

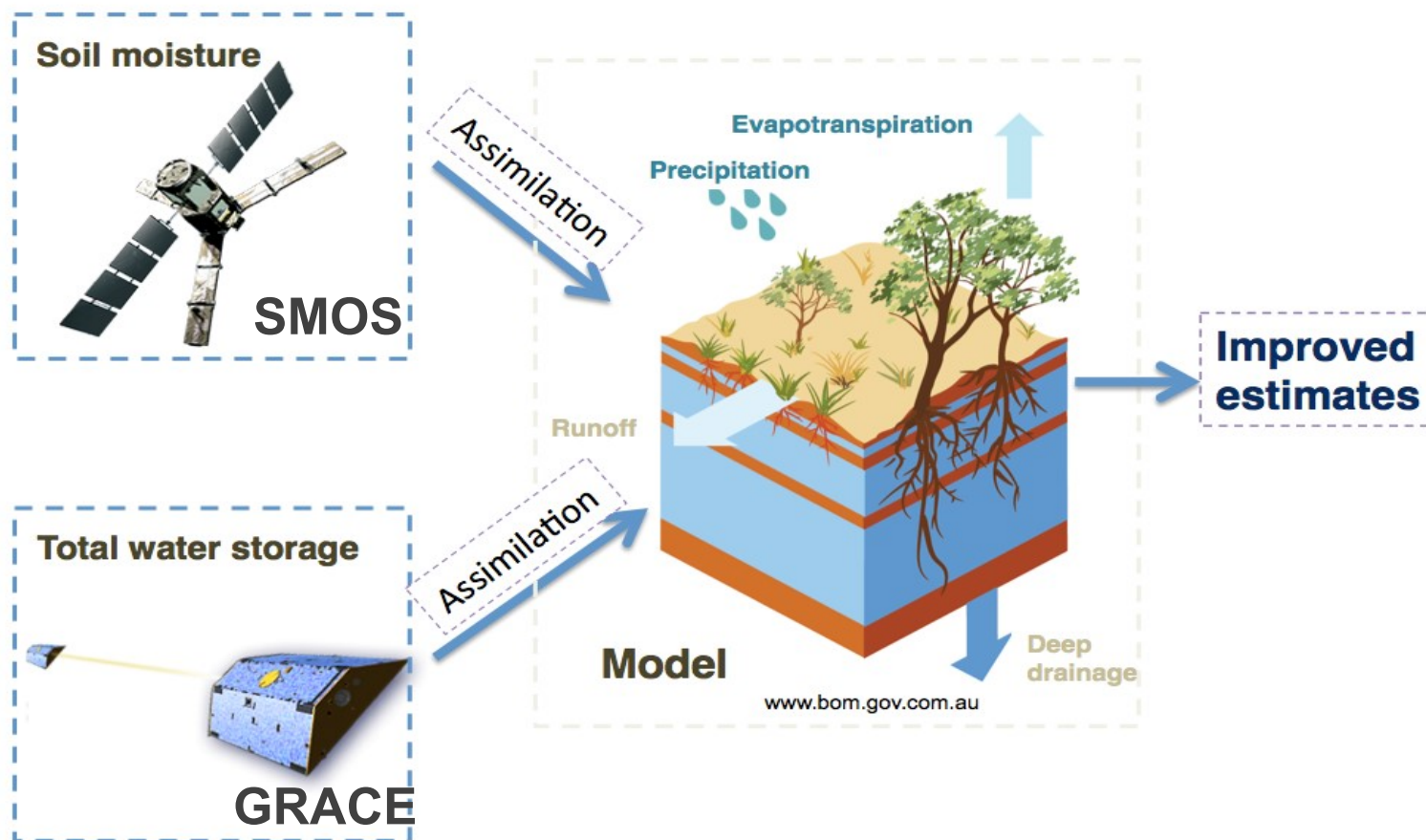
Combining GRACE water storage and SMOS soil moisture to improve water and vegetation forecast

