Interactive Python Widget for Correcting WRF-Hydro Input Grids

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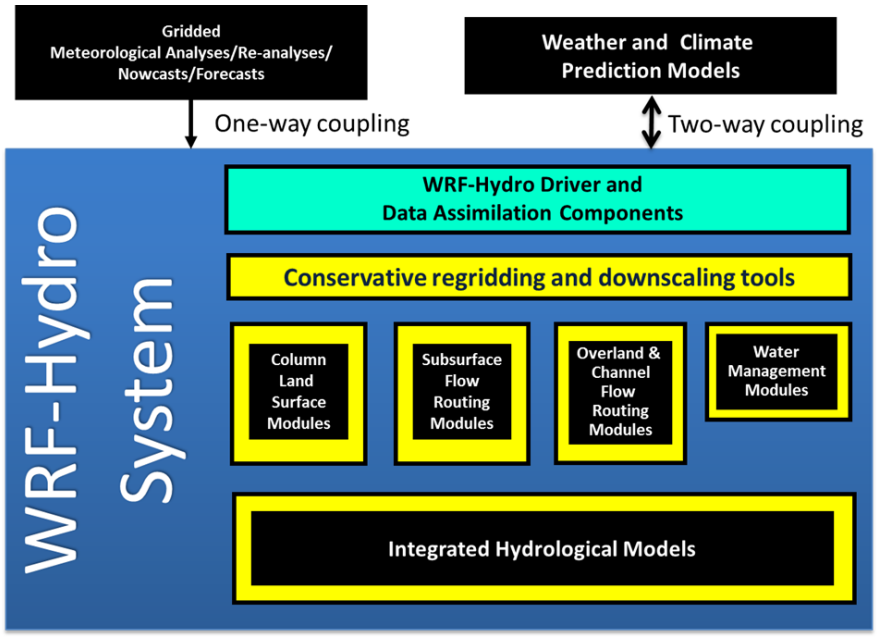
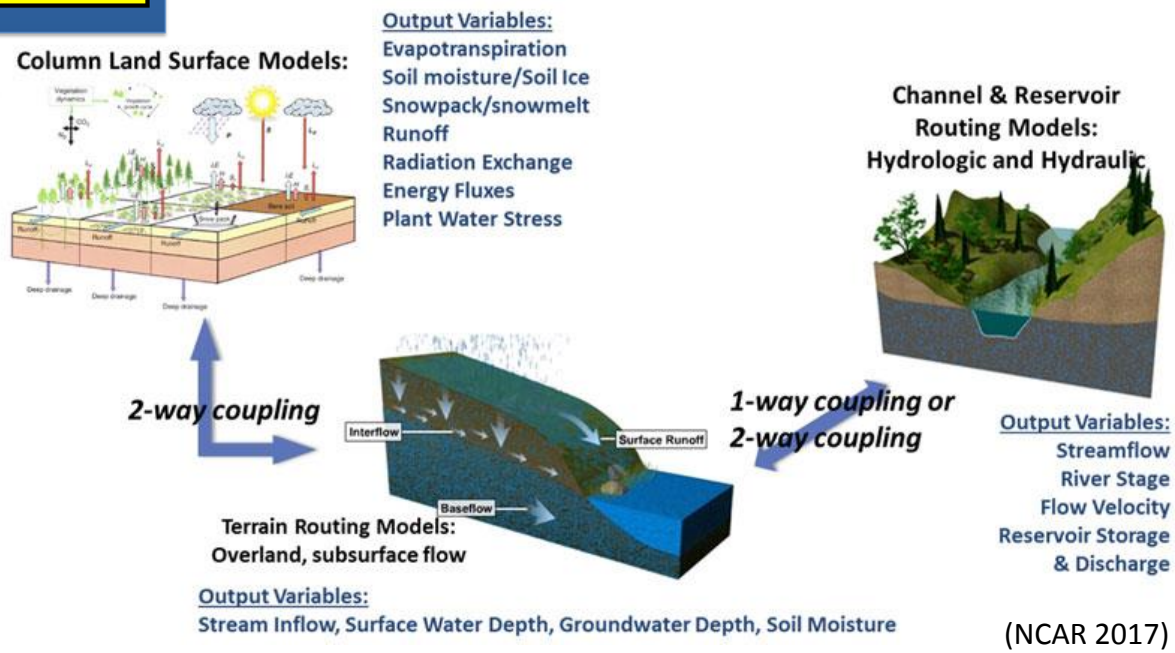
WRF-Hydro System



(NCAR 2017)

- Weather Research and Forecasting (WRF) model hydrological extension package (WRF-Hydro; Gochis et al. 2013)
- Extensible, high-resolution hydrologic routing and streamflow modeling framework
- Can be uncoupled or coupled with WRF
- Contains column land surface, terrain routing, and channel routing modules
- Supports multi-scale domains (each module at different spatial resolutions)

