

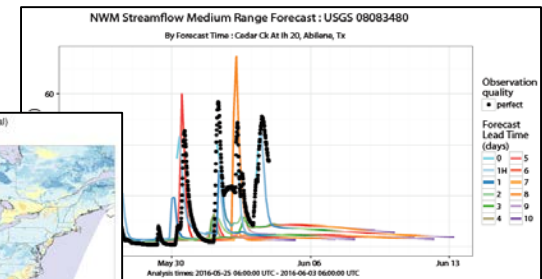
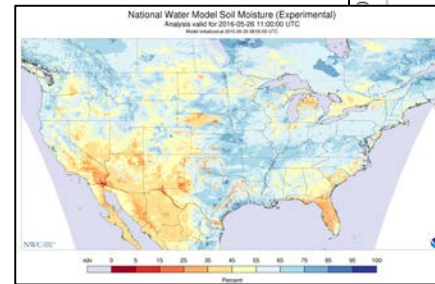
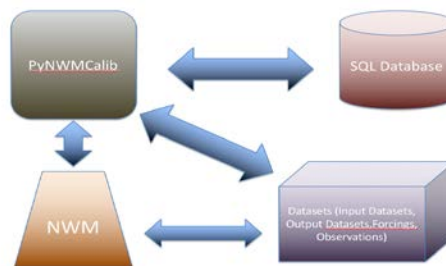
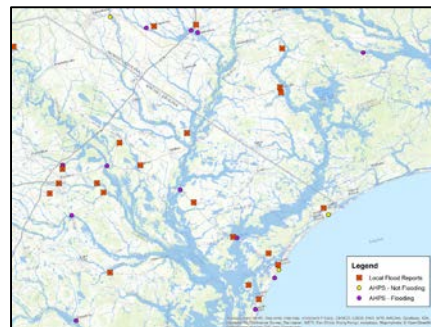
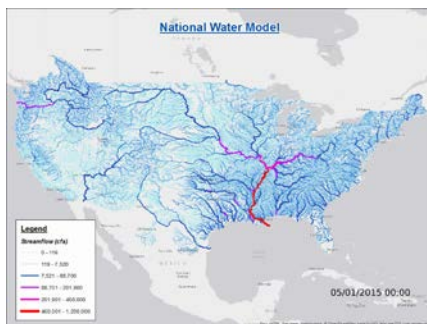
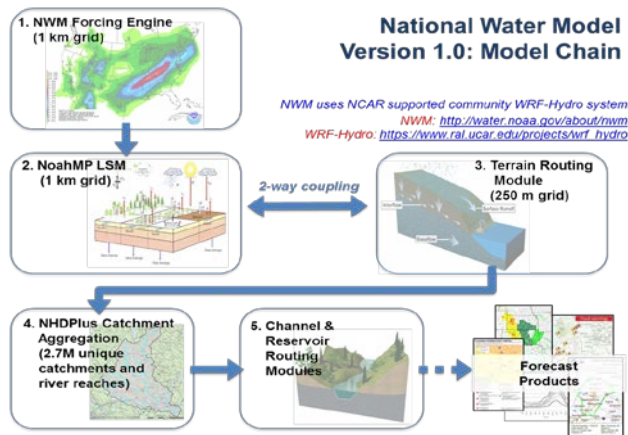
Use of Remotely Sensed Snow Observations for National Water Model Analysis

Logan Karsten - NCAR

*D. Gochis, J. McCreight, K. Aalstad,
G. Fall, C. Olheser, N-Y. Wang*

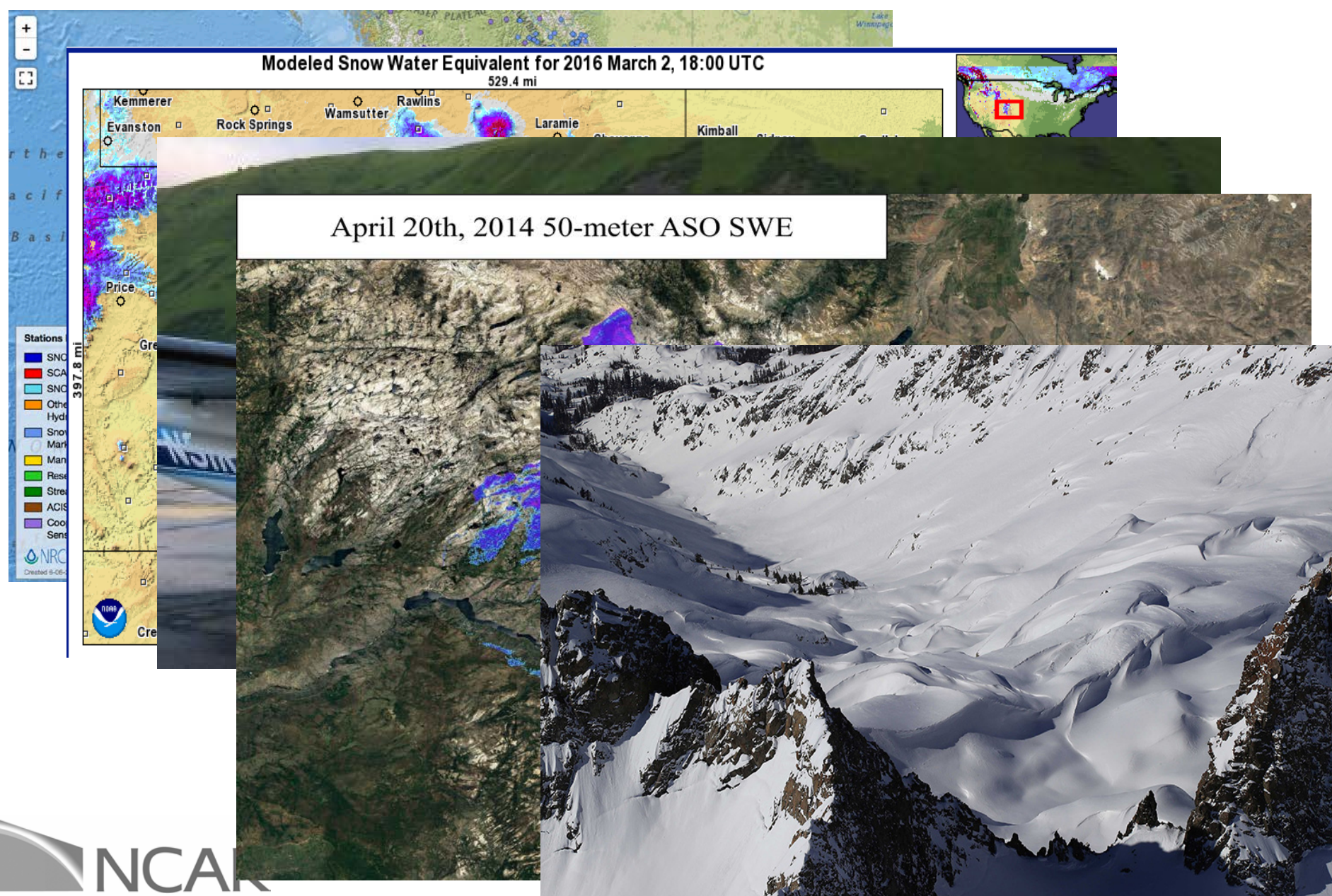


National Water Model Version 2.0



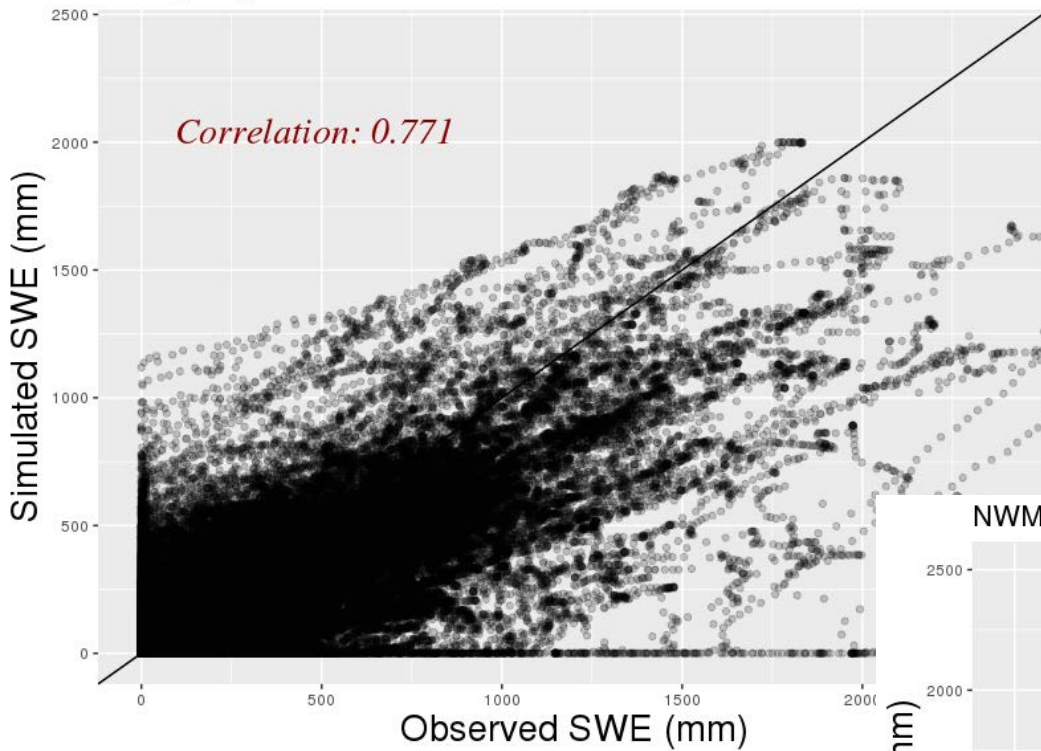
- National Water Model now uses the BATS snow albedo scheme (Yang et al., 1997).
 - Previously used CLASS (Verseghy, 1991) which used simple aging formulation.
 - More parameters now open for future calibration efforts using observed snow albedo.
- Use of Mountain Mapper precipitation downscaling.
 - Better capture high-altitude precipitation.