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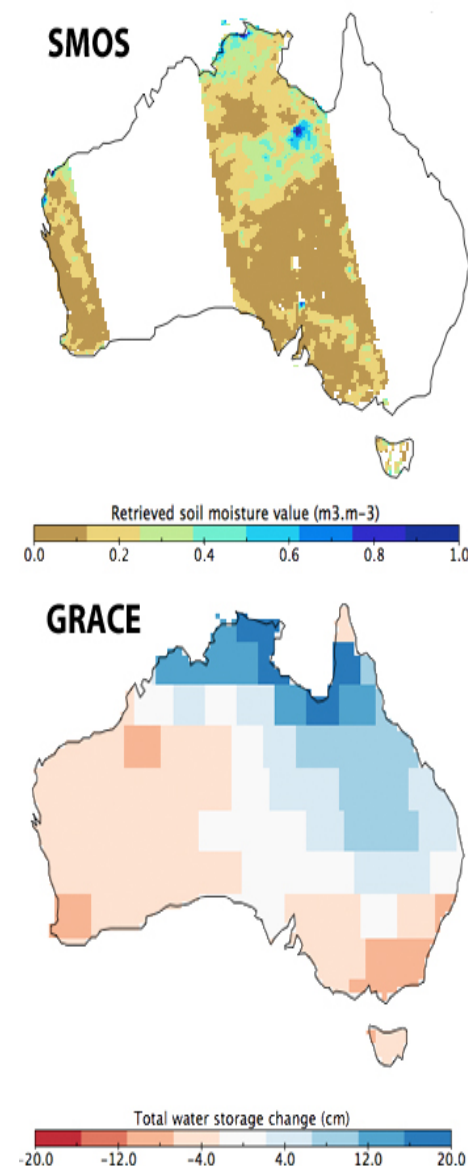


Introduction



Data sets

- **SMOS**
 - L-band
 - CATDS Level 3 daily soil moisture
 - $0.25^\circ \times 0.25^\circ$ ascending
- **GRACE**
 - JPL RL05 Mascons
 - $3^\circ \times 3^\circ$ monthly
- **Model**
 - World-Wide Water (W3) model
 - Grid-based, 2 HRU, water balance model
 - Forcing: WFDEI (WATCH-Forcing-Data-ERA-Interim) $0.5^\circ \times 0.5^\circ$ daily



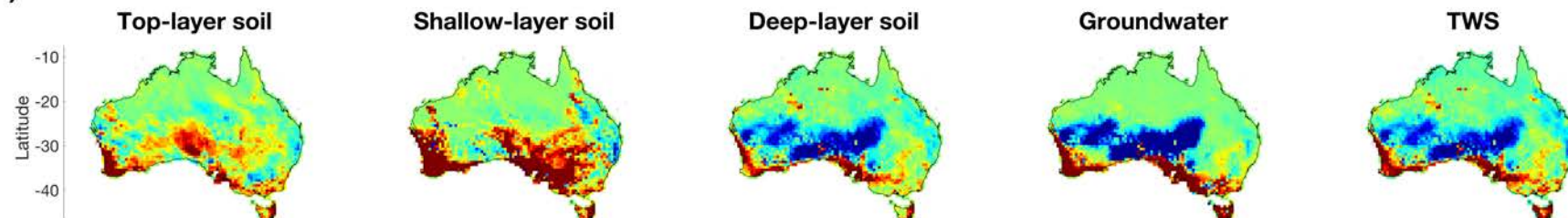
- Assimilation algorithm: Ensemble Kalman Smoother
- Assimilation window:
 - 1 month, considering temporal correlation
- Ensemble generation:
 - perturbation of precipitation, radiation and temperature
 - 100 ensemble members
- Update state variables:
 - surface water storage, soil water storage (surface, shallow, deep), groundwater storage, ice/snow, vegetation water
- Output resolution:
 - $0.5^{\circ} \times 0.5^{\circ}$ daily
 - 2010-2015 (2010-2013 in Tian et. 2017)

Tian, S., Tregoning, P., Renzullo, L.J., van Dijk, A.I., Walker, J.P., Pauwels, V. and Allgeyer, S., Improved water balance component estimates through joint assimilation of GRACE water storage and SMOS soil moisture retrievals. *Water Resources Research*. 2017

