

Filling 'Gaps' in Water Supply Predictions: The 'RIO-SNO-FLOW' Project

Project Team:

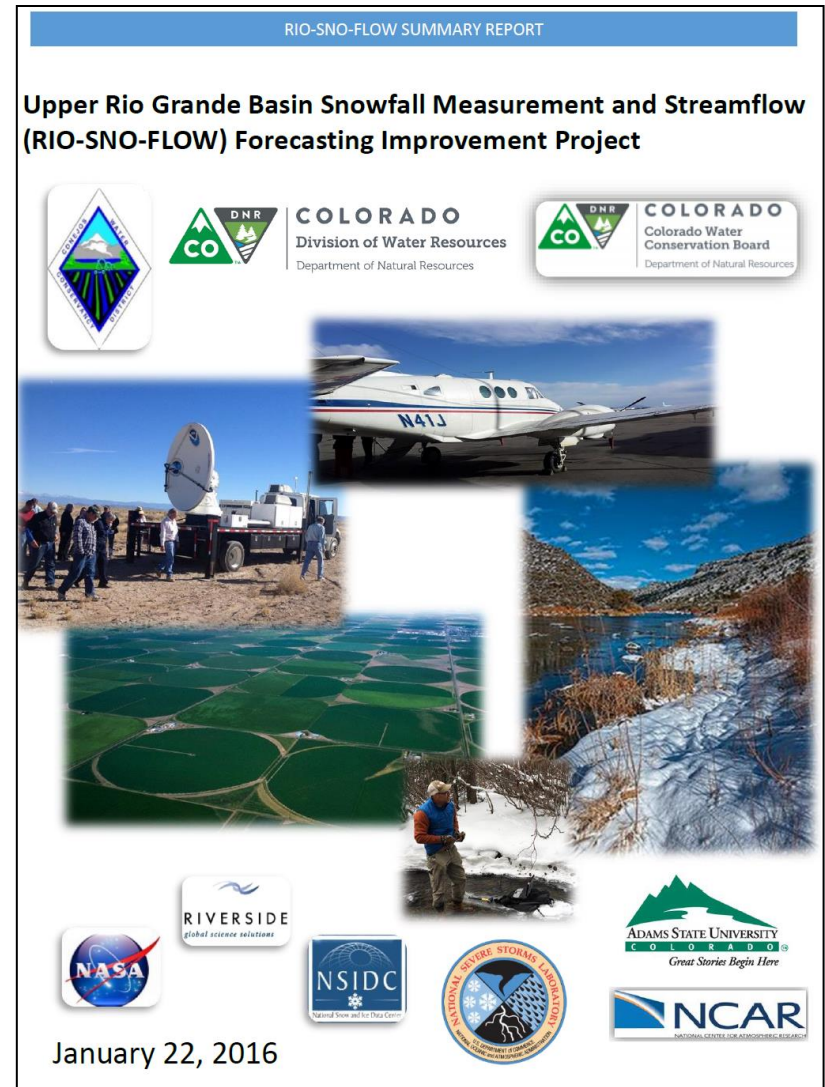
Colorado Water Conservation Board

***NOAA National Severe Storms
Laboratory (NSSL)***

***National Center for Atmospheric
Research (NCAR)***

***NASA Airborne Snow Observatory
(ASO)/NSIDC***

Presented by: David Gochis (NCAR)



Acknowledgements:

- **James Ecklund and Joe Busto: Colorado Water Conservation Board**
- **Craig Cotton and James Heath: Colorado Division of Water Resources**
- **Nathan Coombs: Conejos Water Conservancy District**
- **Andrea Jones and Dan Dallas: USFS**
- **U.S. Bureau of Reclamation WaterSMART Program**
- **Frank Kugel: Upper Gunnison Water Conservancy District**
- **Paul McKee: NOAA/NWS West Gulf River Forecast Center**
- **Ed Clark and Tom Graziano: NOAA Office of Water Prediction**
- **NASA Applied Science Program**
- **National Science Foundation**

The Western Water Challenge:

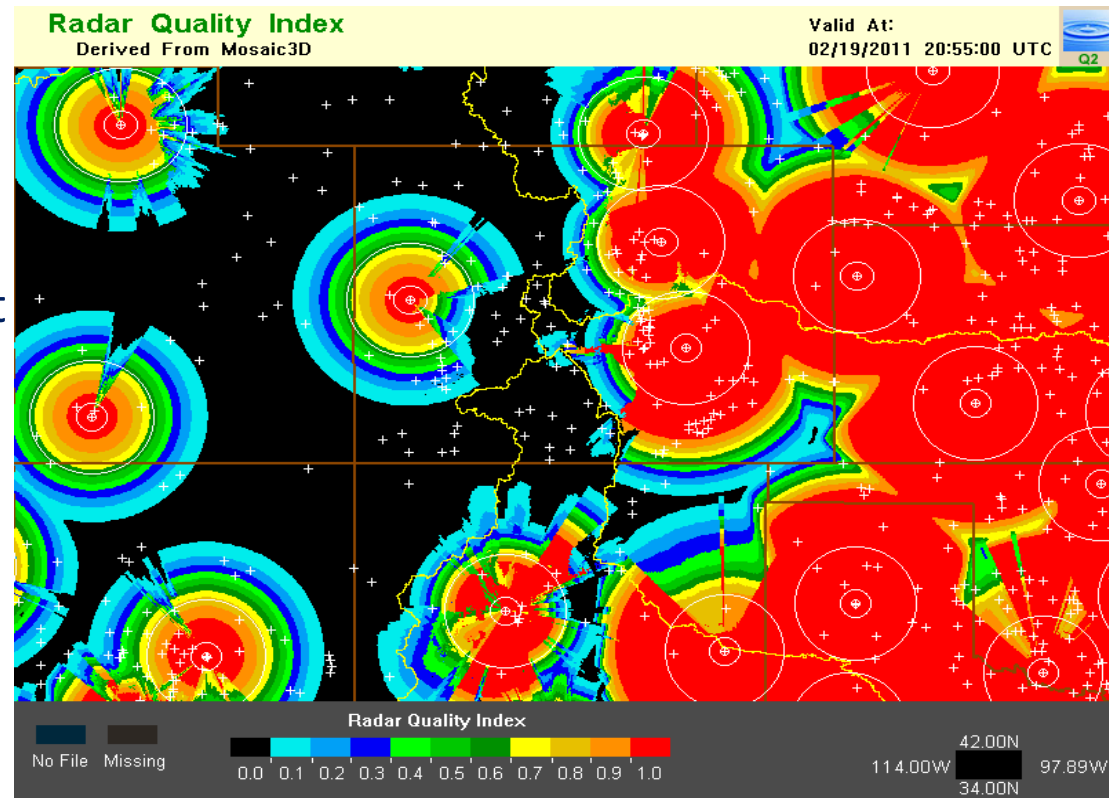
- **Western states have water but demand is ‘outstripping’ supply**
 - Many systems fully/over-allocated
 - Limited prospects for ‘new’ water development
- **Errors in water supply forecasts lead to damages**
 - Economic losses from water users
 - Compact violations and litigation
 - Limited growth
 - Uncertain habitat conditions
- **Insufficient water intelligence:**
 - Inadequate precipitation, snowpack, soil moisture and streamflow observations
 - Non-stationarity & high variability invalidates many statistical methods
 - Inability of historical models to integrate real-time observational data
 - *Fractured or incomplete ‘water data hub’*
- **Goal of new Water Intelligence needs to be to *reduce* uncertainty**

Single-basin/Single-year Study:

RIO-SNO-FLOW Project:

- Millions of dollars in water value lost due to forecast uncertainty and error
- Need better skill in water supply forecasts to better meet interstate Compact requirements
- Emerging water observation and prediction research on multiple fronts

Geographic Focus Area and Gaps in Radar Coverage



Research Question: Can improved observations of precipitation and snowpack improve seasonal snowpack and streamflow simulation and predictions?

Points of Innovation

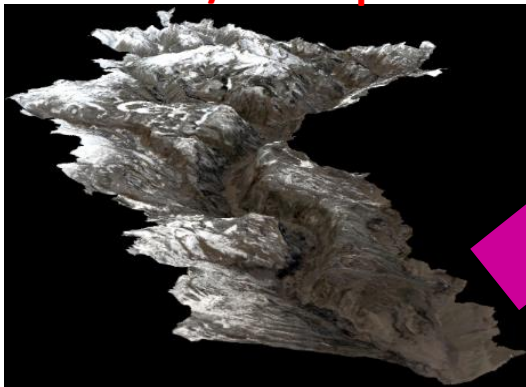
Combining Better Data with Better Forecasting Tools

Dual Polar Doppler Radar



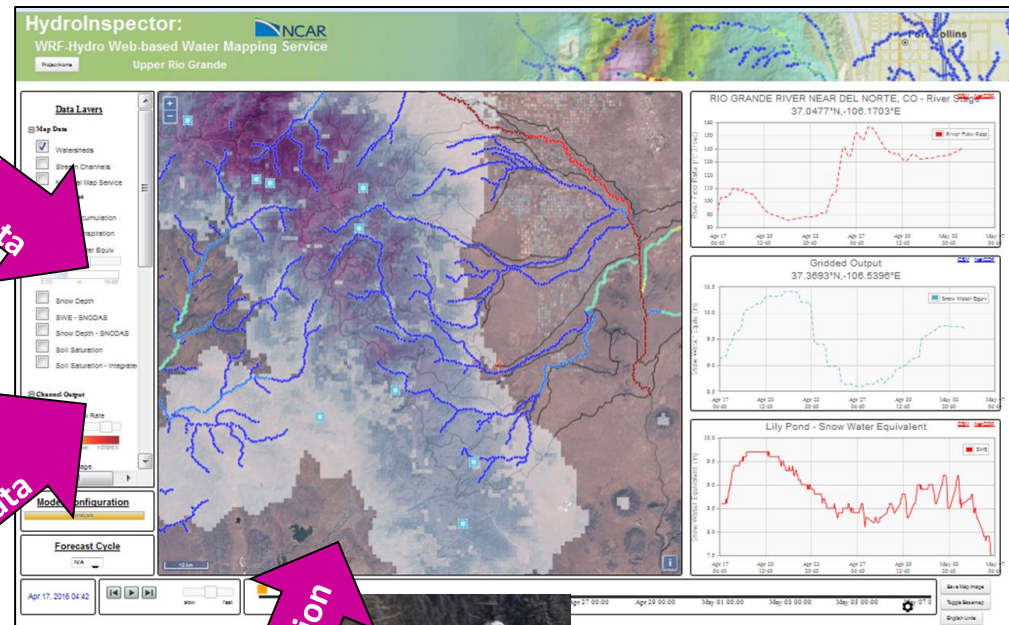
Figure 12: NOXP at Alamosa airport winter of 2014-2015.

