Airborne Snow Observatory in the Tuolumne River Basin: Forecasting streamflow using basin wide SWE estimates

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Airborne Snow Observatory

- NASA / JPL project headed by Dr. Tom Painter
- Lidar with and without snow give snow depth
- Independent modeling (ARS) gives snow density
- Combination gives Snow Water Equivalent (SWE)
- Tuolumne Basin since 2013
- Merced Basin since 2014
How much snow is in the basin?
How much will end up in the Tuolumne River?
May 28, 2018
HH: 120.9 TAF
CHEL: 38.7 TAF
Can we use ASO Basin Wide SWE to Forecast Future Streamflow?
At Hetch Hetchy, precip + snow + baseflow = inflows

\[0.94(\text{ASO} - 10.7351 \text{ TAF}) + 0.93(\text{Accumulated Precip to End of Runoff}) + 0.008 \text{ TAF per Day}\]
At Hetch Hetchy, precip + snow + baseflow = inflows

\[
0.94 \times (ASO - 10.1013 \text{ TAF}) + 0.92 \times (\text{Accumulated Precip to End of Runoff}) + 0.001 \text{ TAF per Day}
\]
At Hetch Hetchy, precip + snow + baseflow = inflows

- Most All the Snow Becomes Streamflow
- Most All the Precipitation Becomes Streamflow
- Not Much Groundwater Becomes Streamflow
At Hetch Hetchy, all the snow ends up in the reservoir.
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1:1 Relationship represents Minimum Possible Seasonal Inflows – Critical for forecasting operations.
Can we use ASO Future Inflows Estimate to improve Seasonal Modeling?
2017 – wettest year on record

- April 1, 2017 ASO flight: 1214 TAF SWE
- 2 times highest previous flight
- 340% of Hetch Hetchy Reservoir volume
- 206% of average seasonal inflows
- Greater than previous max inflows
240 TAF = 12 days at 1,000 cfs
How would improved inflow forecasts improve Reservoir Management?
Relative Importance of Forecast Accuracy

Water Supply

Forecast Relative Value

Dry
Seasonal Inflows
Wet
Relative Importance of Forecast Accuracy

Water Supply

Power Generation

Forecast Relative Value

Seasonal Inflows

Dry

Wet
Relative Importance of Forecast Accuracy

- Water Supply
- Power Generation
- Ecological Releases

Forecast Relative Value

Dry  Seasonal Inflows  Wet
Relative Importance of Forecast Accuracy

Water Supply
Power Generation
Ecological Releases
Dam Safety

Forecast Relative Value

Dry Seasonal Inflows Wet
Relative Importance of Forecast Accuracy

Water Supply
Power Generation
Ecological Releases
Dam Safety

Forecast Relative Value

Dry Seasonal Inflows Wet

2017
June 1 Release Plan
Reminder – Still Outside Calibration Range

Pre 2017 Calibration Range

6/4/2017
CNRFC: Minimum CNRFC Measured

ASO SWE

240 TAF

Inflows (TAF)

06/04 06/11 06/18 06/25 07/02 07/09 07/16 07/23 07/30 08/06

CNRFC  Minimum CNRFC  Measured
Actual Releases

The graph shows the releases over time, with the x-axis representing dates from April 1 to August 5. The y-axis represents releases in cubic feet per second (cfs). The graph includes two lines: blue for valve releases and red for power draft. The releases increase significantly in May and June, with a peak in June, and then decrease in July and August.
Extreme Flooding

Impaired Power Generation
7 days
× 50 MW
× $25/MW
$210,000
ASO => Better Forecasting

• Close relationship between ASO basin wide snow estimate and seasonal inflows
• Independent estimate of minimum future inflows
• Potential water supply, safety, regulatory, financial and environmental impacts
Questions?
Flood Control

Ecological Releases

Power Generation

Fill Reservoirs

Water Deliveries

More Required Releases (Senior Water Right Holders – TID / MID)

Required Releases (Fishes and bugs and what not)