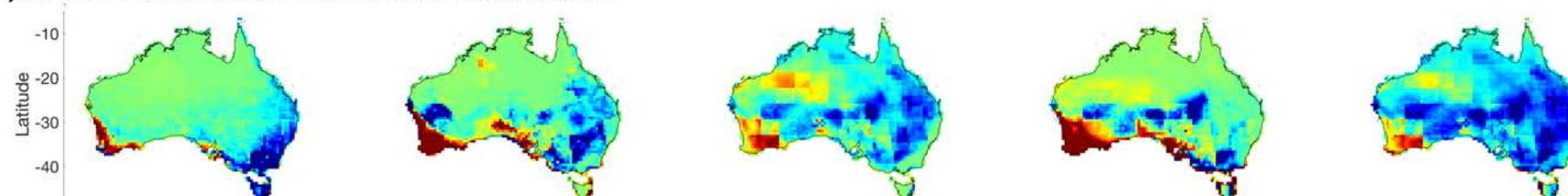


Separation of water storage: monthly increment

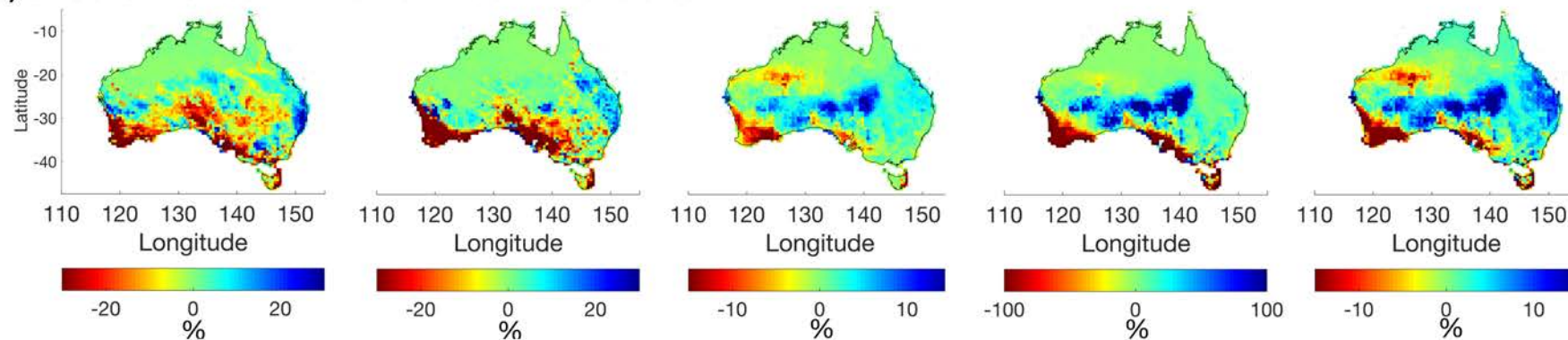
(a) SMOS contribution to different water stores



