A global analysis of water storage variations from remotely sensed soil moisture and daily satellite gravimetry

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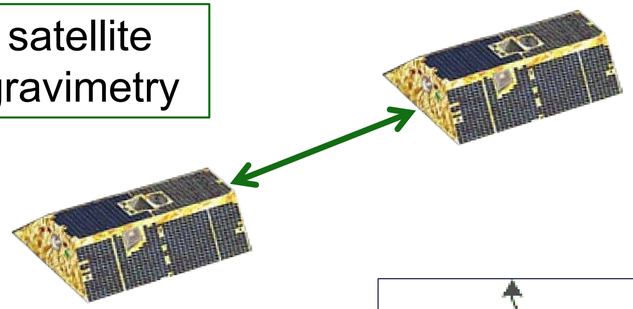
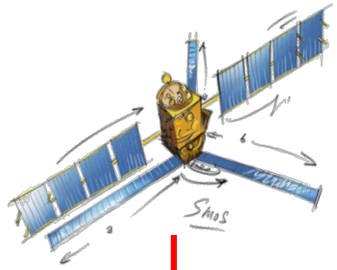
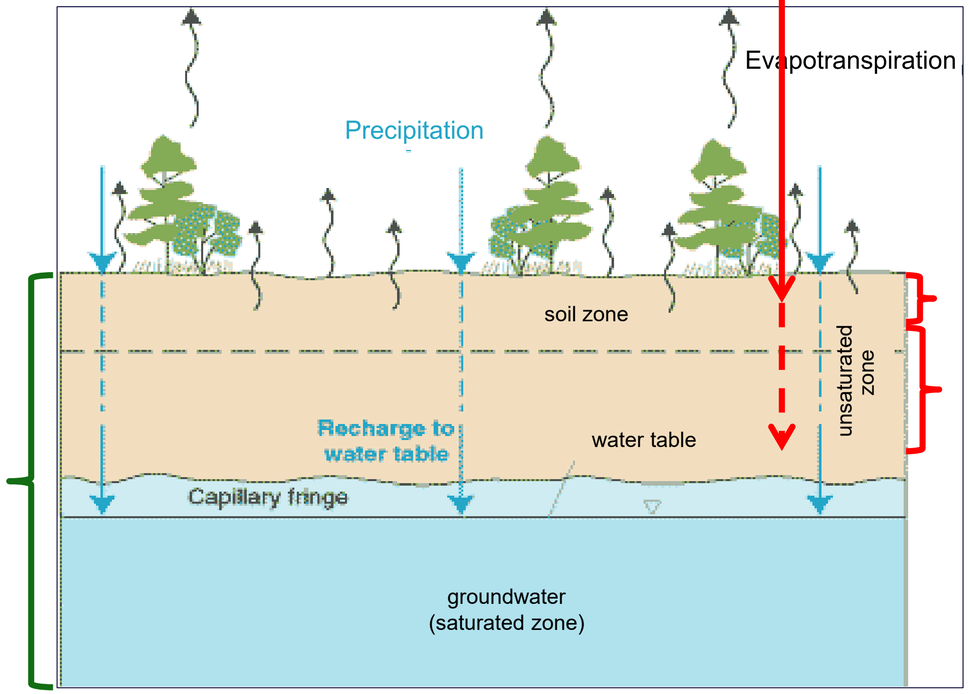
Soil moisture observation

satellite gravimetry





soil moisture (SM) remote sensing



Terrestrial water storage **(TWS)**

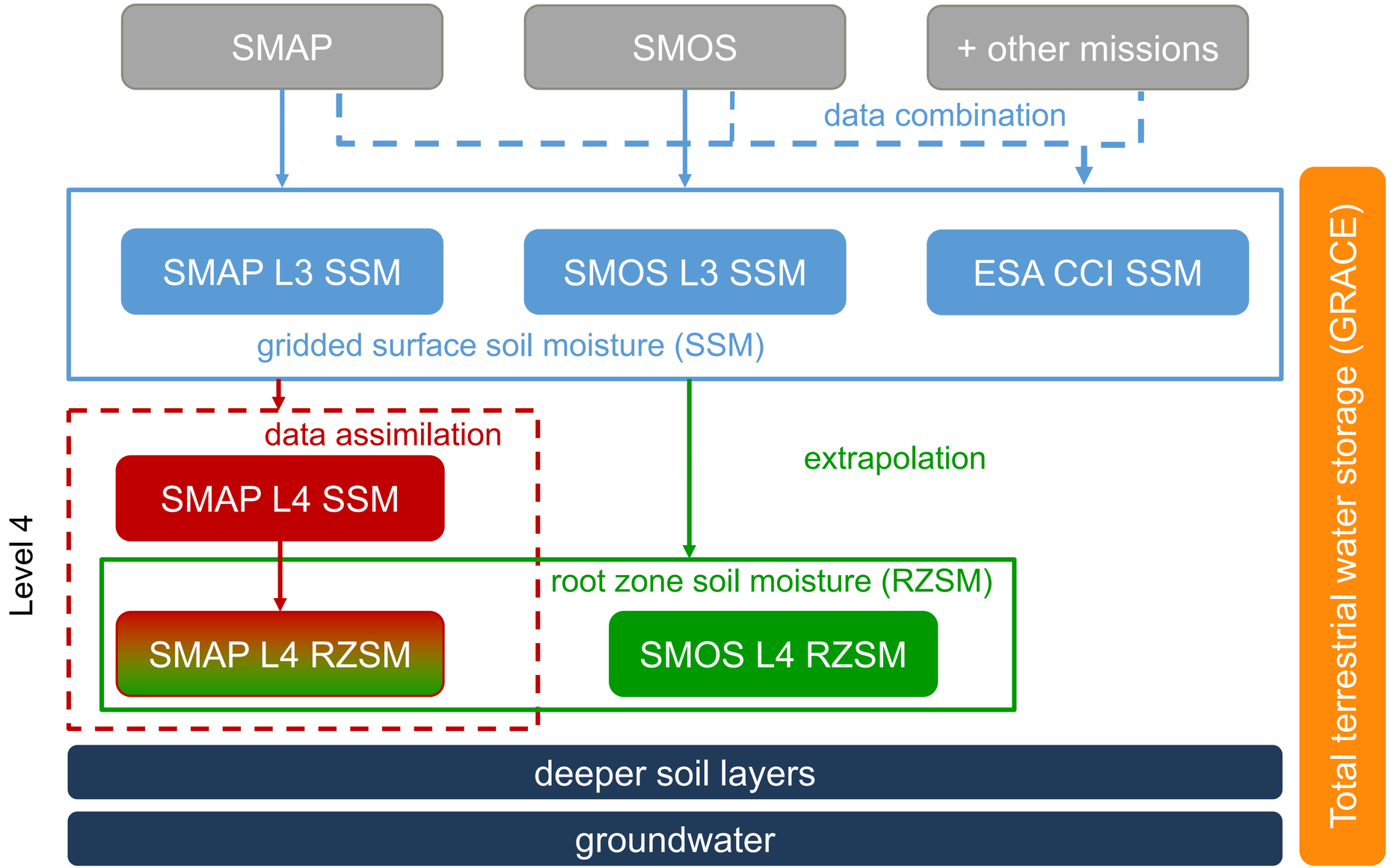
Surface soil moisture **(SSM)** from remote sensing **(up to ~5cm)**

Root-zone soil moisture **(RZSM)** vertical extrapolation **(0-1m)**

(modified from https://pubs.usgs.gov/circ/circ1186/html/gen_facts.html)

Datasets

Satellite observations of surface soil moisture:



Total terrestrial water storage (GRACE)

