Assessment of Land Surface and Atmospheric Model Mass Flux Using Water Balance Techniques and GRACE/GRACE-FO Data

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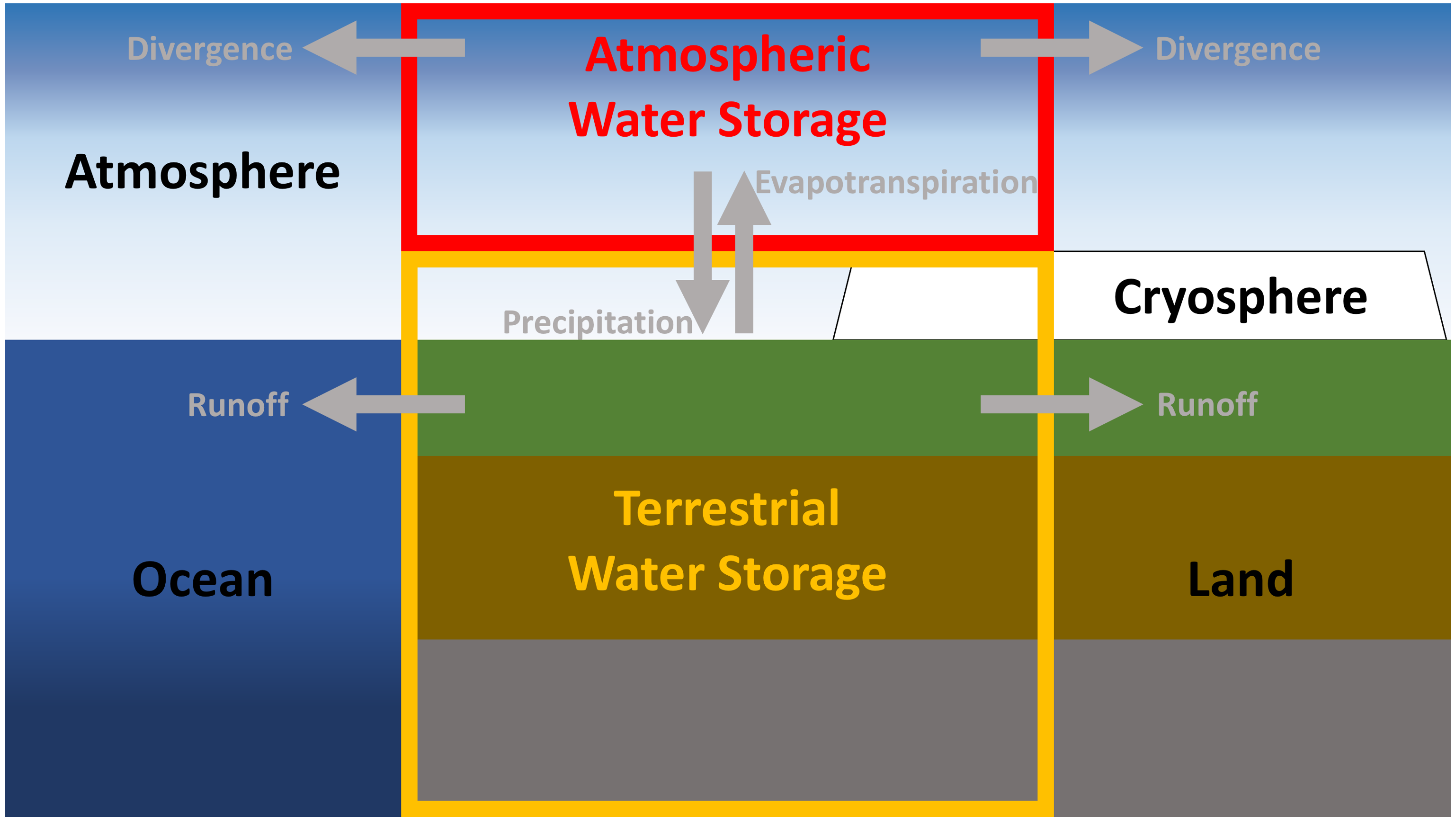
The Water Balance

