



Global Gravity-based Groundwater Product (G3P)

Title:

A global analysis of spatial correlation lengths
of water storage anomalies

Presenter:

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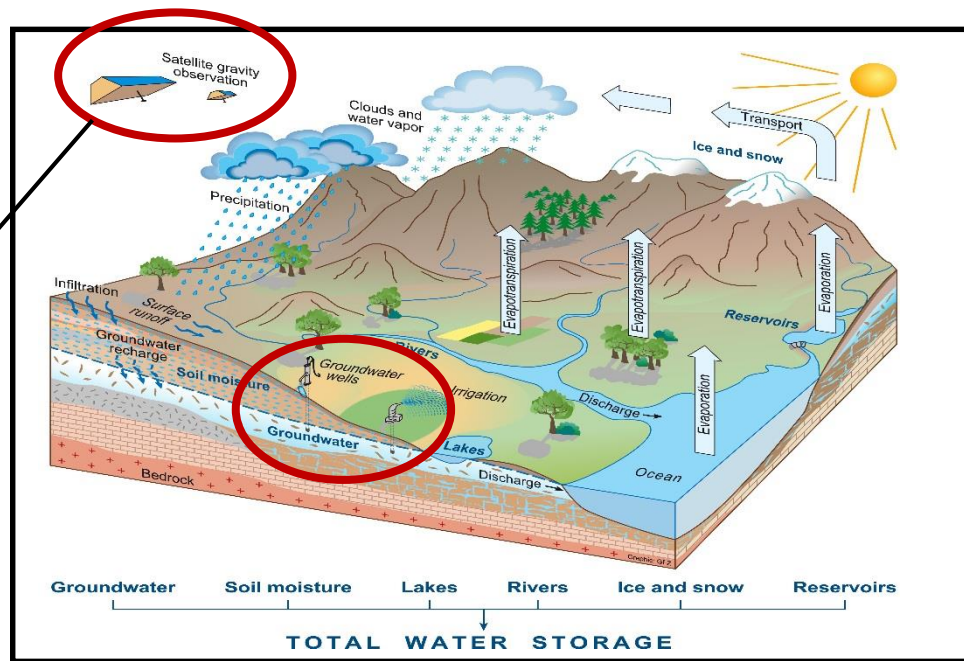
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G3P Concept

- Satellite gravimetry observes Total Water Storage (TWS) variations
- Resolving for groundwater storage variations the following subtraction approach:



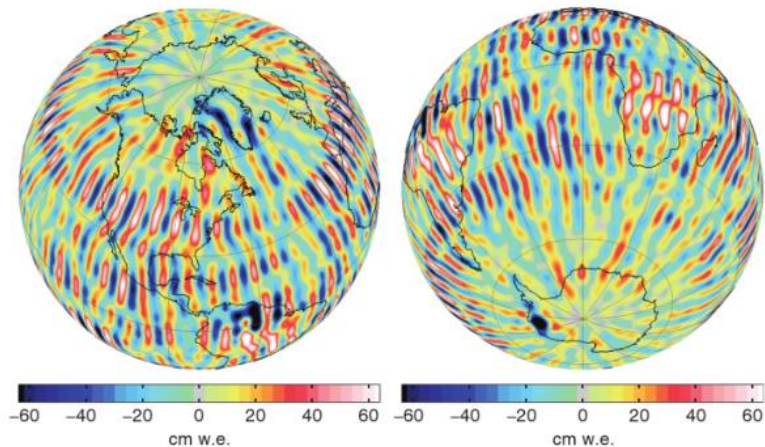
Groundwater = TWS - Glaciers - Snow - Soil Moisture - Storage in Surface Water Bodies

$$\begin{array}{ccccccccc}
 \text{G3P} & = & \text{Earth} & - & \text{Mountains} & - & \text{Snowflake} & - & \text{Plant} & - & \text{Landscape}
 \end{array}$$