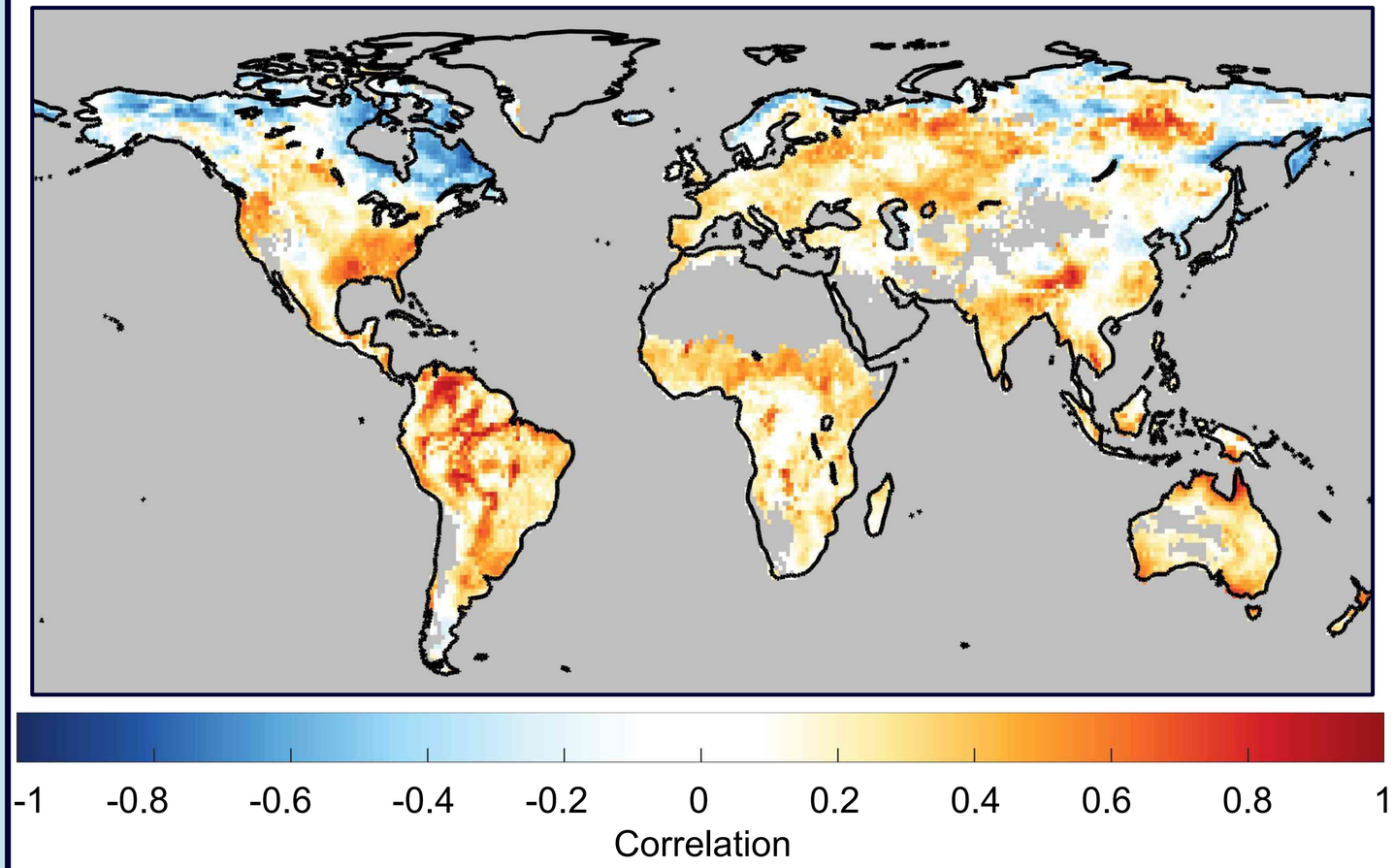
Daily ITSG-Grace2018 data

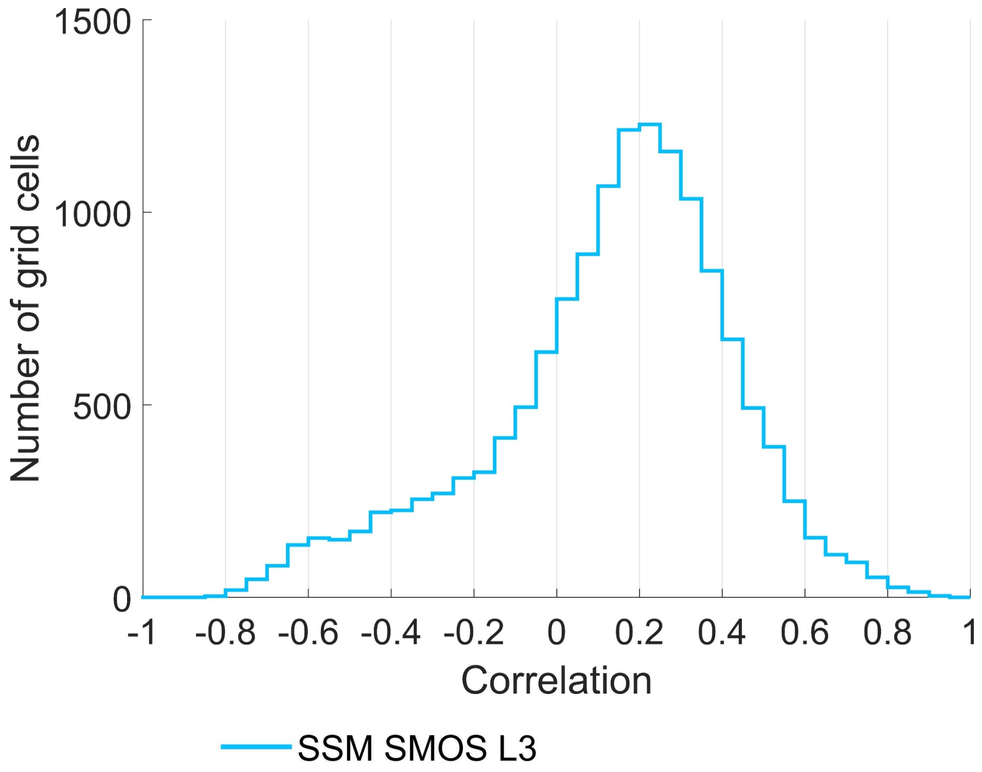
Global grid 1° x 1°

Daily data sets 04.2015 - 12.2019

Correlation with GRACE/GRACE-FO

ITSG-Grace2018 vs. SMOS L3 SSM

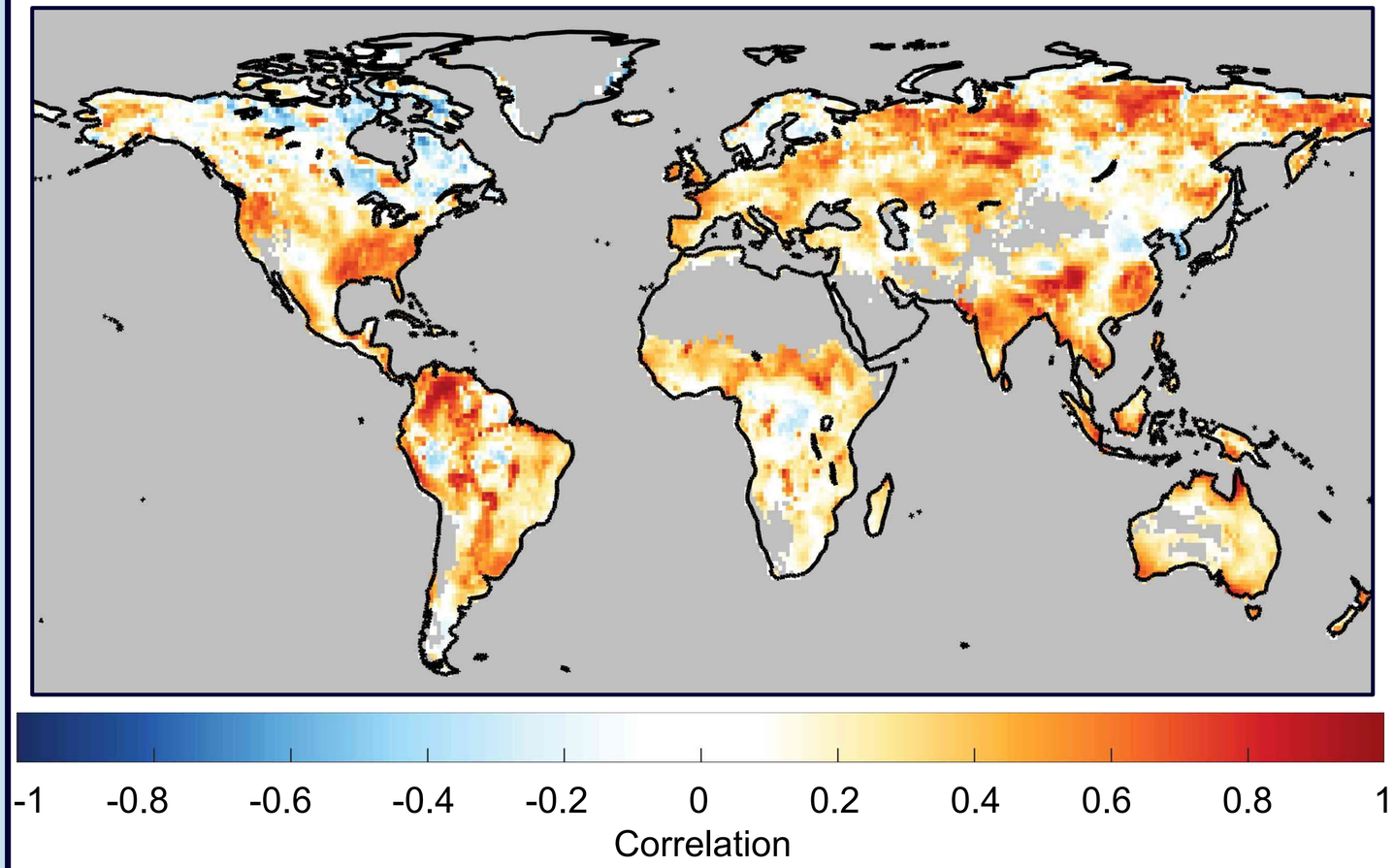


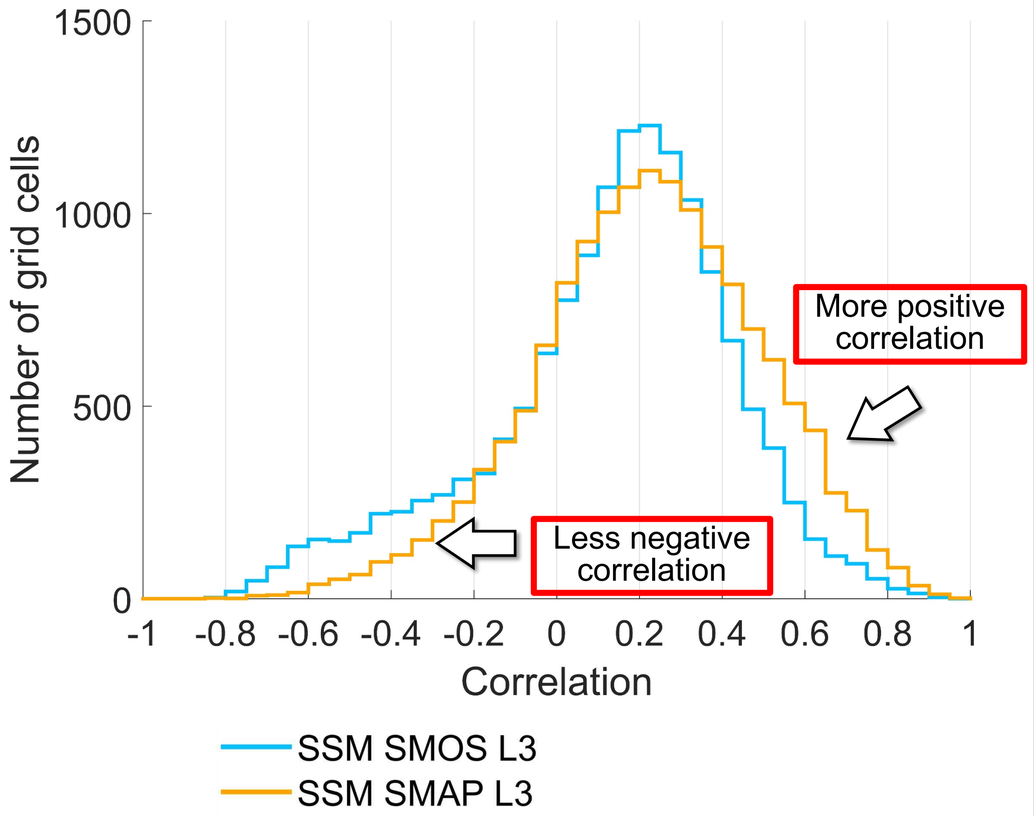


Area-weighted average = 0,18
Maximum = 0,90

Correlation with GRACE/GRACE-FO

ITSG-Grace2018 vs. SMAP L3 SSM

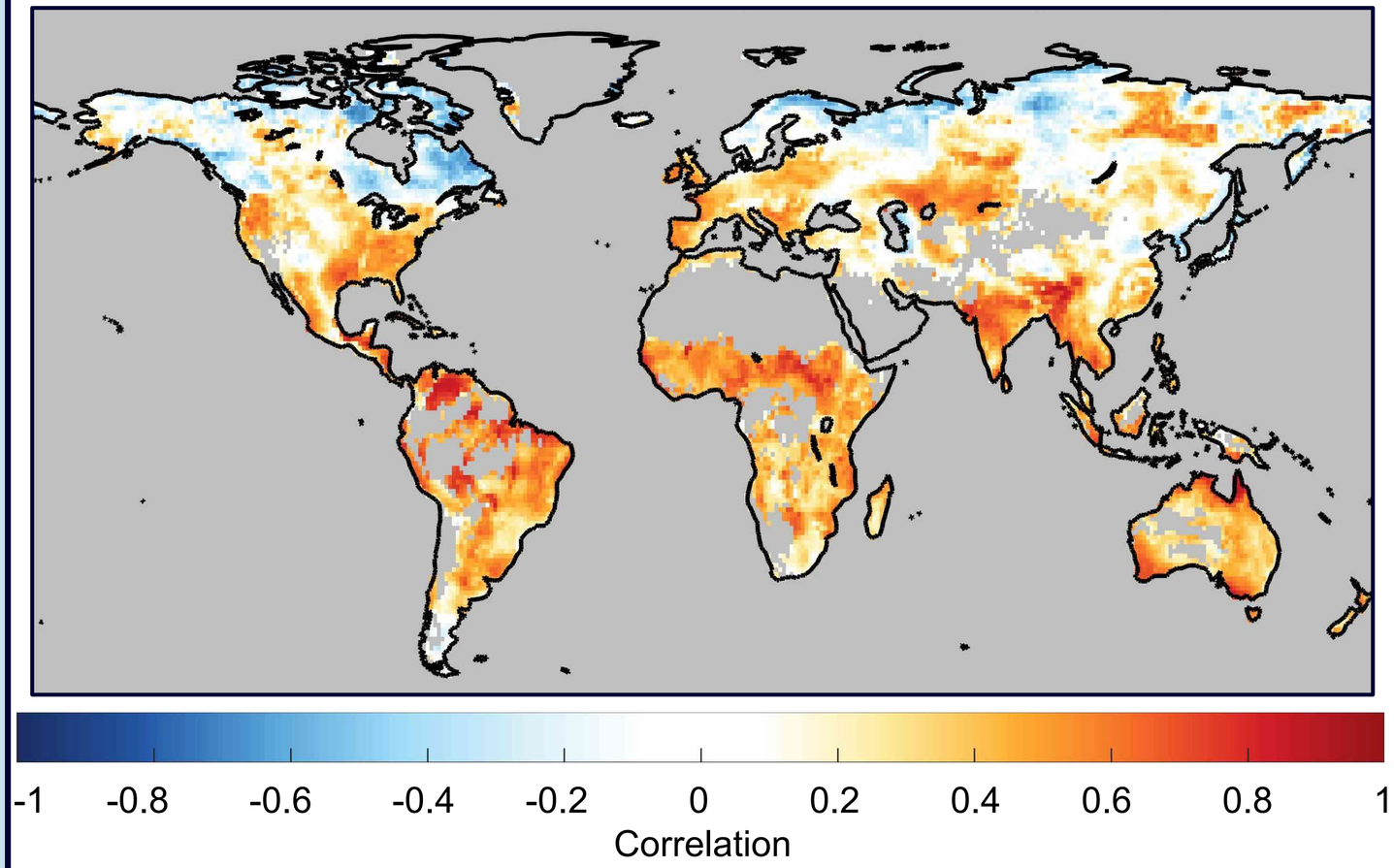


