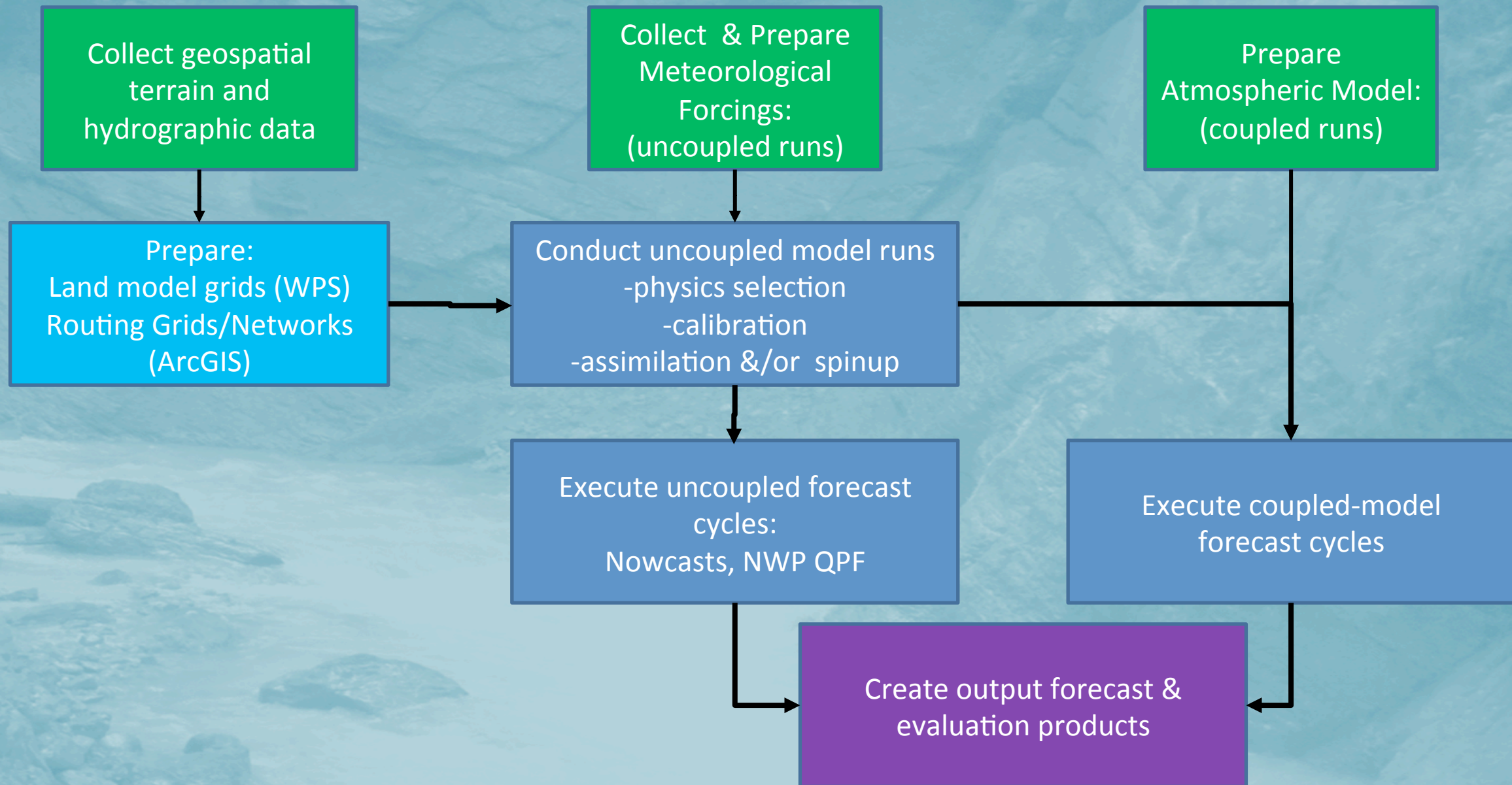


Data I/O Requirements :

May 2015

WRF-Hydro Development Team

WRF-Hydro Implementation Workflow:



WRF-Hydro Input Data:

I/O Philosophy :

1. Single, consistent data format for I/O (helps minimize coding conventions)
2. Convenient and ubiquitous (compatible with many graphical analysis and visualization tools)
3. Multiscale, multi-data type
4. Meta-data capable
5. Efficient in terms of overall data storage

Not surprisingly, we adopted netcdf as our primary format
However, we also utilize a few flat ASCII files where necessary

- ∴ One needs to put/read netcdf files and netcdf library and include directories
- ∴ These MUST BE PROPERLY INSTALLED AND LINKED TO
(see <http://www.unidata.ucar.edu/software/netcdf/>)

If WRF is already installed and compiled, then this is take care of

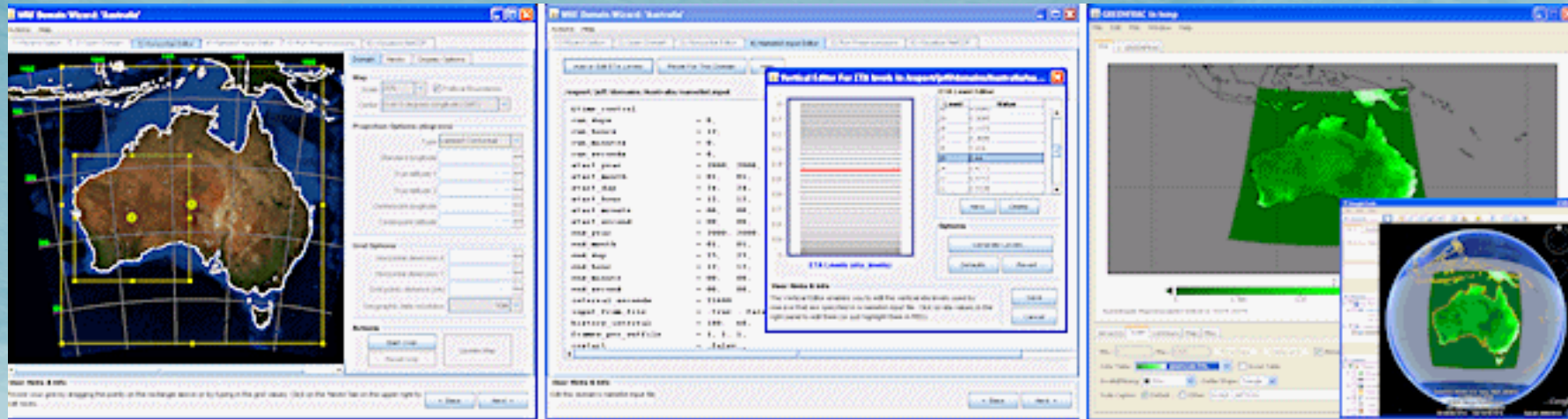
General Requirements:

- Input files needed:
 - Standard WRF-Noah/NoahMP LSM grids (geogrid.exe)
 - 'wrfinput' file for initial conditions (real.exe or utility script)
 - One new netcdf file containing high resolution gridded routing information ('routing grid')
 - Topography, flowdirection, channel network, observation points, watersheds, stream order, calibration parameters
 - 1-3 new ASCII parameter tables depending on activated options (e.g. lake model, baseflow model, reach routing model)

Inputs:

1. Geogrid/LSM grid:

a) LSM/geogrid data: Using WPS &/or Domain Wizard



b) Fields used by WRF-Hydro: soil type, vegetation type, lake mask, green vegetation fraction/LAI, lat/lon, lower soil temperature...(see IDV...)