GRACE/GRACE-FO data need to be filtered

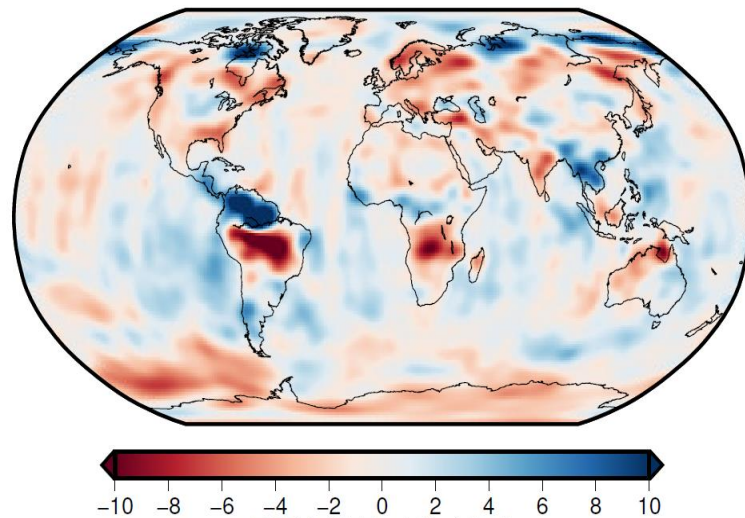
to remove noise and correlated errors (stripes)

before filtering



Mass anomaly of GRACE mass anomaly (March 2010)

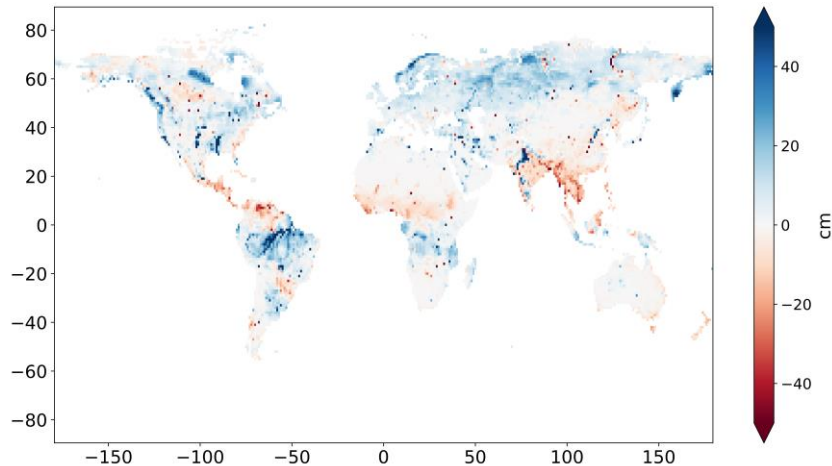
after filtering



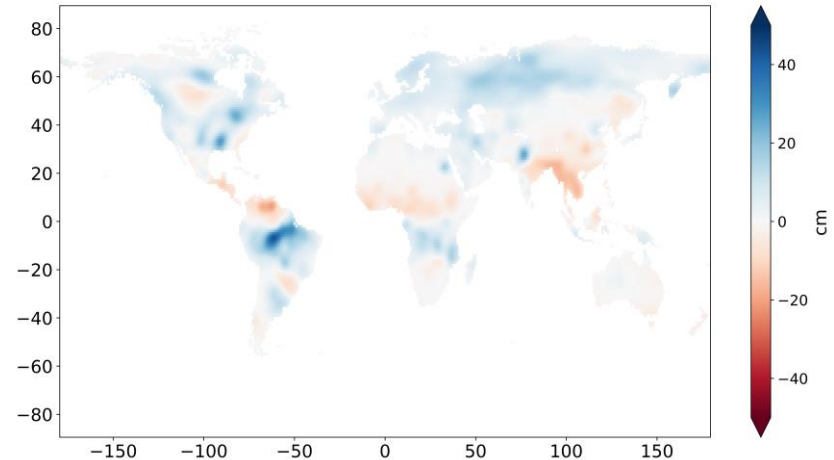
Total water storage anomaly from GRACE [cm]