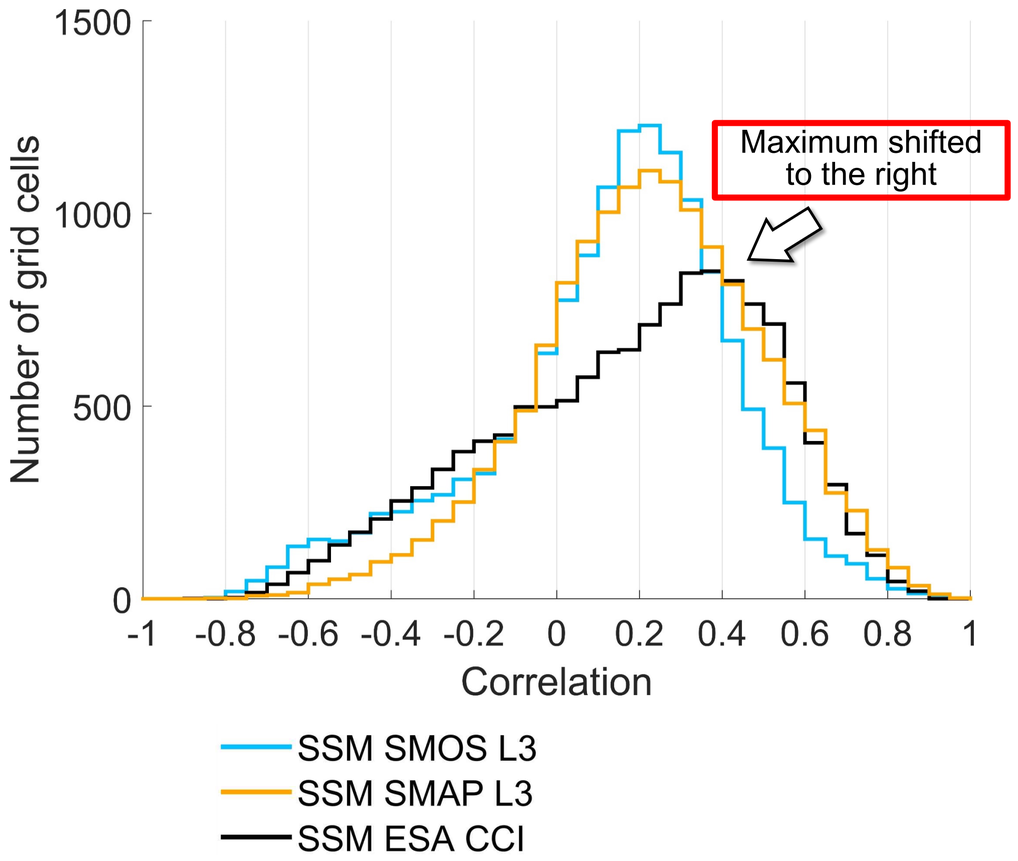


Area-weighted average = 0,26
Maximum = 0,95

Correlation with GRACE/GRACE-FO

ITSG-Grace2018 vs. ESA CCI SSM

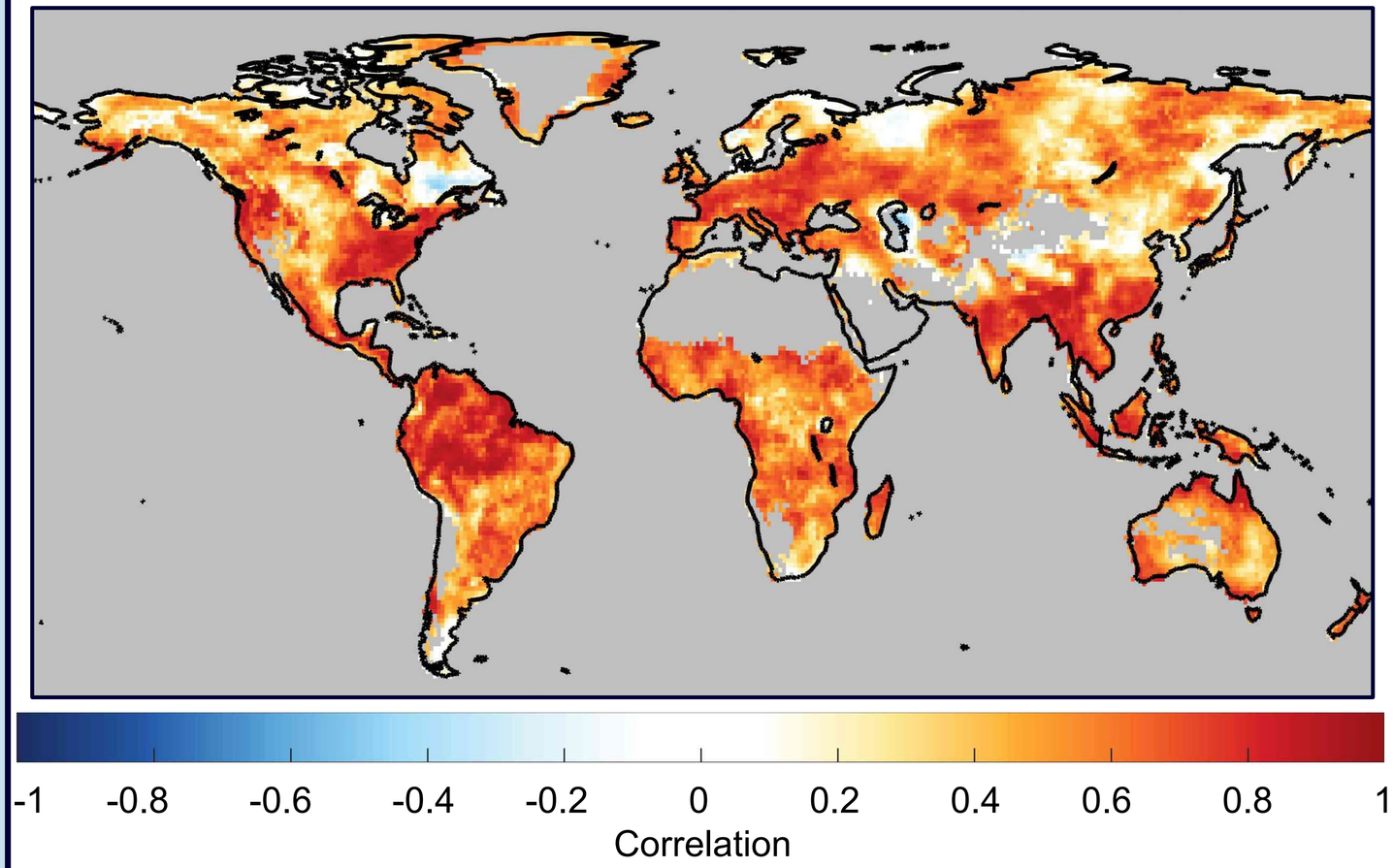


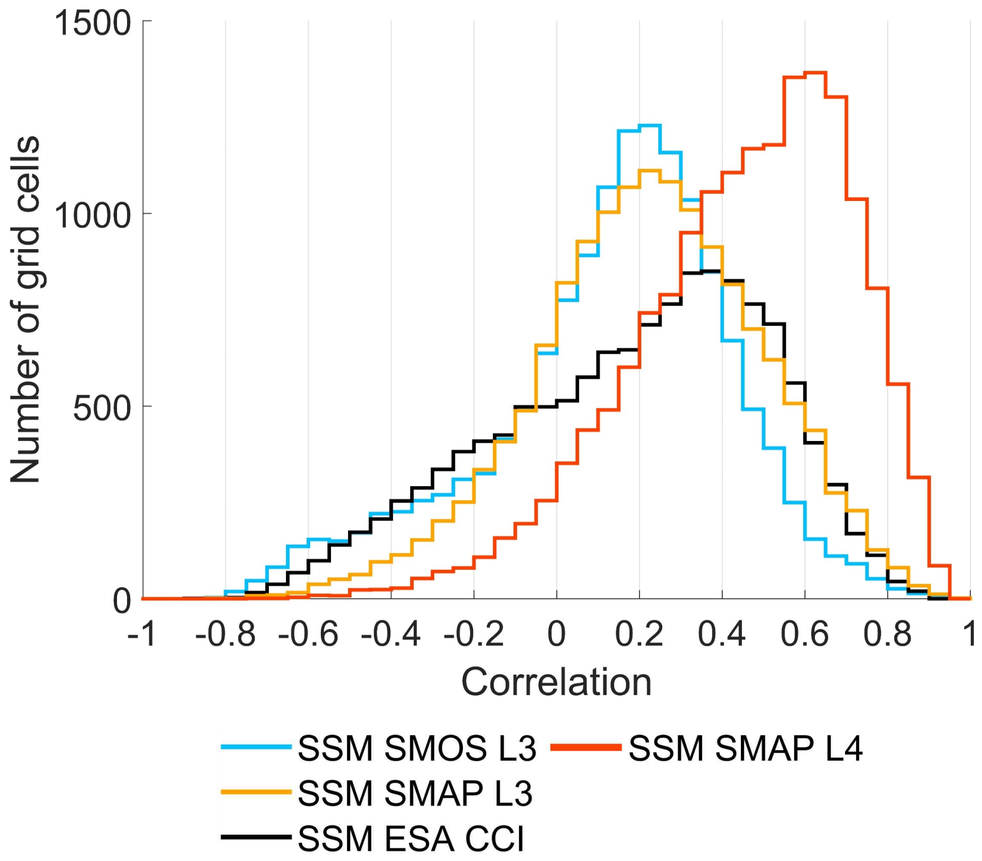


Area-weighted average = 0,26
Maximum = 0,90

Correlation with GRACE/GRACE-FO

ITSG-Grace2018 vs. SMAP L4 SSM

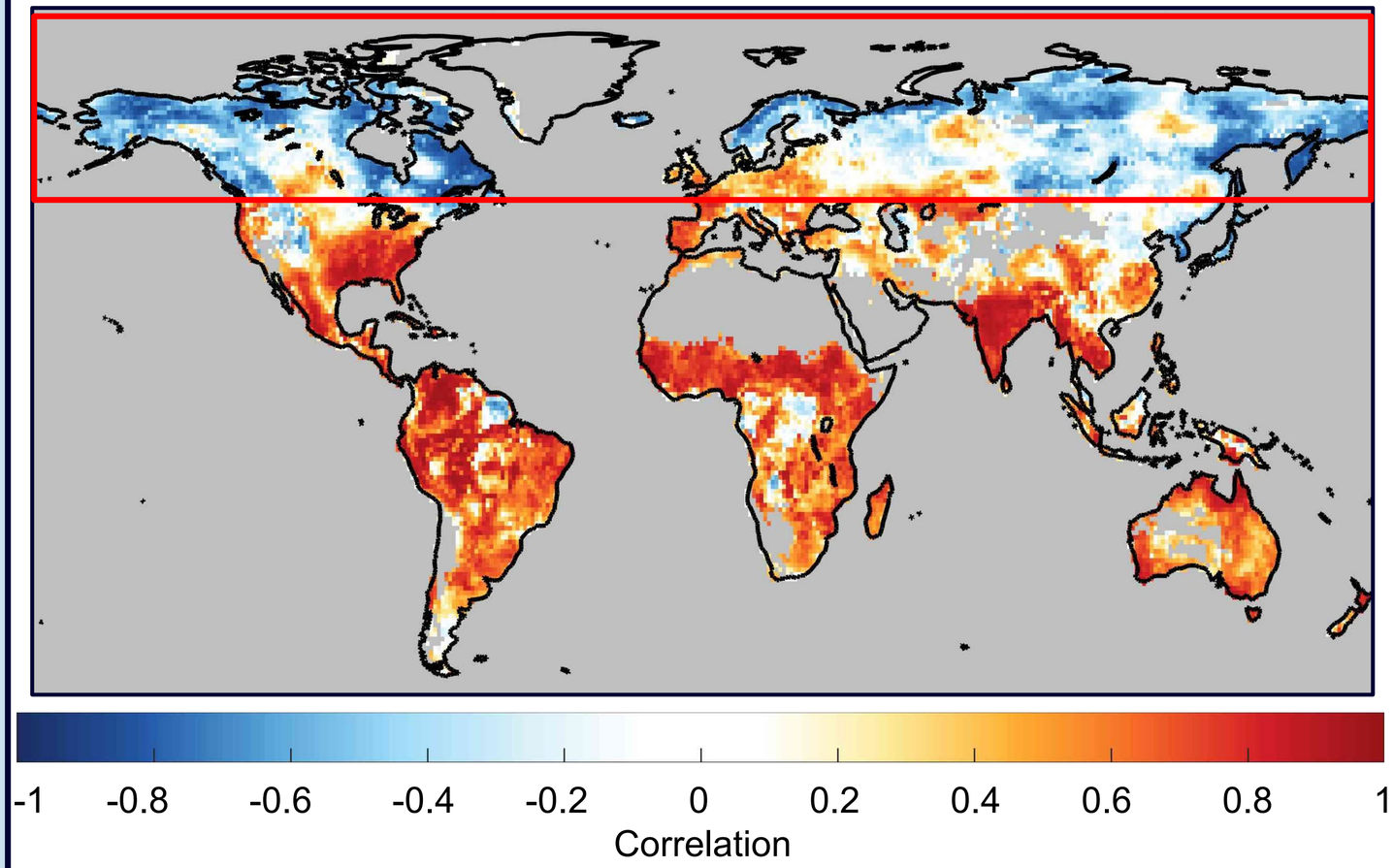


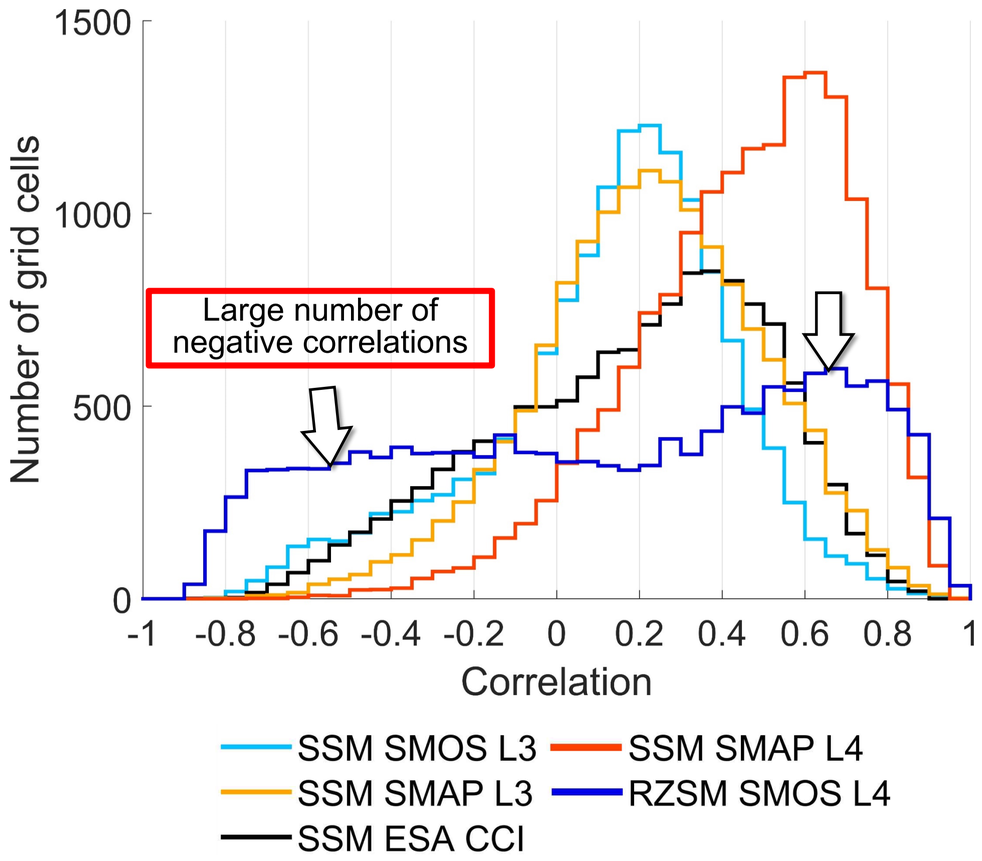


Area-weighted average = 0,52
Maximum = 0,94

