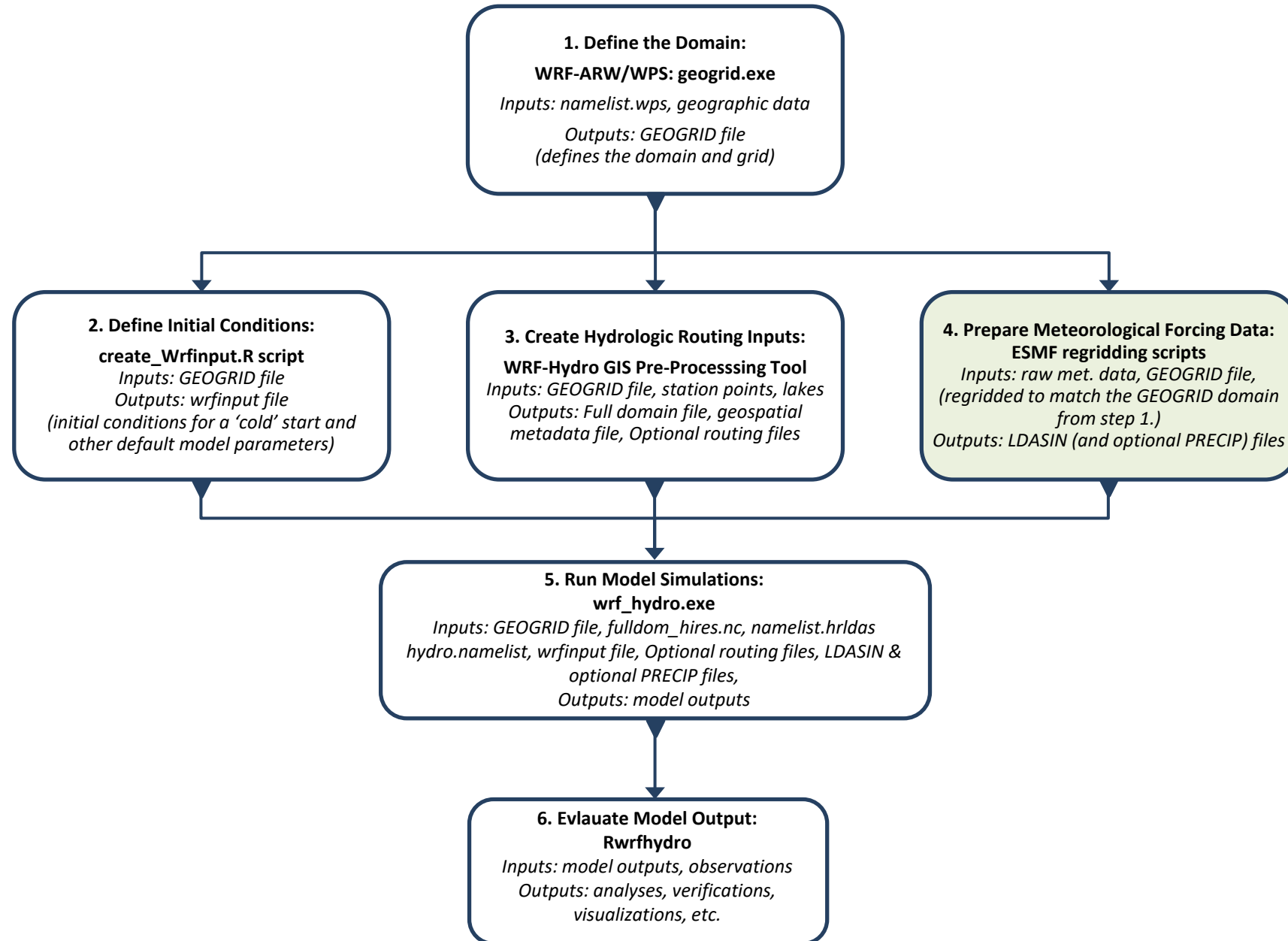# WRF-Hydro Forcing Engine Overview

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WRF-Hydro Workflow

1. Define the Domain:

WRF-ARW/WPS: geogrid.exe

Inputs: namelist.wps, geographic data

*Outputs: GEOGRID file
(defines the domain and grid)*

2. Define Initial Conditions:

create_Wrfinput.R script
*Inputs: GEOGRID file
Outputs: wrfinput file
(initial conditions for a 'cold' start and
other default model parameters)*

