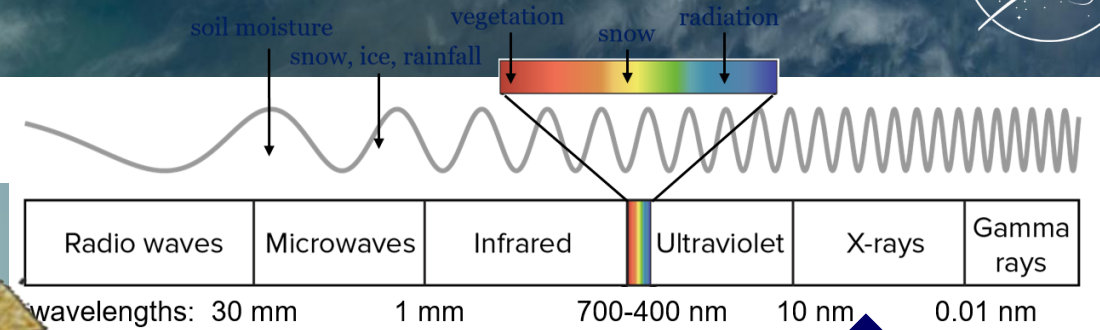
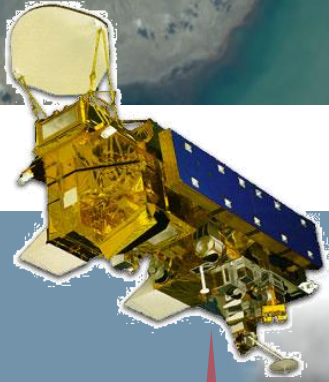
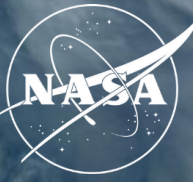


Current and Future