Correlation with GRACE/GRACE-FO

ITSG-Grace2018 vs. SMOS L4 RZSM

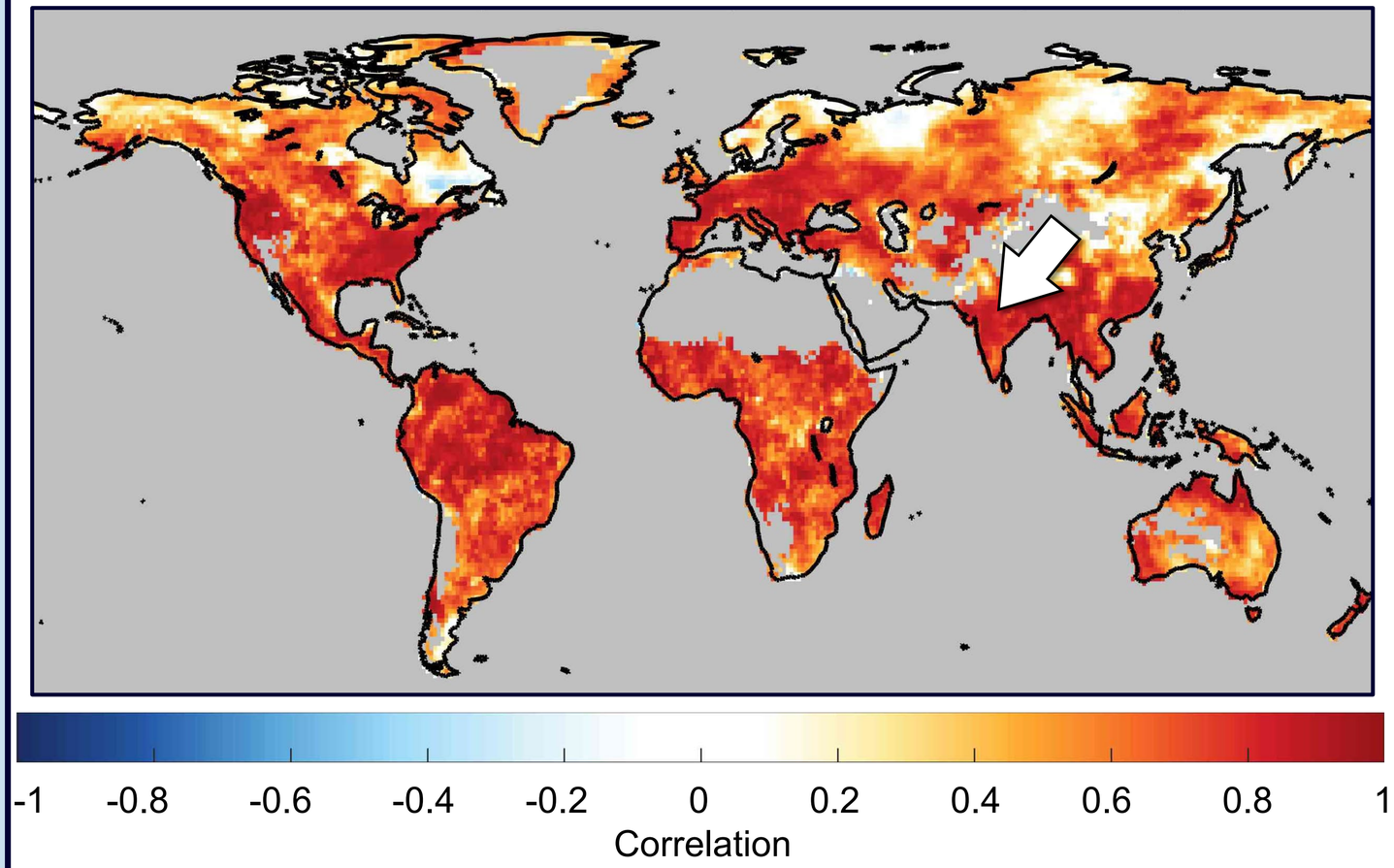


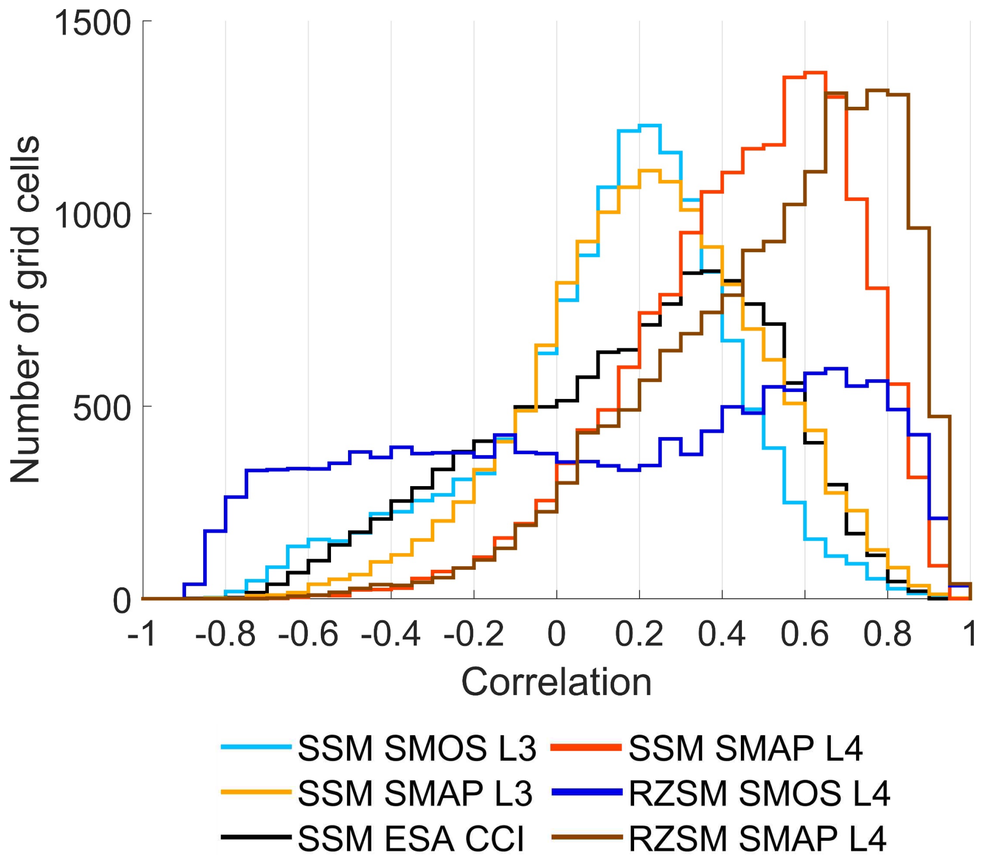


Area-weighted average = 0,26
Maximum = 0,98

Correlation with GRACE/GRACE-FO

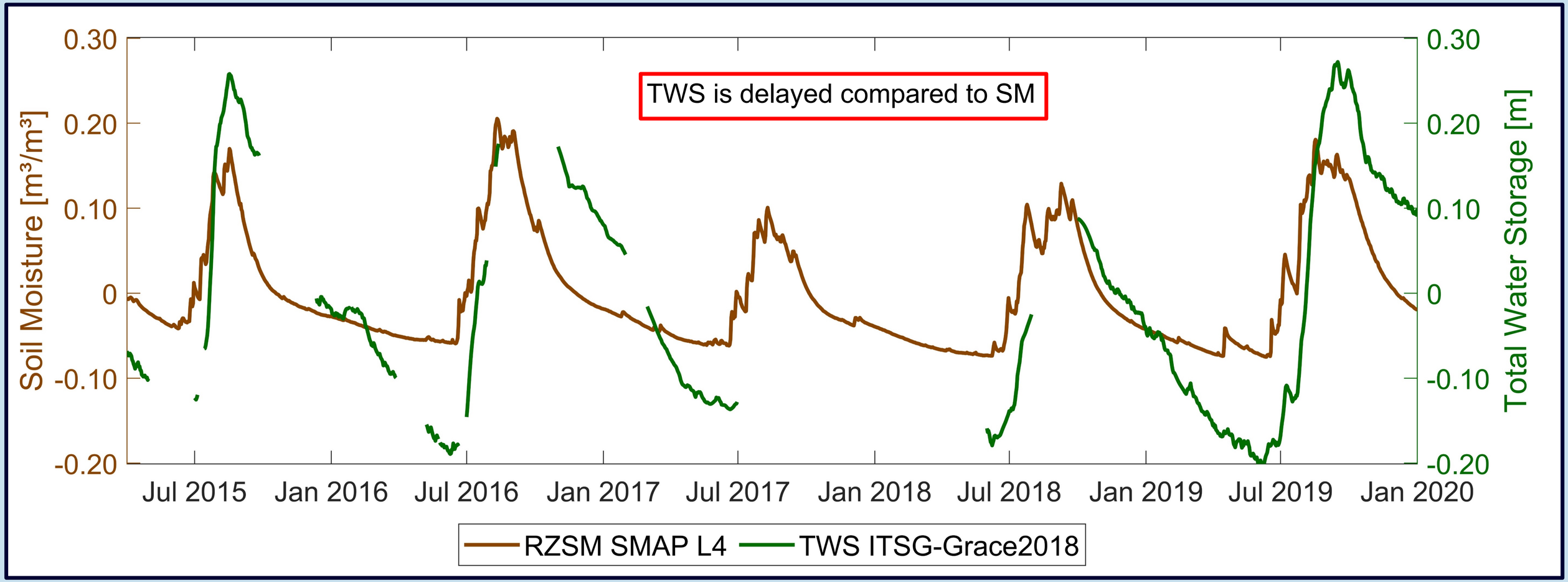
ITSG-Grace2018 vs. SMAP L4 RZSM



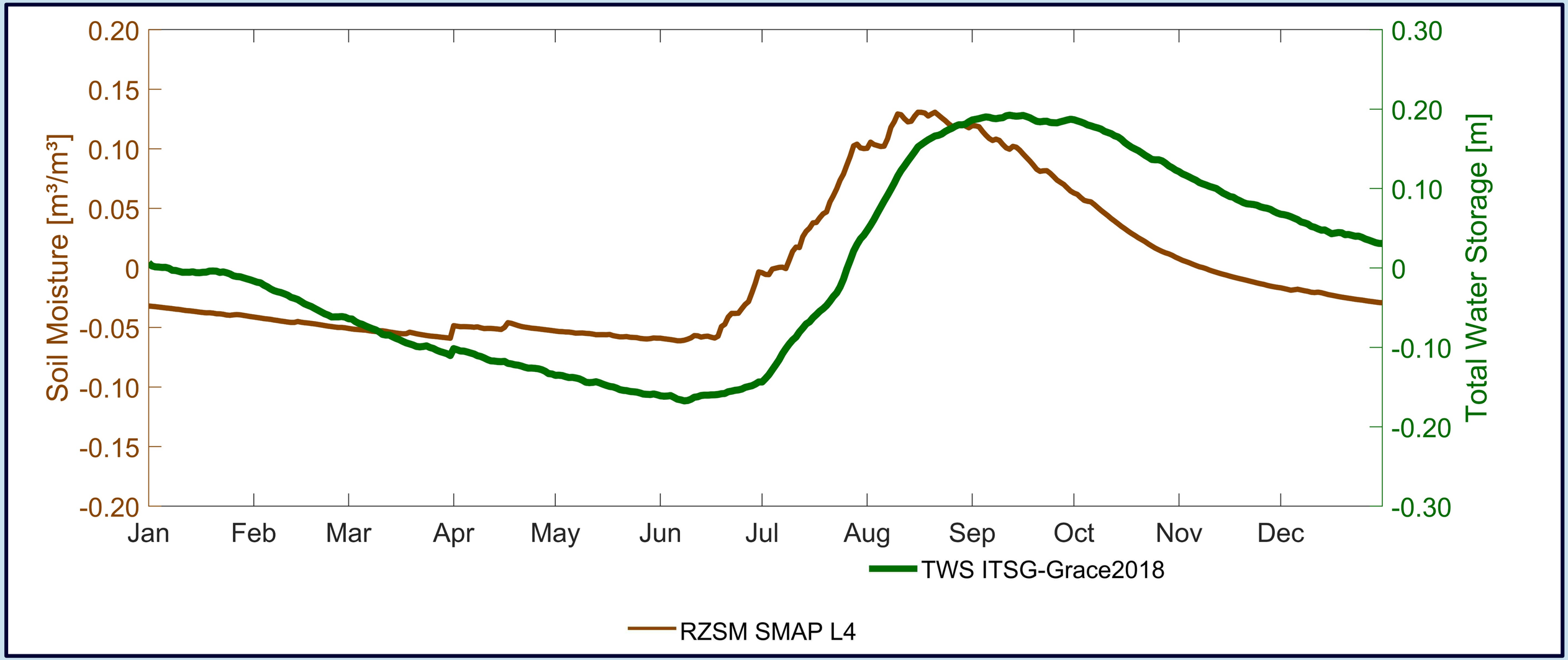


Area-weighted average = 0,61
Maximum = 0,98

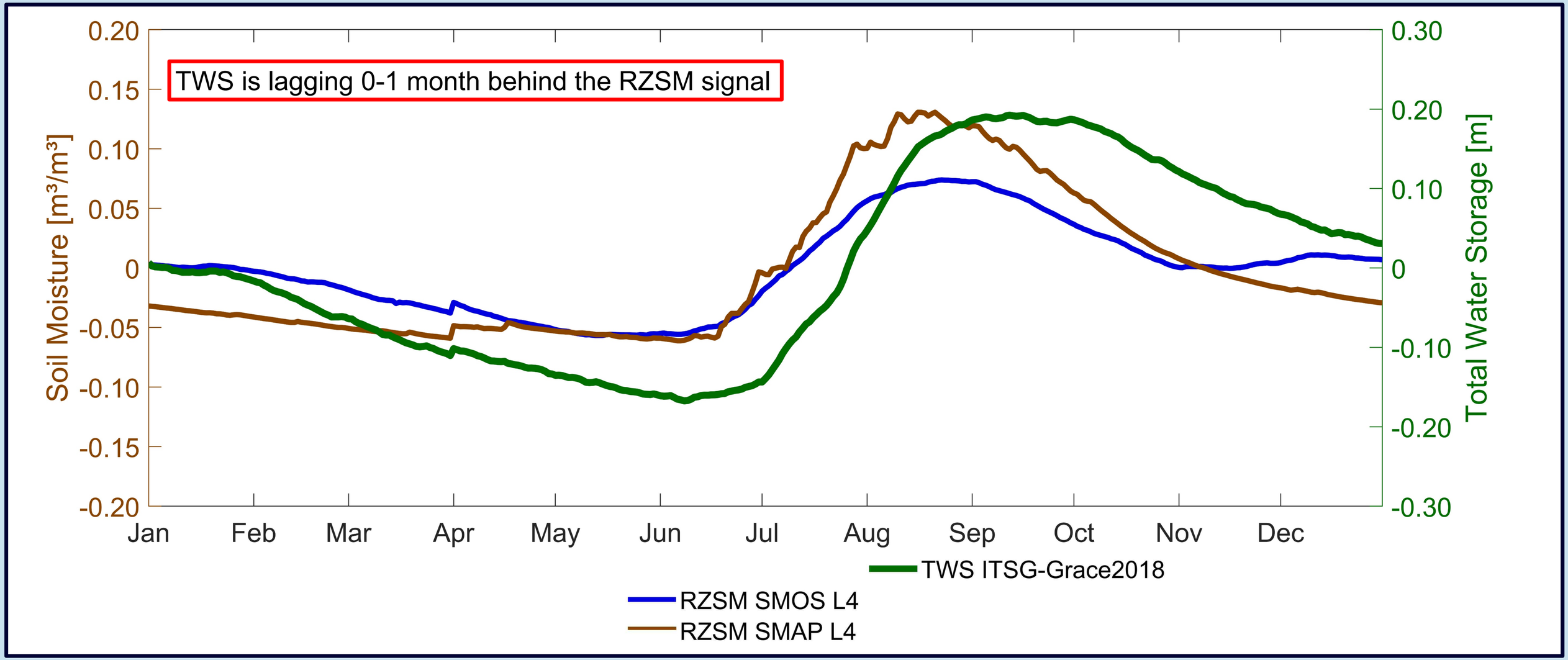
Time series GRACE/GRACE-FO & SMAP L4 RZSM