How GRACE sees the water storage variations

TWS anomaly without filtering
(WGHM-based, 2002-04)



TWS anomaly with Gaussian filter
applied (250 km filter width)



We use data of global hydrological models for testing / method development, here WaterGAP Global Hydrology Model (WGHM)

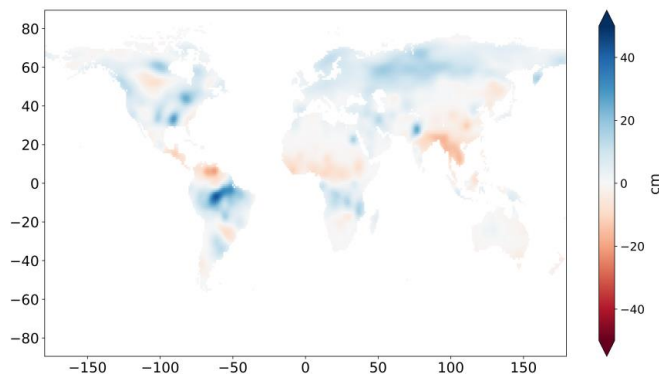
→ Water storage is spatially smoothed after filtering

Need for consistent combination in reduction process

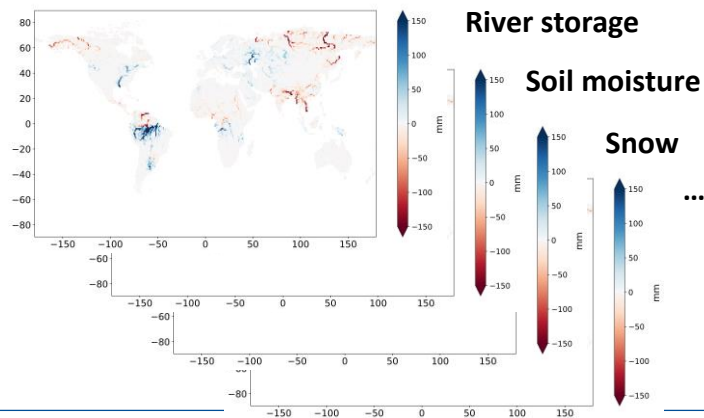
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Filtered TWS anomaly from
GRACE/GRACE-FO