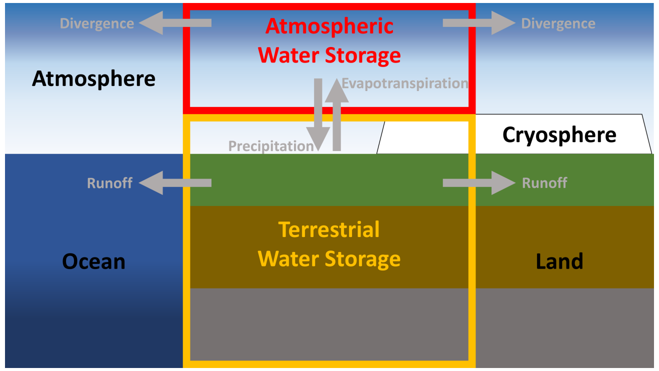
$$\Delta TWS = -D - R - \Delta AWS$$

$$ET - P - D = \Delta AWS$$

$$P - ET - R = \Delta TWS$$



Methods- Divergence

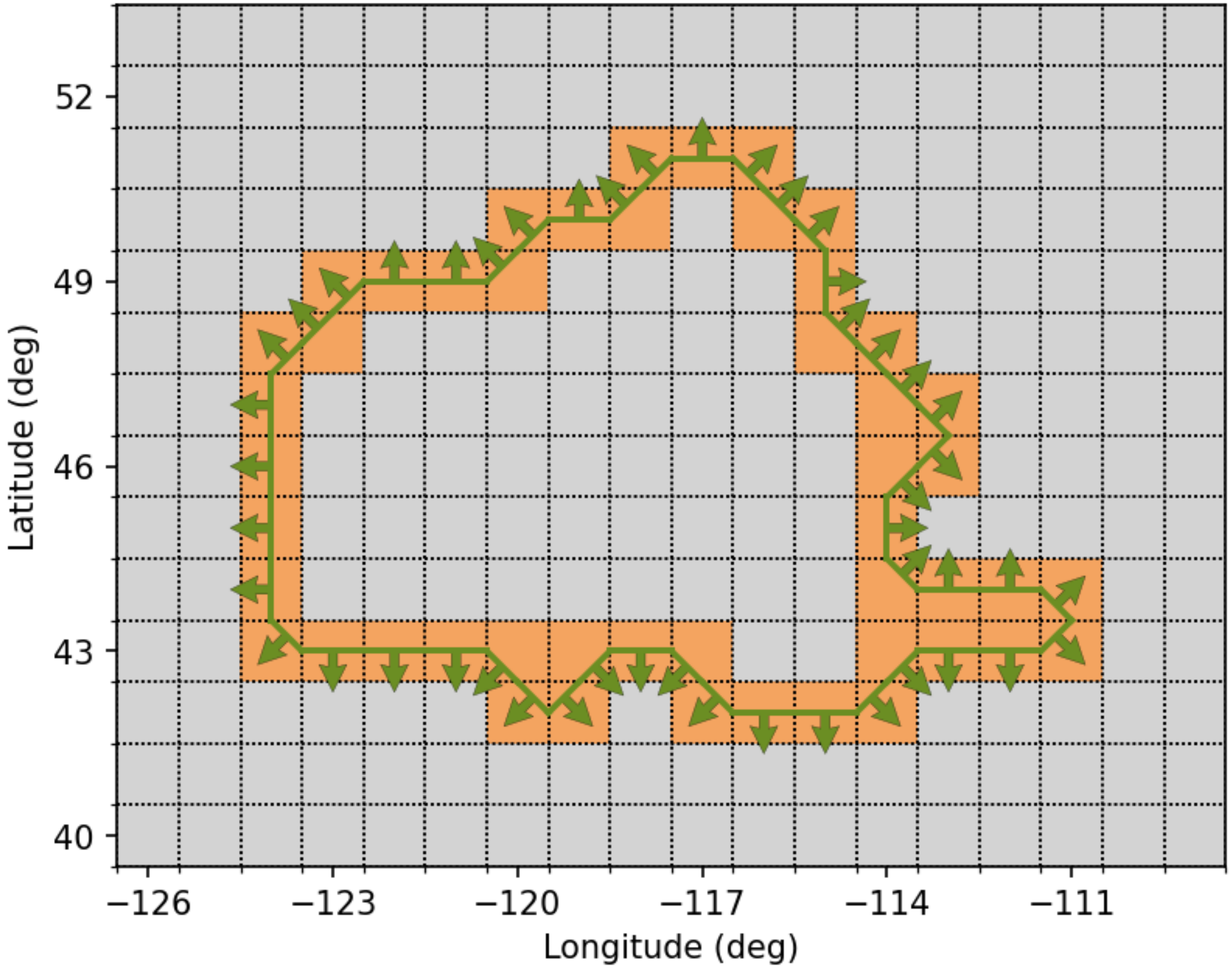


- Given an enclosed surface, two equivalent approaches to calculate atmospheric moisture flux divergence are permitted by the divergence theorem:
  - $\iiint_V (\nabla \cdot \vec{Q})\, dV$ (volume approach)
  - $\oiint_S (\vec{Q} \cdot \hat{n})\, dS$ (surface approach)
- The equivalence of the above formulations assume no sources or sinks within the enclosed area