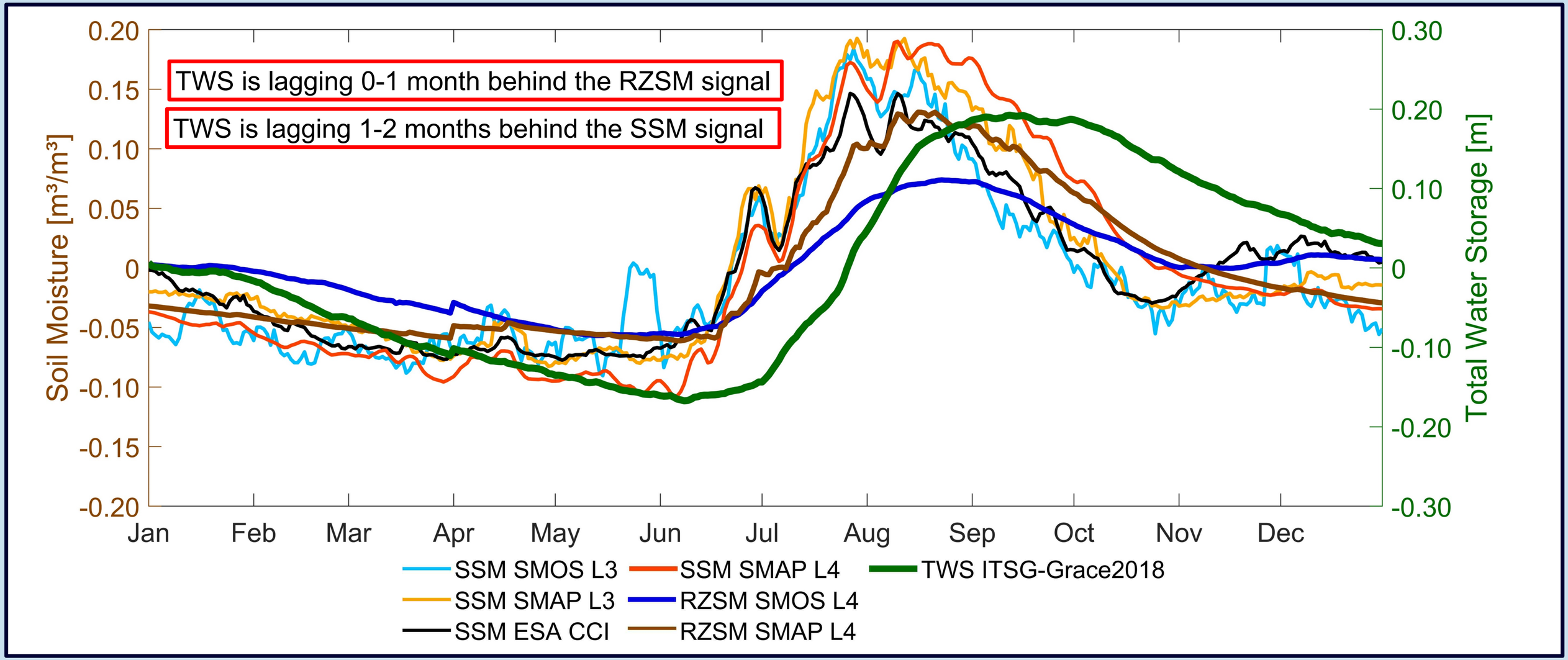
Average year



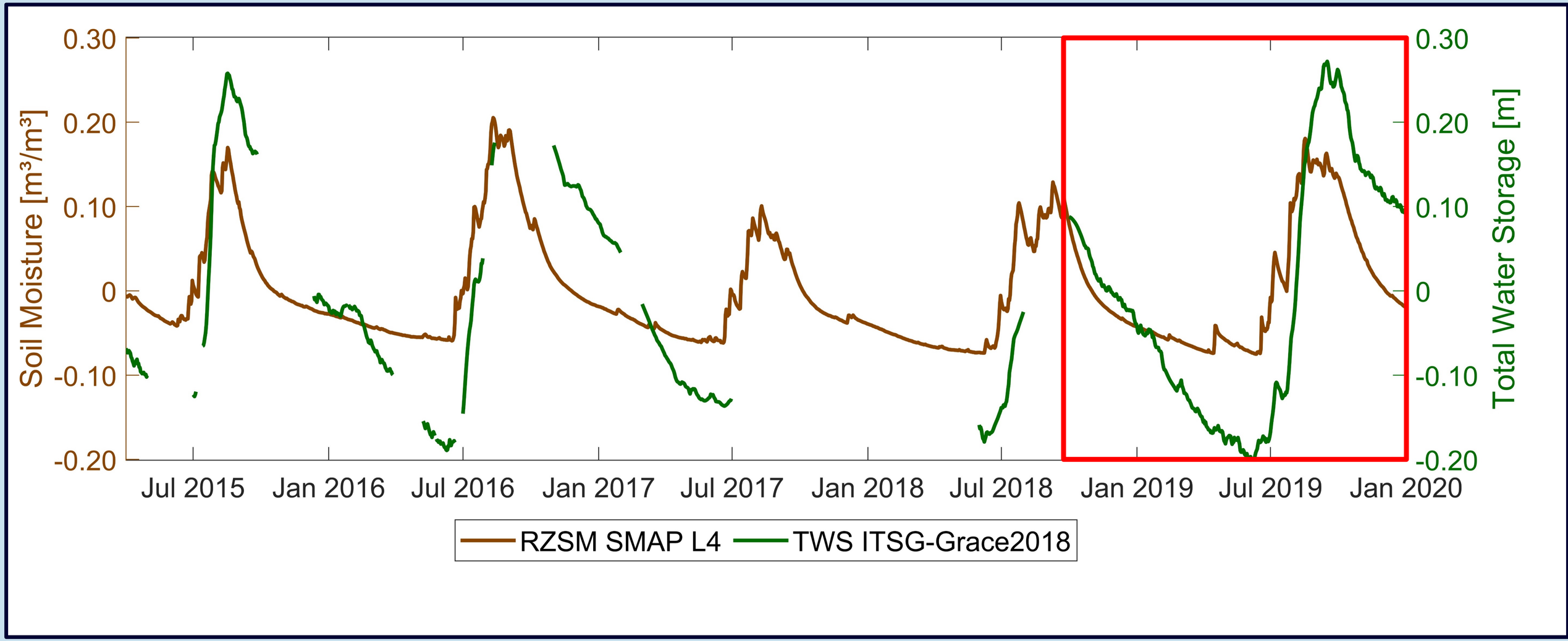
Average year



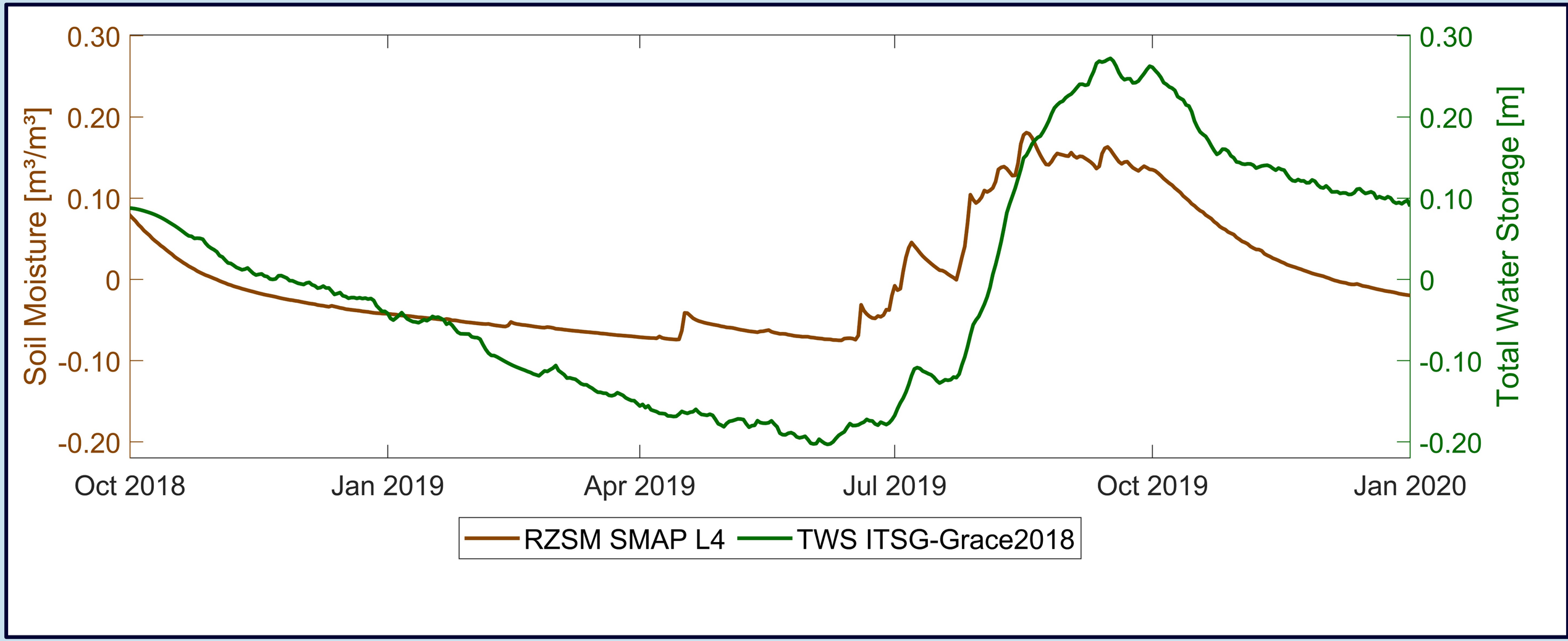
Average year



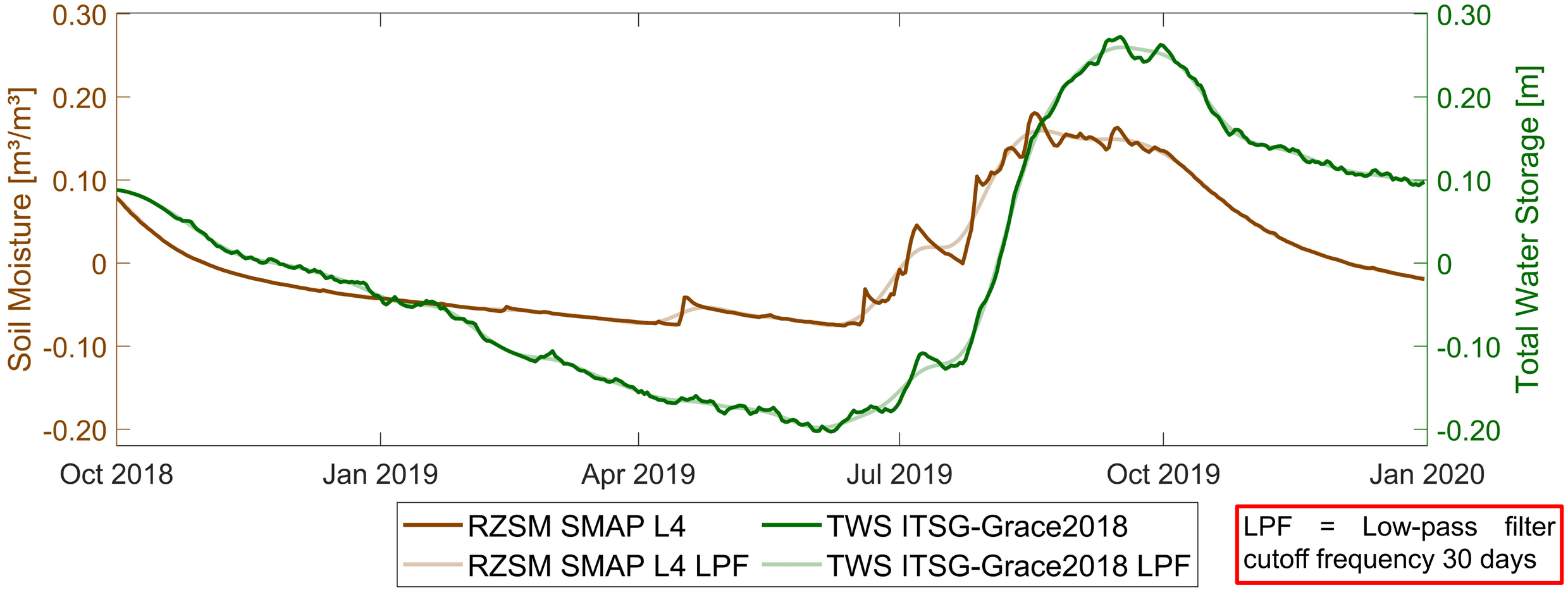
Time series GRACE/GRACE-FO & SMAP L4 RZSM



Signal decomposition

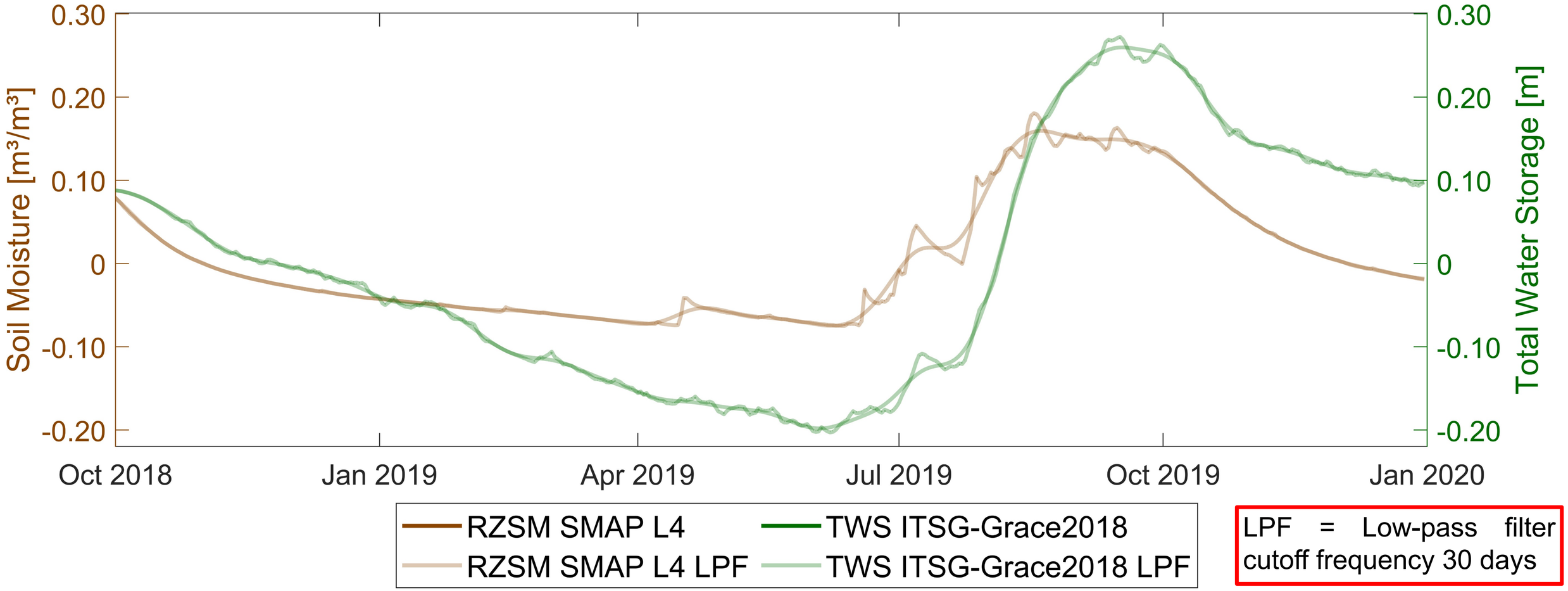


Signal decomposition



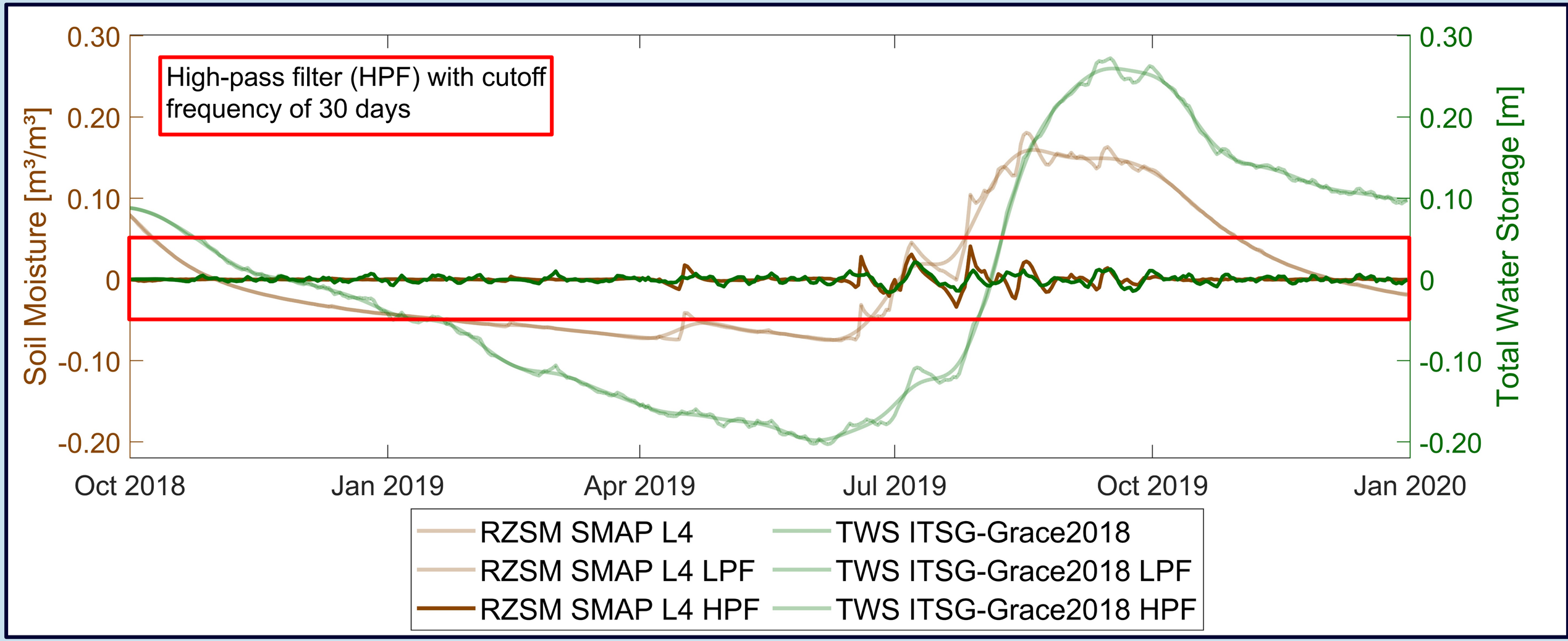
LPF = Low-pass filter cutoff frequency 30 days

