Evaluating short-term hydro-meteorological fluxes in global atmospheric reanalyses using daily GRACE data

Viviana Wöhnke[1], Annette Eicker[1], Laura Jensen[1], Andreas Kvas[2], Torsten Mayer-Gürr[2], Henryk Dobslaw[3]

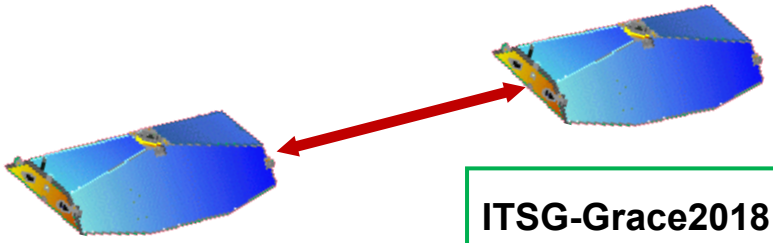
[1]HafenCity University Hamburg, Geodesy and Geoinformatics, Germany

[2]Graz University of Technology, Austria

[3]Helmholtz Centre Potsdam, German Research Centre for Geosciences (GFZ), Potsdam, Germany

EGU General Assembly 2020

How can GRACE evaluate atmospheric reanalyses?

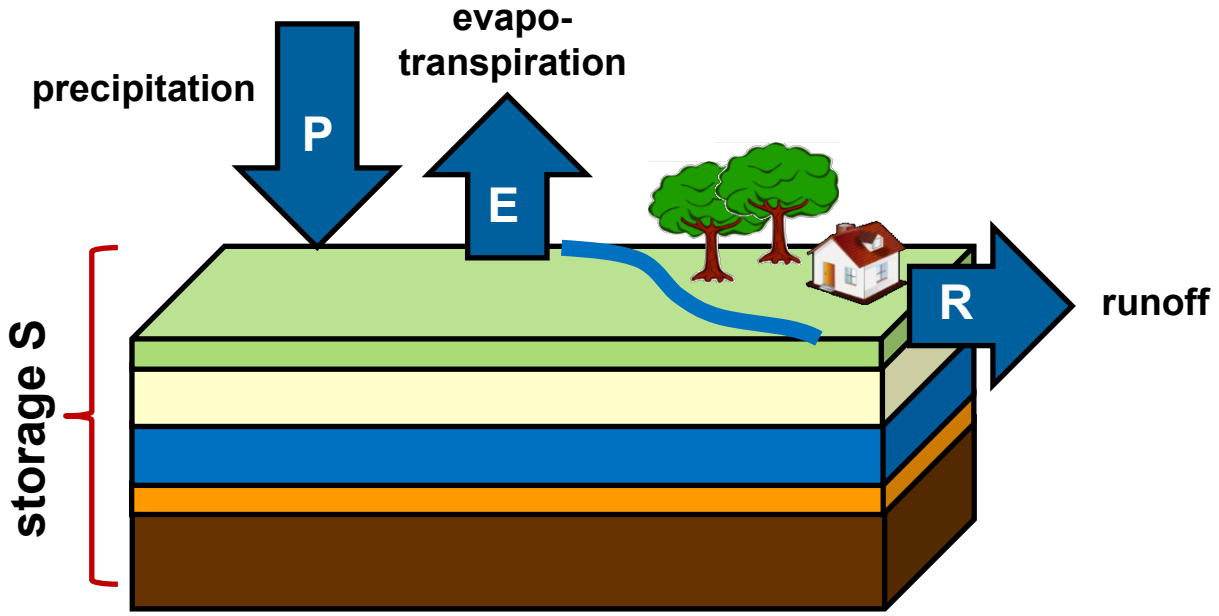


ITSG-Grace2018 daily solutions (TU Graz)
(5-points derivative filter)

Terrestrial water balance

$$\frac{dS}{dt} = P - E - R$$

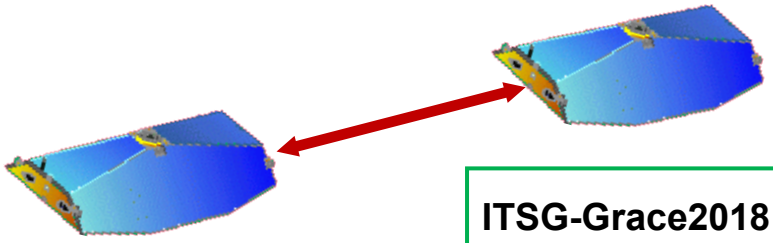
storage change



Global atmospheric reanalyses

ERA-Interim	JRA-55
ERA5	MERRA2
ERA5-Land	NCEP2

How can GRACE evaluate atmospheric reanalyses?



ITSG-Grace2018 daily solutions (TU Graz)
(5-points derivative filter)

Terrestrial water balance

$$\frac{dS}{dt} = P - E - R$$

storage change

Approach:

- Compare both sides of water balance equation
- Apply **high-pass filtering** with 30 days cut-off → focus on **sub-monthly** time scales (5 – 30 days)

Evaluation of atmospheric reanalyses using GRACE:

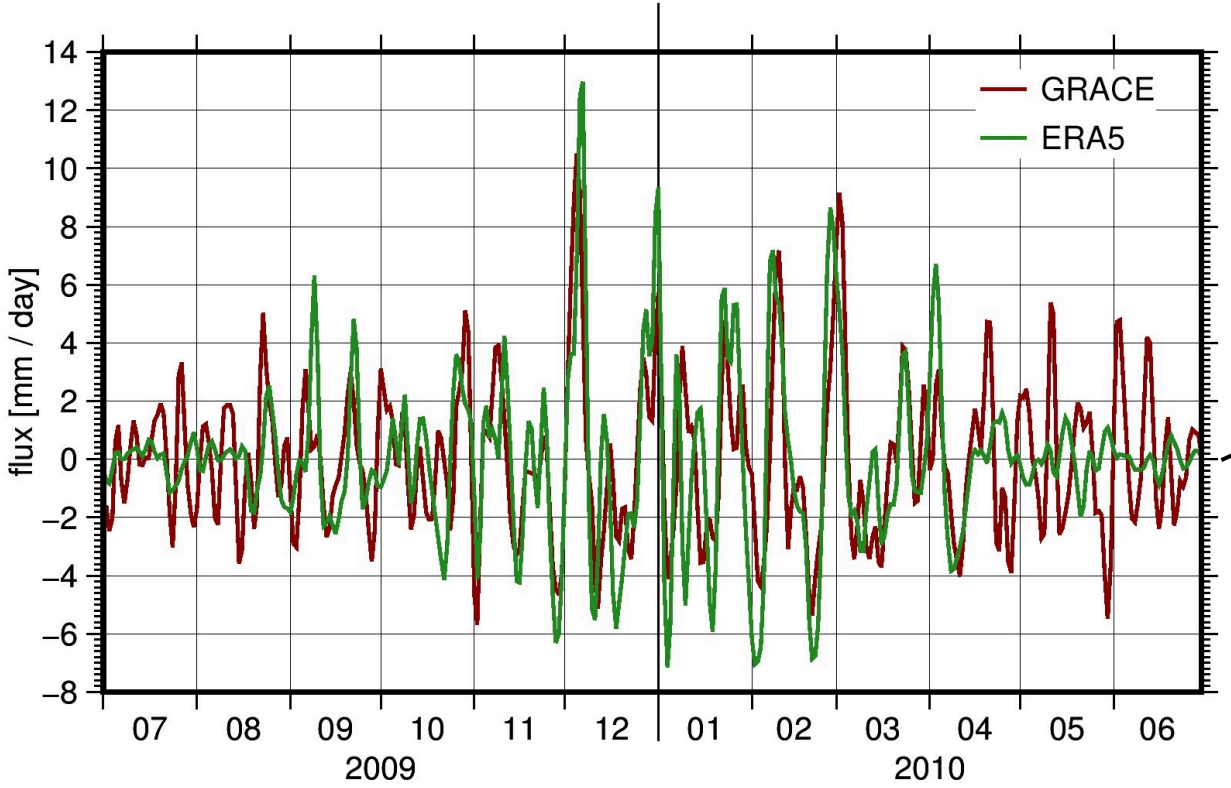
1. Global maps of evaluation metrics (correlation and RMSD (root mean squared deviation)) between GRACE and each reanalysis
2. Identification of improvements of ERA5 over its predecessor ERA-Interim
3. Identification of quality differences between reanalyses relative to ERA5

Global atmospheric reanalyses

ERA-Interim	JRA-55
ERA5	MERRA2
ERA5-Land	NCEP2

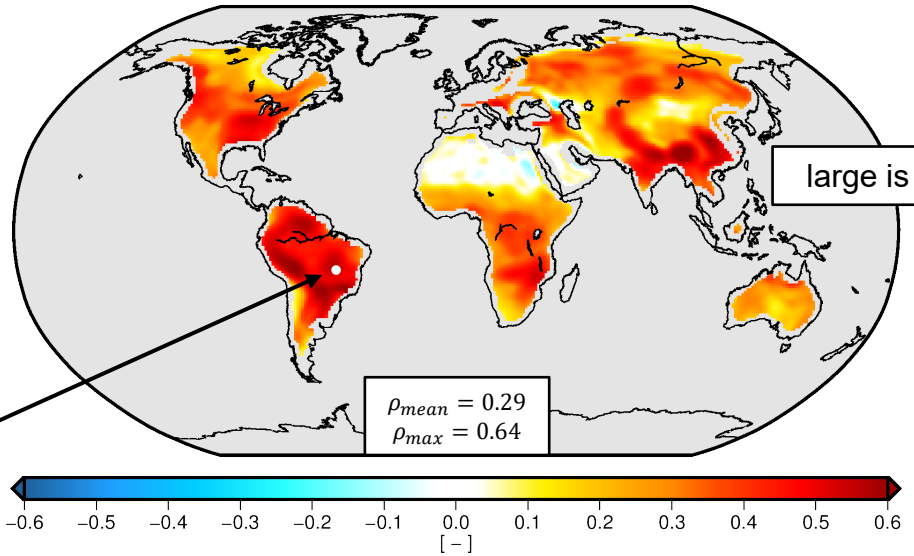
1| GRACE vs. Reanalyses (Example: ERA5)

Sub-monthly fluxes for one exemplary grid cell in Aruanã, Brazil (07/2009 – 06/2010)



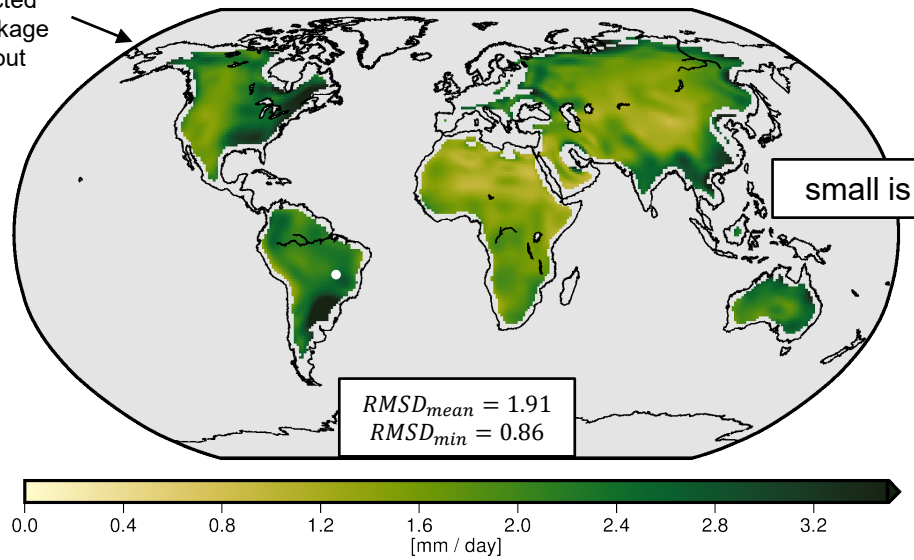
- GRACE can see short-term (5 – 30 days) fluxes similar to ERA5
- GRACE is used to compare different global atmospheric reanalyses for the time period from 2003 – 2015