Consistently filtered data set of each
storage compartment

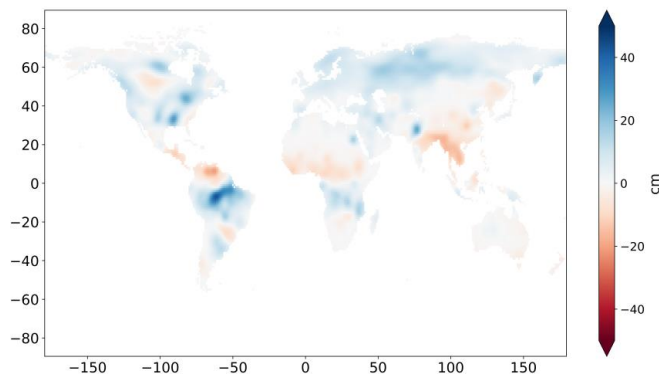


Need for consistent combination in reduction process

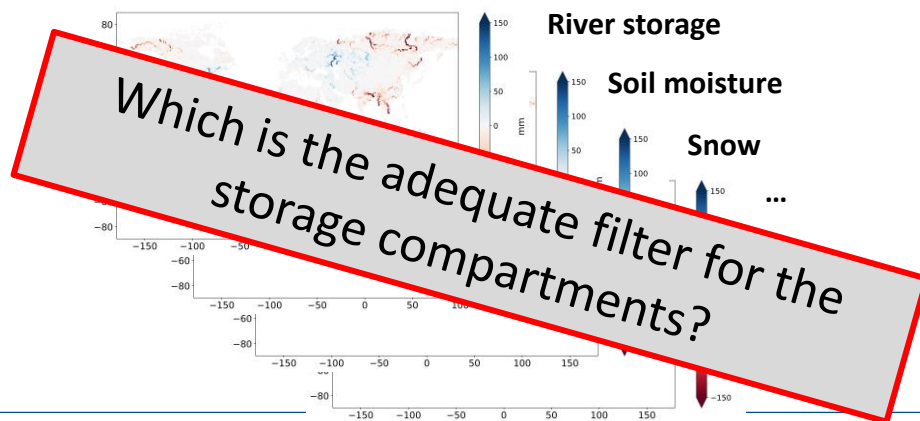
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Filtered TWS anomaly from
GRACE/GRACE-FO



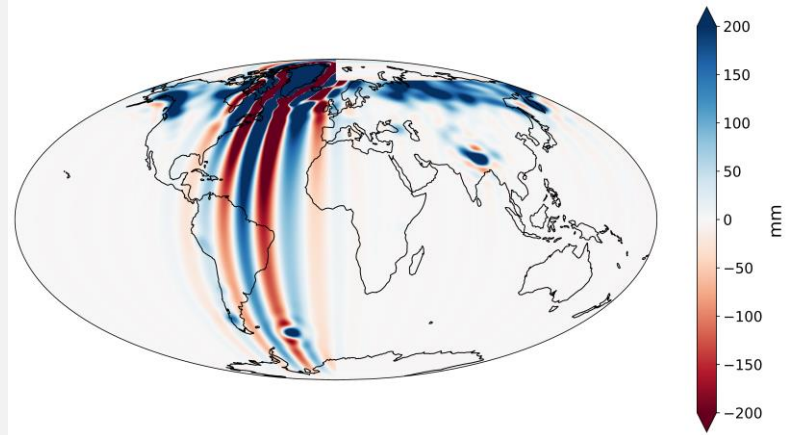
Consistently filtered data set of each
storage compartment



Consistent filtering of water storage compartments

Approach 1: Apply the filter that is used for GRACE / GRACE-FO data
(Anisotropic decorrelation filter DDK/VDK)

Example: Snow storage anomaly
(WGHM-based, 2002-04)
filtered with DDK filter



→ Artefacts in filtered data → **not a suitable method**

Consistent filtering of water storage compartments

Approach 2: Apply isotropic Gauss filter and adjust filter width/strength to GRACE-based TWS

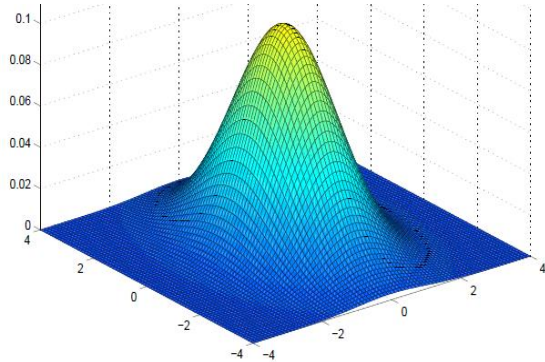
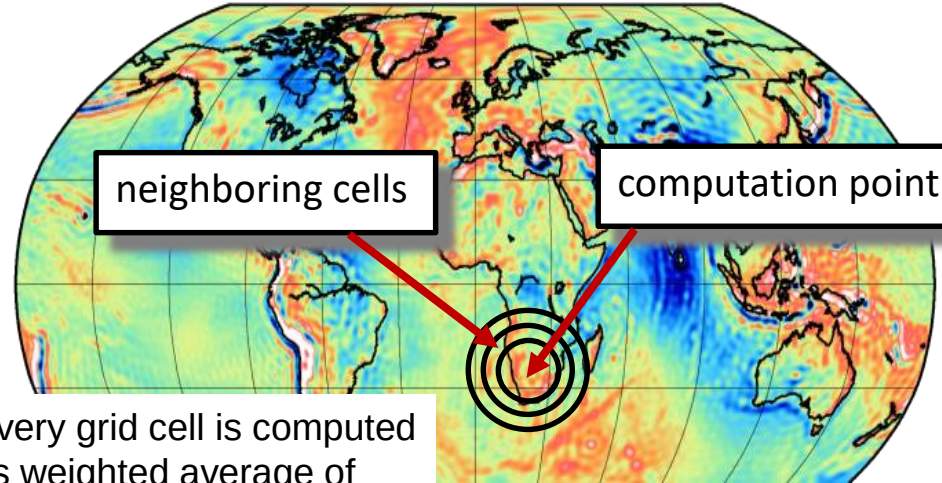
How to select the optimal filter width for each water storage compartment (WSC)?