Signal decomposition

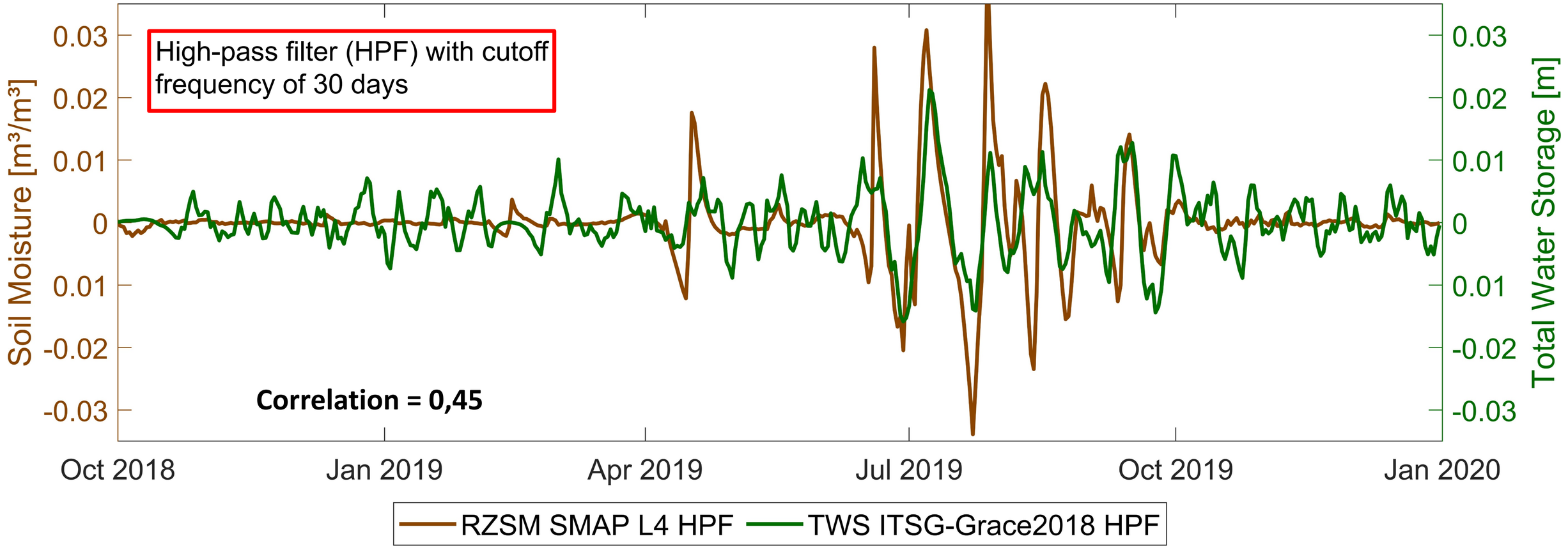


LPF = Low-pass filter cutoff frequency 30 days

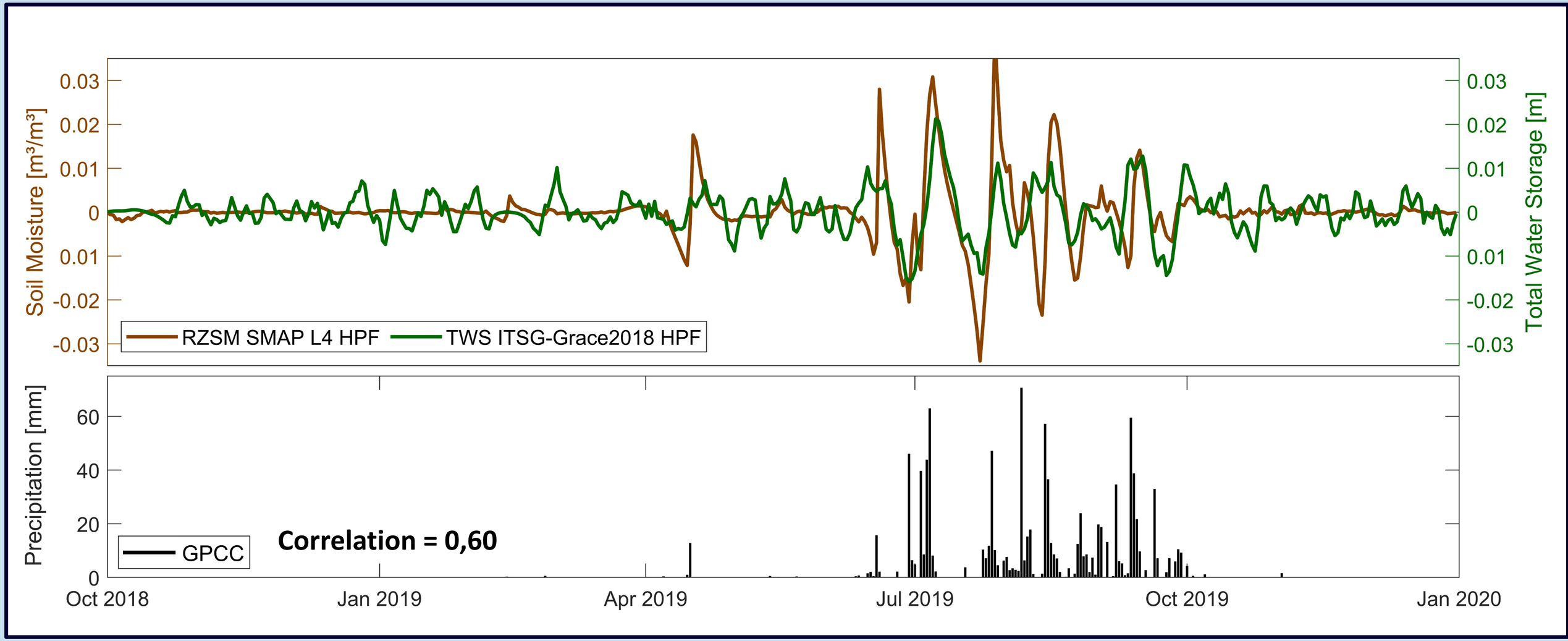
Signal decomposition



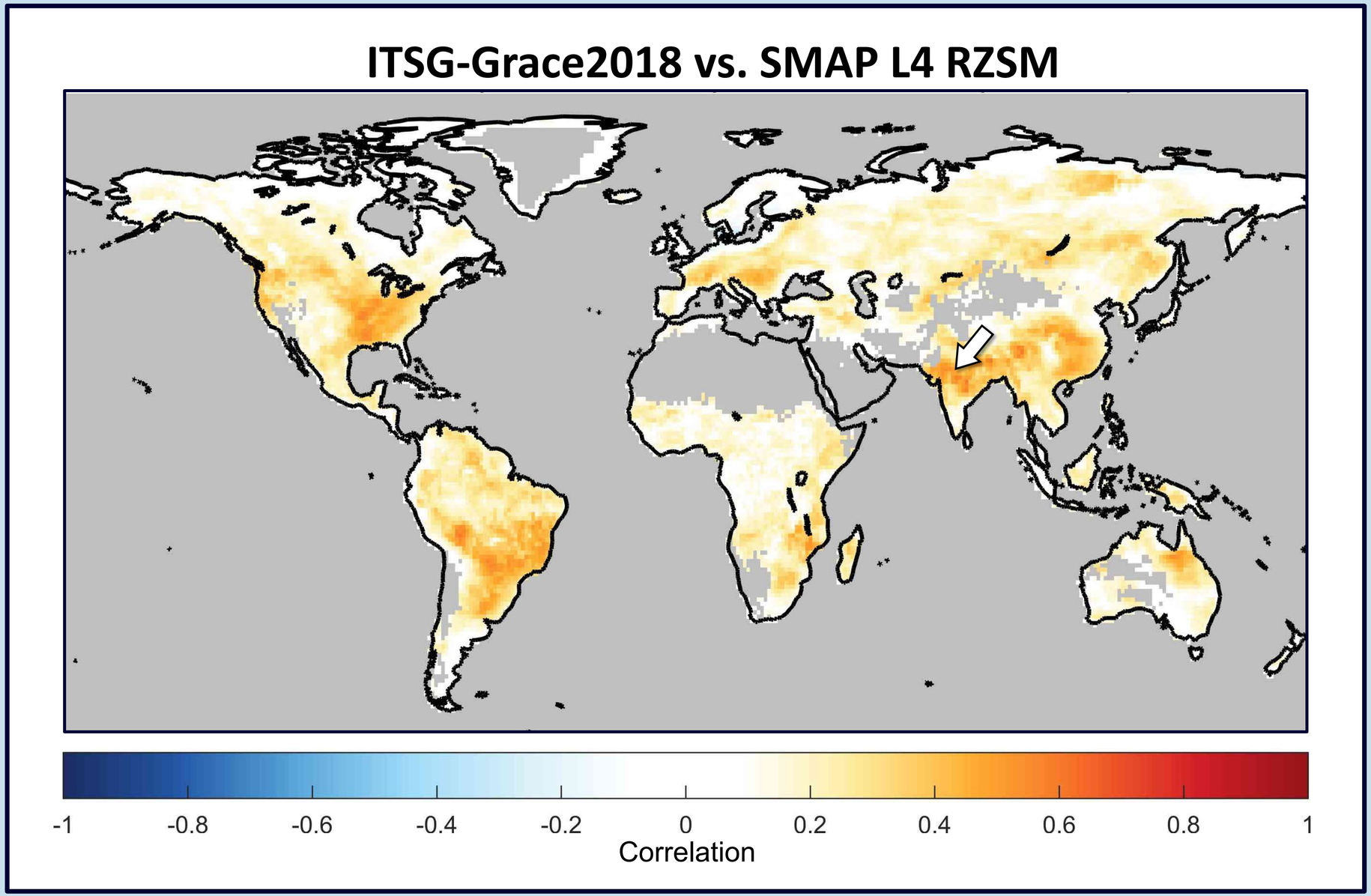
Sub-monthly signal



Sub-monthly signal & precipitation data

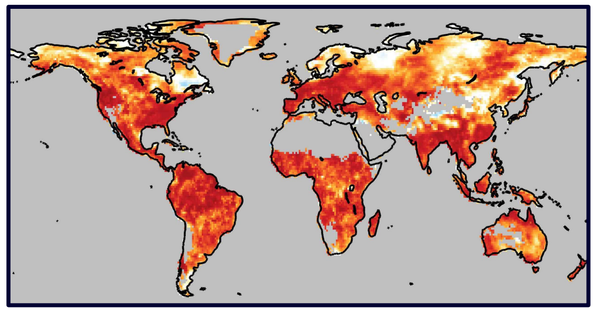


Correlation sub-monthly signal

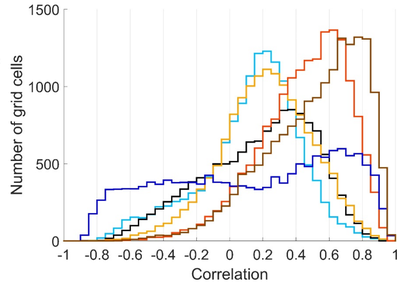


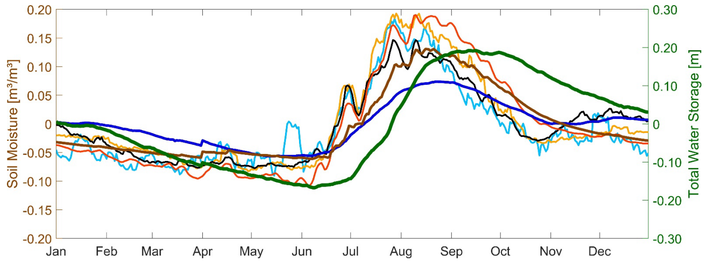
Summary

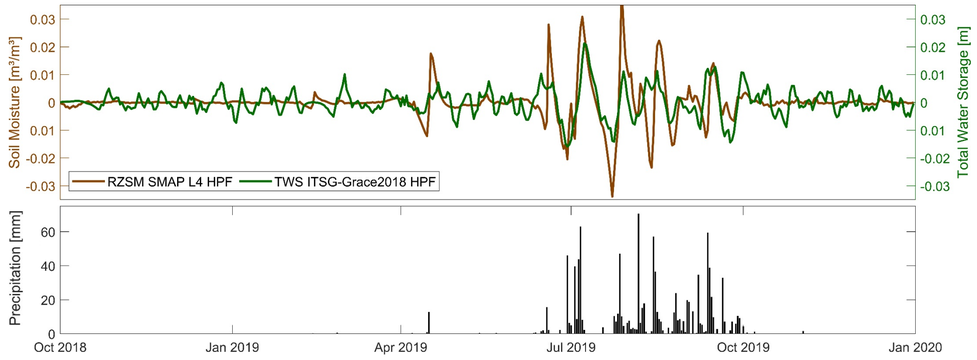
- Global comparison of TWS and soil moisture products
- Calculation of correlations and time-shifts on a global scale
- Signal decomposition into sub-monthly signals



- High correlations between SSM products and TWS. Even stronger correlations with RZSM products.
- TWS is shifted by 1-2 months relative to the SSM and 0-1 month relative to RZSM.
- On sub-monthly time scales, there is agreement between SM and TWS in particular during rainfall events/periods.







