WRF-Hydro Overview for GEWEX Meeting

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NCAR

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Where?

Actionable Water Intelligence

Global to Street Scale

GLOBAL

STREET

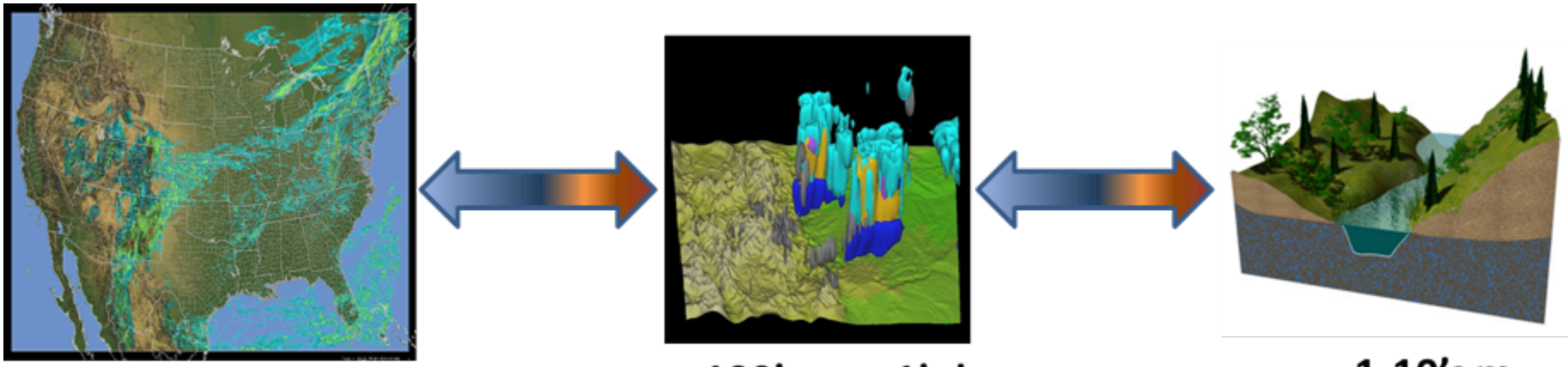
NATIONAL → REGIONAL

WATERSHED

2. WRF-Hydro System Description

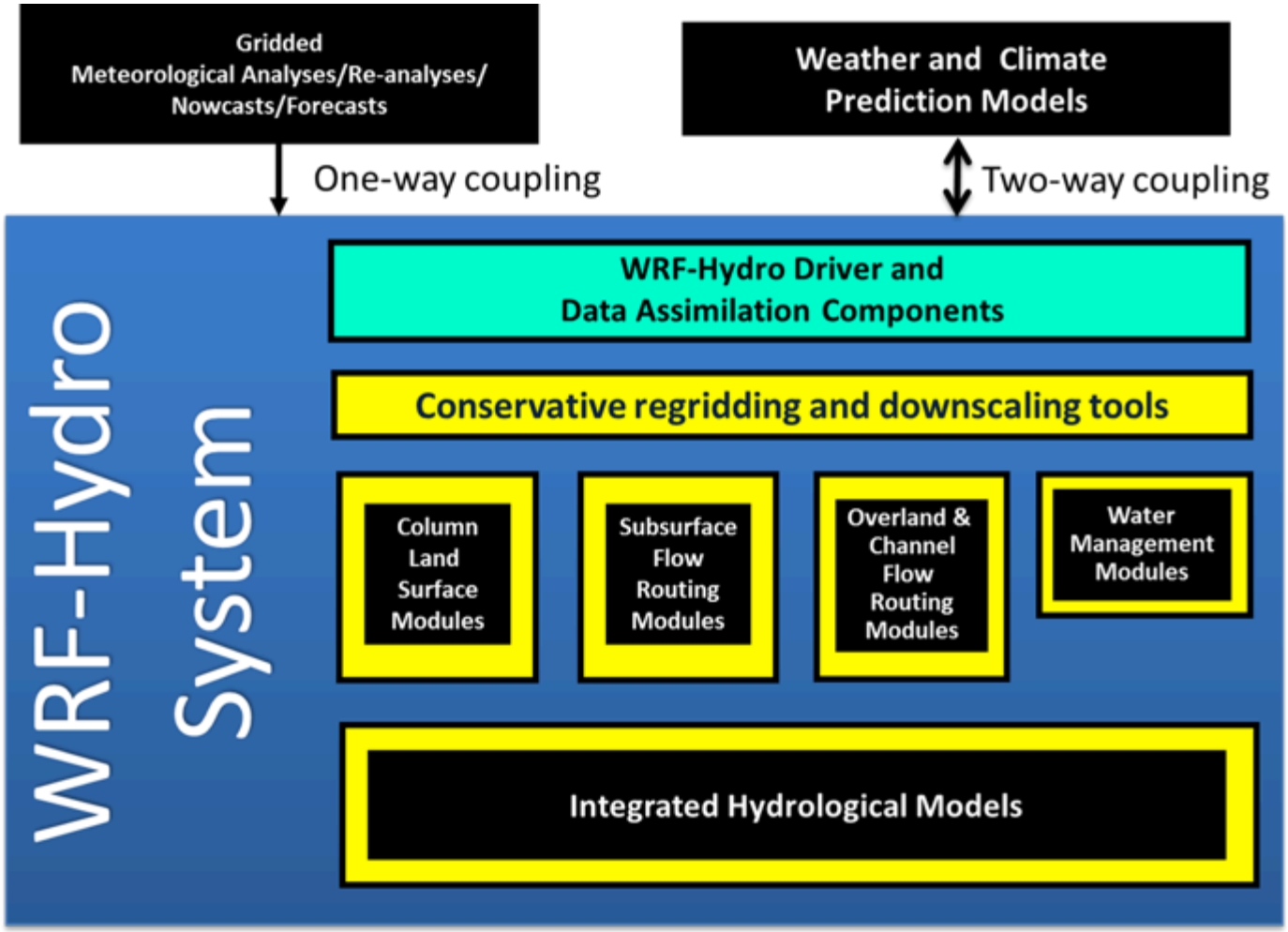
A community-based, supported coupling *framework* designed to provide:

1. An extensible *multi-scale & multi-physics* modeling capability for conservative, continuous, coupled and uncoupled *assimilation & prediction* of major water cycle components such as precipitation, soil moisture, snowpack, groundwater, streamflow, inundation
2. 'Accurate' and 'reliable' streamflow prediction across scales (from 0-order headwater catchments to continental river basins & minutes to seasons)



2. WRF-Hydro Modeling Framework:

- Multi-scale/Multi-physics modeling…



HYDROLOGIC SCIENCE ADVANCES

TECHNOLOGY

APPLICATIONS

ensemble methods

Forcing data

Remote sensing

Geospatial products

LSM (Noah-MP, etc.)

Parameter estimation

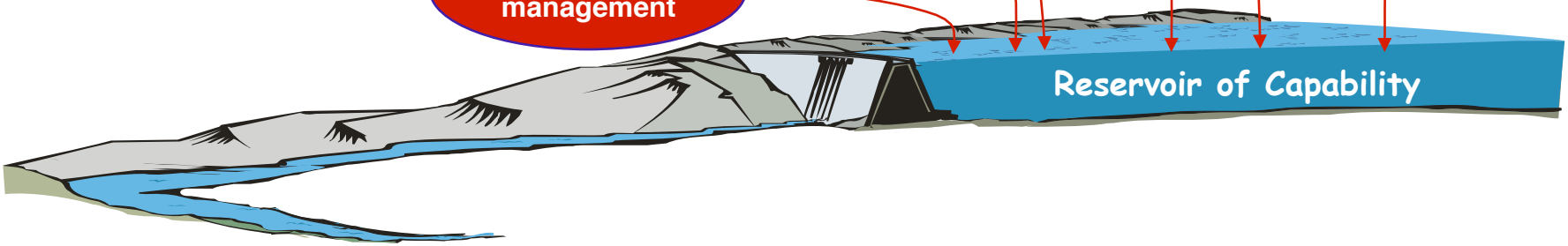
Terrain routing

Routing (RAPID, etc.)

