Institut für Erdmessung

Strategies for Handling the Low-Frequency Noise of the GOCE SGG Data

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Outline

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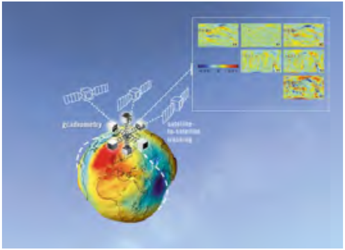
2. A remove-restore strategy to handle the low-frequency noise
3. Computation details
4. Results
5. Conclusions

Background

Gravity gradiometer

- key payload
- medium- and high-frequency part of the gravity field
- high accuracy (1 cm, 1 mGal)
- high resolution (100 km, d/o = 200)

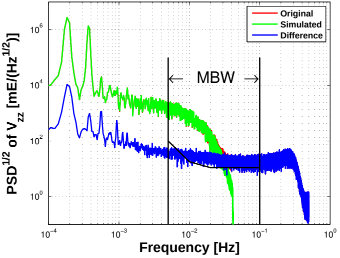


Satellite gradiometry

Background

- Gravity gradiometer
  - key payload
  - medium- and high-frequency part of the gravity field
  - high accuracy (1 cm, 1 mGal)
  - high resolution (100 km, d/o = 200)

- **Error behavior of the gradient**
  - Errors are approximately white within the Measurement BandWidth (MBW).
  - Errors increase approximately with 1/f characteristic below the MBW part (results in large long-wavelength errors in the measurements).



PSD of the gradient Vzz

There is no one-to-one correspondence between the frequency spectrum of the measurements and the spherical harmonic spectrum of the gravity field. The low-frequency noise will severely affect the extraction of the gradient signal within the MBW.

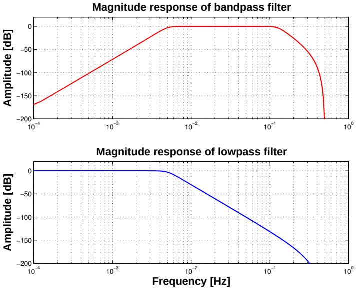
Strategies for dealing with the low-frequency noise

- bandpass filtering the gradients to MBW (e.g., DIR)
- using VCM to down-weight the low-frequency noise (e.g., TIM, ITG-GOCE)
- **a remove-restore method to replace the low-frequency part of measurements**

The remove-restore strategy

Steps

1. bandpass filtering the original gradients to a specified band part
2. lowpass filtering the simulated gradients to the low-frequency part
3. re-construct the observations



Magnitude responses of the filters

5-order butterworth filters are applied, the cut-off frequencies are set as:

- bandpass: 0.005 - 0.125 Hz
- lowpass: 0.005 Hz

Computation details

Data usage

- EGG_NOM_2
  - gravity gradients in GRF (EGG_GGT)
  - attitude information (EGG_IAQ)
- SST_PSO_2
  - precise kinematic orbit (SST_PKI_2)
  - attitude information (SST_IAQ_2)
- data period: Nov. and Dec., 2009
- sampling interval: 5 s

After pre-processing, in total, 1,045,440 observations are left to resolve the 48,837 gravity field coefficients, corresponding to the maximum recovered d/o 220.

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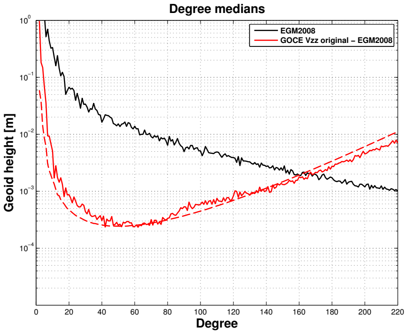
Platforms

- cluster system in LUH
- our own software package

Results from Vzz

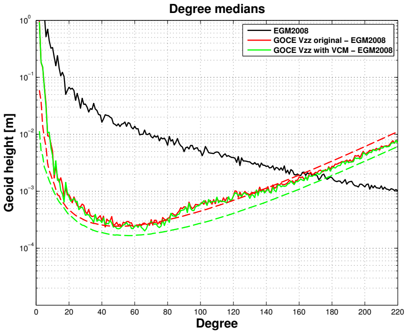
- **without dealing with the low-frequency noise**



Degree medians of the coefficient differences of GOCE-ZZ model w.r.t. EGM2008

Results from Vzz

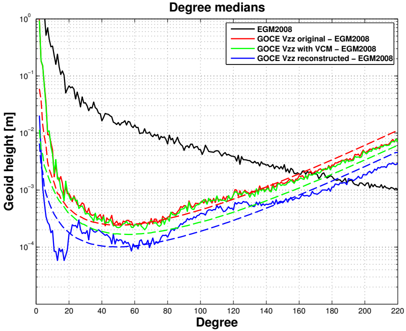
- without dealing with the low-frequency noise
- **using VCM to down-weight the low-frequency noise**



Degree medians of the coefficient differences of GOCE-ZZ model w.r.t. EGM2008

Results from Vzz

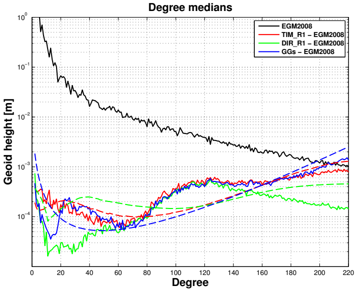
- without dealing with the low-frequency noise
- using VCM to down-weight the low-frequency noise
- **remove-restore to re-construct the observations**



Degree medians of the coefficient differences of GOCE-ZZ model w.r.t. EGM2008

Results from three diagonal components

Three diagonal components Vxx, Vyy, Vzz are used for gravity field recovery, and the results are compared with GOCE TIM_R1 and DIR_R1 models.



Degree medians of the coefficient differences of the TIM, DIR and our model w.r.t. EGM2008

- Above d/o 60, the accuracy of our model is at the same level with the TIM_R1 and DIR_R1, more close to TIM_R1 model above d/o 120.
- Between d/o 20 and 60, the accuracy of our model is slightly worse than the other two models.
- A jump appears at about d/o 20 of our model.
- Below d/o 20, the accuracy of DIR_R1 and our model is better than TIM_R1 model.

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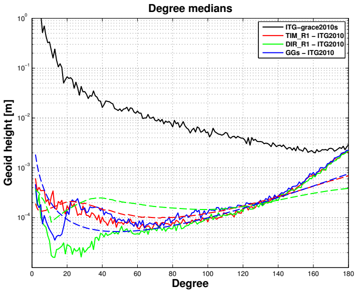

Degree medians of the coefficient differences of the TIM, DIR and our model w.r.t. ITG-Grace2010s

- The similar results can be drawn as that compared to EGM2008.
- Between d/o 70 and 140, the coefficient differences to ITG-Grace2010s are much smaller than that to EGM2008.

Conclusions

- The low-frequency noise of the gradients does affect the recovery of the medium- and high-frequency gravity field part. The remove-restore strategy is an alternative way to reduce the influence of the low-frequency errors. It is valid in extracting the gradient signal at the MBW part.
- The transition zone of the filters affects the accuracy and the consistency at the convergence of the re-constructed signal. It degrades the accuracy of the recovered coefficients between d/o 20 and 60.

Thanks for your attention!

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