3. Create Hydrologic Routing Inputs:

WRF-Hydro GIS Pre-Processsing Tool
*Inputs: GEOGRID file, station points, lakes
Outputs: Full domain file, geospatial
metadata file, Optional routing files*

4. Prepare Meteorological Forcing Data:
ESMF regridding scripts
*Inputs: raw met. data, GEOGRID file,
(regridded to match the GEOGRID domain
from step 1.)
Outputs: LDASIN (and optional PRECIP) files*

5. Run Model Simulations:
wrf_hydro.exe
*Inputs: GEOGRID file, fulldom_hires.nc, namelist.hrldas
hydro.namelist, wrfinput file, Optional routing files, LDASIN &
optional PRECIP files,
Outputs: model outputs*

6. Evlauate Model Output:
Rwrfhydro
*Inputs: model outputs, observations
Outputs: analyses, verifications,
visualizations, etc.*

Input Forcing Data Requirements

Variable name	Description	Units
SWDOWN	Incoming shortwave radiation	W/m^2
LWDOWN	Incoming longwave radiation	W/m^2
Q2D	Specific humidity	kg/kg
T2D	Air temperature	K
PSFC	Surface pressure	Pa
U2D	Near surface wind in the u-component	m/s
V2D	Near surface wind in the v-component	m/s
RAINRATE	Precipitation rate	mm/s or $kg/m^2/s$

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

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

NWM Forcing Data Engine Construction

1. Create national 1km gridded fields of:
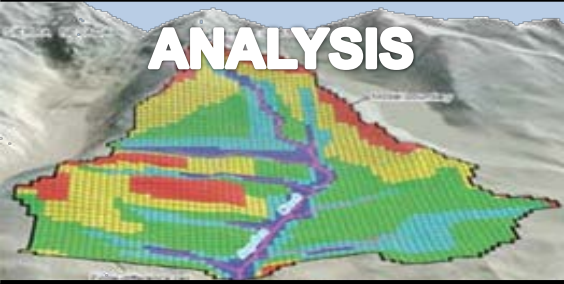
   - Temperature, mixing ratio, surface pressure, u-, v-windspeed, longwave and shortwave radiation, precipitation rate

2. Downscaling of:

   - Temperature (NARR distributed climatological lapse rate)

   - Mixing ratio (conserve RH)

   - Surface pressure

   - Incoming shortwave radiation (terrain slope and aspect)

Forcing Engine (Python Wrapper)

