

GRACE gravity field reprocessing at IGG Bonn

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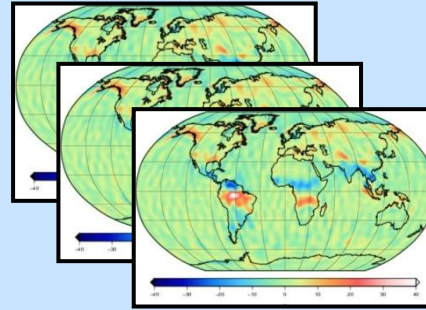
Annette Eicker, Enrico Kurtenbach, Torsten Mayer-Gürr, Akbar Shabanloui, Jürgen Kusche

University of Bonn

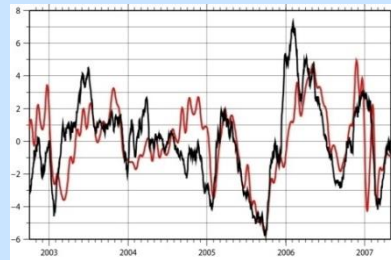
Abschlussseminar “Weltraum Phase III”
Potsdam, 24. Mai 2012

Global gravity field models (ITG-Grace2010)

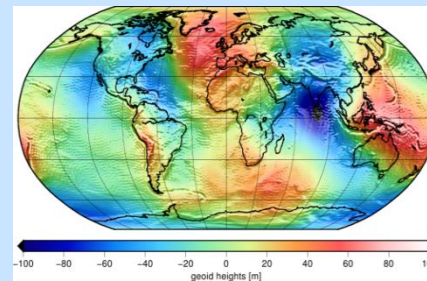
Daily time series



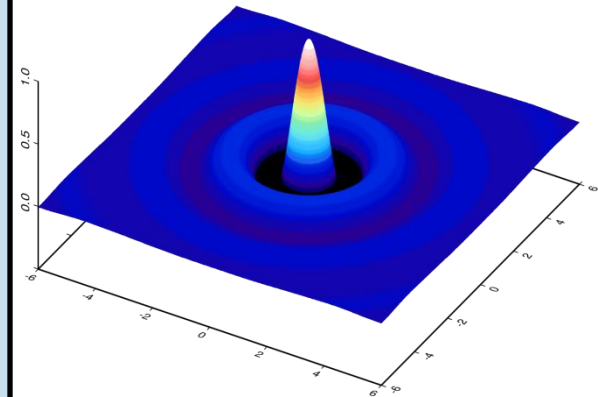
Monthly solutions



Static model



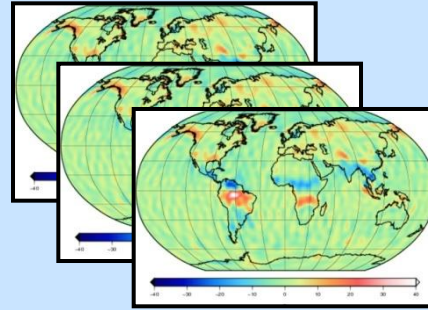
Regional approach



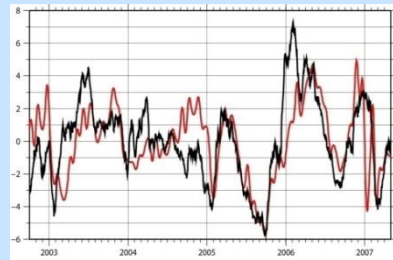
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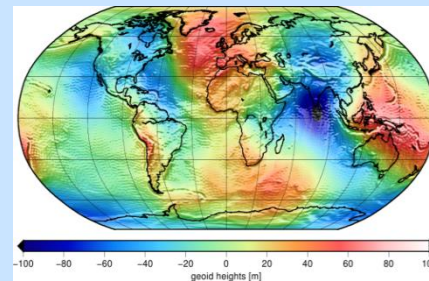
- GRACE Kalman filter approach
- external validation has confirmed physically meaningful signal content



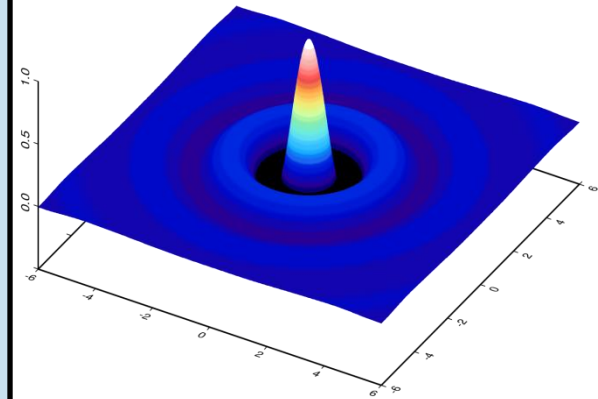
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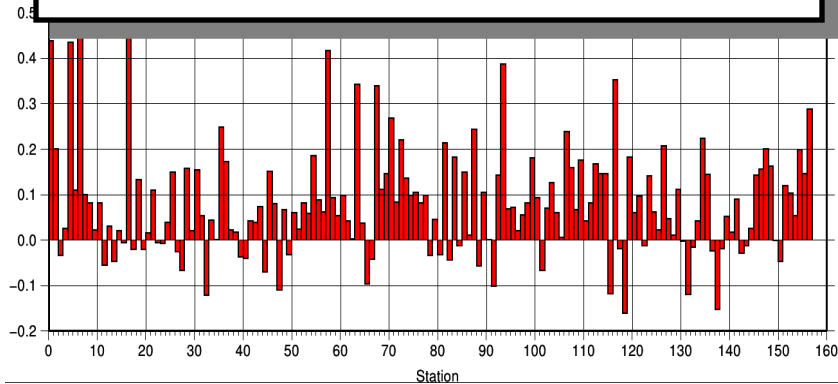


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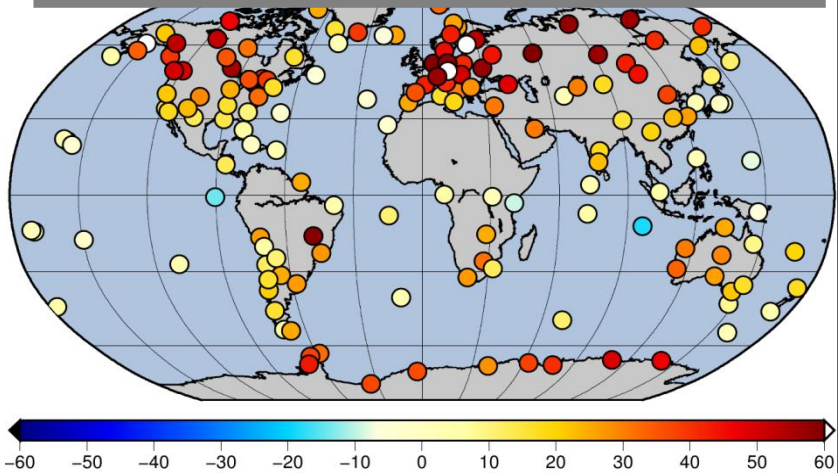


GPS height displacements

Improvement of correlation coefficient



Signal reduction [percent]

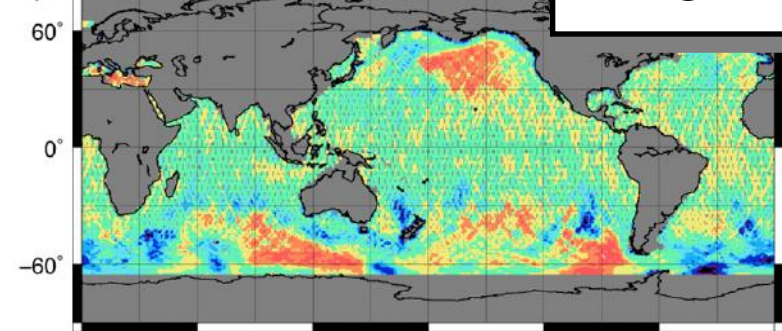


Kurtenbach (2011)

Altimetry

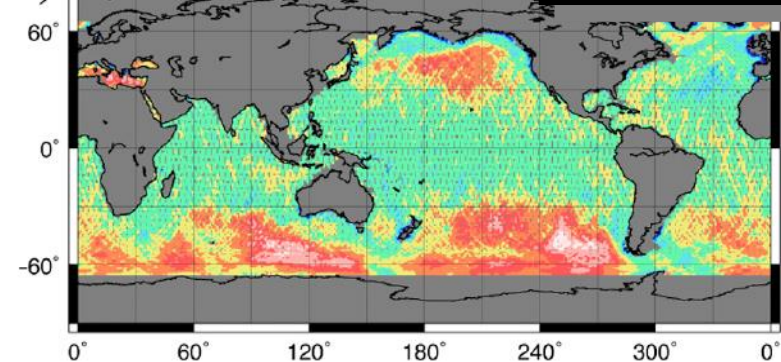
a)

