



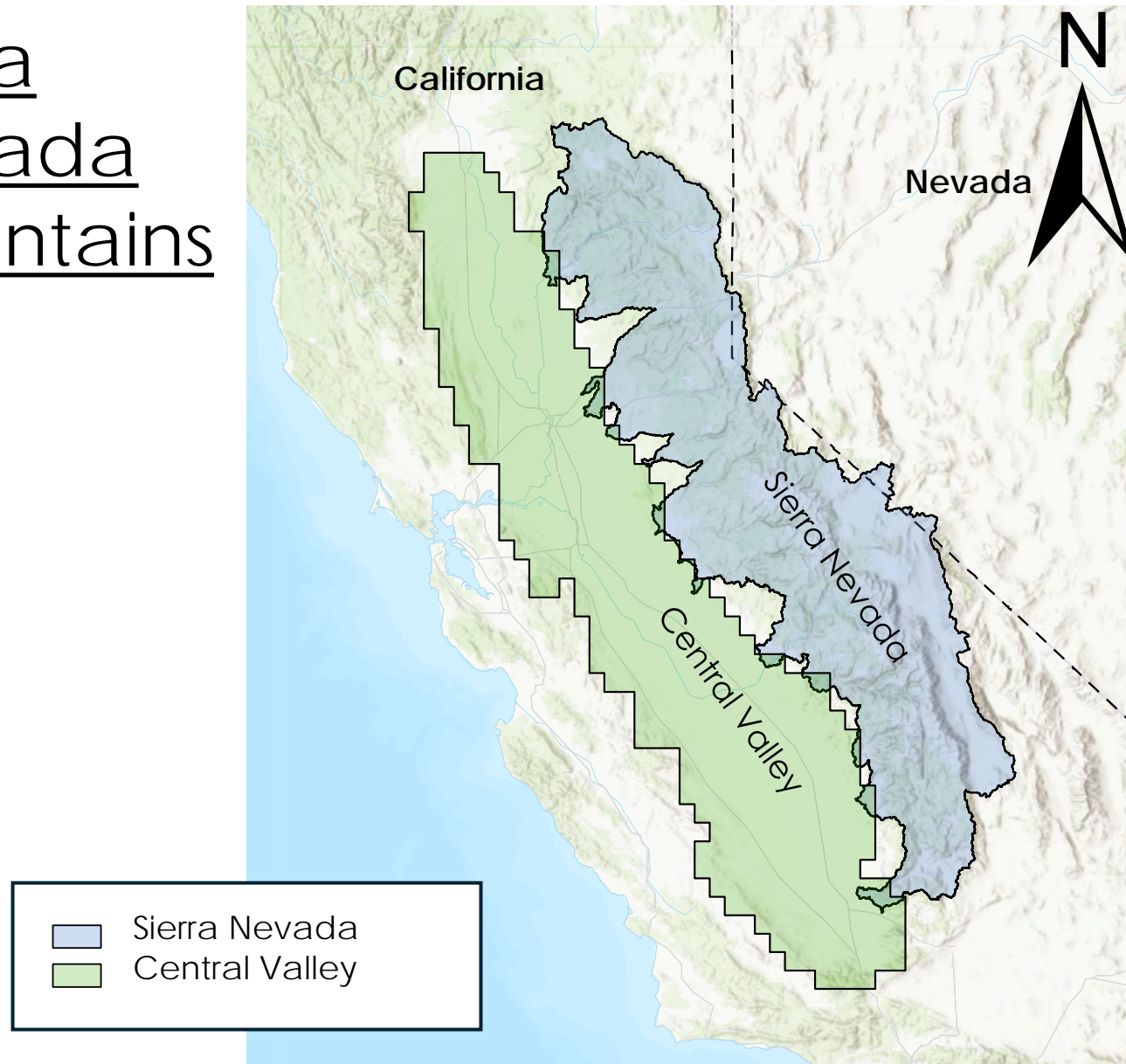
# Geodetic Investigation of Evapotranspiration in the Sierra Nevada



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Payton Gardner

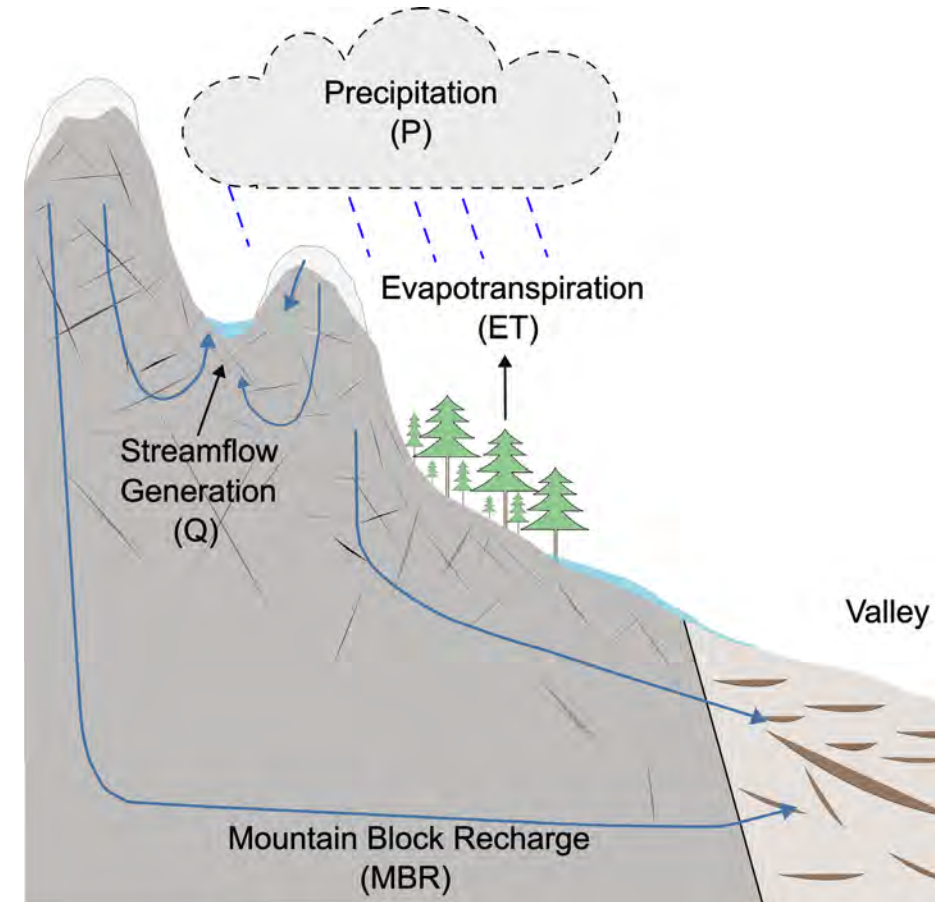


# Sierra Nevada Mountains



Esri, CGIAR, USGS, Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, © OpenStreetMap contributors, and the GIS User Community