Data assimilation

Model evaluation

Water management



WRF HYDRO COMMUNITY MODEL

NATIONAL WATER MODEL

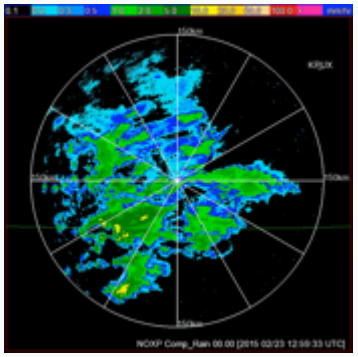
LAND-ESTURARY COUPLING

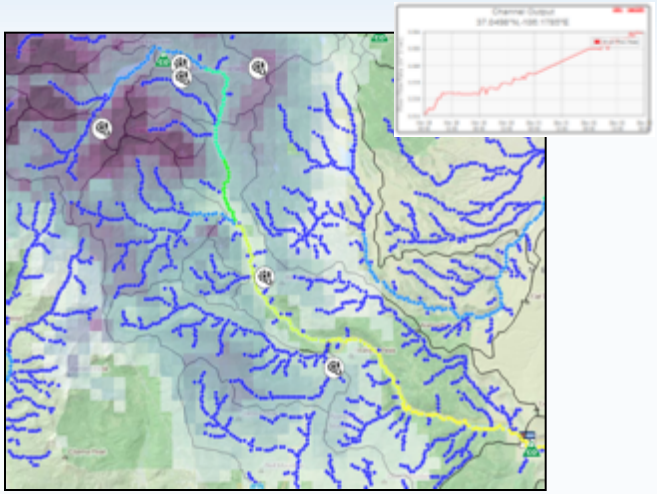
LAND-ATMOSPHERE INTERACTIONS

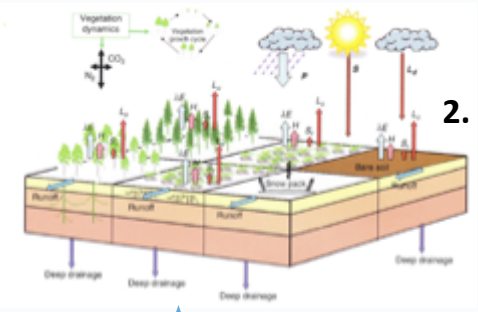
MORE…

Hydrometeorological Modeling System Chain:

1. Meteorological Forcing Engine

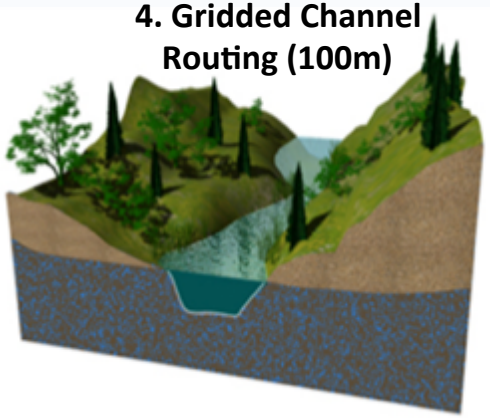




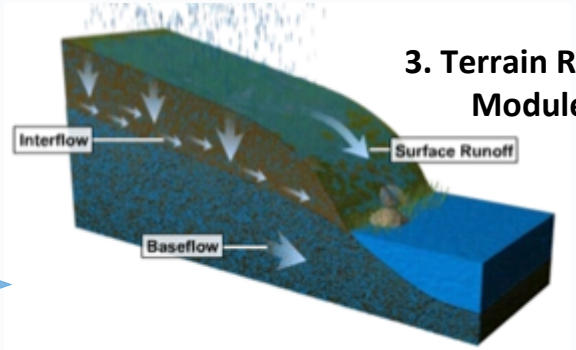


2. Land Surface Models

4. Gridded Channel Routing (100m)



2-way coupling



3. Terrain Routing Modules

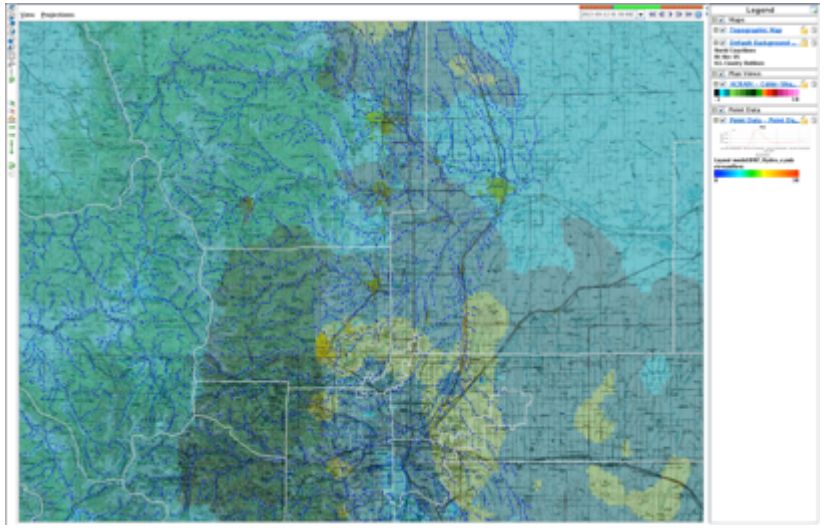
Stream Inflow, Inundation Depth, Groundwater Depth, Soil Moisture