Airborne Lidar/Multispectral Data



Conejos Basin ASO-Snow Water Equivalent

WRF-Hydro Modeling System (Research version of the NOAA-National Water Model)



Improved
Precipitation Data

Improved
Snowpack Data

Ground-validation



In-situ Stations

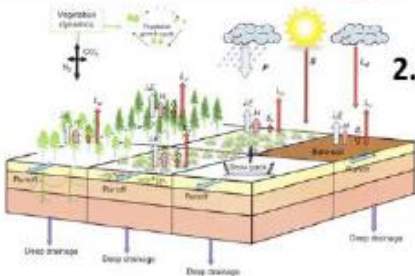
Points of Innovation

WRF-Hydro Modeling System: Framework of the NOAA National Water Model

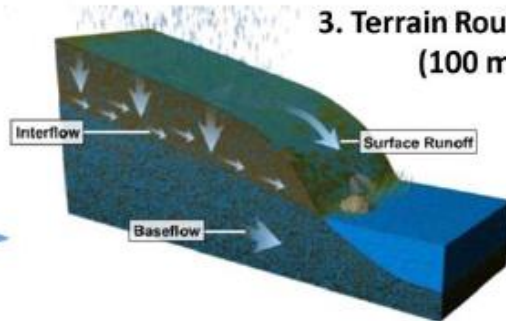
1. NSSL Experimental Radar and NASA/NLDAS2 Forcing Data



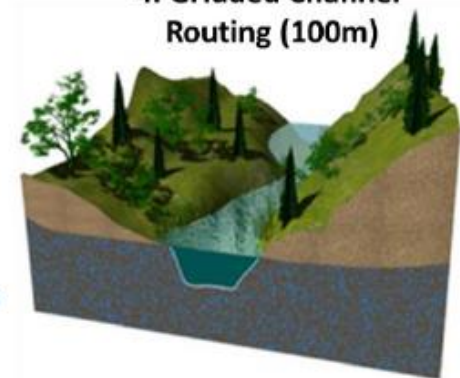
2. NoahMP LSM (1 km grid)



3. Terrain Routing Module (100 m grid)



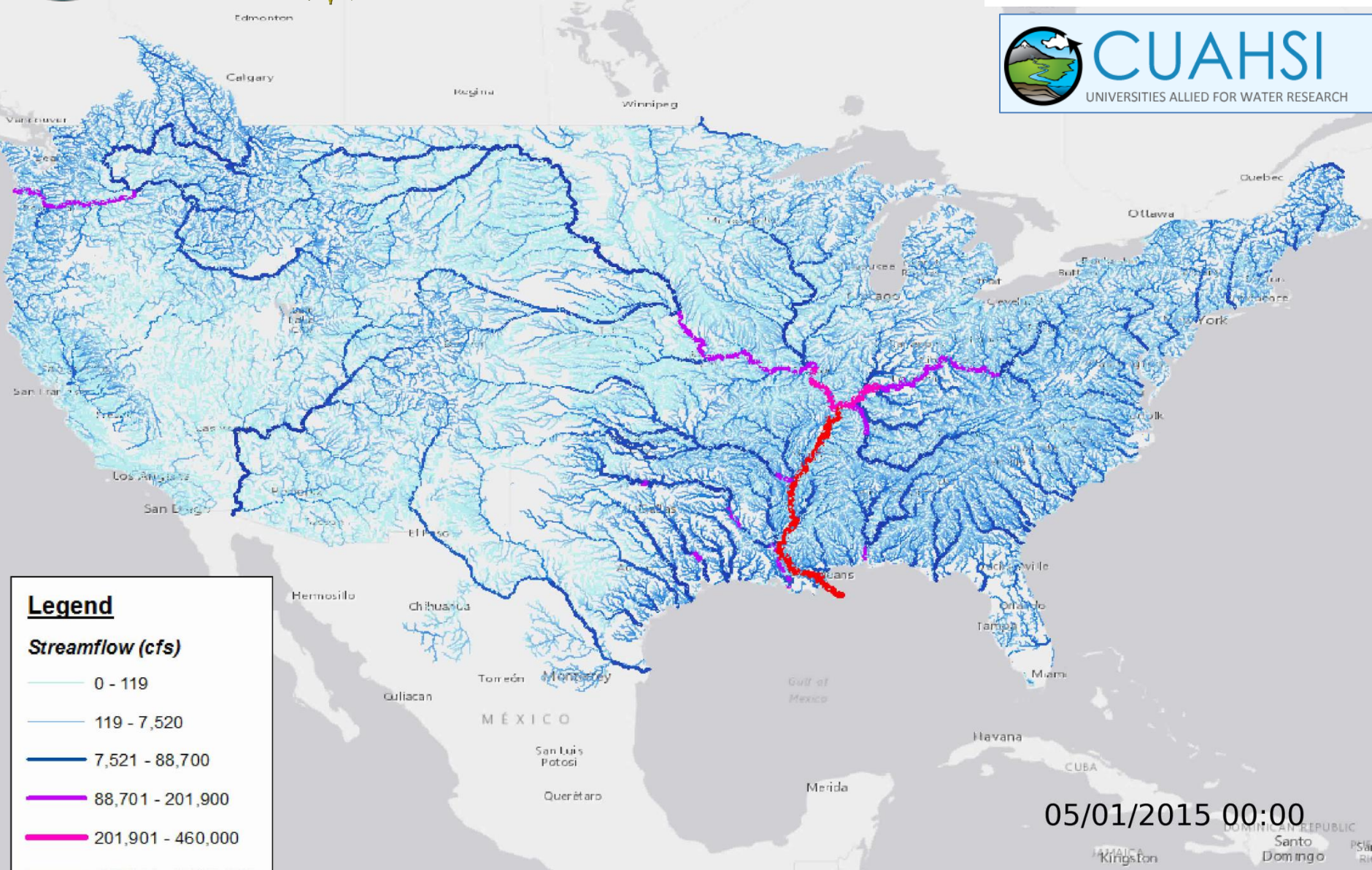
4. Gridded Channel Routing (100m)