Directions for GRACE/FO/C Hydrology Research and Data Assimilation

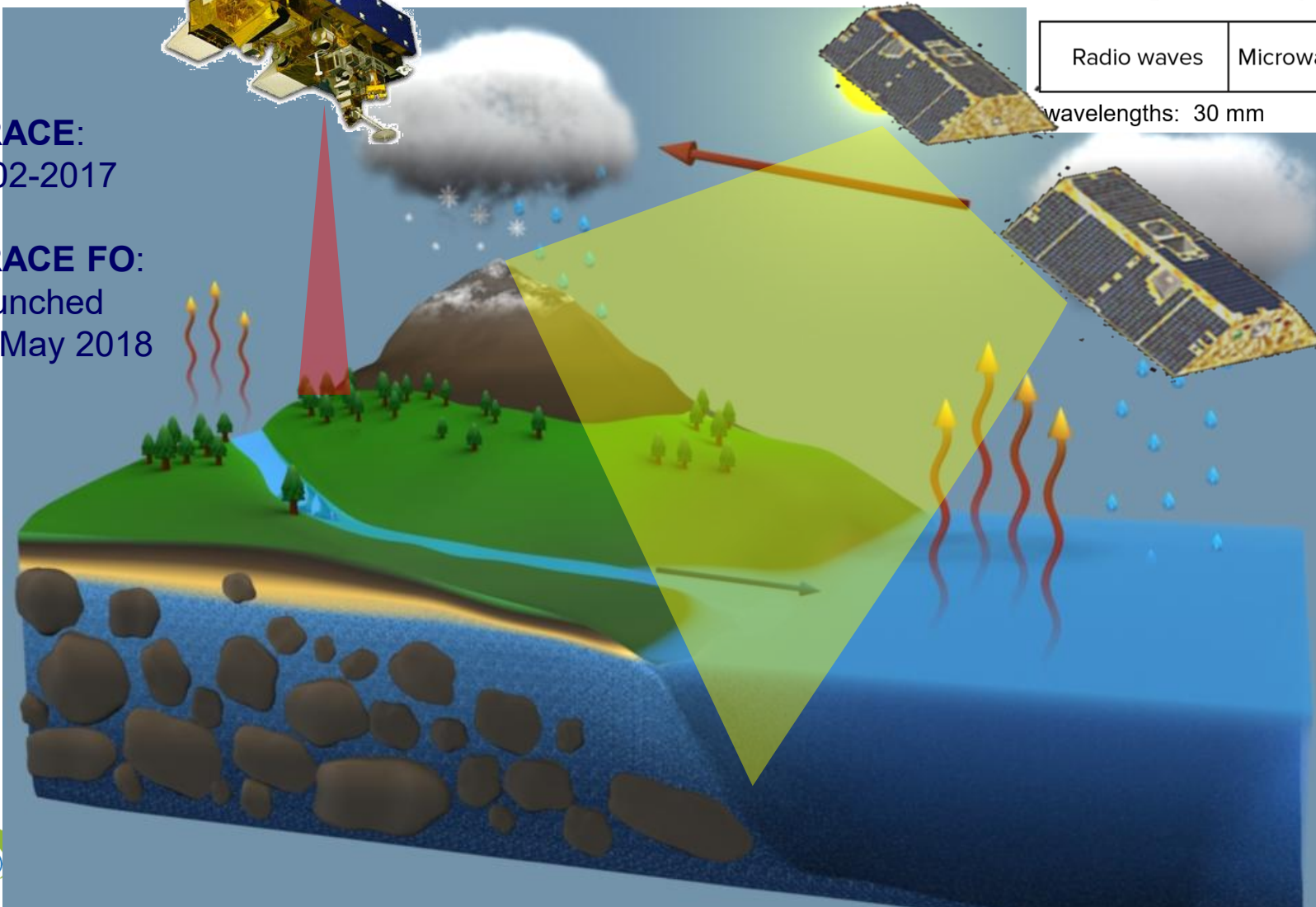
Matt Rodell
NASA Goddard Space Flight Center