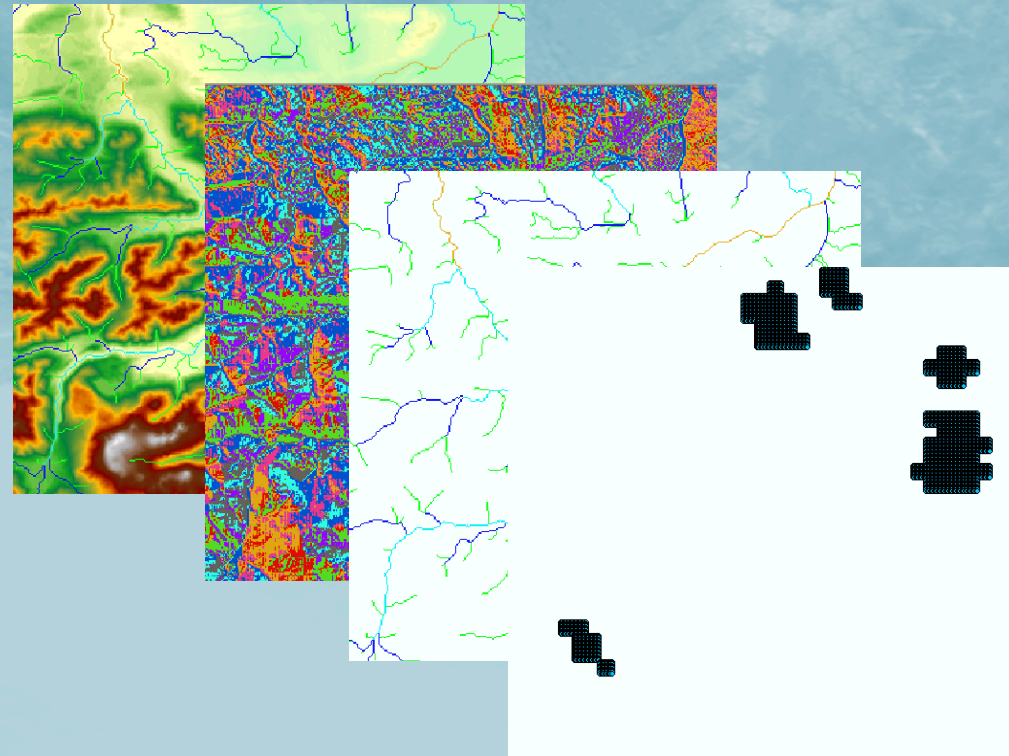
Inputs:

1. Routing Grid:

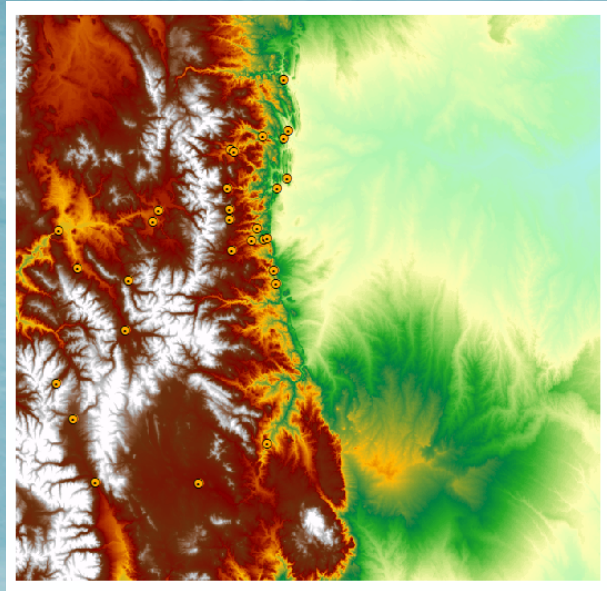
a) High-resolution terrain routing grids: These data are on a fine-resolution terrain grid ($\sim < 100\text{m}$) and are typically created within a GIS such as ArcGIS or manually... (with a little work)... details will be discussed this afternoon...

b) Necessary variables are:

- LATITUDE
- LONGITUDE
- TOPGRAPHY
- FLOWDIRECTION
- CHANNELGRID
- STREAMORDER
- LAKEGRID
- frxst_pts
- gw_basns
- calibration fields



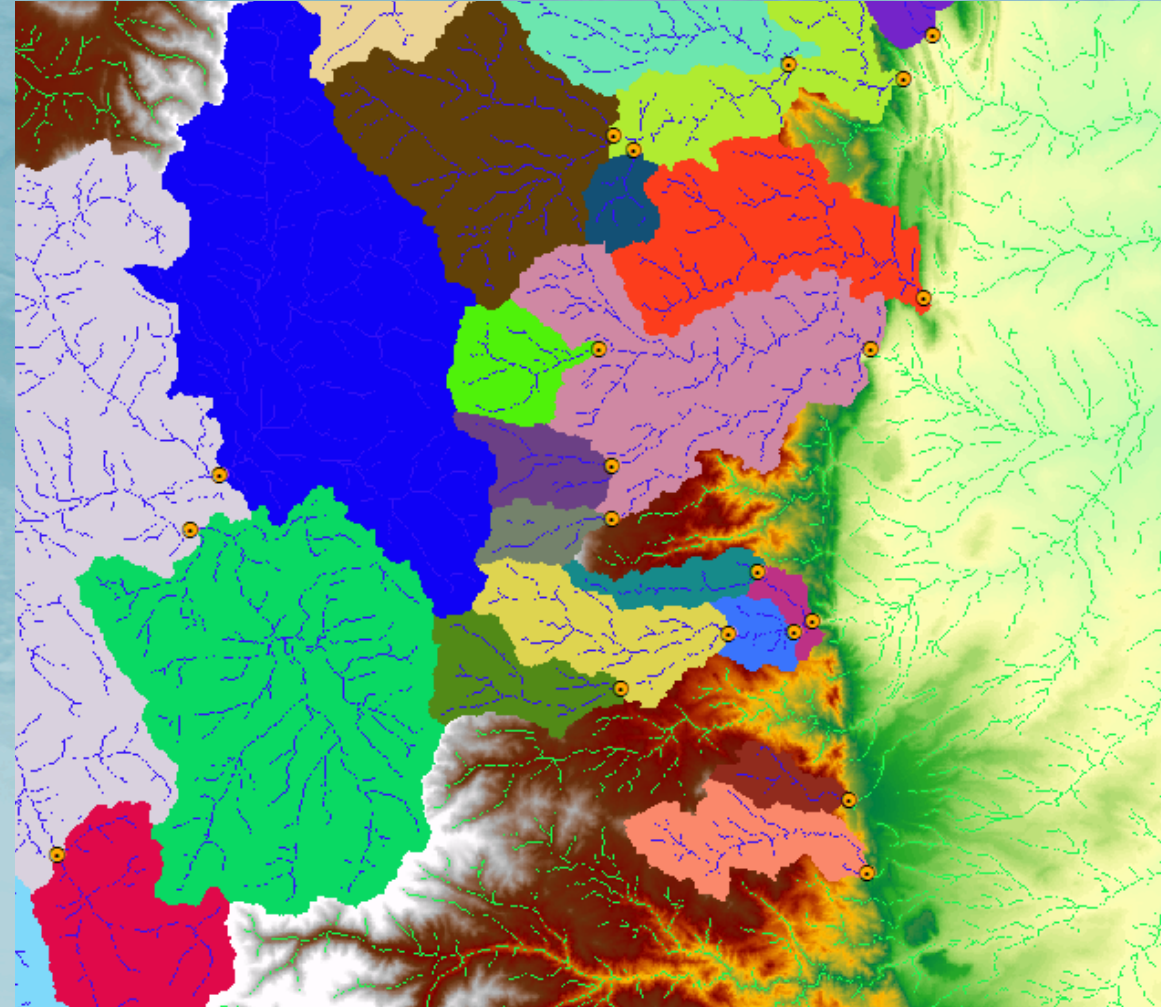
WRF-Hydro 'Hydro-Grid' ArcGIS: Tool Output