(b) GRACE contribution to different water stores



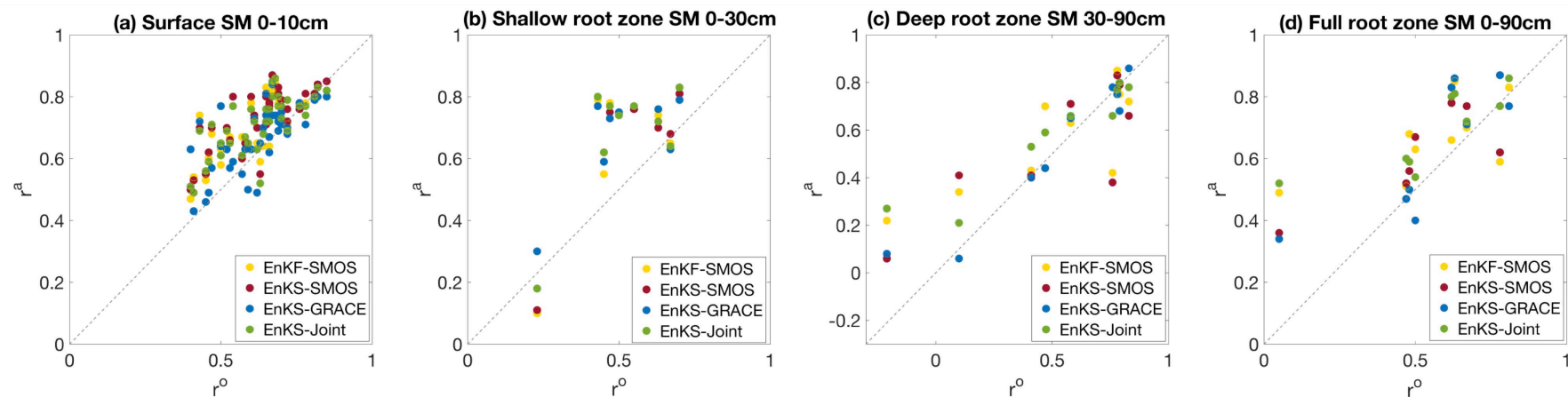
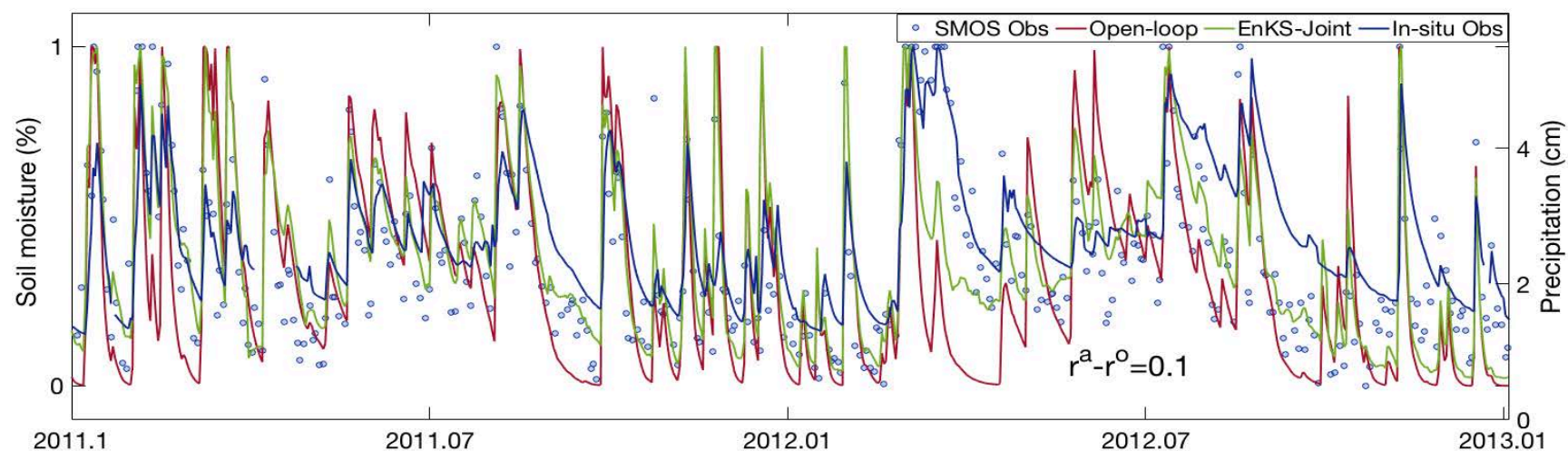
(c) SMOS+GRACE contribution to different water stores





