NOAA'S COLORADO BASIN RIVER FORECAST CENTER

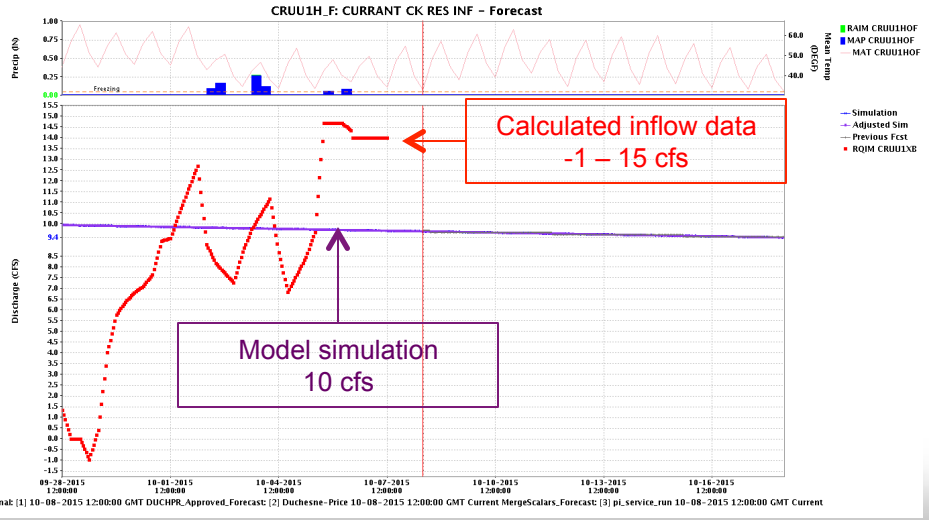
Understanding Sources of Error and Uncertainty

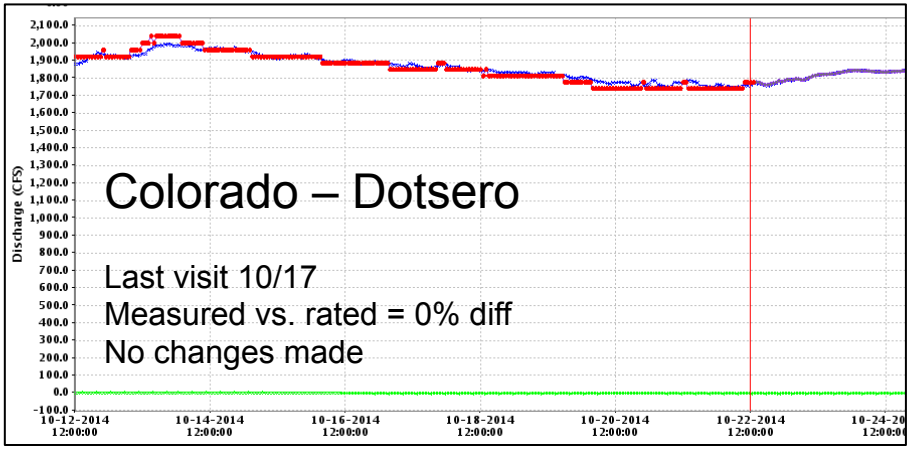
Understanding Sources of Error

- 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)

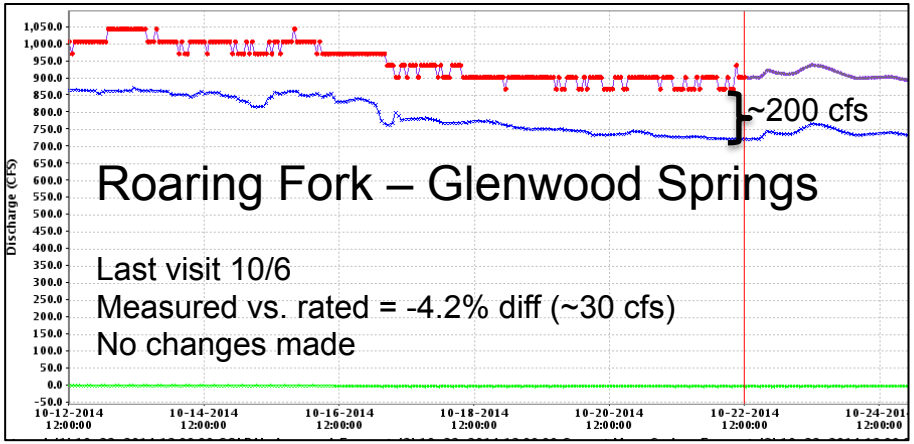
Data

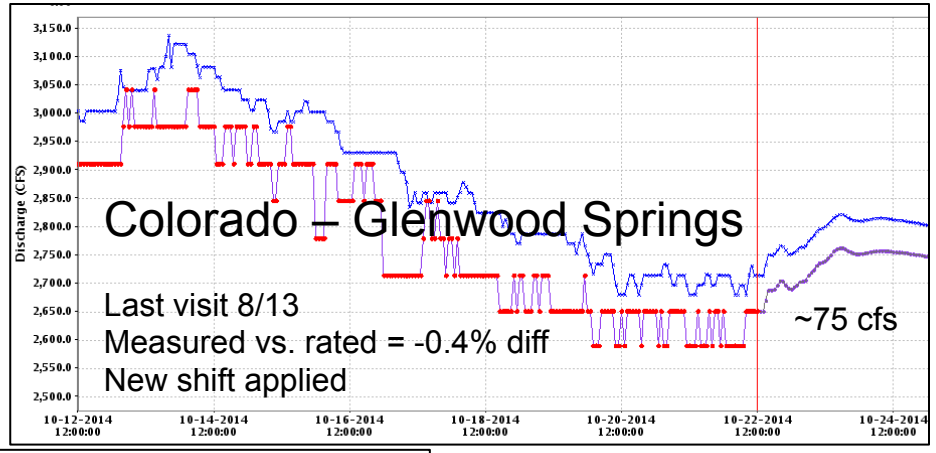
- Gage Issues
  - Freezing, aquatic growth
  - Malfunctions
  - Flooding issues (gage destroyed, channel changes, etc…)
  - Measurement accuracy
- Bad data
- Missing data

