

ICCC Workshop 2023

Time series of Mass Trends for the Greenland Ice Sheet and Peripheral Glaciers

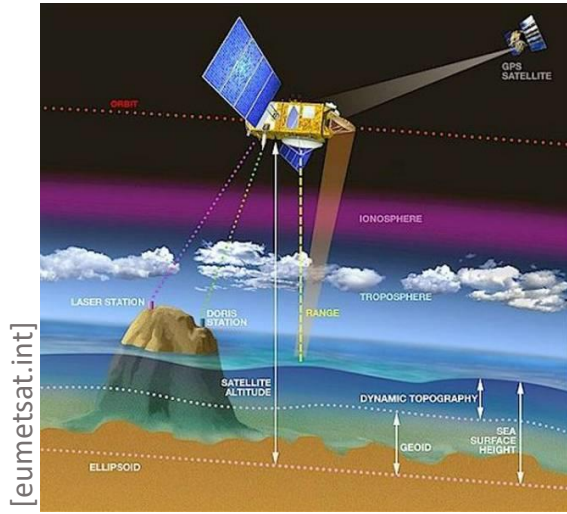
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IAPG



Geometric method

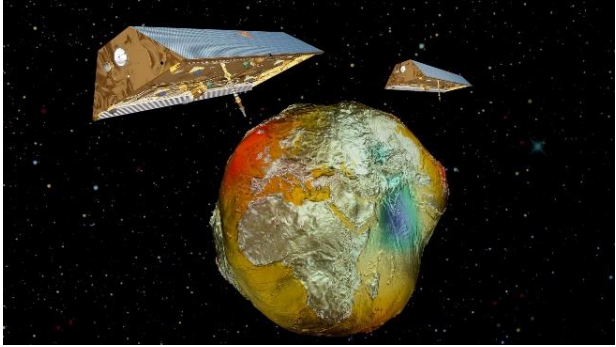
Fine spatial resolution

Mass depending on density model

Gravimetric method

Direct conclusions about mass

Low spatial resolution



[www.dlr.de]

Volume trend

Ice density

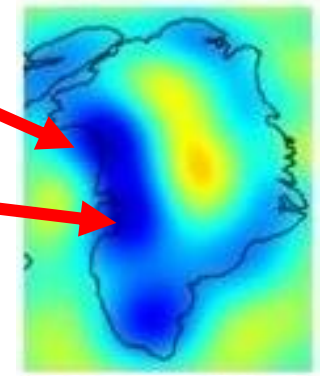
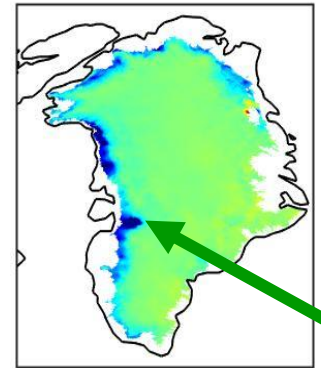
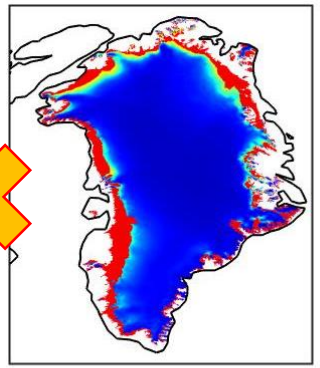
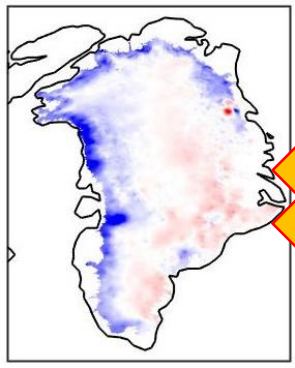
Mass trend

