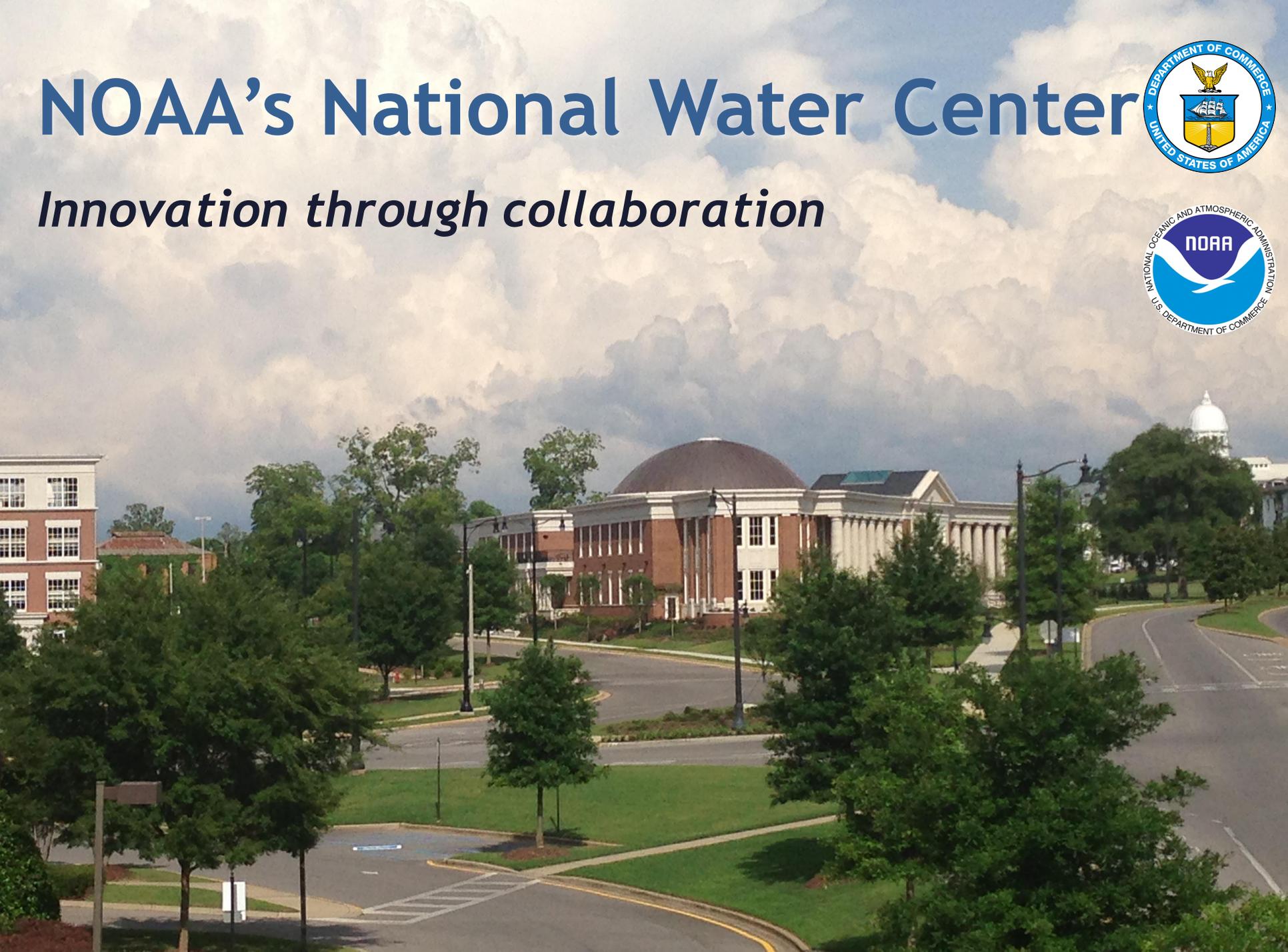


NOAA's National Water Center

Innovation through collaboration



Integrated Water Resources Science and Services

- Established by MOU in 2011, expanded in 2015 to include FEMA, recertified in 2016 for +5 years
- New business model for interagency collaboration
- Share technology, information, models, best practices
- Operations focused
- Members agree to work towards:
 - ✓ *Interoperability of key systems and data synchronization*
 - ✓ *Standardized data formats*
 - ✓ *Enhanced geospatial information and visualization*
 - ✓ *Common Operating Picture*
 - ✓ *Coordinated R&D portfolio investments*
 - ✓ *Leverage multi-disciplinary skills to formulate effective solutions*
- Joint governance structure – shared leadership model
- Joint stakeholder outreach, educational efforts