National Water Model Snow Analysis

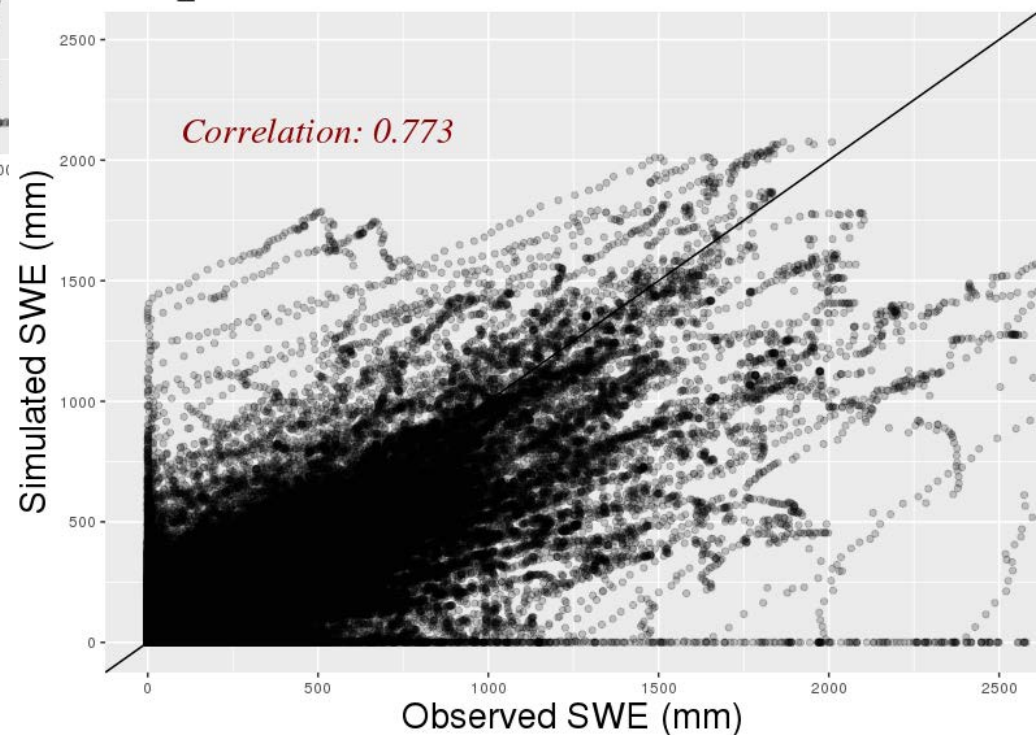


National Water Model Snow Analysis – Version 2.0

NWM_v12_TMP In-Situ SWE Observations for: 2016-10-01 to: 2017-10-01

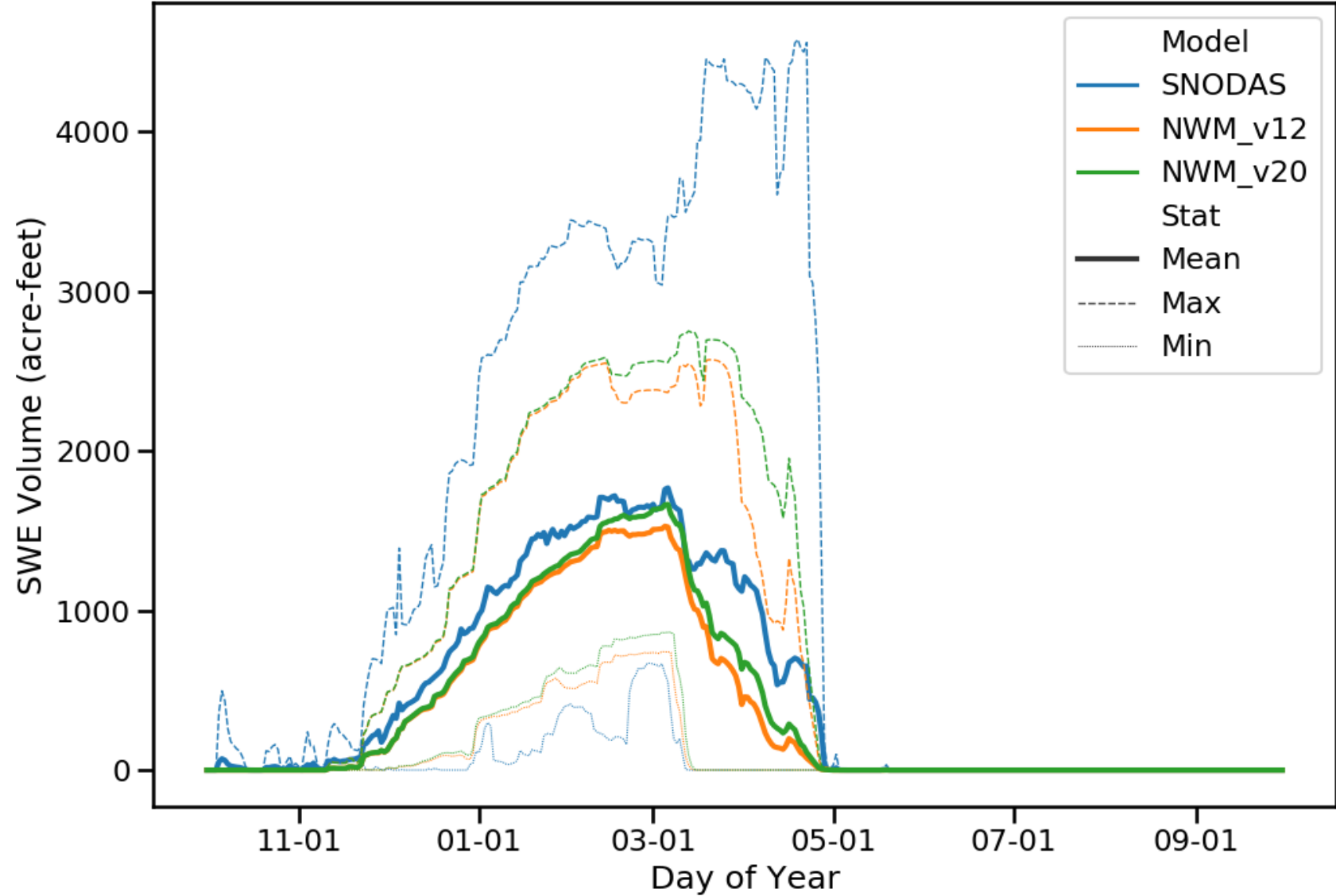


NWM_v20 In-Situ SWE Observations for: 2016-10-01 to: 2017-10-01

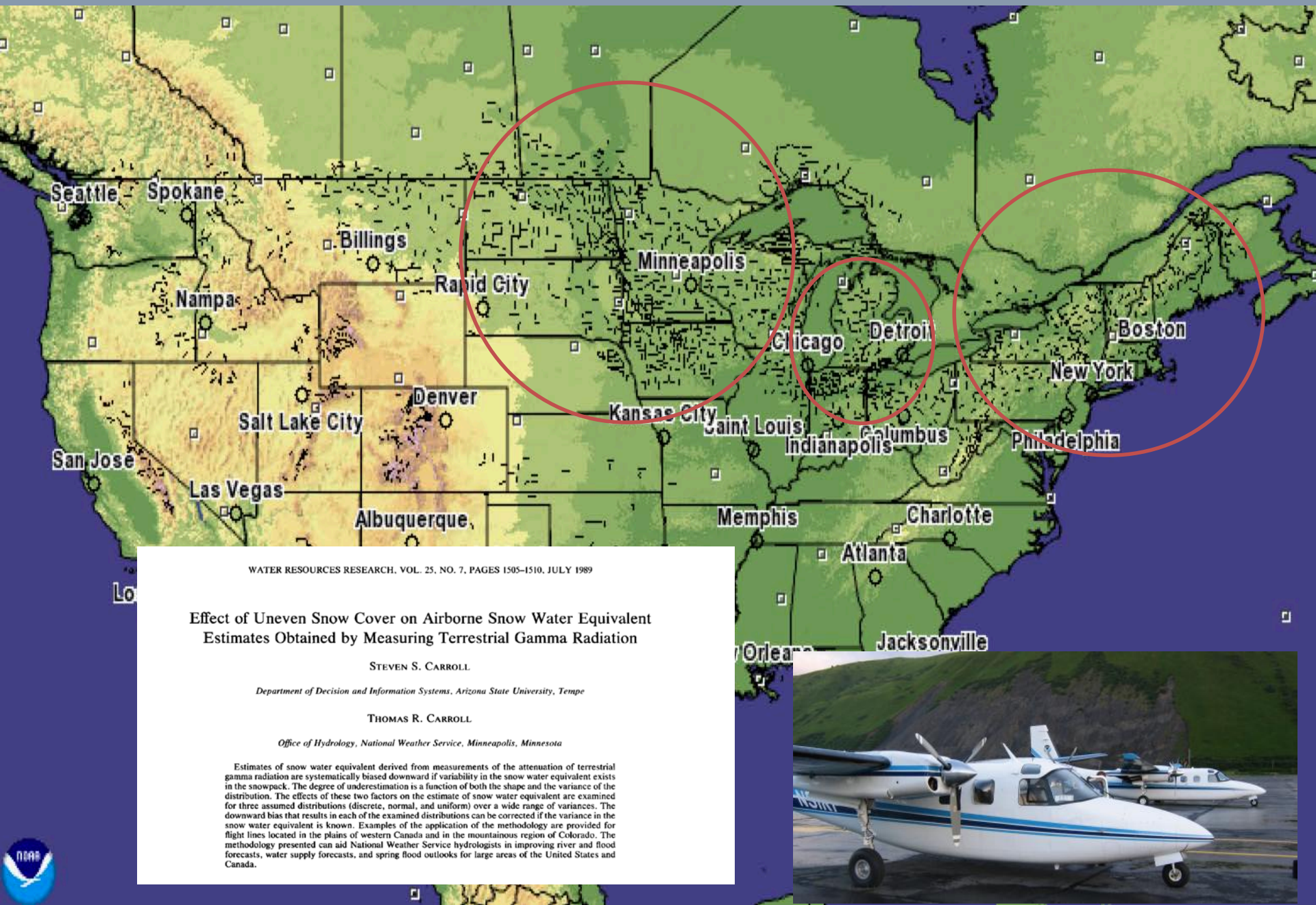


National Water Model Snow Analysis – Version 2.0

SWE Volume Statistics (WY2011-WY2017) Comparison for Red River ND



National Water Model Snow Analysis – Version 2.0



WATER RESOURCES RESEARCH, VOL. 25, NO. 7, PAGES 1505-1510, JULY 1989

Effect of Uneven Snow Cover on Airborne Snow Water Equivalent Estimates Obtained by Measuring Terrestrial Gamma Radiation

STEVEN S. CARROLL

Department of Decision and Information Systems, Arizona State University, Tempe

THOMAS R. CARROLL

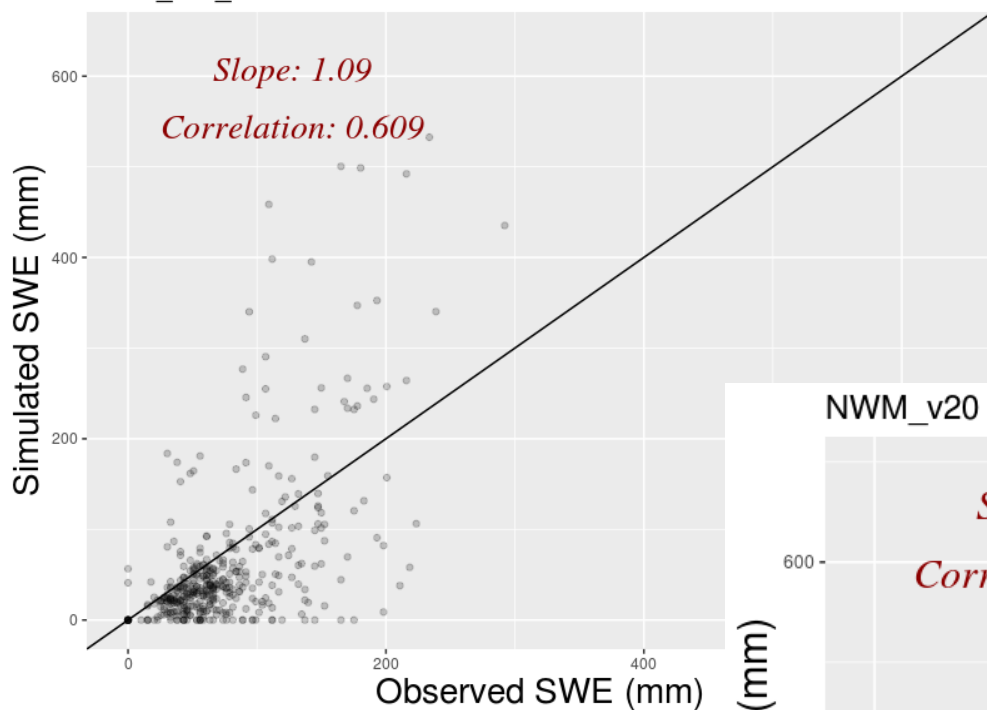
Office of Hydrology, National Weather Service, Minneapolis, Minnesota

Estimates of snow water equivalent derived from measurements of the attenuation of terrestrial gamma radiation are systematically biased downward if variability in the snow water equivalent exists in the snowpack. The degree of underestimation is a function of both the shape and the variance of the distribution. The effects of these two factors on the estimate of snow water equivalent are examined for three assumed distributions (discrete, normal, and uniform) over a wide range of variances. The downward bias that results in each of the examined distributions can be corrected if the variance in the snow water equivalent is known. Examples of the application of the methodology are provided for flight lines located in the plains of western Canada and in the mountainous region of Colorado. The methodology presented can aid National Weather Service hydrologists in improving river and flood forecasts, water supply forecasts, and spring flood outlooks for large areas of the United States and Canada.