AOD



b)

GRACE

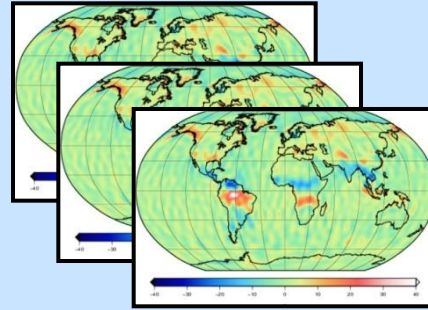


Bonin and Chambers (2011)

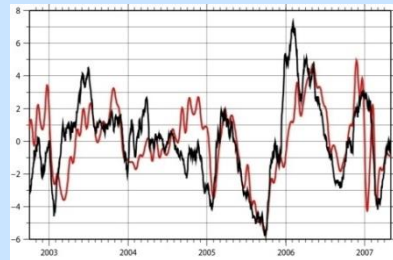
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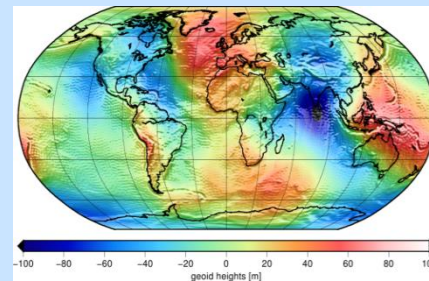
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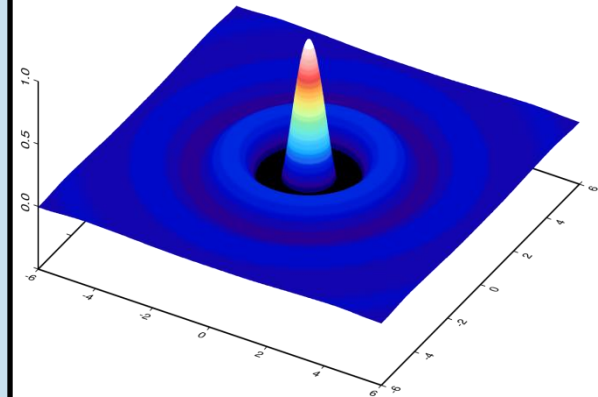
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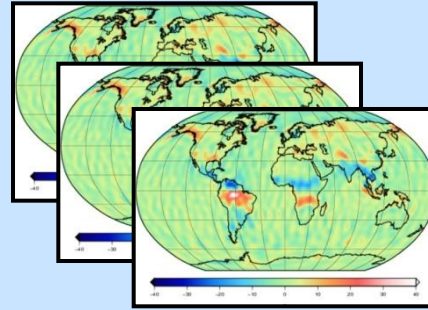
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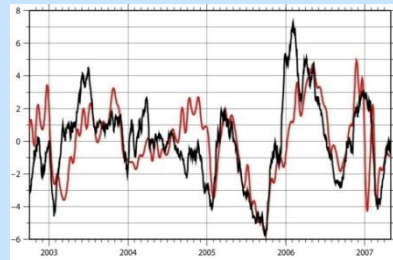
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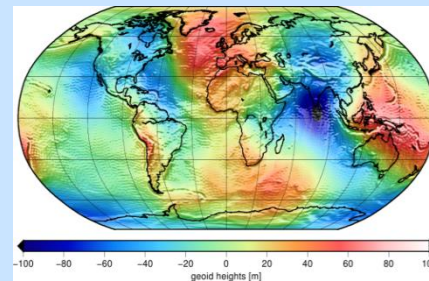


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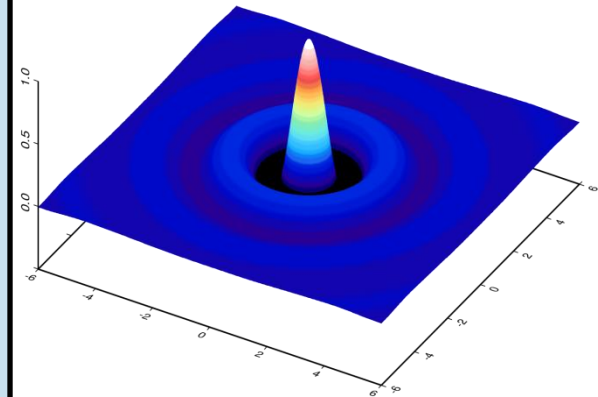
- improved de-aliasing using daily solutions
- widely used for geophysical applications



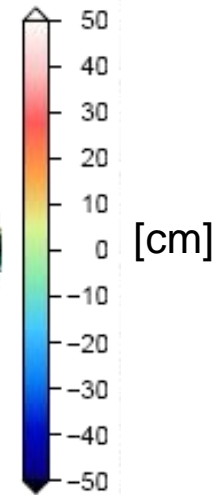
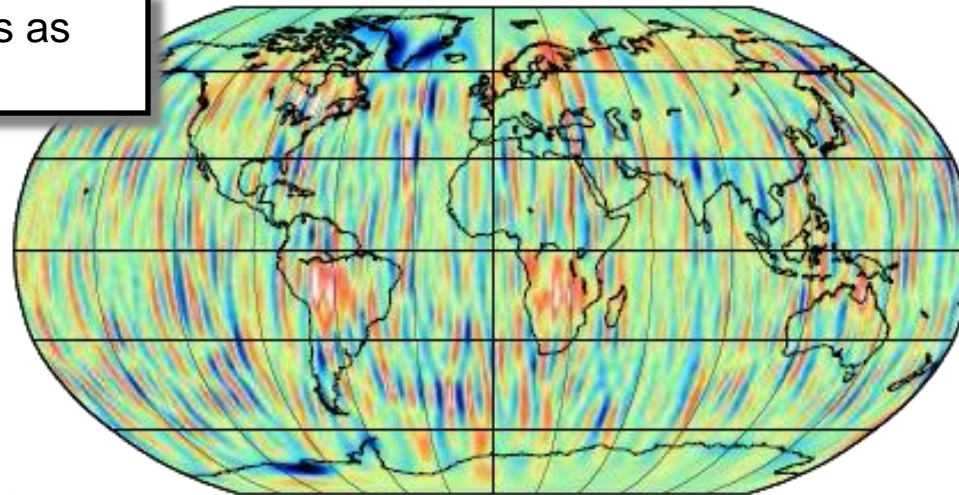
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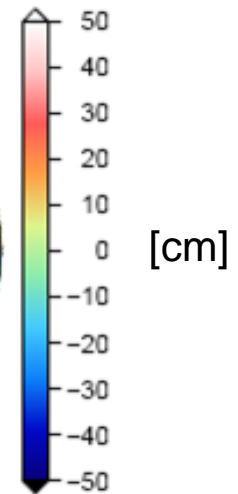
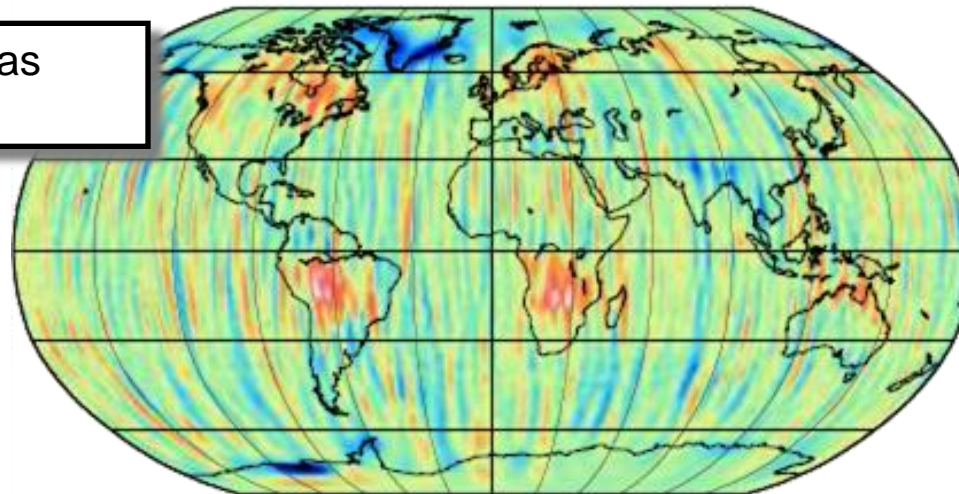
Regional approach



