Combination of CHAMP and GRACE data for Gravity Field Analysis

Introduction

The energy integral approach is applied for monthly gravity field recovery from CHAMP and GRACE using the two GRACE satellites as CHAMP-like satellites. The monthly subsets for each satellite are combined using variance component estimation. The approach yields more consistent results and removes the impact of the groundtrack pattern on the solutions.

Methodology

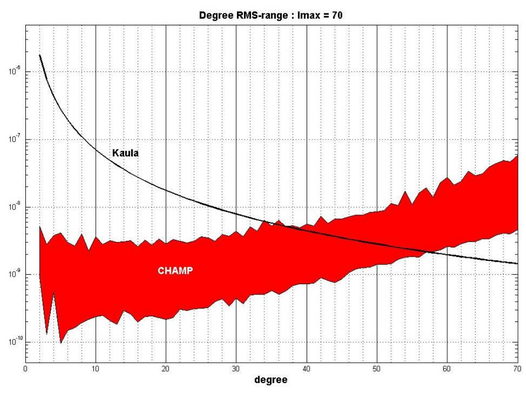
The energy integral approach is connecting position, velocity and acceleration to the disturbing potential:

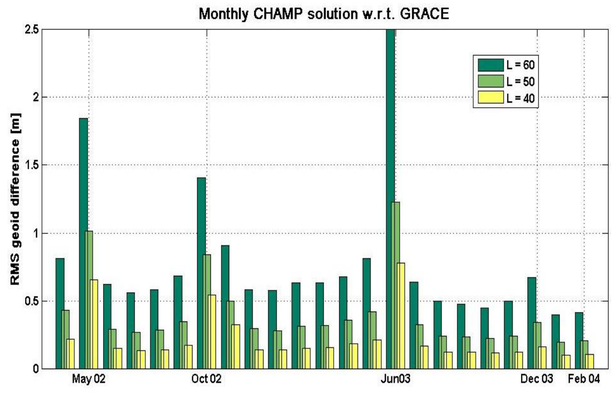
$$T + c = E_{kin} - U - Z - \int \left(f + \sum_k g_k \right) dx$$

T	=	disturbing potential
c	=	integration constant
E_{kin}	=	kinetic energy
U	=	normal gravitational potential
Z	=	centrifugal potential
$\int f dx$	=	dissipative energy
$\int \sum_k g_k dx$	=	time variable changes

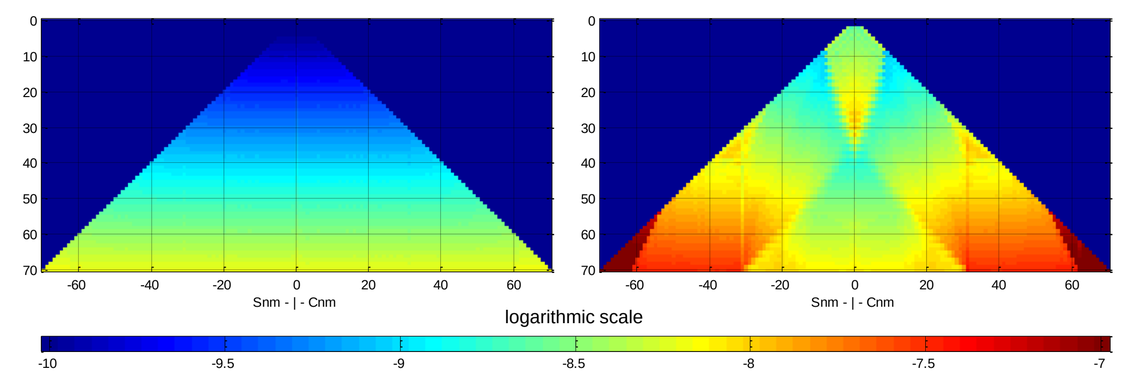
Variability of the CHAMP-only solution

- High variability caused by change in the groundtrack pattern.
- Best solution reached in January 2004, worst in June 2003.
- CHAMP is three times in a $^{31}/_{2}$ repeat mode in the period of interest.