- Data Ingest
- Formatting/Time Sync Component
- Regridding (ncl)
- Downscaling (ncl, FORTRAN)
- Bias Correction (ncl)
- Product Layering (ncl)
- Output
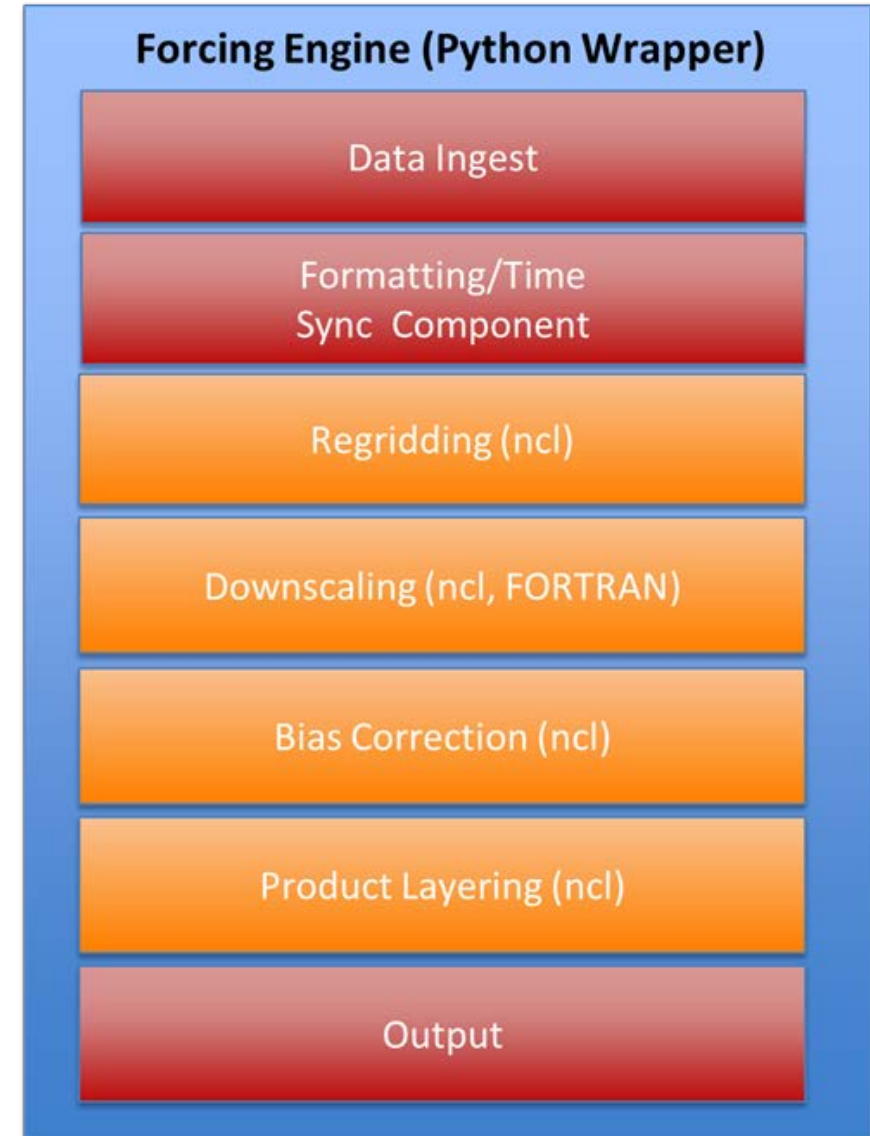
NWM Operational Cycles

|	Cycling	Forecast	Met Forcing	Outputs
ANALYSIS	Hourly	-3 - 0 hrs	MRMS QPE	1-km spatial fluxes (water & energy); 250-m routed fluxes (water); NHDPlus channel routing
SHORT-RANGE	Hourly	1 – 18 hrs	Downscaled HRRR/RAP Blend	1-km spatial fluxes (water & energy); 250-m routed fluxes (water); NHDPlus channel routing
MEDIUM-RANGE	4x Daily	to 10 days	Downscaled GFS	1-km spatial fluxes (water & energy); 250-m routed fluxes (water); NHDPlus channel routing
LONG-RANGE	Daily x 16 ensembles	to 30 days	Downscaled & NLDAS2 Bias-Corrected CFS	1-km spatial fluxes (water & energy); NHDPlus channel routing