“It is amazing what you can accomplish if you do not care who gets the credit.” Harry S. Truman



National Water Center

A catalyst to transform NOAA's water prediction program



Mission: Nationally Integrated Water Prediction

- Earth system modeling and geo-intelligence for water prediction
- Operations Center for water resources common operating picture
- Decision support services for spectrum of water stakeholders
- Proving ground to accelerate research to operations
- Interagency and Academia Collaboration



Scientific excellence and innovation driving water prediction and decisions for a water-resilient nation.

- Collaborative R&D, Operations
 - Support mission-oriented research and development
 - Proving Ground Facility
 - Science and Technology Transition
 - Operations Center
 - Socioeconomic Sector Desks
 - Regional Desks
 - Science Desks
- Interagency Staffing

RESEARCH

OPERATIONS

```
graph TD; Root[ ] --- SID[Social Intelligence Division (SID)]; Root --- ISED[Interdisciplinary Science and Engineering Division (ISED)]; Root --- APD[Analysis and Prediction Division (APD)]; Root --- GID[Geo Intelligence Division (GID)]; SID --- HF[HUMAN FACTORS]; ISED --- CS[CORE SCIENCE]; APD --- IM[INTEGRATED MODELING]; GID --- DA[DATA/ANALYTICS];
```

**Social Intelligence
Division
(SID)**

**HUMAN
FACTORS**

**Interdisciplinary
Science and
Engineering Division
(ISED)**

**CORE
SCIENCE**

**Analysis and
Prediction Division
(APD)**

**INTEGRATED
MODELING**

**Geo Intelligence
Division
(GID)**

**DATA/
ANALYTICS**

Initial Operating Capability: May 2016

STAFFING – First 51

- 12 NOAA NWS – 3 NOAA NOS
- 2 vacancies (GS15 Division Directors)
- 22 UCAR Visiting Scientists inbound
- 6 USGS staff in house
- 1 FEMA staff in process
- 8 Contract staff

IT Vision: since 2011 3 A-IT
IT Capacity: 2 dedicated
data centers (1. operational
and R&D activities; 2. New
and unproven technologies)

Transforming NOAA Water Prediction

TODAY

Approximately 4000 forecast locations at points

Forecast river flow/stage, from summit to coastal zone

Driven by large catchment “lumped” modeling

Forecaster “in the loop” – serial, basin to basin, modeling of flow through the river network

Average basin size greater than 420 square miles

13 RFCs developing separate versions of the same regional model

RFC-generated river forecasts coordinated with WFOs to deliver Impact-based forecasts at selected points

THE FUTURE

Approximately 2,700,000 forecast stream reaches

Forecast all hydrologic parameters which define the water budget, from summit-to-sea

Driven by high/hyper resolution Earth System modeling

Forecaster “over the loop” – simultaneous modeling of the nation’s entire river network

Average basin size ~1 square mile

13 RFCs, NWC, academia, and federal partners developing/evolving same state-of-the-science national, community-based, model (working with NSF, CUASHI, and other Federal agencies to establish community development version of NWM)

National Water Model-based predictions coordinated among NWC, RFCs, and WFOs and linked with detailed local infrastructure data to communicate street level impacts

For the hydrology community, the implementation of the NWM and the leap ahead capability it provides parallels the implementation of mesoscale atmospheric models in the 1970s (i.e., model resolution substantially greater than available observational network)

National Water Model Version 1.0

- **WCOS Implementation and experimental product availability in FY16 Q4 (June 2016)**
 - Leveraged strong NWC/NCAR/NCEP partnership
 - Build upon NCAR's, community-based, WRF-Hydro coupling architecture
 - Implementation accelerated by 2 years, and benefited from close collaboration with CUASHI through NSF
 - No public facing until validation.
- **Foundation for sustained growth in operational hydrologic forecasting capability**
- **Goals for NWM V1.0**
 - Provide forecast streamflow guidance for underserved locations
 - Produce spatially continuous national estimates of hydrologic states (soil moisture, snow pack, etc.)
 - Implement a modeling architecture that permits rapid infusion of new data and science, and allows for geointelligence linkages