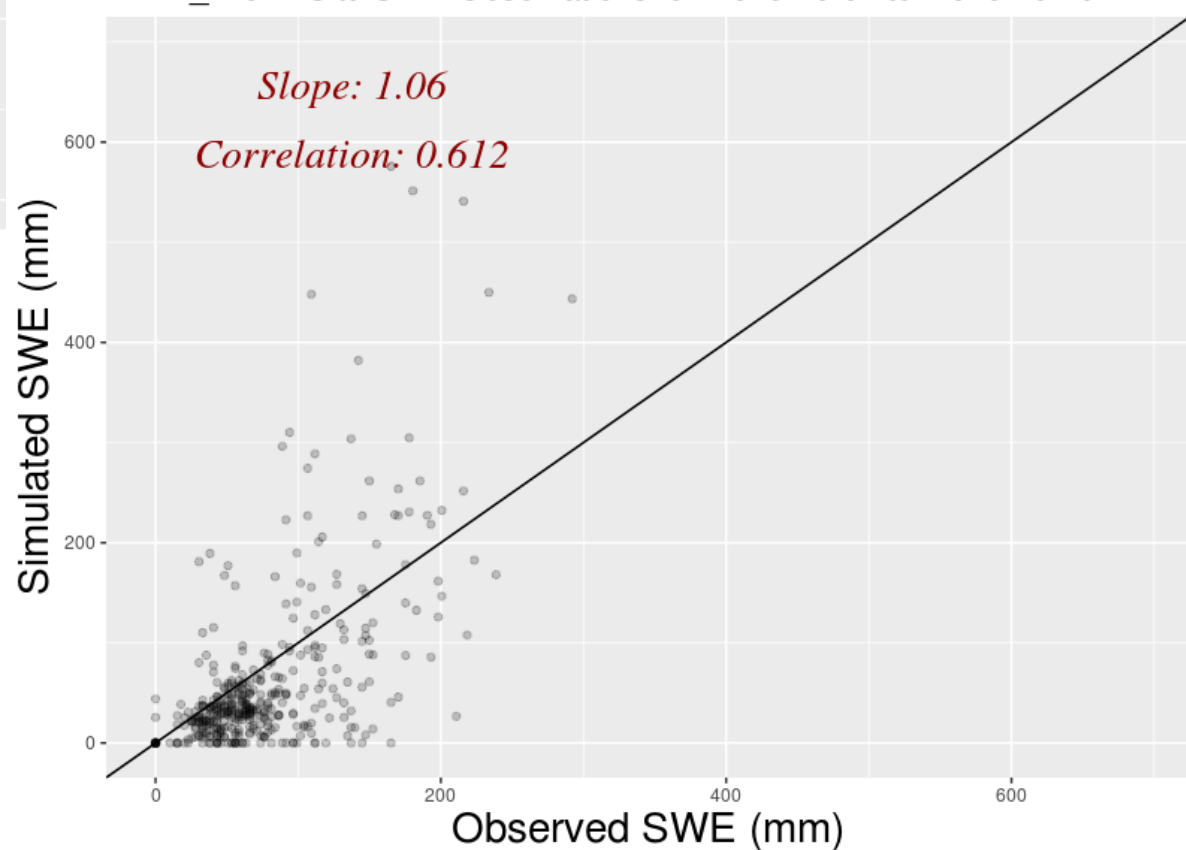


National Water Model Snow Analysis – Version 2.0

NWM_v12_TMP In-Situ SWE Observations for: 2015-10-01 to: 2016-10-10



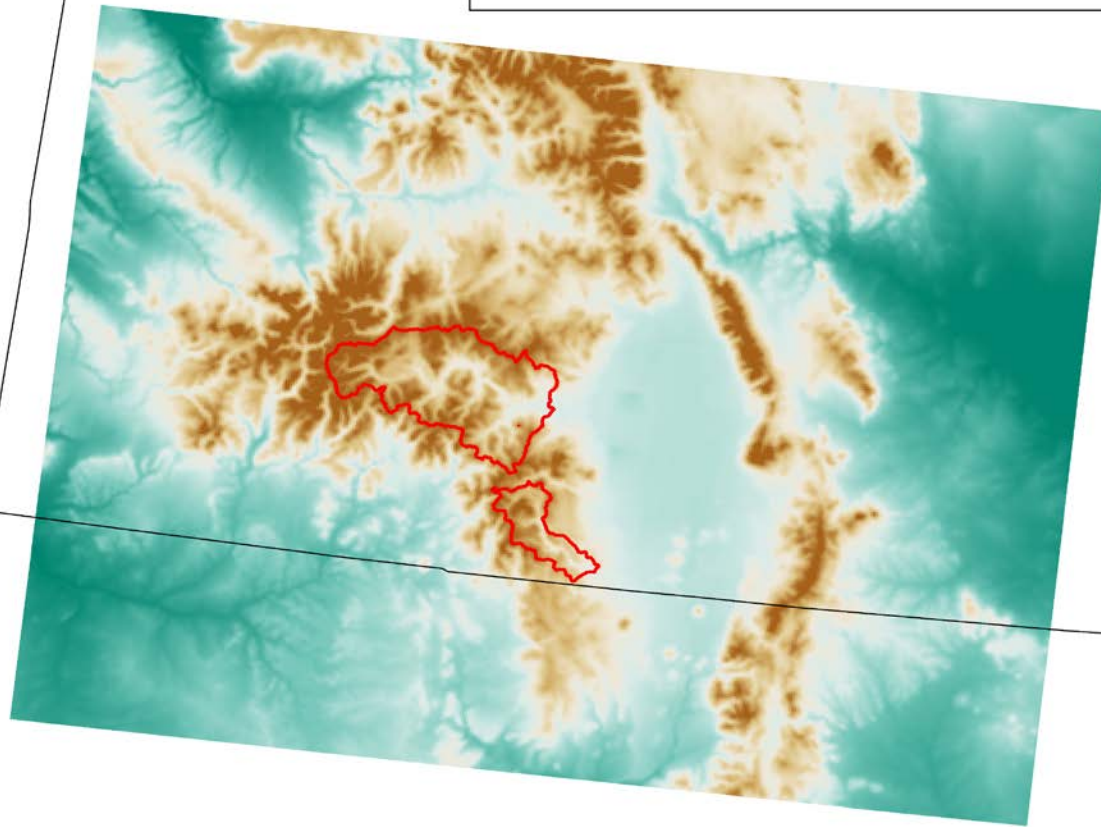
NWM_v20 In-Situ SWE Observations for: 2015-10-01 to: 2016-10-10



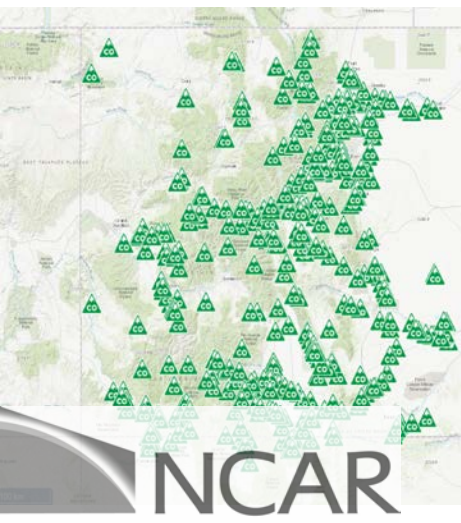
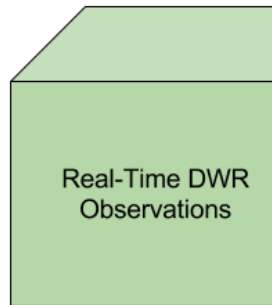
Colorado Ensemble Streamflow Prediction

- Began focusing on headwaters of the Rio Grande in southwestern CO

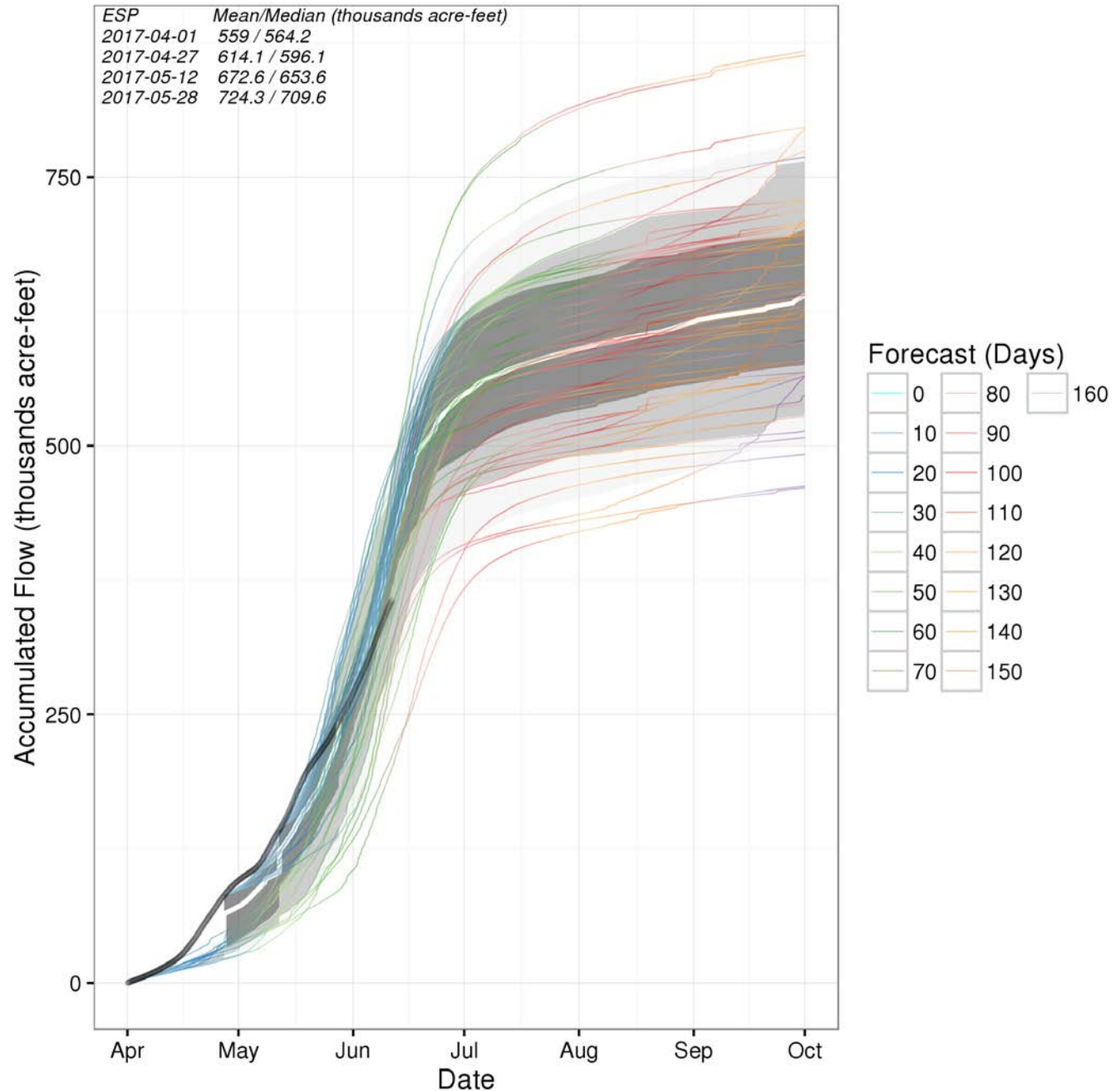
Original Rio Modeling Domain (2015-2016)