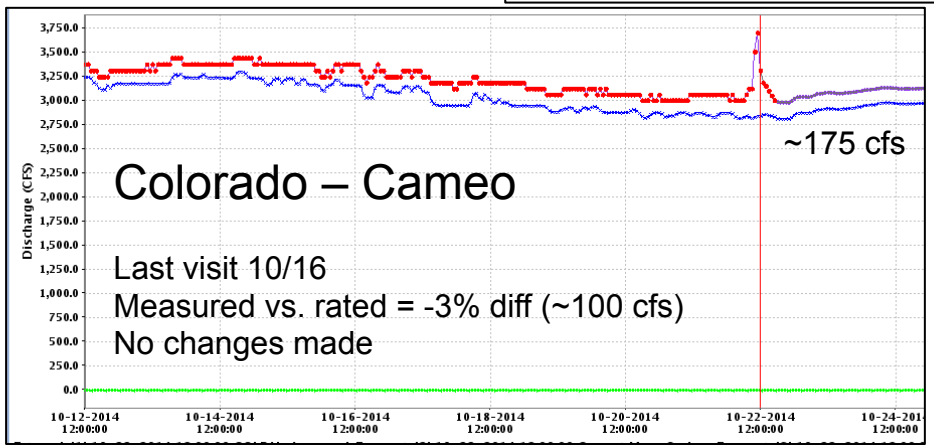




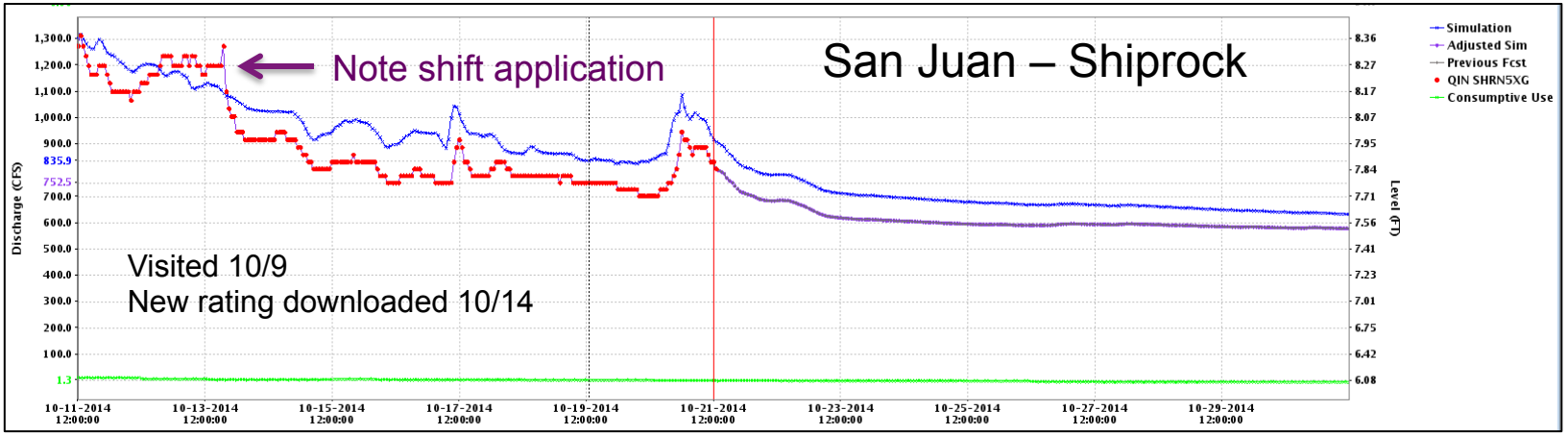
Red = observed
Blue = simulated

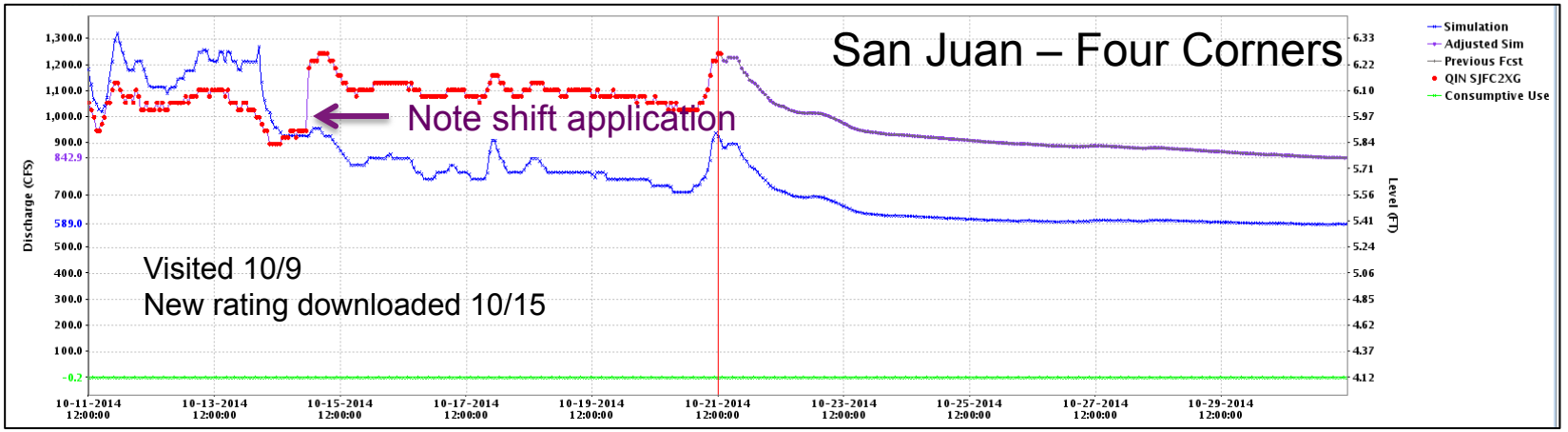


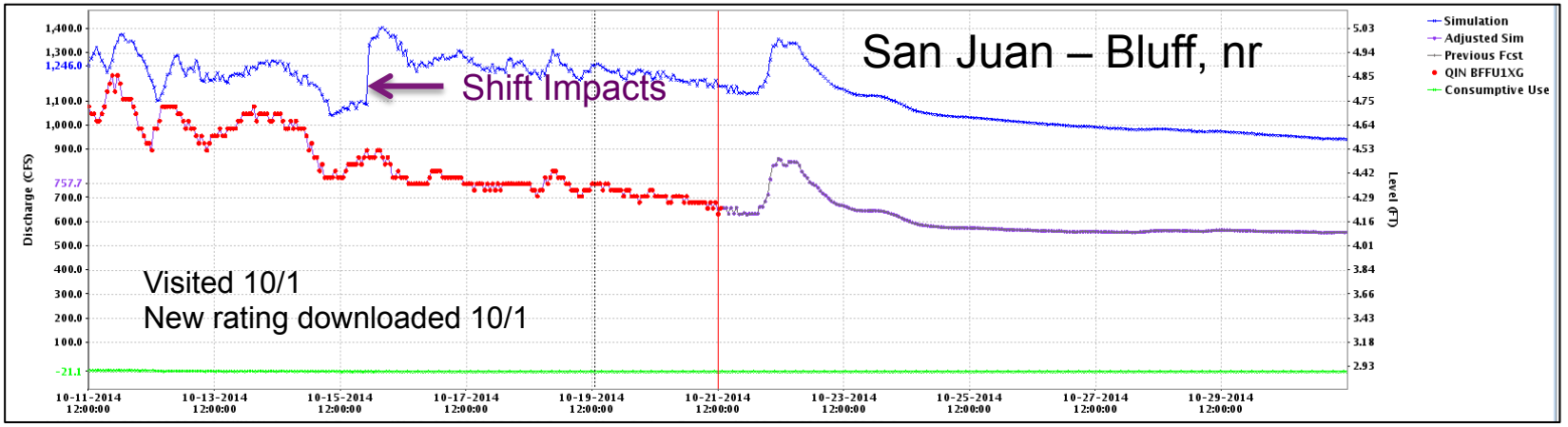




*These dates are from 2014. The USGS has visited all these sites multiple times since then!