Satellite Gravimetry Missions



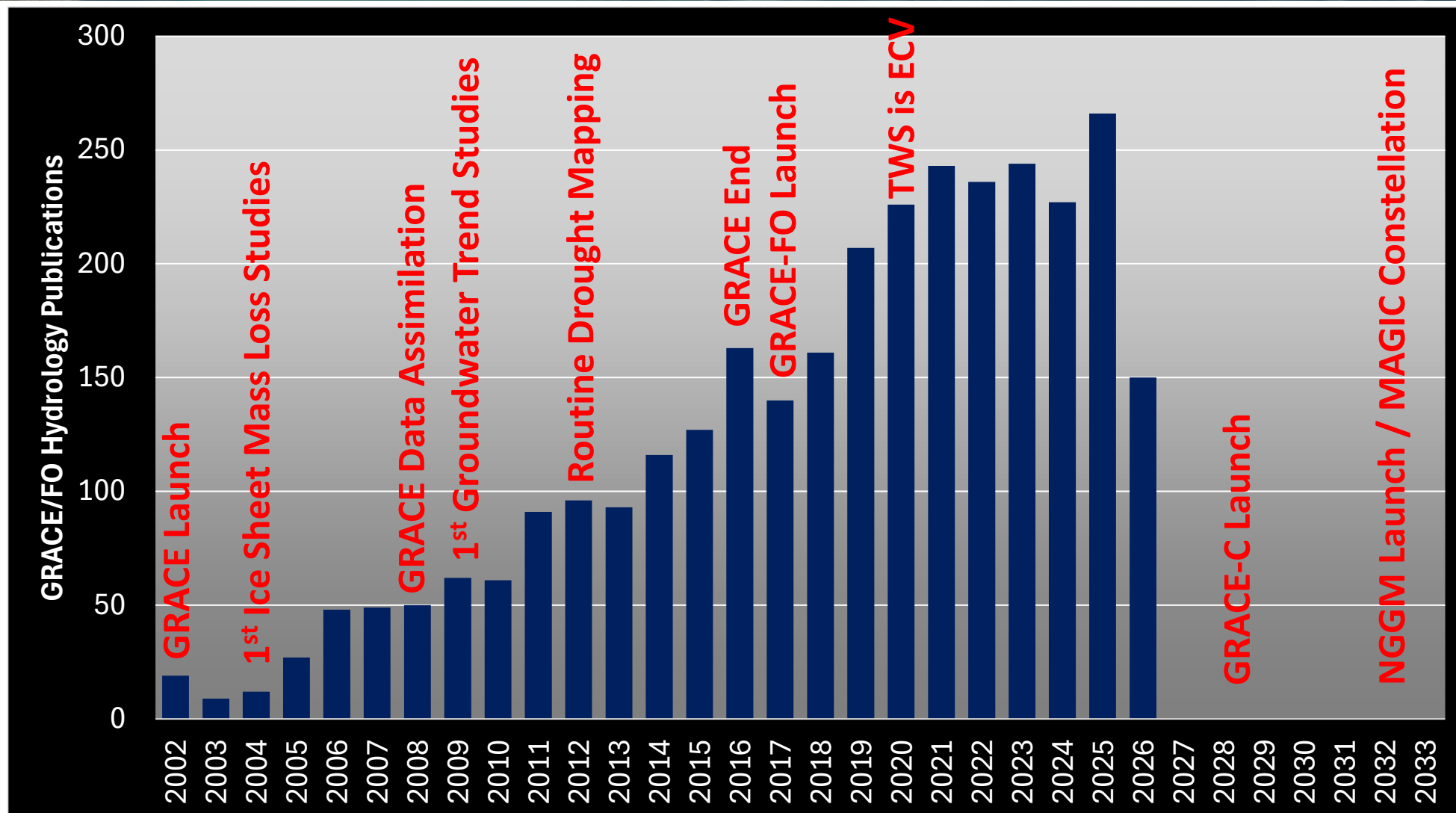
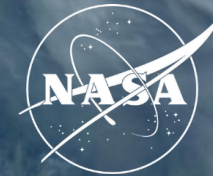
GRACE:
2002-2017