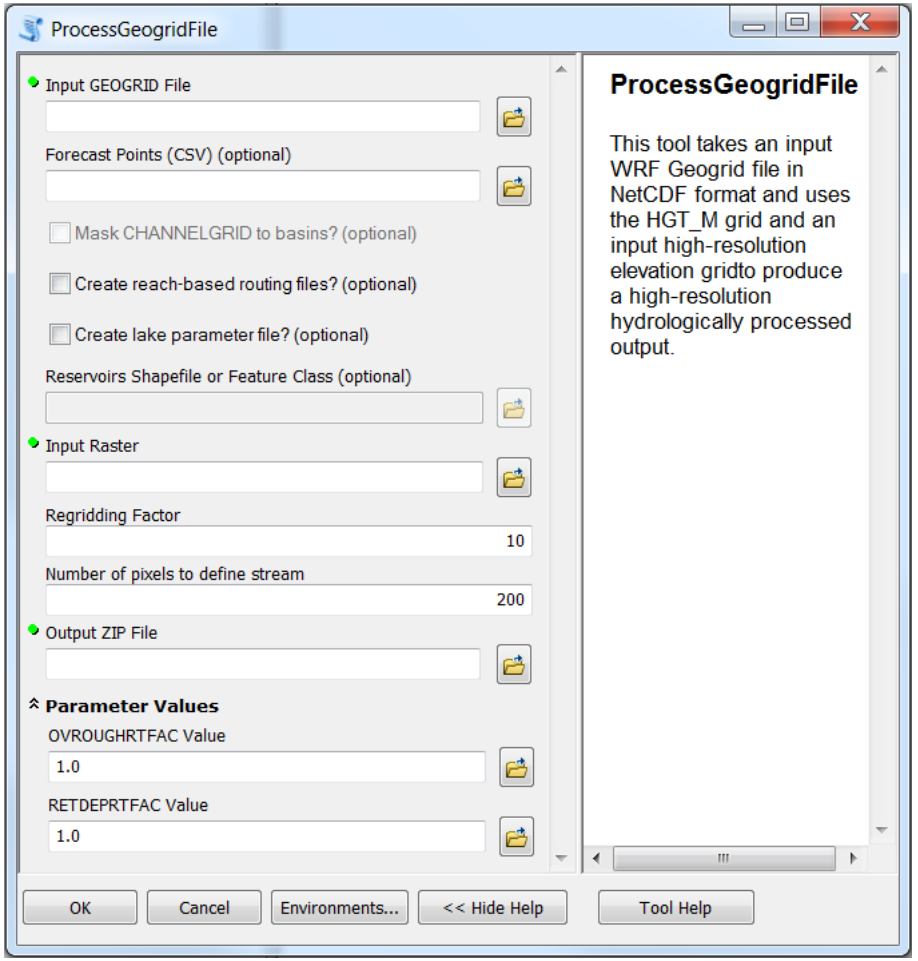
- National Water Model (NWM; Office of Water Prediction 2017) runs instantiation of WRF-Hydro operationally



(NCAR 2017)

WRF-Hydro GIS Preprocessing Tool

- Derives WRF-Hydro terrain routing and channel routing grids using ArcGIS hydrology tools
- Channel routing grids include channel grid and lake grid.
- Inputs:
  - WRF Preprocessing System (WPS) GEOGRID file
  - High-resolution Digital Elevation Model (DEM)
- NCAR working to make tool 100% open-source Python
- Preprocessing Tool Documentation: Sampson and Gochis 2015