Mass trend

2007 - 2011

2007 - 2011

2007 - 2011



Leakage effect

Low-pass filtering

Localization of small-scale features

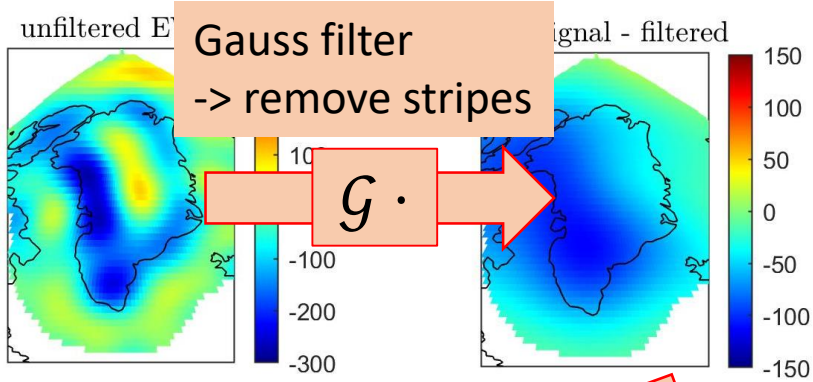
$\dot{h} [m/a]$

$\rho [kg/m^3]$

[Kappelsberger et al., 2021]

