National Water Model Version 1.1
WCOSS Science Quarterly Briefing

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Project Scope: NWM Version 1.1

- **Version 1.1 will be the direct follow-on to NWM version 1.0**
- **Target Dates**
  - **OWP code testing and user feedback complete by December 20th, 2016**
  - **Code handoff to NCO December 21st, 2016**
  - **Implementation date of April 2017 (FY17 Q3)**
- **A quick-turnaround upgrade to address a limited set of high-impact items within a tight timeframe**
- **Drawn directly from <u>feedback</u> from the RFCs, broader NWS user base, internal evaluation and OWP research plans**
- **Node usage will increase by 20 to 185, disk usage <u>will decrease</u>**
- **Version 2.0 will follow 6 months after Version 1.1**
  - **More comprehensive upgrade**
  - **First of the regularly scheduled, annual NWM upgrades**
  - **Target implementation date of October 2017**

Project Scope: NWM Version 1.1 Enhancements

- **Forecast cycling**
  - Extension of short range forecast from 15 to 18 hours
  - Increased frequency of medium range forecast from 1 to 4 times per day
- **Parameter Updates**
  - Parameter calibration to reduce hydrologic biases
  - Improvement of MRMS/HRRR/RAP precipitation blending in NWM Analysis
- **Stream Connectivity Refinements**
  - Corrections to NHDPlusV2 streamflow connectivity errors noted by RFCs
  - Corrections for cross-border NHDPlusV2 issues
  - Improved alignment for hydrographic features in Canada
- **Additional upgrades**
  - Fix for overly large infiltration rate in sandy areas during intense precipitation
  - Fixes to underlying topography leading to isolated extreme OCONUS ponded water values
  - Fix for high altitude excessive snow melt
  - Fix for isolated negative underground runoff
  - Header and NetCDF format updates to improve compatibility with NetCDF file readers
  - Enhancements to USGS data decoder and preprocessor
  - Use of scaling and offset factors along with conversion to NetCDF4 to reduce file sizes and increase accessibility
  - Improved adherence to WCOSS standards via addressing NCO bugzilla tickets

Planned NWM V1.1 Operational Configuration

	Analysis & Assimilation	Short-Range	Medium-Range	Long-Range
Cycling Frequency	Hourly	Hourly	4 X Day (0,6,12,18Z)	Daily Ens (16 mem)
Forecast Duration	- 3 hrs	0-18 hours	0-10 days	0-30 days
Forecast Latency (latency of external forcing data accounts for most of delay)	1 hour	1 hour 45 mins	6 hours	19 hours
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 USGS Obs

Reservoirs (1260 water bodies parameterized with level pool scheme, **focus of active development**)