Import:
geogrid terrain



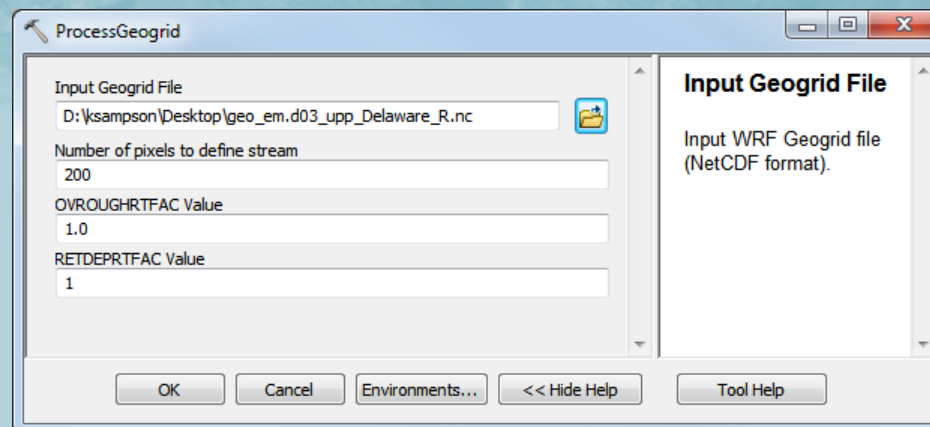
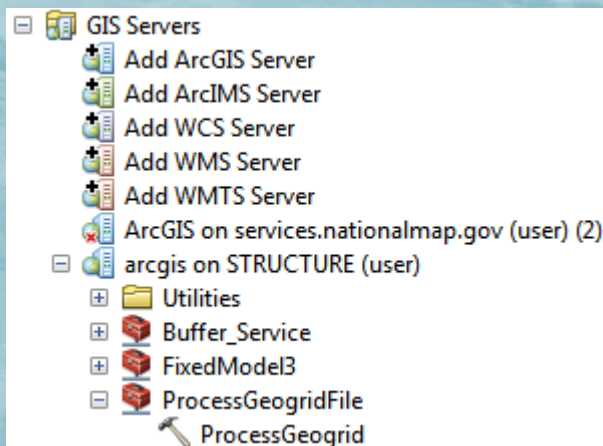
Create:
Hydrological
routing grids



WRF-Hydro 'Hydro-Grid' ArcGIS:

Tool Access: K. Sampson - developer

- Esri ArcCatalog or ArcMap applications
 - Add a user connection to the ArcGIS Server
 - Run the tool just like any other ArcGIS tool
 - Inputs:
 - WRF geogrid file (NetCDF format)
 - Additional parameters (defaults pre-set)



Tool Execution

ArcGIS Stand-alone Tool Dialog Box:

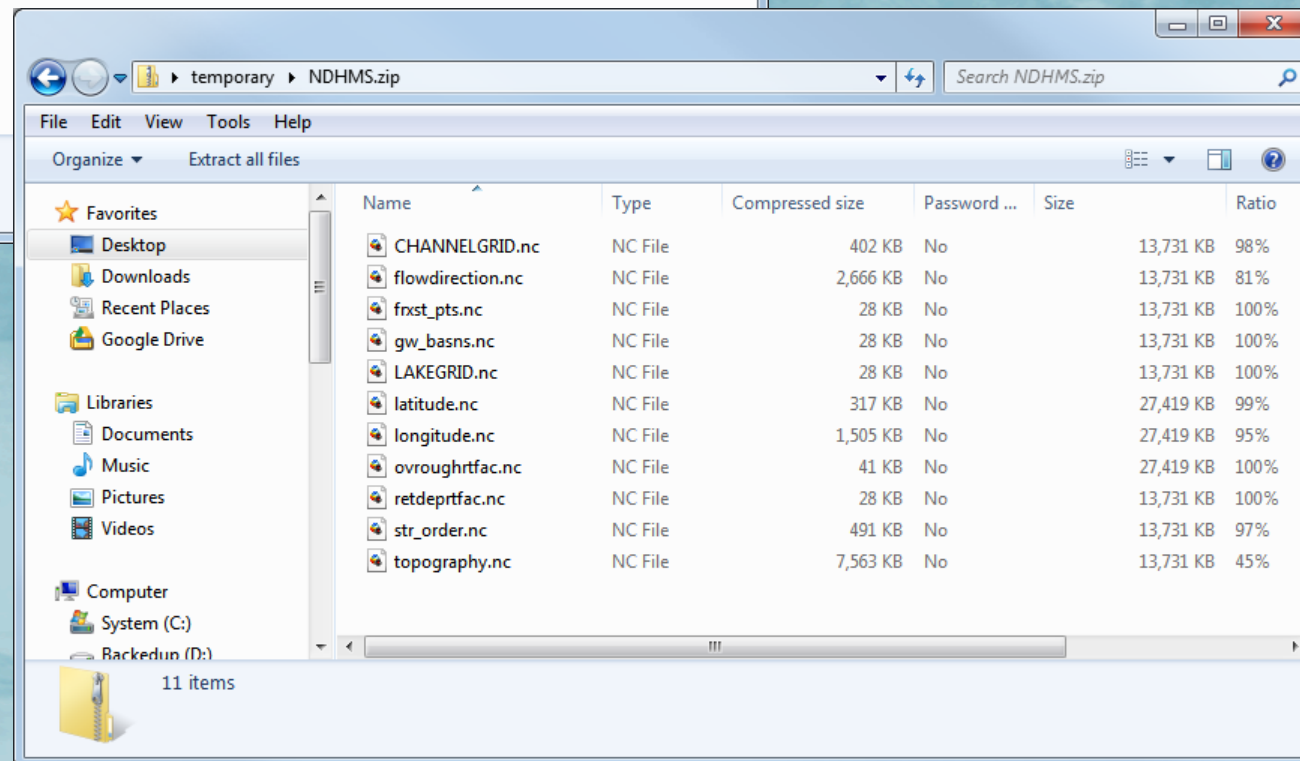
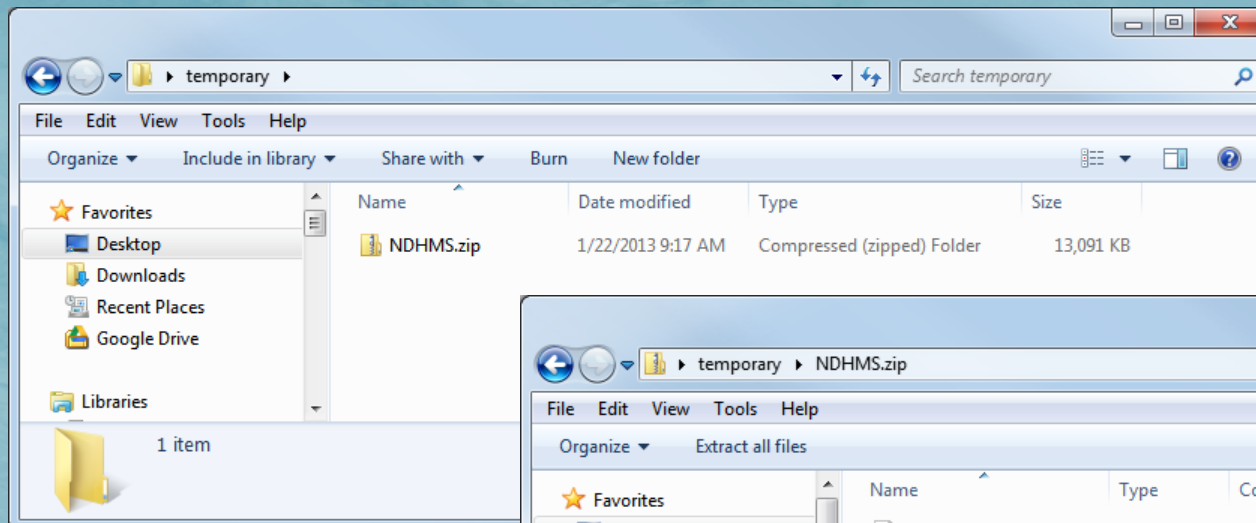
The screenshot shows a dialog box titled "ProcessGeogridFile" with a standard Windows window title bar (minimize, maximize, close). The dialog contains several input fields and options:

- Input Geogrid File:** A text input field with a folder icon to its right.
- Forecast Points (CSV) (optional):** A text input field with a folder icon to its right.
- Mask CHANNELGRID to basins? (optional)**
- Input Raster:** A text input field with a folder icon to its right.
- Regridding Factor:** A text input field containing the value "10" with a folder icon to its right.
- Number of pixels to define stream:** A text input field containing the value "200" with a folder icon to its right.
- Output ZIP File:** A text input field with a folder icon to its right.
- Parameter Values:** A section header with a downward-pointing arrow icon.

At the bottom of the dialog, there are four buttons: "OK", "Cancel", "Environments...", and "Show Help >>".

1-10 min.
to complete

WRF-Hydro 'Hydro-Grid' Web Service: Tool Output



WRF-Hydro 'Hydro-Grid' ArcGIS tool:

The screenshot shows a Mozilla Firefox browser window displaying the WRF-Hydro Modeling System website. The browser's address bar shows the URL "RAL || WRF-Hydro Modeling System". The website's navigation menu includes links for "RAL home", "research", "technology", "people/org", "publications", "events", "pressroom", and "for staff". The main content area features a header with "NCAR WRF-Hydro Modeling System | RAL" and a search bar. Below the header, a breadcrumb trail reads "You are here: NCAR • RAL • WRF-Hydro Modeling System". The page is organized into three columns. The left column contains a navigation menu with links for "Home", "Terms of Use", "Overview", "Downloads", "Documentation", "User Support", and "Related Links". The middle column, titled "WRF-Hydro Modeling System", contains a "Welcome" section with introductory text and a "Description" section detailing the system's design and capabilities. The right column contains sections for "Projects", "Current Projects", "Past Projects", "Recent Accomplishments and Plans", and "Sponsor". The "Current Projects" section lists several ongoing initiatives, including the Colorado Headwaters Water System Program, Flash Flood System, and North American Monsoon Experiment. The "Past Projects" section lists the CASES-97 and IHOP studies. The "Recent Accomplishments and Plans" section includes a link to the Annual Report. The "Sponsor" section indicates a need for a sponsor name. The browser's taskbar at the bottom shows the system time as 7:21 PM on 3/13/2013.

UCAR NCAR Find People Contact/Visit

RAL home research technology people/org publications events pressroom for staff

NCAR WRF-Hydro Modeling System | RAL

You are here: NCAR • RAL • WRF-Hydro Modeling System

Home **WRF-Hydro Modeling System** Projects

Terms of Use Welcome

Overview Welcome to the users page for the WRF-Hydro modeling system. The WRF-Hydro modeling system has been developed by the National Center for Atmospheric Research and its research partners through the generous support of the U.S. National Science Foundation and through research projects supported by the U.S. National Aeronautics and Space Administration (NASA) and the U.S. National Oceanic and Atmospheric Administration (NOAA).

Downloads

Documentation

User Support

Related Links

Description

The WRF-Hydro system was originally designed as a model coupling framework designed to facilitate easier coupling between the Weather Research and Forecasting model and components of terrestrial hydrological models. WRF-Hydro is both a stand-alone hydrological modeling architecture as well as a coupling architecture for coupling of hydrological models with atmospheric models. WRF-Hydro is fully-parallelized to enable its usage on clusters and high performance computing systems alike. Like the WRF model it does not attempt to prescribe a particular or singular suite of physics but, instead, is designed to be extensible to new hydrological parameterizations. Although it was originally designed to be used within the WRF model, it has evolved over time to possess many additional attributes as follows:

- Multi-scale functionality to permit modeling of atmospheric, land surface and hydrological processes on different spatial grids

HYDROMETEOROLOGICAL PROCESSES AT THE LAND SURFACE

Current Projects

Colorado Headwaters Water System Program
Flash Flood System ([view article](#))
North American Monsoon Experiment ([view article](#))
Climate Impacts on local water resource management tool: WEAP ([view article](#))

Past Projects

CASES-97 (Cooperative Atmosphere Surface Exchange Study)
IHOP (Soil Moisture, Soil Temperature, and Vegetation Observation Network)

Recent Accomplishments and Plans

Annual Report

Sponsor

Need Sponsor Name

7:21 PM
3/13/2013

Inputs: Model State Initialization

1. Initialization fields:

- Total soil moisture content, soil liquid water content
- Soil temperature
- Canopy water content

*For WRF-Hydro routing grids, either 'cold-start' or from restart files (groundwater level, surface water ponding, routing grid soil moisture...)