GRACE FO:
Launched
22 May 2018

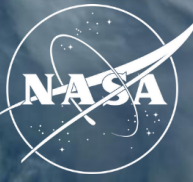


Conventional radiation-based remote sensing technologies cannot sense water below the first few centimeters of the snow-canopy-soil water column. GRACE and GRACE Follow On are unique in their ability to monitor water at all levels, down through the deepest aquifer.

Gravimetry Mission Timeline and Publications



Satellite Gravimetry Data for Hydrology



Advantages

- Uniquely observes changes in terrestrial water storage (TWS), including deep soil moisture and groundwater, globally

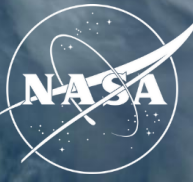
Disadvantages

- Coarse spatial ($>100,000 \text{ km}^2$) and temporal (monthly) resolutions of standard products
- Latency of standard products (2-3 months)
- Cannot distinguish TWS components

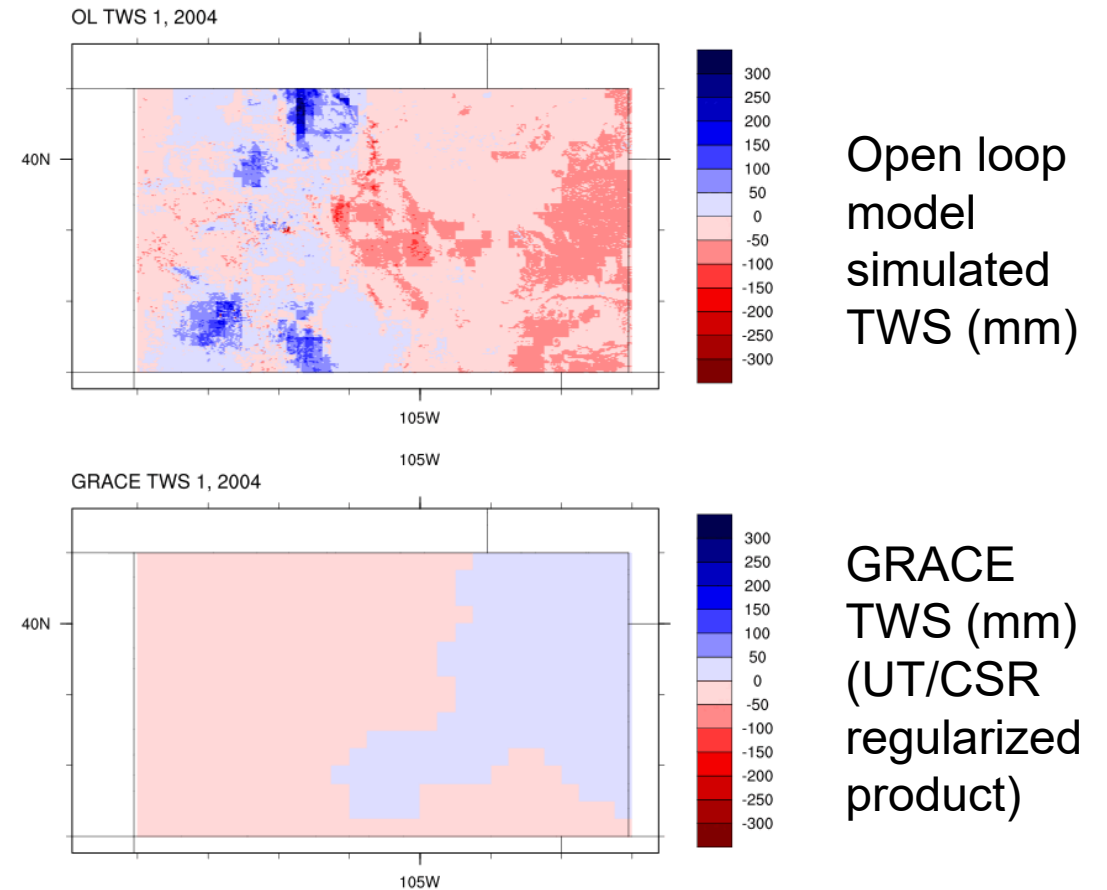
Data assimilation

- Addresses all three disadvantages but can also degrade output at fine scales
Springer et al. (2026) <https://doi.org/10.5194/hess-30-985-2026>

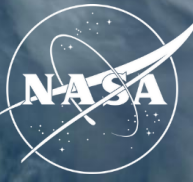
Challenges of Using Satellite Gravimetry Data