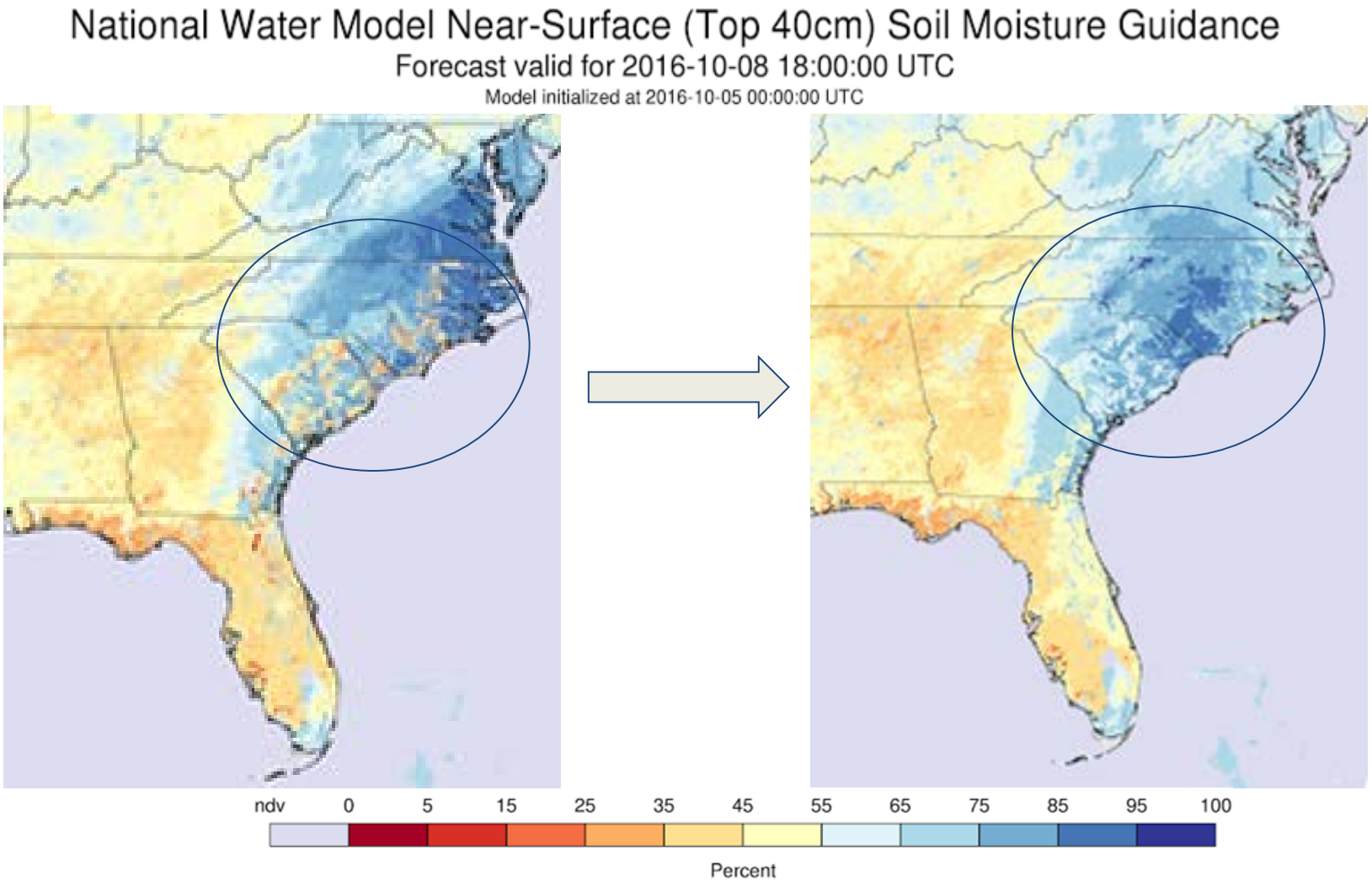
Change from V1.0

NWM Version 1.1 Enhancements (LSM)

Activity: Fix for overly large infiltration rate in sandy areas during intense precipitation