Methods- Surface

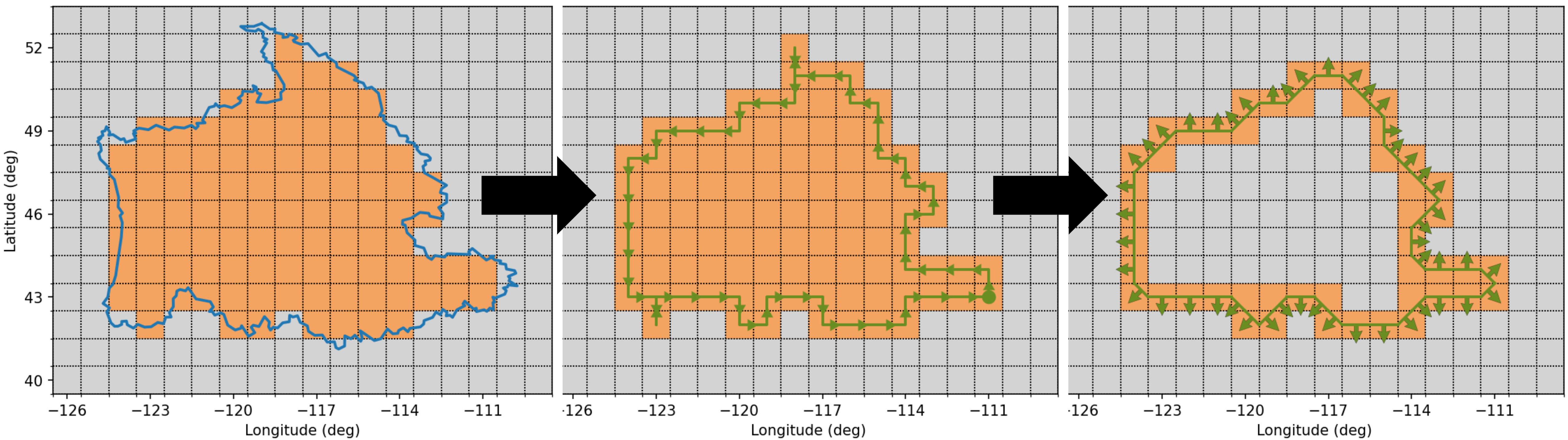
- The surface approach is rarely used (Reed et al. 1996)
- Implementing the surface approach for atmospheric divergence requires an extra step of discretizing the boundary as well
- Boundary discretization handled by pathfinding algorithm (contour tracing)

