The role of a priori information in gravity field determination

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Gravity field and Orbit

Non-linear parameter estimation problem

- A priori model (linearization)
- Observations
- Regularization (a priori knowledge via pseudo-observations)
TheCelestialMechanicsApproach(CMA)

CMA

Orbit

a priori model

Gravity field

corrections

state vector
stochastic parameters

spherical harmonic coefficients
Signal and Noise in monthly fields (GRACE)

noise

signal
Signal and Noise in monthly fields (GRACE)

noise

Signal in Amazone

signal
Signal and Noise in monthly fields (GRACE)

**Signal**

**noise**
Signal and Noise in monthly fields (GRACE)

Signal

Noise

wRMS over oceans

AIUB old
GFZ–RL04
GFZ–RL05
All IR new

2007 2008 2009

Geod [mm]

0.8 1.0 1.2 1.4 1.6 1.8 2.0 2.2

Signal in Amazone

AIUB old
GFZ–RL04
GFZ–RL05
All IR new

2007 2008 2009

Water [m]

-0.2 -0.1 0 0.1 0.2 0.3
Signal and Noise in monthly fields (GRACE)

noise

signal
Signal and Noise in monthly fields (GRACE)

noise

signal
NEQ–modification tools

- Sampling / Binning of stochastic parameters.
- Absolute / Relative constraining of stochastic parameters.
- Pre-Elimination of arc-specific parameters (correlations with SH coefficients are kept).
- Deletion of arc specific parameters (correlations with SH coefficients are destroyed).
Separation of Orbit and Gravity field

noise

signal
Separation of Orbit and Gravity field

noise

signal
Separation of Orbit and Gravity field noise

Signal

wRMS over oceans

Signal in Amazone
Separation of Orbit and Gravity field

noise

signal
Separation of Orbit and Gravity field noise

signal loss

signal

wRMS over oceans

Signal in Amazone

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Separation of Orbit and Gravity field noise

signal
Separation of Orbit and Gravity field

Noise

Signal

wRMS over oceans

Signal in Amazone
Separation of Orbit and Gravity field noise

signal
Separation of Orbit and Gravity field

noise

Signal in Amazone

AIUB old
GFZ–RL05
AIUB new with ad.

wRMS over oceans

AIUB old
GFZ–RL05
AIUB new with ad.

2007 2008 2009

Geoid [mm]

2007 2008 2009

2007 2008 2009

Water [m]
Separation of Orbit and Gravity field

**signal**

**noise**
Separation of Orbit and Gravity field

noise

signal loss

signal
Separation of Orbit and Gravity field

**noise**

![Graph of wrMS over oceans showing different datasets and their performance over time.]

**signal**

![Graph showing signal in Amazone with various markers indicating different models and their outputs over time.]
Monthly field – a priori model

Combined solution, 15 min
Monthly field – a priori model

Separate solution, 60 min
Monthly field – a priori model

Separate solution, 15 min
Degree Variances (monthly field)

monthly field – static field

monthly field – timevar. model
Degree Variances (monthly field)

**monthly field – static field**

**signal-dominated**

**noise-dominated**

**monthly field – timevar. model**
Degree Variances (monthly field)

- monthly field – static field
  - signal damaged
- monthly field – timevar. model
Degree Variances (monthly field)

monthly field – static field

all degrees influenced

monthly field – timevar. model
Degree Variances (monthly field)

monthly field – static field

Difference degree amplitudes monthly field – static field

- AIUB old
- AIUB new
- 60 min, separate, static
- 60 min, separate, timevar
- 15 min, separate, timevar

signal is dampened

monthly field – timevar. model

Difference degree amplitudes monthly field – a priori model

- AIUB old
- AIUB new
- 60 min, separate
- 15 min, separate
How does it work?

How do we influence spherical harmonics of all degrees by only a few low frequent stochastic parameters?

High pass filter of Lumped Coefficients of orbit perturbations.

What happens if we estimate arc specific orbit parameters and gravity field coefficients separately?

Correlations are destroyed, signal in stochastic parameters is lost for gravity field coefficients.
Discussion

Is it good or bad?

- Is it correct?
  - Not really
- Is it helpful?
  - Yes
- Is it dangerous?
  - Yes
GOCE polar gap
GOCE polar gap

GOCE GPS – GRACE GPS/KBR, 6 min, separate