Correlation GRACE vs. ERA5 (2003 – 2015)

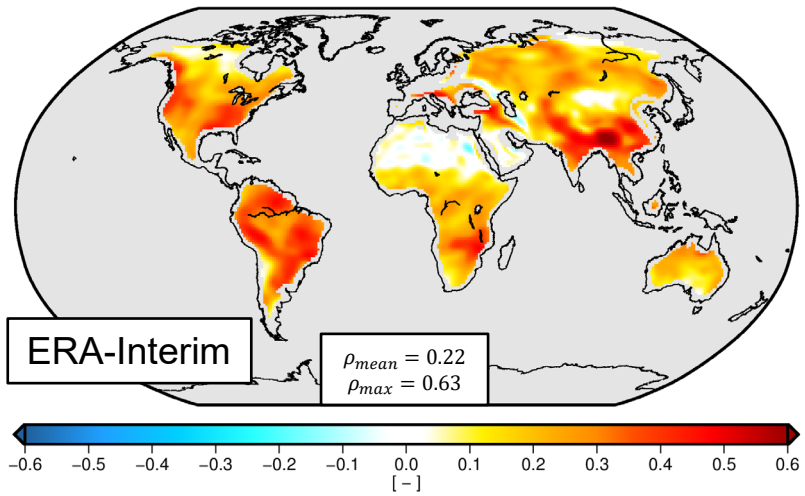


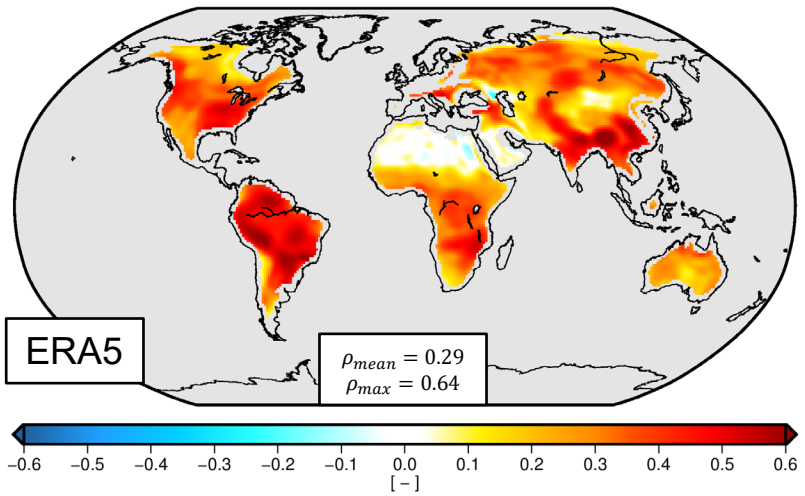
Coastal regions strongly affected by ocean leakage are masked out

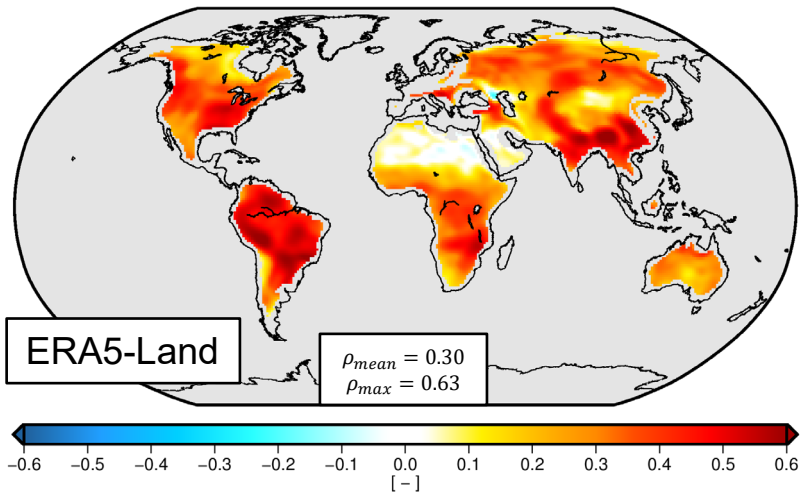
RMSD GRACE vs. ERA5 (2003 – 2015)

