD Radar Rainfall



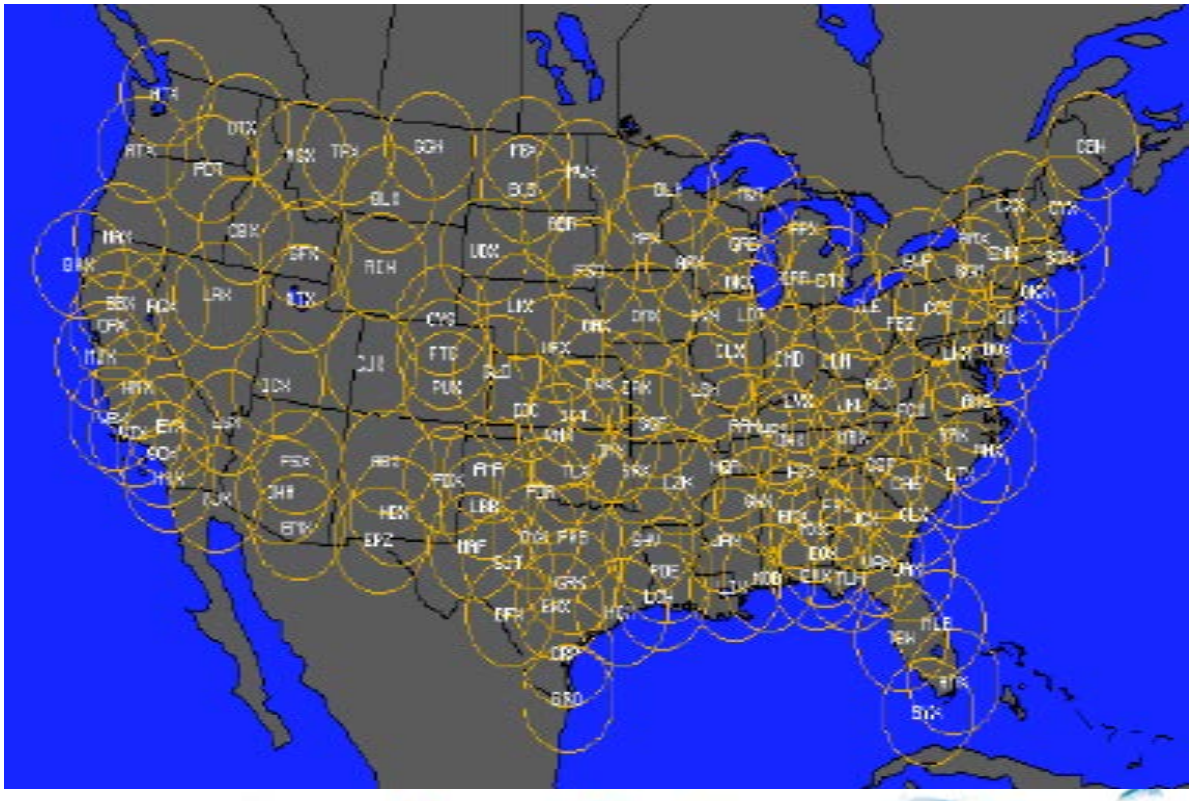


What is NEXRAD

- Developed by National Weather Service
- NEXt generation RADar (WSR-88D weather radar)
- NERAD senses the rainfall by transmitting a radio signal and measuring the reflection from falling rain drops
- Data available with 2Km*2Km grid

Coverage

- Available for entire United States



Benefits

- When near the watershed NEXRAD data are typically of good quality and compare well with ground based gages.
- Provides superior spatial distribution of rainfall
- Can be used in GSSHA using WMS interface that processes the data and saves in the format accepted by GSSHA