National Water Model (NWM) Core: WRF-Hydro

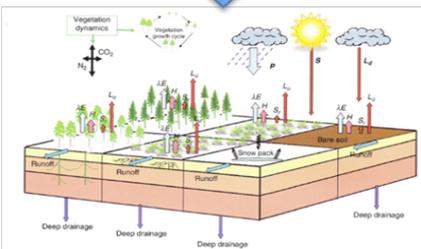
- WRF-Hydro forms the foundation of the National Water Model
- A community-based, ESMF compliant hydrologic modeling *framework* supported by NCAR being put into operations by an NWC, NCAR and NCEP partnership
- *Not dependent* on a particular forcing data source or choice of LSM
- Able to operate over multiple scales and with multiple physics options

IOC System Flow

1. NWM Forcings Engine (NWS numerical weather models and observations)

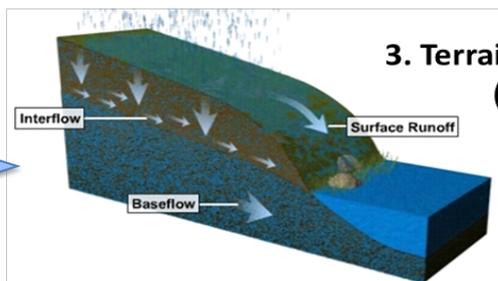


2. NoahMP LSM
(1 km grid)

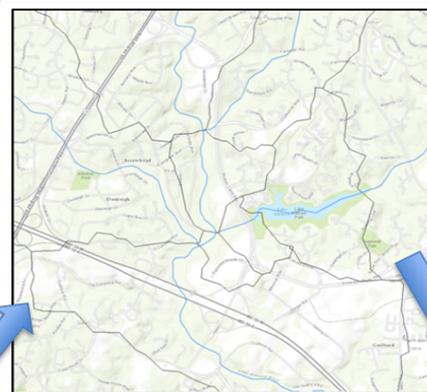


2-way coupling

3. Terrain Routing Module
(250 m grid)

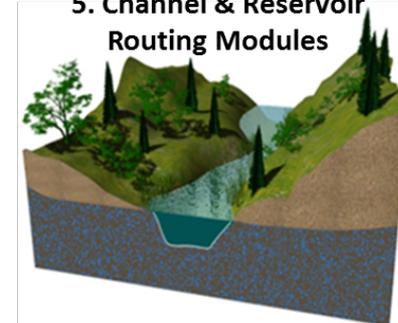


4. NHDPlus Catchment Aggregation



(avg. size ~1mi²)

5. Channel & Reservoir
Routing Modules



Forecasts

- * Long-time-ongoing collaboration among NASA GSFC, NCEP-EMC, NASA-MSFC, and NWC.
 - * Develop improved forcing data,
 - * improved land surface hydrologic models,
 - * improved validation techniques under the North American Land Data Assimilation System (NLDAS) umbrella
- * mutual interest in improving the simulation skill and capability of hydrologic models, along with the verification tools needed to assess such models.

* **Our NOAA-NASA
history**

- * Development and integration of multiple remotely sensed products and data that could support updates to key water budget variables within the National Water Model through data assimilation: Of interest are integrated:
 - * snow/ice and glacial extent
 - * surface elevations of natural lakes and regulated reservoirs -- especially in the OCONUS regions
 - * soil moisture/ground water
 - * dynamic changes in the vegetation
- * Collaboration to explore that availability of remotely sensed data to expand knowledge of terrain and geomorphology
- * Developing new verification systems/approaches based on in site and remotely-sensed observations
- * Developing improved approaches to modeling aspects of the hydrologic system
- * Collaboration with the NASA's LIS effort

* Suggested Points of
Coordination/Collaboration with
NASA

NWM V1.0 EXPERIMENTAL OUTPUT

- **Hydrologic Output**

- River channel discharge and velocity at 2.7 million river reaches
- Reservoir inflow, outflow, elevation
- Surface water depth and subsurface flow (250 m CONUS+ grid)