- ## Medium Range Configuration
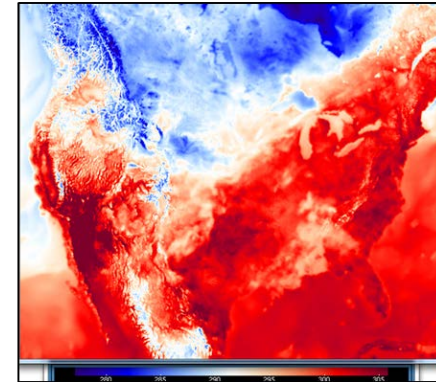 - Downscaled GFS (incoming shortwave radiation Sept. 11, 2015 21Z)
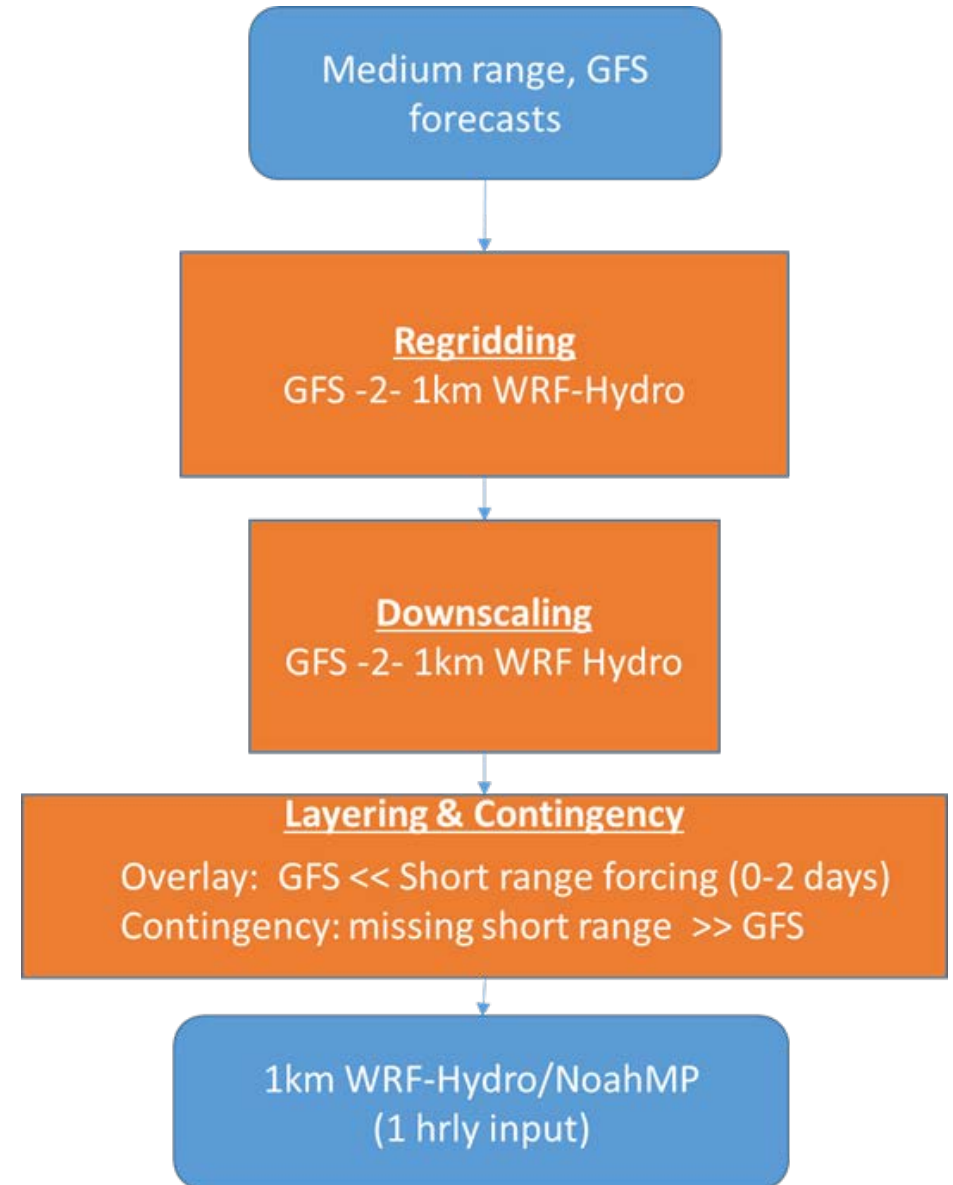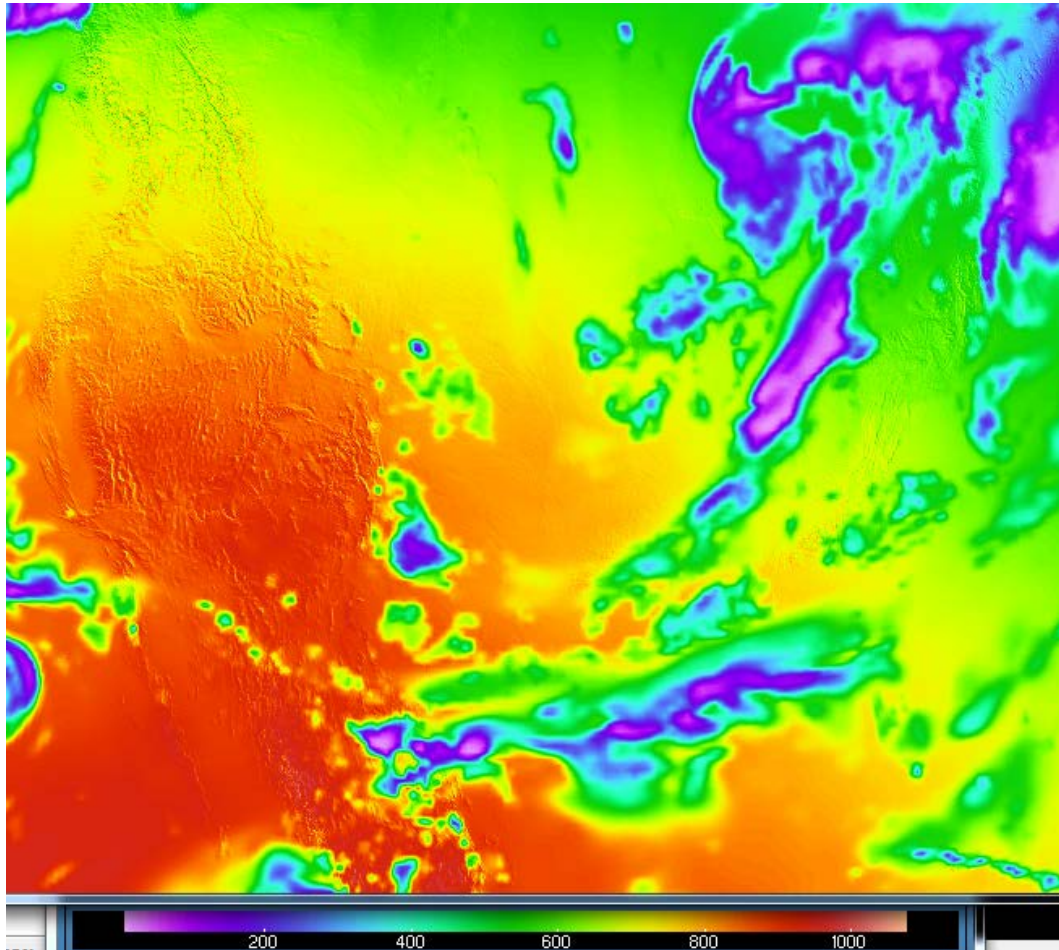
NWM Meteorological Forcing Engine (MFE)