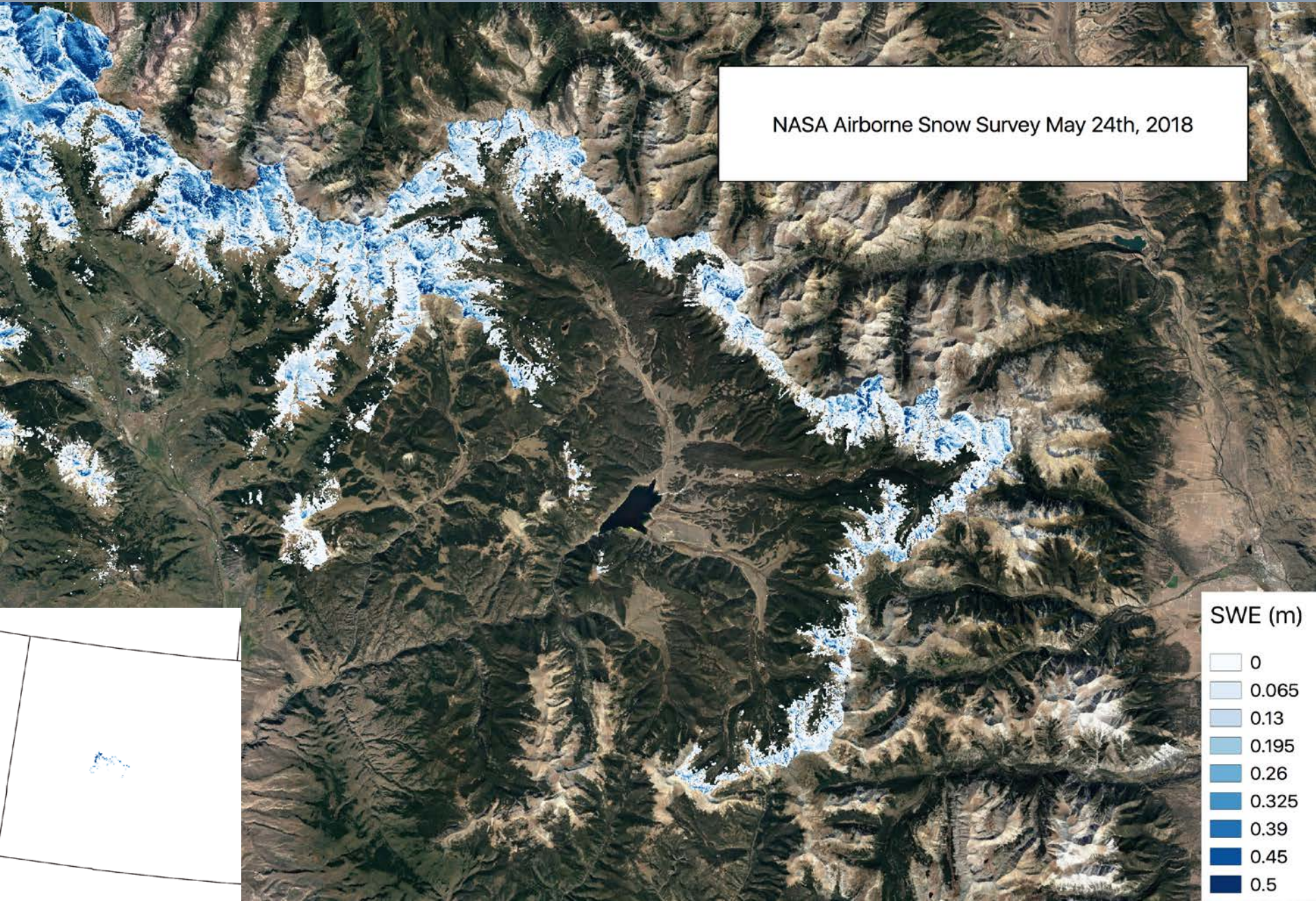
- Real-Time Workflc
 - Python execu
 - Each processi
 - functions.
 - R continues t
 - accumulated