Outcome: Significantly improved depiction of infiltration of heavy rainfall

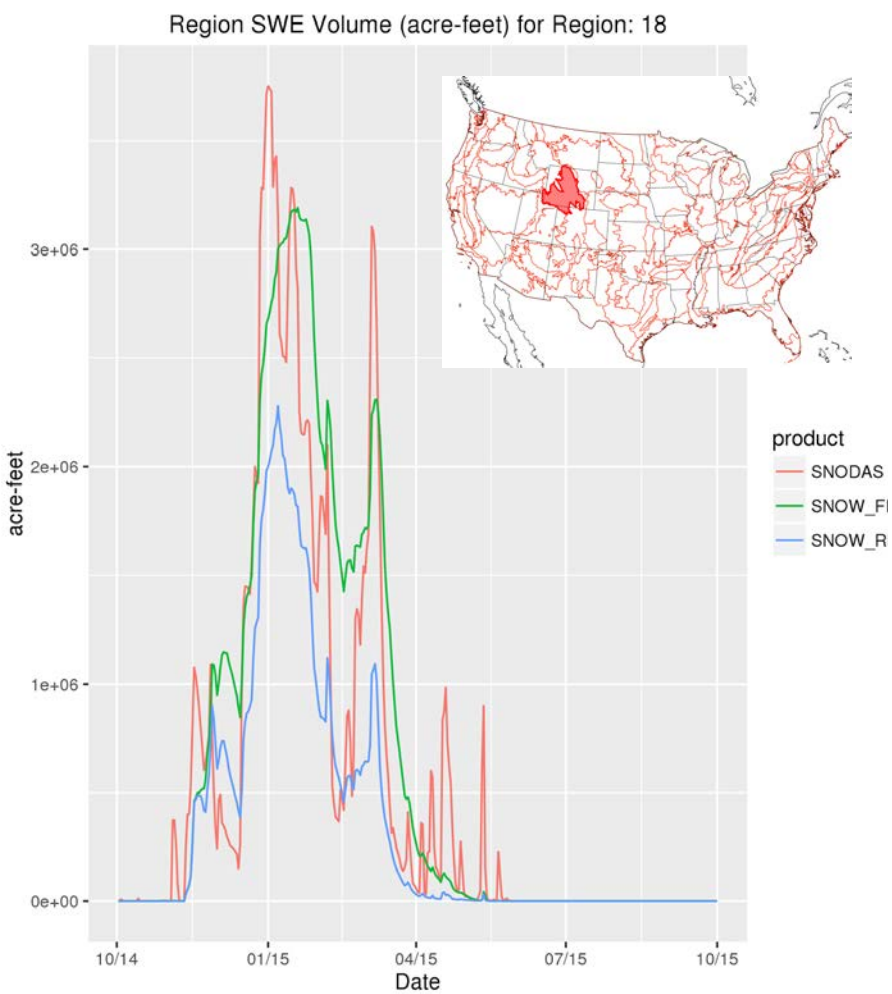
[Example below from Hurricane Matthew Re-forecast]