Without daily solutions as de-aliasing



With daily solutions as de-aliasing

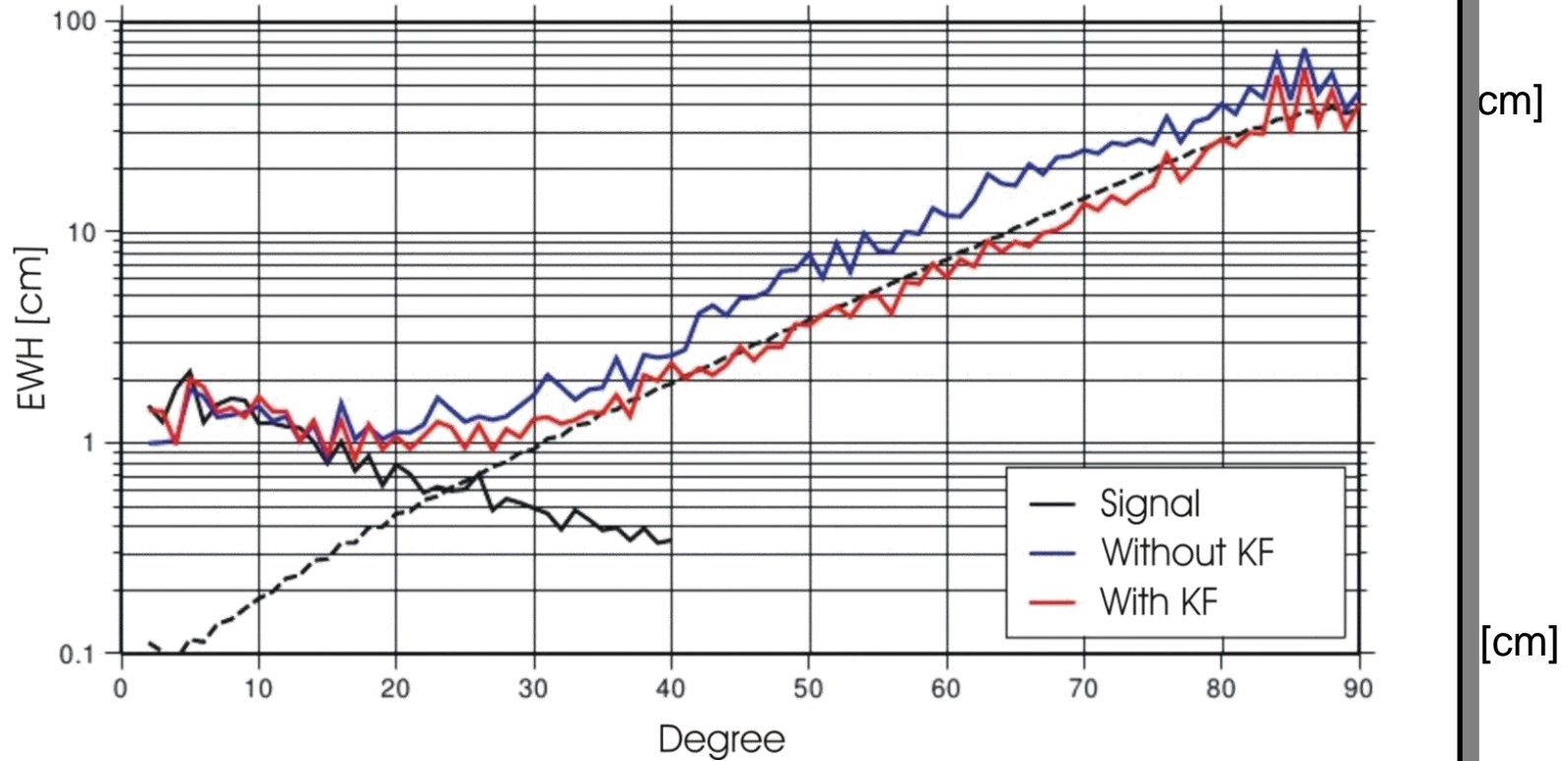


monthly solution 2008 - 02

water heights

Without daily solutions as

Differences between monthly (2008-02) and static model



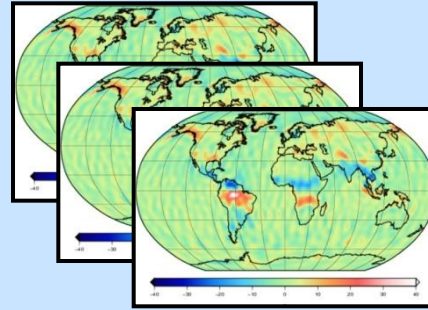
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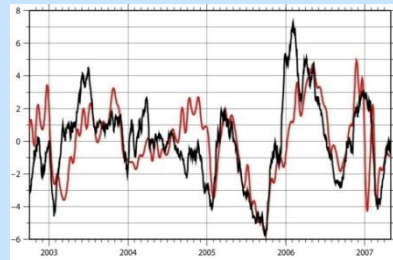
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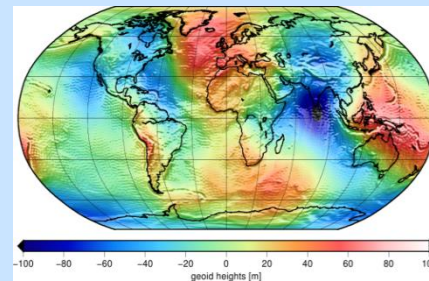


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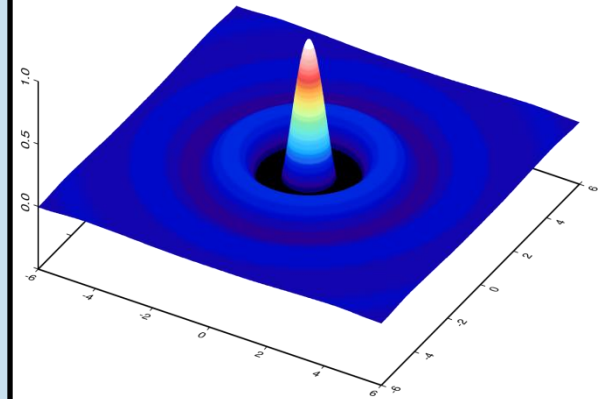
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Static model



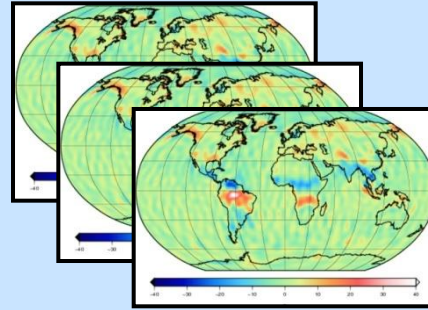
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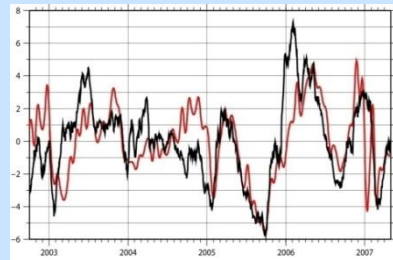
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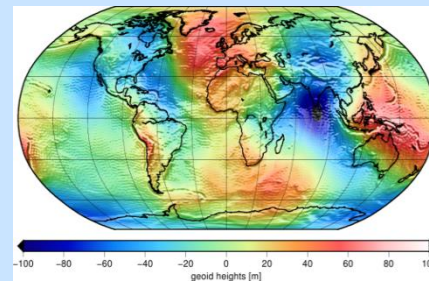
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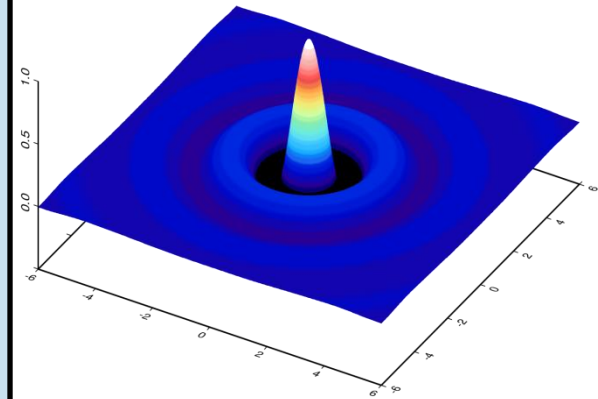