- Applied the Gaussian filter with different widths (50 km to 650 km) for each WSC
- Investigated the empirical *spatial correlation function* for each WSC
- Select the best filter width for which the correlation function is closest to the TWS GRACE-based correlation function

Consistent filtering of water storage compartments

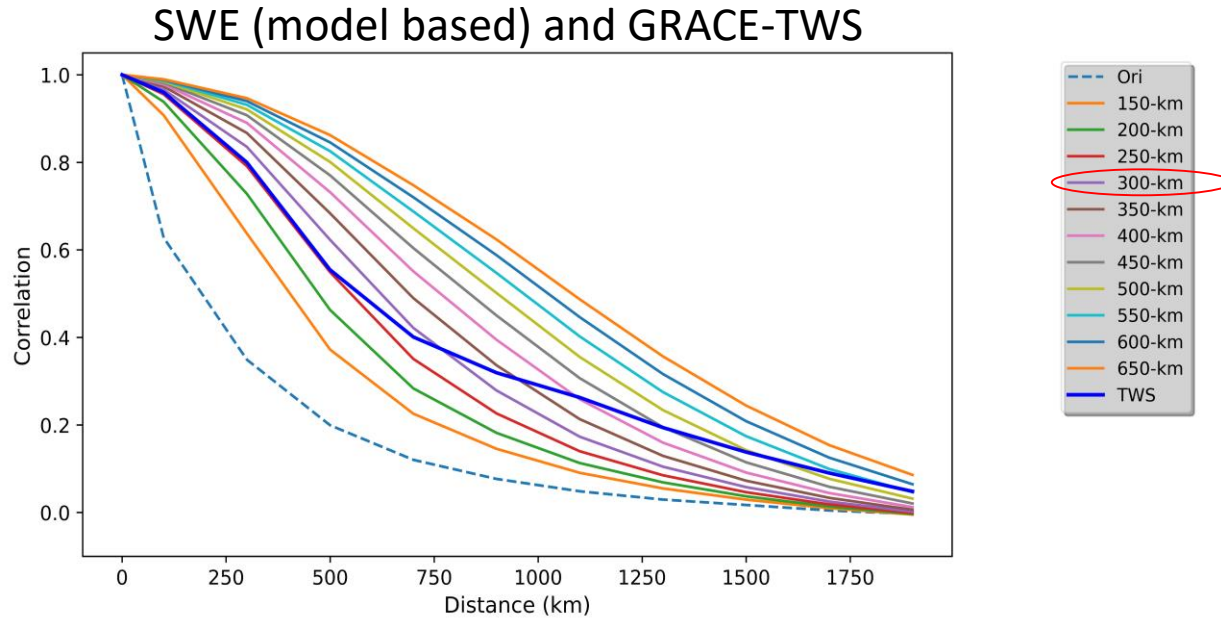
Approach 2: Apply isotropic Gauss filter and adjust filter width/strength to GRACE-based TWS