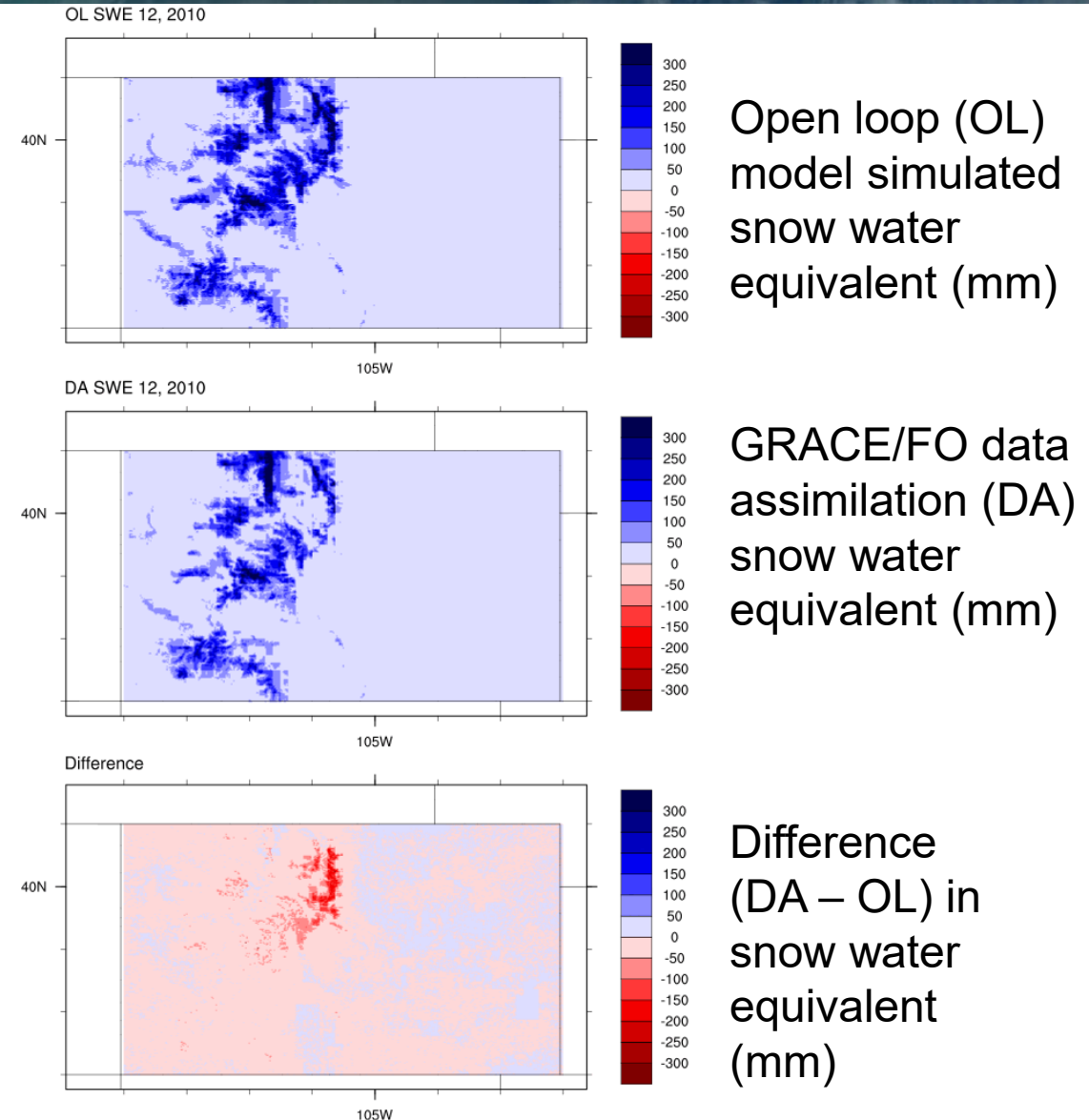
- GRACE and GRACE-FO are unable to resolve fine scale terrestrial water storage (TWS) variations
- Example: seasonal snowpack in the Rocky Mountains



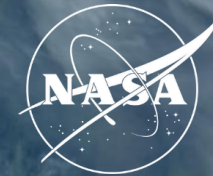
Challenges of GRACE/FO Data Assimilation



- GRACE and GRACE-FO are unable to resolve fine scale terrestrial water storage (TWS) variations
- As a result, GRACE-FO data assimilation causes underestimation of snowpack variations



Future Prospects



- GRACE-C (2028 launch)
 - Will include a low latency (1-3 week) TWS data product
 - Will include a standard Level-4 data assimilation product
- Advanced data assimilation
 - Assimilation of low latency products
 - Assimilation into land surface models with advanced groundwater formulations (e.g., LIS/Noah-Parflow)
 - Maina et al. (2025) <https://doi.org/10.1029/2024MS004415>
 - Abbaszadeh et al. (2025) <https://doi.org/10.5194/hess-29-5429-2025>
 - Direct assimilation of intersatellite range-rate data
 - Tang et al. (2025) <https://doi.org/10.1029/2025WR040534>
- Future Gravimetry Missions
 - GRACE-C will launch in 2028
 - ESA's Next Generation Gravity Mission (NGGM) is planned for launch in 2032
 - The Mass-change and Geosciences International Constellation (MAGIC) will combine GRACE-C and NGGM data to improve spatial and temporal resolutions and reduce uncertainty