2. File creation options:

- a) wrfinput file...created from WRF real.exe OR simple 'user-specified' script (mandatory but values may be over-written by restart files)
- b) Restart files...created from previous runs of WRF and/or WRF-Hydro

Lakes and Reservoirs in WRF-Hydro

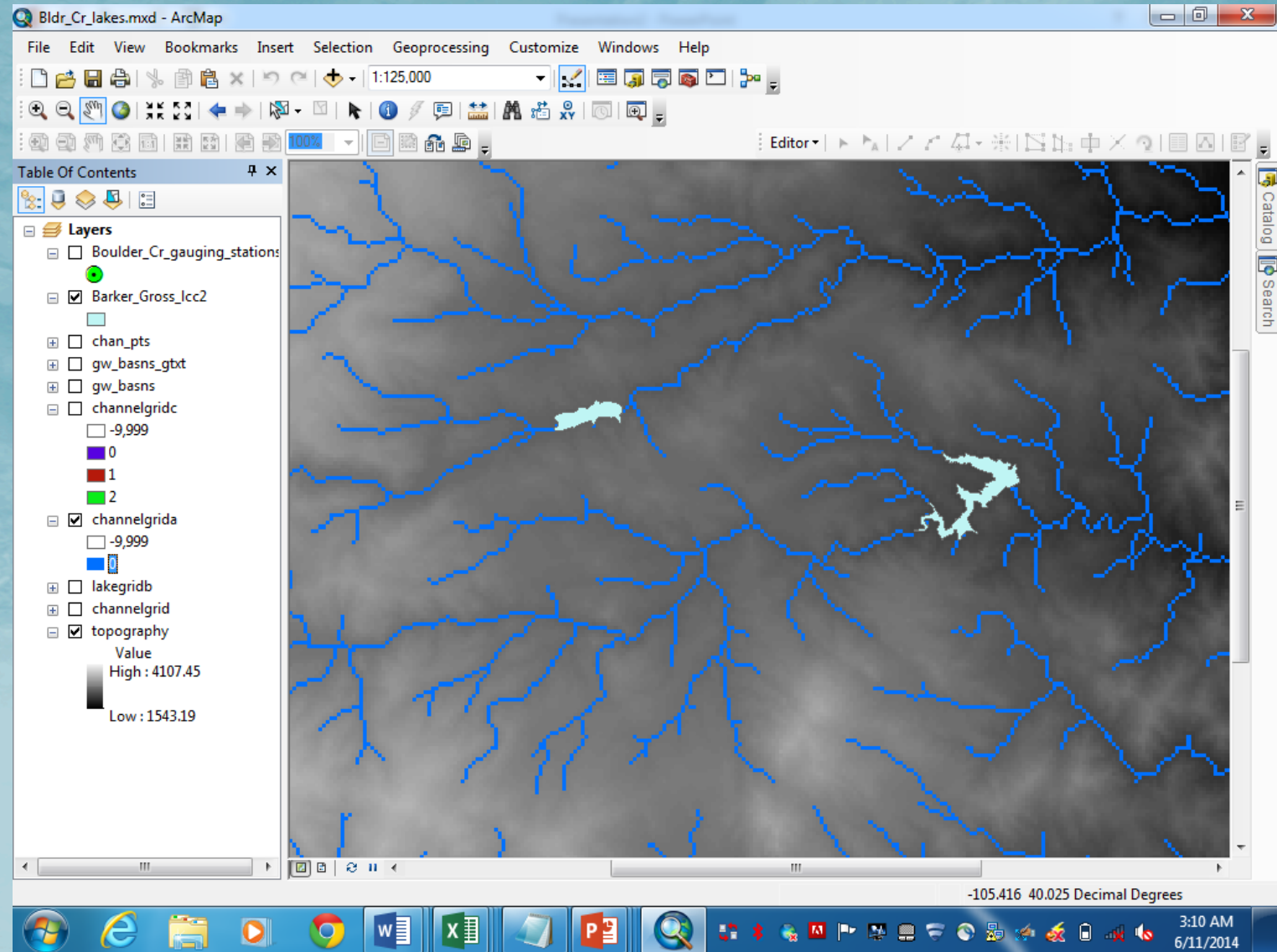
Outline: Implementing lakes and reservoirs in WRF-Hydro

- On-channel reservoirs
- Level-pool storage
- Multiple discharge modes
 - Orifice flow
 - Spillway flow
 - Rule curve
 - Mgt. Schedule

This procedure will help isolate problems which may otherwise be difficult and/or time-consuming to diagnose in many implementations:

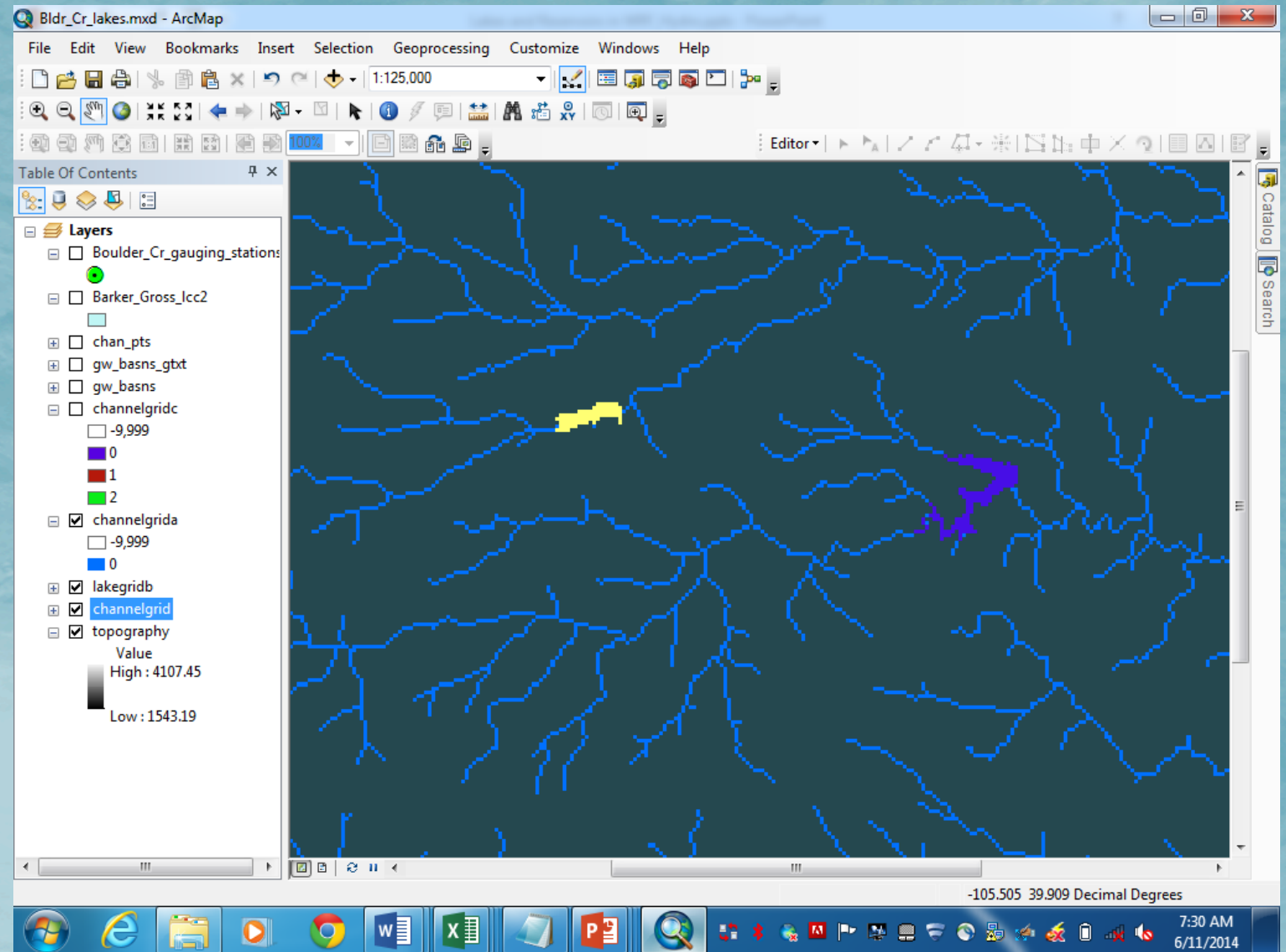
Implementing lakes and reservoirs in WRF-Hydro