2-way coupling



National Water Model



Legend

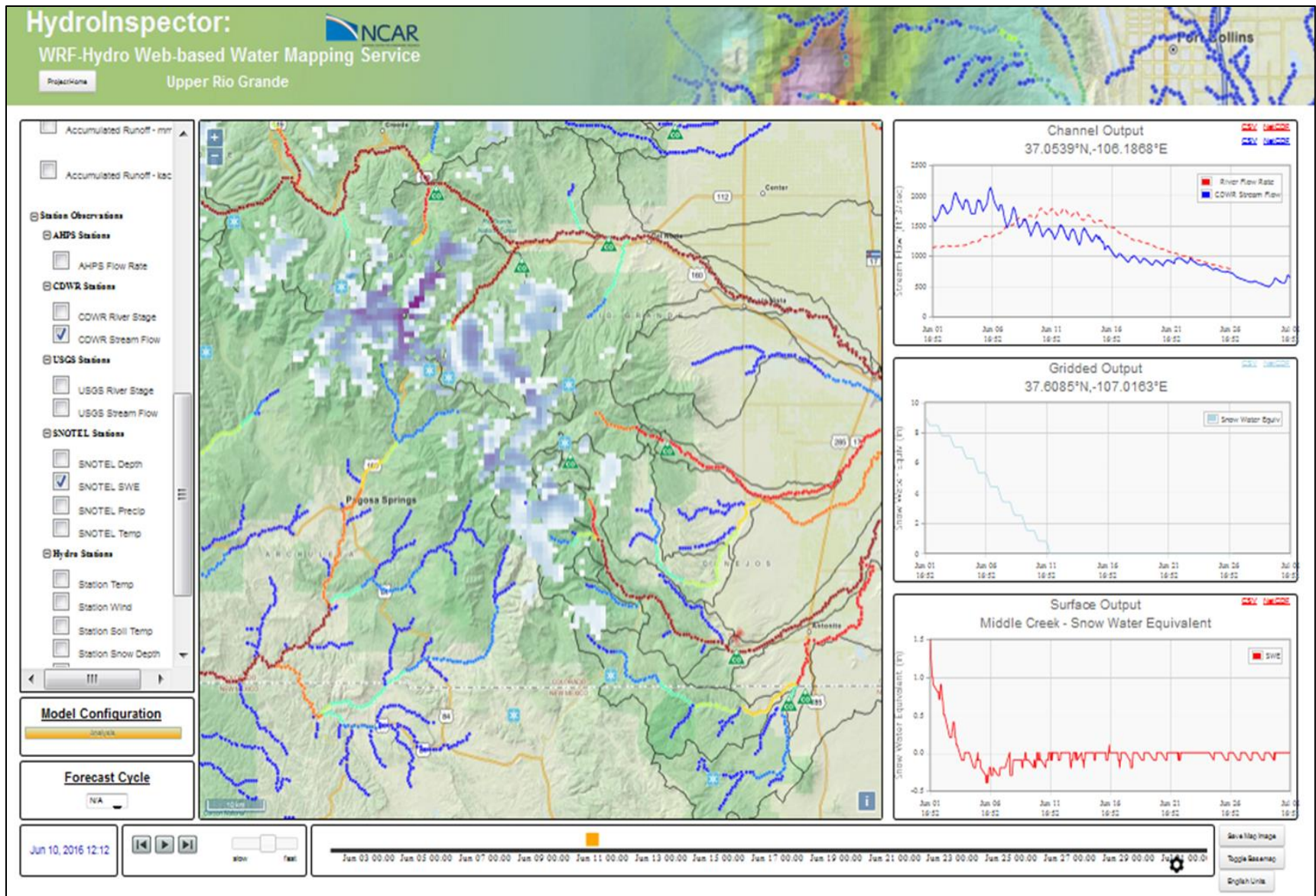
Streamflow (cfs)

- 0 - 119
- 119 - 7,520
- 7,521 - 88,700
- 88,701 - 201,900
- 201,901 - 460,000
- 460,001 - 1,200,000