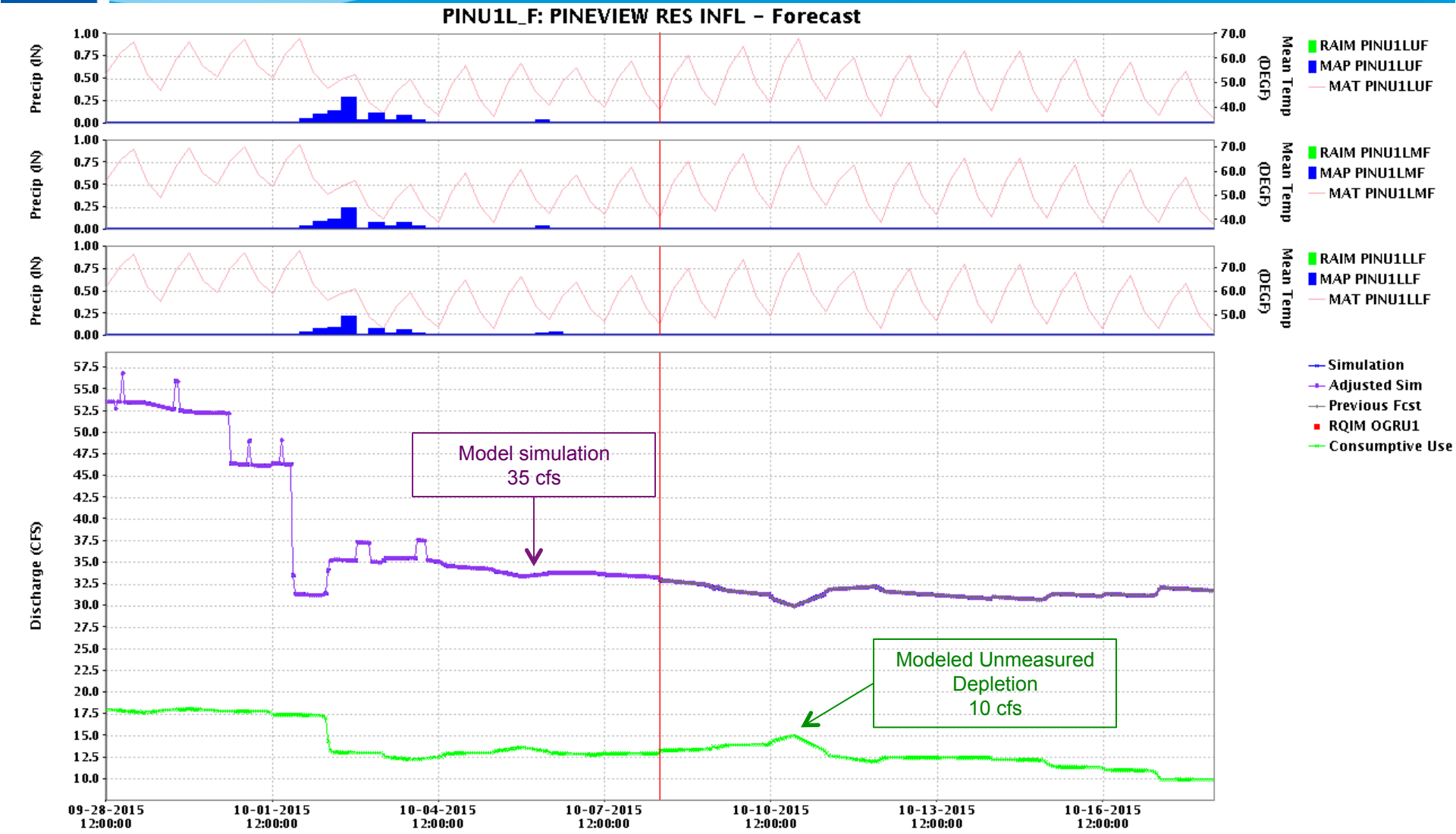




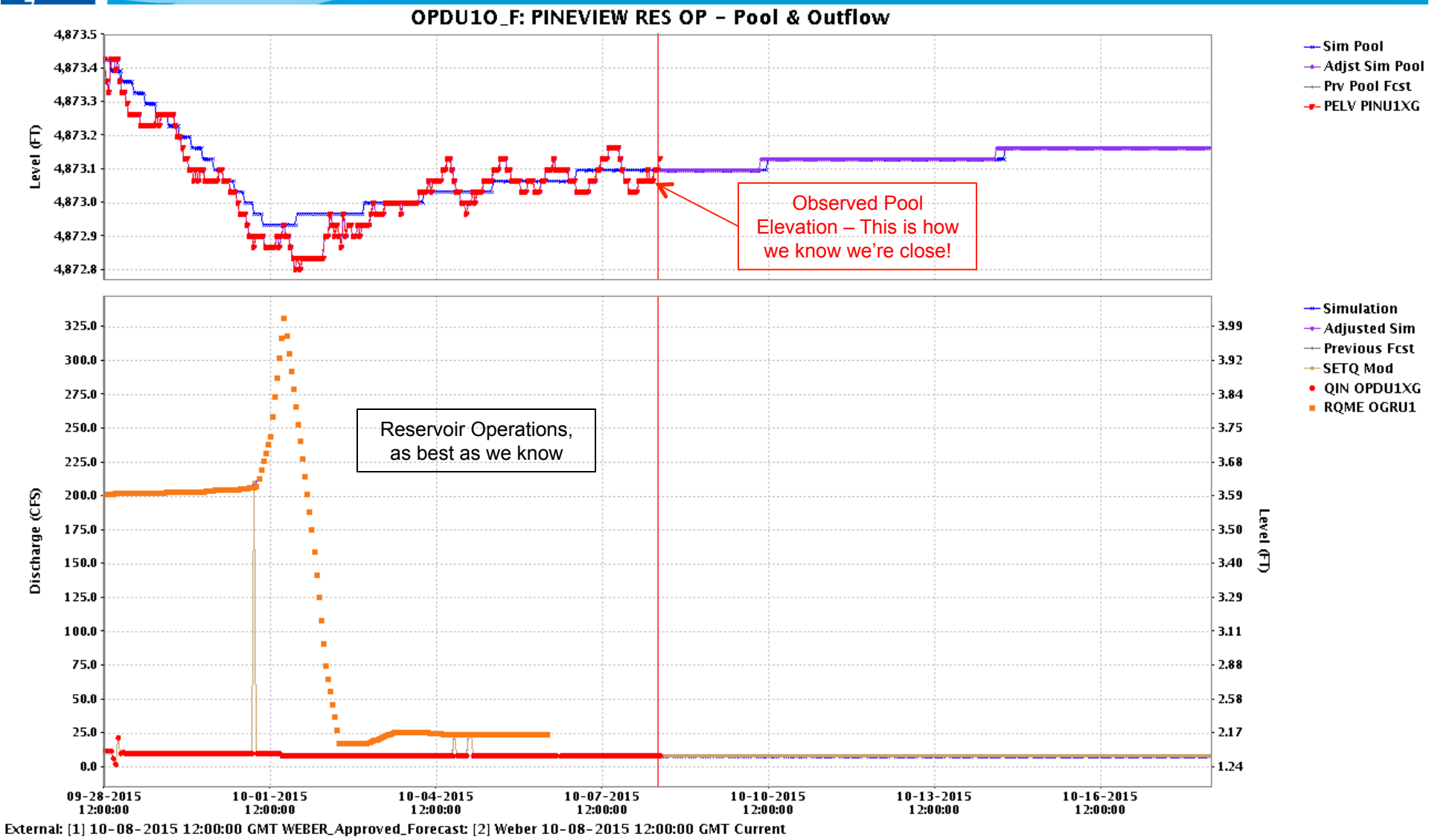


*Again, these dates are from 2014. The USGS has visited all these sites multiple times since then!

Missing Data

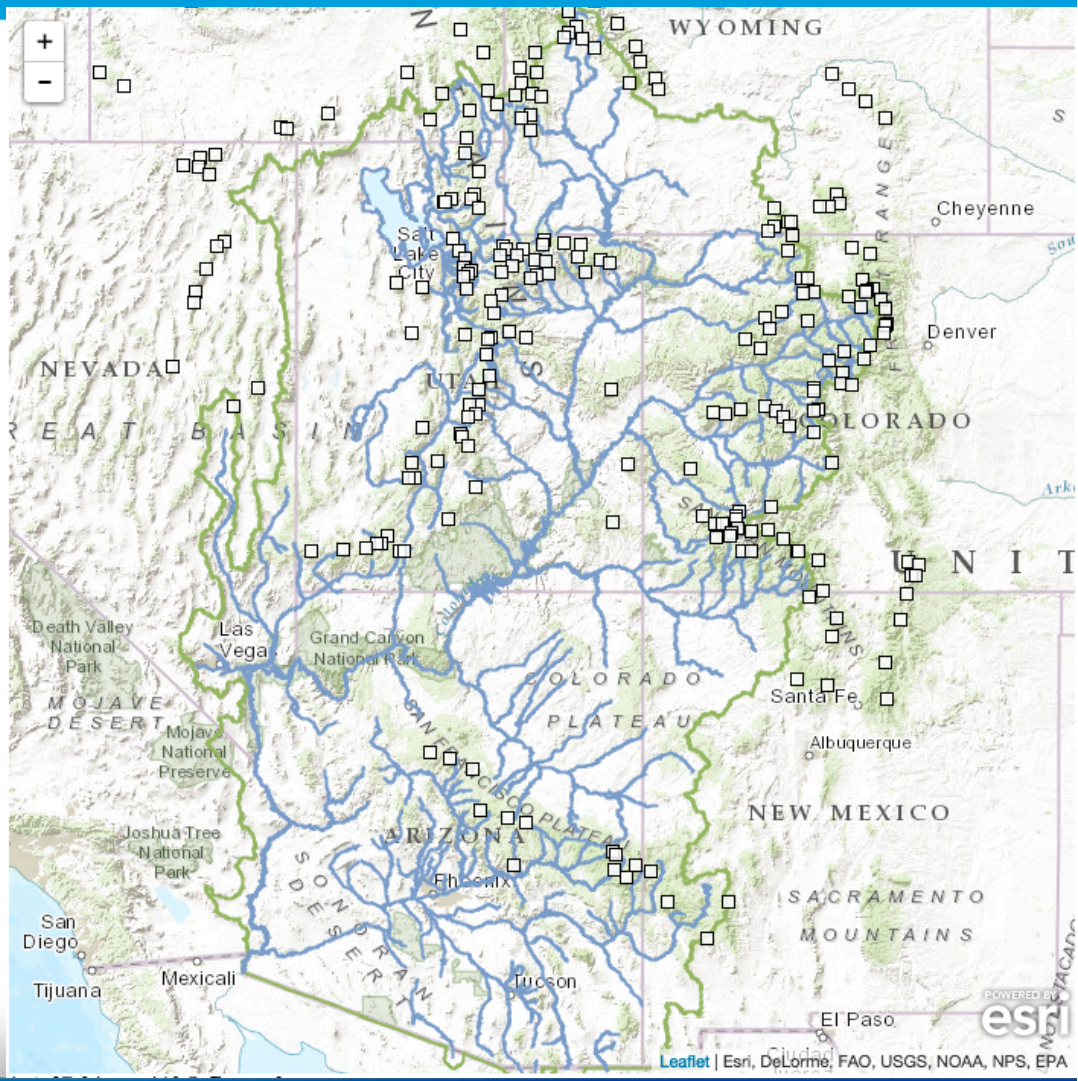


Missing Data



Gage Density

- SNOTEL Network
  - Since it became available, has improved accuracy of forecasts
  - In some areas the gage density is better
- All gages ➔



