Joint assimilation of SMOS brightness temperature and GRACE terrestrial water storage observations for improved soil moisture estimation

Manuela Girotto1,2, Rolf H. Reichle1, Gabriëlle J. M. De Lannoy2, Matt Rodell1* (1NASA Goddard Space Flight Center, Greenbelt, MD, USA; 2USRA/GESTAR, Columbia MD, USA; 3KU Leuven, Department of Earth and Environmental Sciences, Heverlee, Belgium)

Motivation & Hypothesis

- Accurate estimates of soil moisture will enhance weather and climate forecast skill and will improve flood prediction and drought monitoring capability.
- Can we improve soil moisture profile estimates by merging both SMOS and GRACE satellite-based observations into a land surface model?

Measuring Soil Moisture from Space

**Soil Moisture and Ocean Salinity (SMOS):**
- L-band brightness temperature (Tb) at multiple incidence angles
- Launched Nov. 2009

**Gravity Recovery and Climate Experiment (GRACE):**
- Gravity observations to provide Terrestrial Water Storage (TWS) anomalies
- Launched Mar 2002

**Results: Validation**

**Blue colors:** data assimilation (DA) is better than openloop (or model only, OL); **red colors:** OL better than DA

Results: Impact on Soil Moisture Profile

**Blue colors:** data assimilation (DA) reduces OL uncertainty; **red colors:** DA improves surface and root zone soil moisture.

Conclusions

- GRACE-DA improves groundwater while SMOS-DA improves surface and rootzone soil moisture.
- The joint GRACE-TWS & SMOS-Tb assimilation maintains good skills in TWS, groundwater, surface and rootzone soil moisture.
- GRACE and SMOS DA are complementary as:
  - SMOS-DA is responsible for most of the ensemble spread reduction in deeper moisture layer (i.e., catdef).
  - SMOS-DA is responsible for most of the ensemble spread reduction in shallower moisture layers (i.e., sfmc).

References:


Acknowledgment:

This work was supported by the NASA Terrestrial Hydrology, NASA-Arctic Anthropic Processes (TAP) mission, and NASA’s GRACE Follow-On (GFO) project.