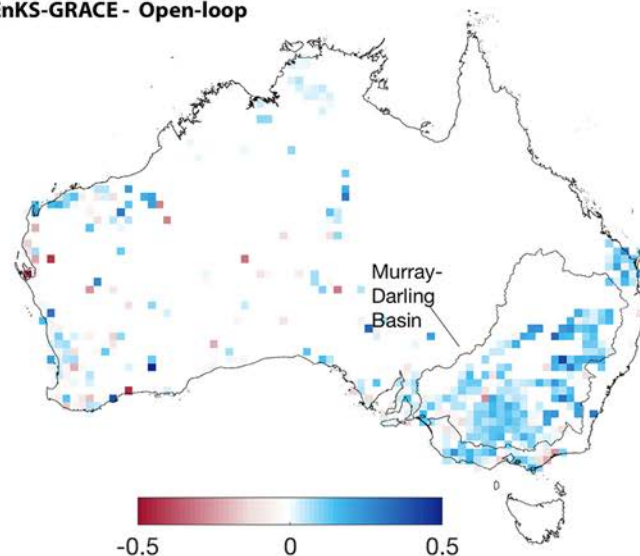
Results

Improvements on soil moisture profile: surface and root-zone

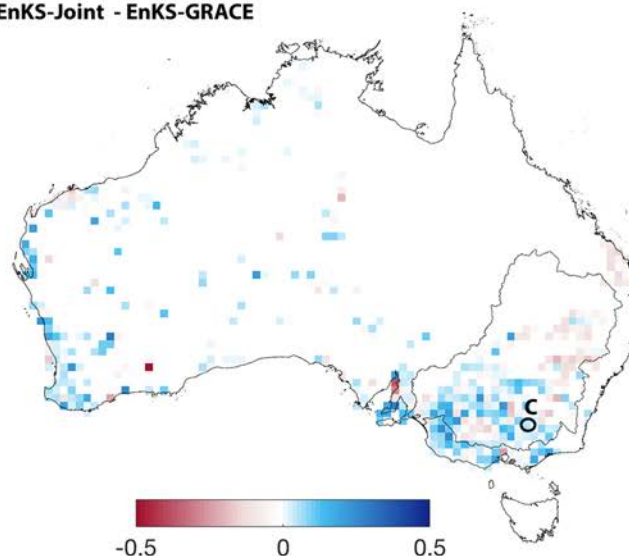


Improvements on groundwater estimates

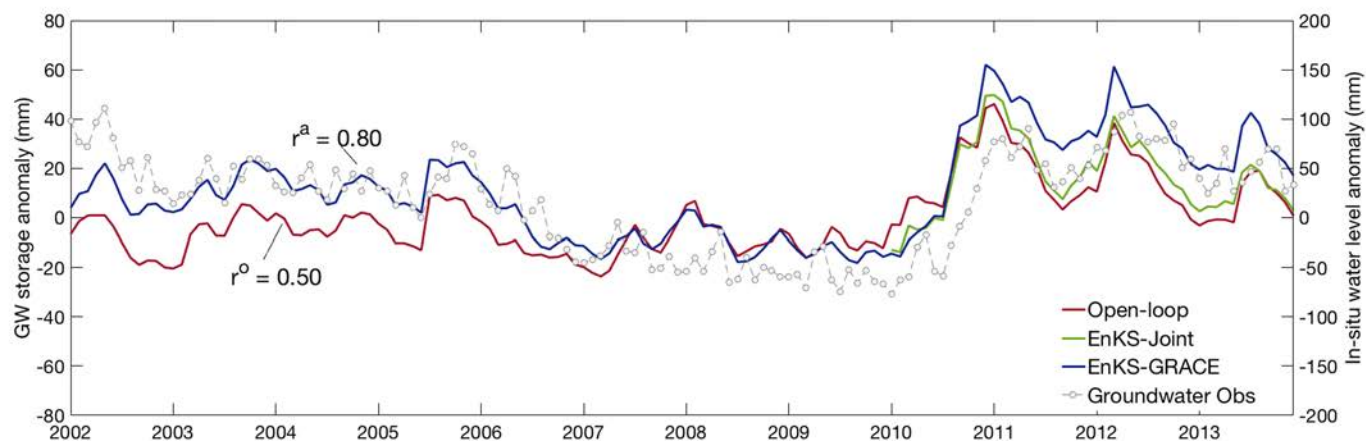
(a) Correlation improvement:
EnKS-GRACE - Open-loop