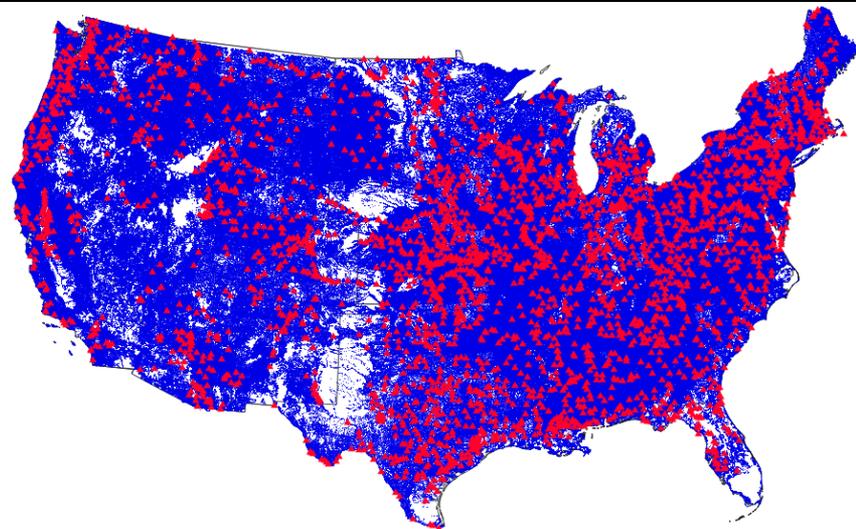
- **Land Surface Output**

- 1km CONUS+ grid
- Soil and snow pack states
- Energy and water fluxes

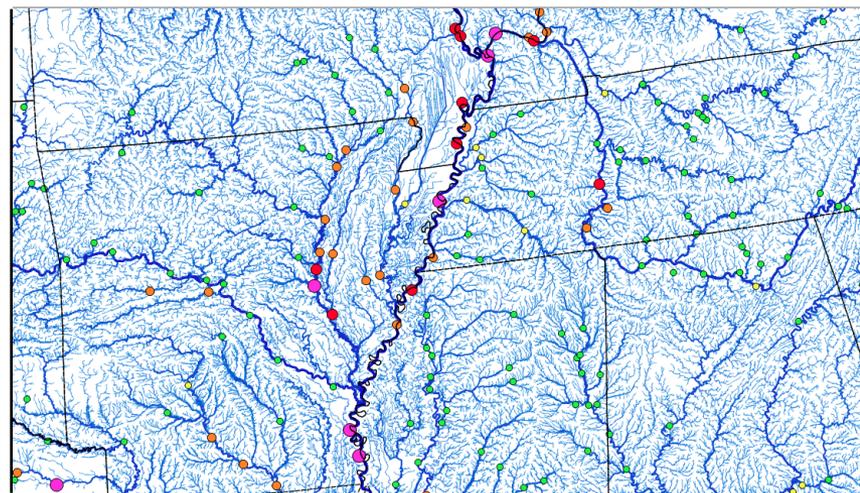
- **Direct-output and derived products** (e.g. stream flow anomalies)

- **Three pronged dissemination strategy**

- NOMADS
- Web
- Direct to field



Current NWS AHPS points (red)
NWM output points (blue)



Current NWS River Forecast Points (circles)
Overlaid with NWM Stream Reaches

NWM V1.0 Operational Configuration

Analysis &
Assimilation

Short-Range

Medium-Range

Long-Range

Cycling Frequency

Hourly

Hourly

Daily

Daily Ens (16 mem)

Forecast Duration

- 3 hrs

0-18 hours

0-10 days

0-30 days

Meteorological Forcing

MRMS blend/
HRRR/RAP bkgnd.

Downscaled
HRRR/RAP blend

Downscaled GFS

Downscaled &
bias-corrected CFS

Spatial Discretization & Routing

1km/250m/NHDPlus
Reach

1km/250m/NHDPlus
Reach

1km/250m/NHDPlus
Reach

1 km/NHDPlus Reach

Assimilation of 8k USGS Obs

Reservoirs (1240 water bodies parameterized with level pool scheme)