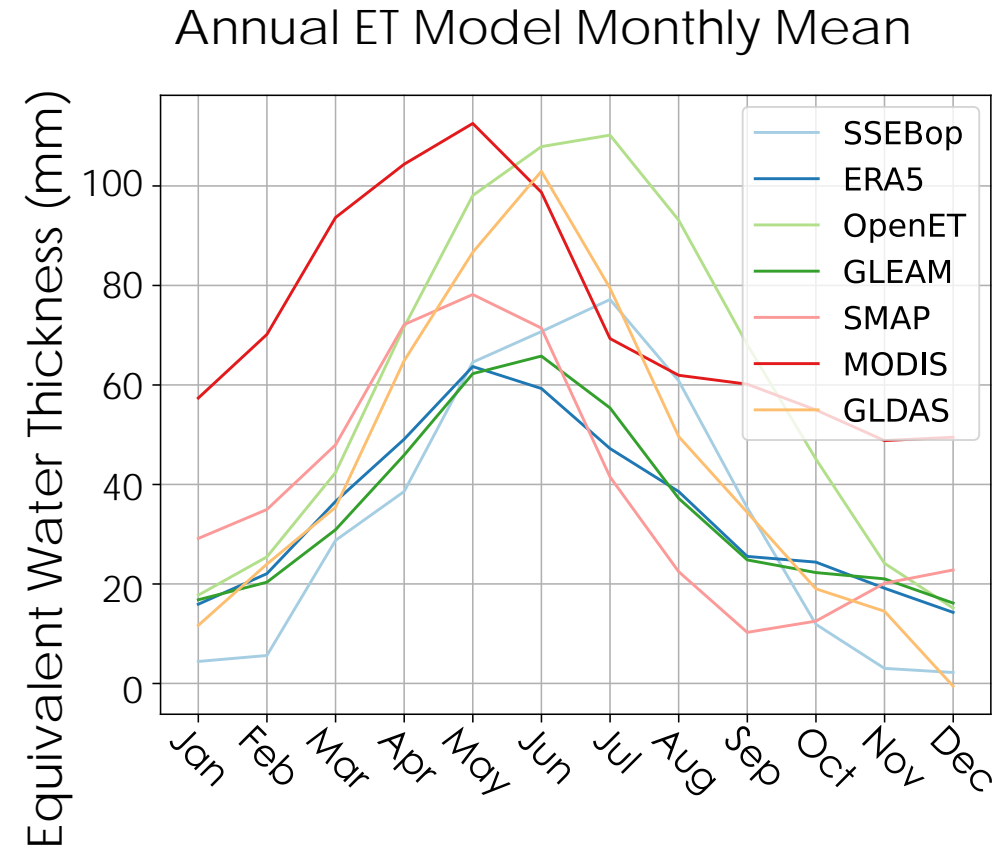
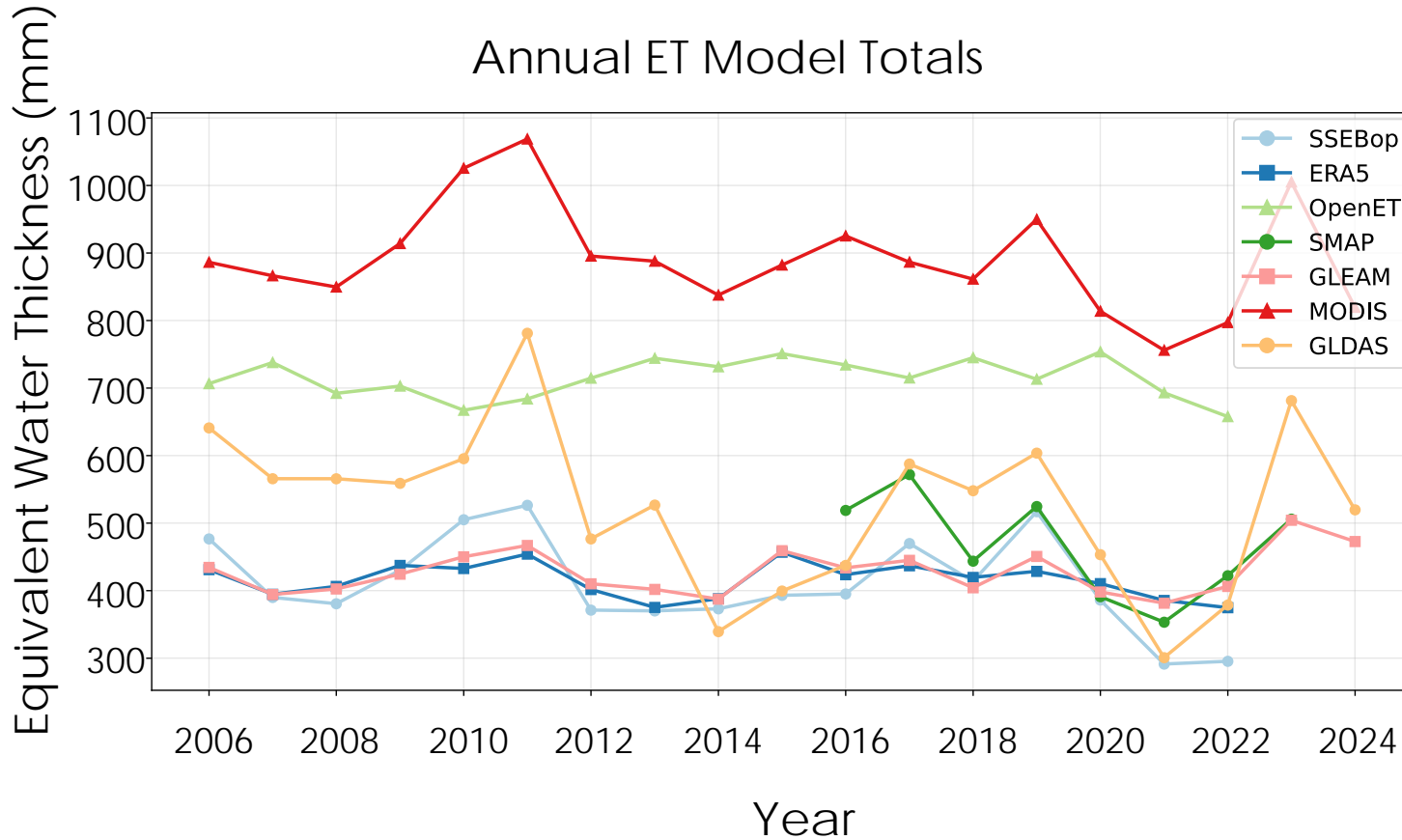
$$\frac{dS}{dt} = P - ET - Q - MBR$$