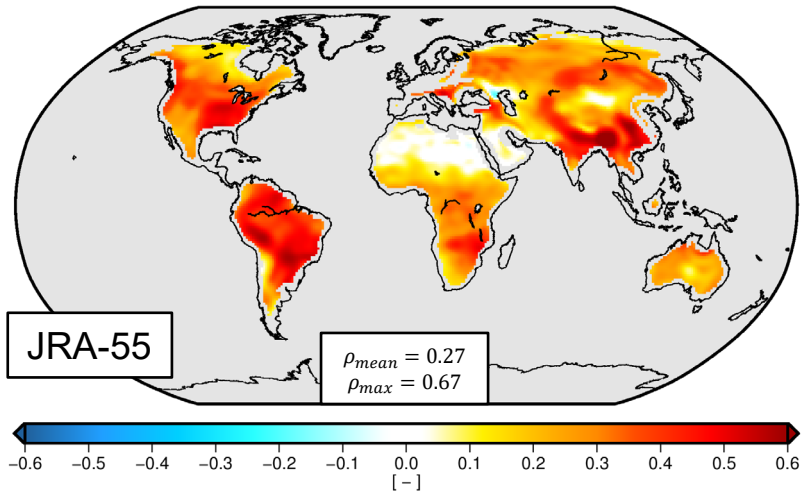


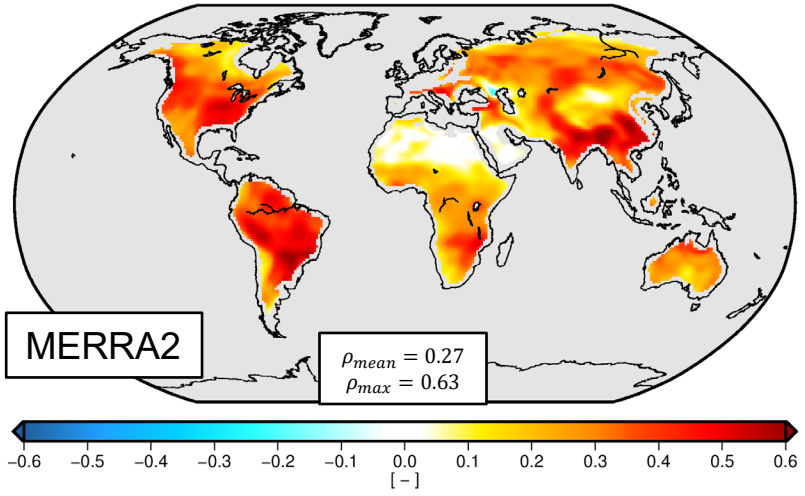
1| GRACE vs. Reanalyses: Correlation

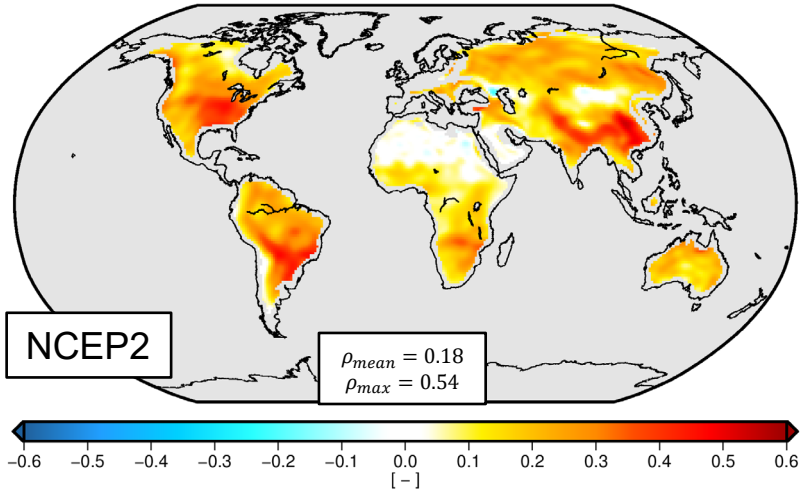




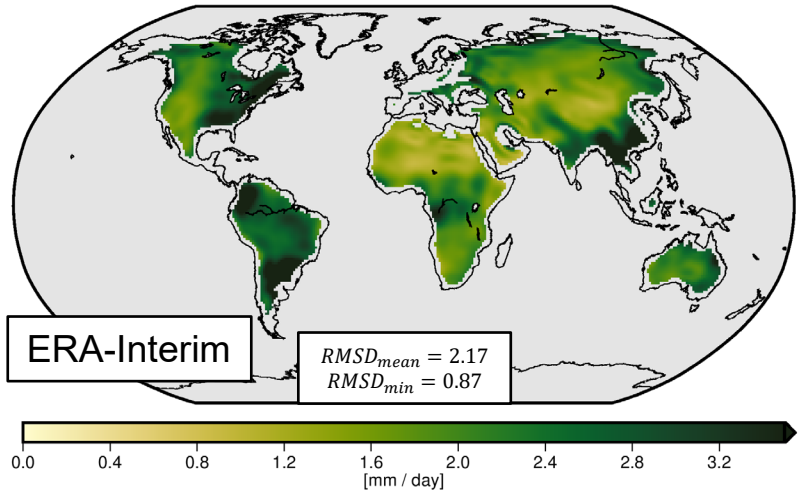


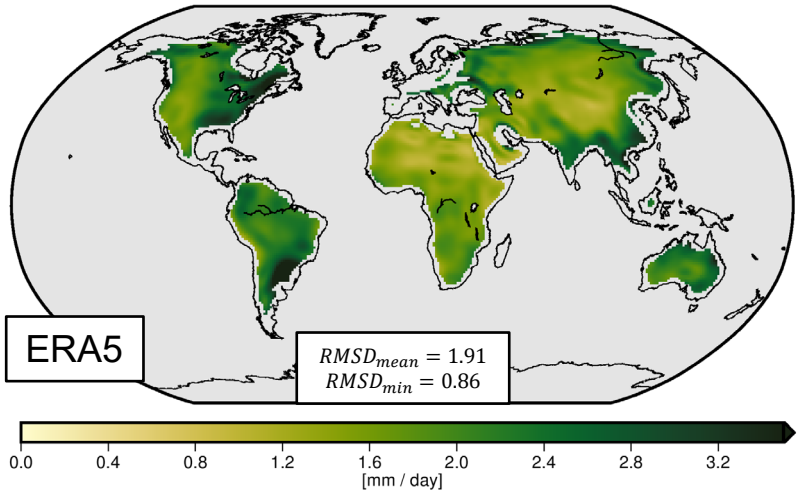


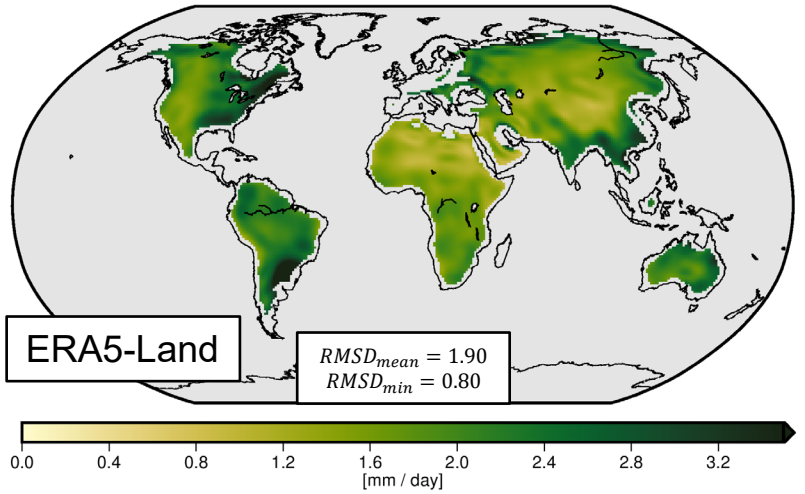


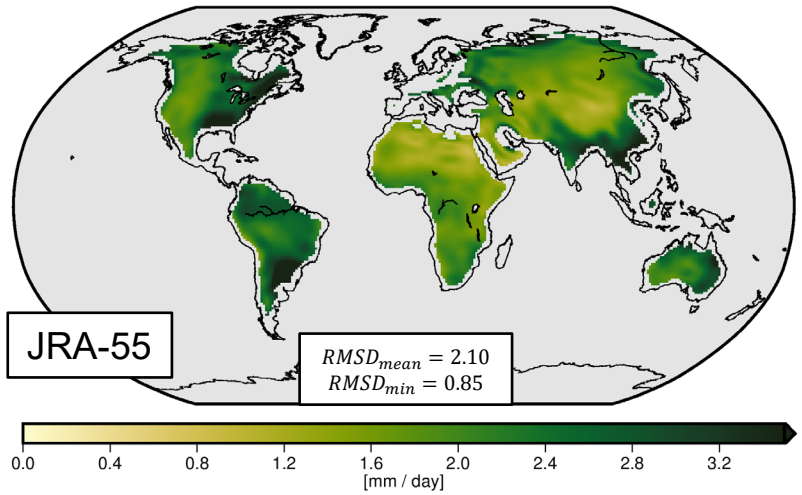


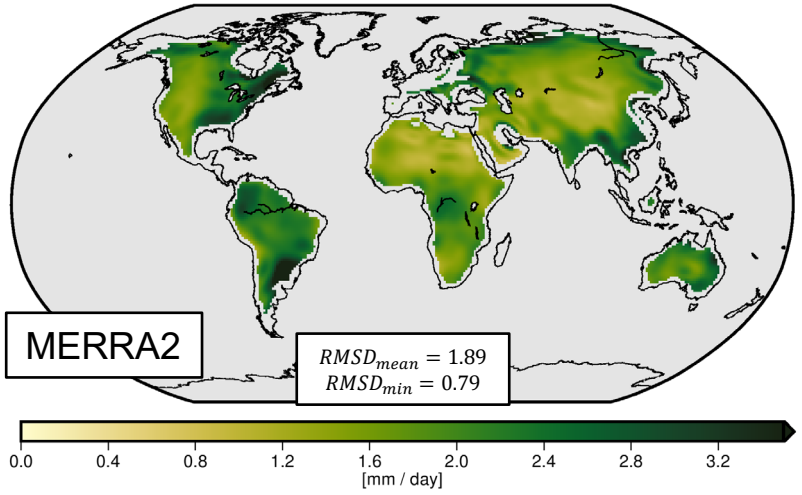