Screen capture of WRF-Hydro GIS Preprocessing Tool within ArcGIS

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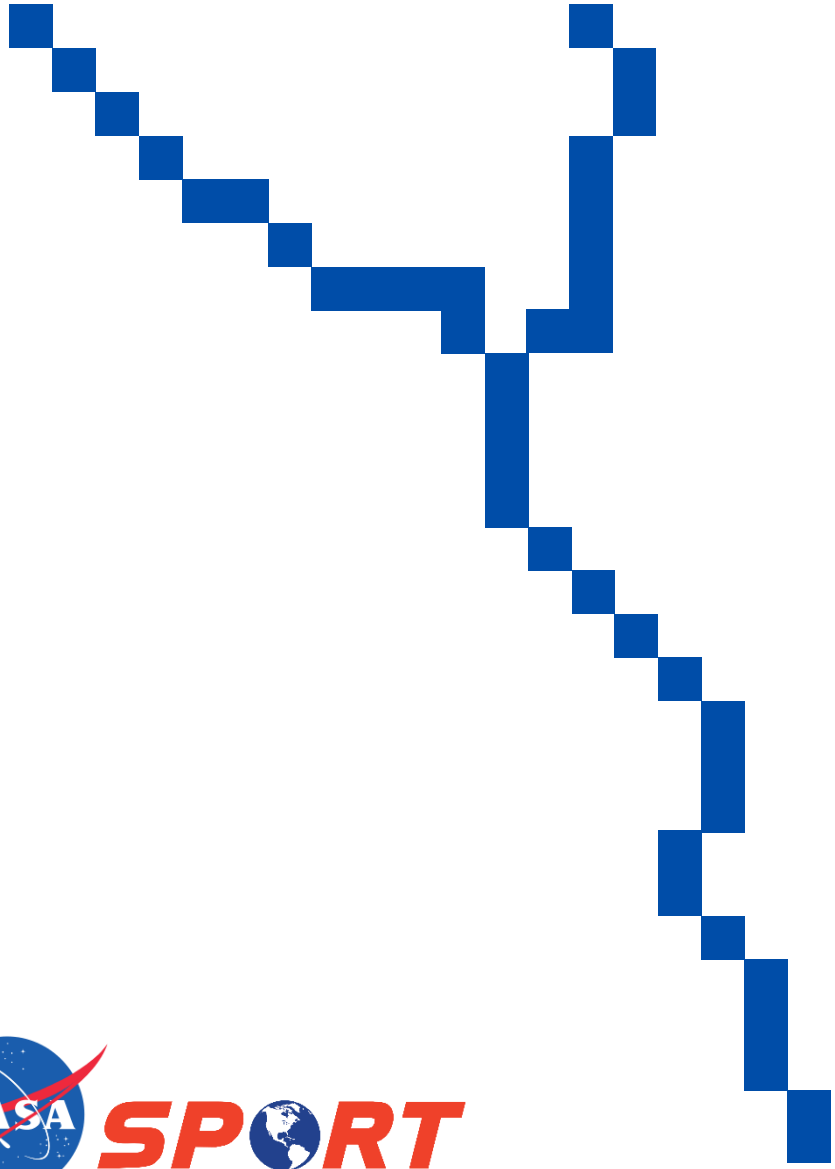
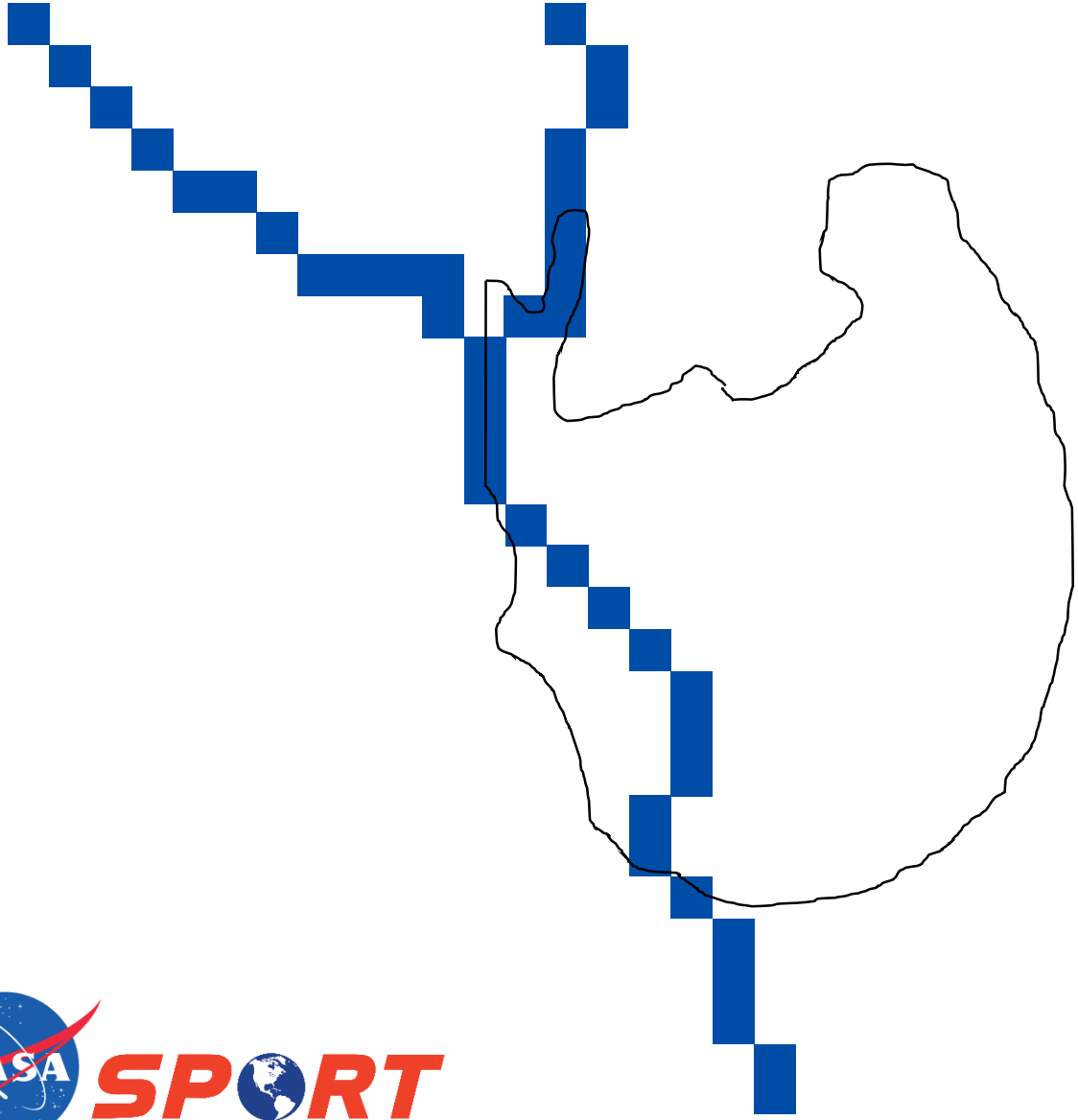
WRF-Hydro GIS Preprocessing Tool



- Channel grid derived from high-resolution DEM

(Sampson and Gochis 2015)