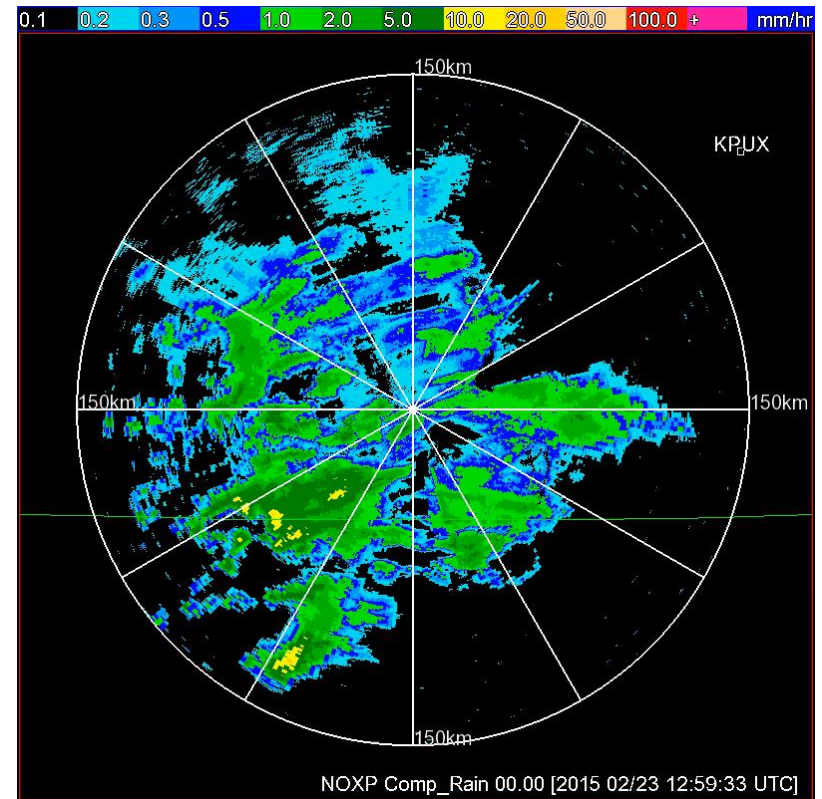
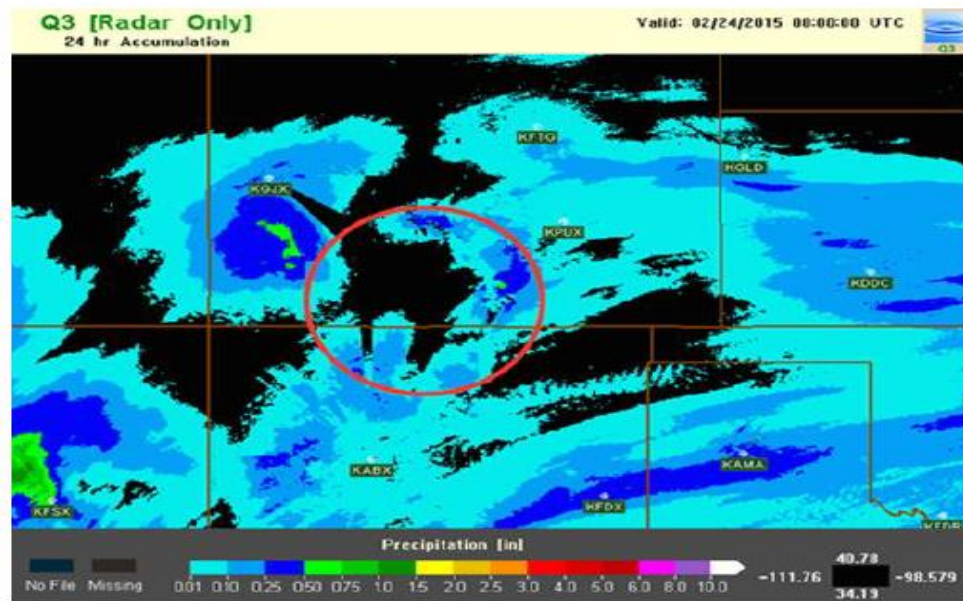
Seamless Simulation of Nation's Hydrologic System

What was learned?

Prototyping a 'Water Data Hub' capability to provide improved Water Intelligence:

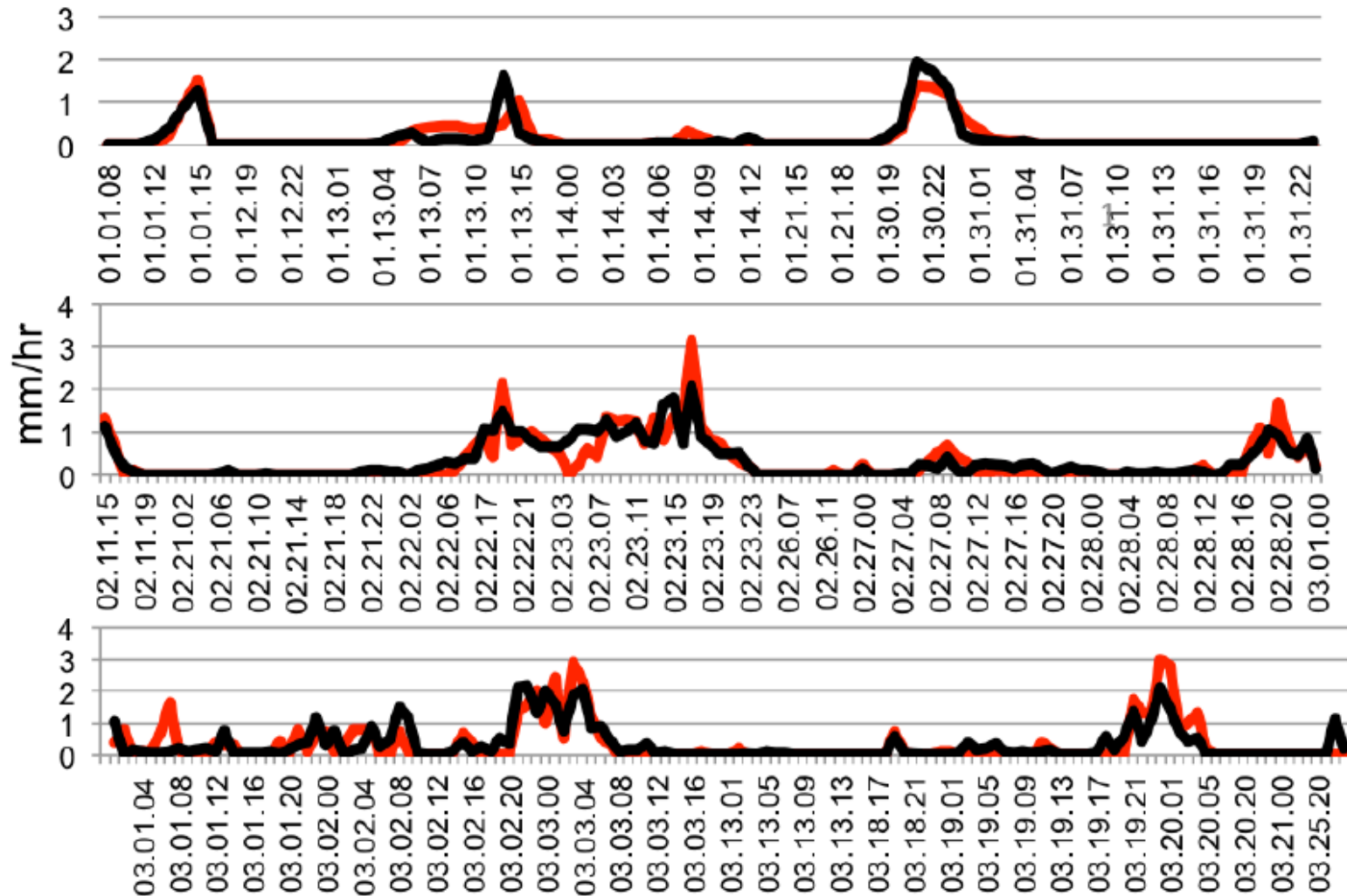


NOAA mobile radar plugged the gap



Radar vs. Rain Gauge

URG6 1hr accumulation vs. QPE 1h accumulation

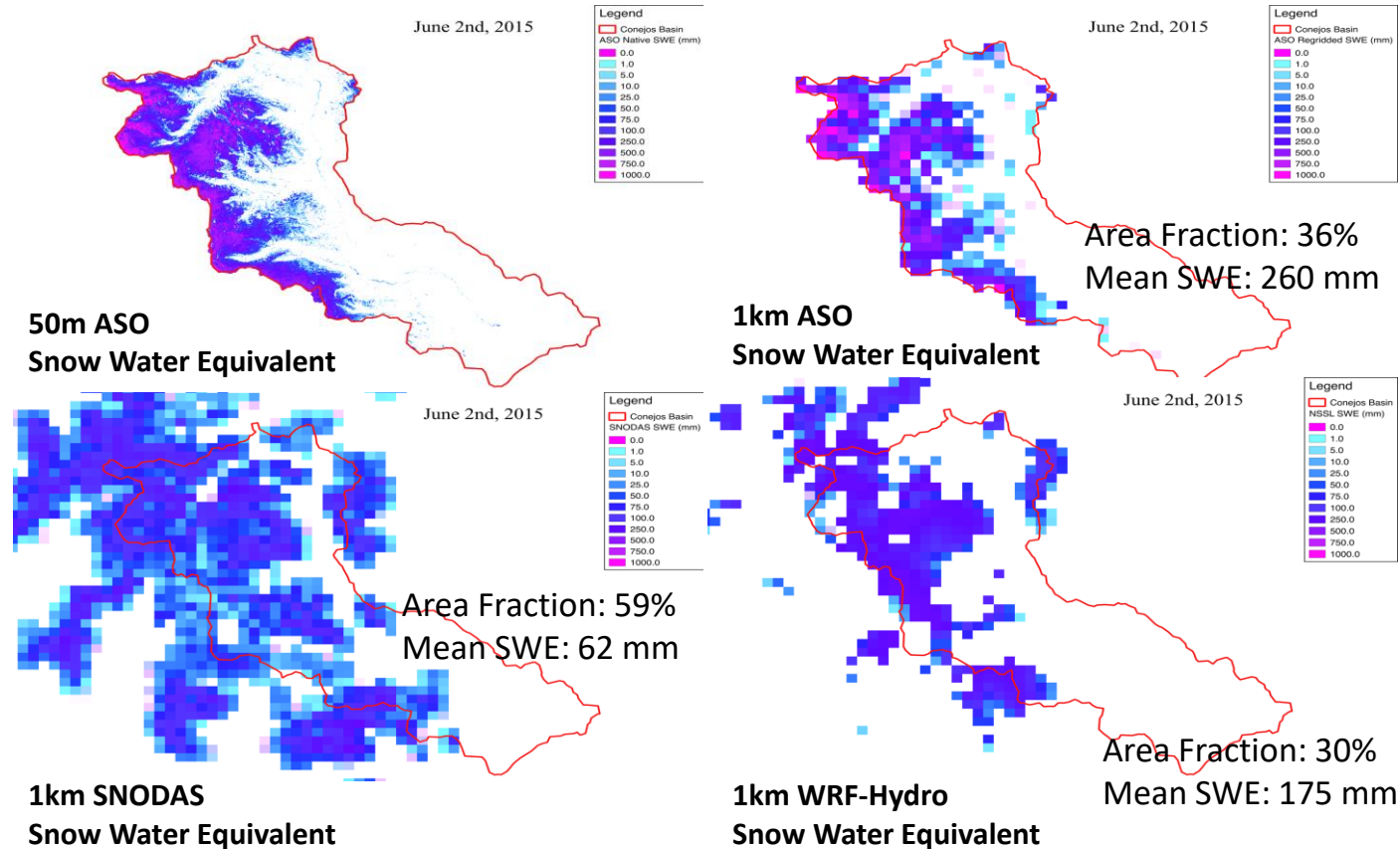


Inter-comparison of Snowpack Estimates:

NOAA/SNODAS, NASA-ASO, WRF-Hydro over Conejos River Basin

- ASO provides unprecedented view of snowpack in Conejos Wilderness

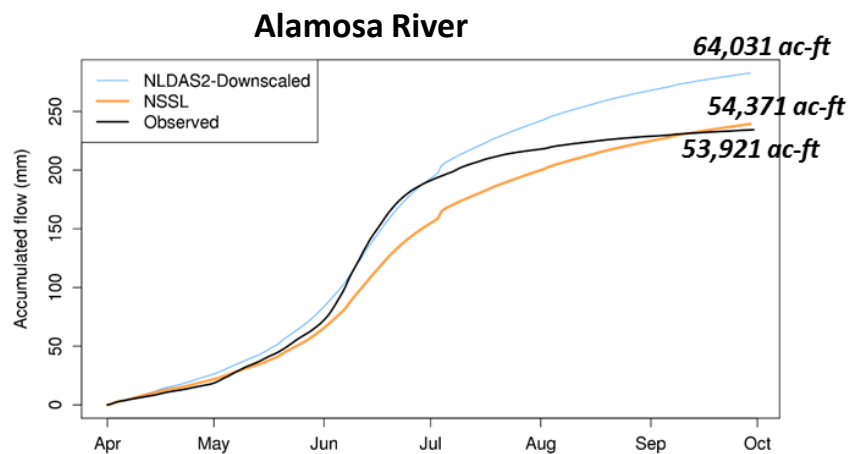
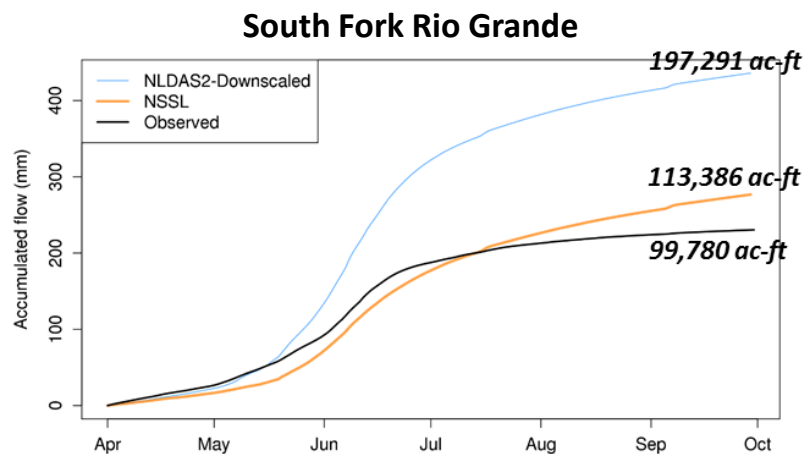
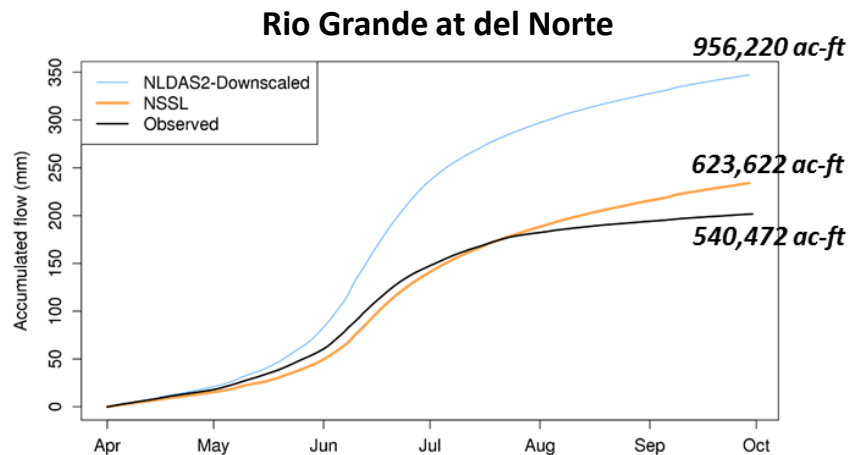
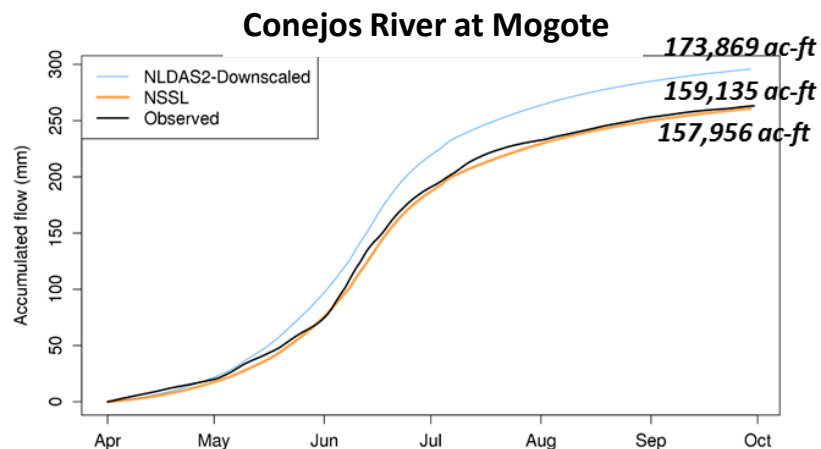
- Gap-filling radar-driven WRF-Hydro simulated snowpack provide better estimate than operational SNODAS



