River Forecast Centers provide a broad array of products and services, including short-term forecasts, peak flow forecasts, and seasonal water supply forecasts

- Data and coordination is extremely important
- Every RFC is different, but all provide decision support and welcome stakeholder engagement
- Western RFCs are particularly adept at seasonal water supply forecasting, which impact decisions at all scales

Focused on decision support and providing products and services that aid stakeholders – always looking for ways to improve!
River Forecast Centers

13 River Forecast Centers Nationwide

- Cover the entire Colorado River Basin and eastern portion of the Great Basin
- Reclamation is a primary stakeholder
- Just under 500 daily forecast points
- Progressive water supply program

About 4,000 locations supporting NWS Watch/Warning Program and Water Management
Developing a Forecast
Unique Challenges of the CBRFC

- Topography
  - Snowmelt-driven systems
  - Orographic weather impacts
- Low average annual precipitation
- Large reservoirs
- Basin water exports
- High impact of forecasts increase scrutiny
1981-2015 Unregulated Flow

LAKE POWELL
APR-JUL UNREG INFLOW

- APR-JUL VOLUME
- 5 YEAR AVE
- 10 YEAR AVE
- 71-'00 AVE
- 81-'10 AVE (7160)
- 81-'15 AVE (7010)
Providing Decision Support

• Work with a broad and diverse set of stakeholders, who all have different needs
  – Federal agencies (e.g. Reclamation, USACE)
  – Municipal and Agricultural Water Users
  – State, academic, NGOs

• We are data consumers – we rely on information provided by many of our stakeholders
Providing Decision Support

Short term forecasts provide support for WFOs, resource managers, emergency managers, recreationalists.

Peak flow forecasts help resource managers meet environmental targets, also allow for more time to prepare for flood impacts.

Forecasts of seasonal volumetric flow allow for resource managers to make operational decisions.
We Know The Climate Is Changing

Temperatures are rising and will continue to rise.

Precipitation outlook is uncertain, but we do expect more extreme events.

Decreased water supply, particularly for the Southwest and Colorado River Basin.

Impacts to the Colorado River Basin

Figure from: Christensen and Lettenmaier, 2007. A multimodel ensemble approach to assessment of climate change impacts on the hydrology and water resources of the Colorado River Basin. Hydrology and Earth System Sciences.

Figure from: Hoerling and Eischeid, 2007. Past Peak Water in the Southwest. Southwest Hydrology.

Figure from the IPCC 5th Assessment Report.


Figures from the 2014 National Climate Assessment.
Impacts to the Colorado River Basin

- Temperatures are going to increase
  - About 3 °F to 10 °F over the next 20 – 80 years
  - Southwest is particularly effected

- Precipitation
  - More uncertainty
  - Locally and orographically influenced
  - Southwest could see little change to about a 20% decrease

- Impacts to Streamflow
  - Locally variant, but overall decrease in water supply
  - More rainfall events, less snowfall
  - Earlier runoff
  - Increased evapotranspiration
  - Consensus seems to hover around 8% to 10% decrease over the next 20 – 80 years
  - Extreme events still possible, more likely
Moving Forward

• Incorporation of remotely sensed snow information
  – Aerial extent
  – Dust on snow impacts

• An innovative way to get new information into an old model
No “dust on snow”-informed temperature adjustment

May 2009: simulated flow = too low!

WITH “dust on snow”-informed temperature adjustment

May 2009: snowmelt is earlier and simulated flow = much improved!
Water Management in the West

New map collects water supply forecasts from 6 western RFCs to display seasonal runoff volumes.
More to come...

- Incorporation of an energy balance snow model
  - Working with RTi
  - Utah Energy Balance Model

- Would like to increase use of remotely sensed snow characteristics
  - NASA JPL work
  - GOES Satellite information

- Account for temperature trends in use of historical data

- Working with stakeholder to develop an applied science agenda
Questions?

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Extra Slides
• Climate change attribution
  – Can we start to quantify how much climate change contributes to a particular event?
  – Difficult, but the science is rapidly advancing
    • Comparison with the observational record
    • Comparison to model simulations without anthropogenic climate change