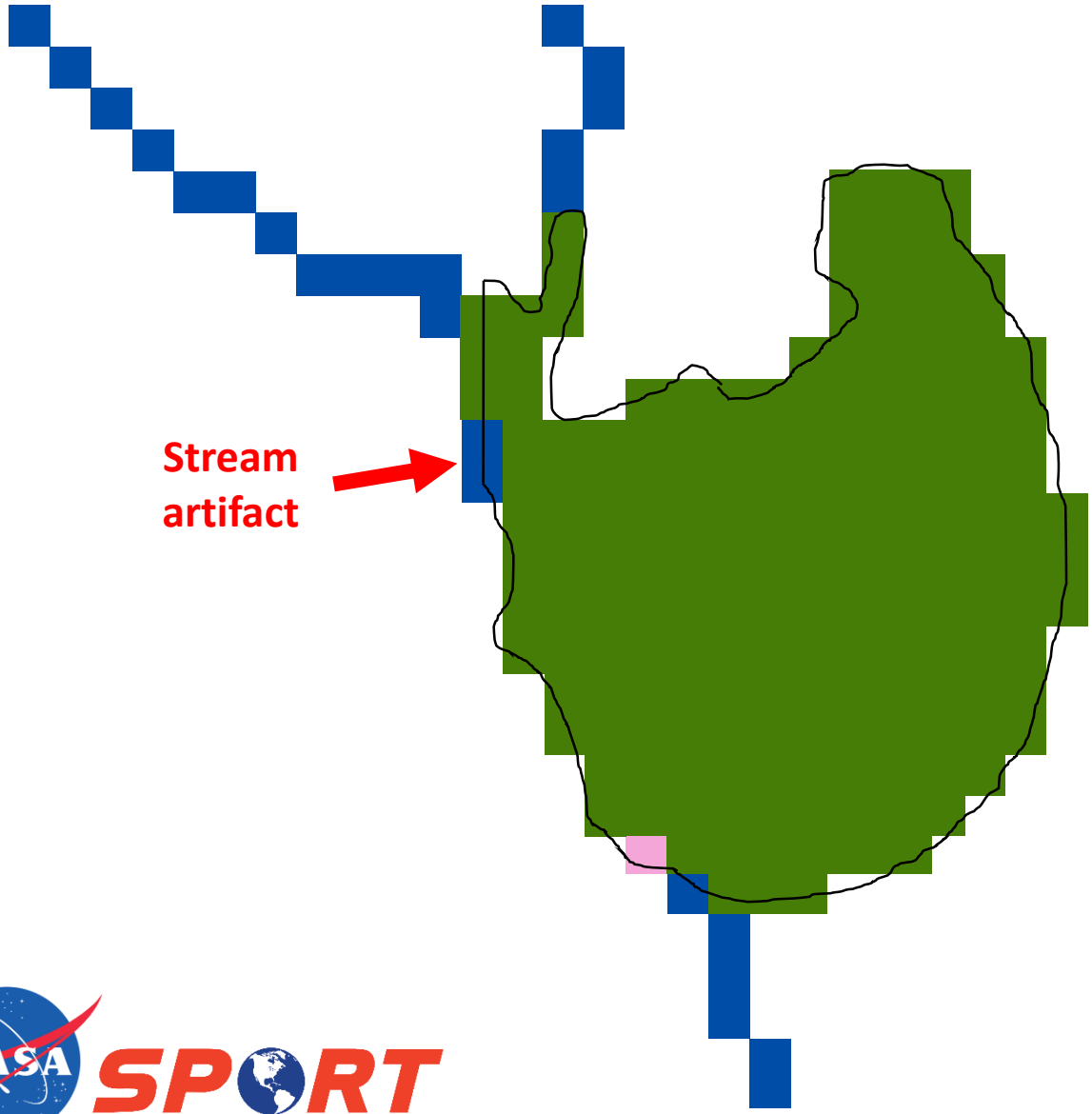
WRF-Hydro GIS Preprocessing Tool



- Channel grid derived from high-resolution DEM
- Insert reservoirs/lakes using lake shapefile

(Sampson and Gochis 2015)

WRF-Hydro GIS Preprocessing Tool

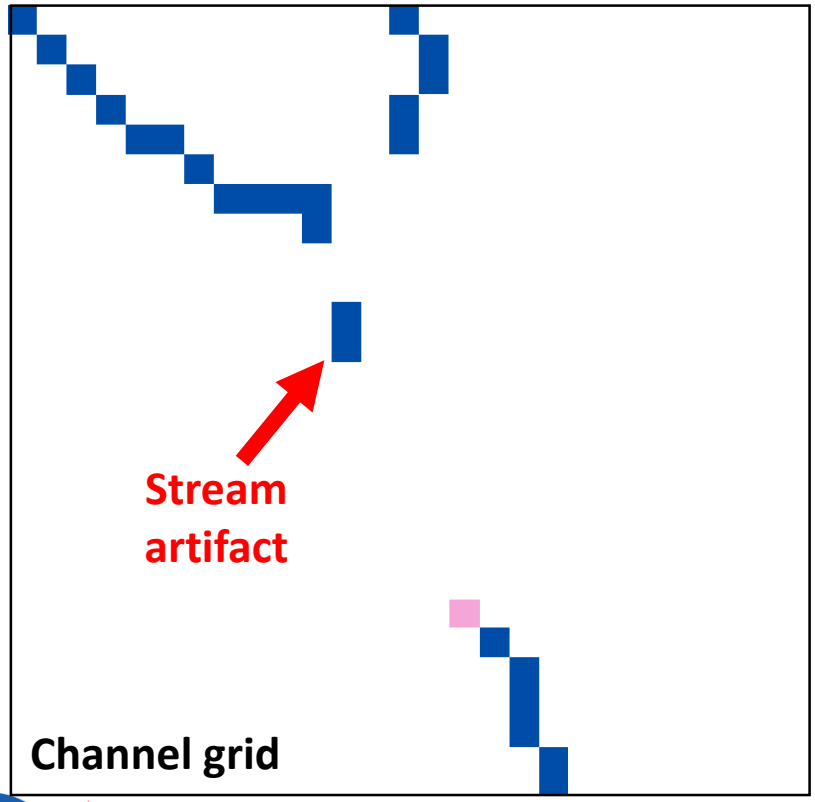


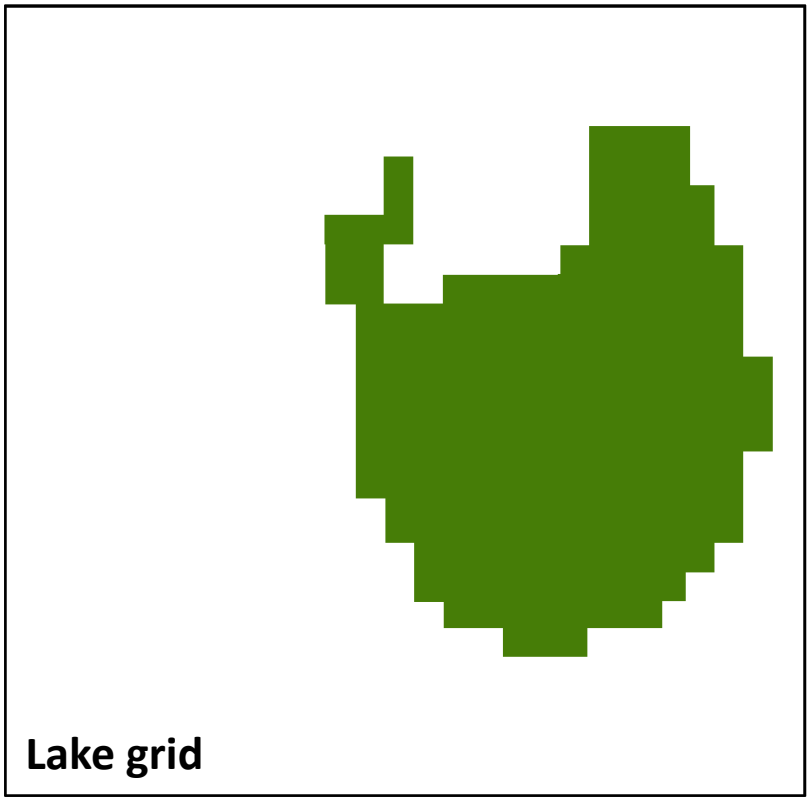
- Channel grid derived from high-resolution DEM
- Insert reservoirs/lakes using lake shapefile
- Lake polygon rasterized to mask channel grid
- Lakes numbered 1 to n
- Stream artifacts may result

