Understanding Sources of Error and Uncertainty
Understanding Sources of Error

• Data
  – Undetected errors in historical/current observations
  – Data density/Gage network distribution
  – Unmeasured Depletions
  – Forecasted Weather Conditions

• Hydrologic Model
  – The model itself
  – Initial Conditions
  – Calibration Error (bias)
• **Gage Issues**
  - Freezing, aquatic growth
  - Malfunctions
  - Flooding issues (gage destroyed, channel changes, etc...)
  - Measurement accuracy

• **Bad data**

• **Missing data**

**Calculated inflow data**
-1 – 15 cfs

**Model simulation**
10 cfs
**Colorado – Dotsero**

- Last visit: 10/17
- Measured vs. rated: 0% diff
- No changes made

**Roaring Fork – Glenwood Springs**

- Last visit: 10/6
- Measured vs. rated: -4.2% diff (~30 cfs)
- No changes made

**Colorado – Glenwood Springs**

- Last visit: 8/13
- Measured vs. rated: -0.4% diff
- New shift applied

**Colorado – Cameo**

- Last visit: 10/16
- Measured vs. rated: -3% diff (~100 cfs)
- No changes made

*These dates are from 2014. The USGS has visited all these sites multiple times since then!*
San Juan – Shiprock
Visited 10/9
New rating downloaded 10/14

San Juan – Four Corners
Visited 10/9
New rating downloaded 10/15

San Juan – Bluff, nr
Visited 10/1
New rating downloaded 10/1

*Again, these dates are from 2014. The USGS has visited all these sites multiple times since then!
Missing Data

PINU1L_F: PINEVIEW RES INFL - Forecast

Model simulation
35 cfs

Modeled Unmeasured Depletion
10 cfs
Missing Data

Reservoir Operations, as best as we know

Observed Pool Elevation – This is how we know we’re close!
• SNOTEL Network
  – Since it became available, has improved accuracy of forecasts
  – In some areas the gage density is better
• All gages ➔
• SNOTEL Network
  - Since it became available, has improved accuracy of forecasts
  - In some areas the gage density is better

• All gages $\geq 7,000$ ft.
SNOTEL Network
- Since it became available, has improved accuracy of forecasts
- In some areas the gage density is better

All gages $\geq 9,000$ ft.
• SNOTEL Network
  – Since it became available, has improved accuracy of forecasts
  – In some areas the gage density is better
• All gages $\geq 10,000$ ft.
DAILY QC 24 HOUR PRECIPITATION ENDING 10/13/2014 12Z

ALL GAGES

SNOTEL ONLY
SNOTEL Issues

- Bad precipitation readings (2014)
  - Columbine
  - Lake Irene
  - Tower
  - Schofield Pass
- Bad pillow readings (2014)
  - Lily Pond
- Changing conditions at the sites
  - Vail Mountain
  - Upper San Juan
Quantitative Precipitation Estimate (QPE)

- Combination of gage, radar, and satellite information
- Coverage can vary based on season
- Despite QA/QC process, incorrect data can slip through
Quantitative Precipitation Estimates (QPE)

GOES Satellite Estimate

Rain Gage Measurement

Radar Estimate

Gridded Precipitation Estimate

Climate patterns

Forecaster Analysis

MM of Precip

0.01 - 10
11 - 20
21 - 30
31 - 40
41 - 50
51 - 60
61 +
We use precipitation forecast out to 5 days

We use temperature forecast out to 10 days

Convective storms are difficult for models to forecast
Unmeasured Depletions

- Representative of water taken from the basin, but not gaged and/or reported
- Function of temperature and irrigated acreage
- An calculated value, not based on actual use that may be occurring
Hydrologic Model

- Current model is basically a temperature index model
  - Could we do better with a more physically based model?
  - A distributed model?
  - Could a different model utilize more and new data in a timely way?
• Seasonal volumes are controlled by SWE and soil moisture
• Do we have SWE right?
  – Mischaracterizing rain vs. snow events
  – Missed precipitation event
• Do we have the soil moisture right?
  – Have we captured baseflow conditions accurately?
  – Has a storm event impacted soil state conditions?
• Initial Conditions can be a source of error
  - Data errors caused by gage malfunction or inaccuracy
  - Missing Data
  - Incorrect model states

• Common errors
  - SWE too high/low, snow or rain?
  - Bad streamflow information
  - Inaccurate precip/temp
  - Reservoir conditions
  - Diversions