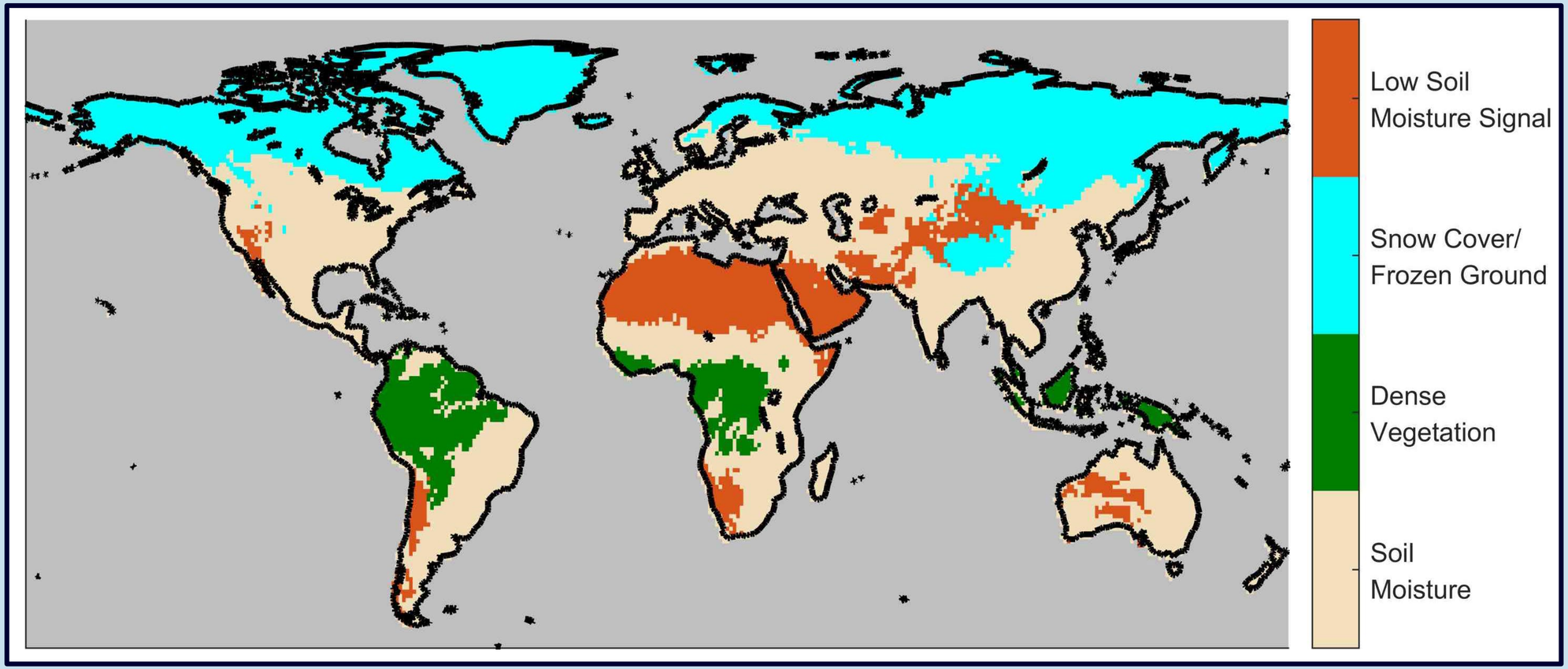
Results: Blank et al. 2022 (submitted)

Blank, D., Eicker, A., Jensen, L., Güntner, A., 2022. A global analysis of water storage variations from remotely sensed soil moisture and daily satellite gravimetry