Static model

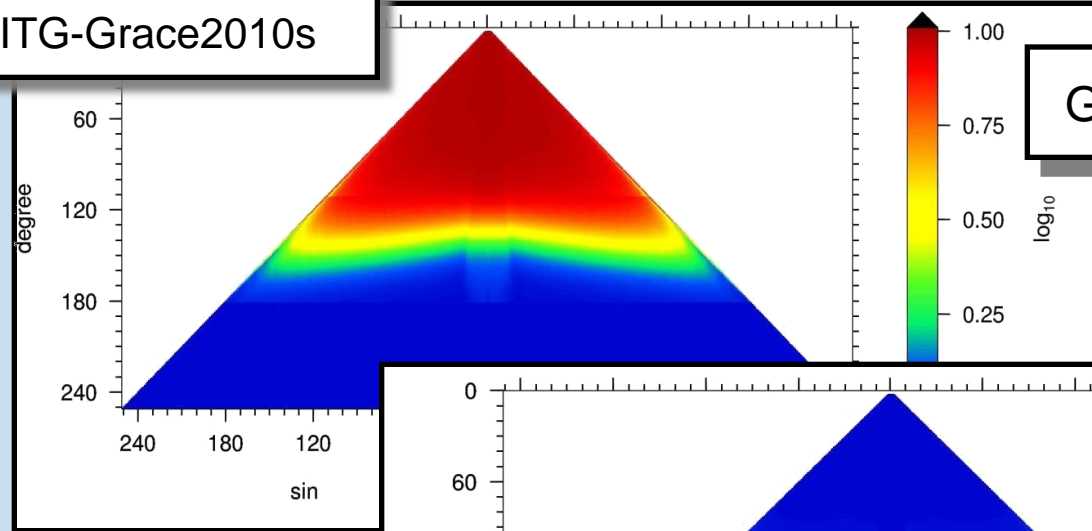
- ITG-Grace2010s
- GOCE reference model
- GOCE combination GOCO02s



Regional approach

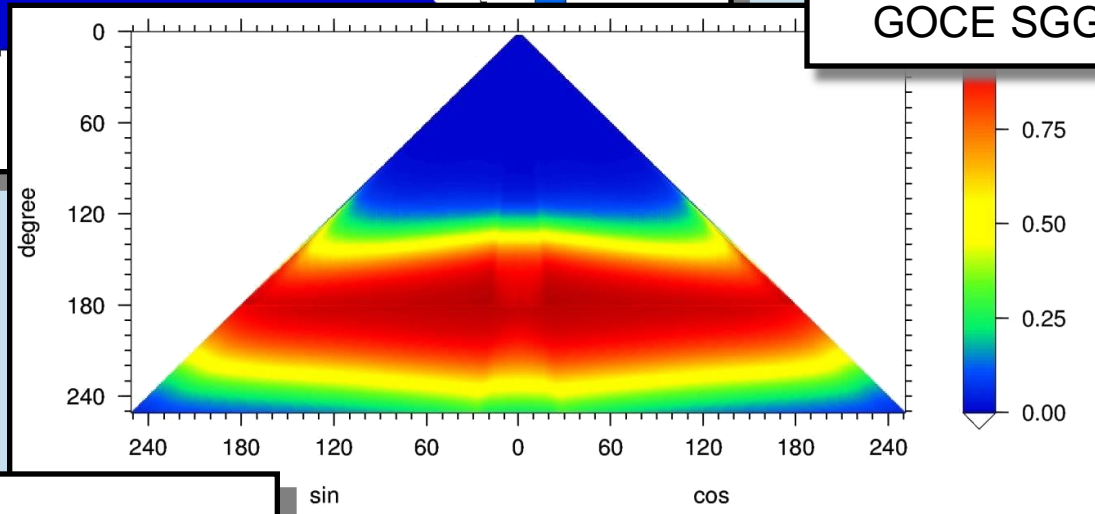


ITG-Grace2010s



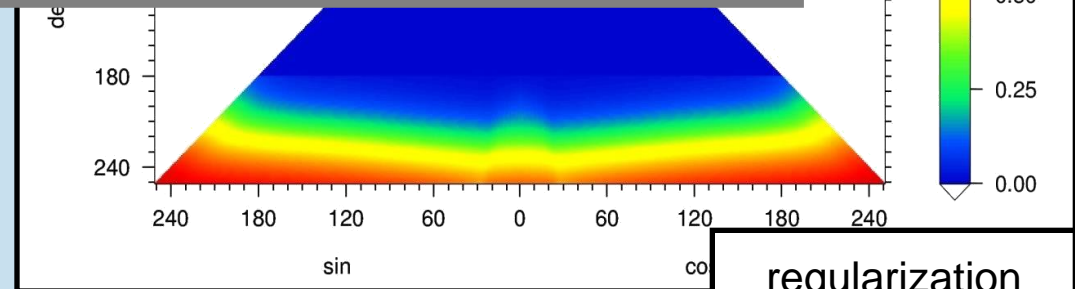
GRACE dominant up to $n=120$

GOCE SGG



GOCO02s:

- Combination of consistent normal equation systems
- optimal weighting by variance component estimation

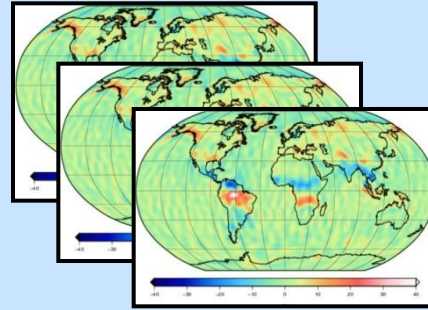


regularization

Global gravity field models (ITG-Grace2010)

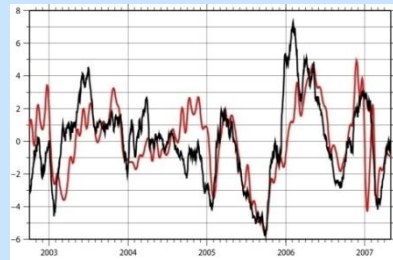
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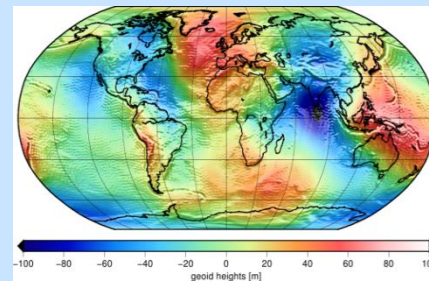
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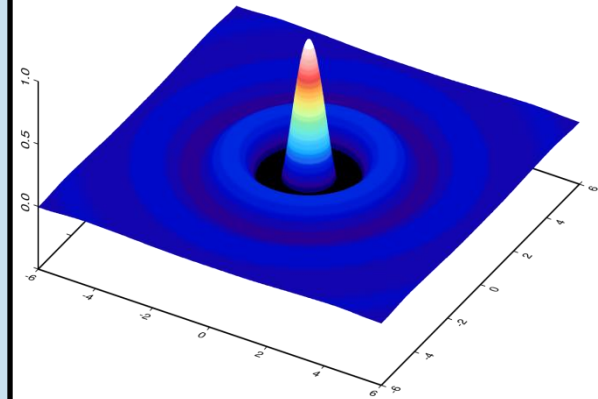


Static model

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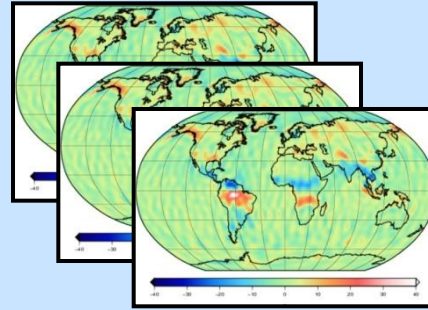
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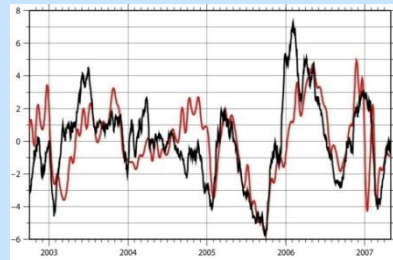
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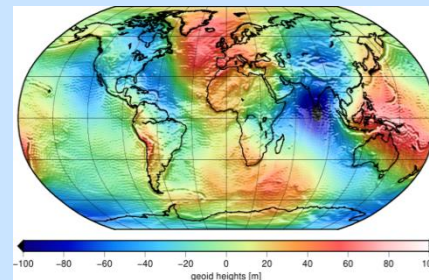
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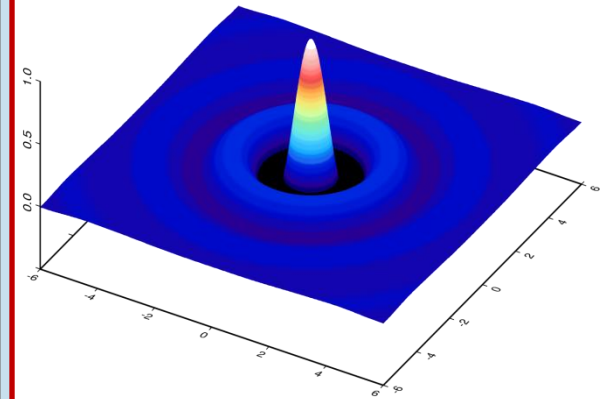