(b) Correlation improvement:
EnKS-Joint - EnKS-GRACE



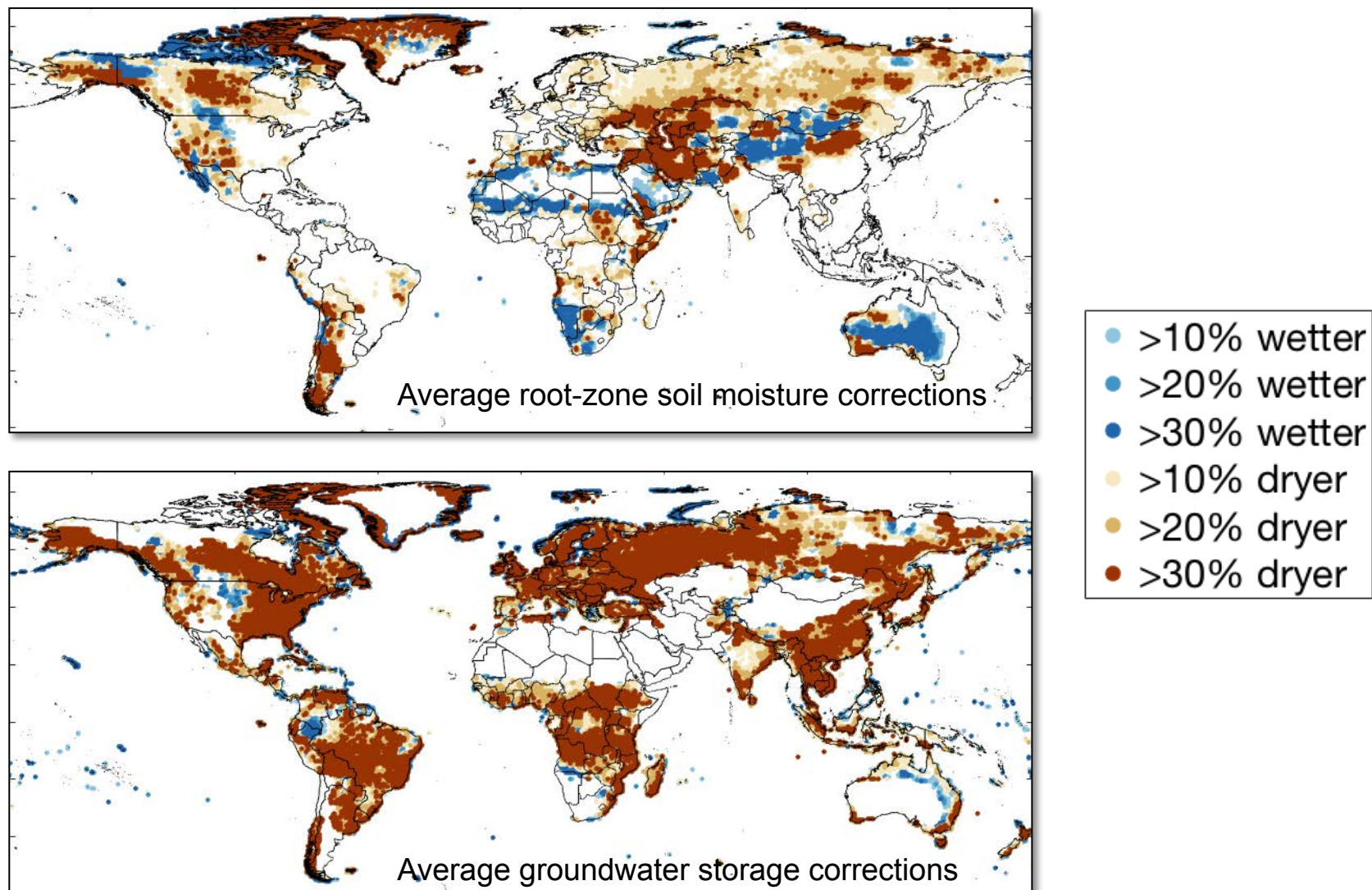
(c) Averaged groundwater storage change estimates of Murray-Darling Basin



Tian et al. (2017)