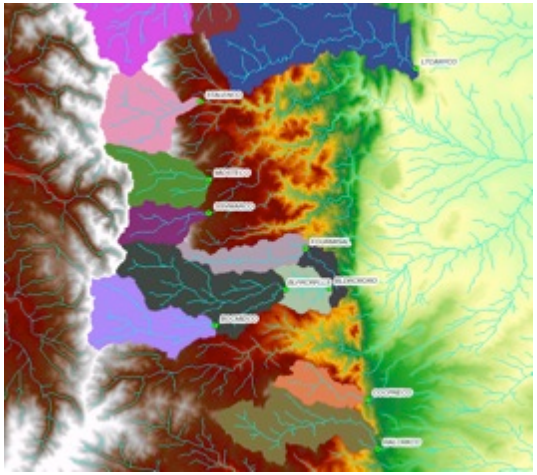
Streamflow
River Stage
Flow Velocity
Reservoir Storage
& Discharge

https://www.ral.ucar.edu/projects/wrf_hydro

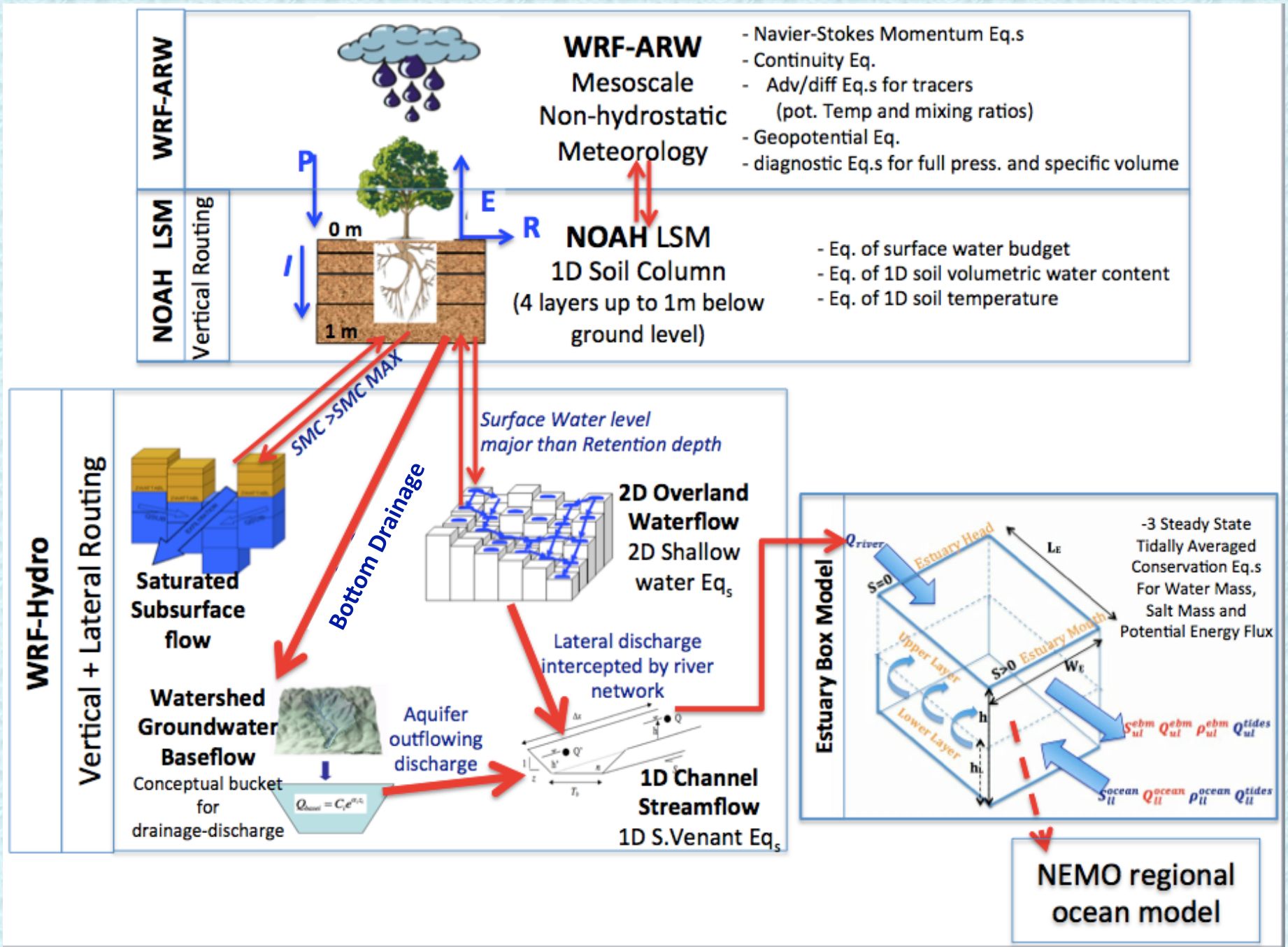
WRF-Hydro Process Permutations and System Features