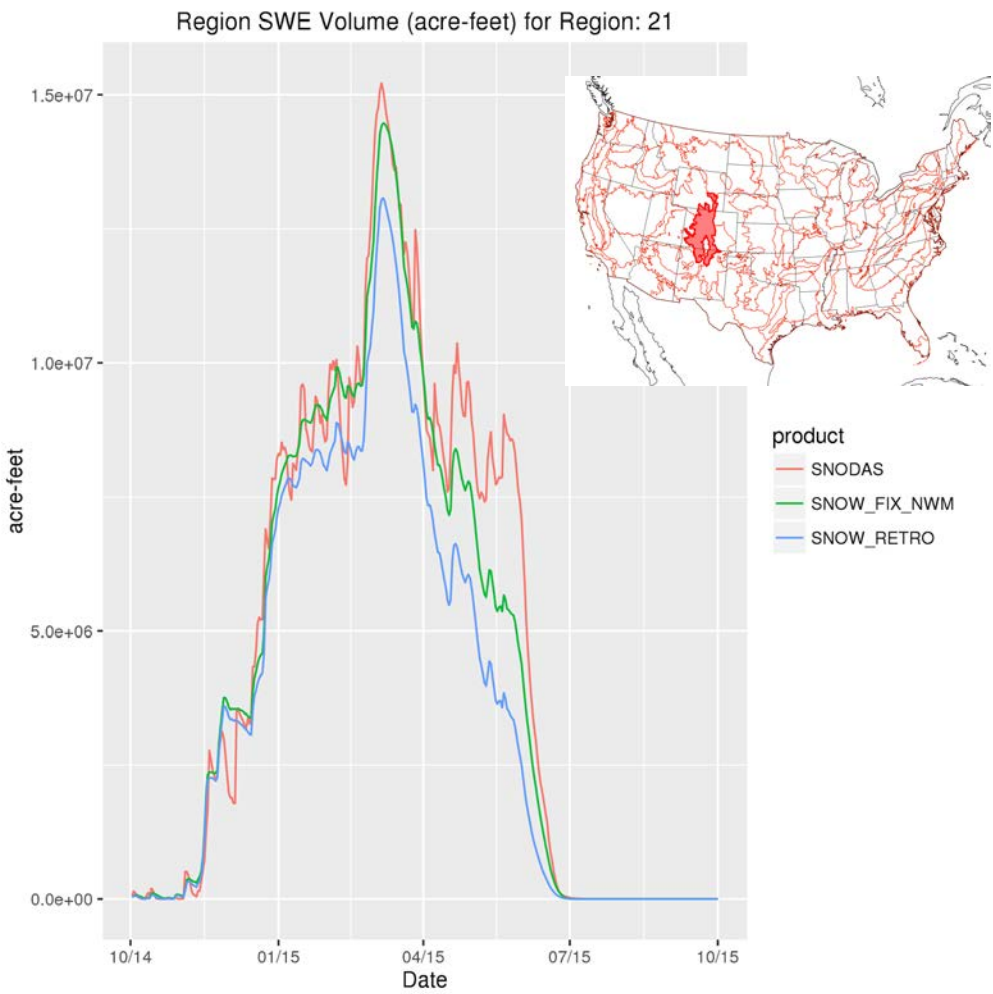


NWM Version 1.1 Enhancements (LSM)

Activity: Update to the NoahMP multi-layer snow model to modify snow roughness length formulation.

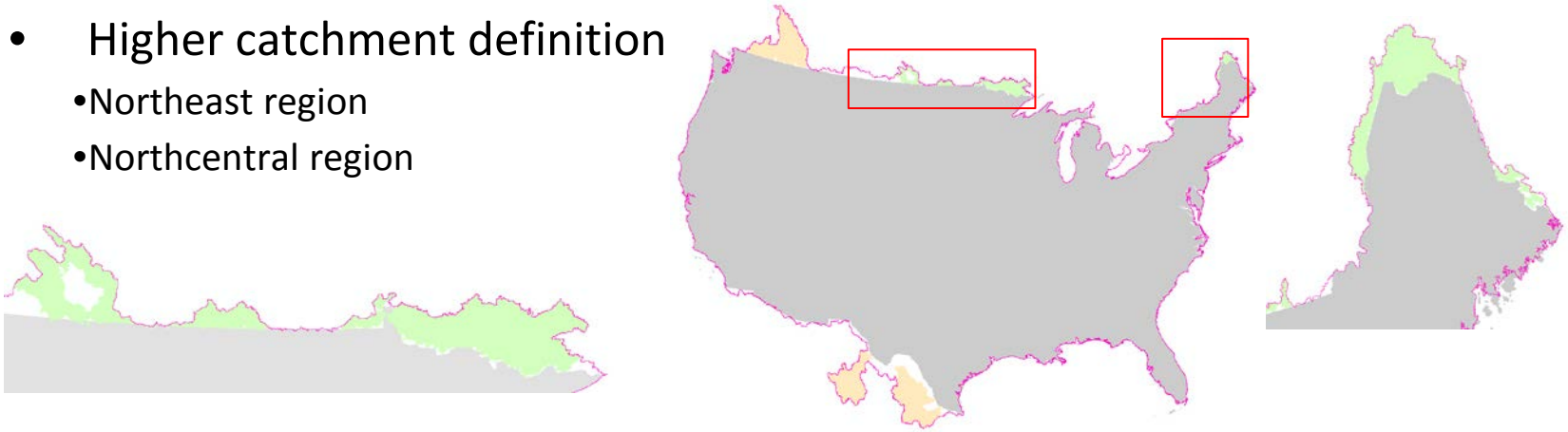
Outcome: Improved characterization of peak snowpack and snow ablation



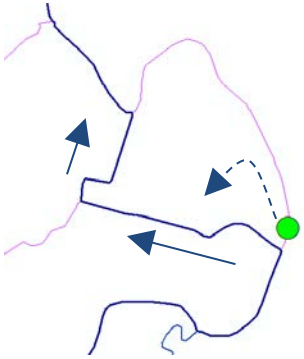


NWM Version 1.1 Enhancements (GIS)

- **Added ~5000 oCONUS contributing basins to NWM channel routing domain**
  - Higher catchment definition
    - Northeast region
    - Northcentral region