M. Swarr

# Regional Models

- ET models vary greatly in both magnitude and timing

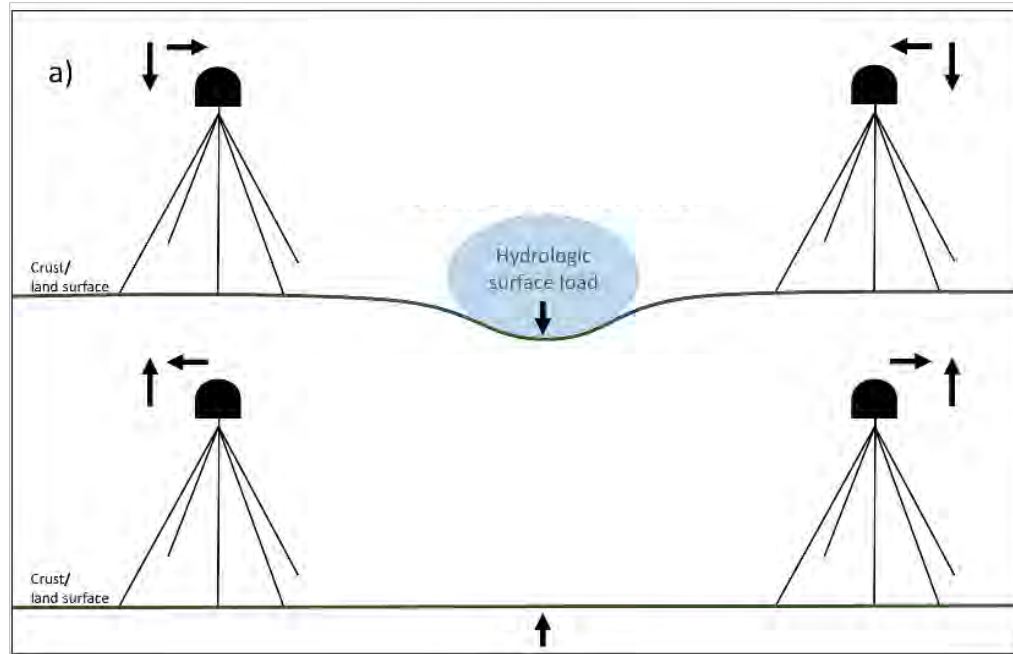


# Hydrogeodesy

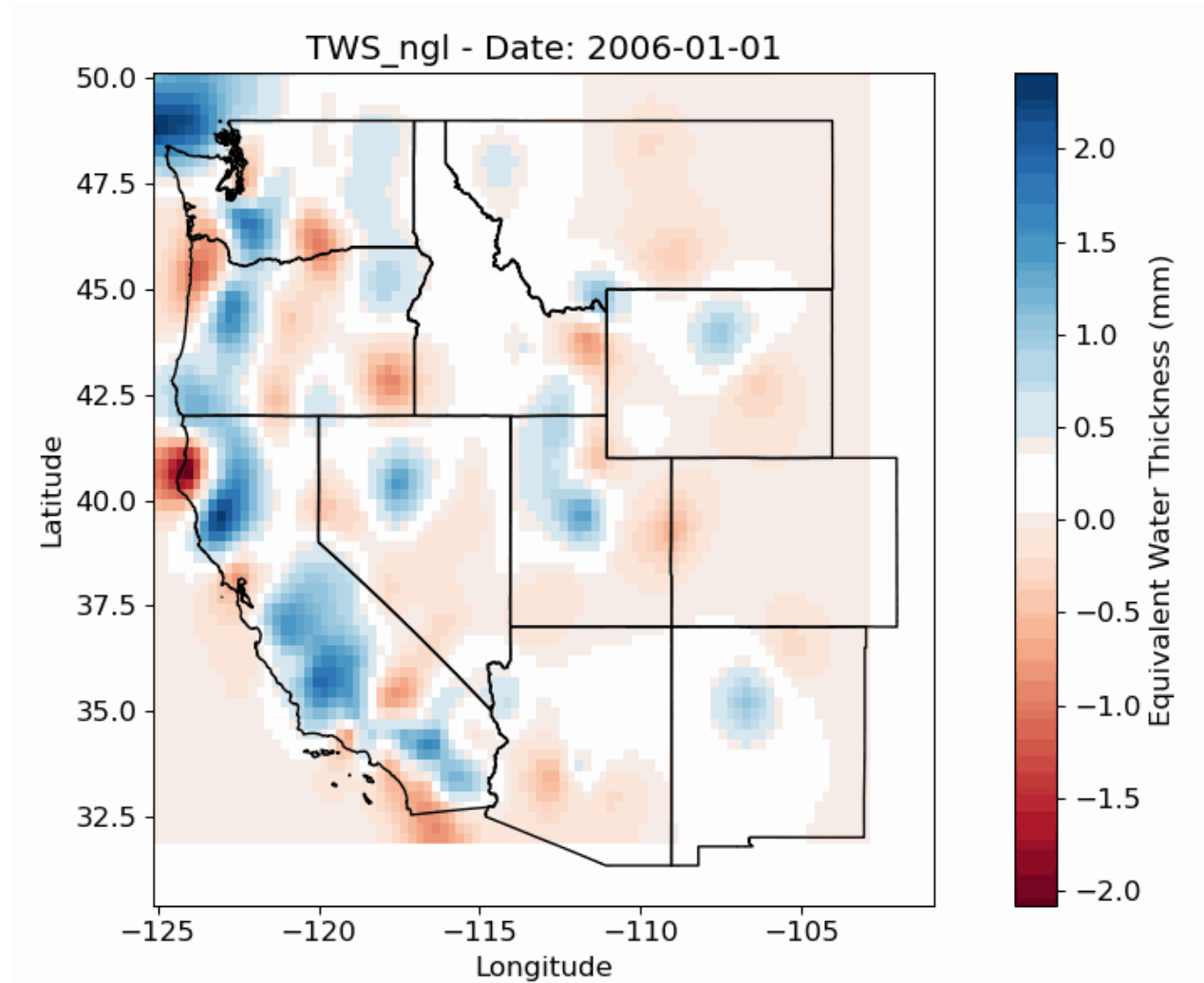
$$\frac{dS}{dt} = P - ET - Q - MBR$$



$$P - \frac{dS}{dt} - Q = ET + MBR$$



White et al. 2022