$\dot{\sigma} [kg/m^2/a]$

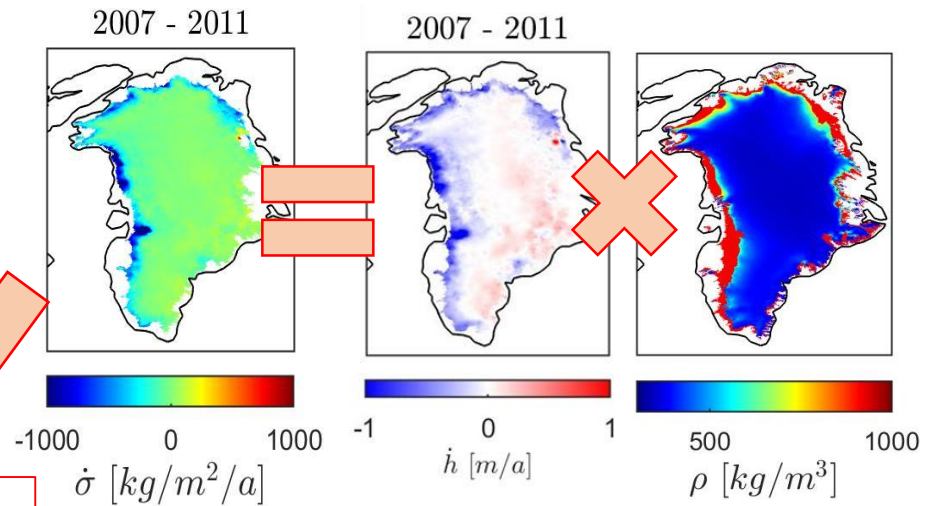
$\dot{\sigma} [kg/m^2/a]$



EWH trends computed from GRACE GFs: $\Delta\dot{\sigma}$

A priori distribution

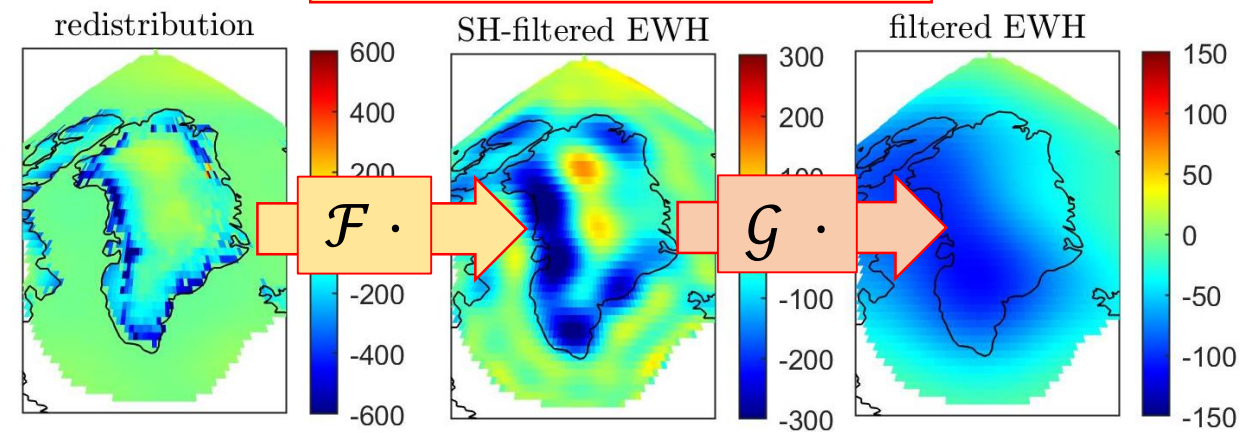
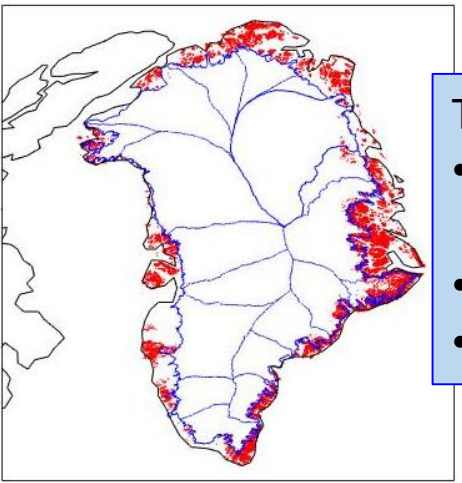
$$\hat{\sigma}_{GIS} = \hat{\sigma}_{GIS}^{(0)} + \Delta\hat{\sigma}_{GIS}$$



$$\mathcal{G}_\delta \cdot \Delta\dot{\sigma} + \hat{v} = \mathcal{G}_\delta \cdot \mathcal{F} \cdot \begin{pmatrix} \Delta\hat{\sigma}_{GIS} \\ \Delta\hat{\sigma}_L \\ \Delta\hat{\sigma}_S \end{pmatrix}$$

- Tikhonov parameters:
- α_{GIS} (where geometric info available)
 - α_L (land surface)
 - α_S (se surface)