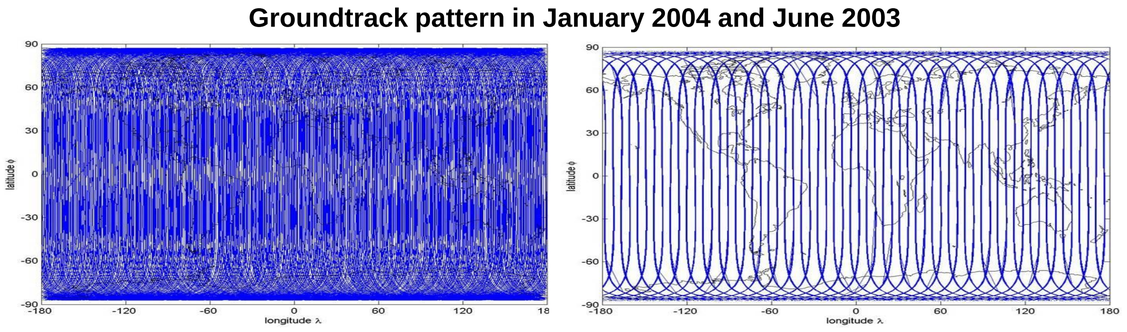




Error spectrum in January 2004 and June 2003



Groundtrack pattern in January 2004 and June 2003



Combination using variance component estimation

GRACE satellites used as two CHAMP-like satellites.

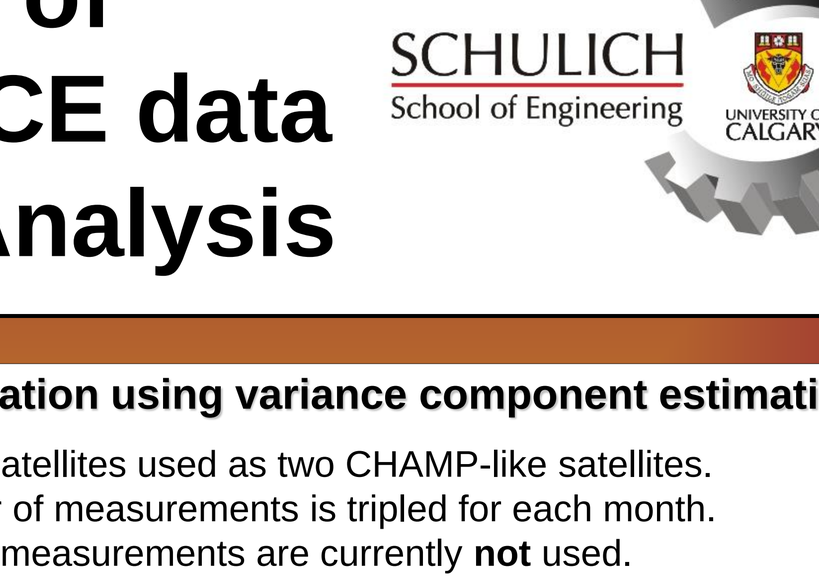
- Number of measurements is tripled for each month.
- K-band measurements are currently **not** used.
- GRACE A and GRACE B have stronger downward continuation effect due to higher altitude.
- Equal weight combination consequently yields worse results.

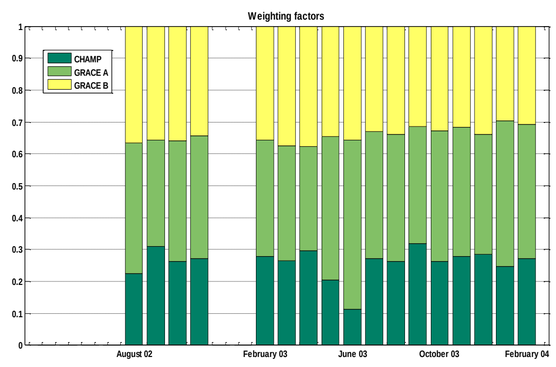
Variance component estimation (Koch & Kusche, 2002):

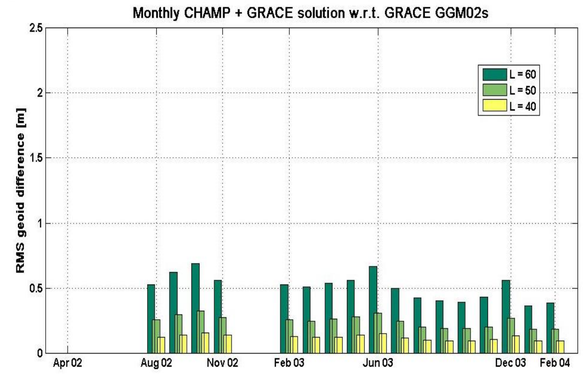
- Variance component is estimated for each month and each satellite, and is used for relative weighting.
- Regularization can be implemented but was not used in this study.
- Convergence was reached after 3 – 5 iteration steps.

Results:

- Spread of the solutions is reduced, i.e., more consistent solutions.
- RMS dropped by a factor of 5 in months with poor groundtrack coverage.
- Weighting factors reflect the quality of each subset but might be suboptimal since a small residual effect is still visible in the RMS.







Conclusions

- Groundtrack pattern causes high variations and consequently a degradation in the monthly CHAMP solutions.
- Variance component estimation provides the weighting factors.
- Combining multiple satellites yields consistent results with a small residual effect which might be an indication for suboptimal weighting factors.

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