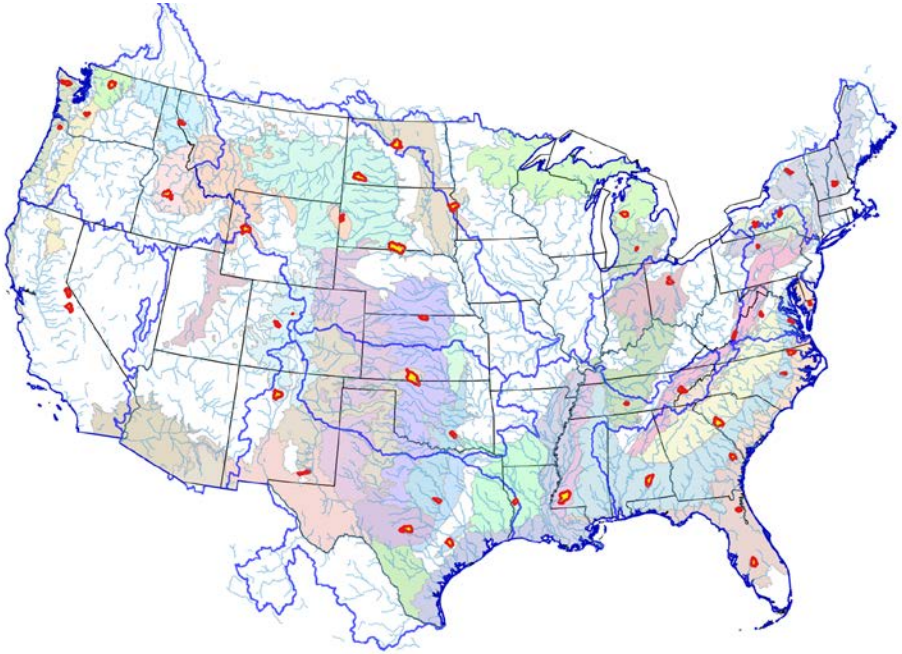
- **Incorporating RFC feedback, corrected geolocation of 99 USGS gages on NWM stream network to support data assimilation scheme**
- **Re-routed flow due to diversions and errors in NHDPlusV2 (329 flow-line alterations)**
- **Corrected breaks in existing channel network (~100 fixes)**
- **Corrected ~500 cross-border stream order mismatches**
- **Filled in sinks in isolated areas of extreme ponded water accumulation**



NWM Version 1.1 Enhancements (Parameters)

- **Example of successful *operations→ research→ operations* feedback loop**
- **Hydrologic Parameter Calibration Process**
  - River Forecast Centers prioritized areas for parameter improvement
  - NCAR combined RFC feedback with national statistical assessment
  - NCAR/OWP executed calibration for select basins, regionalized parameters
  - Focus was on improving biases noted in V1.0 of the model
  - 5-year validation simulation conducted to verify improvements
  - Each RFC has NCAR/OWP contact for their region to facilitate local feedback

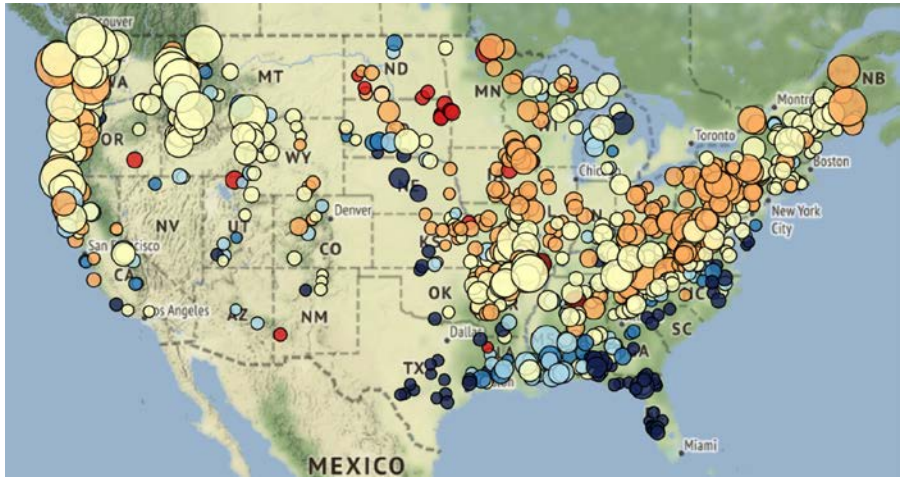
Map of 48 unique Gauges-II reference calibration basins (red)...Also shown are ecoregions for parameter regionalization (shaded)