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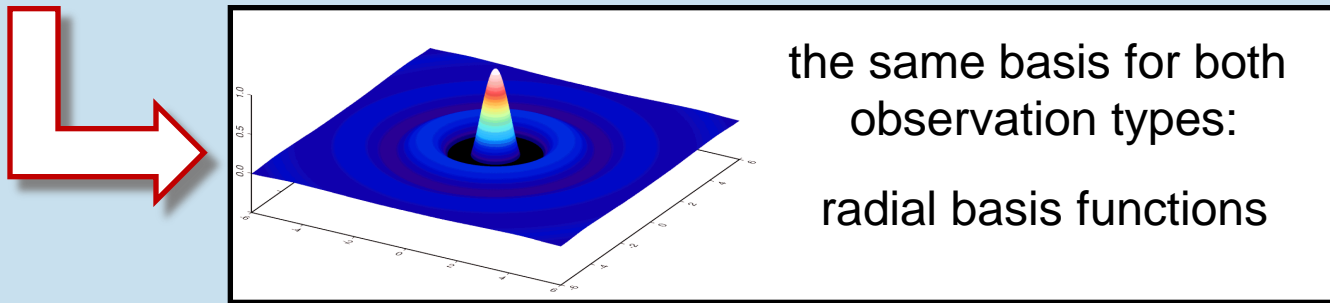
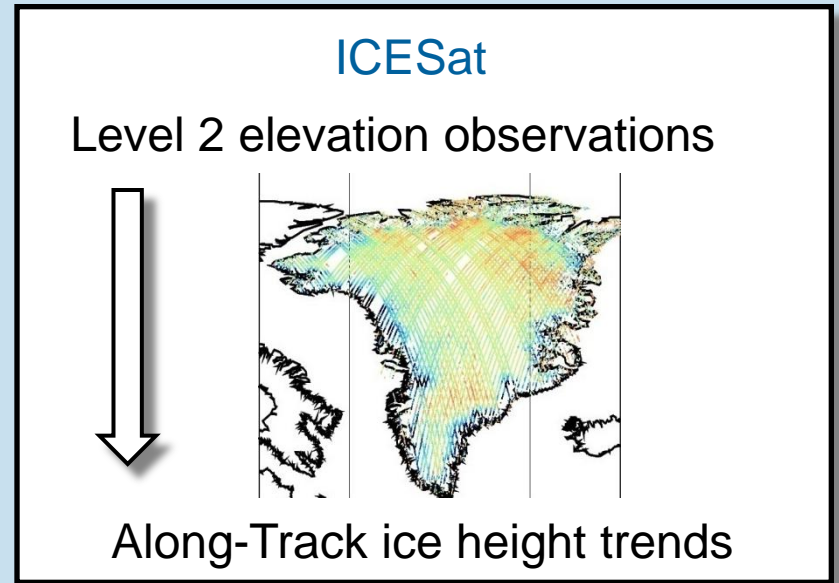
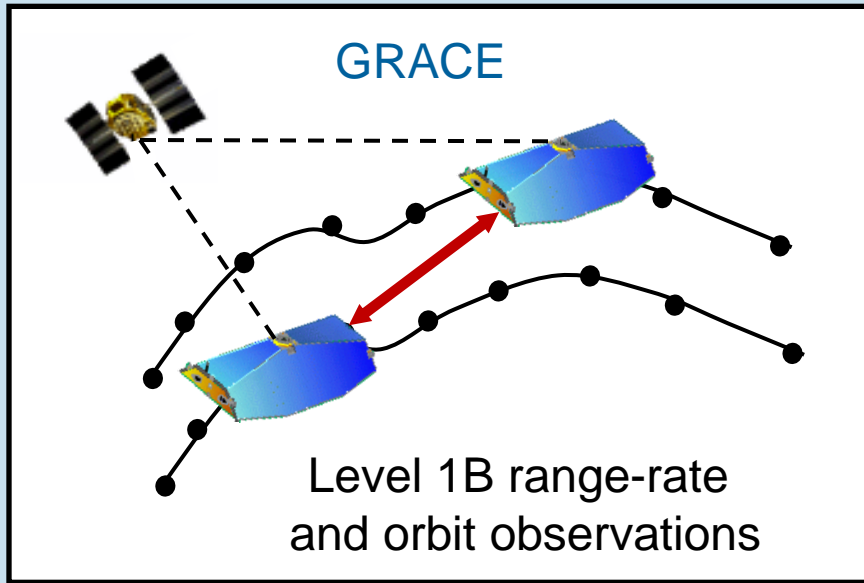
Regional approach



- space localizing radial basis functions
- tailored to investigation of specific regional phenomena

Examples:

- hydrology in Siberian river basins
- ice mass trend in Greenland

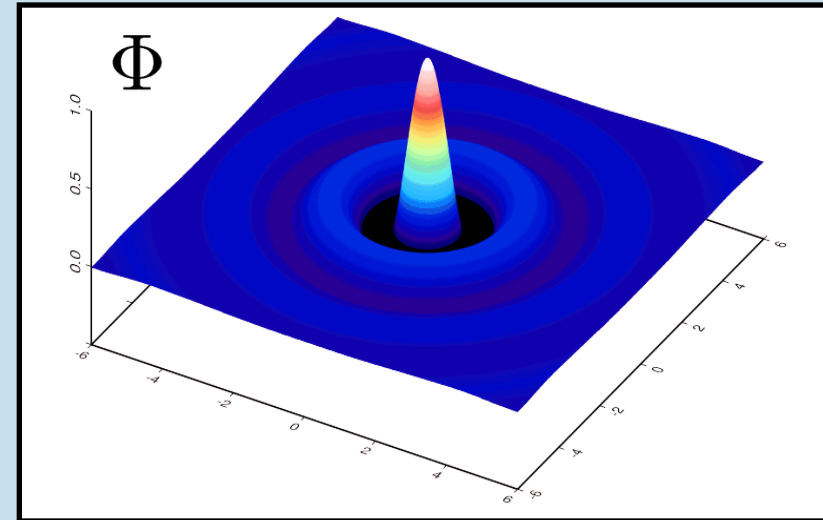


Estimation of trends

gravity field signal

$$s(\mathbf{x}) = \sum_{i=1}^I a_i \Phi(\mathbf{x}, \mathbf{x}_i)$$

unknown
parameters



radial basis functions (spherical splines)

$$\Phi(\mathbf{x}, \mathbf{x}_i) = \sum_{n=2}^{\infty} \sum_{m=-n}^n k_n Y_{nm}(\mathbf{x}) Y_{nm}(\mathbf{x}_i)$$

shape coefficients spherical harmonics

choice of the coefficients

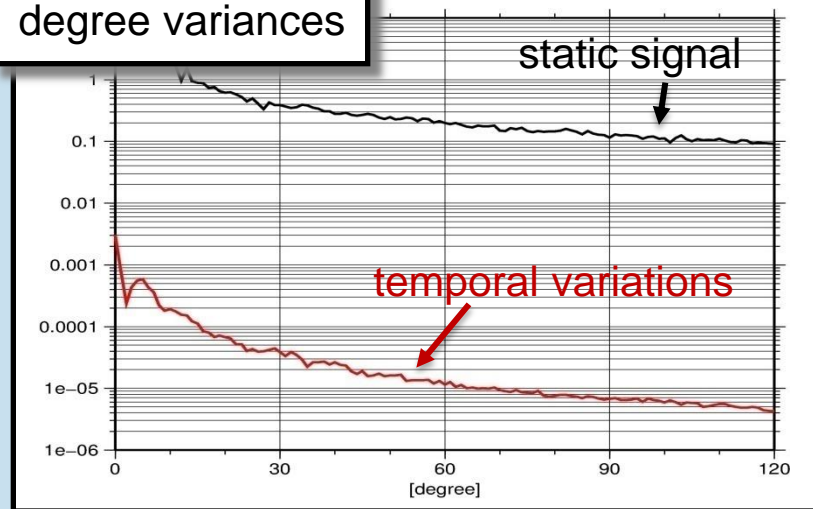
$$k_n = \frac{\sigma_n}{\sqrt{2n+1}}$$

gravity field signal

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degree variances



radial basis functions (spherical splines)