1. After deriving channel network without reservoirs, overlay lake polygons on top of channel grid



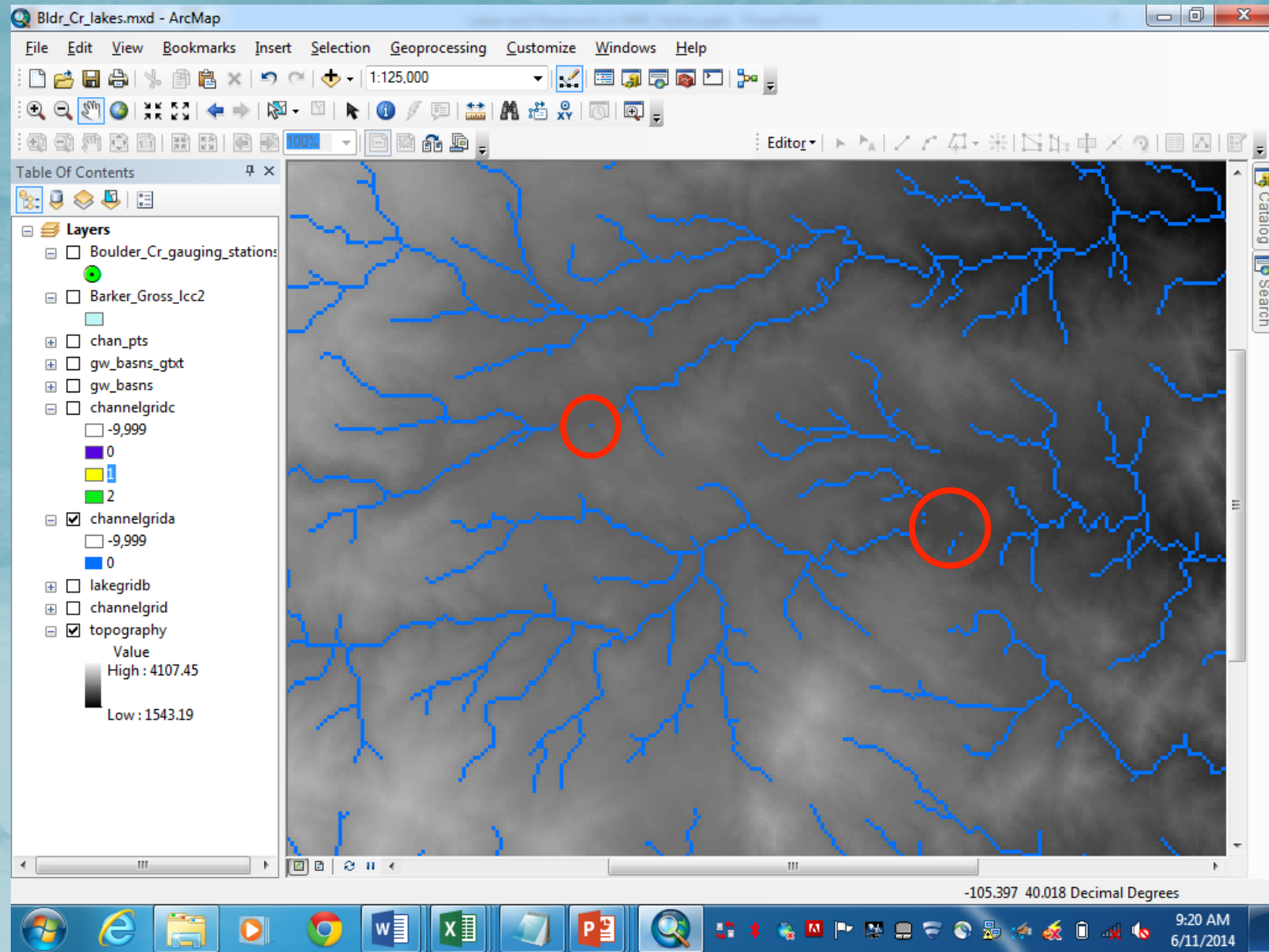
Implementing lakes and reservoirs in WRF-Hydro