Spherical harmonic filter truncates signal at degree 60

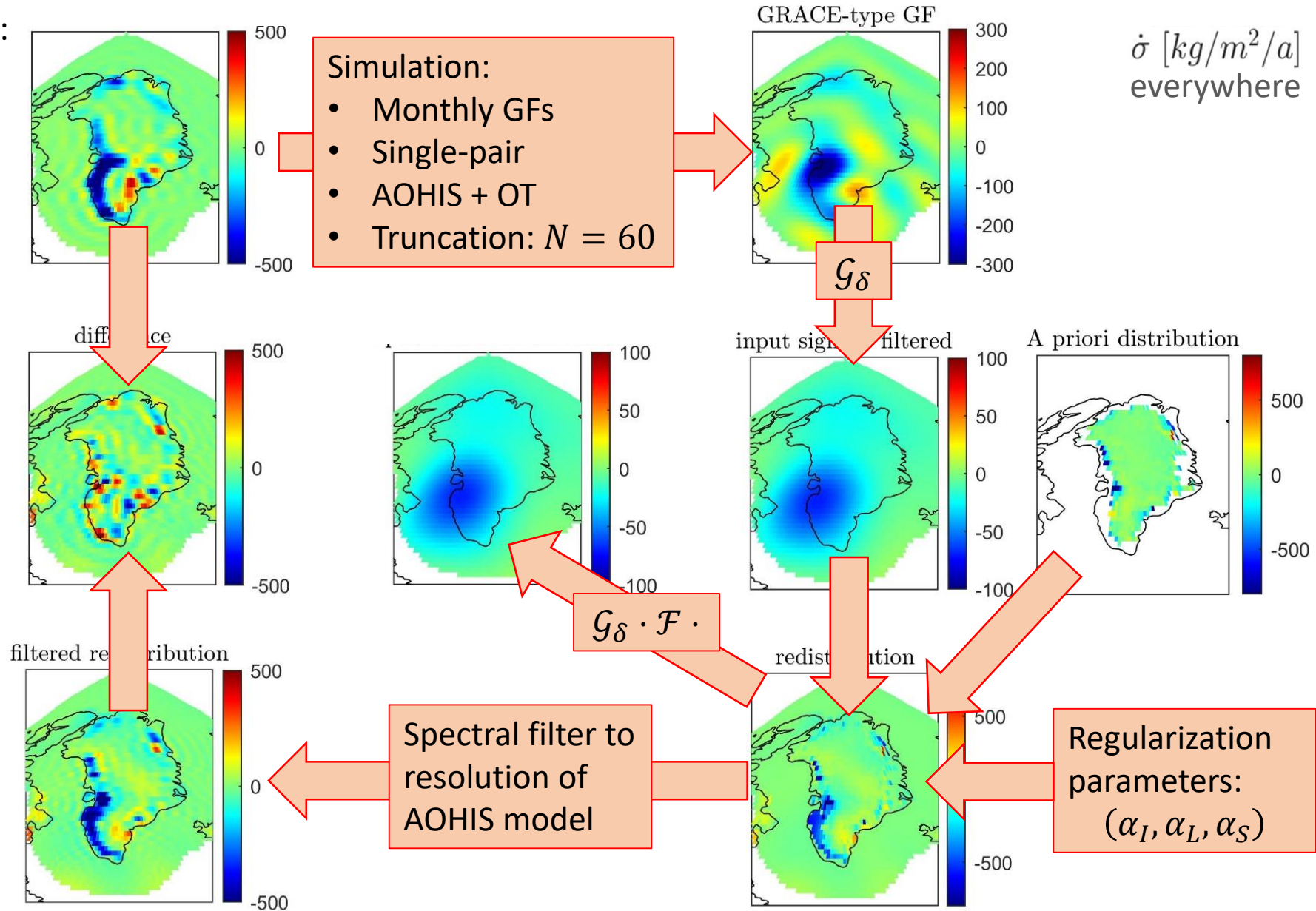


Functional model of redistribution:

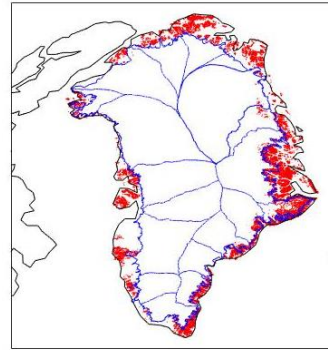
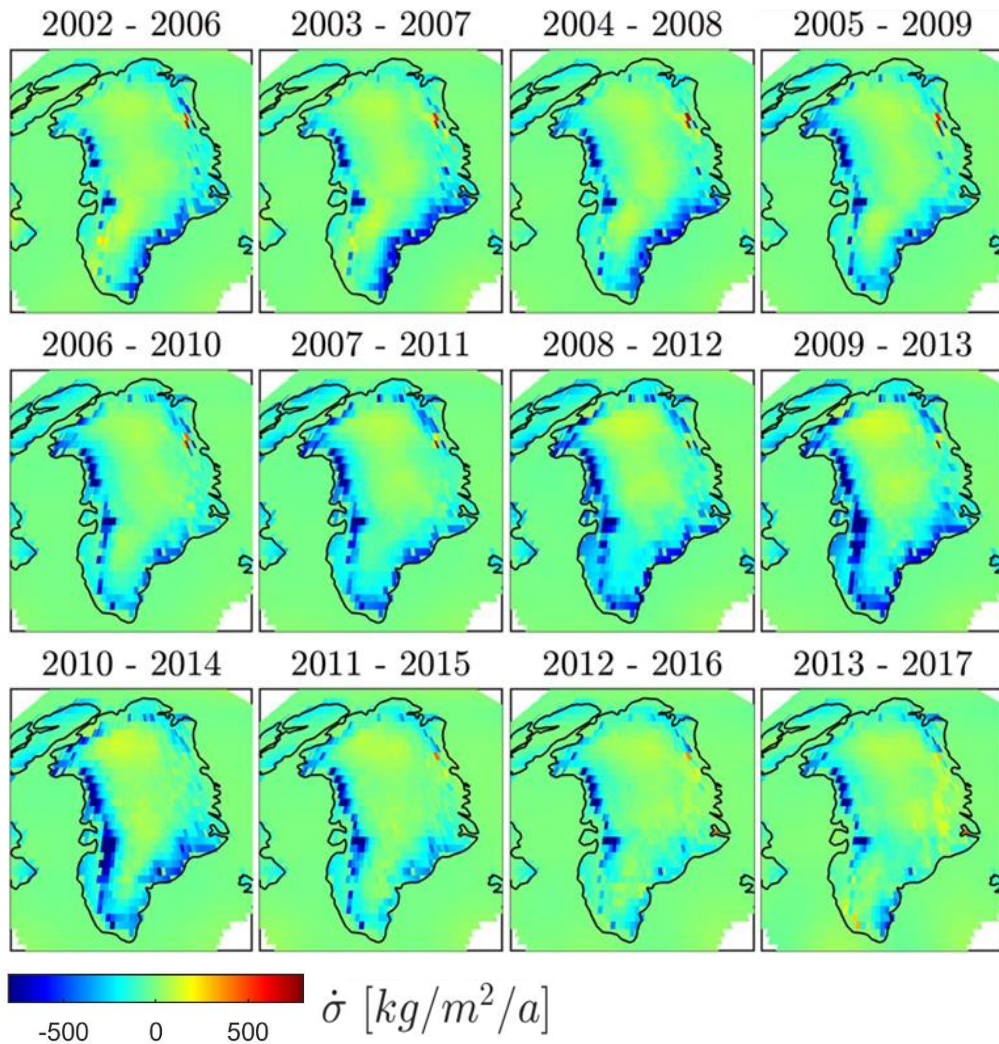
$$\mathcal{G}_\delta \cdot \Delta\dot{\sigma} + \hat{v} = \mathcal{G}_\delta \cdot \mathcal{F} \cdot \begin{pmatrix} \Delta\hat{\sigma}_{GIS} \\ \Delta\hat{\sigma}_L \\ \Delta\hat{\sigma}_O \end{pmatrix}$$