1| GRACE vs. Reanalyses: RMSD

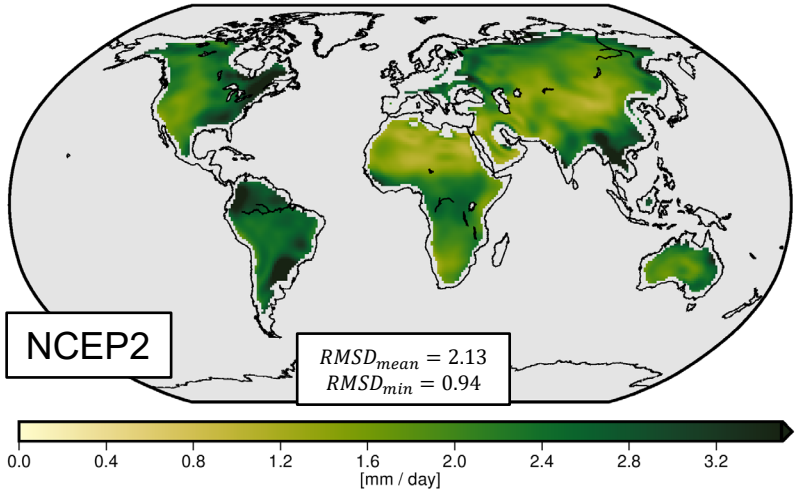




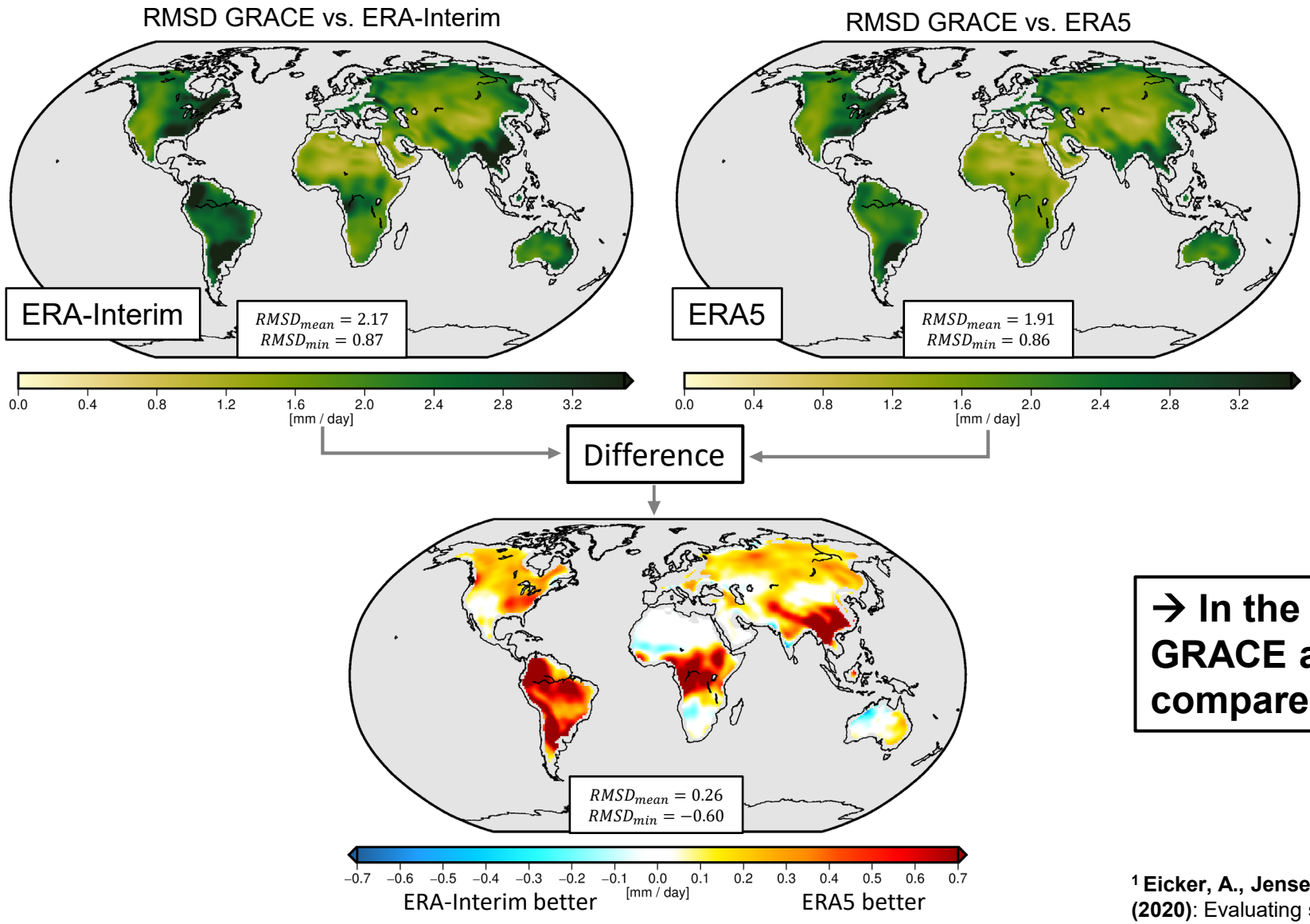








2| ERA-Interim vs. ERA5

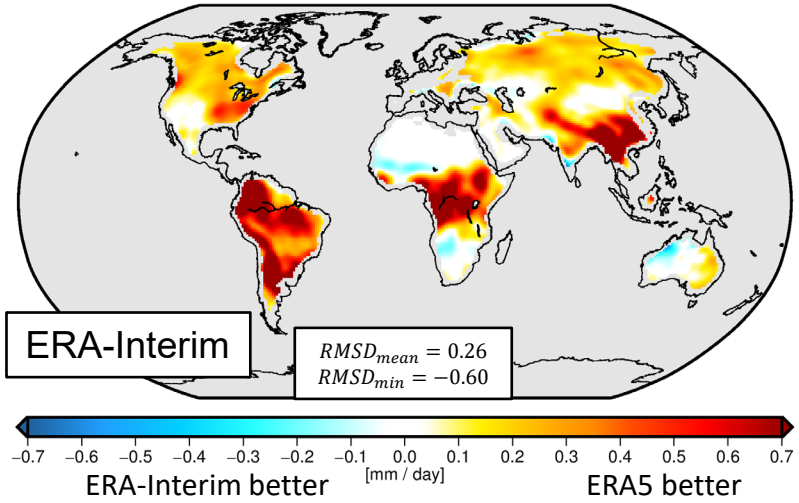


With GRACE, a clear improvement of ERA5 compared to its predecessor ERA-Interim can be detected at time scales of 5 – 30 days → see also Eicker et al. (2020)[1]