(Sampson and Gochis 2015)

WRF-Hydro GIS Preprocessing Tool

- Preprocessing Tool does not remove stream artifacts
- Stream artifacts must be removed prior to running WRF-Hydro
  - Straightforward, programmatic method not available
  - Can be done interactively in Python using TkInter module





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TkInter – A Python Graphical User Interface

- Provides basic Graphical User Interface (GUI) within Python
- Contains classes which allow display, positioning, and control of widgets
- Wrapper functions for Tcl/Tk
- Importing TkInter

```
import sys
if sys.version_info[0] < 3:
    from Tkinter import *
else:
    from tkinter import *
```

- Online documentation and resources:
  - https://wiki.python.org/moin/TkInter
  - http://tkinter.unpythonic.net/wiki/
  - http://infohost.nmt.edu/tcc/help/pubs/tkinter/tkinter.pdf

TkInter Widgets

Button
Canvas
Checkbutton
Entry
Frame
Label
LabelFrame
Listbox
OptionMenu
PanedWindow
Radiobutton
Scale
Scrollbar
Spinbox
Text
Tk
Toplevel

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*Spyder 2.3.8, Python 2.7, TkInter 8.5

Applying TkInter – Interactive Python Widget

```
from Tkinter import *
class Tool(object):
    def _save(self):
        :
    def _quit(self, *kwargs):
        :
    def plot_subset(self, *kwargs):
        :
    def key(self, event):
        :
    def click(self, event):
        :
    def __init__(self, master, path,
        :

def main(path, *kwargs):
    root = Tk()
    tool = Tool(root, path, *kwargs)
    root.mainloop()

if __name__ == '__main__':
    #define parameters here
    path = "......."
    main(path, *kwargs)
```

```
def __init__(self, master, path, *kwargs):
    self.master = master
    #set up figure
    self.fig = mplfig.Figure()
    self.ax2 = self.fig.add_subplot(121)
    self.ax1 = self.fig.add_subplot(122)
    self.canvas = FigureCanvasTkAgg( \
        self.fig, master=self.master)

    #define event connections
    self.cid = self.canvas.mpl_connect( \
        'button_press_event', self.click)
    self.kid = self.canvas.mpl_connect( \
        'key_press_event', self.key)
    quit_but = Button(master=self.master, \
        text='Quit', command=self._quit)
    quit_but.pack(side=BOTTOM)

    #add event connections to canvas
    self.canvas.get_tk_widget().pack()

    #read WRF-Hydro input netCDF files here
    self.plot_subset(*kwargs)
```

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*Spyder 2.3.8, Python 2.7, TkInter 8.5