Gage Density

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

➔

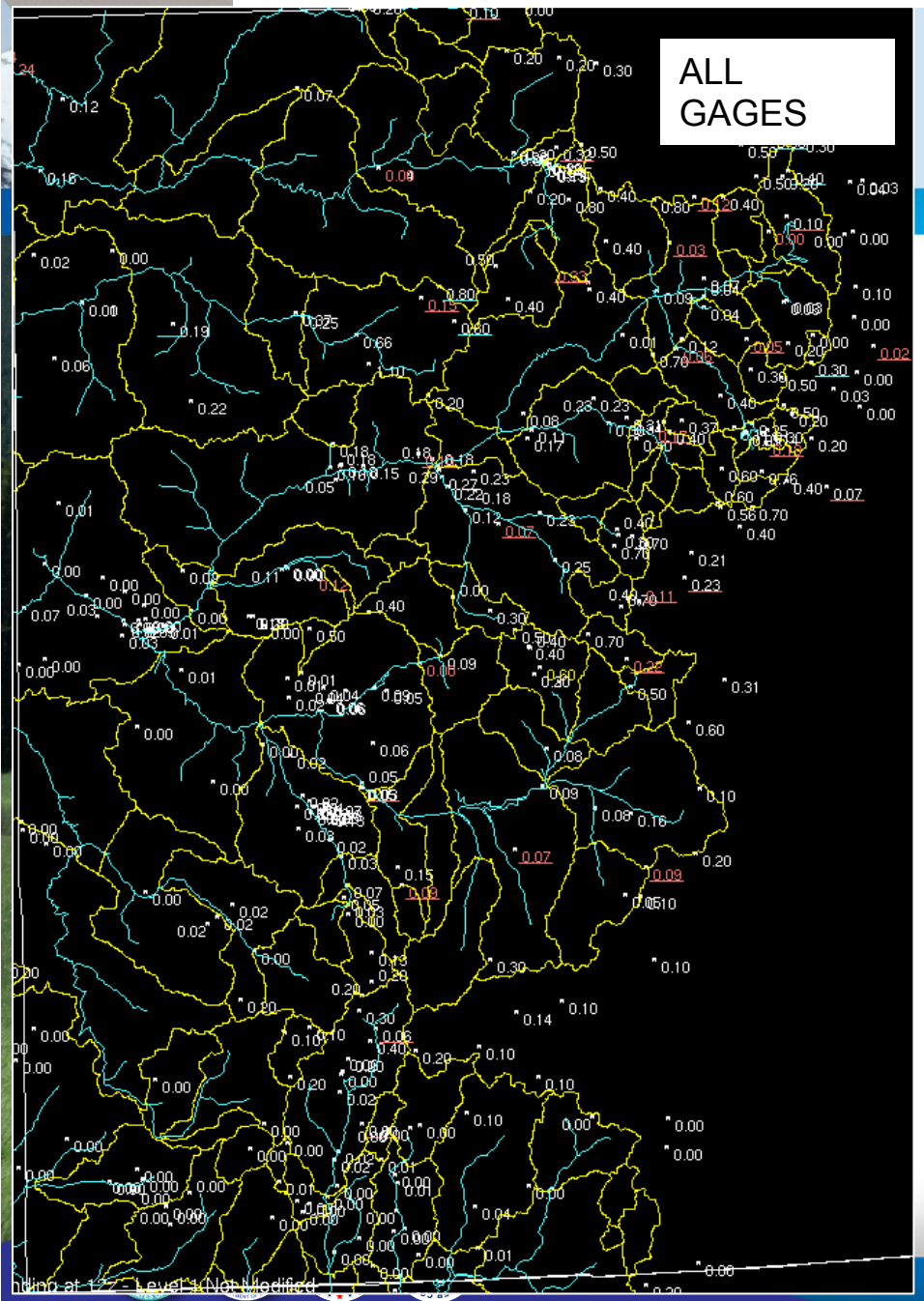
Gage Density

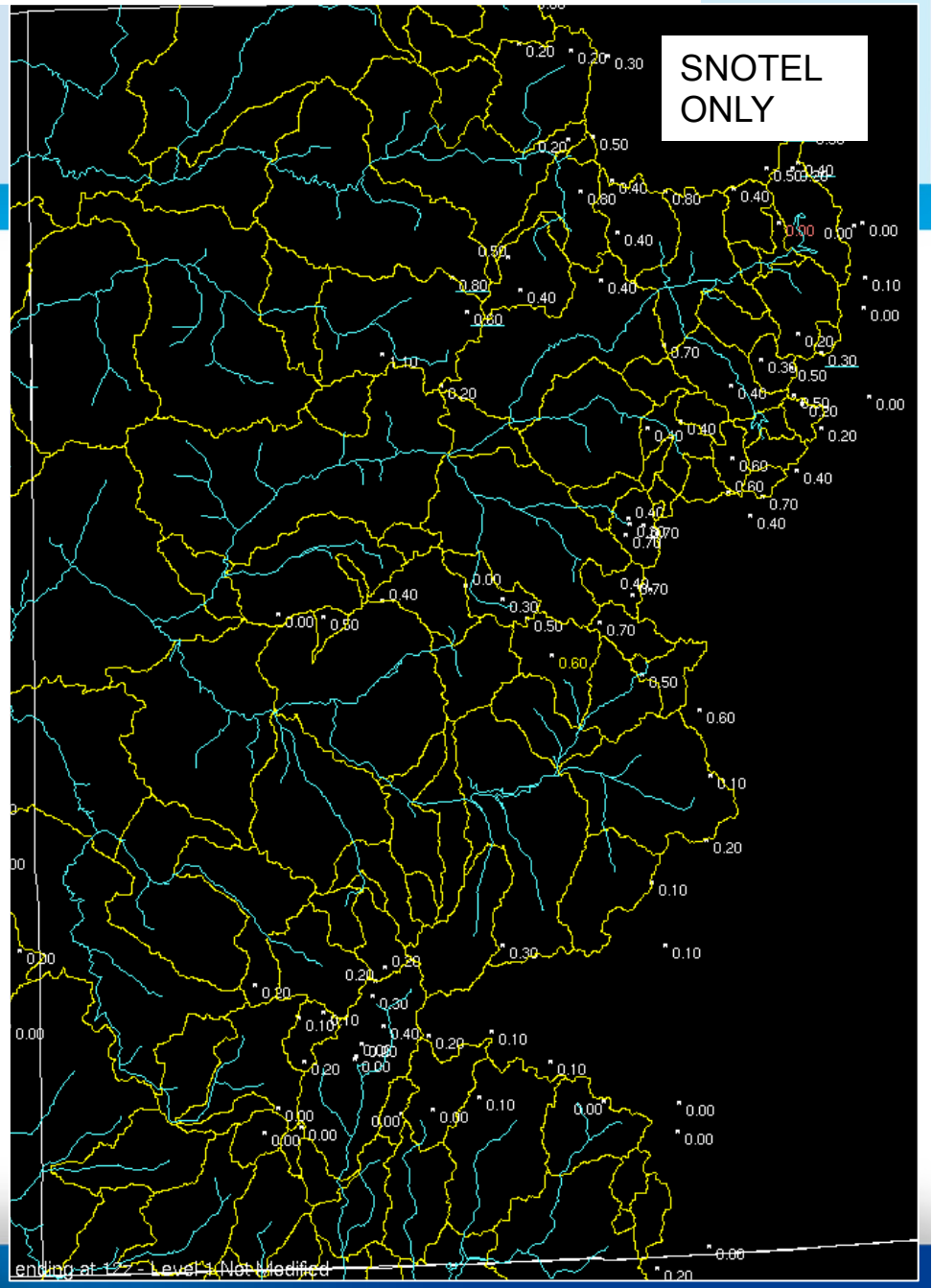
- SNOTEL Network
  - Since it became available, has improved accuracy of forecasts
  - In some areas the gage density is better
- All gages ≥ 9,000 ft. ➔

Gage Density

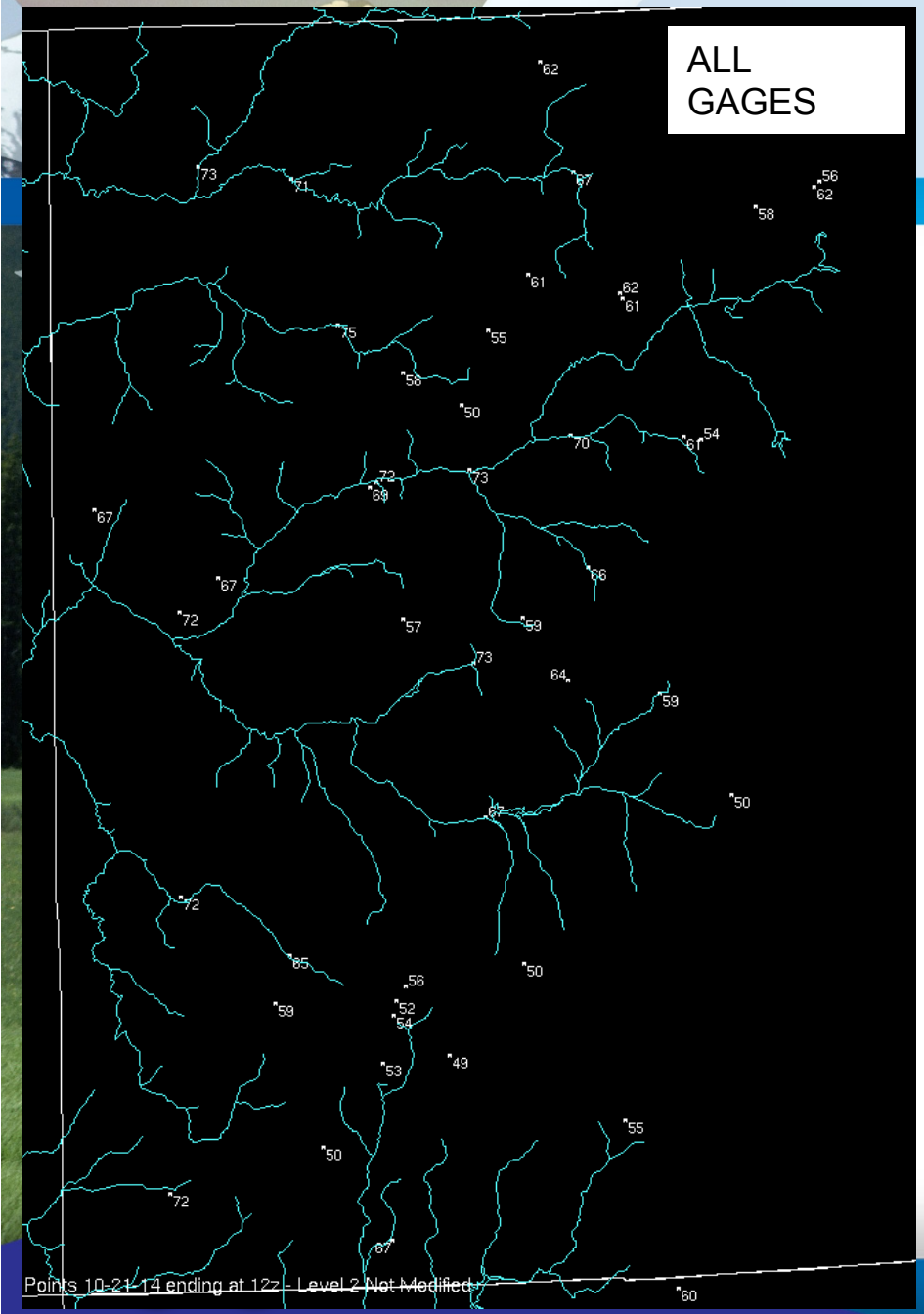
- SNOTEL Network
  - Since it became available, has improved accuracy of forecasts
  - In some areas the gage density is better
- All gages ≥ 10,000 ft. ➔