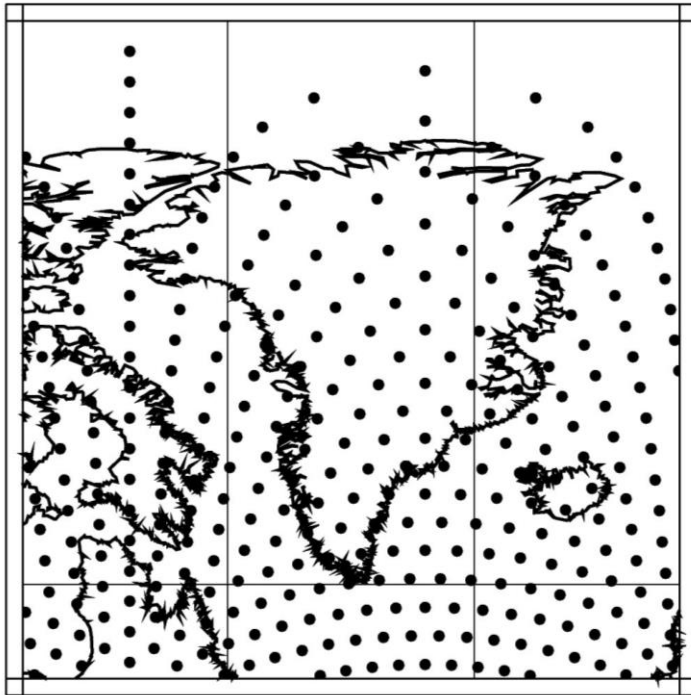
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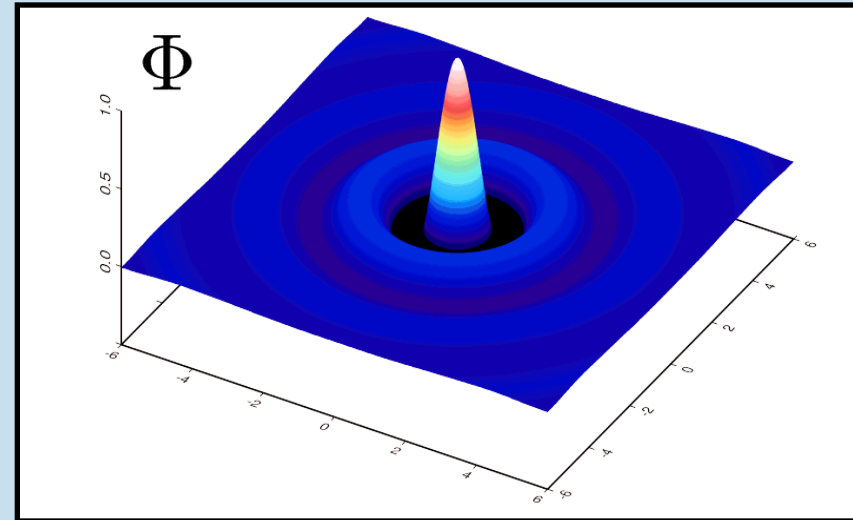
$$k_n = \frac{\sigma_n}{\sqrt{2n+1}}$$

Uniform point distribution:
triangular grid



Greenland area plus boundaries

Resolution: approx. spherical
harmonic degree N=120



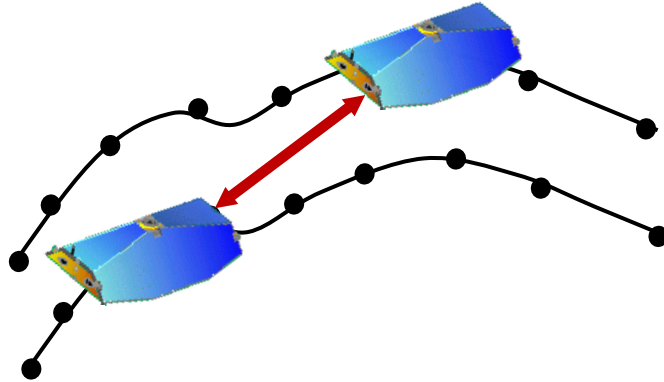
Regularized regional solution:

$$\hat{\mathbf{x}} = (\mathbf{A}^T \mathbf{P}_\epsilon \mathbf{A} + \alpha \mathbf{R})^{-1} \mathbf{A}^T \mathbf{P}_\epsilon \mathbf{y}$$

↑
regularization parameter
by variance component
estimation

(Eicker 2008)

GRACE level 1B processing



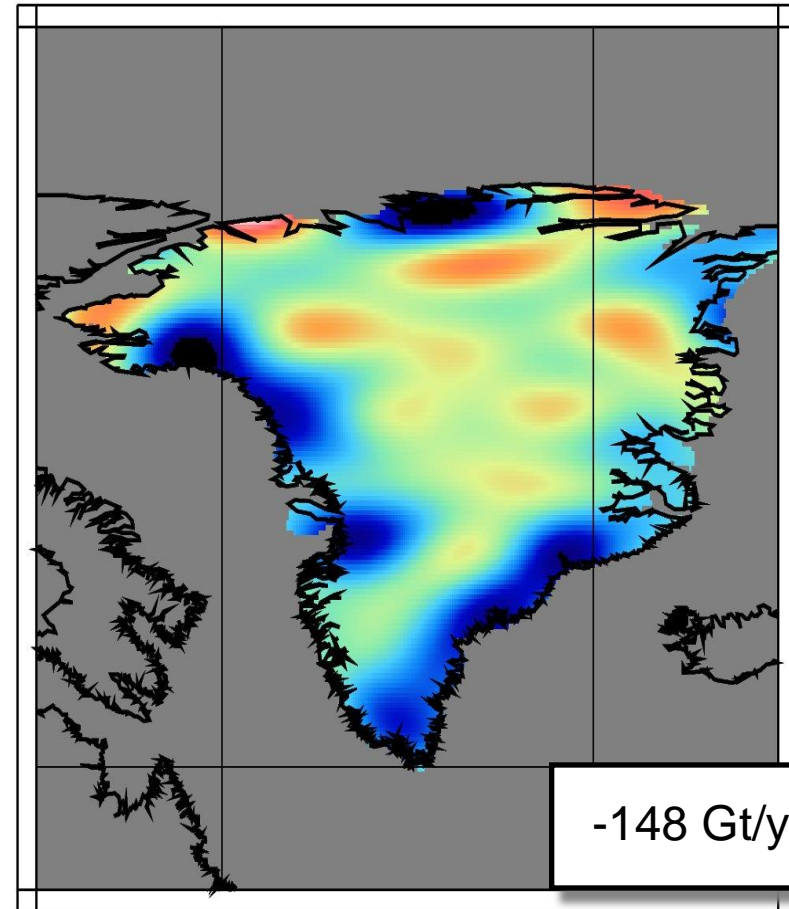
Short arc method
(as for ITG-Grace time series)

Background models:

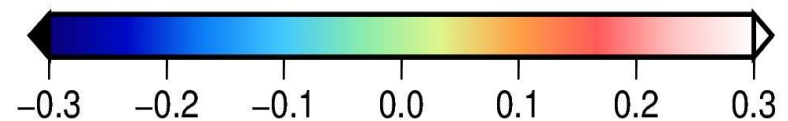
- tides
- atmosphere and ocean de-aliasing product (AOD1B RL05)
- annual /semi-annual signal

Regional representation by radial basis functions

Monthly solutions => trend estimation

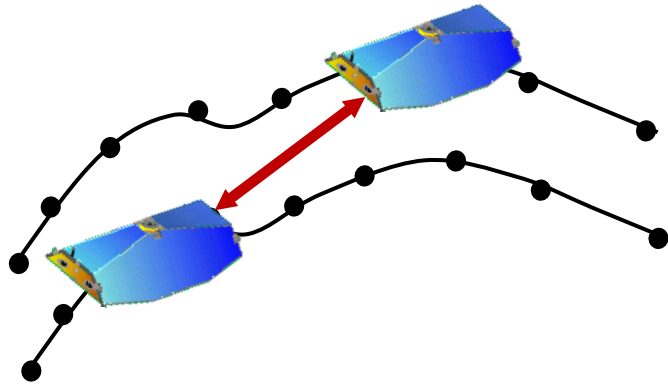


-148 Gt/year



water heights [m/year]