- ~180 possible 'physics' component configurations for streamflow prediction:
  - 3 up-to-date column physics land models (Noah, NoahMP, CLM4.0)
  - 3 overland flow schemes (Diffusive Wave, Kinematic Wave, Direct basin aggregation)
  - 4 lateral/baseflow groundwater schemes (Boussinesq shallow-saturated flow, 2d aquifer model, Direct Aggregation Storage-Release: pass-through or exponential model)
  - 5 channel flow schemes: Diffusive wave, Kinematic Wave, RAPID-Muskingam for NHDPlus, Custom Network Muskingam/ Muskingam Cunge
- Level-pool reservoir with parameterized or actual discharge specification
- Data Assimilation:
  - National nudging-based streamflow DA system
  - DART, filter-based hydrologic data assimilation

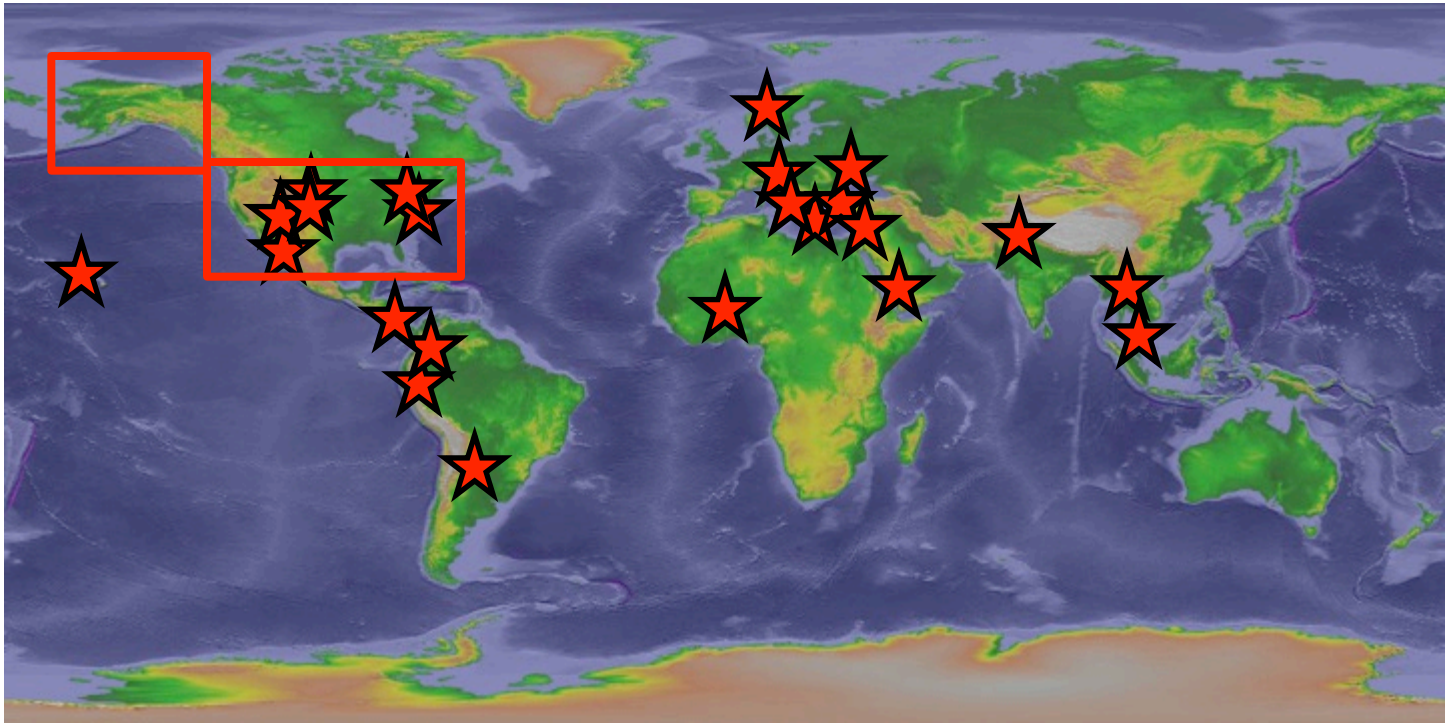




The integrated modeling chain



WRF-Hydro Community Applications:



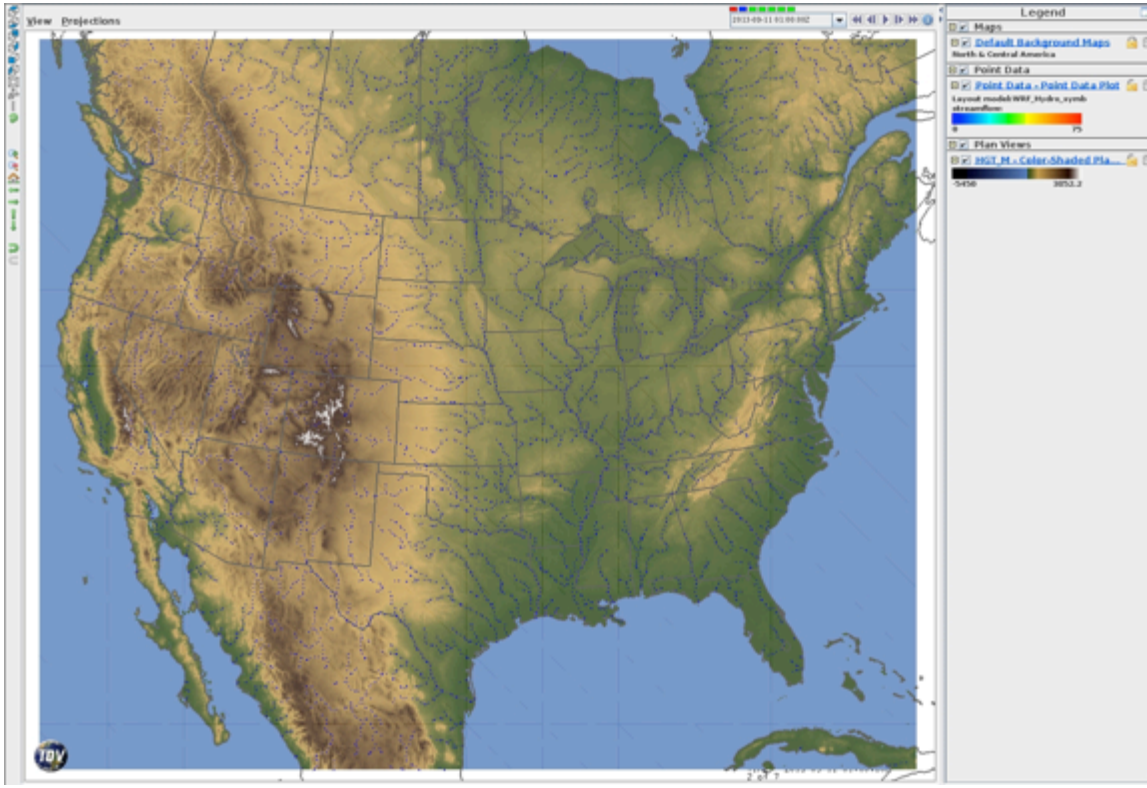
★ Past or current implementations

Streamflow Forecasting Support for the National Water Center

Objective: Operationalize a CONUS domain, distributed streamflow prediction capability using WRF-Hydro at NCEP

Goals:

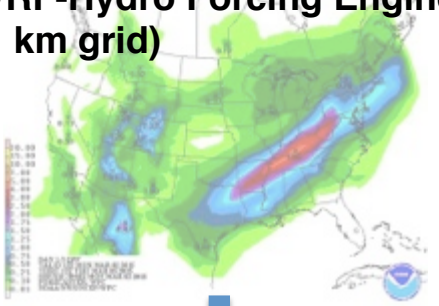
- Guidance for currently underserved locations
- Spatially continuous estimates of hydrologic states for the nation
- Interface with advanced geospatial intelligence framework
- Earth system model development approach that permits rapid model evolution of new data, science and technology



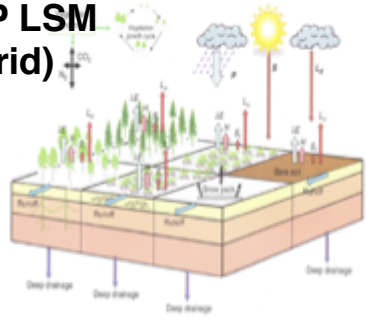
NWS National Water Model
WRF-Hydro System configuration