Acquisition

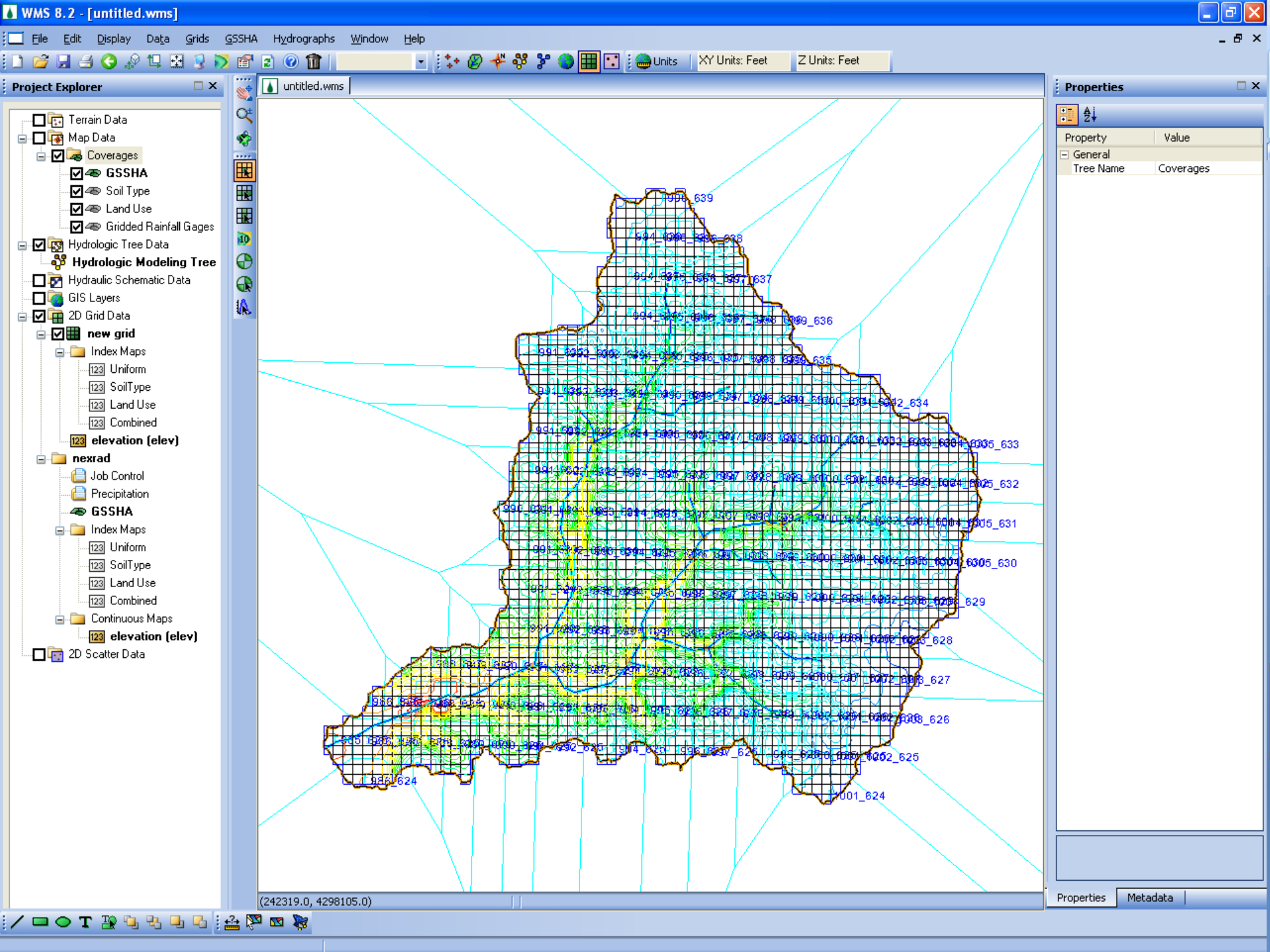
- The data that can be used with WMS interface is obtained from the National Climatic Data Center (NCDC)

  http://www.ncdc.noaa.gov/oa/radar/radardata.html
- Data acquisition involves two steps:
  - Ordering the data
  - Conversion of the data to ASCII format that WMS recognizes
- Ordering
  - Using NEXRAD inventory search
  - Using NCDC HDSS Access
  - The details of ordering the data can be found at
- Data can also be directly downloaded at the NCDC site