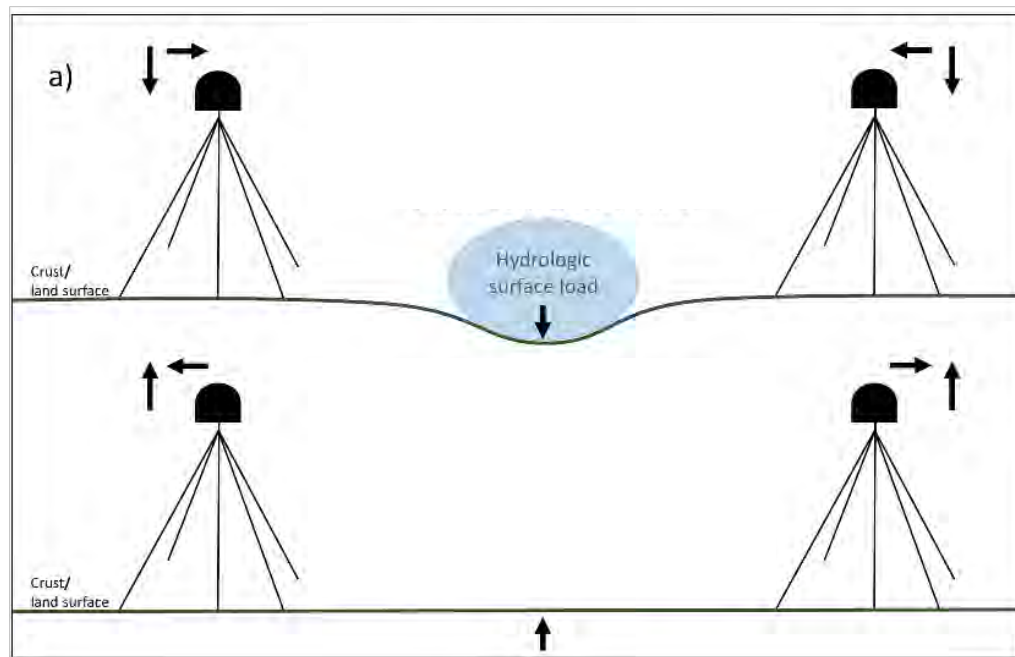


# Hydrogeodesy

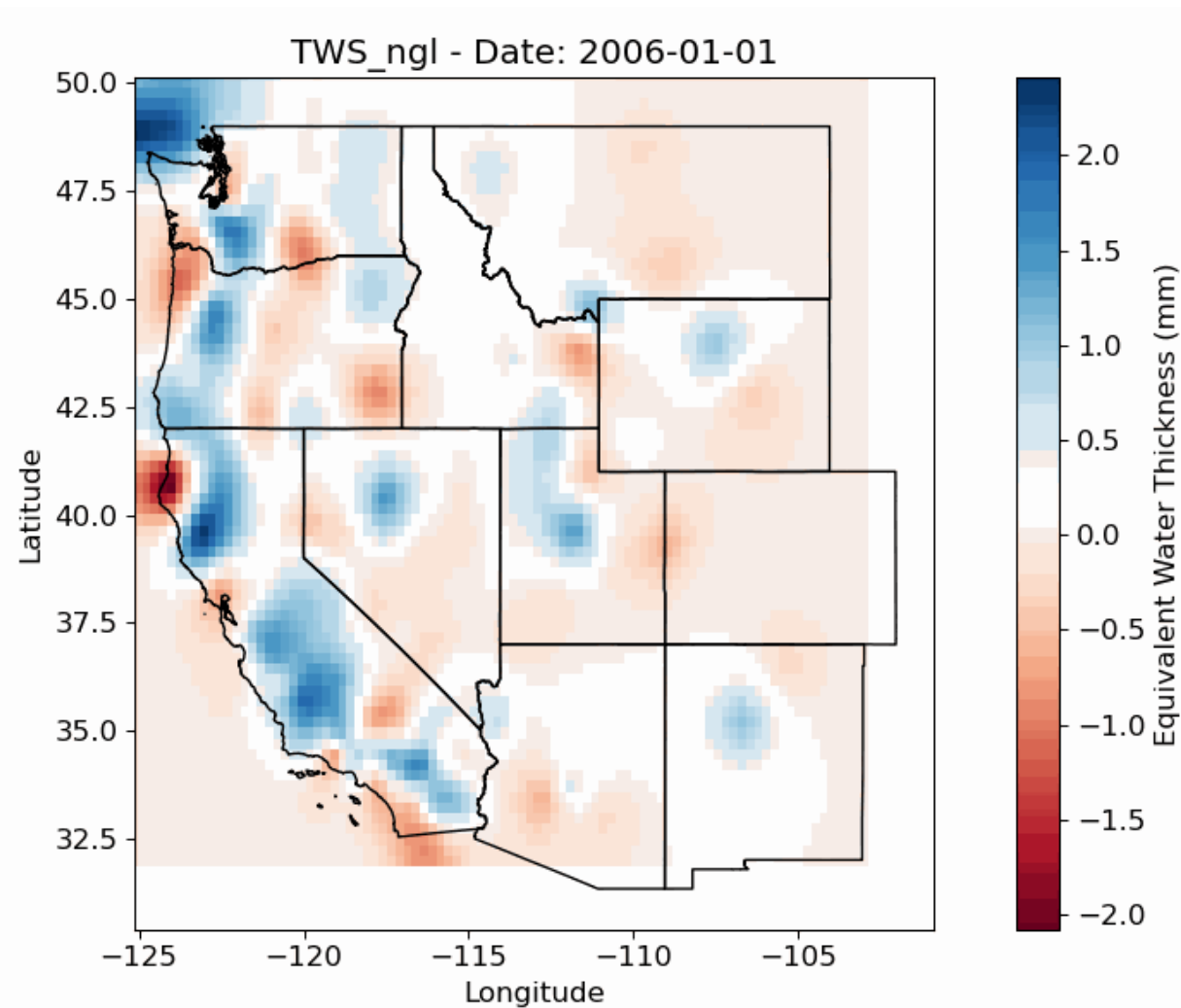
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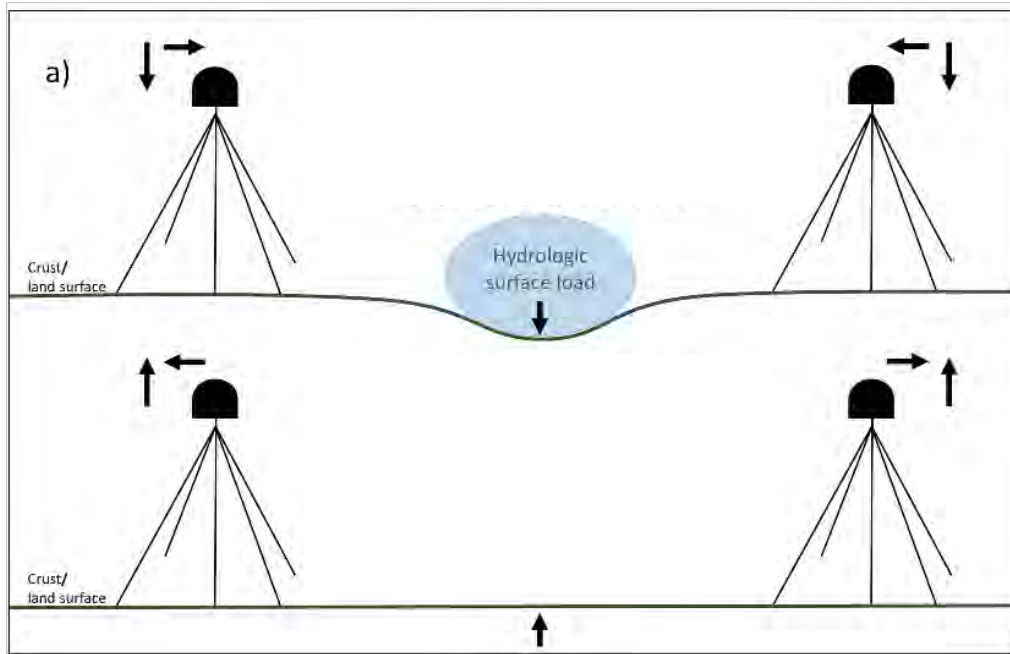


# Hydrogeodesy

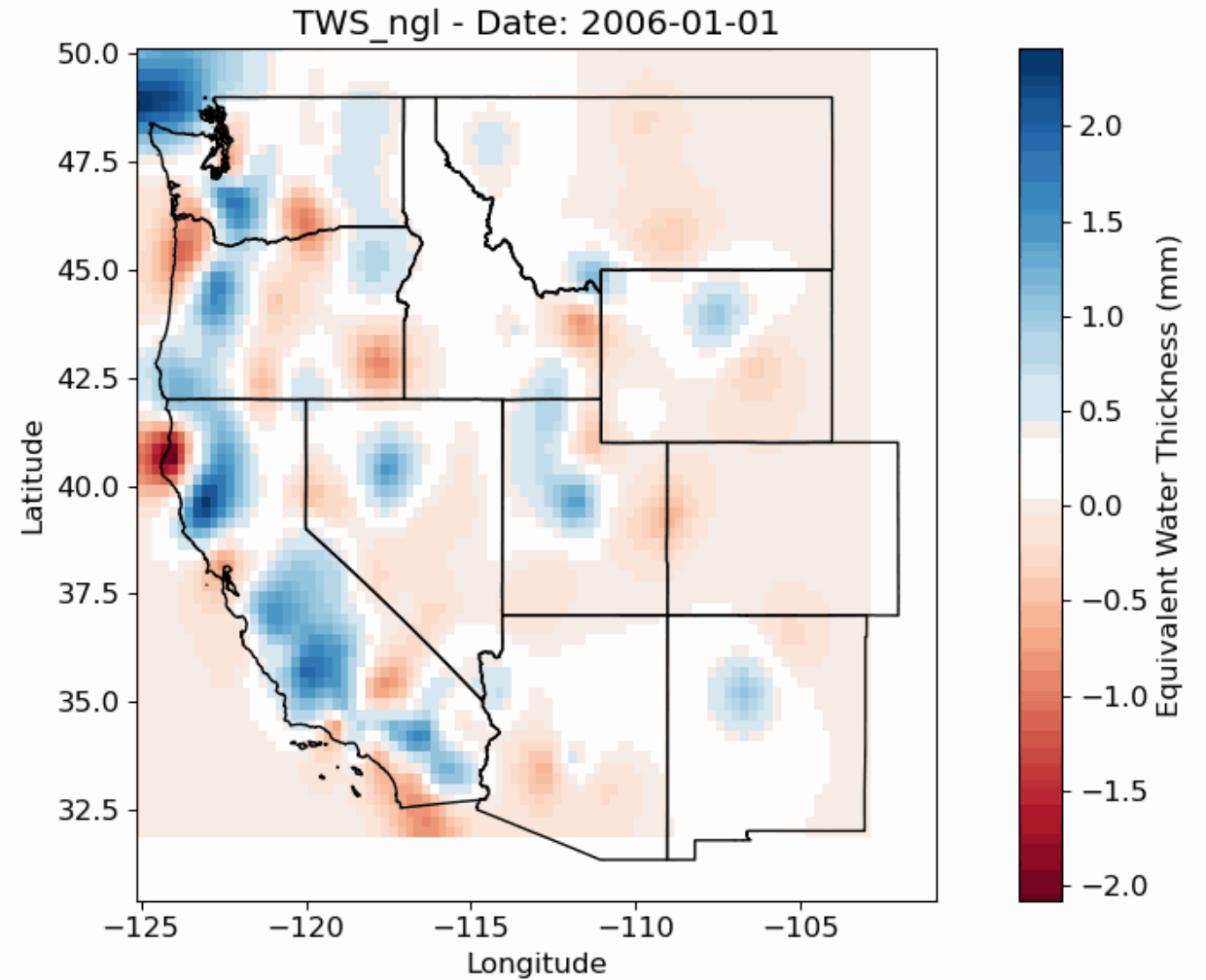
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White et al. 2022