2017 Colorado ESP for: RIODELCO

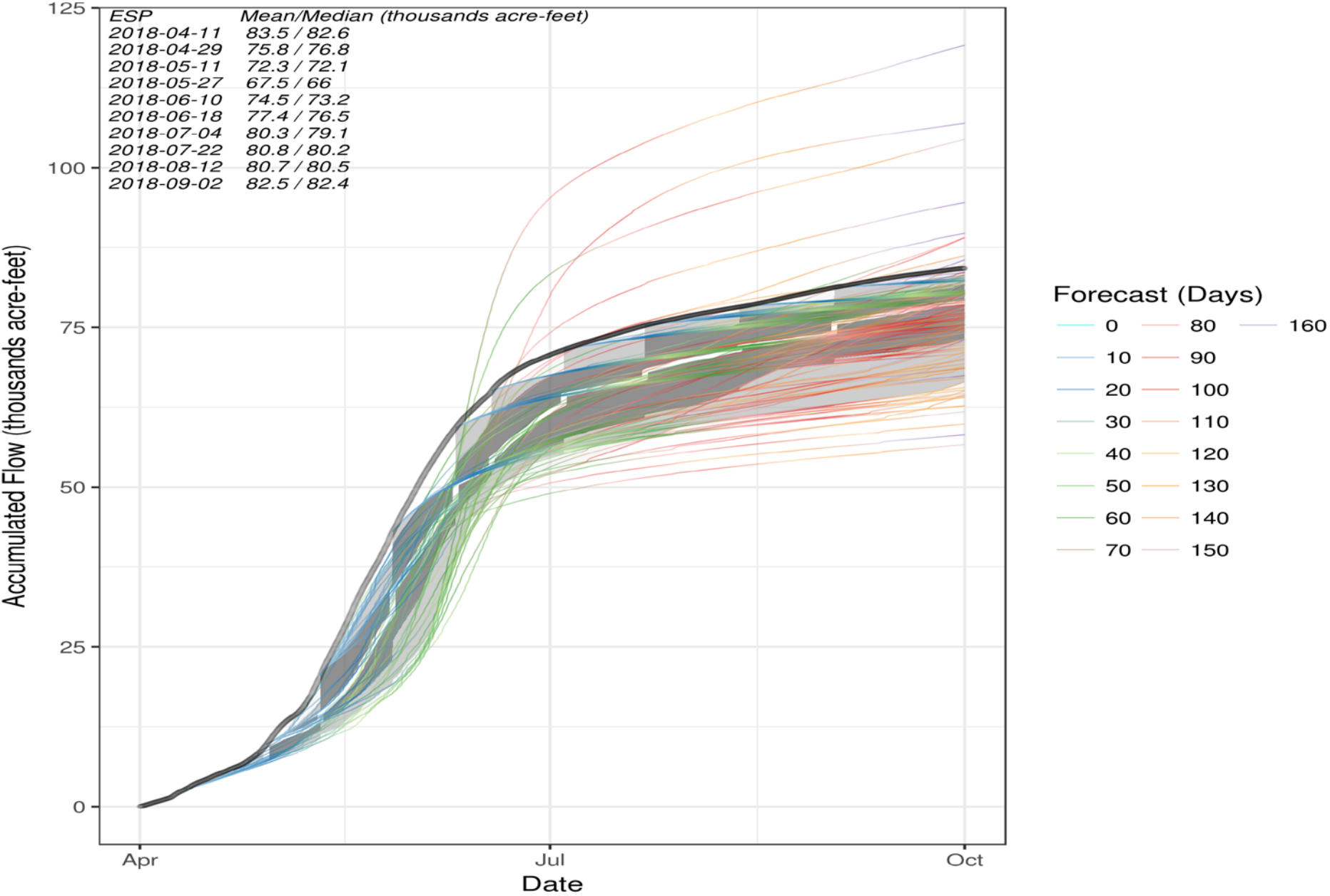


2018 Airborne Survey Observations

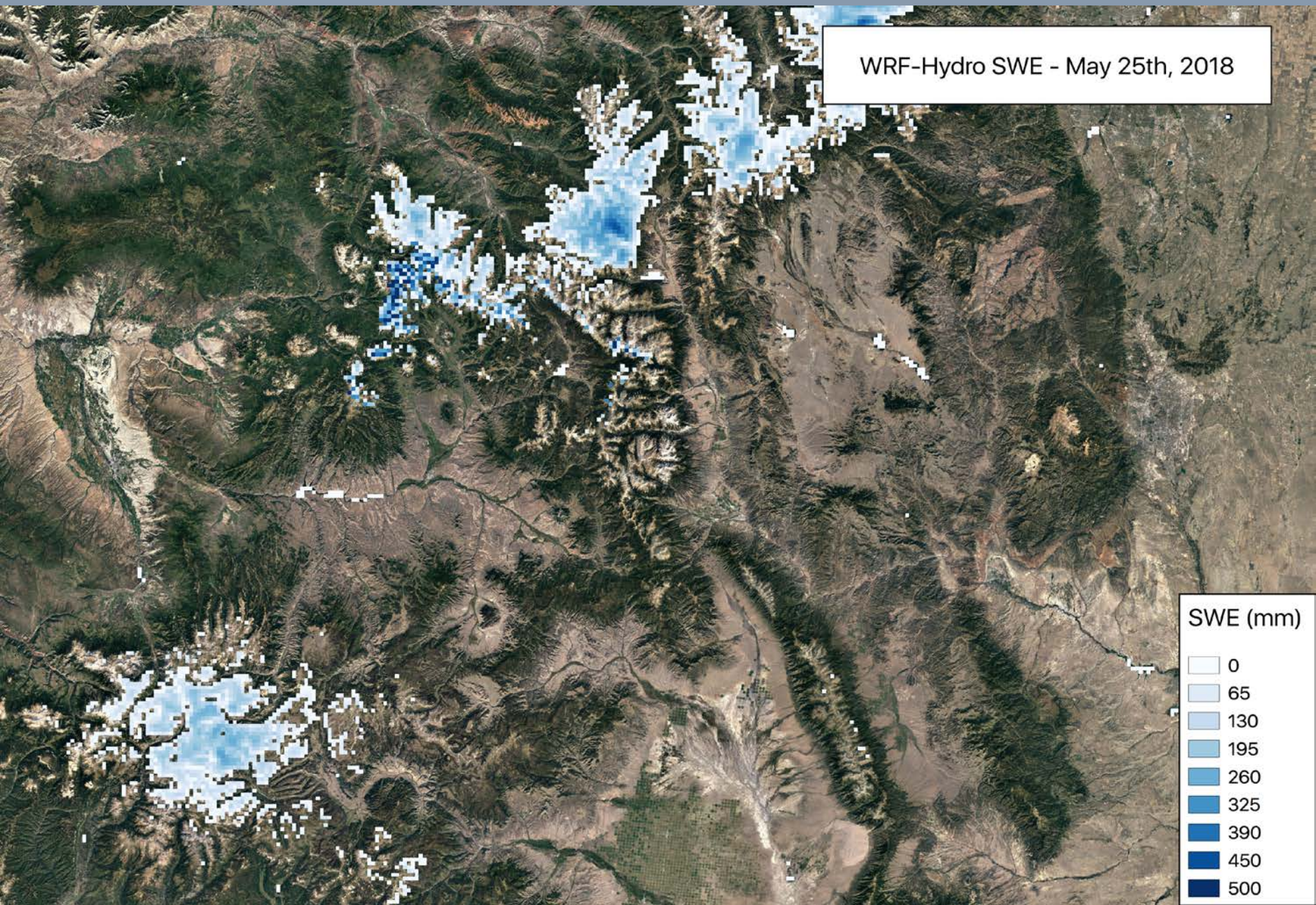


2018 Ensemble Predictions

2018 Colorado ESP for: EASALMCO

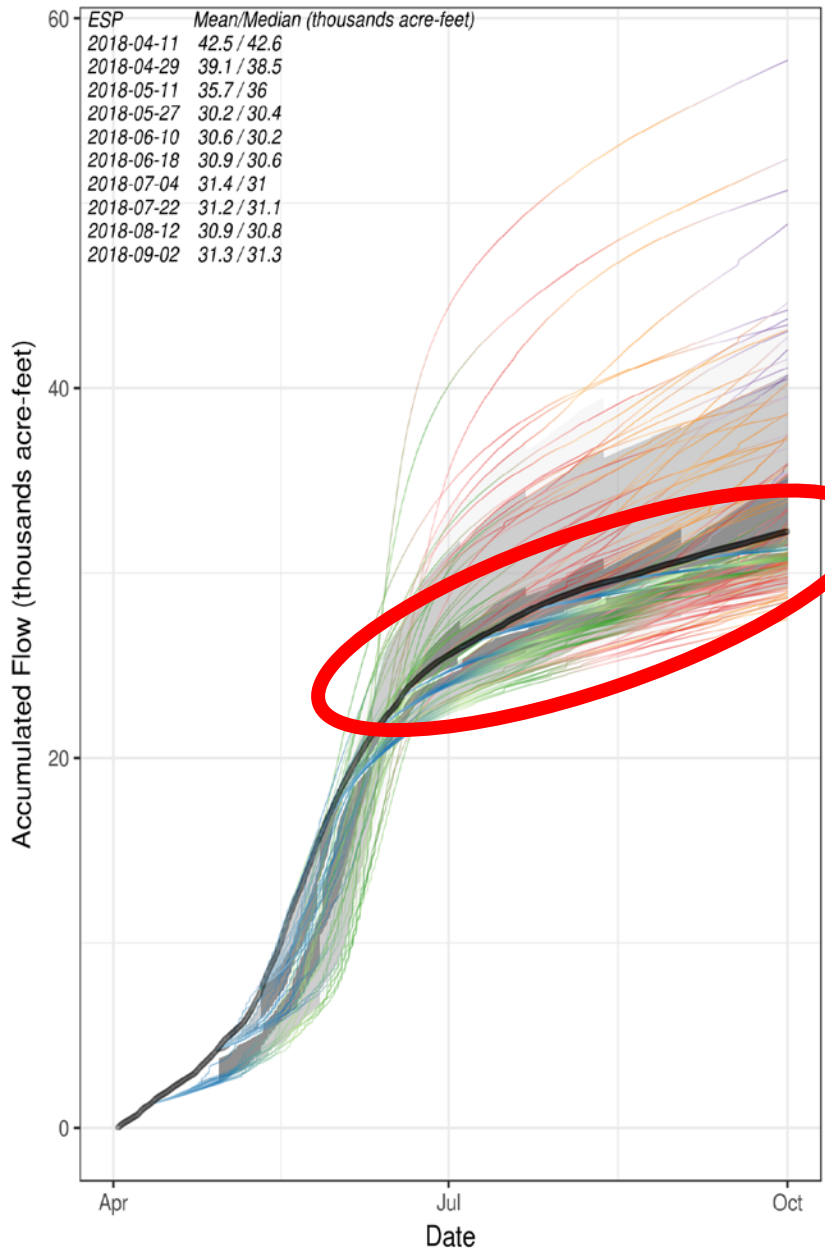


ASO Direct Insertion

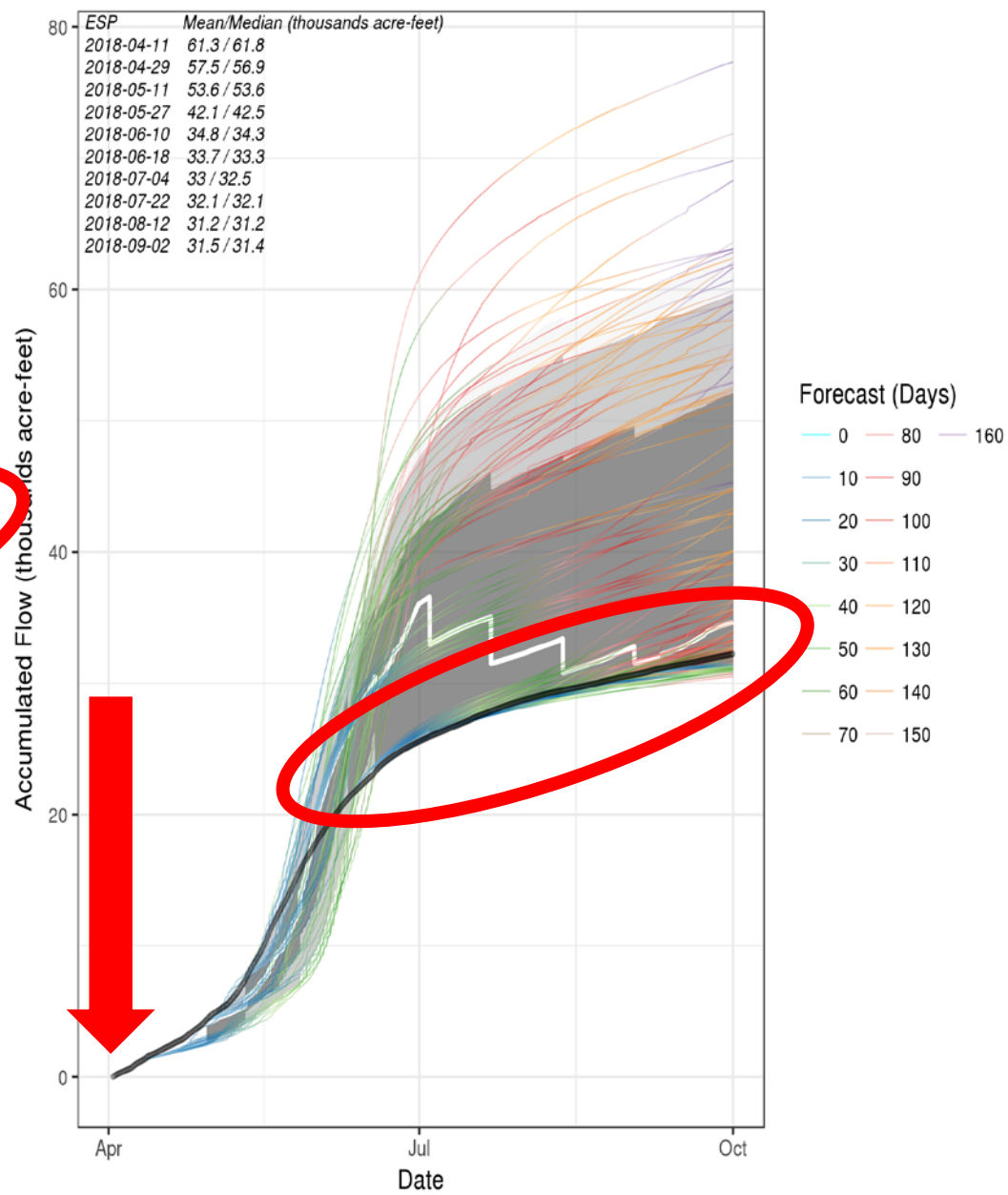


ASO Direct Insertion – Taylor Park March Assimilation

2018 Colorado ESP for: TAYATPCO