Results

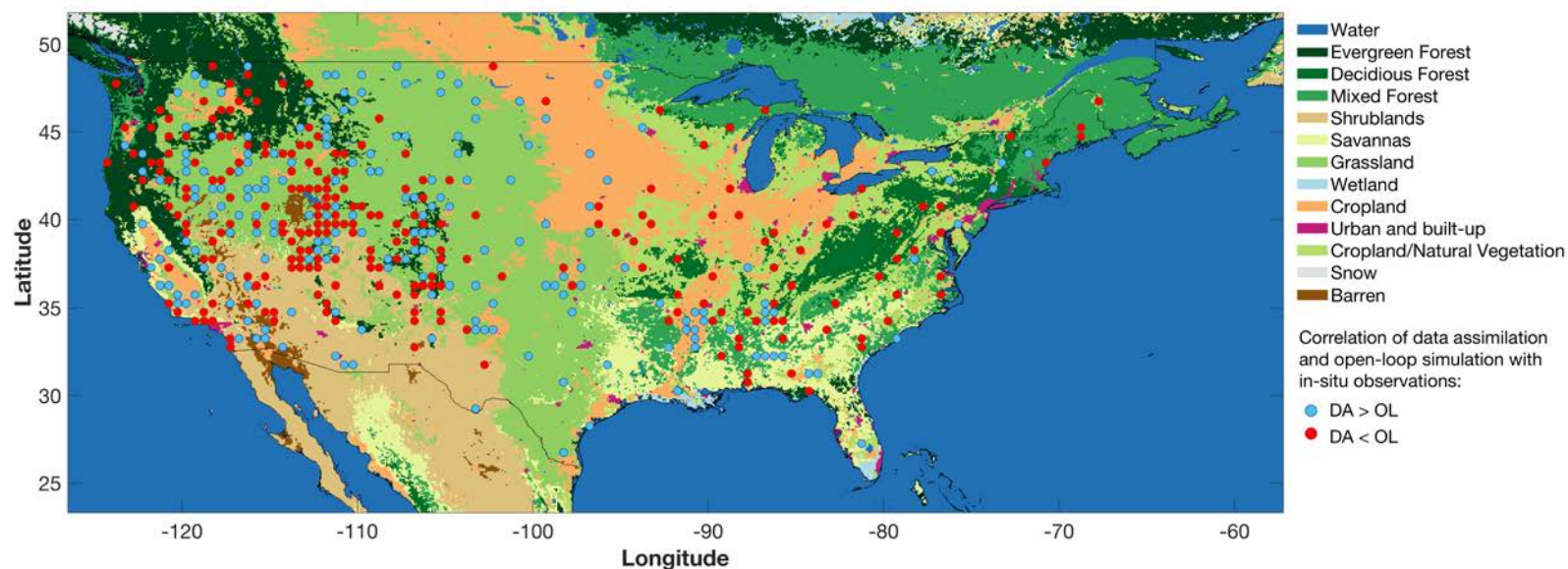
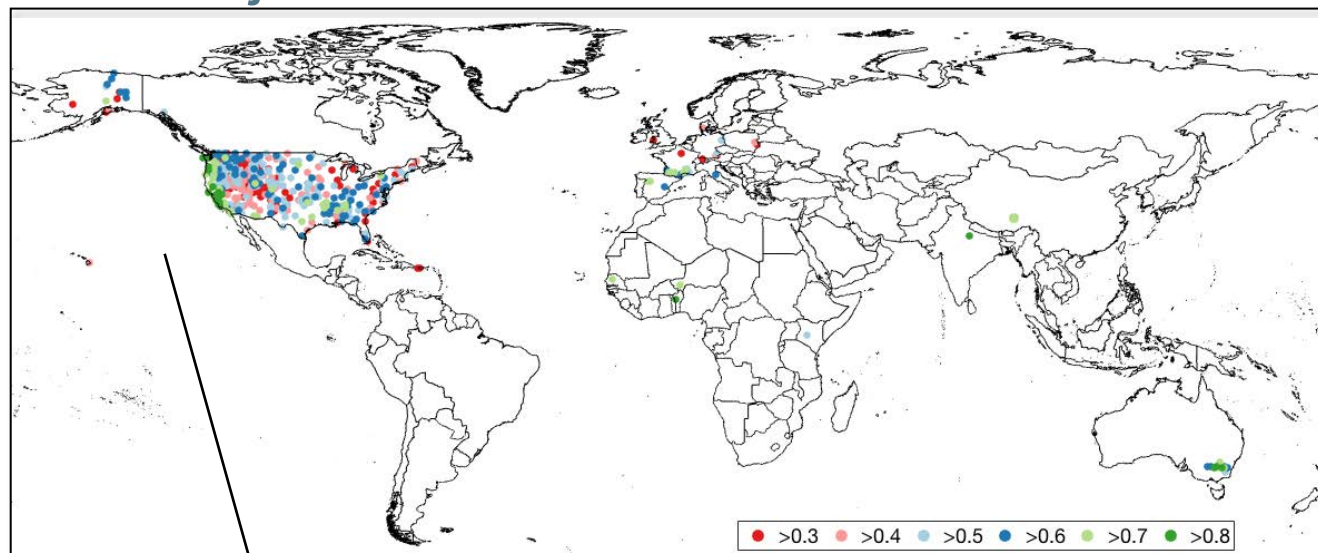
Global joint assimilation compared with model open-loop