1. Create national 1km gridded fields of:
   - Temperature, mixing ratio, surface pressure, u-, v-windspeed, longwave and shortwave radiation, precipitation rate

2. Terrain Downscaling of:
   - Temperature (NARR distributed climatological lapse rate)
   - Mixing ratio (conserve RH)
   - Surface pressure
   - Incoming shortwave radiation (terrain slope and aspect)
   - Rain-snow portioning (in development)
   - Wind (in development)

3. Statistical Bias Correction

4. Open source ncl/bash scripted workflow utilizing ESMF regridding tools

5. Multi-thread job, scales almost linearly because there is no memory sharing across processors (1-d calculations)
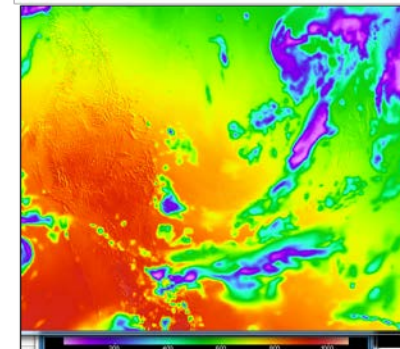
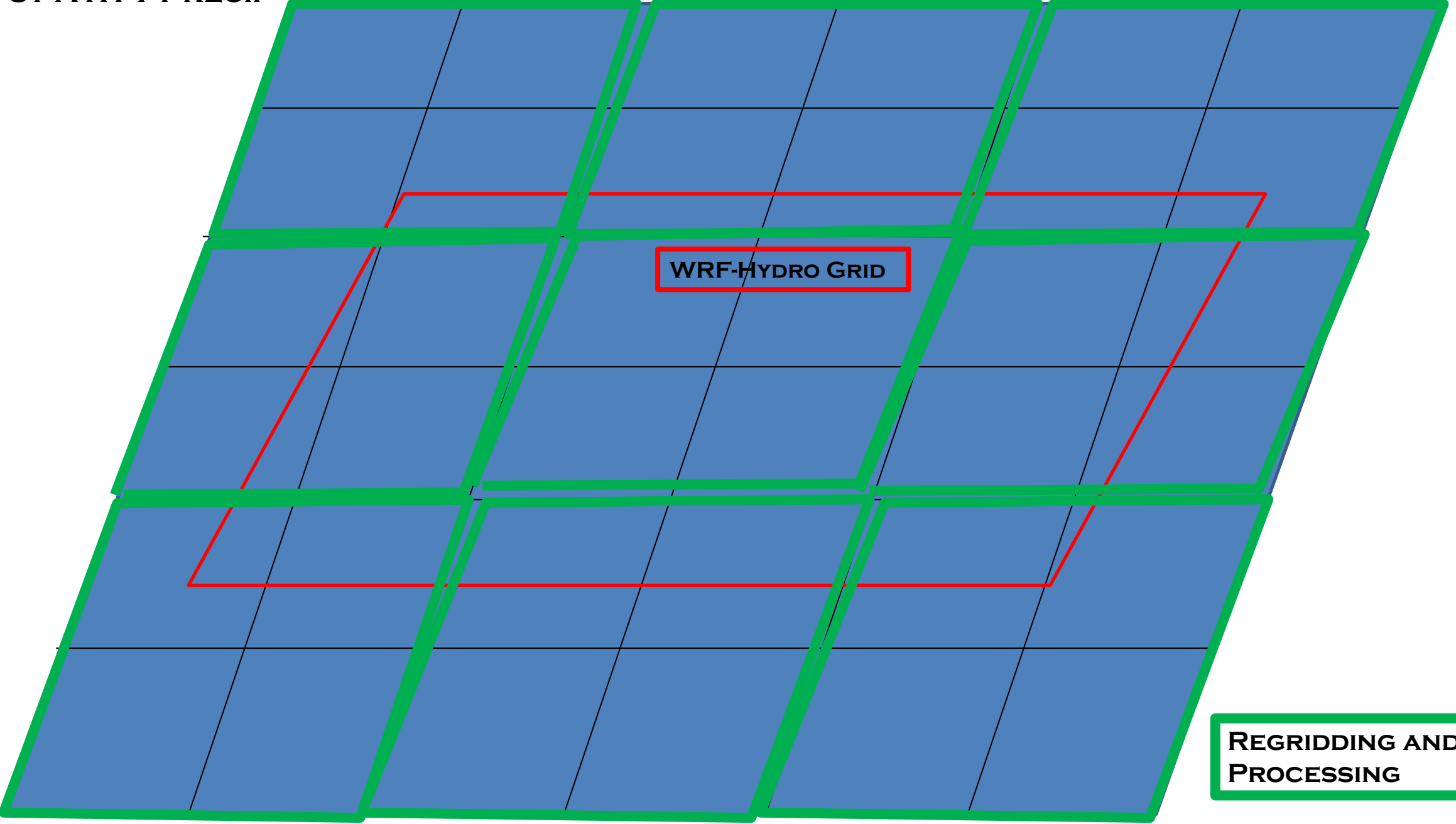**Seasonally-varying MRMS RQI**
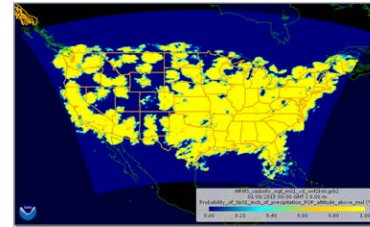
HRRR-RAP 2m Air Temperature