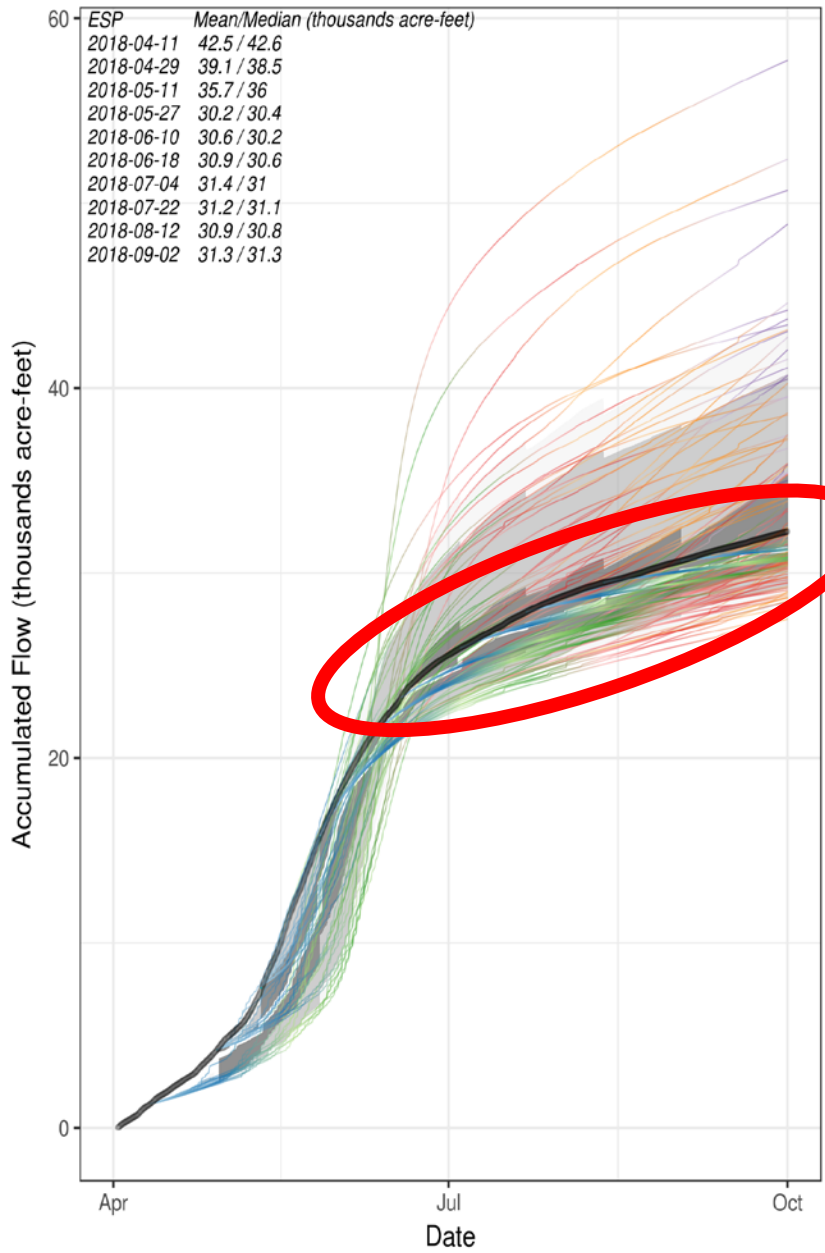


2018 Colorado ESP for: TAYATPCO

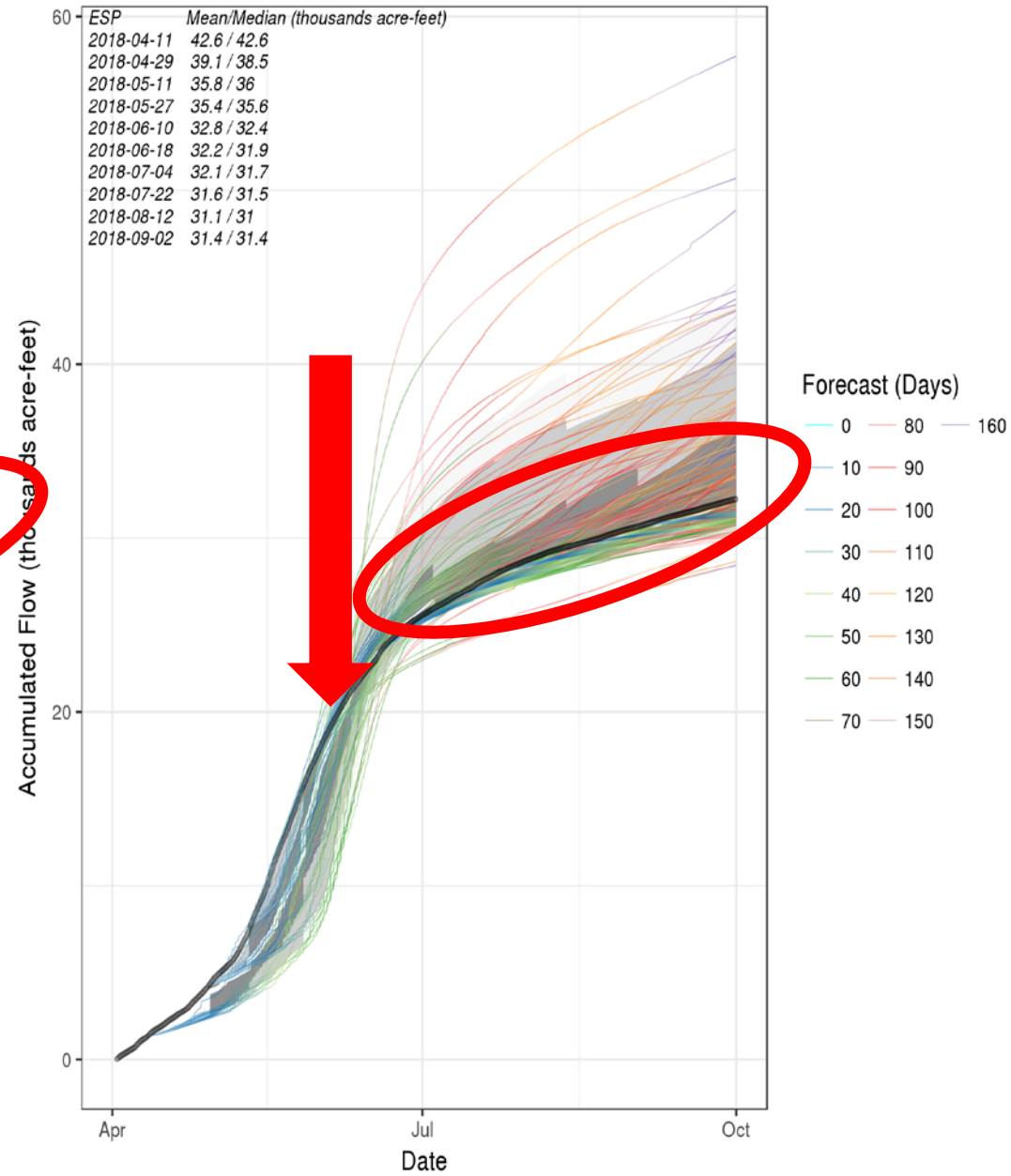


ASO Direct Insertion – Taylor Park May Assimilation

2018 Colorado ESP for: TAYATPCO



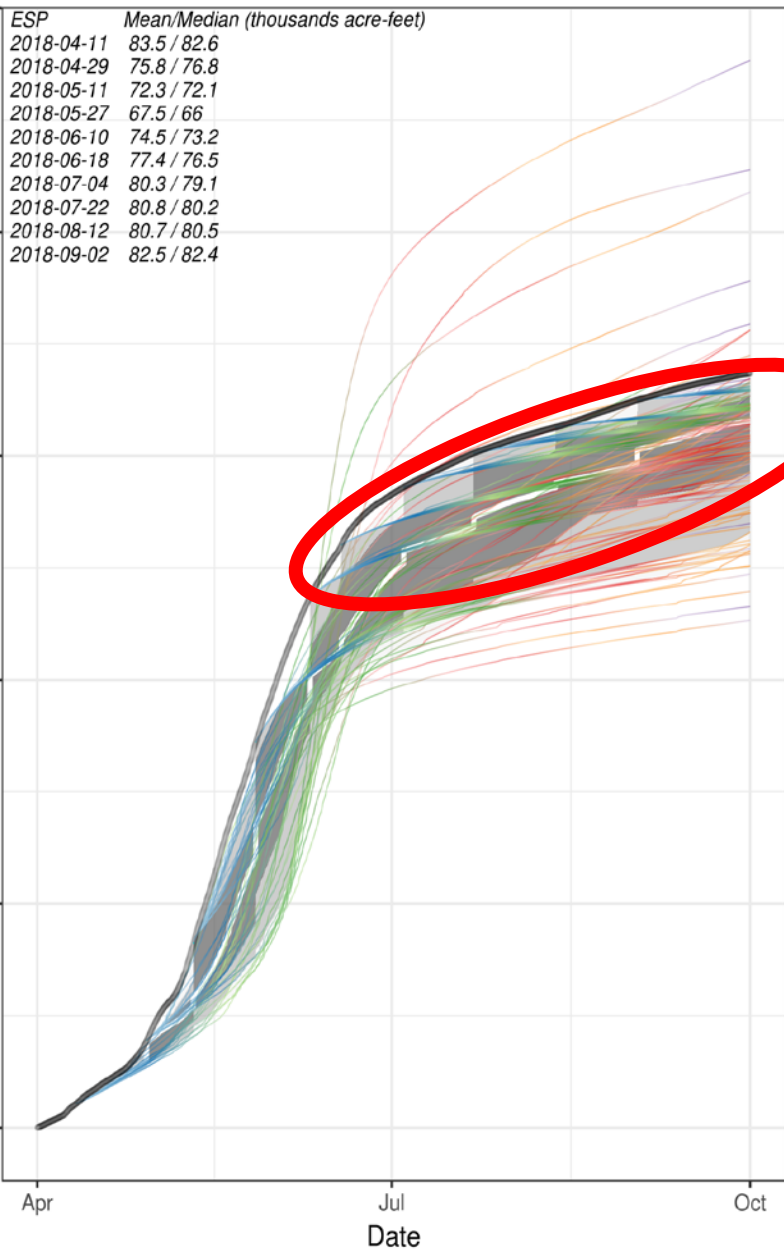
2018 Colorado ESP for: TAYATPCO



ASO Direct Insertion – East River March Assimilation

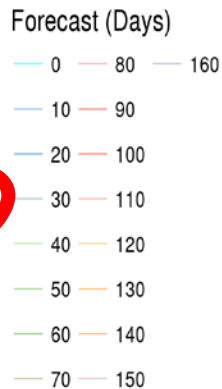
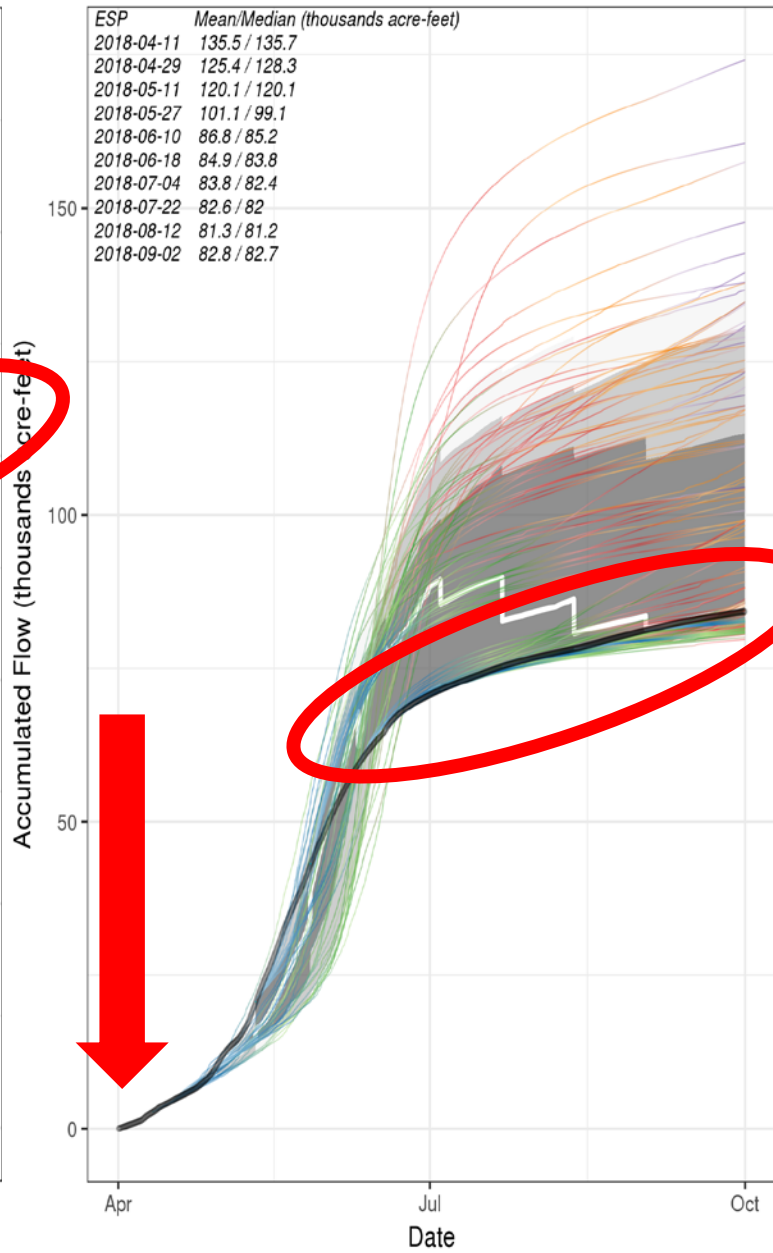
2018 Colorado ESP for: EASALMCO