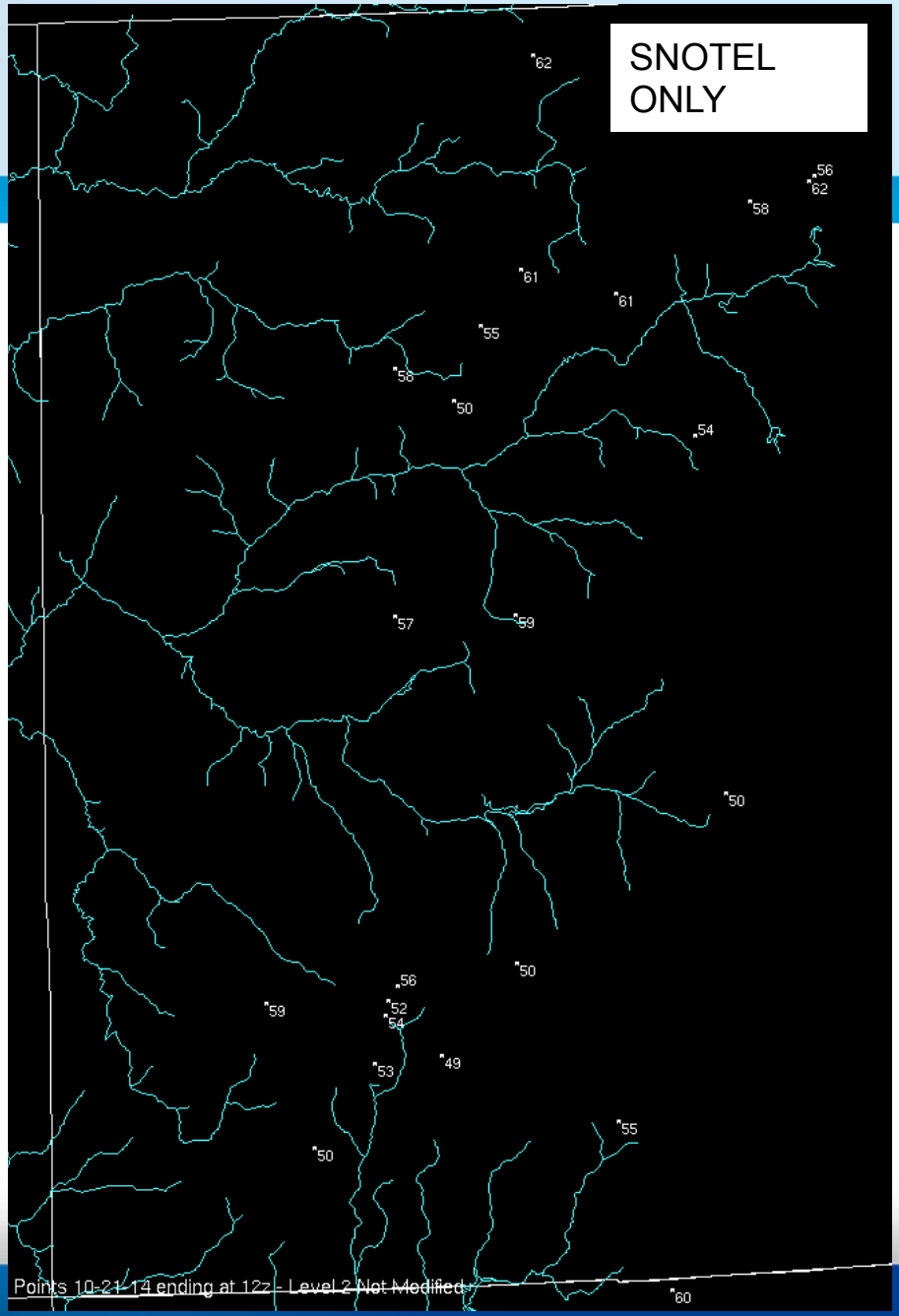
DAILY_QC 24 HOUR PRECIPITATION ENDING 10/13/2014 12Z