HU2-17 Pacific Northwest – 1 degree grid

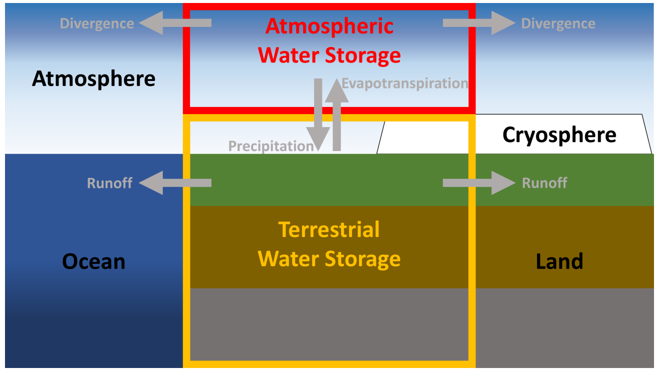


Methods- Surface

HU2-17 Pacific Northwest – 1 degree grid

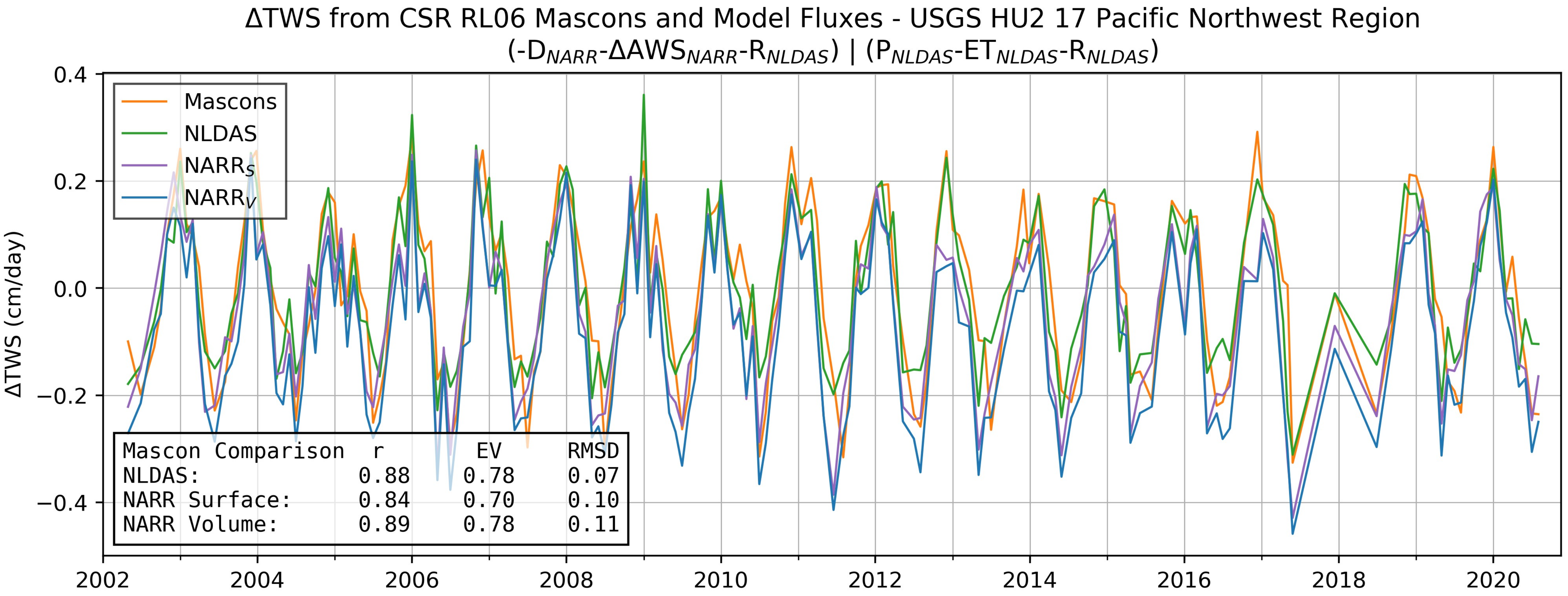


The Water Balance- Components



- Terrestrial water balance: $P - ET - R = \Delta TWS$
- Atmospheric water balance: $ET - P - D = \Delta AWS$
- Total column water balance: $\Delta TWS = -D - R - \Delta AWS$
- Components:
  - GRACE CSR RL06 Mascons
  - NLDAS-2 Noah v2.8
  - NARR
- Chosen models are linked:
  - NARR uses a version of NLDAS Noah as its land surface component
  - NLDAS-2 utilizes NARR for forcing data
    - precipitation forcing is adjusted by CPC gauge data, doppler radar precipitation data, and CMORPH products