https://www.ral.ucar.edu/projects/wrf_hydro

1. WRF-Hydro Forcing Engine
   (1 km grid)

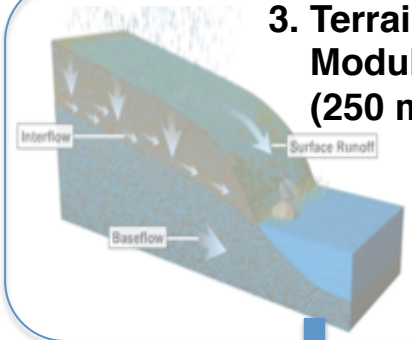


2. NoahMP LSM
   (1 km grid)



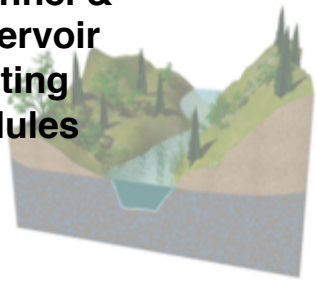
2-way coupling

3. Terrain Routing Module
   (250 m grid)



4. NHDPlus Catchment Aggregation
   (2.6M unique catchments and river reaches)

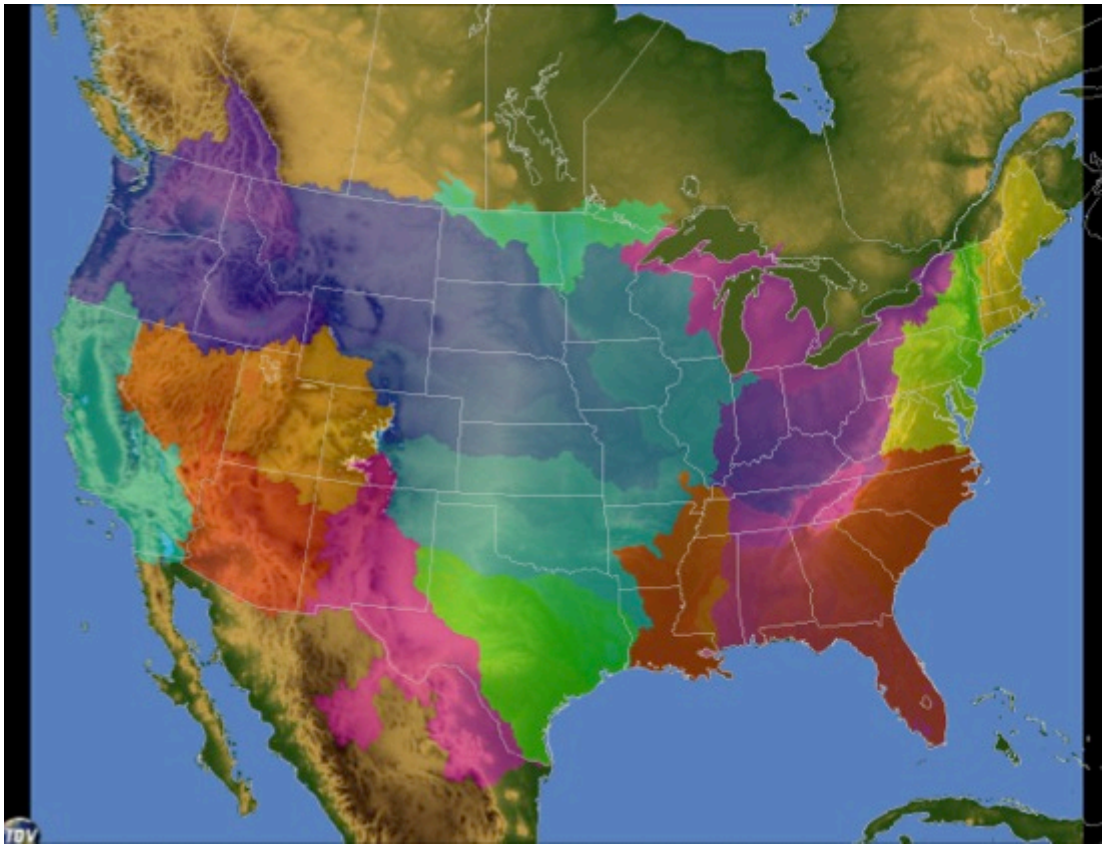
5. Channel & Reservoir Routing Modules



Forecast Products

3. IOC WRF-Hydro System Configuration:

- NHDPlusV2-Encompassing Domain
- 1km NoahMP land model:
  - USGS-NLCD land cover (2011)
  - NRCS STATSGO, 1km soils
  - Climatological vegetation structure (v1.0)
- 250m routing
  - Diffusive wave overland flow
  - Saturated subsurface flow
  - NHDPlusv2 catchment-based baseflow parameterization
- NHDPlusv2 channel routing
  - Muskingum-Cunge
  - oCONUS manual processing….
  - 1651 passive, level-pool reservoirs
- Benchmarking in progress: 18 year 1998-2015 continuous run
  - NLDAS2/NARR,
  - StageIV/II