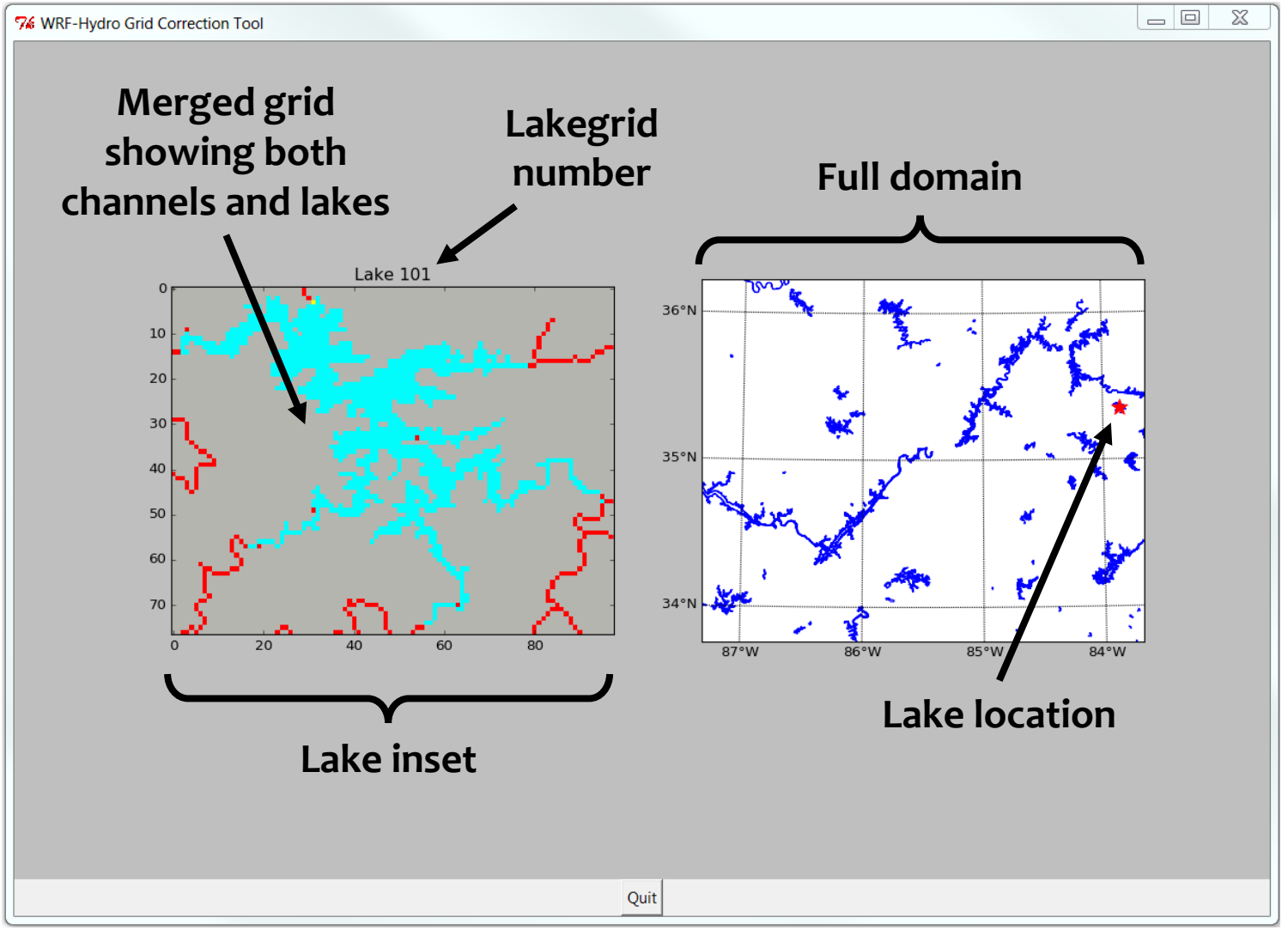
Interactive Python Widget

Lake

Channel

Node / outlet

Land



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    root.mainloop()

if __name__ == '__main__':
    #define parameters here
    path = "......."
    main(path, *kwargs)
```

```
def _quit(self, *kwargs):
  self._save()
  #disconnect event connections
  self.fig.canvas.mpl_disconnect(self.cid)
  self.fig.canvas.mpl_disconnect(self.kid)
  self.master.quit()     # stops mainloop
  self.master.destroy()  # this is necessary
  return
```

```
def key(self, event):
  if event.key == 'q': # quit
      self._quit()
  elif event.key == 's': # save
      self._save()
  elif event.key == 'up' or event.key == 'down' \
      or event.key == 'left' \
      or event.key == 'right' : # pan
      :
  elif event.key == 'z': # zoom
      :
  else: print 'The %s key does nothing...' \
      %repr(event.key)
  return
```

