Landscape Water Balance Closure is Represented by the Combination of SMAP and GPM Data

Problem: Landscape water balance cannot be closed using available observations

The landscape water budget is:

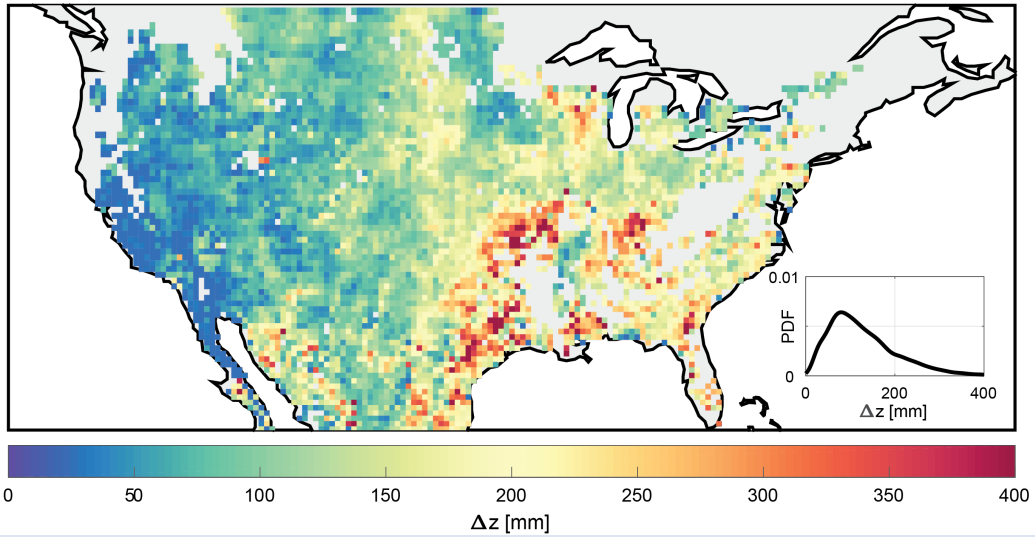
$$\Delta z \frac{d\theta}{dt} = P - ET(\theta) - D(\theta) \quad [\text{mm day}^{-1}]$$

Equivalent to

$$\frac{d\theta}{dt} = \frac{P}{\Delta z} - E\left[-\frac{\Delta\theta^-}{\Delta t_{obs}}\middle|\theta\right] \quad [\text{day}^{-1}]$$

The functional form of the landscape moisture loss is approximated by the expectation $E[\ ]$ of dry-down SMAP rate $\frac{\Delta\theta^-}{\Delta t^{obs}}$ conditioned on the soil moisture state θ:

$$L(\theta) = E\left[-\frac{\Delta\theta^-}{\Delta t^{obs}}\middle|\theta\right]$$



Finding: The characteristic hydrologic depth Δz that

- *tracks* the dynamics of landscape water balance,
- *closes* the water budget

is identifiable with *only* precipitation (P from GPM) and soil moisture (θ and $\Delta\theta$ from SMAP)

Impact: Taken together, soil moisture and precipitation define a closed landscape water budget. Together they define a landscape storage that is deeper than the sensing depth of surface soil moisture.

Akbar, Gianotti, Haghighi, McColl, Salvucci, Entekhabi, 2018: Hydrological storage length scales represented by remote sensing estimates of soil moisture and precipitation, *Water Resources Research.*