⇒ 4 parameters: $(\alpha_I, \alpha_L, \alpha_S, \delta)$

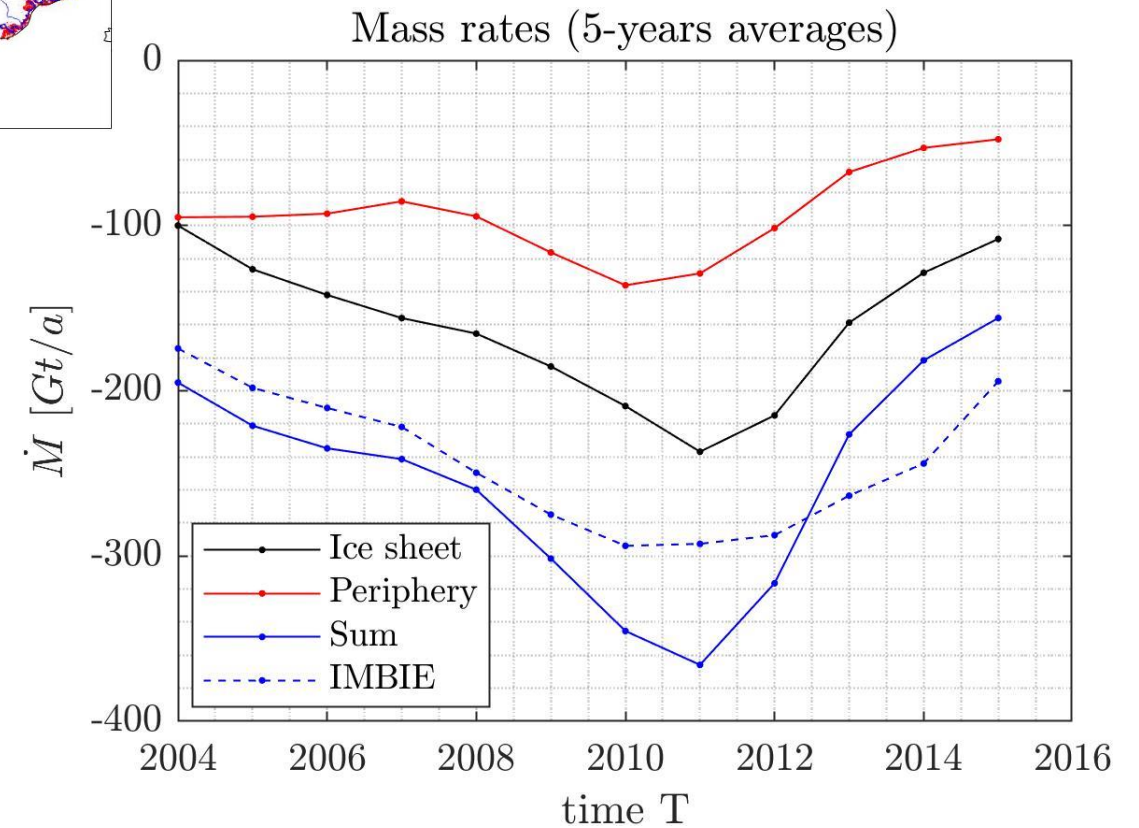
Idea: Computation of RMSE with respect to simulated truth with ESM [Dobslaw et al., 2015]