1. Convert lake polygon into grid at the same resolution and projection as the channel grid



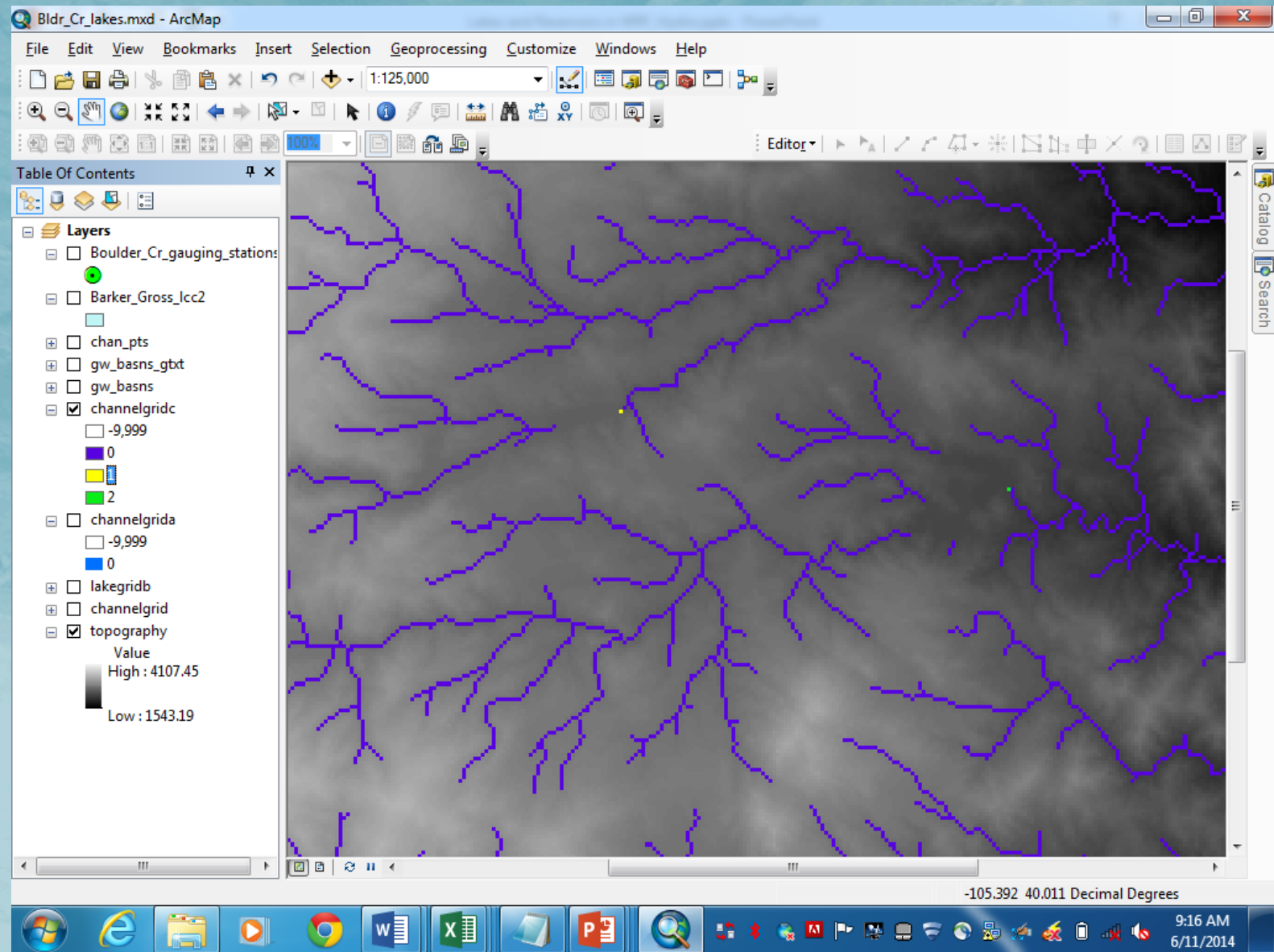
Implementing lakes and reservoirs in WRF-Hydro

1. Using lake grids as masks, then remove channel grid points 'underneath' lakes
2. If channel artifacts exist (see red circles), users will need to remove those by directing editing of grids or conversion to points



Implementing lakes and reservoirs in WRF-Hydro

1. Need to change value of selected channel grid elements to specify where reservoir discharge is input into channel
2. Channel grid at reservoir discharge location has same index value as reservoir



Implementing lakes and reservoirs in WRF-Hydro

1. Parameter Table (LAKEPARAM.TBL)

A7. Lake parameters table (LAKEPARAM.TBL)

LAKEPARAM.TBL

<u>lake</u>	<u>LkArea</u>	<u>LkMxH</u>	<u>WeirC</u>	<u>WeirL</u>	<u>OrificC</u>	<u>OrificeA</u>	<u>OrificeE</u>
	<u>lat</u>	<u>long</u>		<u>elevation</u>			
1	9.67	1752.1	0.4	12.1	0.1	1.0	1664.4
	40.5580	-105.1586		1752.1			
2	3.07	1530.8	0.4	3.8	0.1	1.0	1519.6
	40.4407	-105.0586		1530.8			
3	1.61	1537.7	0.4	2.0	0.1	1.0	1528.7
	40.4158	-105.0903		1537.7			
4	1.11	1554.6	0.4	1.4	0.1	1.0	1544.4
	40.3876	-105.1441		1554.6			
5	3.82	1785.1	0.4	4.8	0.1	1.0	1758.2
	40.3377	-105.2196		1785.1			
6	1.36	1569.5	0.4	1.7	0.1	1.0	1565.6
	40.3378	-105.1278		1569.5			
7	1.47	1571.1	0.4	1.8	0.1	1.0	1565.3
	40.3297	-105.1167		1571.1			

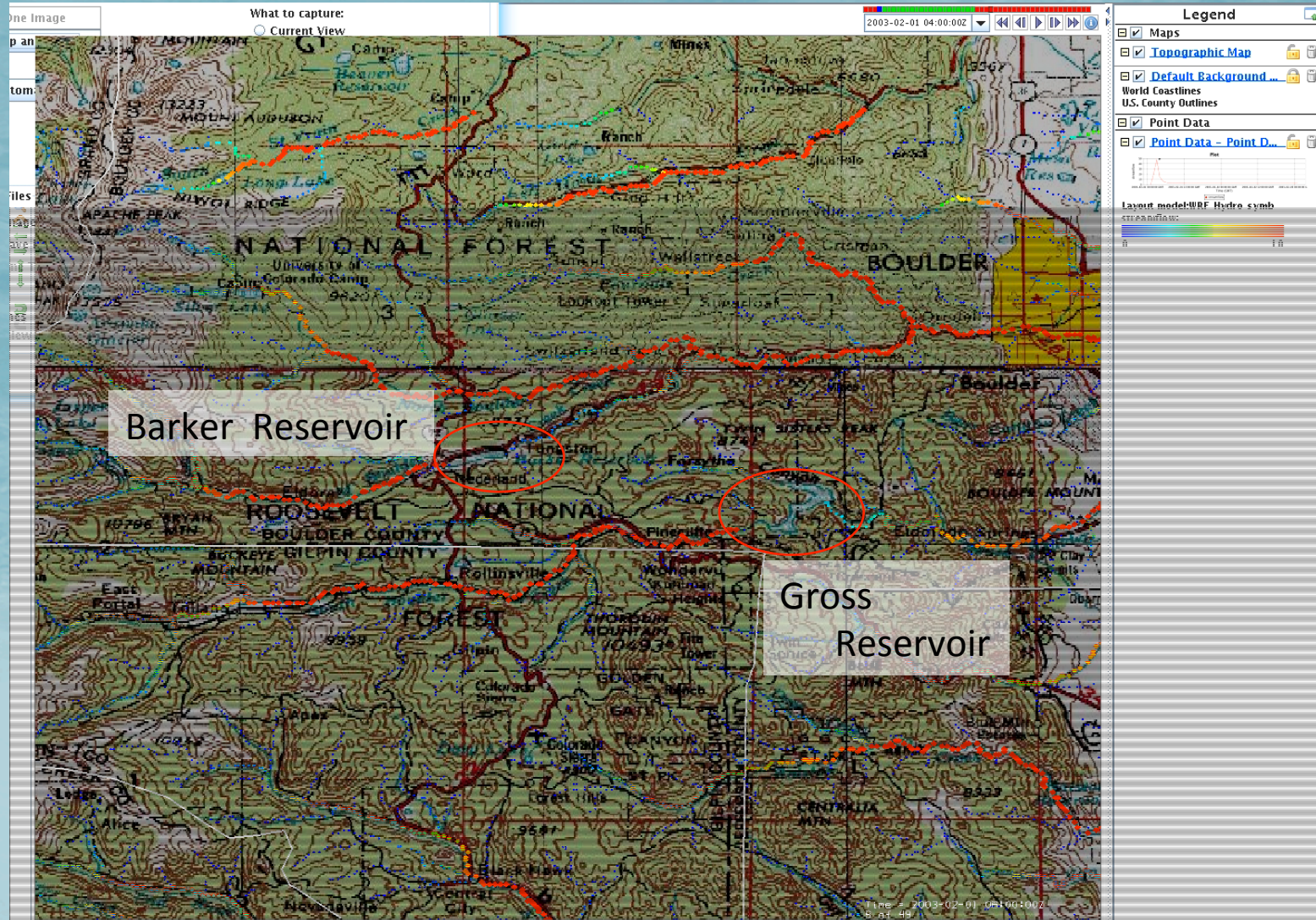
- this example assumes there are 7 lakes defined within the simulation domain (note column wrapping...)