ESP	Mean/Median (thousands acre-feet)
2018-04-11	83.5 / 82.6
2018-04-29	75.8 / 76.8
2018-05-11	72.3 / 72.1
2018-05-27	67.5 / 66
2018-06-10	74.5 / 73.2
2018-06-18	77.4 / 76.5
2018-07-04	80.3 / 79.1
2018-07-22	80.8 / 80.2
2018-08-12	80.7 / 80.5
2018-09-02	82.5 / 82.4



2018 Colorado ESP for: EASALMCO

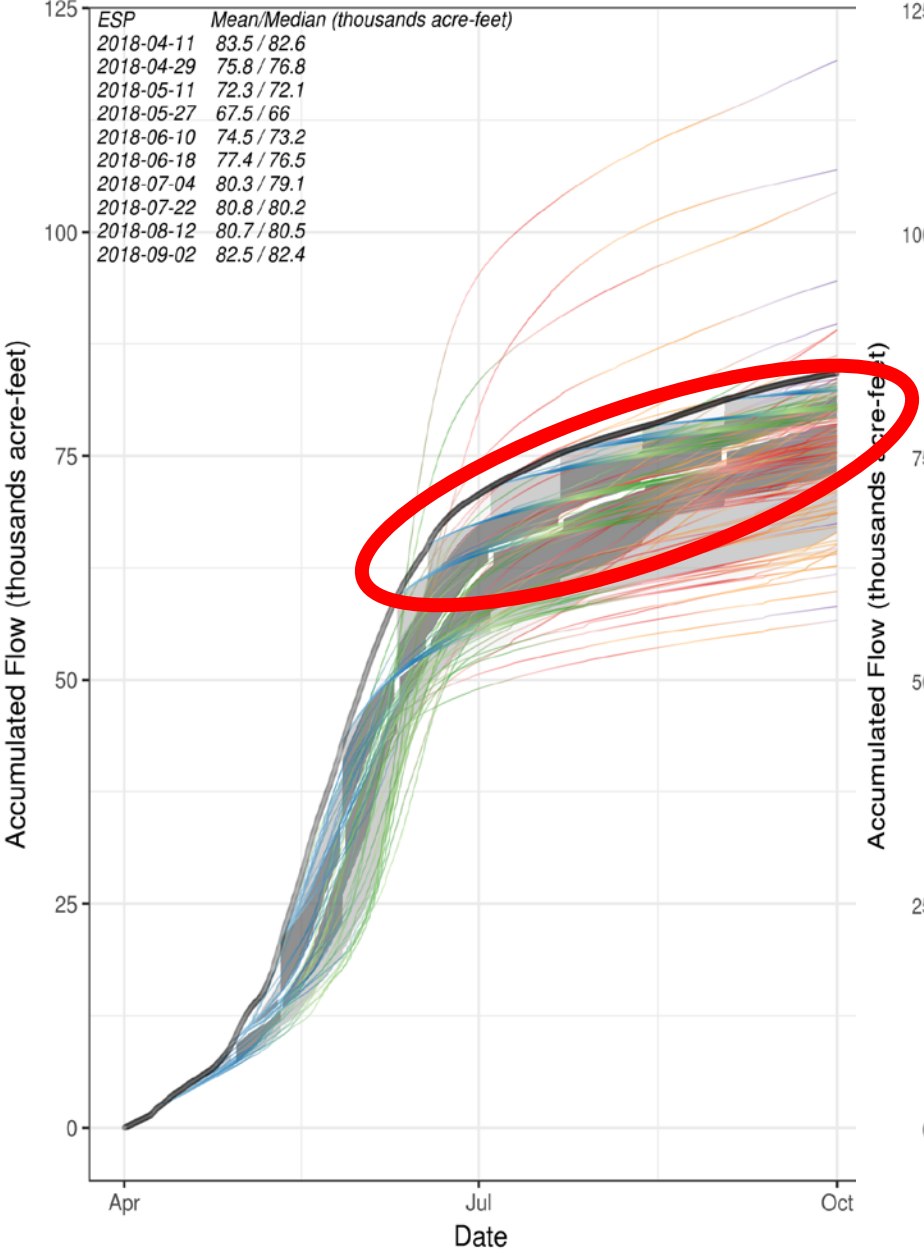
ESP	Mean/Median (thousands acre-feet)
2018-04-11	135.5 / 135.7
2018-04-29	125.4 / 128.3
2018-05-11	120.1 / 120.1
2018-05-27	101.1 / 99.1
2018-06-10	86.8 / 85.2
2018-06-18	84.9 / 83.8
2018-07-04	83.8 / 82.4
2018-07-22	82.6 / 82
2018-08-12	81.3 / 81.2
2018-09-02	82.8 / 82.7



ASO Direct Insertion – East River May Assimilation

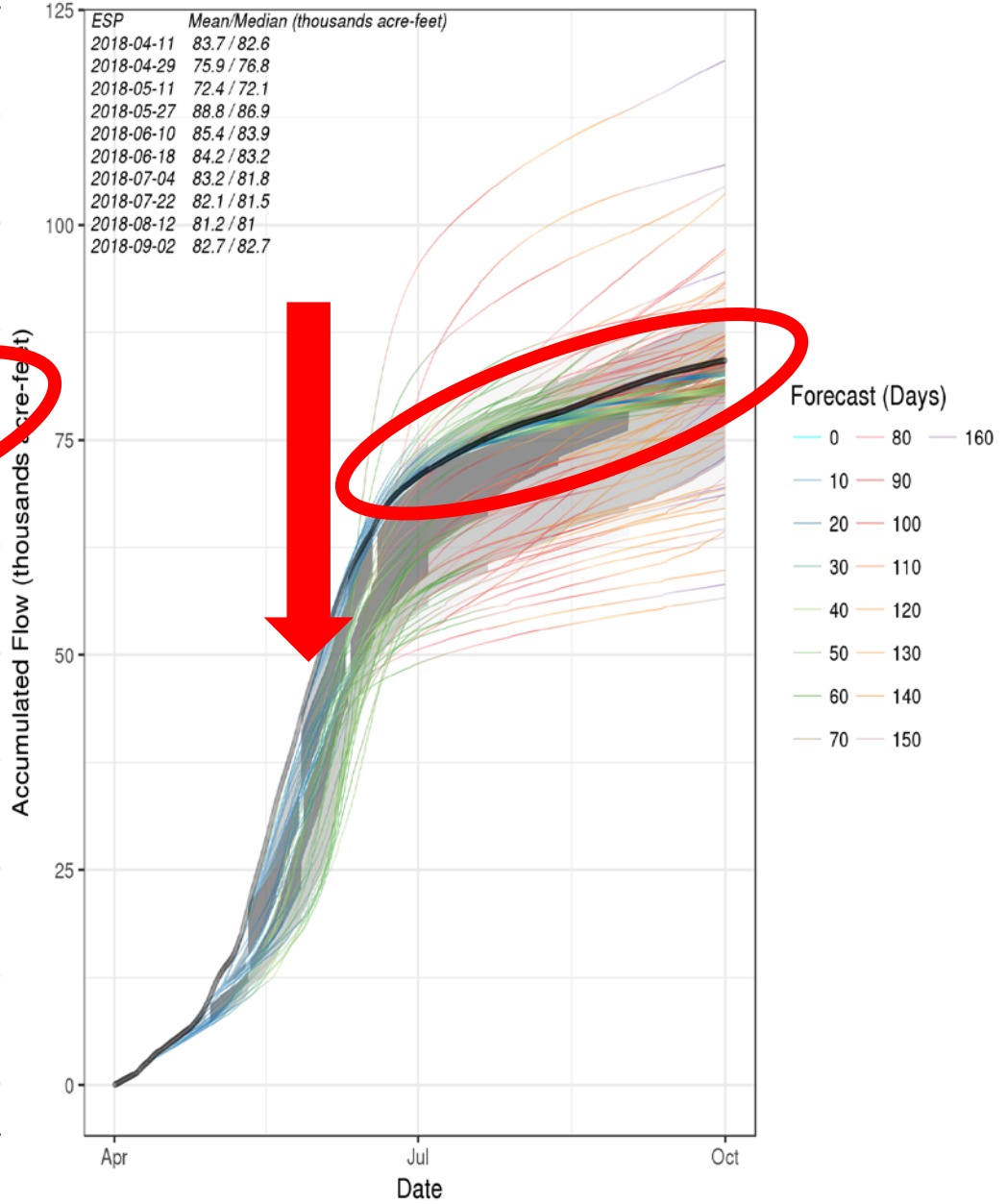
2018 Colorado ESP for: EASALMCO

ESP	Mean/Median (thousands acre-feet)
2018-04-11	83.5 / 82.6
2018-04-29	75.8 / 76.8
2018-05-11	72.3 / 72.1
2018-05-27	67.5 / 66
2018-06-10	74.5 / 73.2
2018-06-18	77.4 / 76.5
2018-07-04	80.3 / 79.1
2018-07-22	80.8 / 80.2
2018-08-12	80.7 / 80.5
2018-09-02	82.5 / 82.4