→ In the following, the agreements between GRACE and the atmospheric reanalyses are compared relative to ERA5

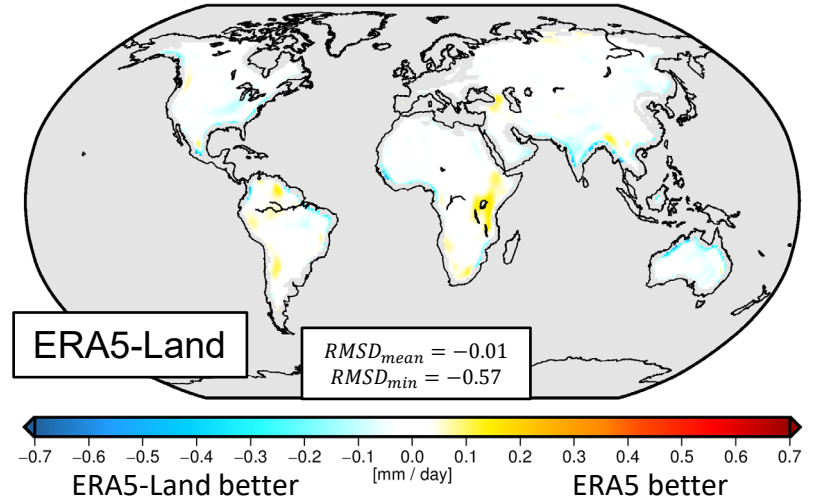
[1] **Eicker, A., Jensen, L., Wöhnke, V., Dobslaw, H., Kvas, A., Mayer-Gürr,. T., Dill, R. (2020)**: Evaluating short-term hydro-meteorological fluxes with daily satellite data from the GRACE mission, *Scientific reports*, *10, 4505,* https://doi.org/10.1038/s41598-020-61166-0