GRACE level 1B processing



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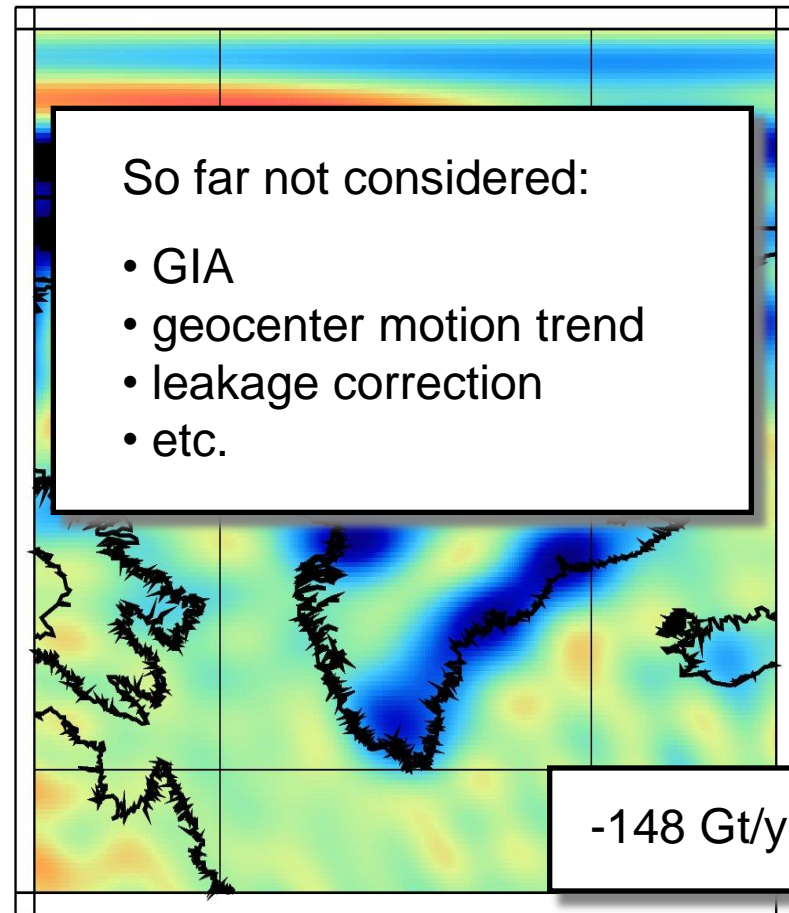
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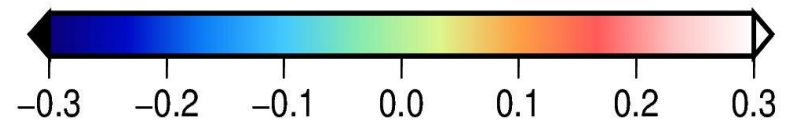
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So far not considered:

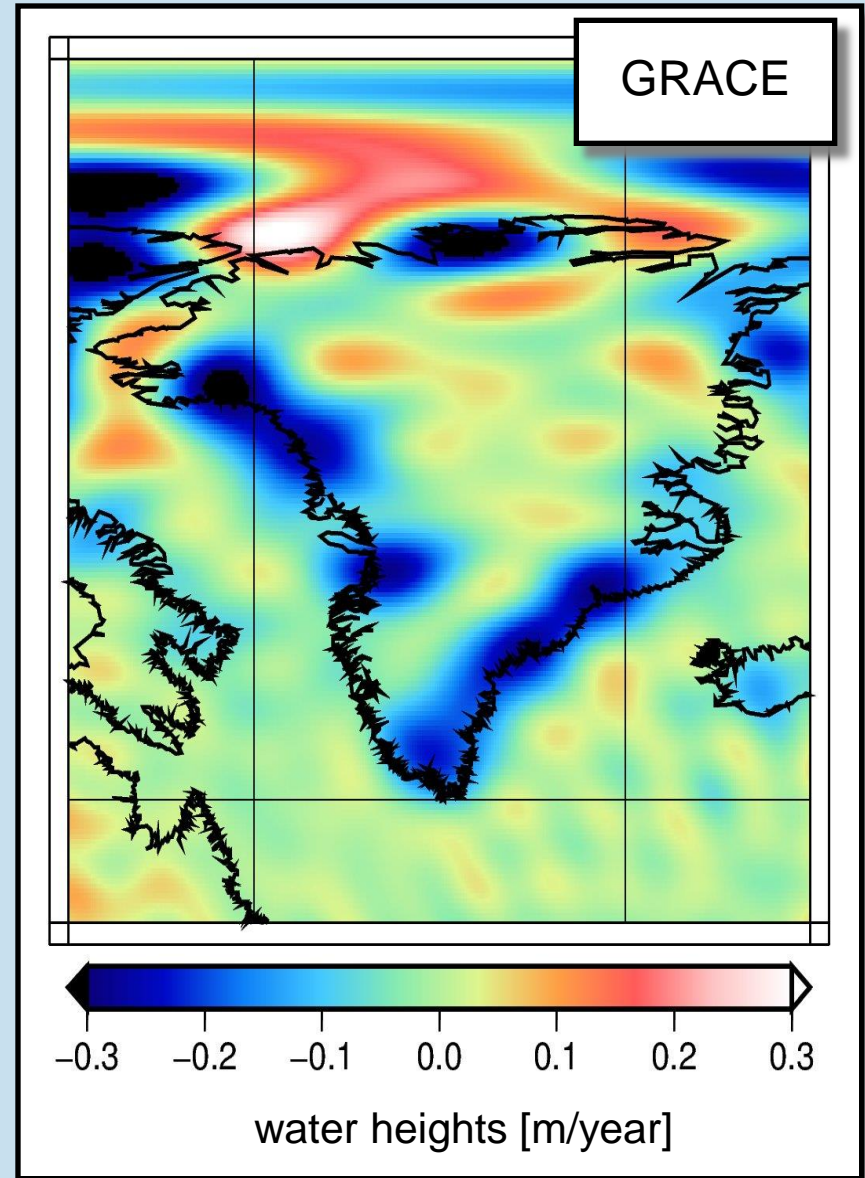
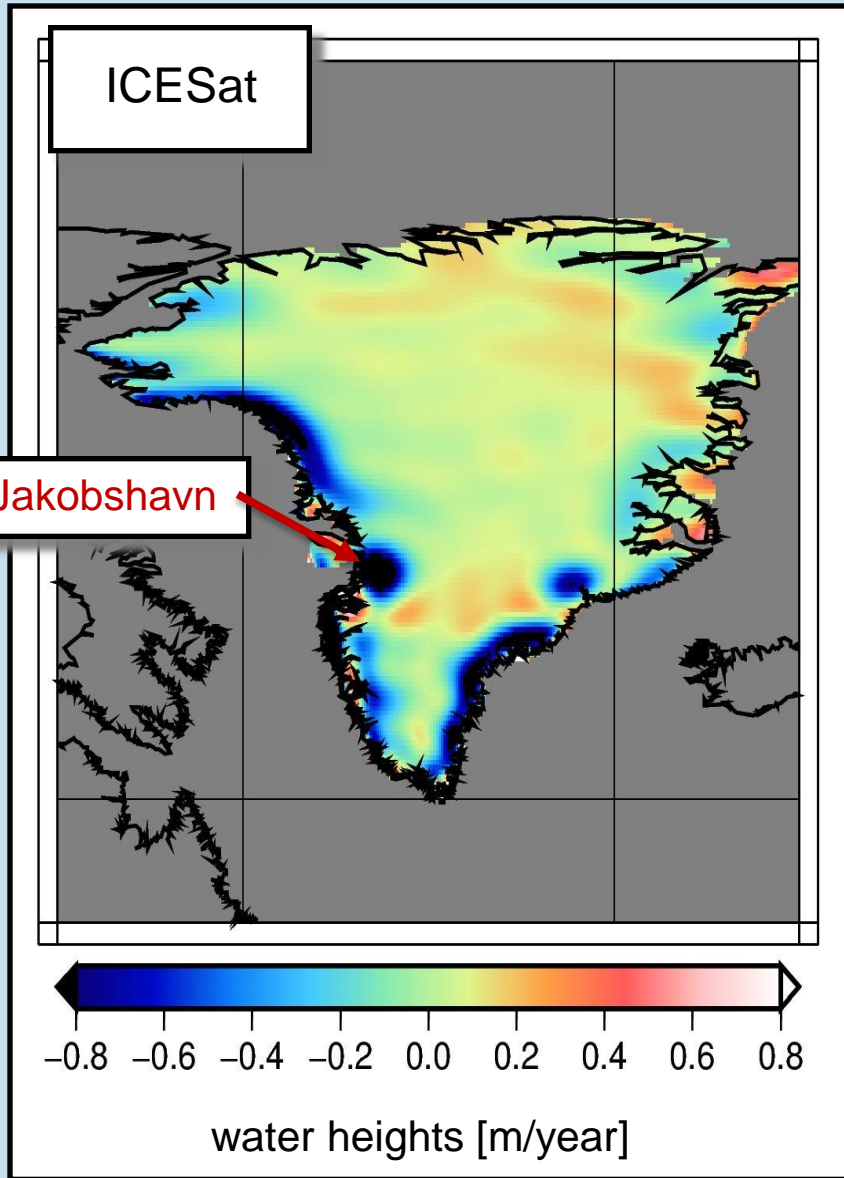
- GIA
- geocenter motion trend
- leakage correction
- etc.