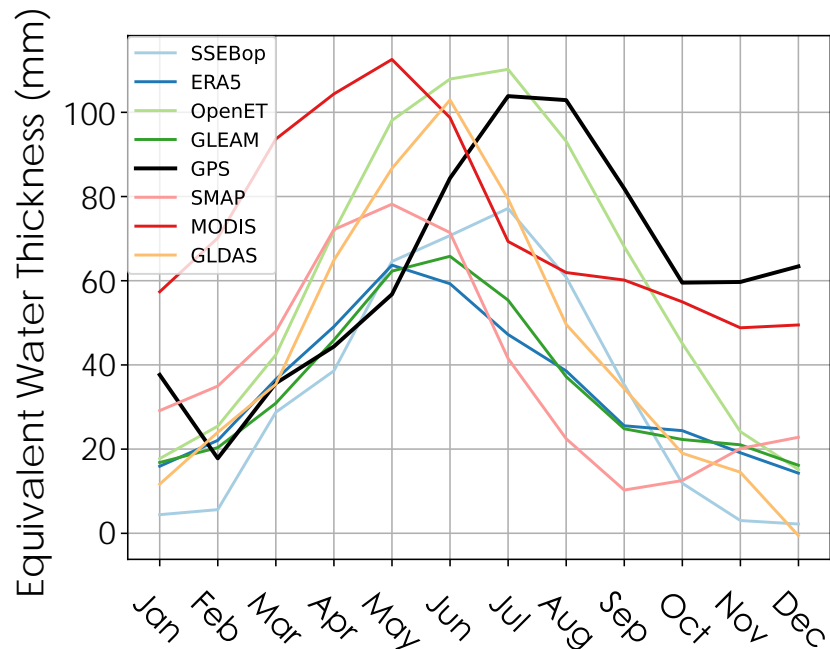


# Monthly Average ET

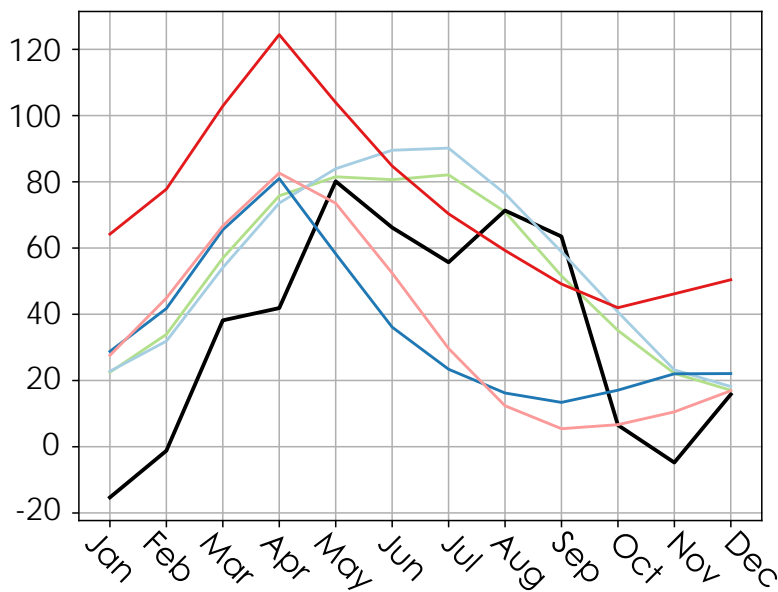
$$P - \frac{dS}{dt} - Q = ET + MBR$$

PRISM —  $P$  — GPS —  $\frac{dS}{dt}$  — Stream Gages —  $Q$

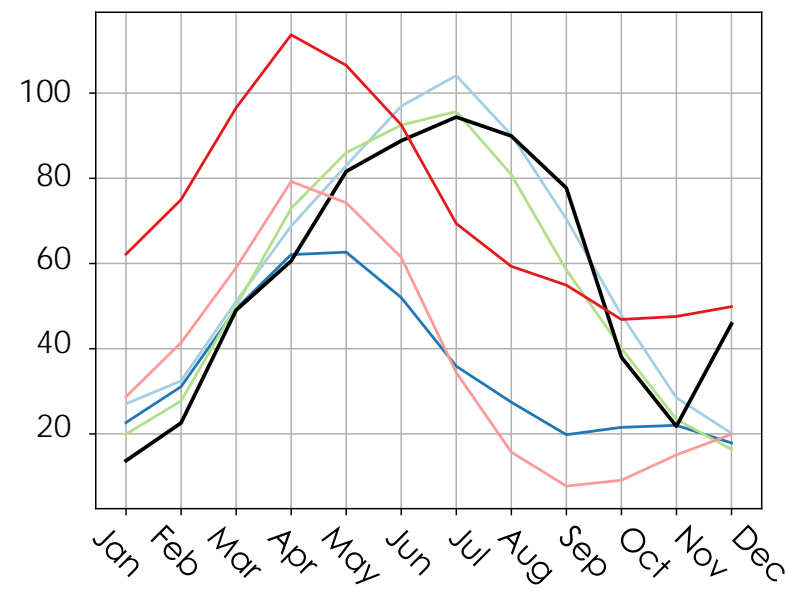
Sierra Nevada:



Central Valley:



Sierra Nevada + Central Valley:



# Model Design

Precipitation (P)  
(PRISM)

-

Change in TWS (dS/dt)  
(GNSS)

-

Discharge (Q)  
(CDEC Gages)