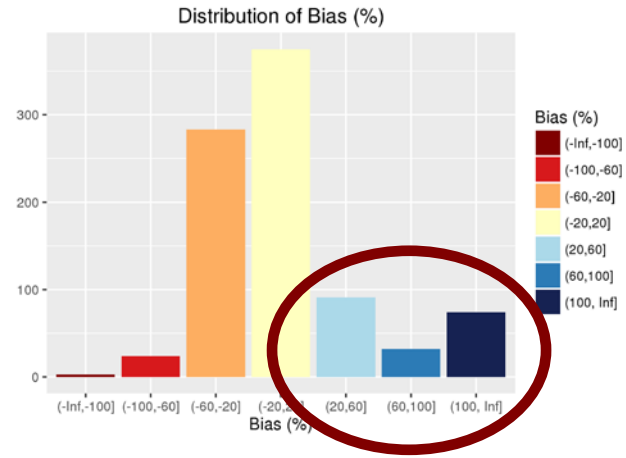
NWM Version 1.1 Enhancements (Parameters)

<u>Initial</u> Calibration Results: Retrospective Analysis, GAGES-II Reference Basins, NLDAS-2 Forcings
→ Parameters at 48 basins calibrated, regionalized...then validation at several hundred locations

NWM v 1.0: Oct 2010-June 2012

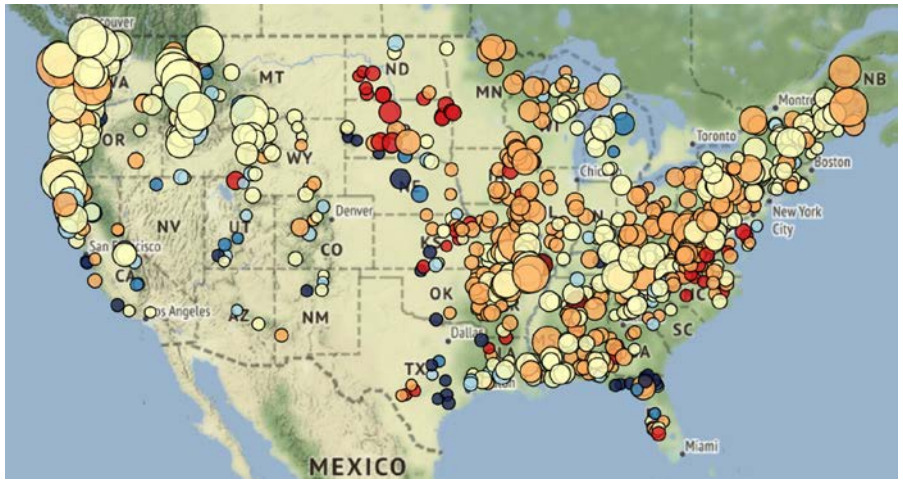


Bias (%)
- (-Inf,-100]
- (-100,-60]
- (-60,-20]
- (-20,20]
- (20,60]
- (60,100]
- (100, Inf]