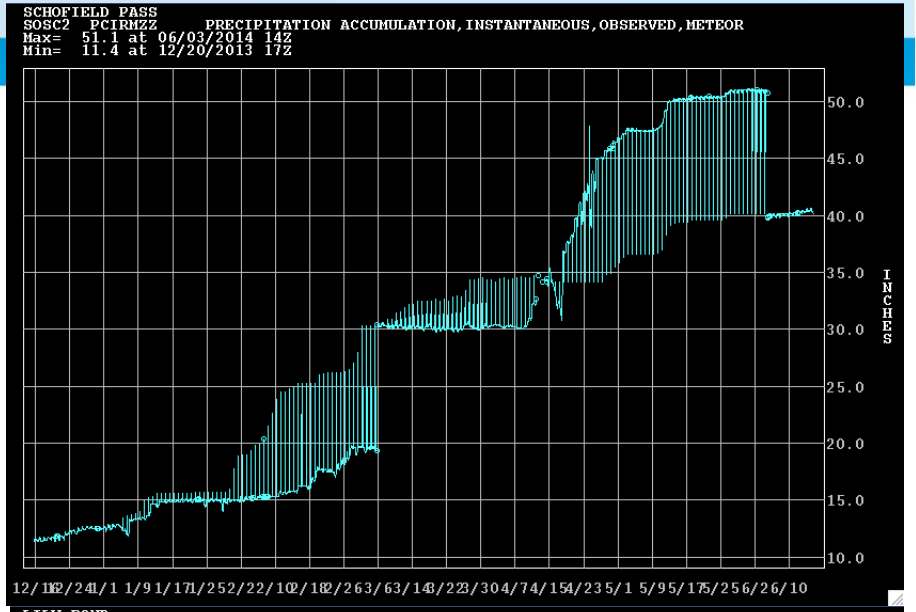
DAILY_QC TEMPERATURE STATIONS

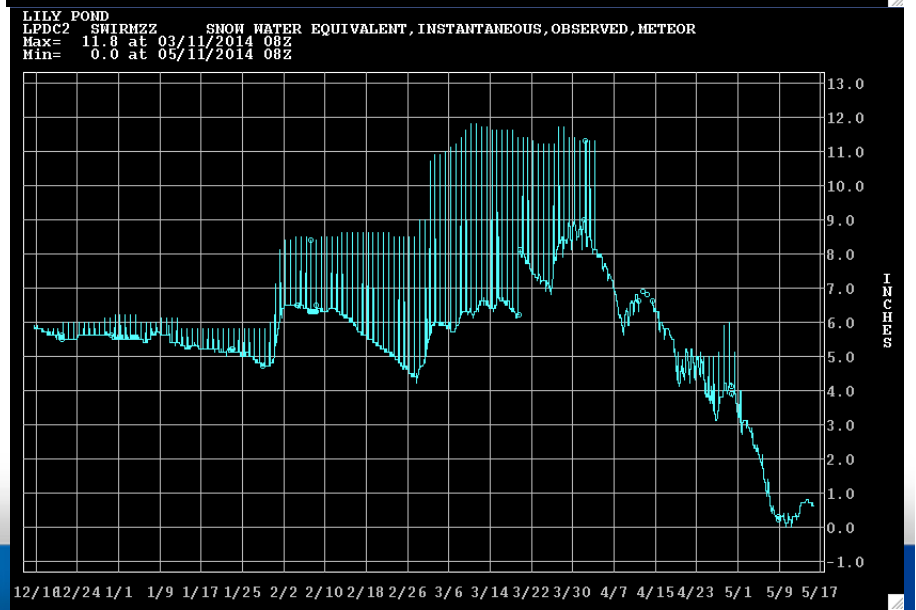


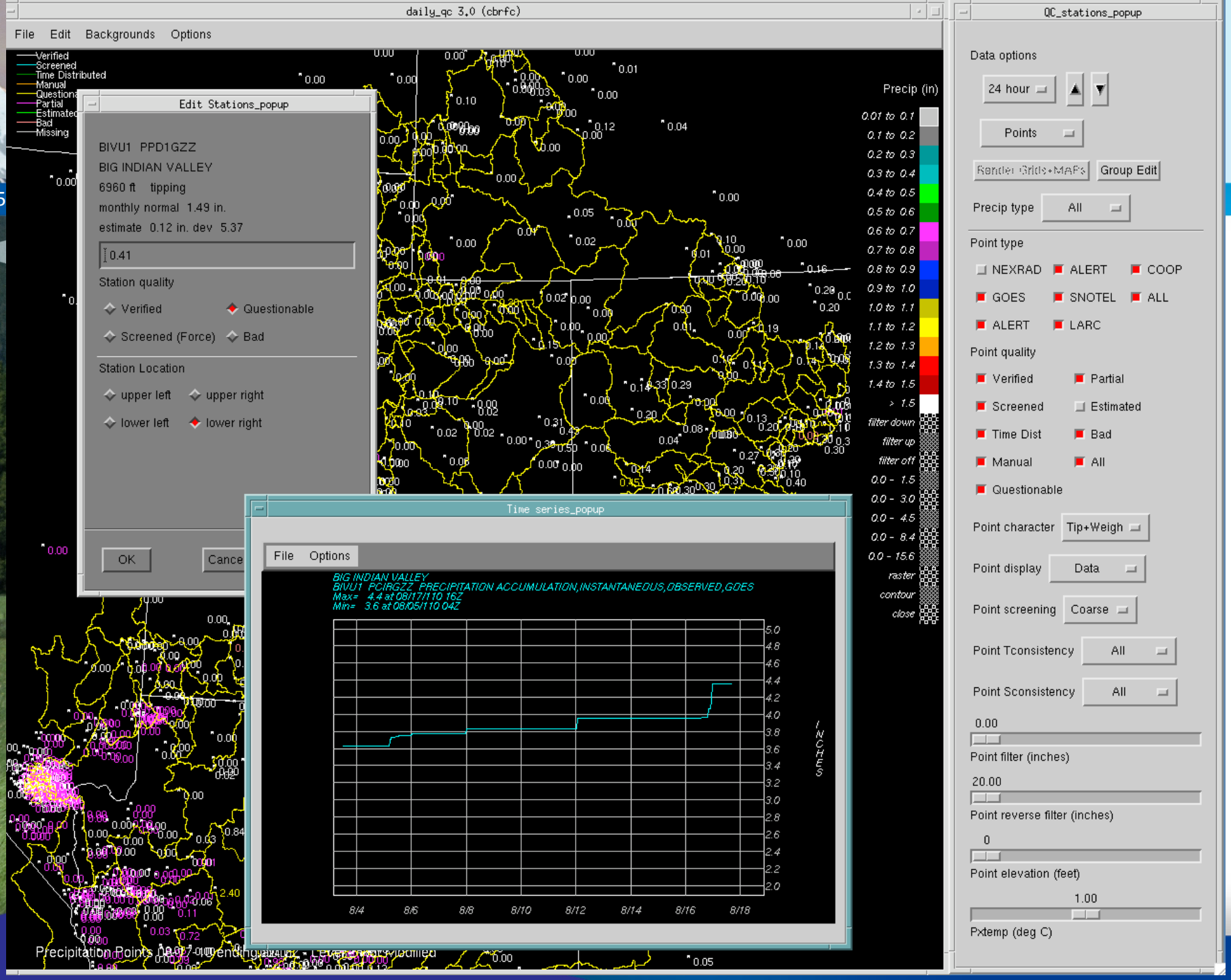


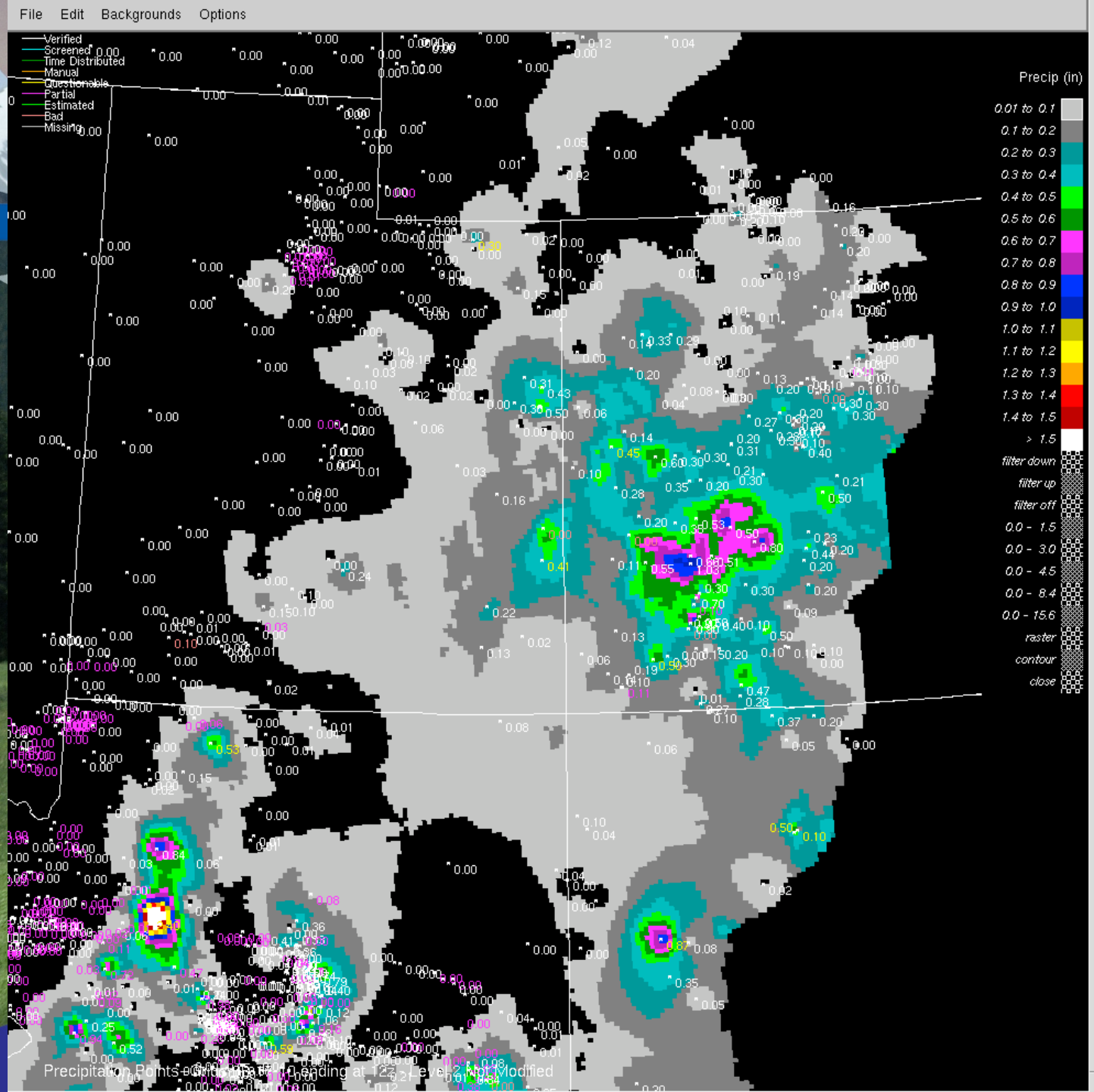
SNOTEL Issues

- 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






daily_qc 3.0 (cbrfc)
File Edit Backgrounds Options
Verified
Screened
Time Distributed
Manual
Questionable
Partial
Estimated
Bad
Missing
Edit Stations_popup
BIVU1 PPD1GZZ
BIG INDIAN VALLEY
6960 ft tipping
monthly normal 1.49 in.
estimate 0.12 in. dev 5.37
0.41
Station quality
Verified
Questionable
Screened (Force)
Bad
Station Location
upper left
upper right
lower left
lower right
OK
Cance
Precip (in)
0.01 to 0.1
0.1 to 0.2
0.2 to 0.3
0.3 to 0.4
0.4 to 0.5
0.5 to 0.6
0.6 to 0.7
0.7 to 0.8
0.8 to 0.9
0.9 to 1.0
1.0 to 1.1
1.1 to 1.2
1.2 to 1.3
1.3 to 1.4
1.4 to 1.5
> 1.5
filter down
filter up
filter off
0.0 - 1.5
0.0 - 3.0
0.0 - 4.5
0.0 - 8.4
0.0 - 15.6
raster
contour
close
Time series_popup
File Options
BIG INDIAN VALLEY
BIVU1 PCIRGZZ PRECIPITATION ACCUMULATION,INSTANTANEOUS,OBSERVED,GOES
Max= 4.4 at 08/17/110 16Z
Min= 3.6 at 08/05/110 04Z
5.0
4.8
4.6
4.4
4.2
4.0
3.8
3.6
3.4
3.2
3.0
2.8
2.6
2.4
2.2
2.0
INCHES
8/4
8/6
8/8
8/10
8/12
8/14
8/16
8/18
QC_stations_popup
Data options
24 hour
Points
Render Grids+MAPs
Group Edit
Precip type
All
Point type
NEXRAD
ALERT
COOP
GOES
SNOTEL
ALL
ALERT
LARC
Point quality
Verified
Partial
Screened
Estimated
Time Dist
Bad
Manual
All
Questionable
Point character
Tip+Weigh
Point display
Data
Point screening
Coarse
Point Tconsistency
All
Point Sconsistency
All
0.00
Point filter (inches)
20.00
Point reverse filter (inches)
0
Point elevation (feet)
1.00
Pxtemp (deg C)
Precipitation Points