HU2-17: Pacific Northwest



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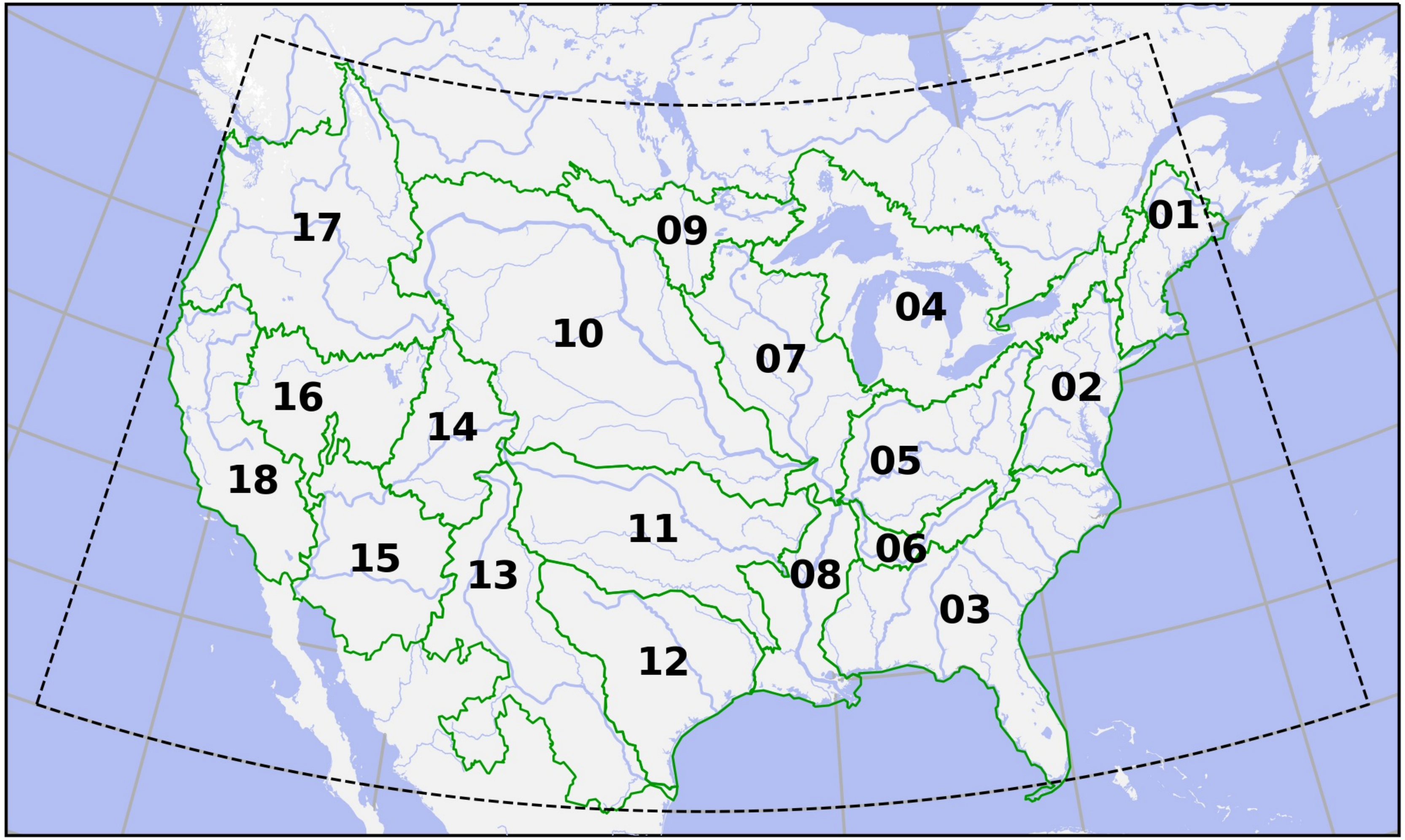