Time series of mass trends across Greenland and the surrounding region



One should make a strict difference between ice sheet and peripheral glaciers!



Conclusions and Outlook

Conclusions:

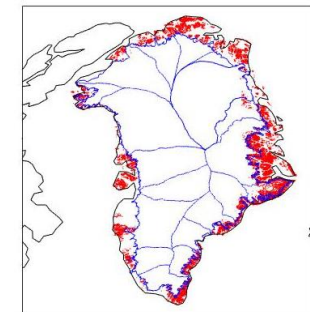
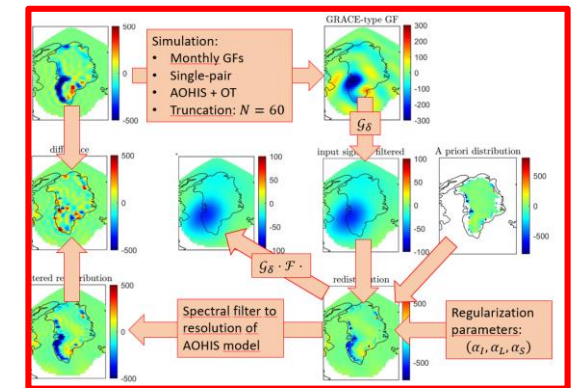
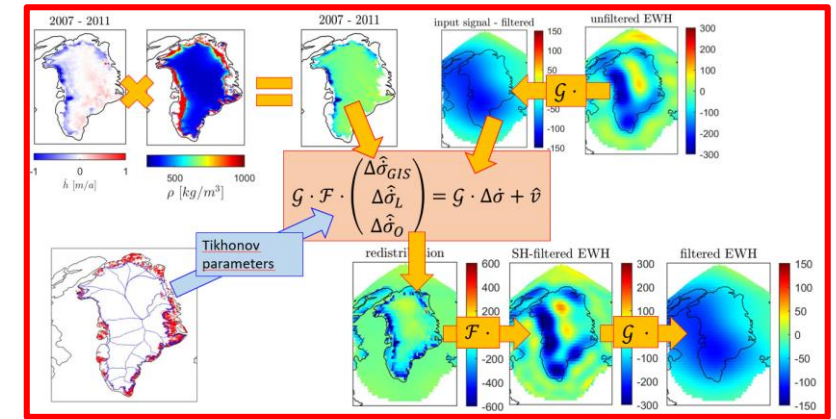
- **Localization** of mass changes with **geometric information**
- Estimation of the mass changes' **amplitudes** based on **gravimetric information**
- **Separation of GIS and peripheral glaciers** is possible

Verification of our Procedure:

- Synthetic closed-loop determination of **regularization parameters**
- Reasonable treatment of **leakage effect**

Outlook:

- Application of the procedure to **further regions**
- Introduction of **geometric information on the peripheral glaciers** would be worthwhile
- Test on **SLR-based** time series of gravity fields



References

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