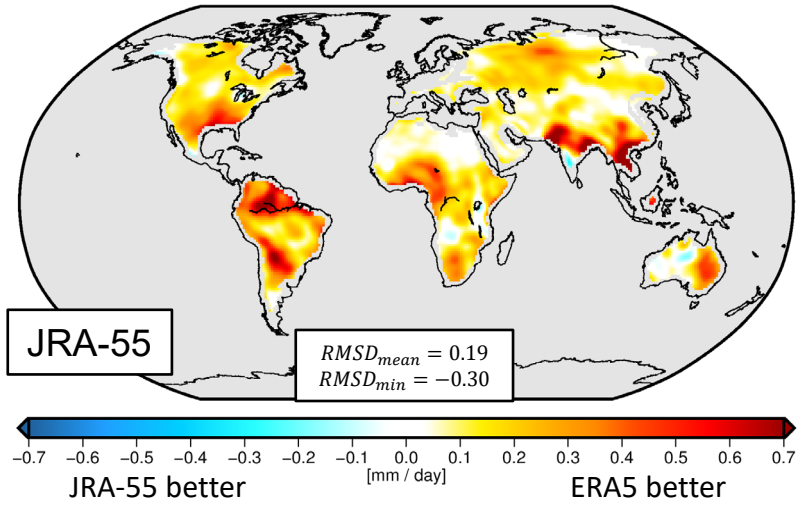
3| ERA5 vs. Reanalyses: RMSD relative to ERA5

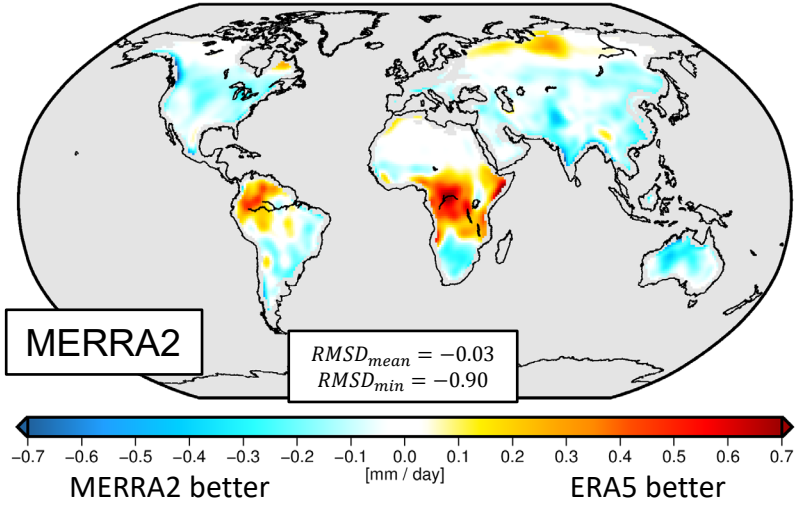


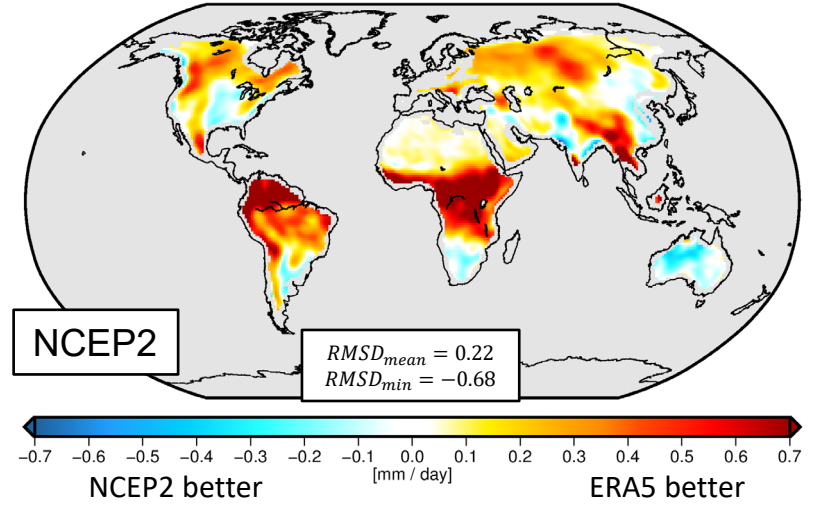
Reduced and increased RMSD of reanalyses vs. GRACE compared to ERA5 vs. GRACE