PAGE 5 OF 15 27932 WORDS

9:35 AM 6/11/2014

Implementing lakes and reservoirs in WRF-Hydro

1. Visualization of lake impacts



WRF-Hydro Forcing Data:

Input Forcing Data Requirements:

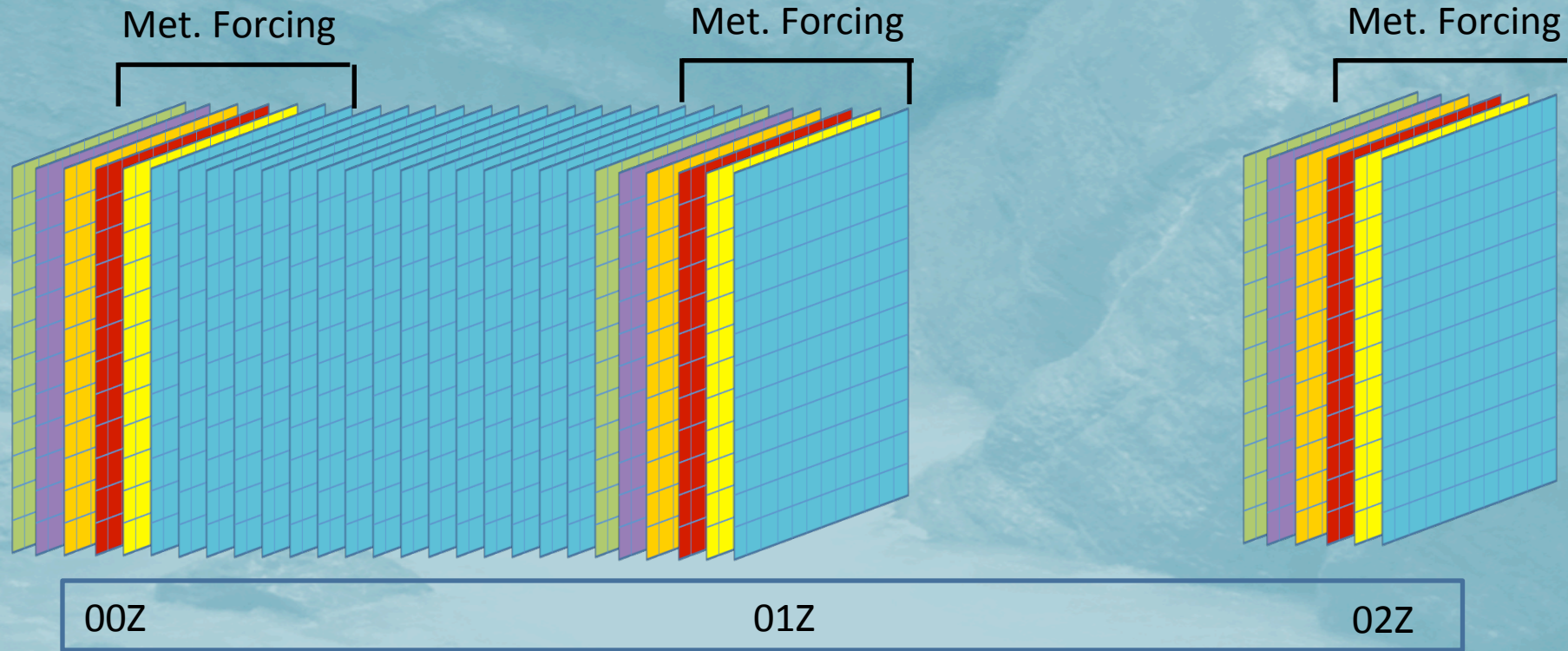
- Forcing Inputs:
 - Temperature (deg K), humidity-mixing ratio (kg/kg), short & longwave radiation (W/m^2), pressure (Pa), wind speed (m/s) and precipitation rate (mm/s)
 - Optional formats of forcing data:
 - Fully-coupled model
 - Existing wrf output files
 - Unified analysis (all met. variables together – Netcdf file, e.g. NLDAS-hourly)
 - Specified precipitation (Netcdf file , precipitation comes from alternate source, e.g. radar, satellite, gauge analysis)

ALL FORCING DATA IS MAPPED TO SAME GRID (based on WRF 'geogrid')

SPECIFIED PRECIPITATION MAY HAVE HIGHER TIME RESOLUTION (e.g. 5min)

Input Forcing Data Requirements:

- Data Requirements:
 - Forcing Input: Forecast Example...



Input Forcing Data Requirements:

- Data Pre-processing Options:
 - Several utilities for formatting and creating ‘forcing’ data:
 - Using netcdf as the underlying data model...
 - One file per forcing input time...
 - Direct use or simple regrid of existing wrf output
 - ESMF/ncl scripts for conservative regridding of data between structured or unstructured grids, ASCII-netcdf formats, etc.
 - nco-based shell scripts to change variable names, threshold units, re-order grids, etc
 - HRLDAS tools for preparing forcing with topographic adjustment

* BEST PRACTICE: Use as high of time-resolution forcing data as possible! (particularly rainfall)

Input Forcing Data Requirements:

- netcdf forcing input file header...(see documentation Appendix A11)

A11. Forcing data netcdf file header

```
netcdf\201111040900 {  
  dimensions:  
    Time = UNLIMITED; // (1 currently)  
    south_north = 475;  
    west_east = 475;  
  variables:  
    float Q2D(Time, south_north, west_east);  
      Q2D:FieldType = 104;  
      Q2D:MemoryOrder = "XY";  
      Q2D:description = "QV at 2 M";  
      Q2D:units = "kg kg-1";  
      Q2D:stagger = "";  
      Q2D:coordinates = "XLONG XLAT";  
    float T2D(Time, south_north, west_east);  
      T2D:FieldType = 104;  
      T2D:MemoryOrder = "XY";  
      T2D:description = "TEMP at 2 M";  
      T2D:units = "K";  
      T2D:stagger = "";  
      T2D:coordinates = "XLONG XLAT";  
    float SWDOWN(Time, south_north, west_east);  
      SWDOWN:FieldType = 104;  
      SWDOWN:MemoryOrder = "XY";  
      SWDOWN:description = "DOWNWARD SHORT WAVE FLUX AT  
GROUND SURFACE";  
      SWDOWN:units = "W m-2";  
      SWDOWN:stagger = "";  
      SWDOWN:coordinates = "XLONG XLAT";  
    float LWDOWN(Time, south_north, west_east);
```