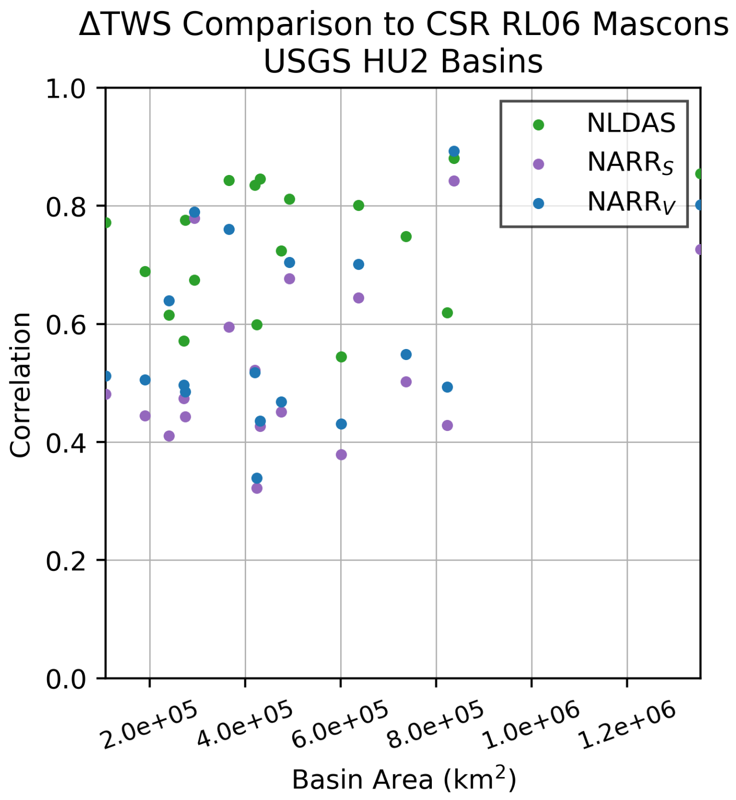
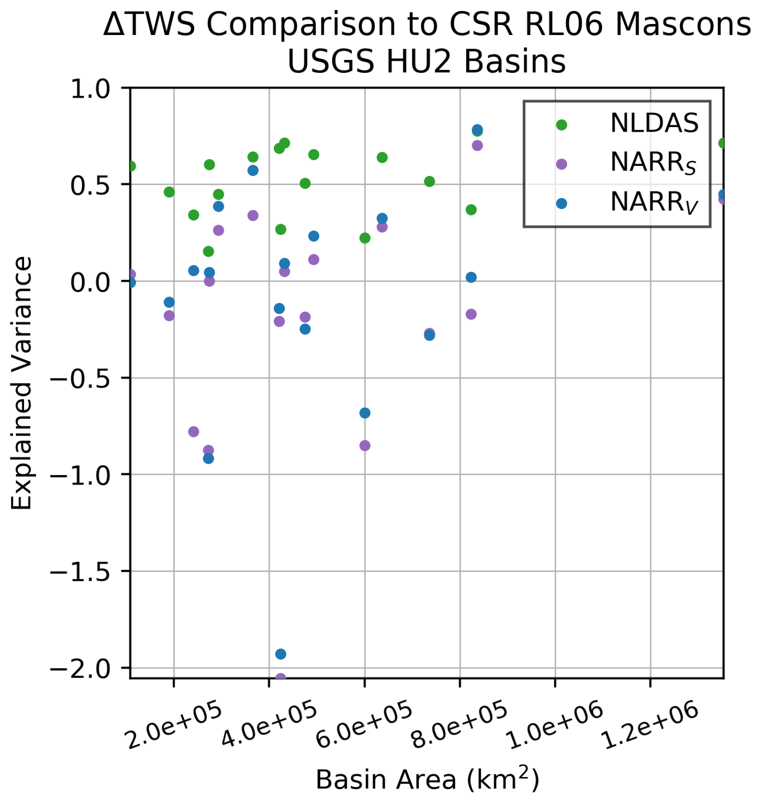
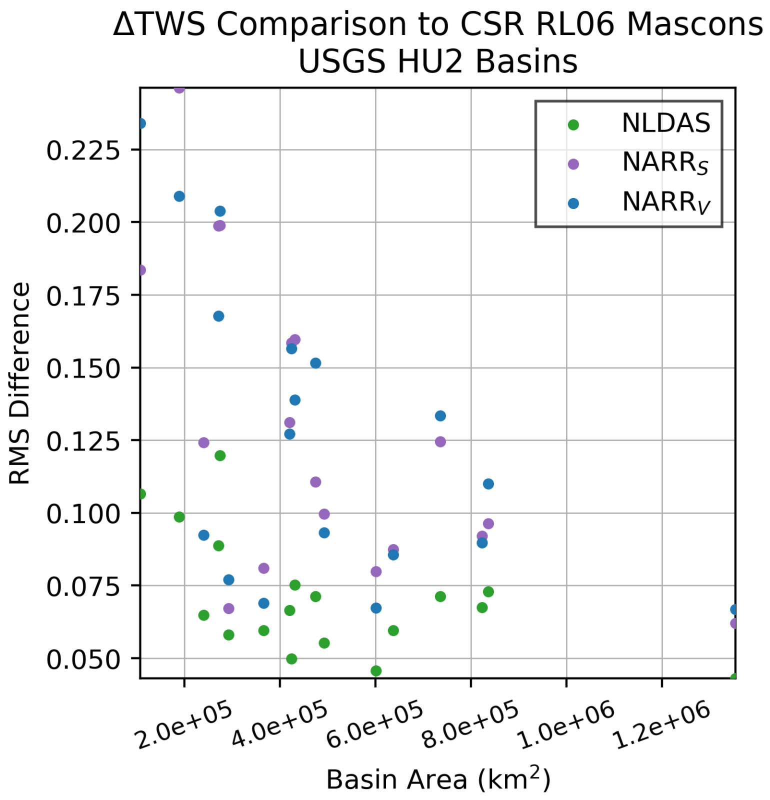
USGS Watershed Boundary Dataset – HU2