Data options

24 hour

Points+Grids

Render Grids+MAPS | Group Edit

Precip type: All

Point type

- NEXRAD
- ALERT
- COOP
- GOES
- SNOTEL
- ALL
- ALERT
- LARC

Point quality

- Verified
- Partial
- Screened
- Estimated
- Time Dist
- Bad
- Manual
- All
- Questionable

Point character: Tip+Weigh

Point display: Data

Point screening: Coarse

Point Tconsistency: All

Point Sconsistency: All

0.00

Point filter (inches)

20.00

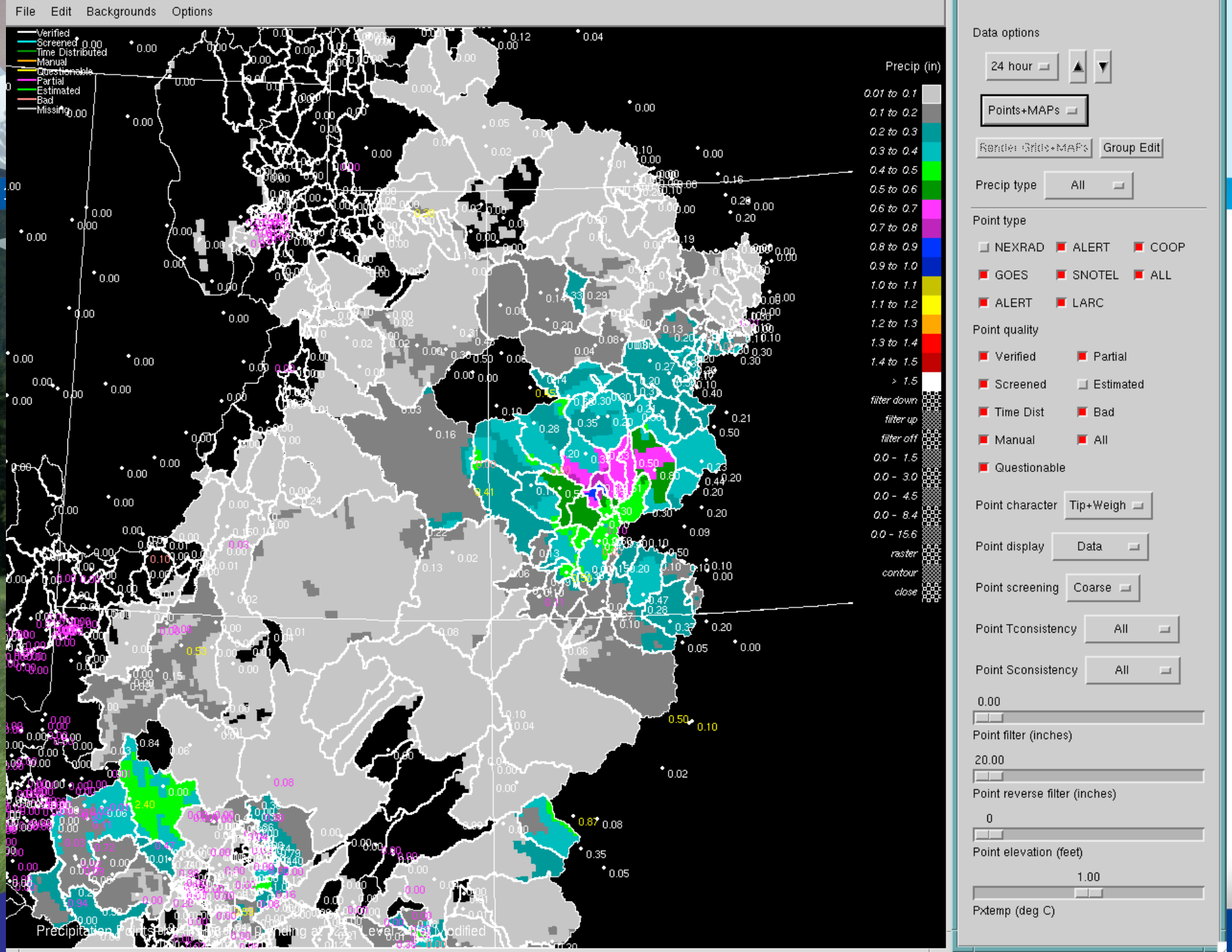
Point reverse filter (inches)

0

Point elevation (feet)

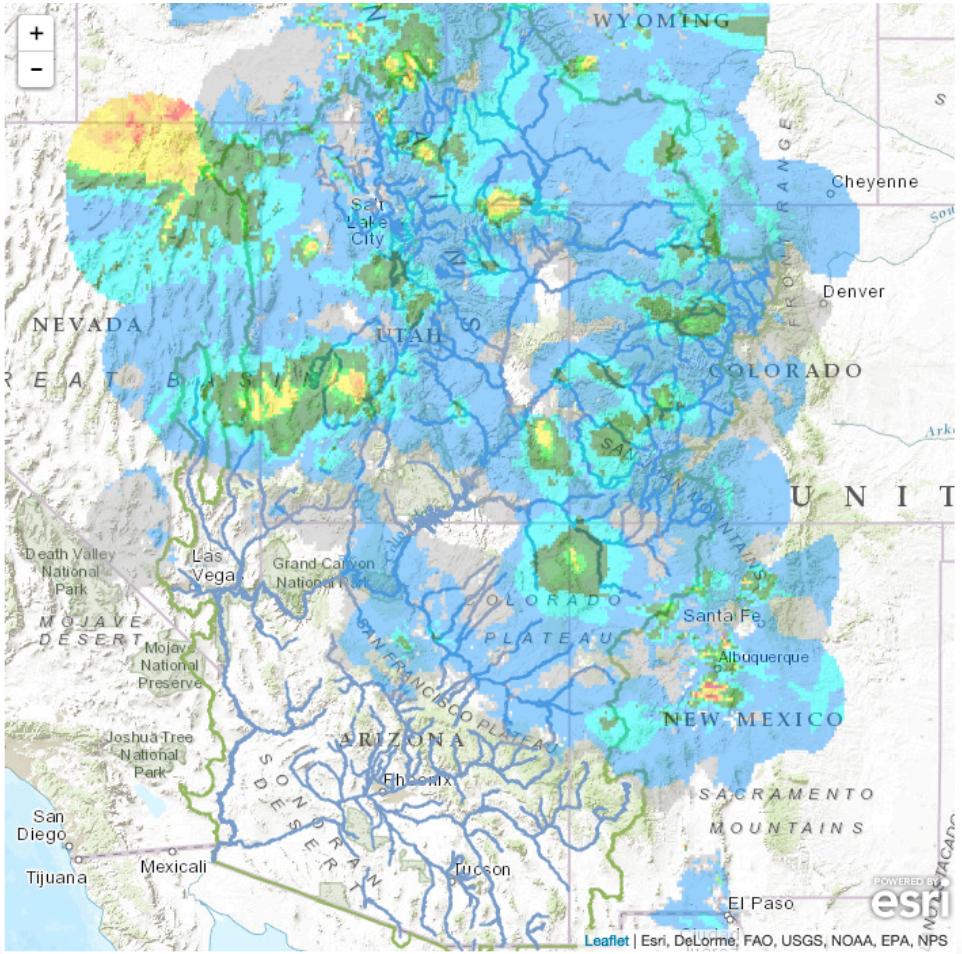
1.00

Pxtemp (deg C)


File
Edit
Backgrounds
Options
Verified
Screened
Time Distributed
Manual
Questionable
Partial
Estimated
Bad
Missing
Precip (in)
0.01 to 0.1
0.1 to 0.2
0.2 to 0.3
0.3 to 0.4
0.4 to 0.5
0.5 to 0.6
0.6 to 0.7
0.7 to 0.8
0.8 to 0.9
0.9 to 1.0
1.0 to 1.1
1.1 to 1.2
1.2 to 1.3
1.3 to 1.4
1.4 to 1.5
> 1.5
filter down
filter up
filter off
0.0 - 1.5
0.0 - 3.0
0.0 - 4.5
0.0 - 8.4
0.0 - 15.6
raster
contour
close
Data options
24 hour
Points+MAPs
Render Grids+MAPs
Group Edit
Precip type
All
Point type
NEXRAD
ALERT
COOP
GOES
SNOTEL
ALL
ALERT
LARC
Point quality
Verified
Partial
Screened
Estimated
Time Dist
Bad
Manual
All
Questionable
Point character
Tip+Weigh
Point display
Data
Point screening
Coarse
Point Tconsistency
All
Point Sconsistency
All
0.00
Point filter (inches)
20.00
Point reverse filter (inches)
0
Point elevation (feet)
1.00
Pxtemp (deg C)