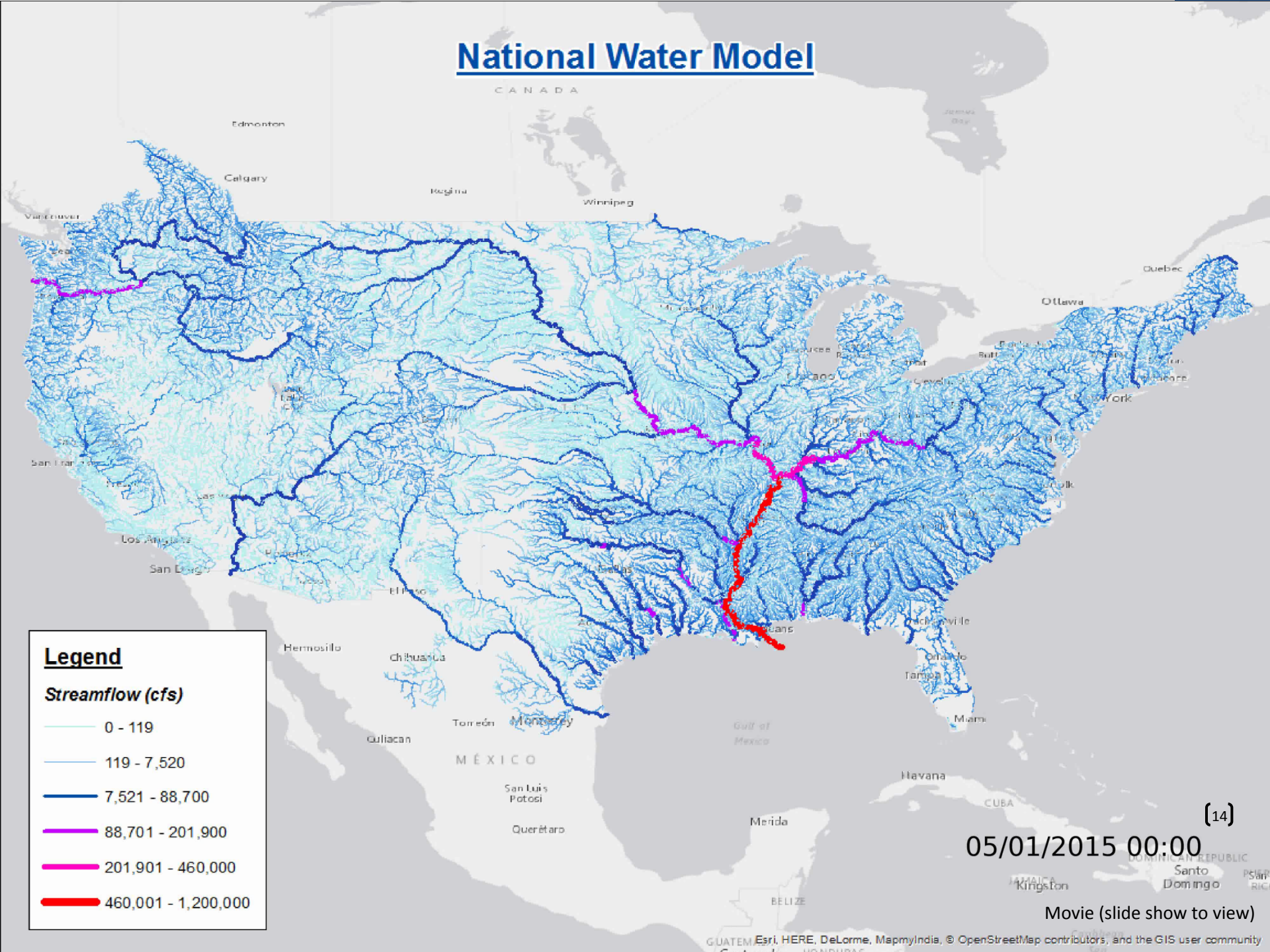
National Water Prediction Model Configurations

WRF-Hydro Configuration

Analysis & Assimilation	Short Range	Medium Range	Long Range
Cycling Frequency			
Hourly	Hourly	Daily	Daily (4x4)
Forecast Duration			
- 3 hrs	0-18 hrs	0-10 days	0-30 days
Meteorological Forcing			
MRMS blend/ dwnscaled HRRR/RAP anal	Downscaled HRRR/RAP blend	Downscaled GFS	Downscaled & Bias-Corrected CFS
Spatial Discretization & Routing Physics			
1 km / 250m / NHDPlus reach	1 km / 250m / NHDPlus reach	1 km / 250m / NHDPlus reach	1 km / NHDPlus reach

Reservoirs

National Water Model



Movie (slide show to view)

Upcoming Developments:

- National Water Model operational on Jun 15, 2016
- Community Support
  - 2 Tutorials/yr.
  - User Workshop
  - Release of model support tools (Rwrfhydro, met. forcing engine, visualization tools)

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WRF-Hydro: http://www.ral.ucar.edu/projects/wrf_hydro/

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WRF-HYDRO: HTTP://WWW.RAL.UCAR.EDU/PROJECTS/WRF_HYDRO/

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