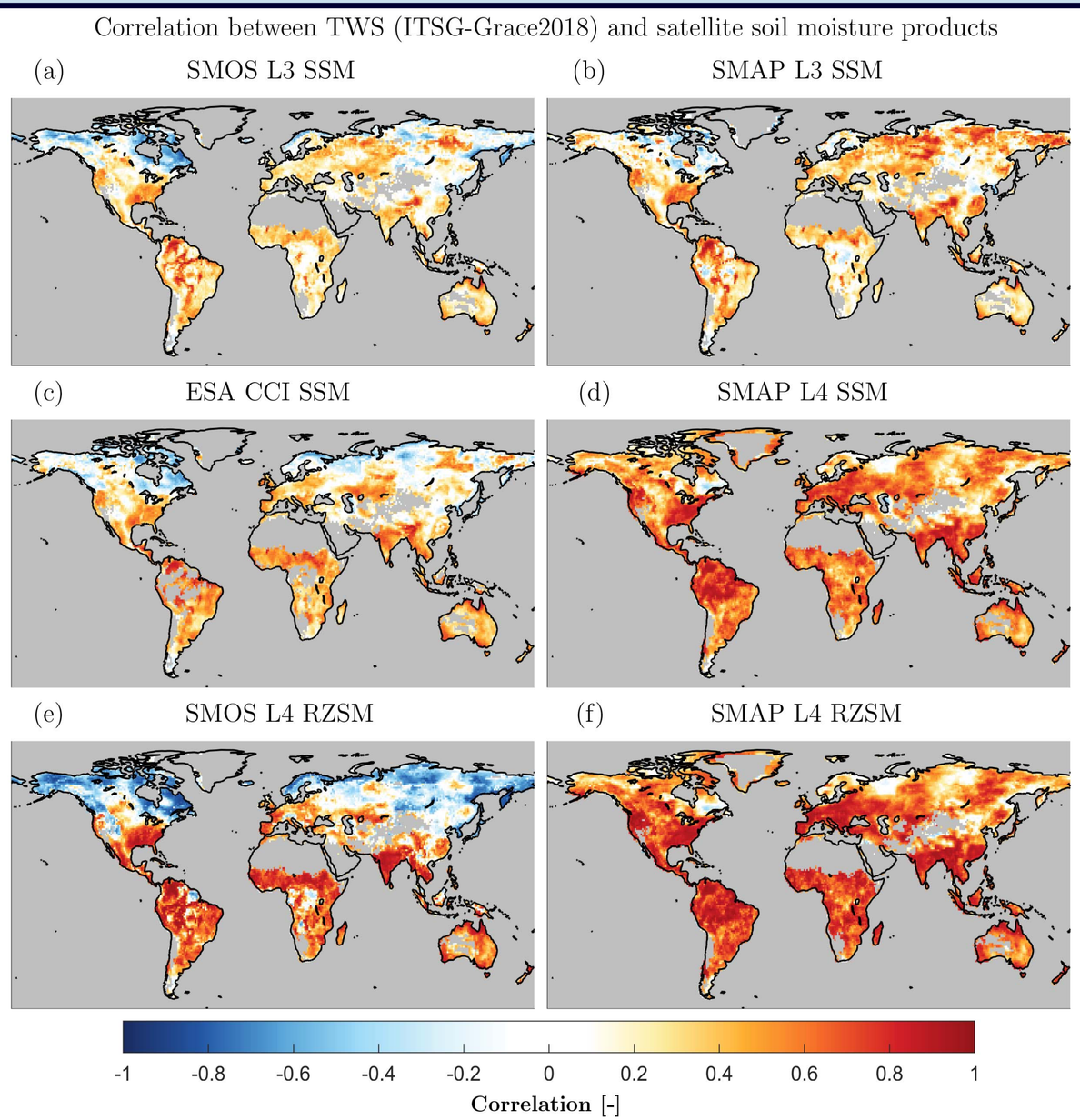
Questions? daniel.blank@hcu-hamburg.de

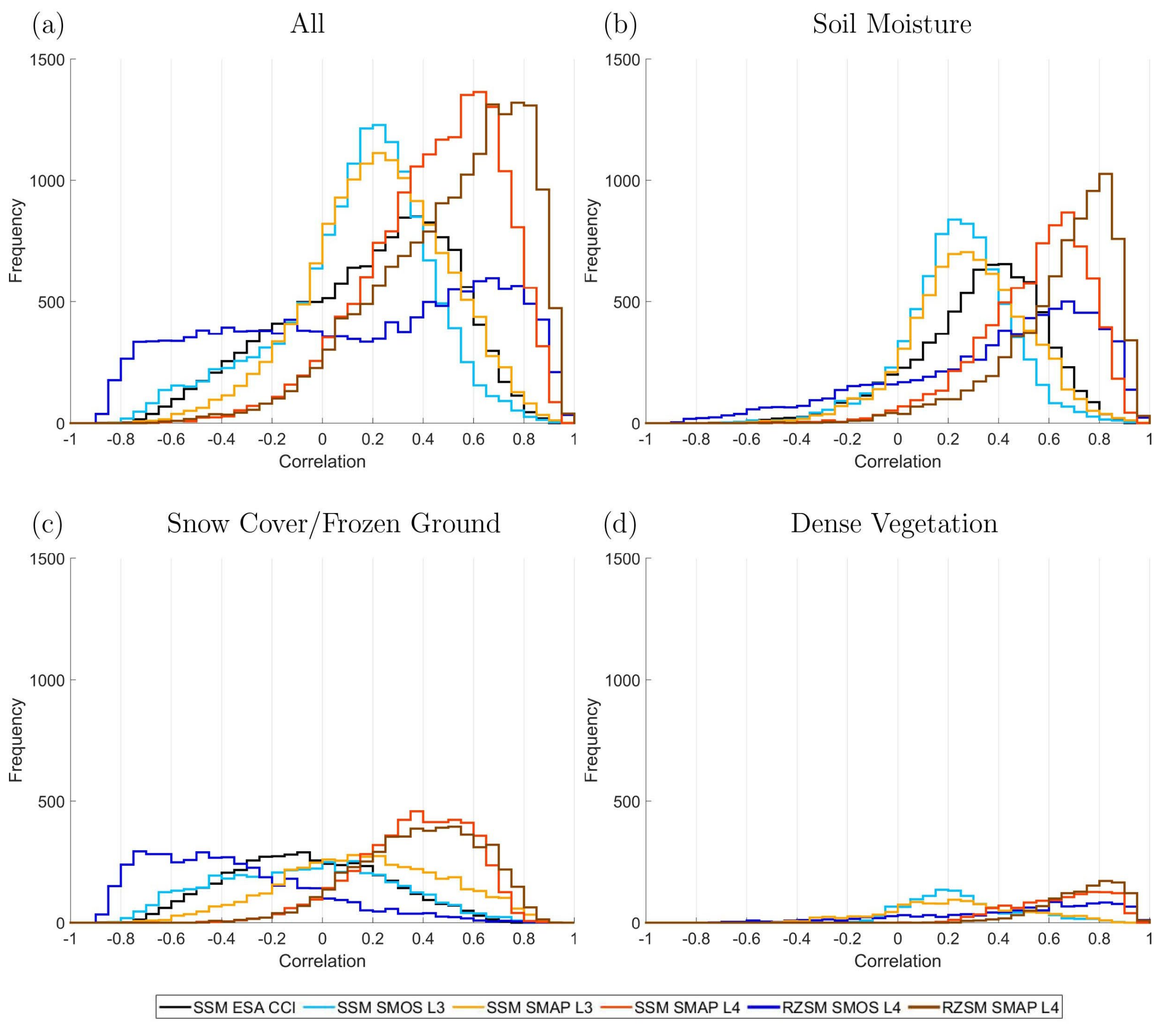
Supplementary Slides

Spatial mask

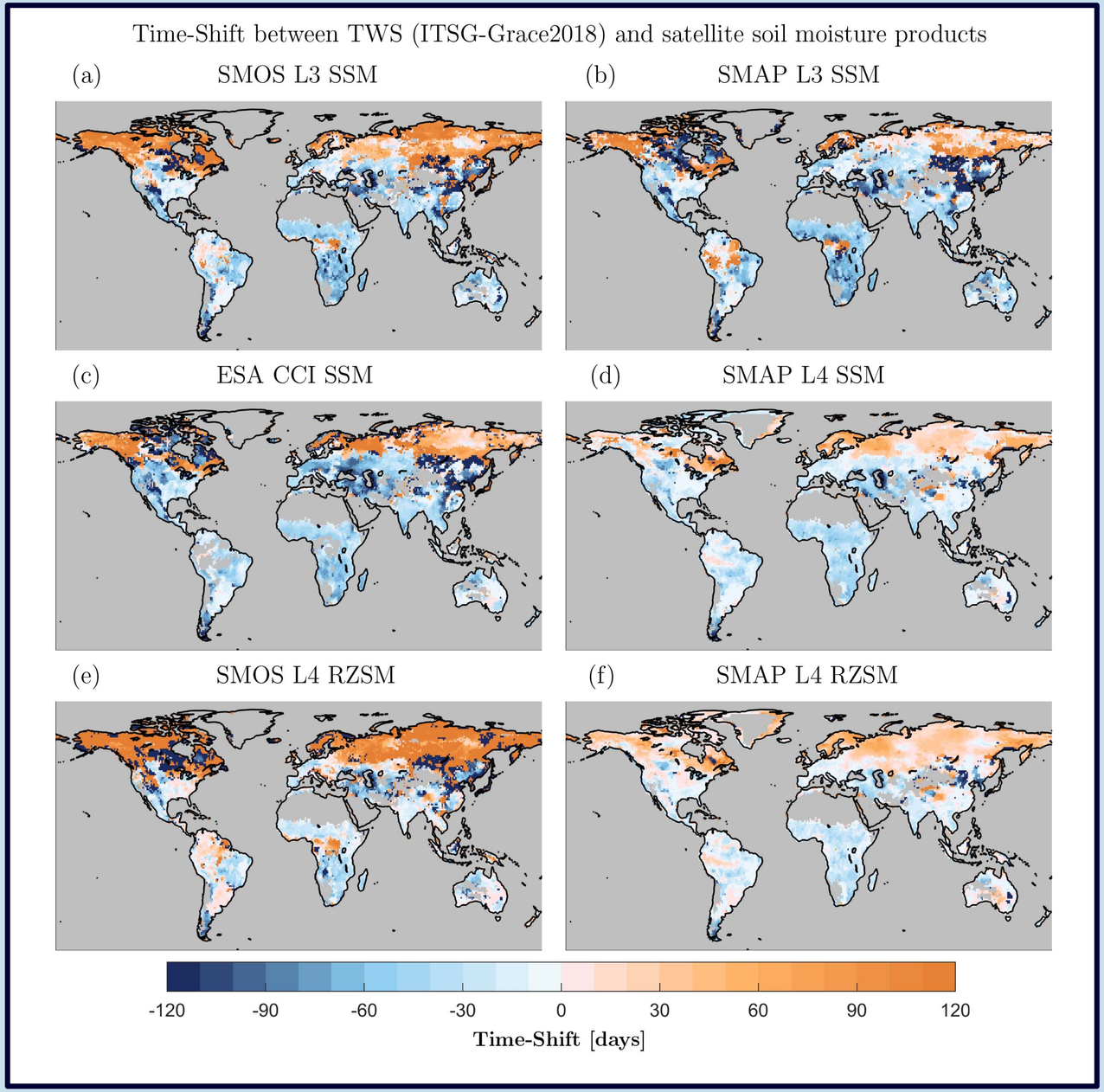


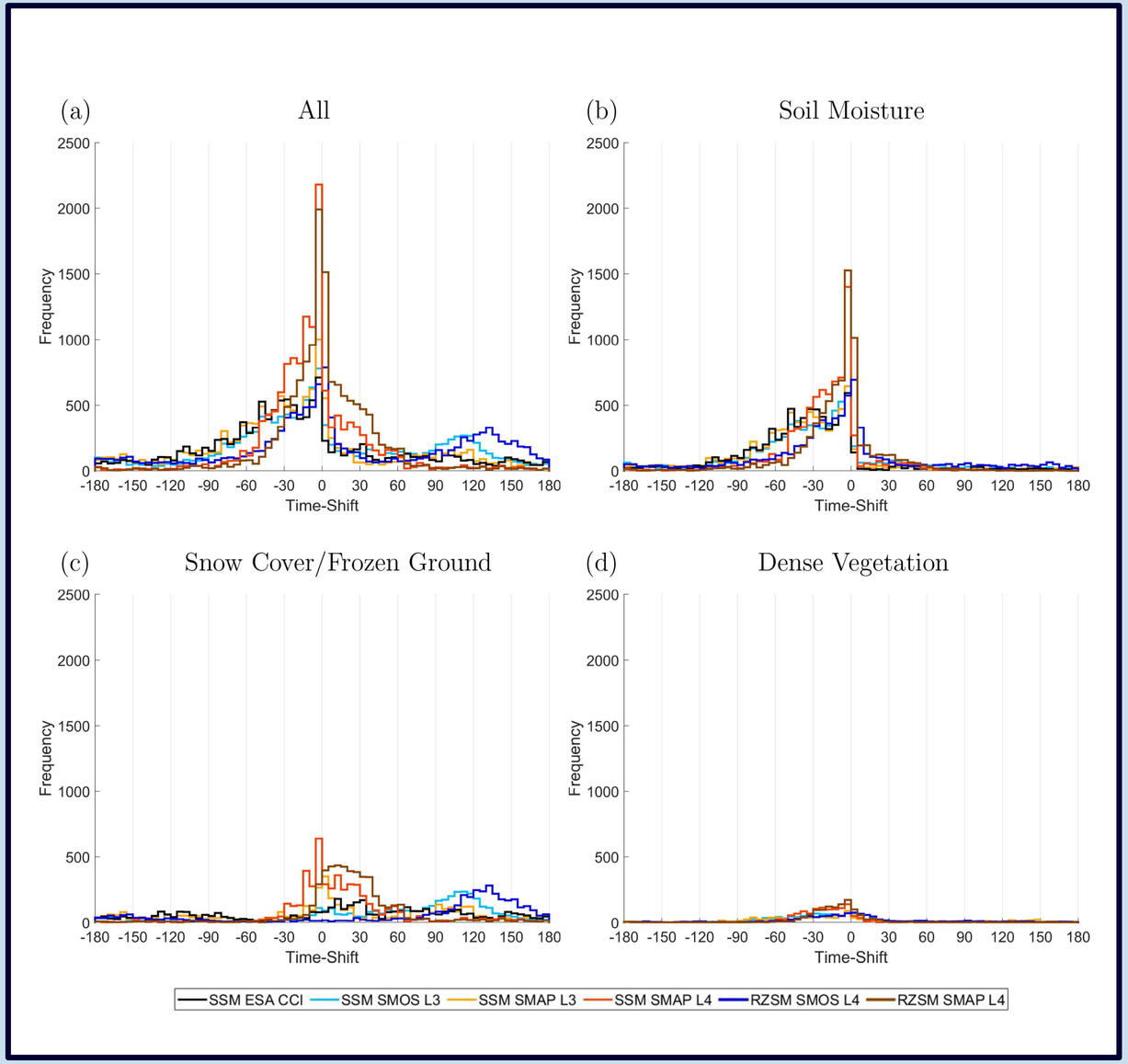
Correlation total signal



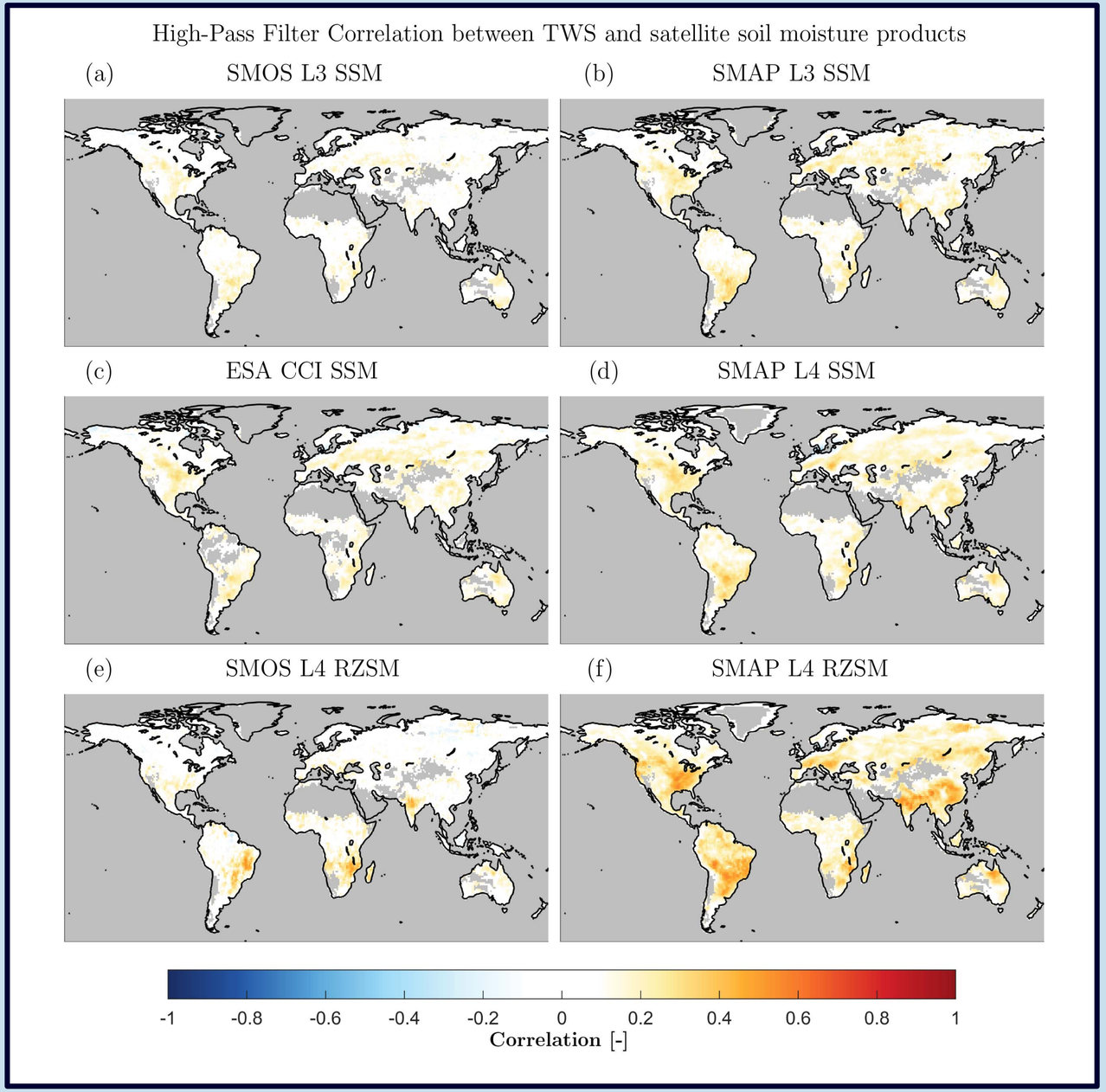


Time-shift total signal

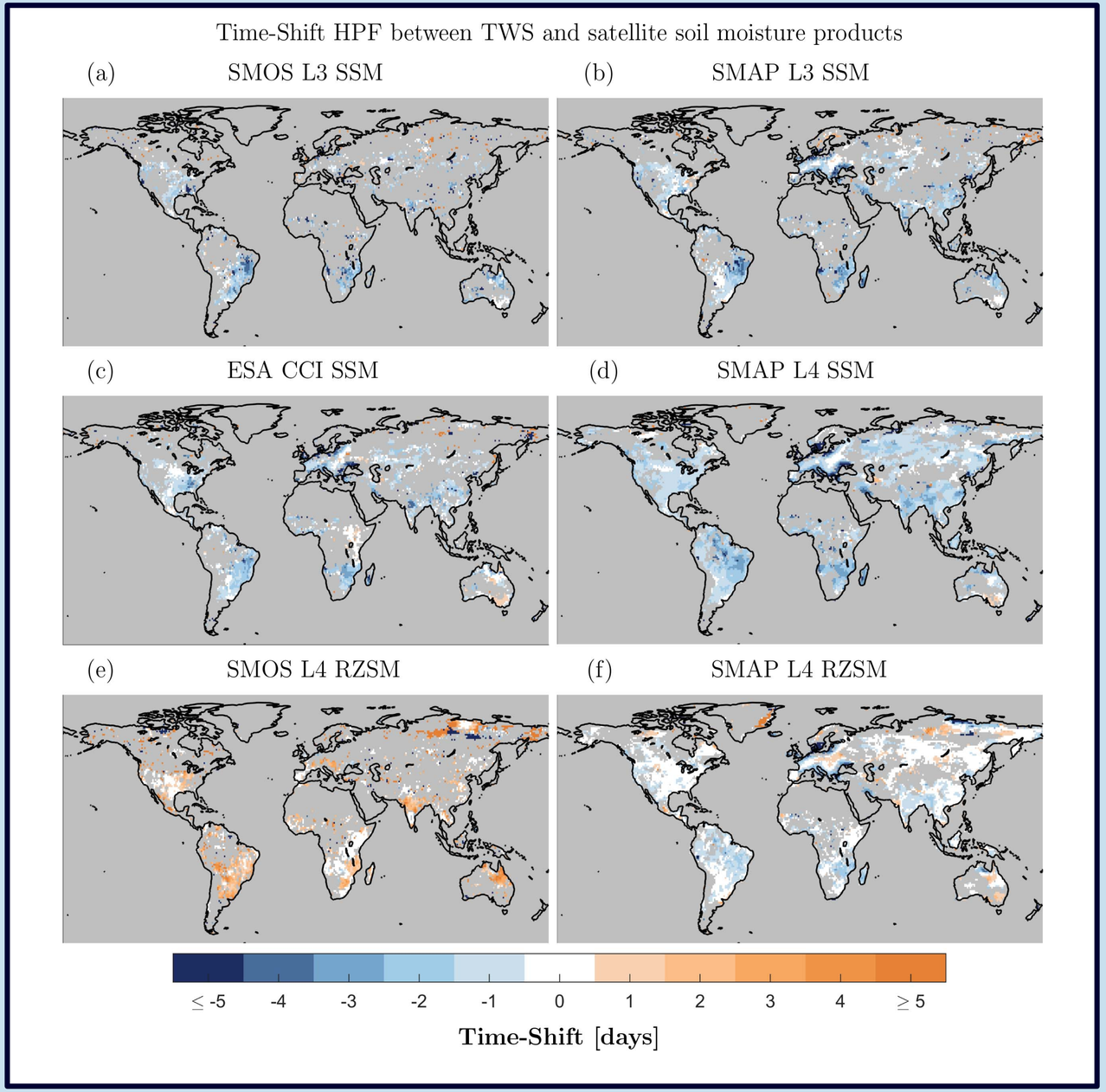




Correlation high-pass filter signal

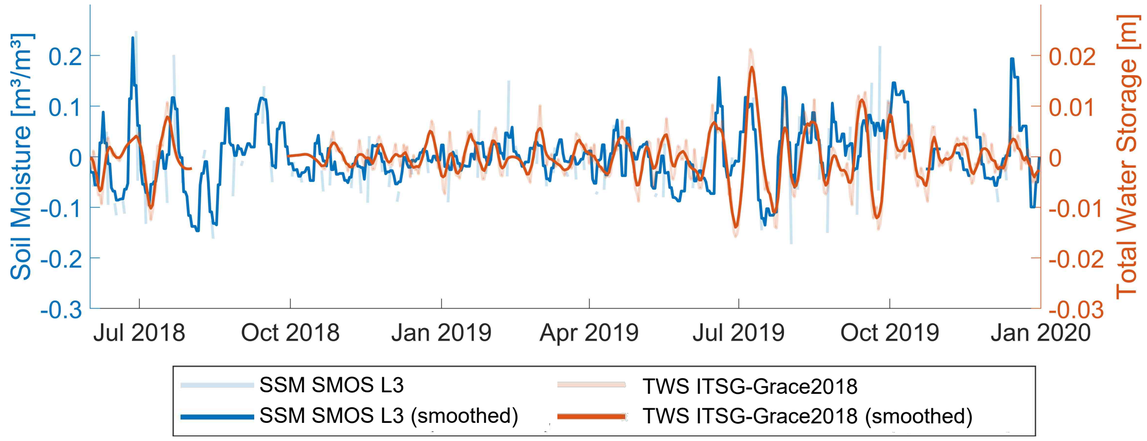


Time-shift high-pass filter signal

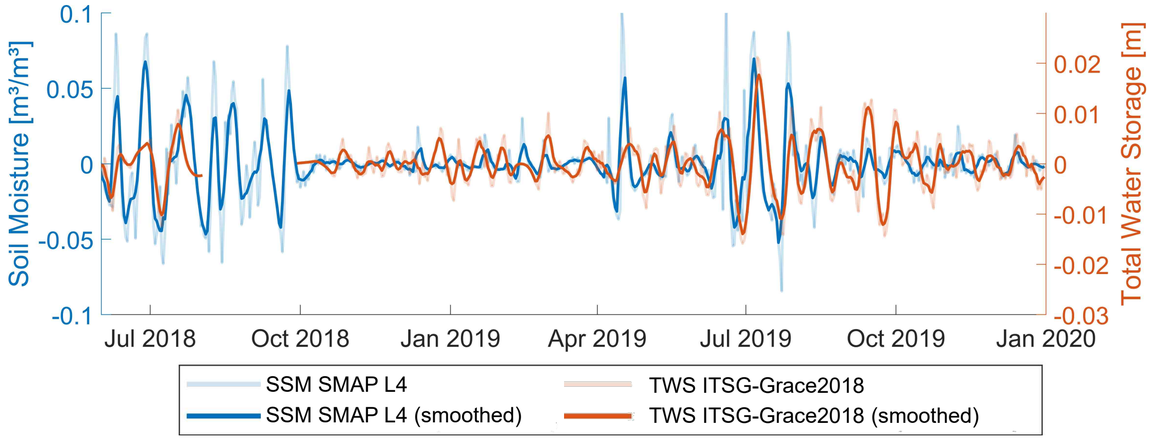


High-pass filter signals

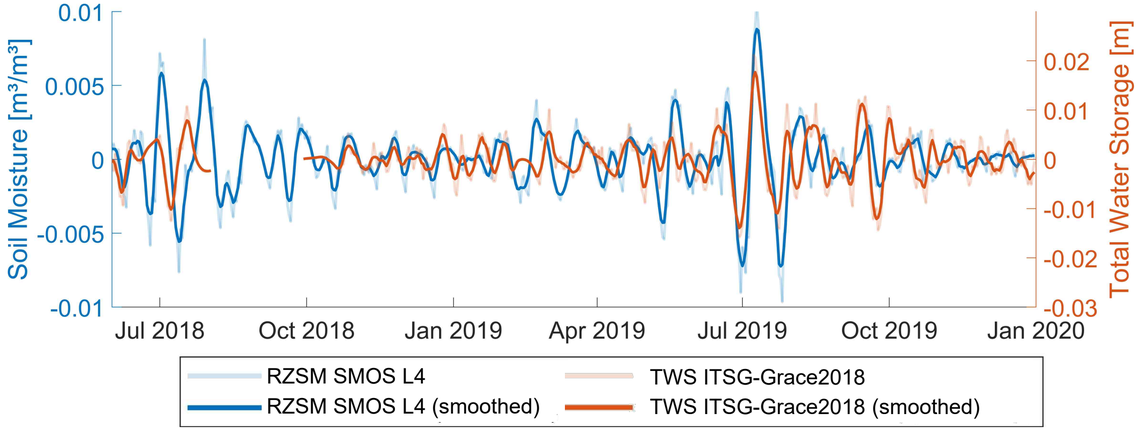
ITSG-Grace2018 vs. SMOS L3 SSM



ITSG-Grace2018 vs. SMAP L4 SSM



ITSG-Grace2018 vs. SMOS L4 RZSM



ITSG-Grace2018 vs. ESA CCI SSM