Gaussian filter



Spatial correlation functions - example

Approach 2: Apply isotropic Gauss filter and adjust filter width/strength to GRACE-based TWS



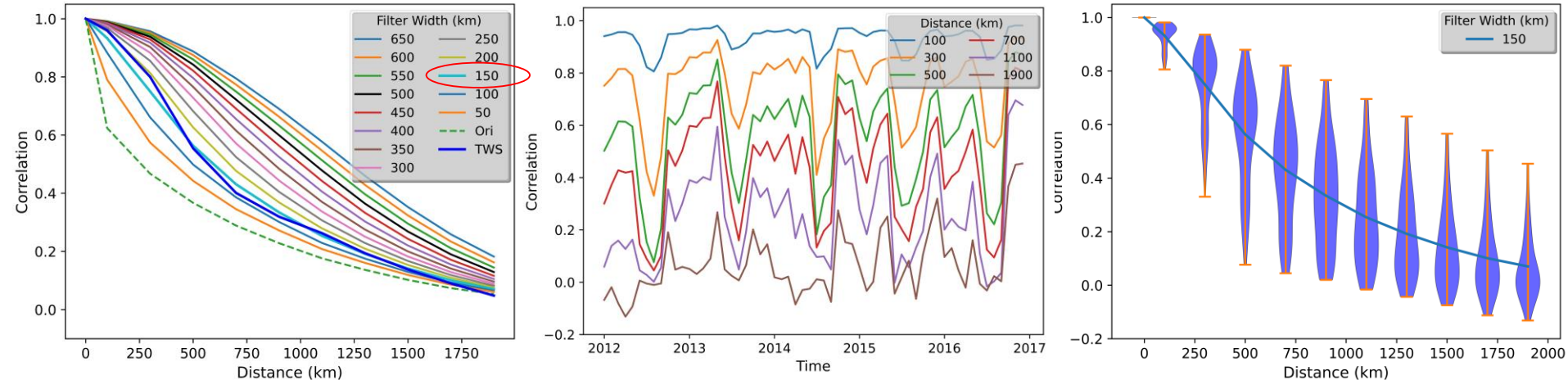
Consistent filtering of water storage compartments

Approach 2: Apply isotropic Gauss filter and adjust filter width/strength to GRACE-based TWS

Water Storage Compartment (anomaly)	Optimal Filter Width (km) for WGHM model
Snow Water Equivalent	300
Soil moisture	250
River storage	300
Lake	400

Consistent filtering of water storage compartments

Example: Apply isotropic Gauss filter and adjust filter width/strength to SWE data

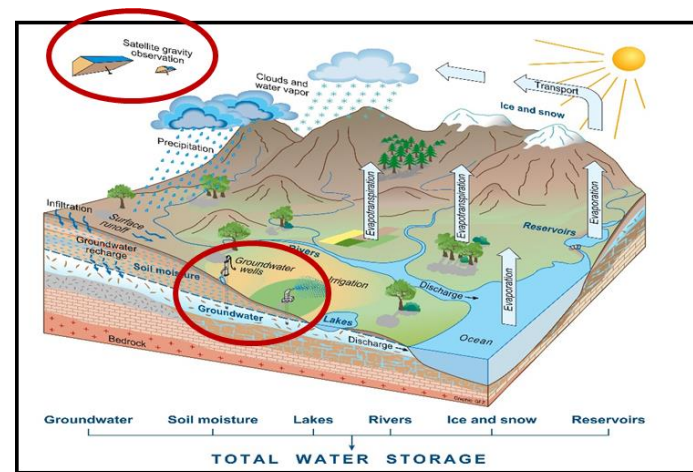


Spatial correlation functions vary in time

→ to be considered for filtering of the storage compartments?

Next steps

- First groundwater storage calculation from subtraction approach
- Water storage / water budget closure analysis



Groundwater = TWS - Glaciers - Snow - Soil Moisture - Storage in Surface Water Bodies



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