Known Data

ET

+

MBR

Unknown Quantities

=

Sierra:

$$P - \frac{dS}{dt} - Q$$

=

$$ET_s + MBR$$

Central Valley:

$$P - \frac{dS}{dt} + Q$$

=

$$ET_{cv} - MBR$$

$$\alpha = \frac{ET_s}{ET_s + ET_{cv}}$$

Sierra:

$$P - \frac{dS}{dt} - Q$$

~

$$N(\alpha ET_M + MBR_i, \epsilon)$$

Central Valley:

$$P - \frac{dS}{dt} + Q$$

~

$$N((1 - \alpha)ET_M + MBR_i, \epsilon)$$

# Model Design

## Likelihoods:

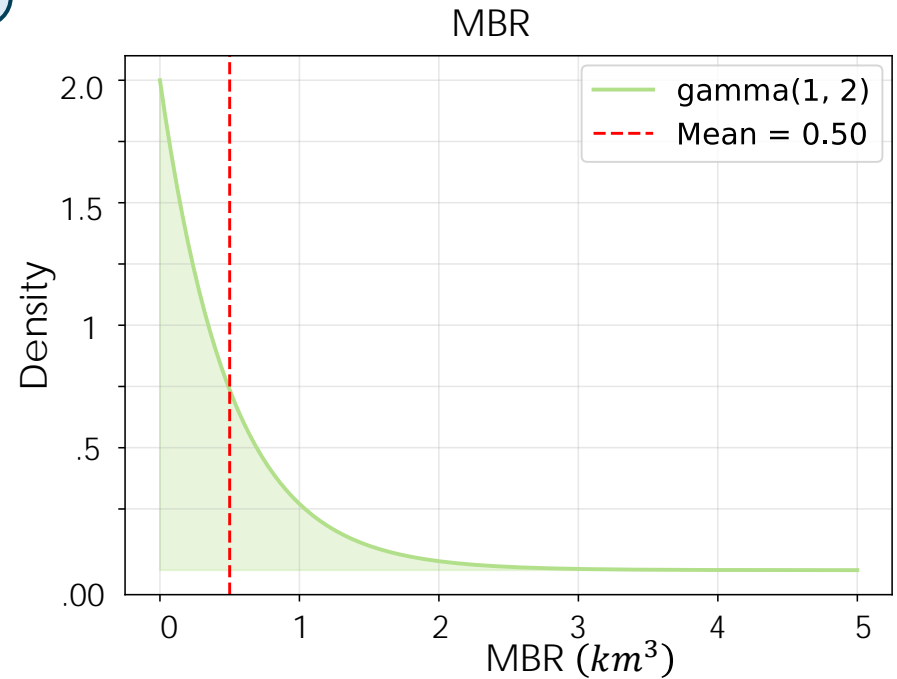
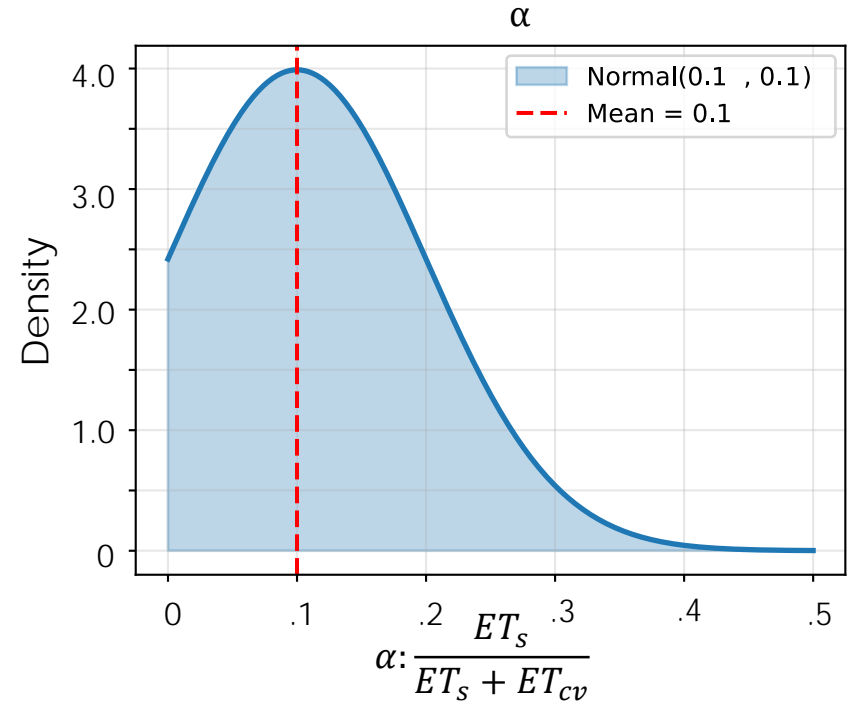
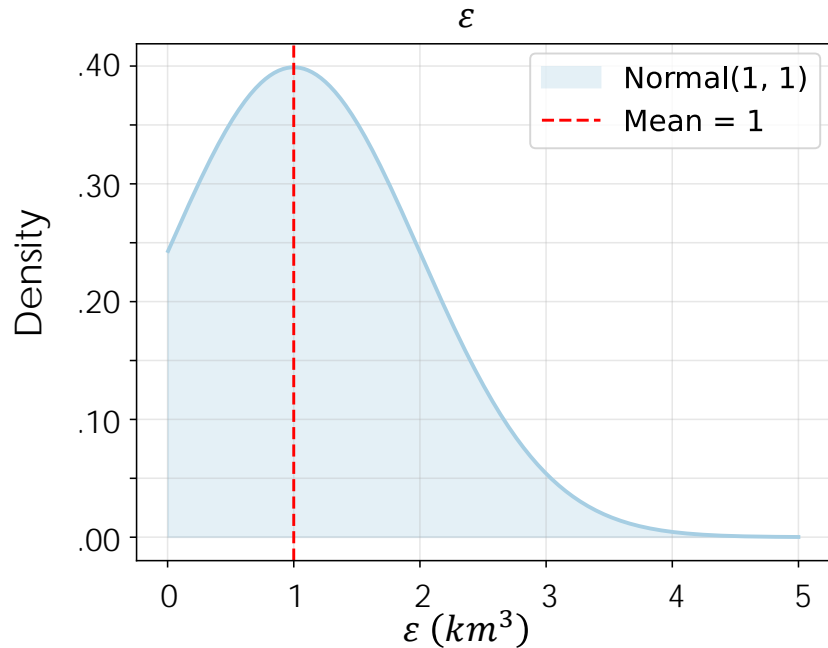
Sierra:

$$P - \frac{dS}{dt} - Q \sim N(\alpha ET_M + MBR_i, \varepsilon)$$

Central Valley:

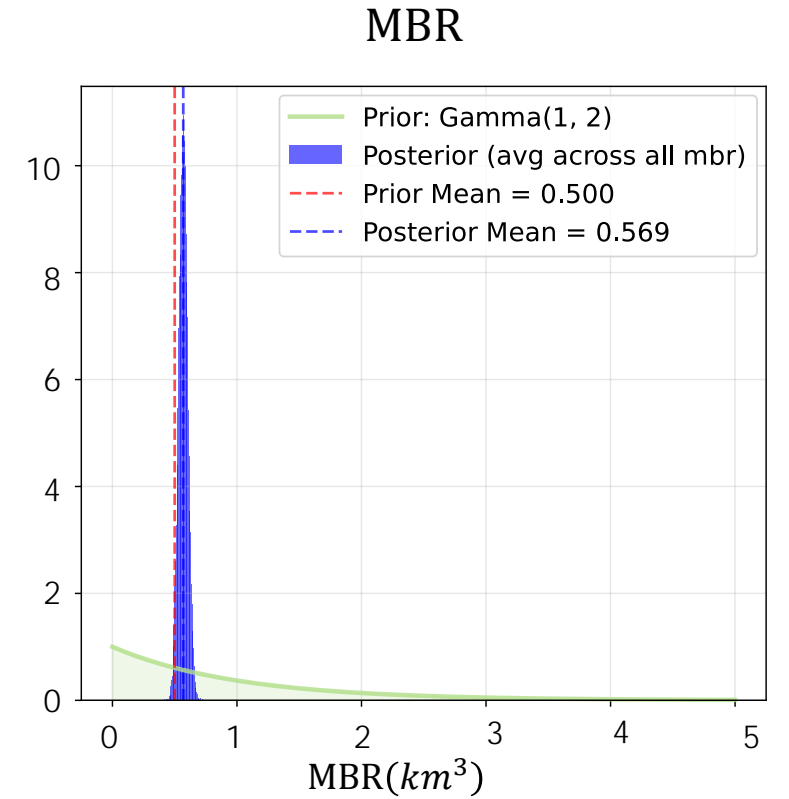
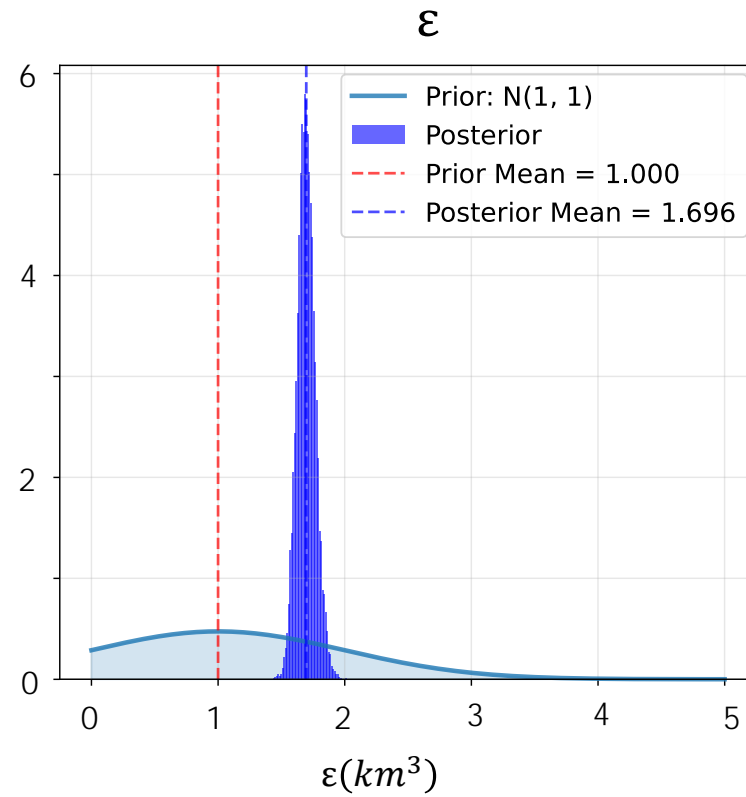
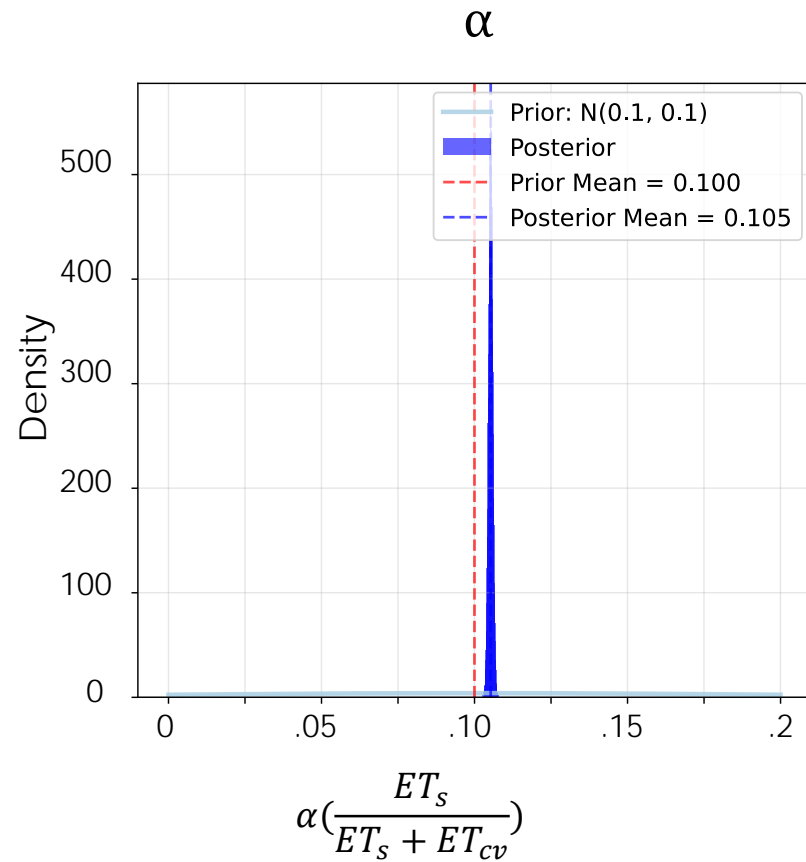
$$P - \frac{dS}{dt} + Q \sim N((1 - \alpha)ET_M - MBR_i, \varepsilon)$$

## Priors:



# Prior vs Posterior

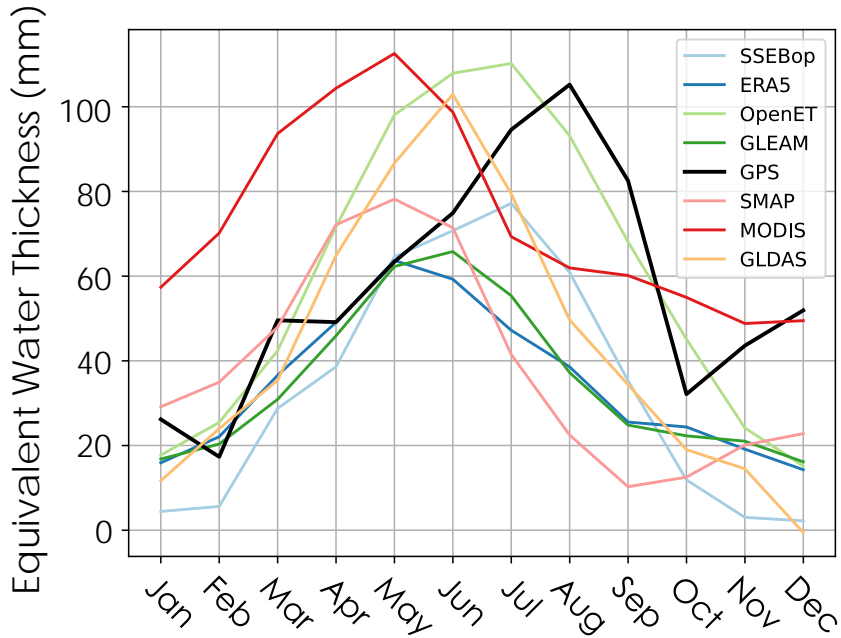
- Posterior distributions show significantly less variance



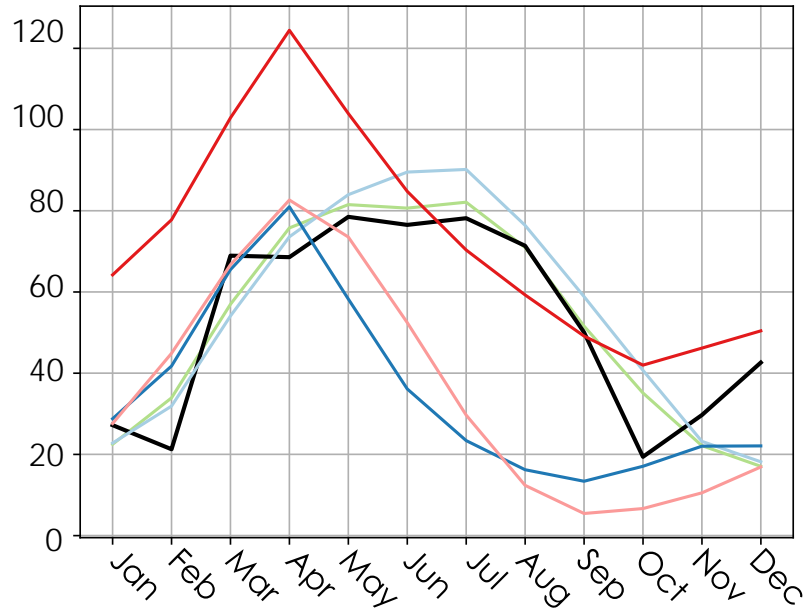
# ET and MBR

- Remaining high values in winter:
  - Underestimated mountain precipitation
  - Remaining groundwater flow outside of Sierra Nevada-Central valley system