Model Simulated Streamflow:

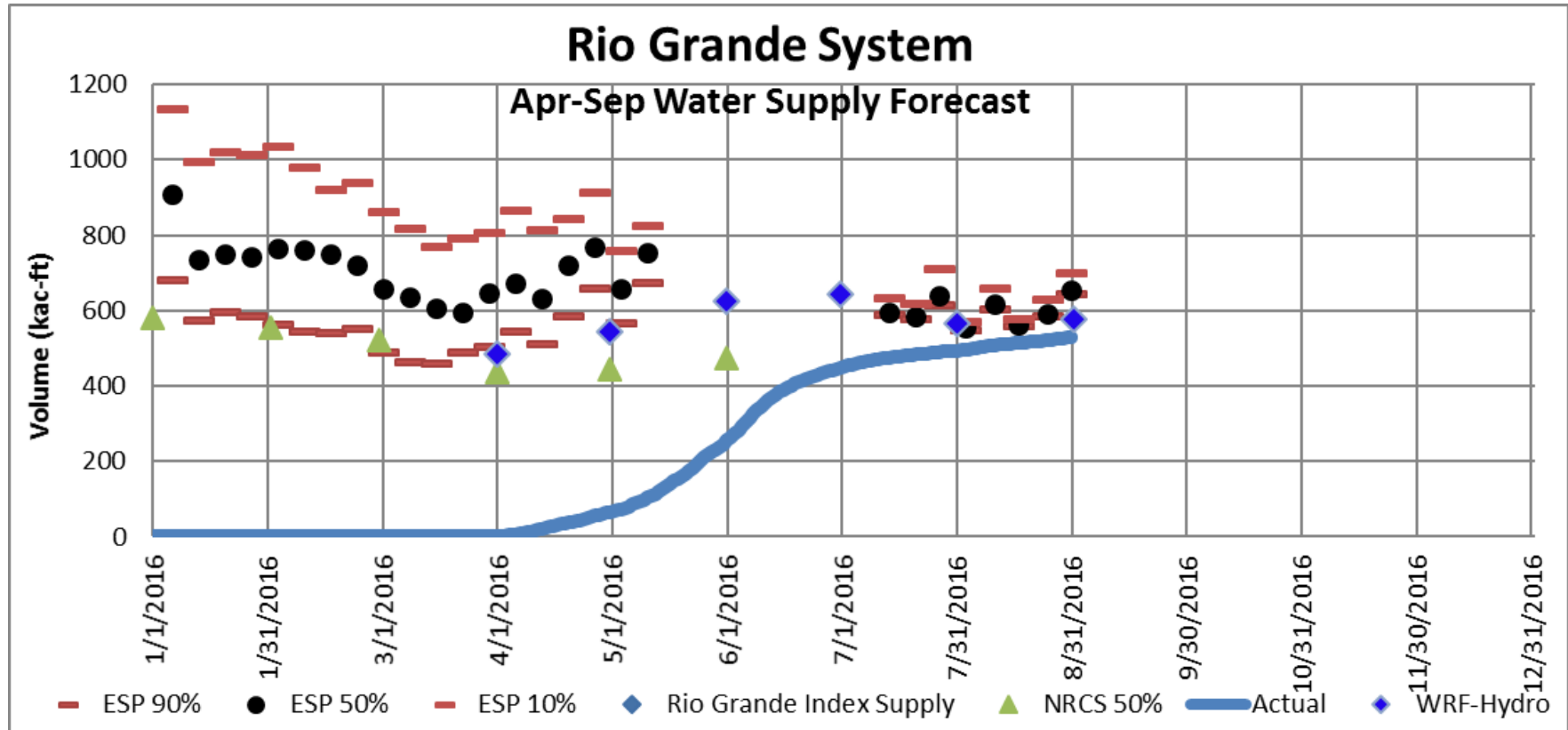
Experimental WRF-Hydro Simulated Accumulated Runoff

.... *uncalibrated....unbias-corrected....*



Year 2: Model predictions...no new data...

Experimental bias-corrected forecasts equal or better than current operational forecasts



"The WRF-Hydro forecast takes into account a much wider range of variables than the older NRCS forecasting technique, and is providing us with more accurate forecasts as we face a changing landscape caused by climate change, beetle kill, and wildfires in our watersheds." - Craig Cotton, CDWR District Engineer for the Upper Rio Grande.

Relevant Outcomes:

- **Successful partnership between local-state-federal-academic participants**
- **From the beginning R2O was ‘baked-in’**
 - **NSSL demonstrates wintertime gap-filling radar QPE relevant for MRMS**
 - **NCAR improved snow model formulation in NWM land surface model**
 - **WGRFC obtained early experience with experimental WRF-Hydro ESPs**
- **Need to expand domain to evaluate robustness *and* quantify how value of improved forecast scales out**