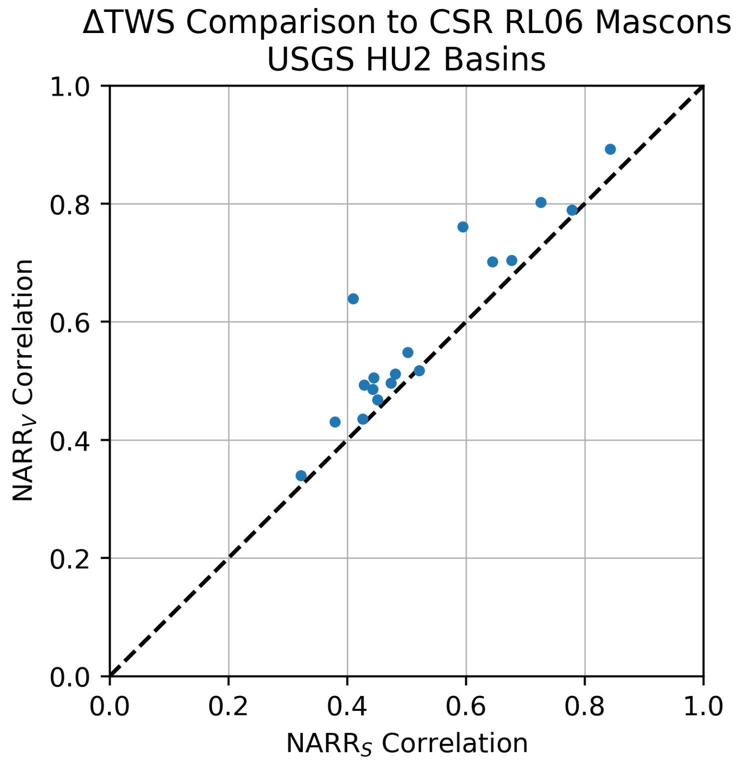
HU2 Results for All Approaches

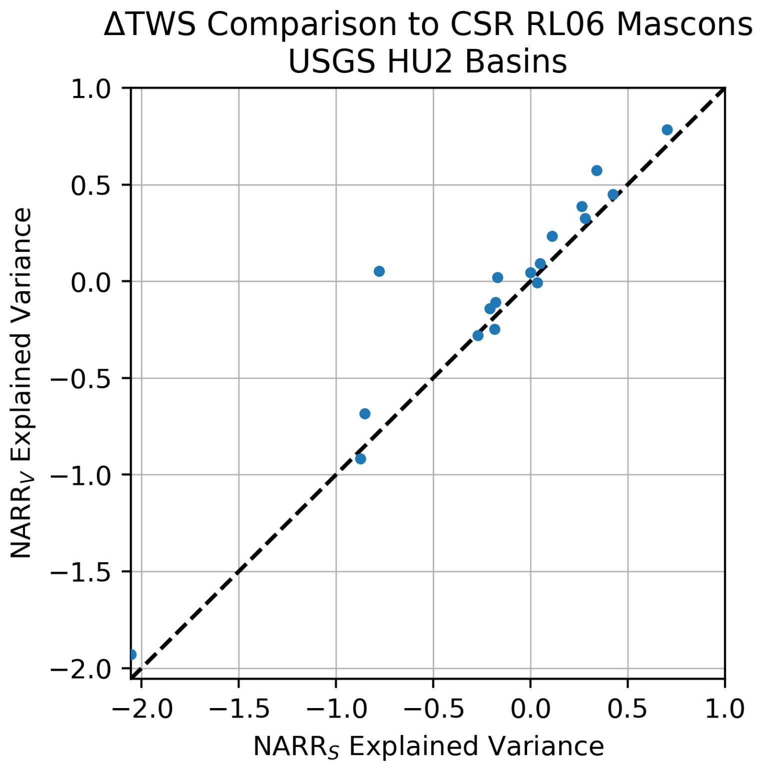


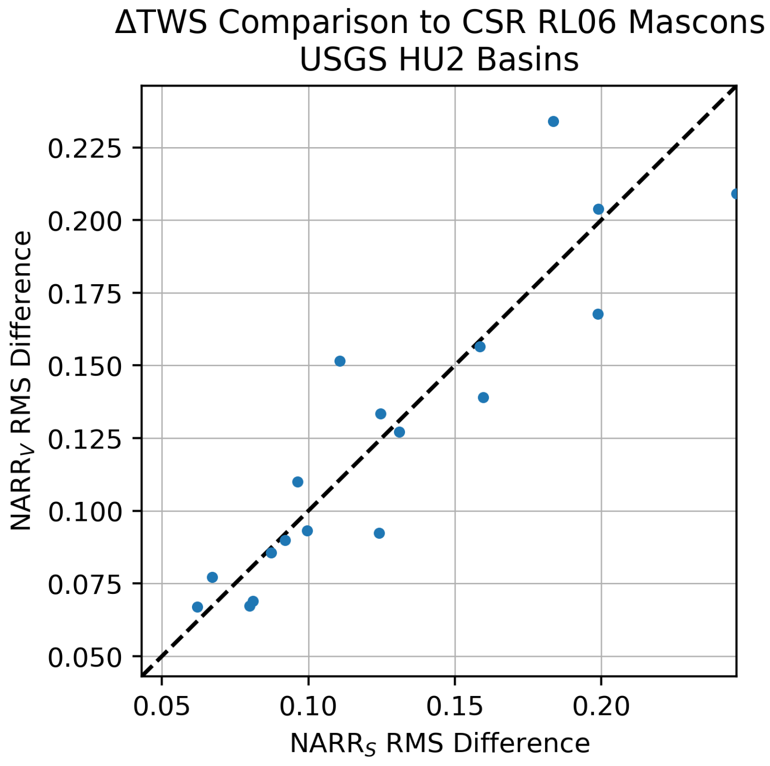




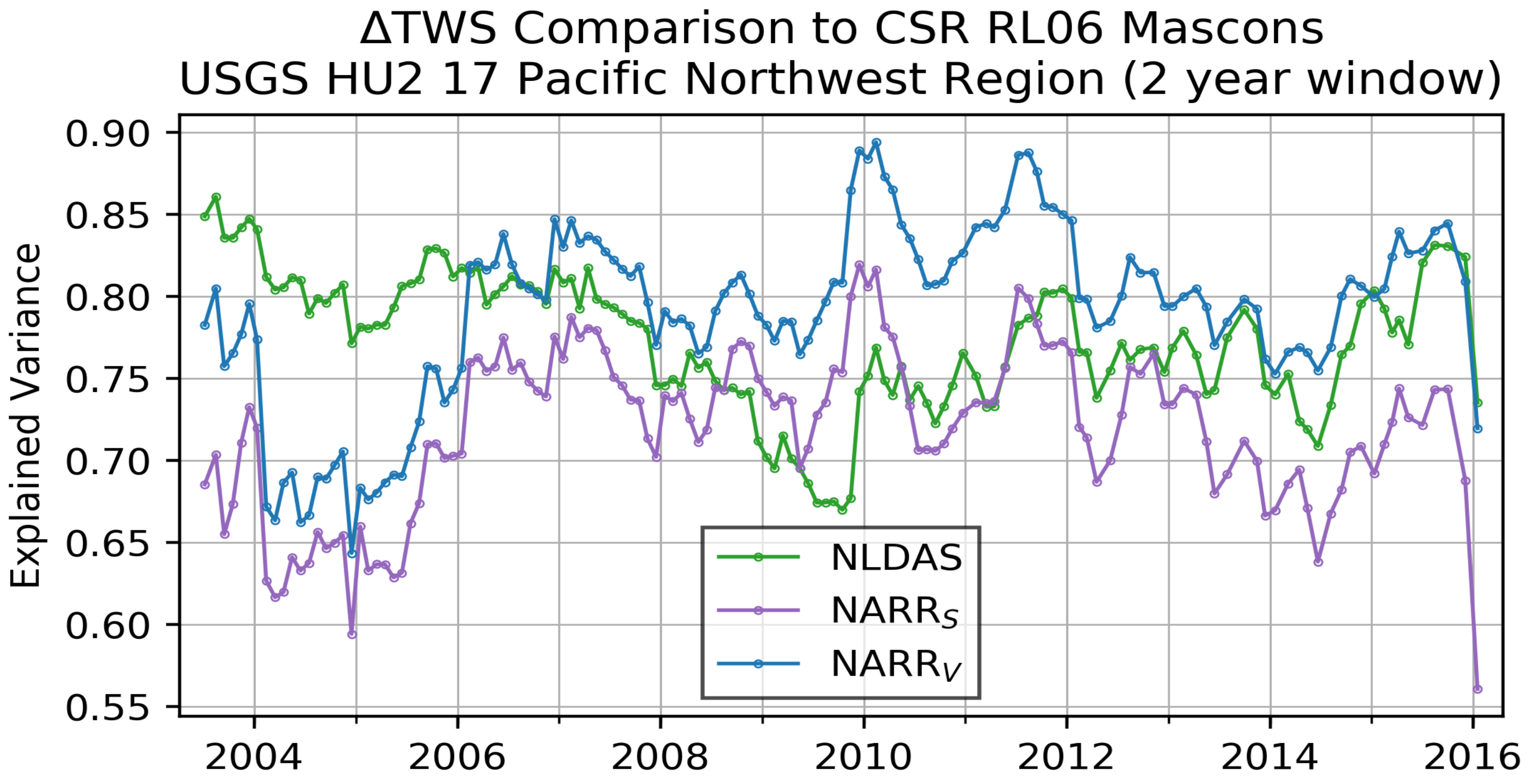
Total Column Balance: Surface vs. Volume Approach