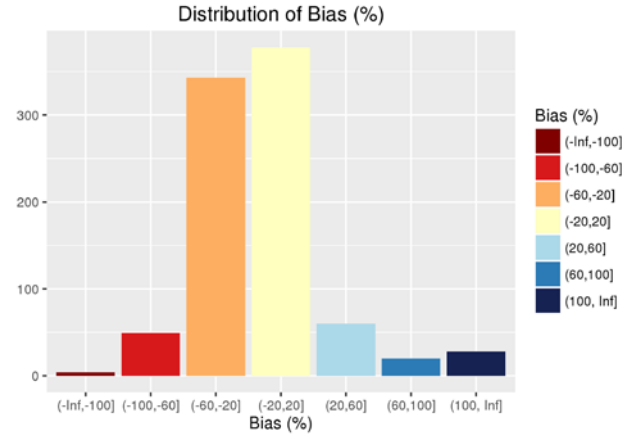


22% bias above 20%

NWM v 1.1: After <u>initial</u> regional calibration



Mean Flowrate (cms)
- 0
- 50
- 100
- 150
- 200



12% bias above 20%

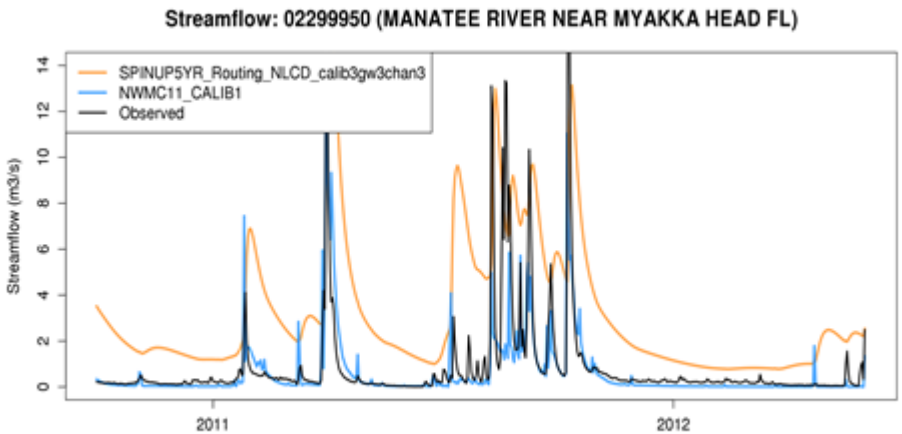
NWM Version 1.1 Enhancements (Parameters)

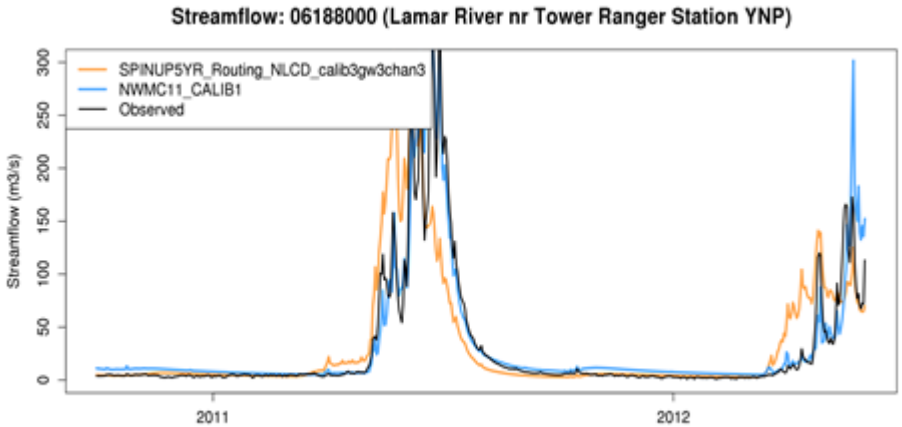
Initial Calibration Results:

Retrospective Analysis, GAGES-II Reference Basins, NLDAS-2 Forcings

- Positive streamflow bias greatly reduced via calibration of parameters
- Timing improved via calibration and science enhancements

*Note: these locations were not directly calibrated, rather they are products of the regionalization process





NWM v1.0 — After select regional calibration

NWM Version 1.1 Enhancements--Next Steps

- Version 1.1 development work finishing by November 15th
- NWM upgrade will follow new NCO implementation procedures
  - 30-Day real-time simulation using operational configuration on WCOSS Cray for science evaluation starts November 15th
  - NWM reforecast (Hurricane Matthew and Iowa flooding) in November
  - Code handoff to NCO December 21st
  - 30-Day real-time NCO IT stability test in March
  - Implementation of V1.1 in April
- Future upgrades will follow annual cycle with V2.0 scheduled for October 2017