```
def click(self, event):
  if event.button == 1: # left click
      print event.xdata, event.ydata
      :
  elif event.button == 2: # right click
      :
  else: print 'Try Again...'
  return
```

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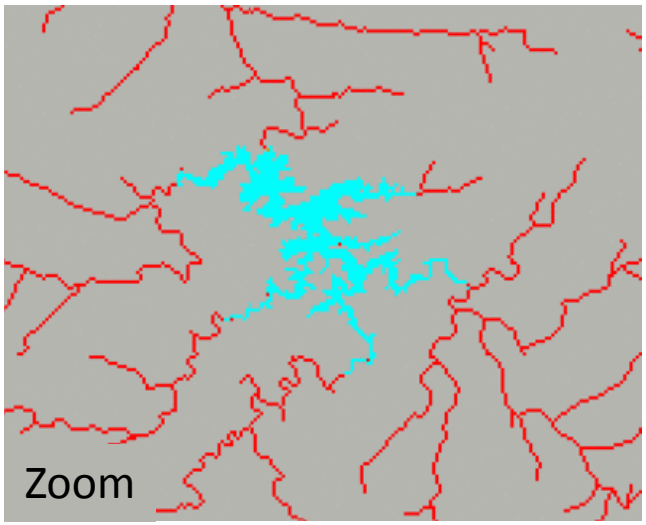
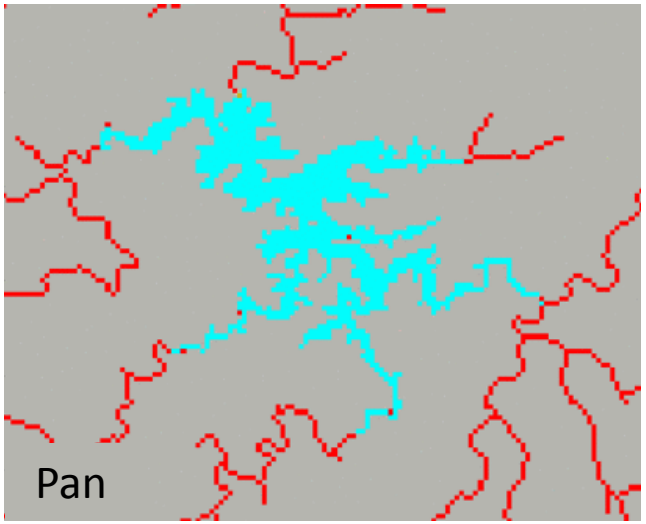
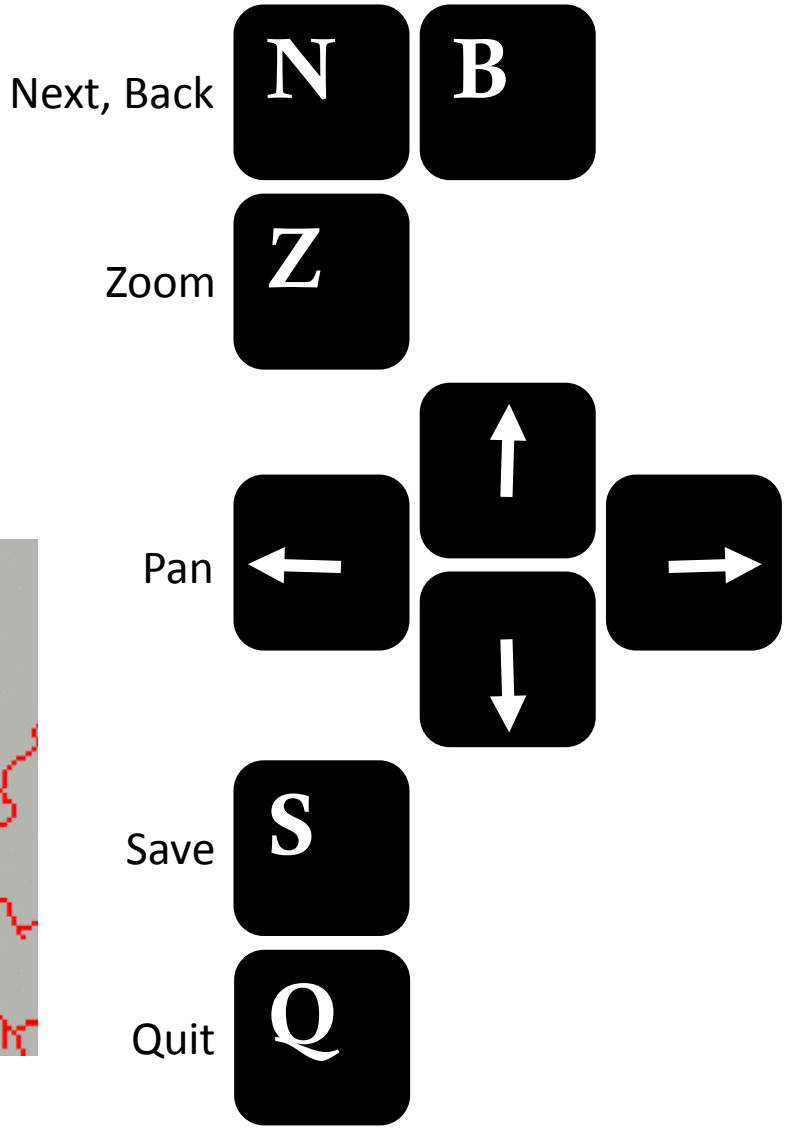
Interactive Python Widget







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Interactive Python Widget

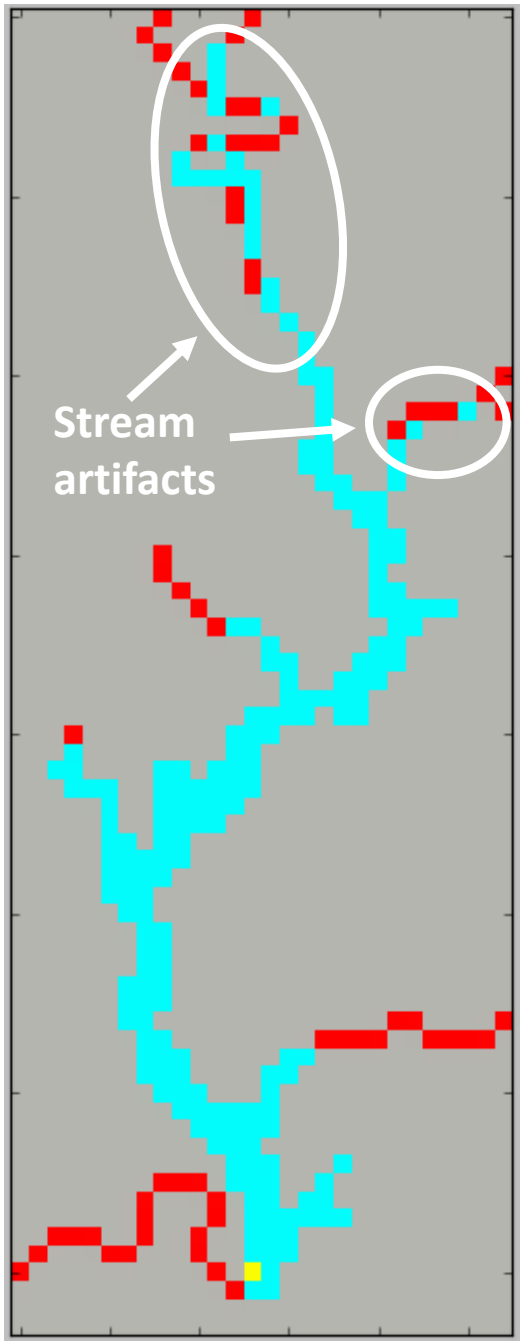
Lake

Channel

Node / outlet

Land

Lake Catoma, Ala. (Google Maps)



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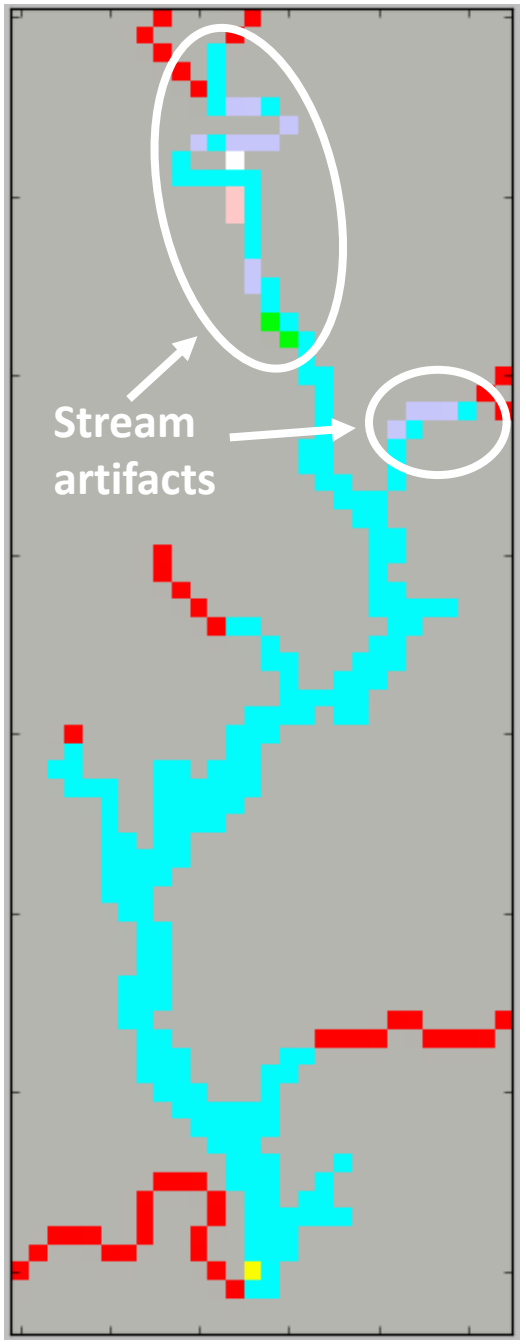
Interactive Python Widget

- Lake
- Channel
- Node / outlet
- Land
- Channel → Lake
- Channel → Land
- Lake → Land
- Land → Lake

Lake Catoma, Ala. (Google Maps)



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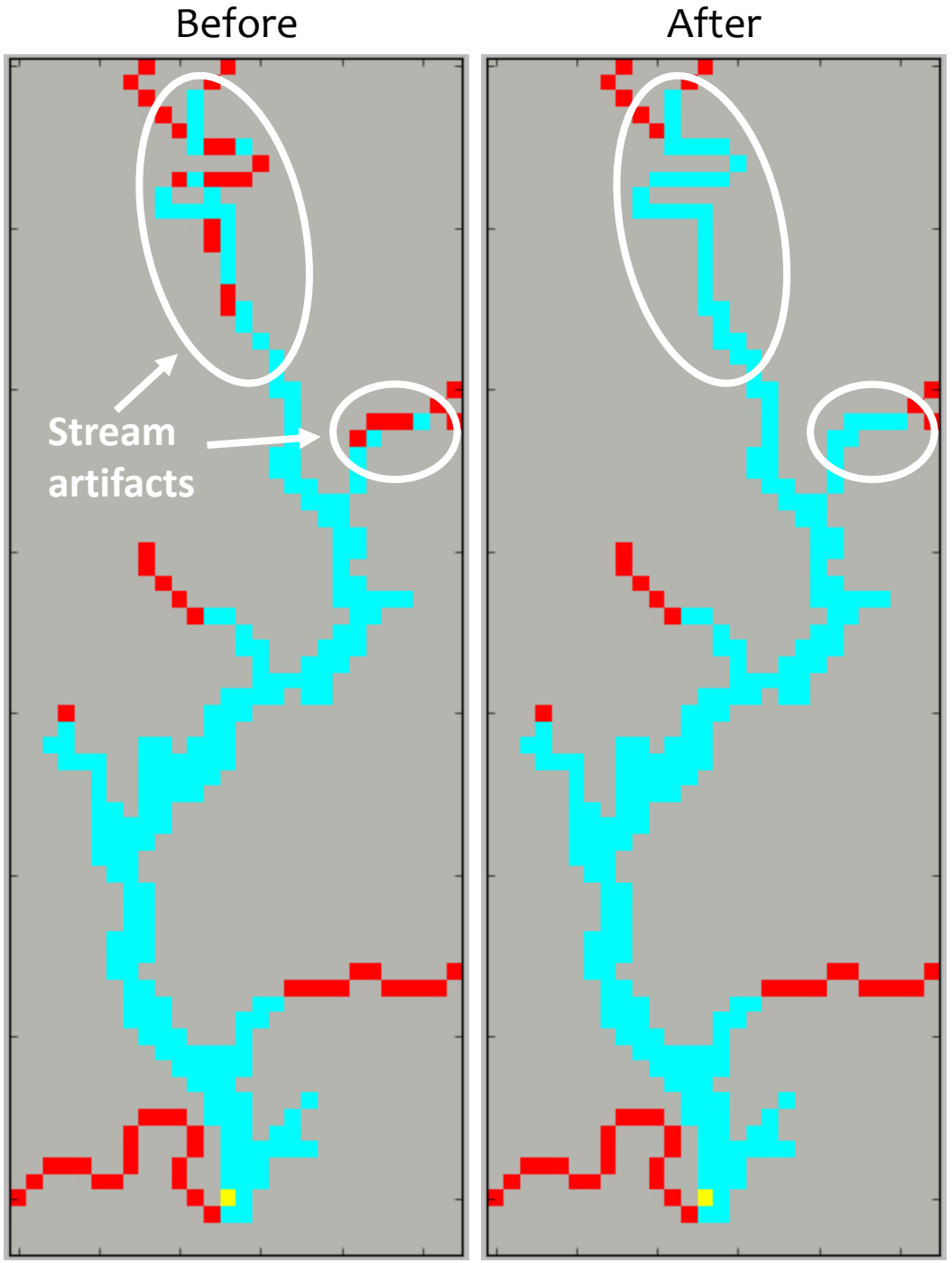
Interactive Python Widget

- Stream artifacts removed, resulting in continuous channel/lake grid
- Widget saves updated channel and lake grids for use in WRF-Hydro
- Process only takes a few minutes



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Summary

- TkInter is standard Python GUI package
- For many applications requiring array manipulations, programmatic methods using Python or netCDF operators (NCO) are preferred
- However, TkInter widgets can be beneficial when straightforward, programmatic methods are not available, thereby requiring manual modifications
- Interactive Python Widget
  - Modifies grids created by WRF-Hydro GIS Preprocessing Tool
  - Independent of ArcGIS; 100% open-source Python
  - Enables array to be visualized and modified concurrently
  - Can be extended/modified for many other applications

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Webpage: http://weather.msfc.nasa.gov/sport/

Blog: https://nasasport.wordpress.com/

Facebook: NASA SPoRT Center

Twitter: @NASA_SPoRT

References

Gochis, D., W. Yu, and D. Yates, 2013: The NCAR WRF-Hydro technical description and user's guide: version 1.0, 120 pp., http://www.ral.ucar.edu/projects/wrf_hydro/images/ WRF_Hydro_Technical_Description_and%20User_Guide_v1.0.pdf.

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