Blended MRMS-HRRR Precipitation

GFS – derived incoming shortwave radiation

Developed by Linlin Pan and Wei Yu with contributions from D. Kitzmiller, G. Fall, A. RafieeiNasab
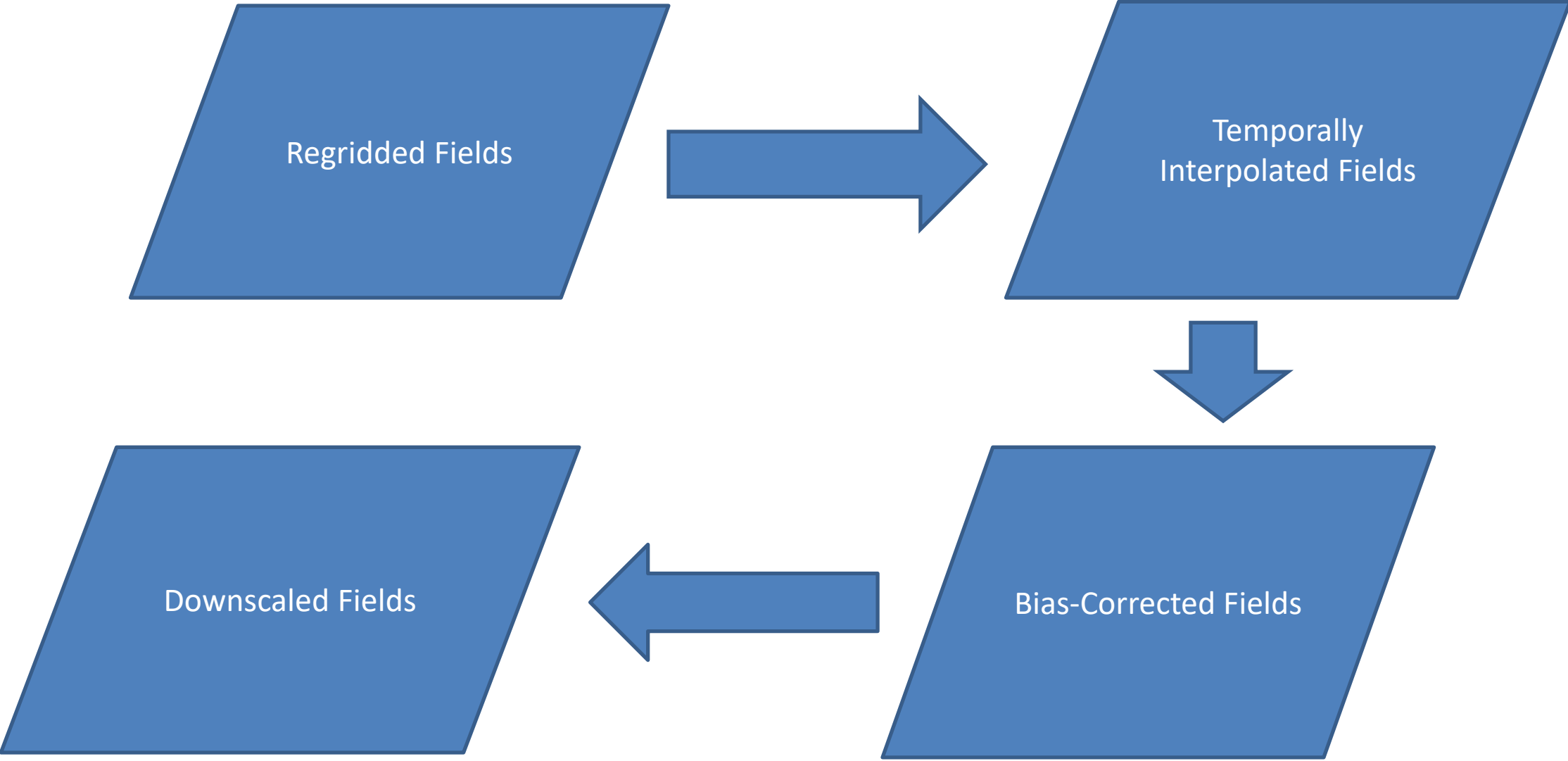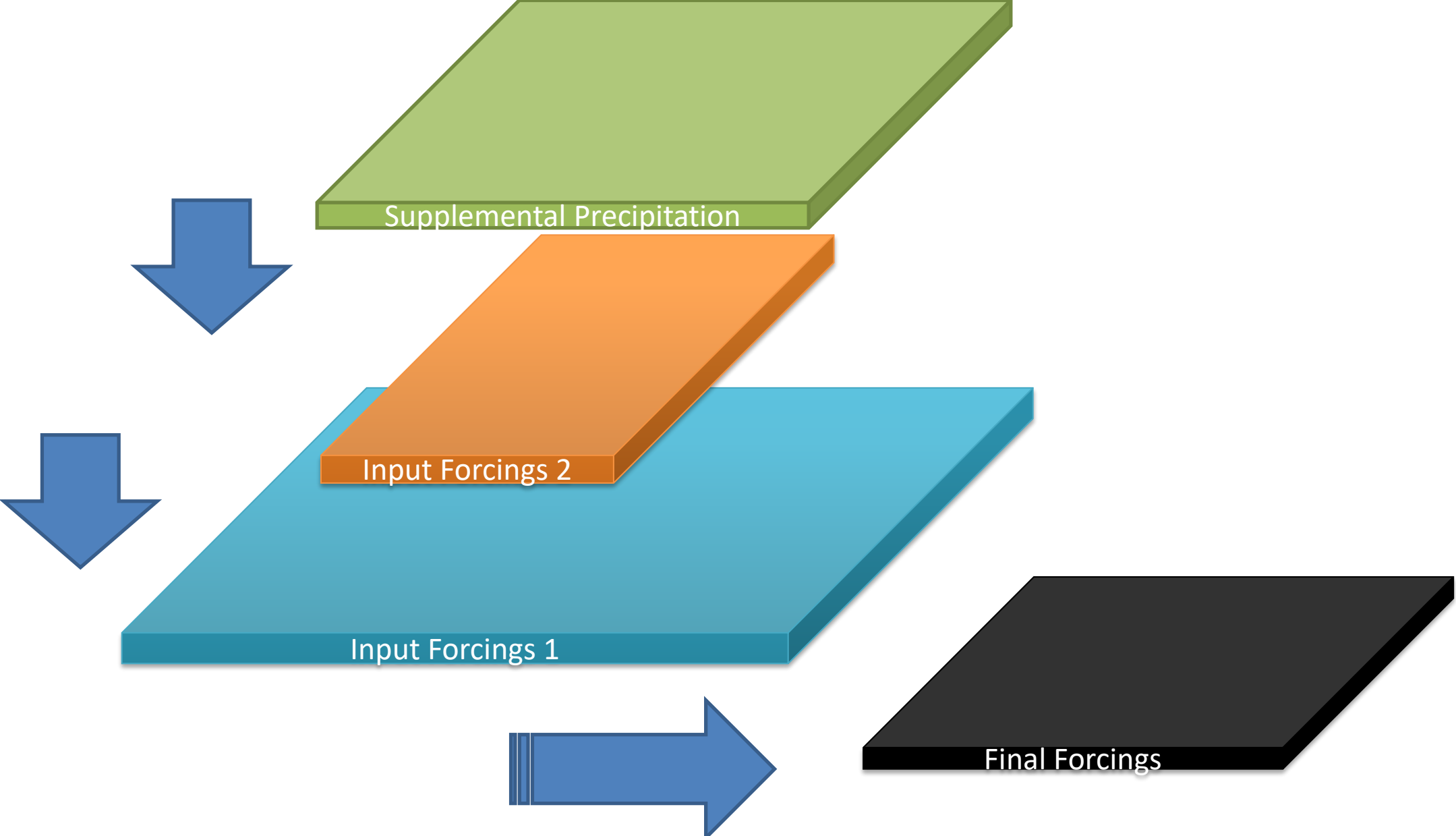
Input NWP/Precip

WRF-Hydro Grid

Regridding and Processing

Forcing Engine Workflow

Forcing Engine Workflow

Questions?