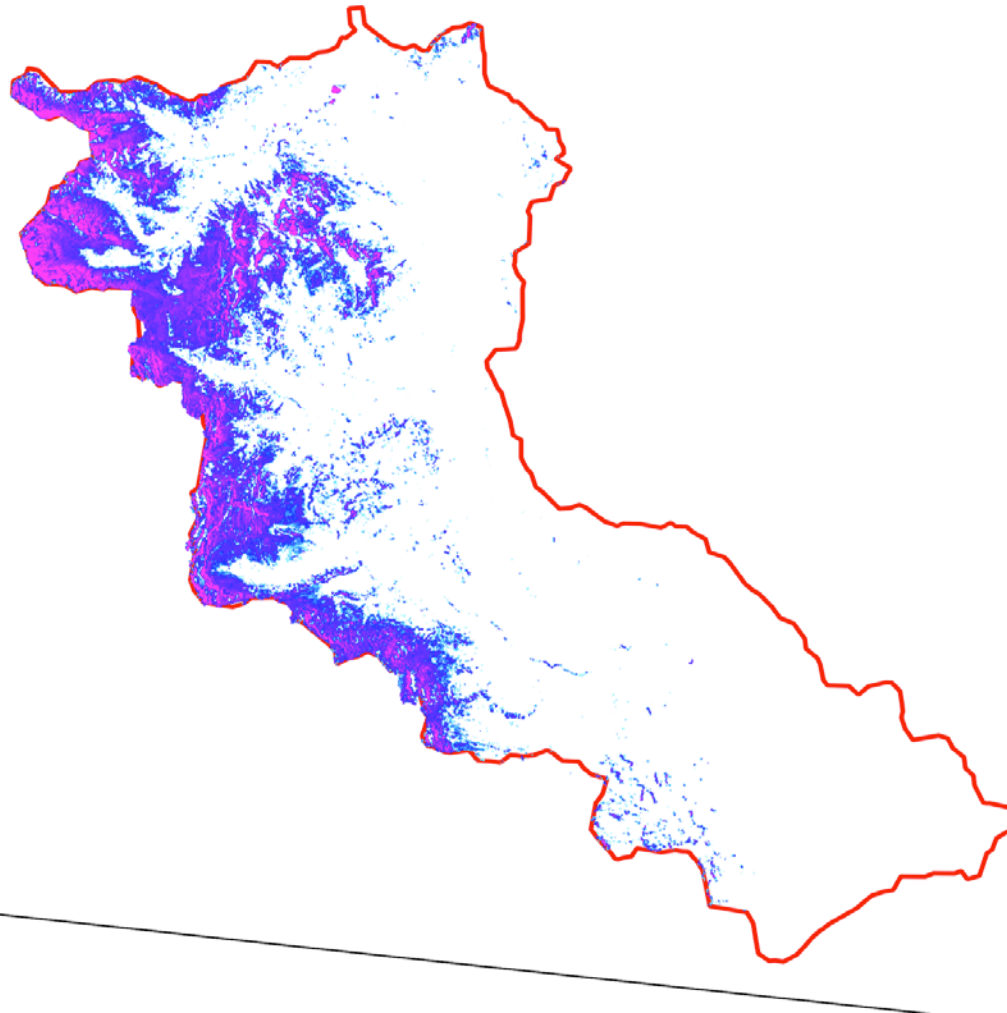
2018 Colorado ESP for: EASALMCO

ESP	Mean/Median (thousands acre-feet)
2018-04-11	83.7 / 82.6
2018-04-29	75.9 / 76.8
2018-05-11	72.4 / 72.1
2018-05-27	88.8 / 86.9
2018-06-10	85.4 / 83.9
2018-06-18	84.2 / 83.2
2018-07-04	83.2 / 81.8
2018-07-22	82.1 / 81.5
2018-08-12	81.2 / 81
2018-09-02	82.7 / 82.7

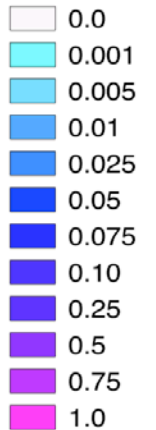


ASO Direct Insertion – Conejos Basin

June 9th, 2017 50 Meter SWE

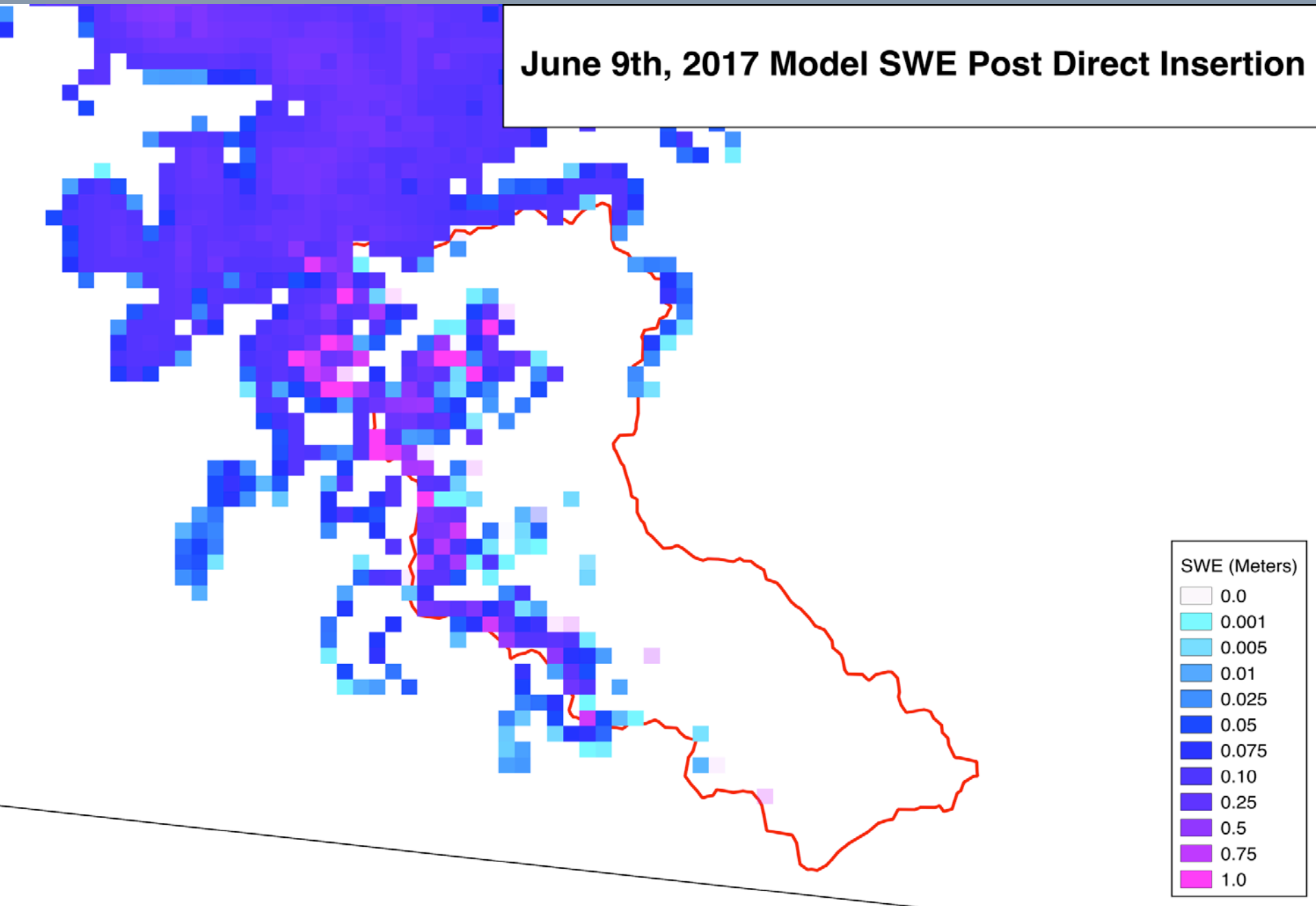


SWE (Meters)

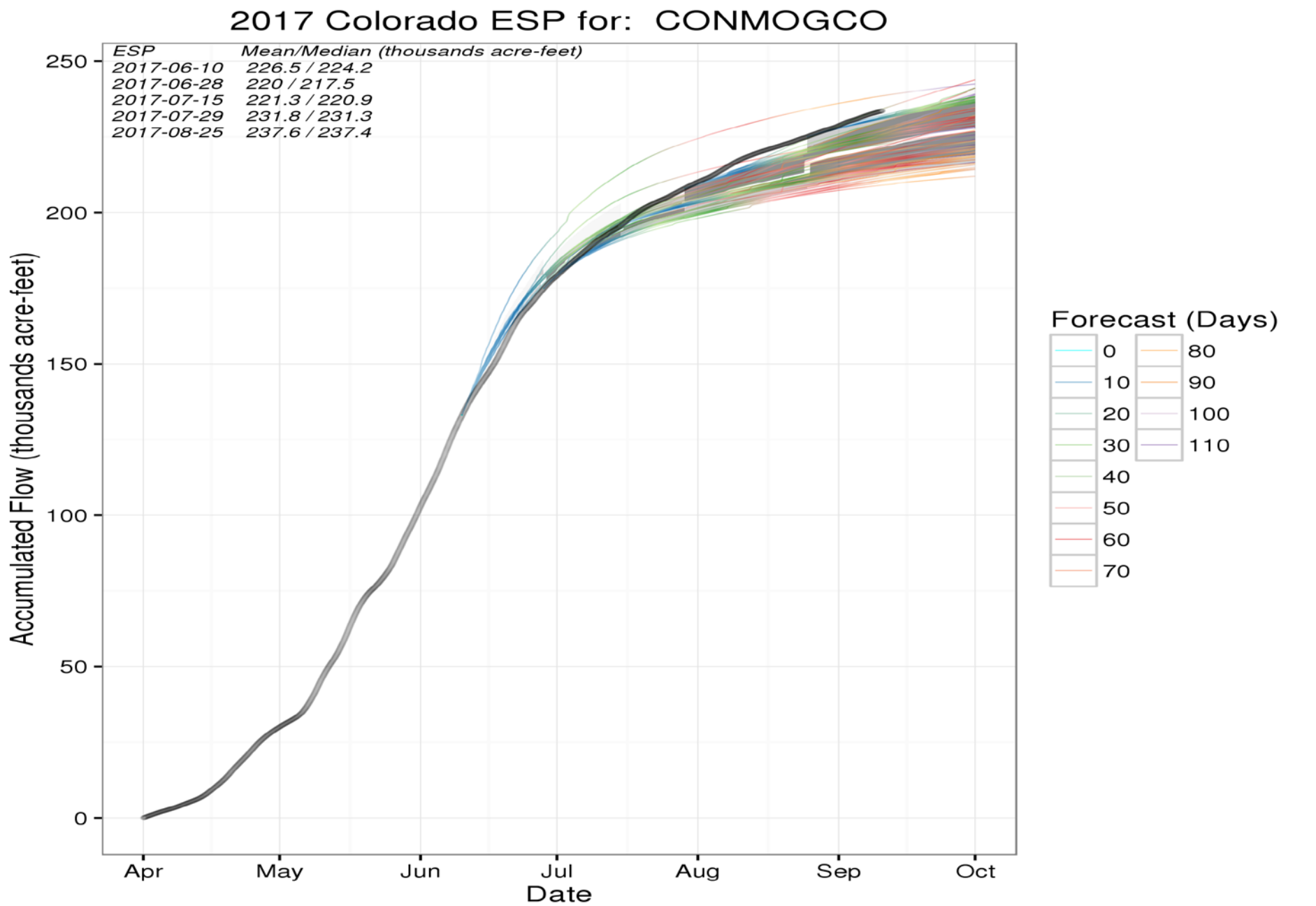


ASO Direct Insertion – Conejos Basin

June 9th, 2017 Model SWE Post Direct Insertion



ASO Direct Insertion – Conejos Basin



Next Steps

- Continue incorporating additional remote sensing products into analysis and assimilation frameworks
- Continue exploring snow data assimilation methods within the modeling framework
- Explore the use of remotely sensed snow observations for use in calibration of snow-related parameters in model

Questions?

- Community WRF-Hydro page (Including links to code, training materials) - https://ral.ucar.edu/projects/wrf_hydro/overview
- karsten@ucar.edu