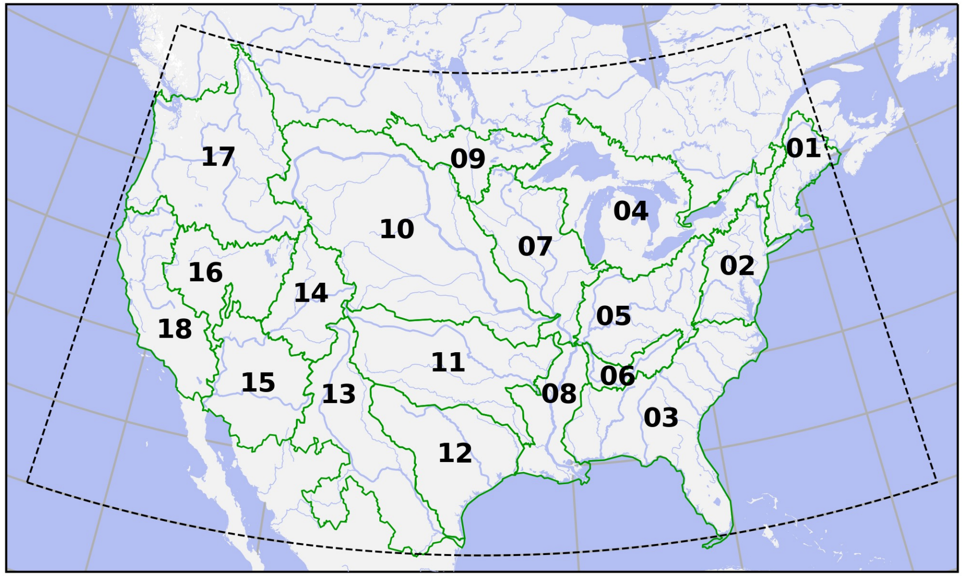


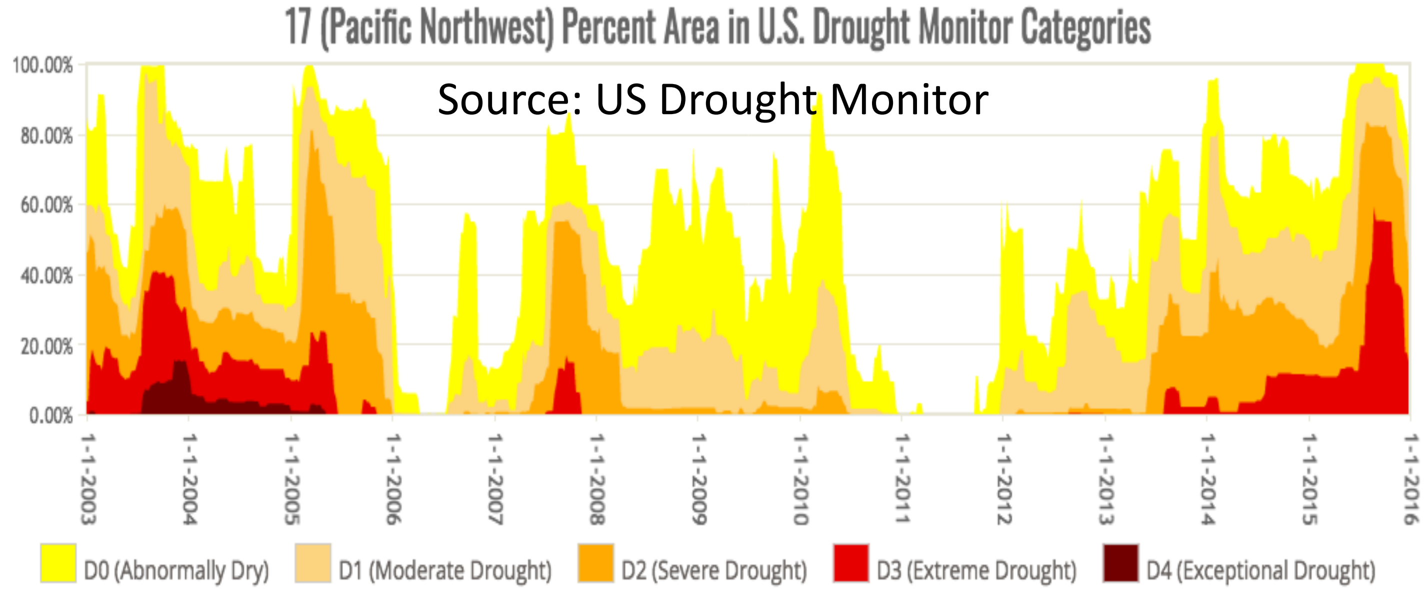


Relationship Between Drought Conditions and NARR Mass Flux



HU2 Regions





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