Results

Global joint assimilation validation: surface soil moisture

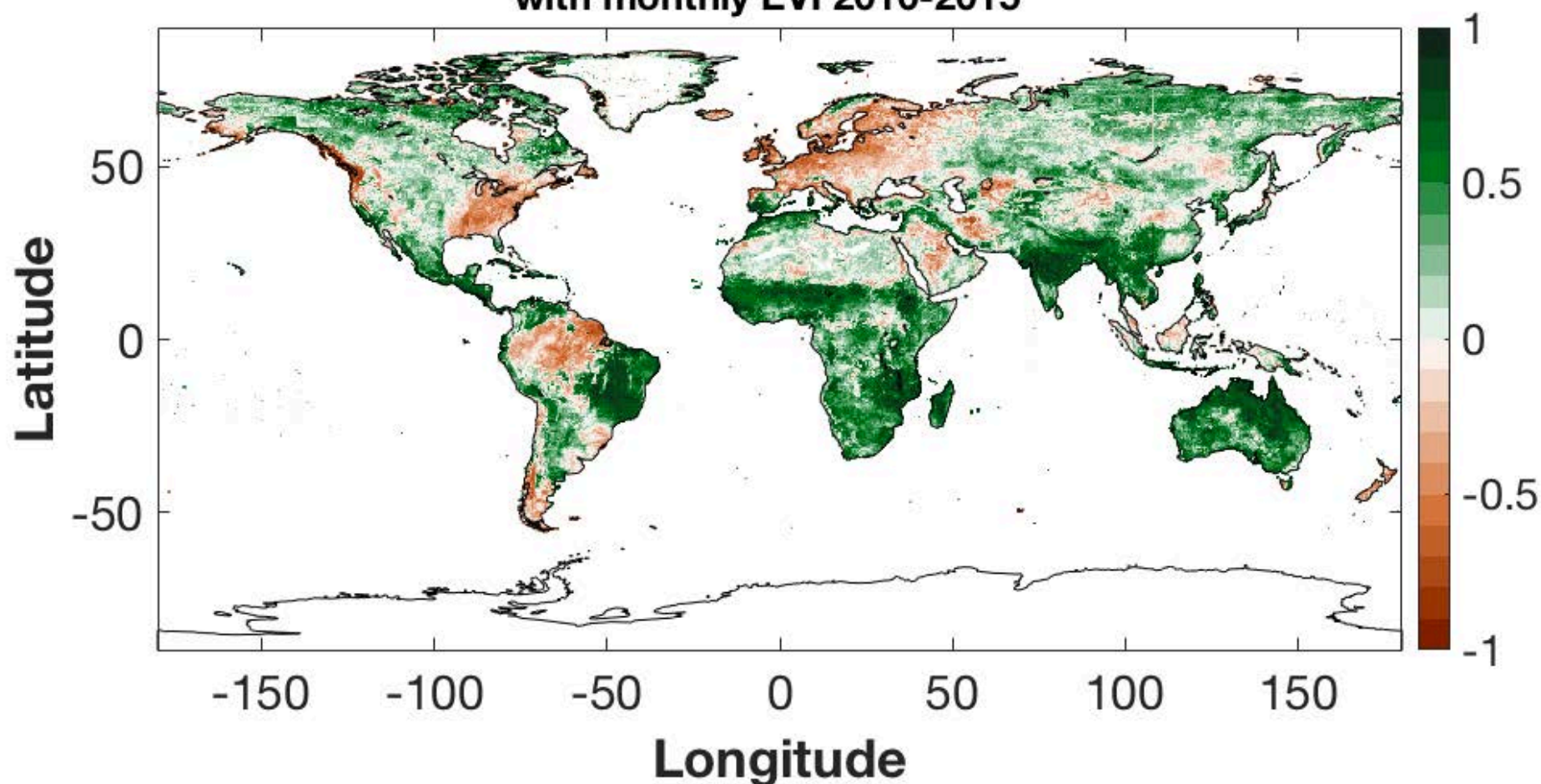




Results

Global joint assimilation validation: root-zone soil moisture

**correlation of root-zone soil moisture
with monthly EVI 2010-2015**



- SMOS soil moisture can help to better isolate groundwater signal from GRACE observed TWS and may even help to quantify the impacts of large-scale groundwater extraction
- SMOS +GRACE can help to mitigate the lack of rain gauges in remote areas and reduce the uncertainty of meteorological forcing data
- SMOS+GRACE limited the degradation of other state/flux variable compared to the assimilation of SMOS-only or GRACE-only
- Resulting improvements in surface and root-zone soil moisture estimates helps in forecasting vegetation productivity

- $0.25^{\circ} \times 0.25^{\circ}$ daily global water storage reanalysis with improved spatial coverage of both ascending and descending SMOS, 2010-2016
- Global root-zone soil moisture forecasting
- Vegetation productivity forecasting
- ANU GRACE solutions