10-day time series of the geoid from GRACE and LAGEOS data

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EIGEN-GRGS RL02 gravity products

This poster presents the GRACE gravity products made at CNES/GRGS in Toulouse (France) in our second release (RL02). It includes our 10-day gravity field models and our new periodic mean field EIGEN-GRGS_RL02_MEAN-FIELD.

Processing standards

Modelling context (GINS software)

Gravity	*EIGEN-GL04C / EIGEN-GRGS RL02 MF (dg 160)*
Ocean tide	*FES-2004 (degree 80) + ocean pole tide*
Atmosphere	*6 hourly 3-D ECMWF pressure grids*
Ocean mass model	*6 hourly MOG2D (non-IB)*
Atmospheric tides	*Model based on ECMWF pressure grids (Bode & Biancale)*
3rd body	*Sun, Moon, 6 planets (DE403)*
Solid Earth tides	*IERS 2003*
Solid Pole tides	*IERS 2003*
Non gravitational	*Accelerometer data (+biases and scale factors)*

SLR stations	*ITRF2005 coordinates*
GPS	*IGS orbits and CODE clocks*

Hydrology	*none*
Glacial Isostatic Adjustment	*none*

Orbit computation

Orbit computation is processed in 24-hour arcs (or down to 6-hour arcs in case of problems along the arc), by a least square adjustment made with the GINS software. It uses GPS data and KBR range-rate data, the KBRR data being derived in house from the official range data.

Inversion of normal equations

The daily GRACE normal equations obtained are then packed into 10-day normal equations and combined with LAGEOS SLR normal equations. The LAGEOS SLR data allows a better determination of lower degrees. Inversion of 10-day equations provides spherical harmonic coefficients of d/o 2-50.

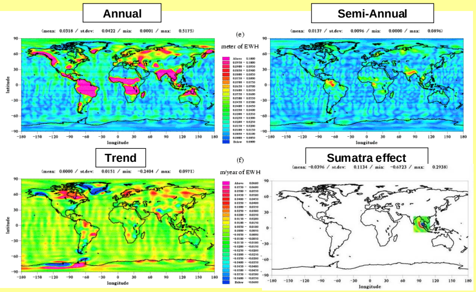
The inversion procedure does not need a posteriori filtering. However, we use regularization by adding an empirically determined a priori σ^{-2} to the diagonal of the normal matrices. This is accomplished by constraining the coefficients $c_{n,m}$ to the ones ($C_{n,m}$) of the periodic mean field EIGEN-GRGS RL02 by the following equation:

$$c_{n,m} - C_{n,m} = 0 \pm \sigma_{n,m}$$

The value of $\sigma_{n,m}$ are based on the a posteriori σ of the gravity field coefficients for a typical 10-day *unconstrained* solution taking into account the maximum correlation between each coefficient and all of the others.

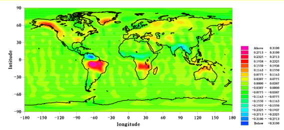
Mean field and 10-day solutions

Mean field

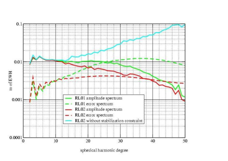


EIGEN-GRGS RL02 MEAN-FIELD results from the inversion of 4.5 years of GRACE and LAGEOS data. Regular spherical harmonic coefficients were solved up to degree 160, as well as time-variable coefficients up to degree 50: drift, annual and semi-annual sine and cosine, and Sumatra correction to add to the field before the 2004 tsunami.

10-day RL02 solutions



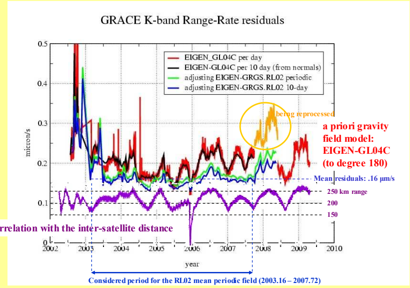
The noise over deserts and oceans in the form of North-South striping is reduced by 20-40% with respect to RL01. The uncertainty of an individual point in equivalent water heights is approximately 2 cm.



The RL02 power spectrum presents less energy from degree 12 indicating a noise reduction which can be seen over oceans and deserts

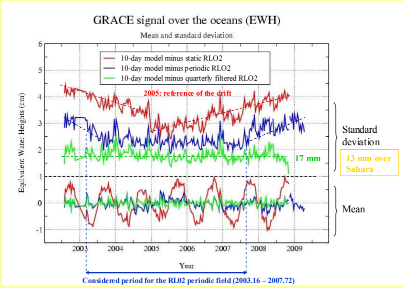
Evaluation of solutions

KBR range-rate residuals



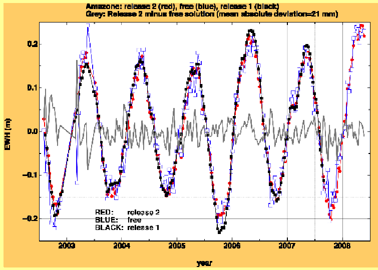
The red curve shows the daily KBRR residuals obtained in the orbit computation with a static a-priori gravity field model (EIGEN-GL04C). The blue curve shows the residuals obtained using the 10-day solutions as a-priori model. The green one shows the residuals using a periodic mean field (EIGEN-GRGS RL02MF). The apparent correlation with the purple curve indicates that a larger inter-satellite distance allows a better variance reduction.

Noise estimation over global oceans



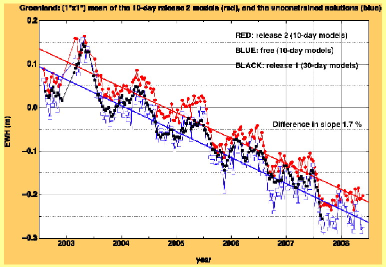
Analysis of variations in EWH inferred from GRACE solutions of selected areas with very small variability is an alternative method to evaluate the solution error. The red curve above represents the RL01 noise level over global oceans (between 3 and 5 cm). Blue is RL02 (slightly above 2cm), and green is RL02 quarterly filtered.

Noise reduction over the Amazon basin
No amplitude change



From the equivalent water height obtained over the Amazon basin it can be seen that the regularizing process applied does not change the maximum amplitude of the signal. The difference between the 10-day models from RL02 and the unconstrained solutions reaches randomly 21 mm (1σ).

Noise reduction over Greenland
No slope change



The mass loss over Greenland observed here in equivalent water height shows almost no change between the RL02 and the unconstrained solution. That guarantees as well that the regularizing process applied just reduces noise. The slope difference between the RL02 10-day models and the unconstrained solutions reaches only 1.7%.

Conclusion and perspectives

RL02 10-day gravity fields are available on BGI website : http://bgi.cnes.fr:8110/geoid-variations/README.html, as well as mean field.
We plan to make a third release end of 2010, including new ways of improvement. One of them is solving for systematic biases as observed in the KBR data, resulting in the reduction of horizontal stripes in the gravity models (see Martin Horwath oral presentation in session A.1, GRACE Geodesy). We will also study new regularization processes in order to get rid completely of high frequency noise and to increase the spatial and temporal resolutions as much as possible.