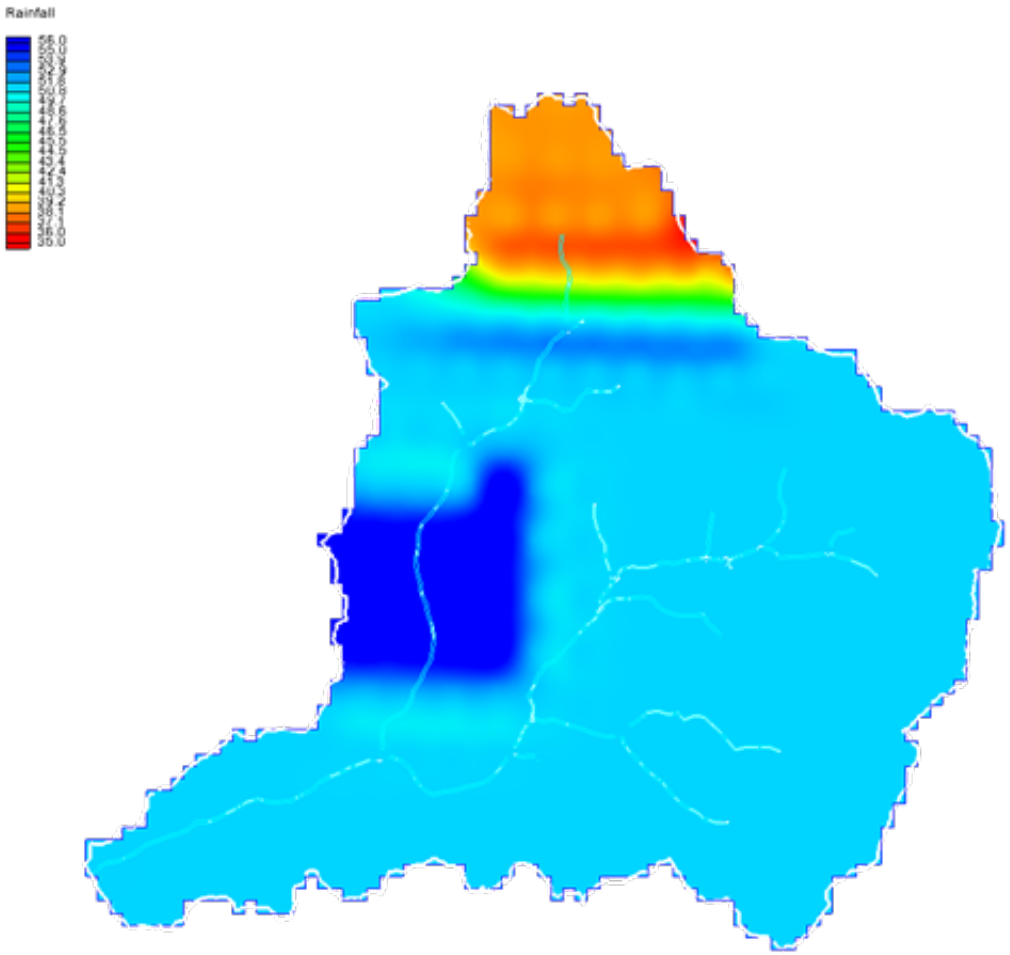
http://www.ncdc.noaa.gov/oa/radar/radardata.htmlhttp://www.xmswiki.com/xms/GSDA:Obtaining_NEXRAD_Radar_Data_from_NC`