- ERA5 better in equatorial regions
- MERRA2 better in mid-latitudes

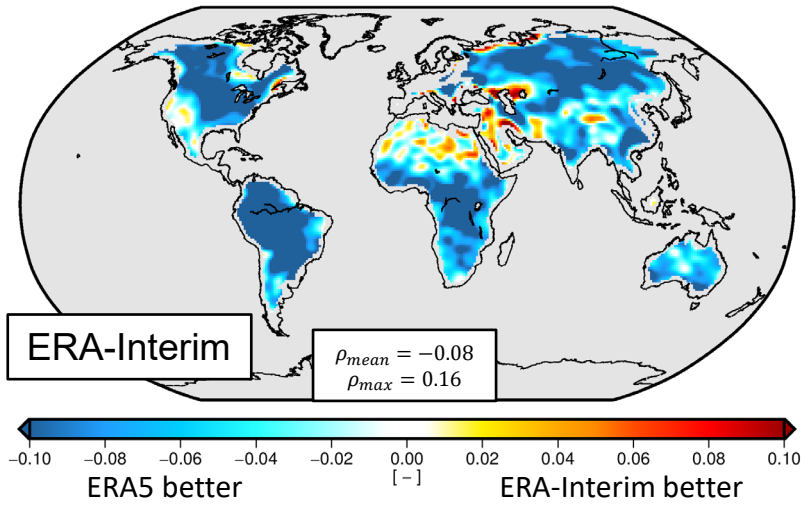






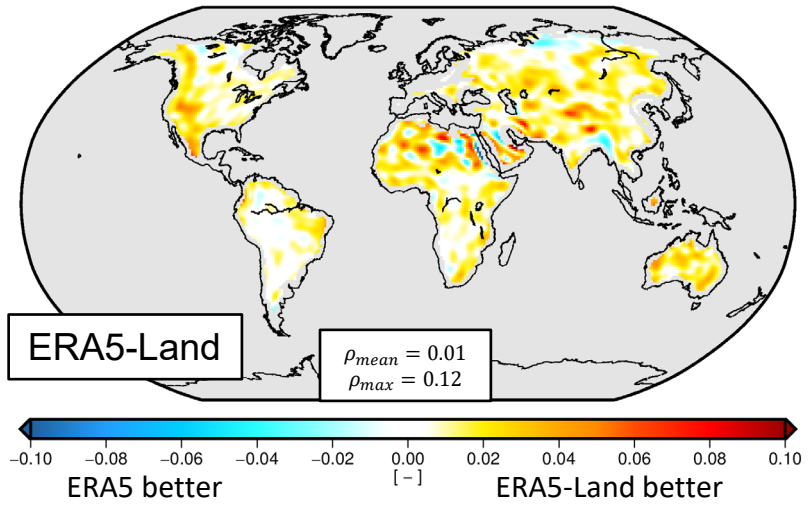


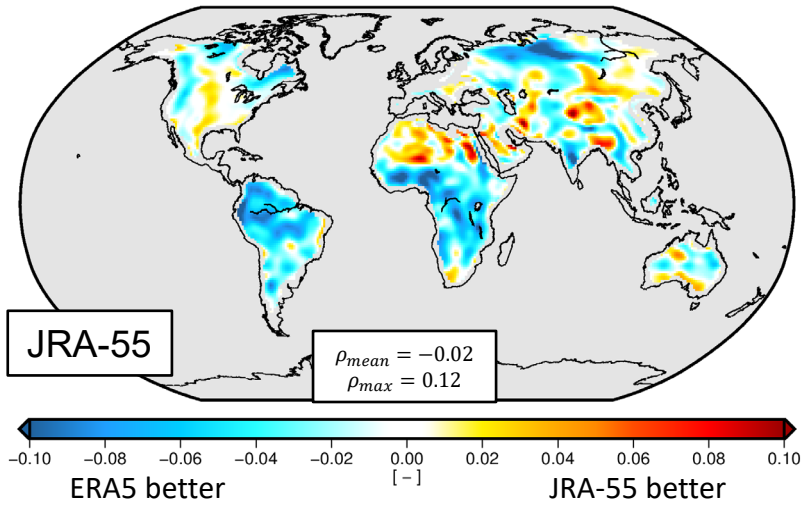
3| ERA5 vs. Reanalyses: Correlation relative to ERA5

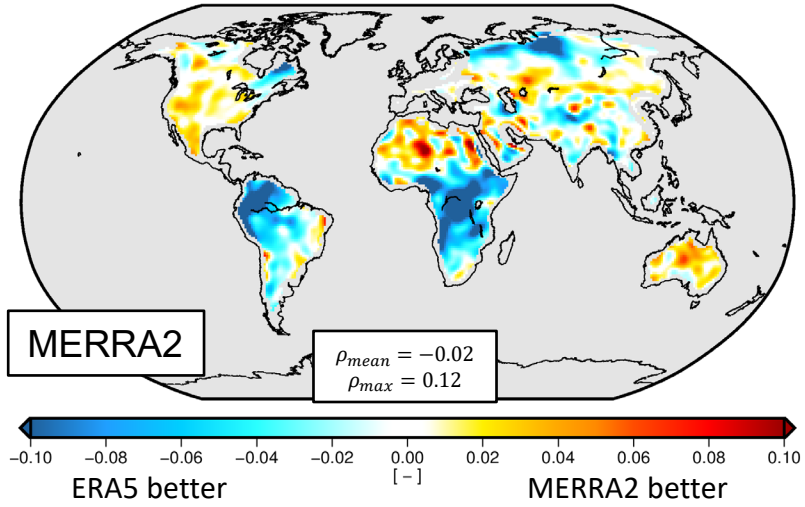


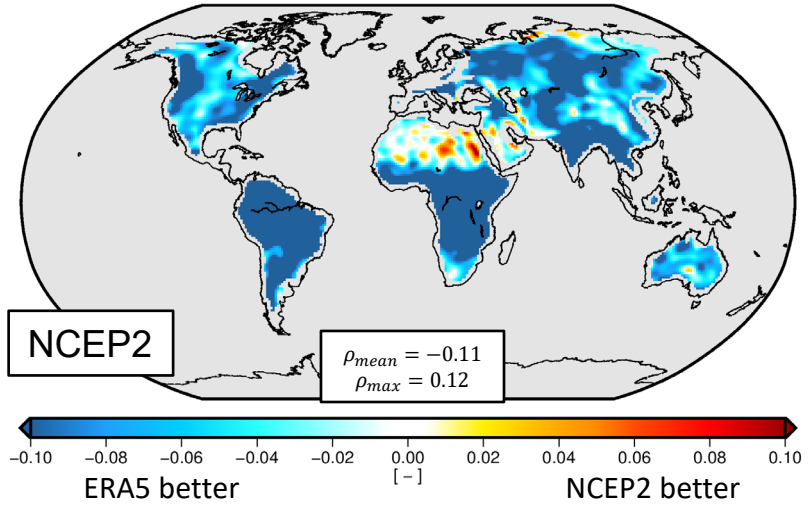
Improved and deteriorated correlation of reanalyses vs. GRACE compared to ERA5 vs. GRACE

- ERA5-Land: slightly higher correlation in most regions
- ERA5 better in equatorial regions
- MERRA2 and JRA-55 partly better in mid-latitudes









Summary

- GRACE can identify quality differences between the net flux deficit in different atmospheric reanalyses at sub-monthly time scales
- GRACE clearly shows a higher agreement (higher correlation and smaller RMSD) with ERA5 than with its predecessor ERA-Interim
- ERA5 shows better agreement with GRACE than the other reanalyses in large parts of continental areas, especially in equatorial regions. Even higher correlations for ERA5-Land
- MERRA2 and JRA-55 perform partly better than ERA5 in mid-latitudes