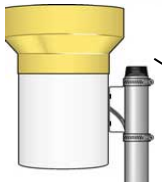
Quantitative Precipitation Estimate (QPE)

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

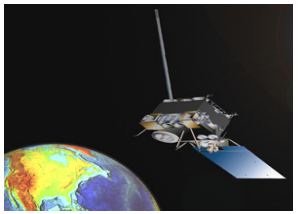


Quantitative Precipitation Estimates (QPE)

Rain Gage Measurement

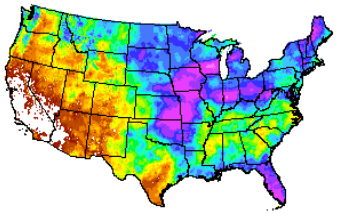


GOES Satellite Estimate



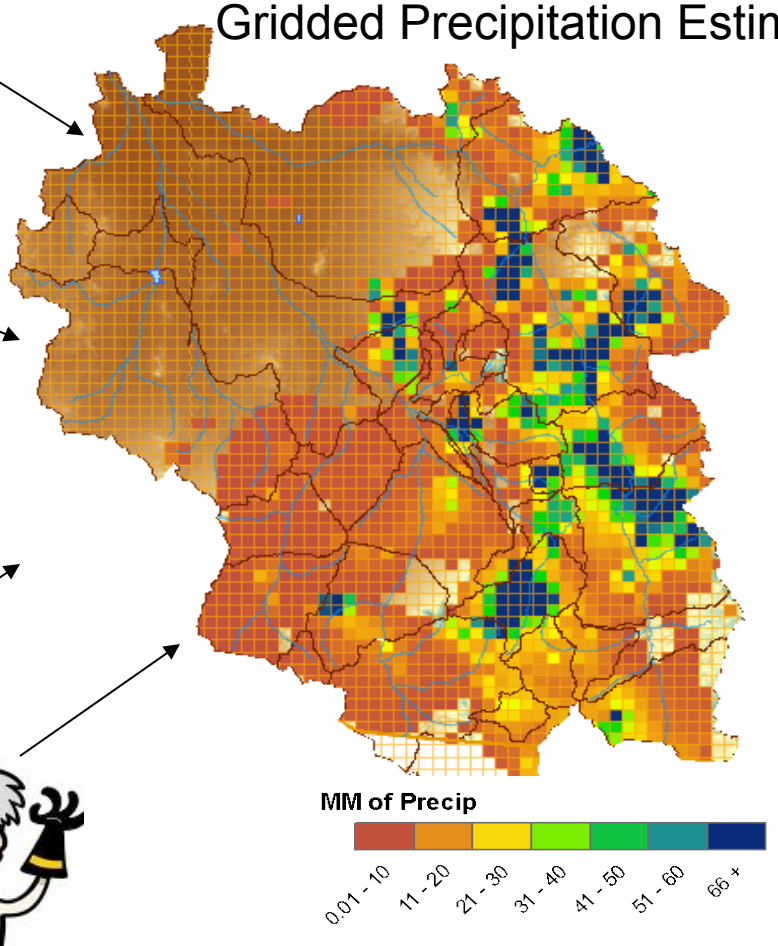
Radar Estimate

Climate patterns



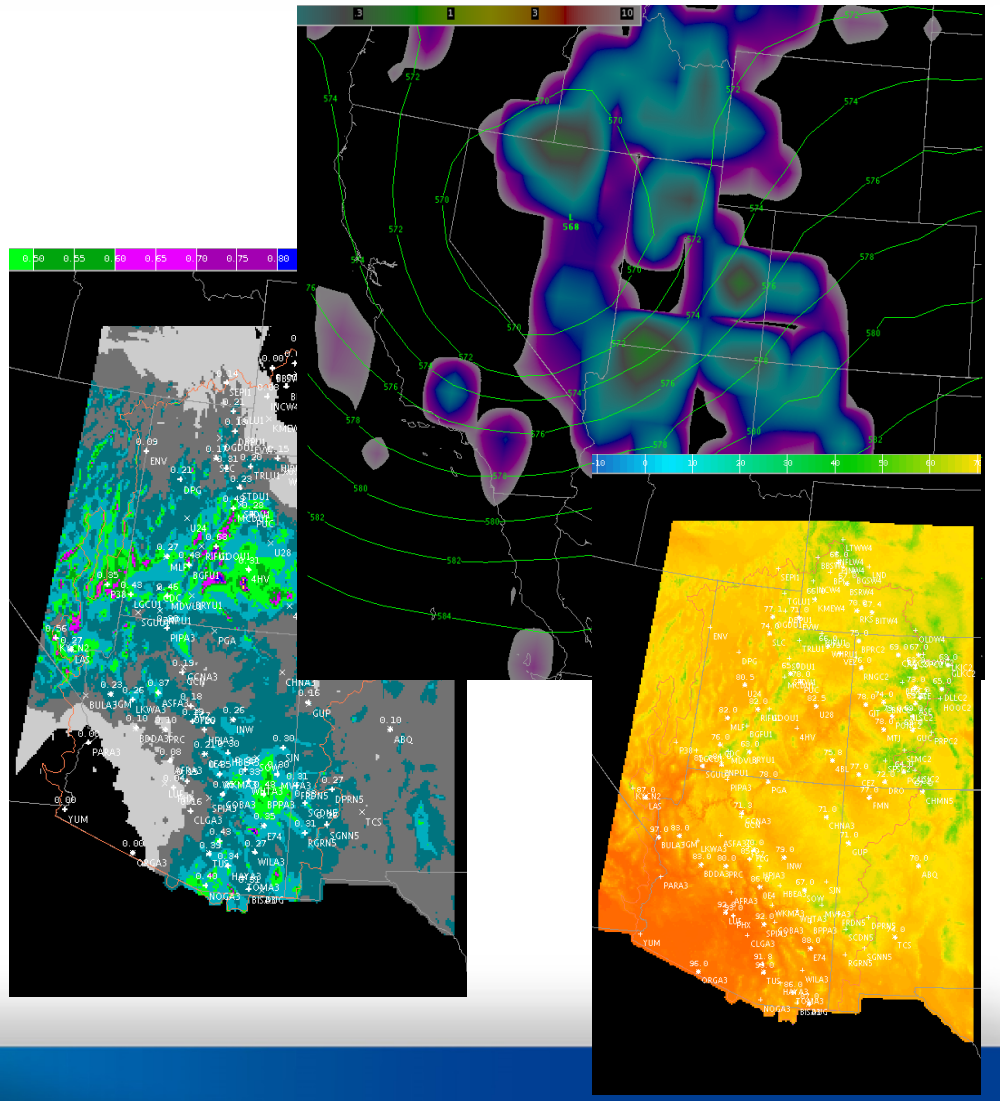
Forecaster Analysis

Gridded Precipitation Estimate



Quantitative Precipitation/ Temperature Forecast (QPF/QTF)

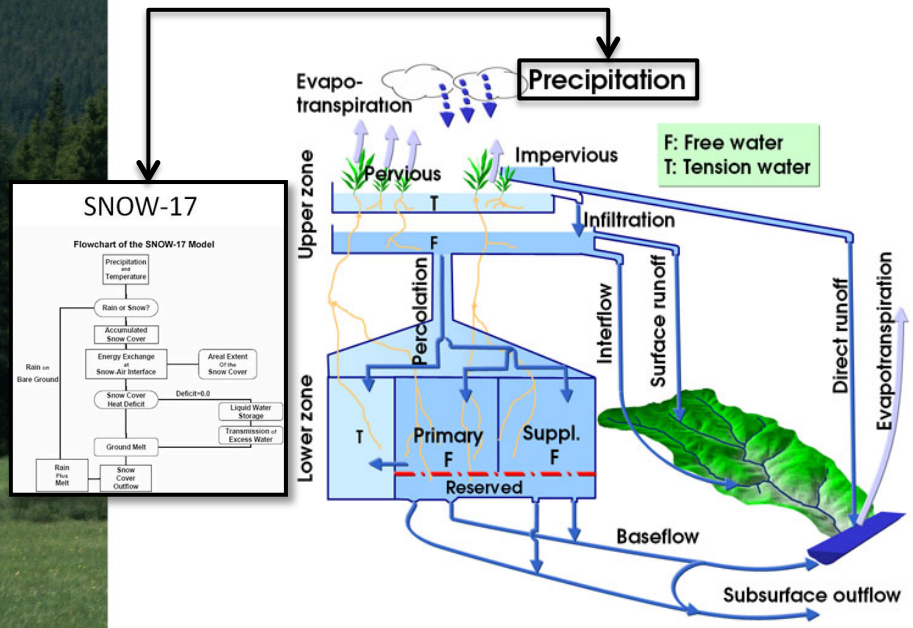
- We use precipitation forecast out to 5 days
- We use temperature forecast out to 10 days
- Convective storms are difficult for models to forecast



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?

CBRFC Soil Moisture

- 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?

Hydrologic Model

- 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