Acquisition

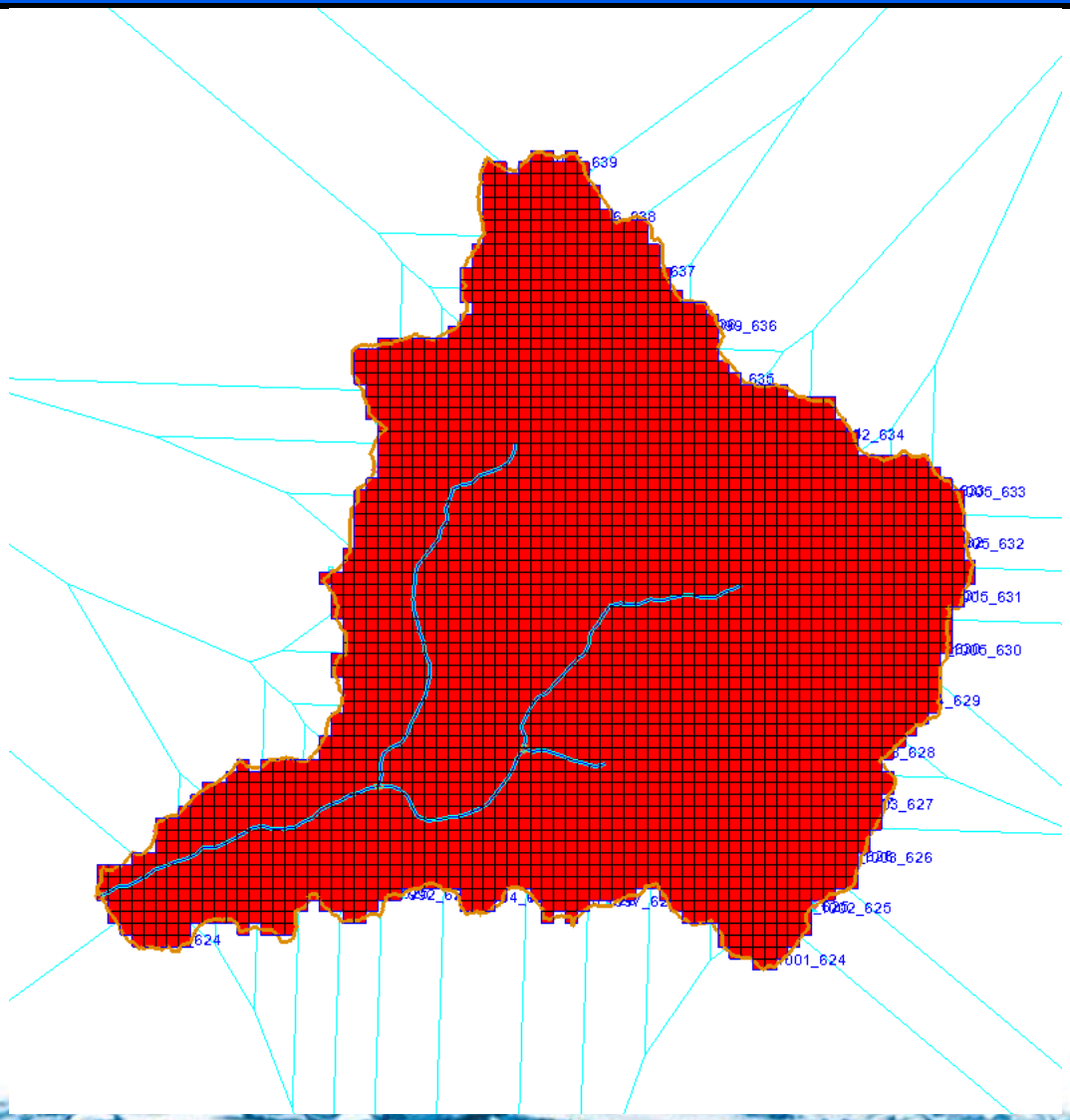
- NCDC has web based tools to visualize, order and convert the radar data
- This tool is called NCDC Java NEXRAD viewer and Data Exporter
- The tool is used to convert the data to ASCII grid so that it can be read in WMS and processed for GSSHA
- The details of using this web based tool can be found in http://www.xmswiki.com/xms/GSDA:Obtaining_NEXRAD_Radar_Data_from_NCDC


WMS 8.2 - [untitled.wms]
File Edit Display Data Grids GSSHA Hydrographs Window Help
Units
XY Units: Feet
Z Units: Feet
Project Explorer
Terrain Data
Map Data
Coverages
GSSHA
Soil Type
Land Use
Gridded Rainfall Gages
Hydrologic Tree Data
Hydrologic Modeling Tree
Hydraulic Schematic Data
GIS Layers
2D Grid Data
new grid
Index Maps
Uniform
SoilType
Land Use
Combined
elevation (elev)
nexrad
Job Control
Precipitation
GSSHA
Index Maps
Uniform
SoilType
Land Use
Combined
Continuous Maps
elevation (elev)
2D Scatter Data
untitled.wms
Properties
Property
Value
General
Tree Name
Coverages
Properties
Metadata
(242319.0, 4298105.0)

Spatial vs Lumped Rainfall



Visualizing the Rainfall Data



Animations in Google Earth