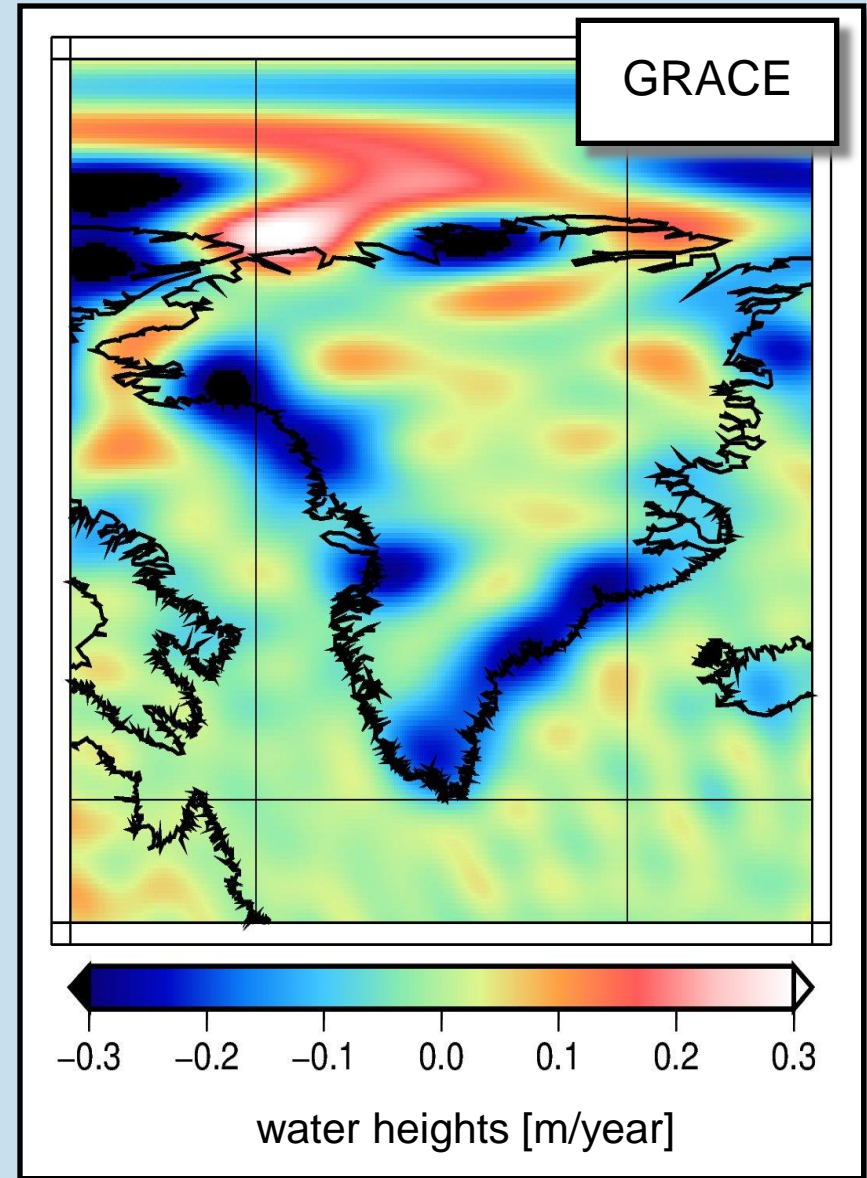
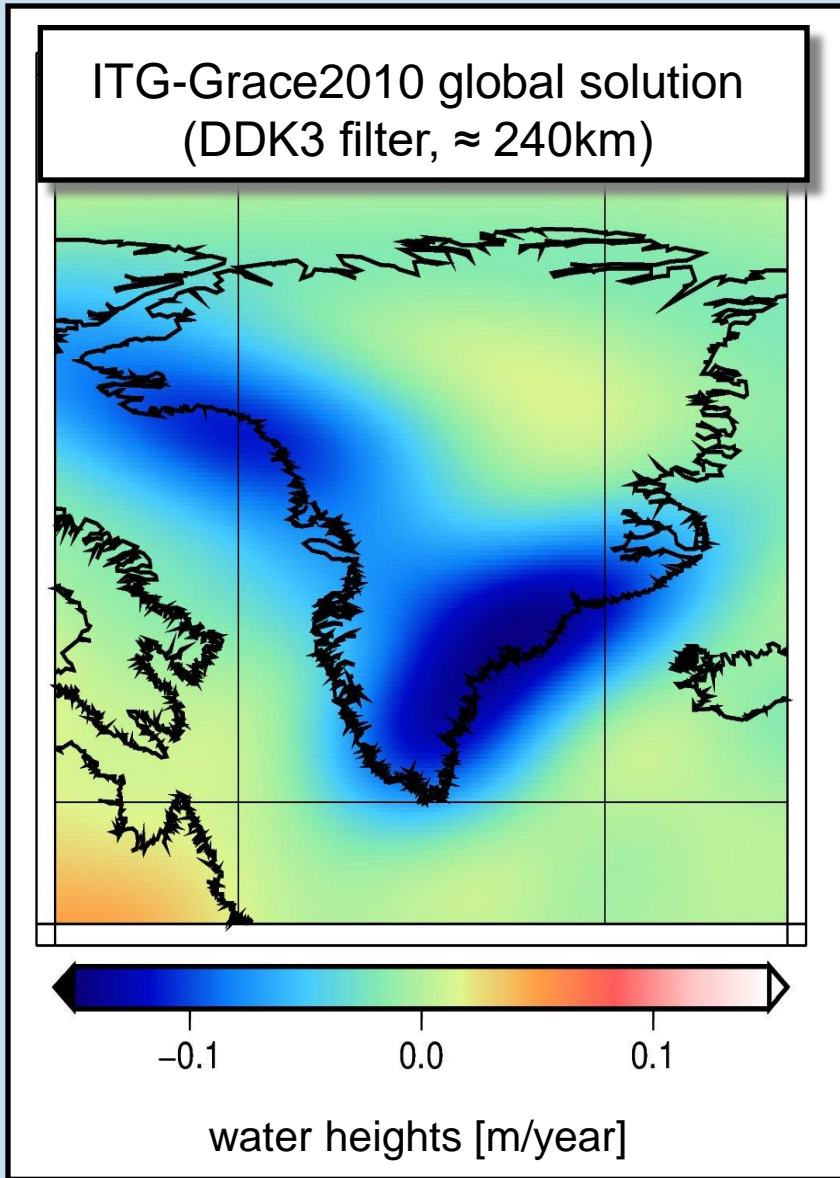


-148 Gt/year



water heights [m/year]





Global GRACE processing:

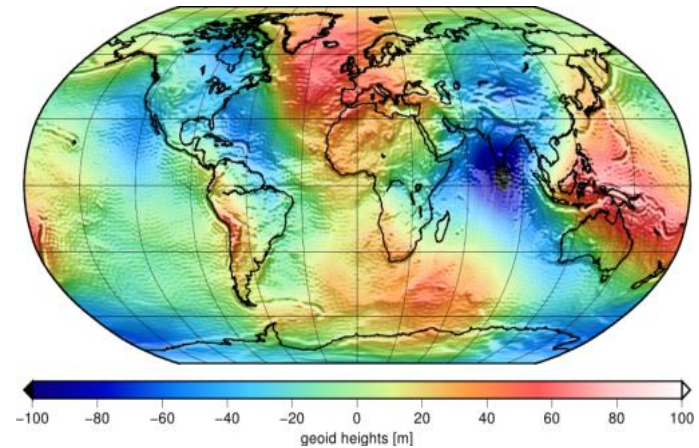
ITG-Grace2010 gravity field model

- daily, monthly, static

Outlook:

Continuation of the time series (in progress)

- new level 1B data (L1B-RL02)
- new de-aliasing product (AOD1B-RL05)



Regional approach:

- Ice mass trend for Greenland shows good agreement with ICESat trend
- promising spatial resolution

Outlook:

- Application to other regional areas