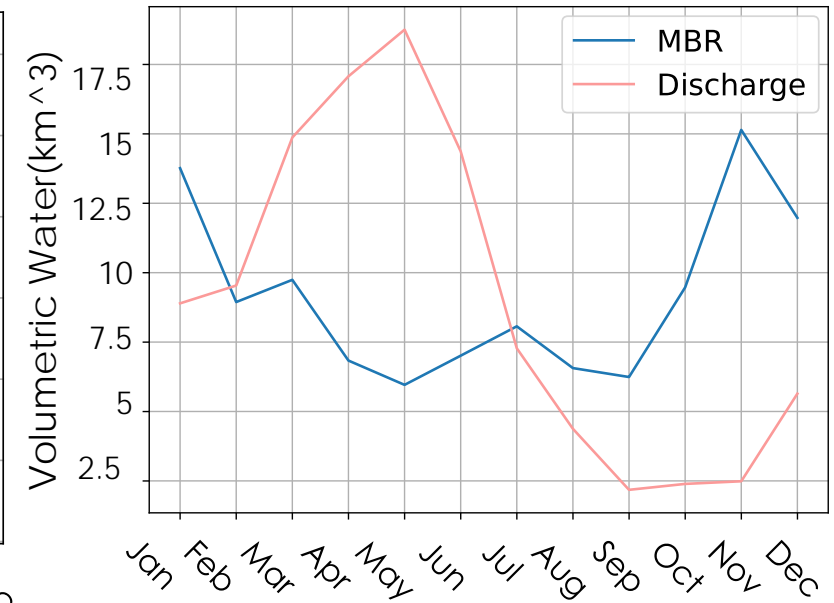
Sierra Nevada:



Central Valley:



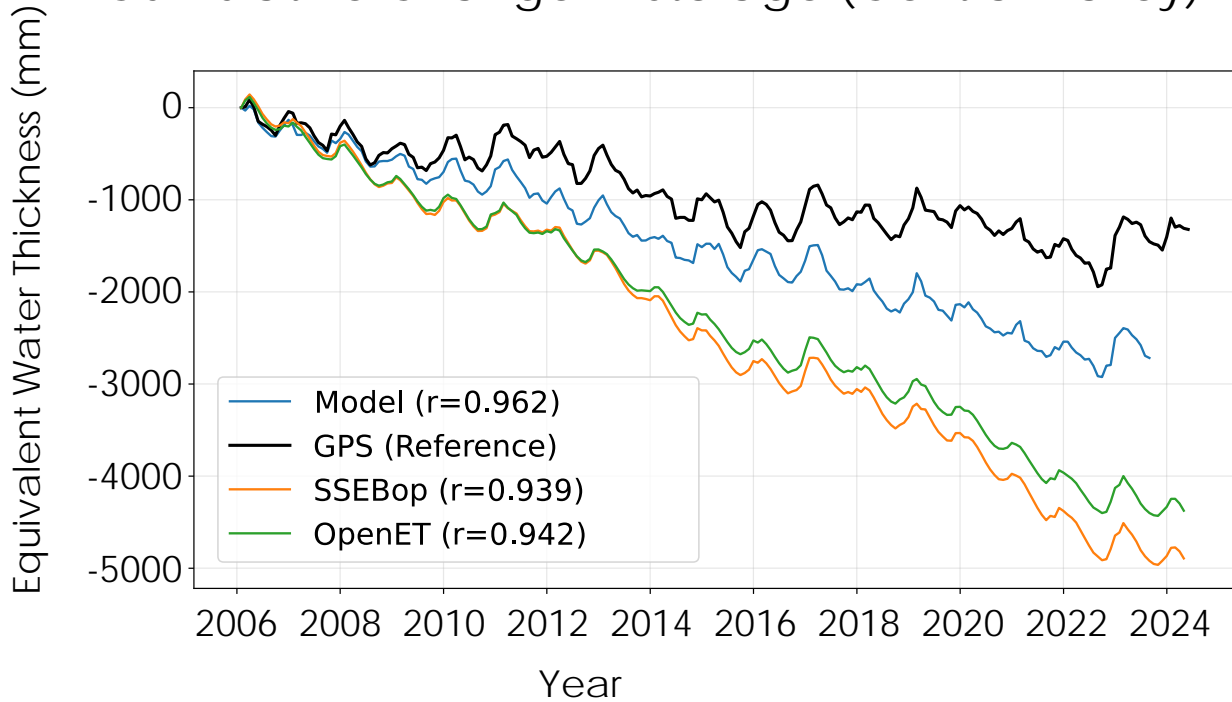
Mountain Block Recharge:



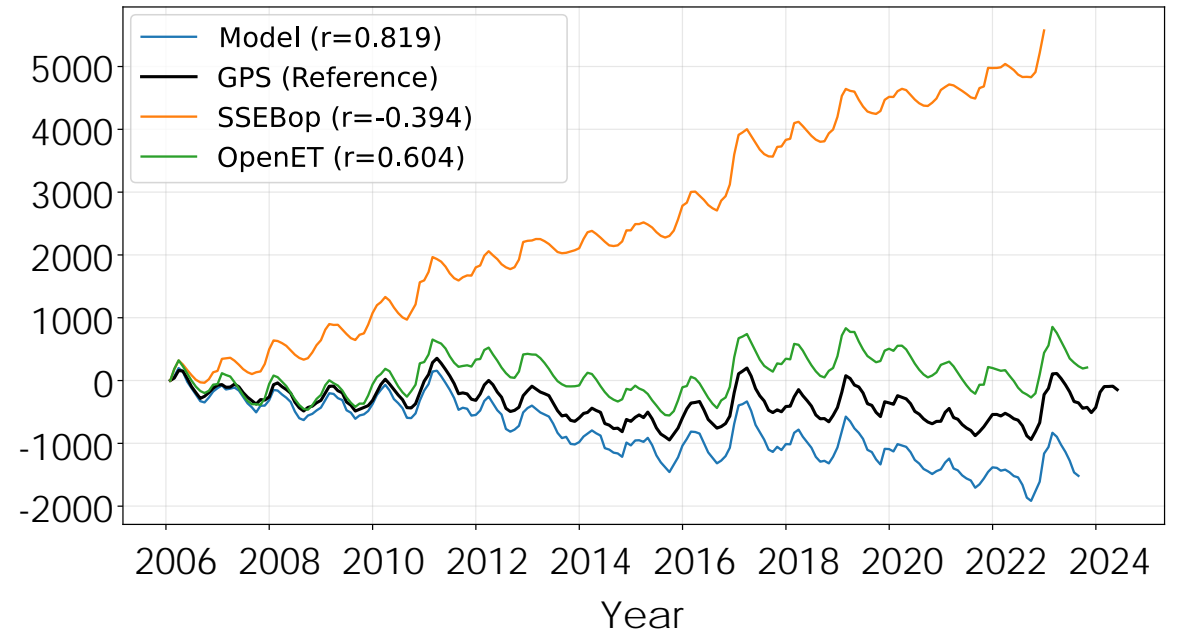
# ET + MBR VS ET Models

$$\frac{dS}{dt} = P - ET - Q - MBR$$

### Cumulative Change in Storage (Central Valley)



### Cumulative Change in Storage (Sierra)



# Conclusions

- MBR is on the same magnitude as discharge
- Using ET models alone for water balance calculations in mountain-valley systems neglects water from MBR
- Moving forward:
  - Further investigation into constraining ET values



Thank You!

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# Citations

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