A 4-year series of Earth mass changes derived from GRACE and Lageos data

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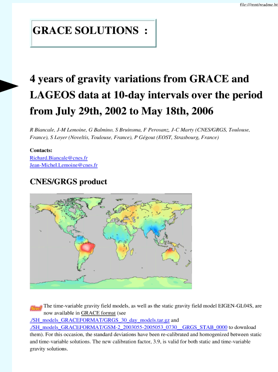
GRACE and Lageos data processing at CNES/GRGS

The CNES/GRGS Team of Space Geodesy provides, since 2005, time-variable global Earth gravity field models based on GRACE and Lageos data at a spatial resolution of 400 km and at a temporal resolution of 10 days. More than 4 years of data have now been processed and the products are available on either the BGI or the ICGEM web sites (http://bgi.cnes.fr). The products include:

- Model coefficients in spherical harmonics from degree 2 to 50;
- Grids of the geoid and equivalent water height (EWH) anomalies with respect to the mean field;
- Images and animations of the geoid and EWH anomalies.


GRACE SOLUTIONS :

4 years of gravity variations from GRACE and LAGEOS data at 10-day intervals over the period from July 29th, 2002 to May 18th, 2006

Contacts:

CNES/GRGS product

GRACE data is processed per 1-day arcs and Lageos-1 and -2 per 10-day arcs. The weighting of the data is 0.1 µm/s for GRACE K-Band Range-Rate data, 8 mm for GRACE GPS phase data and 1 cm for Lageos SLR data.

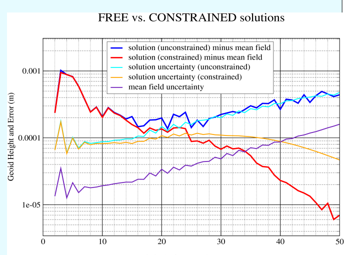
The time-variable gravity models that are taken into account in the reduction of the data are:

- Solid Earth tides (IERS2003 conventions)
- Ocean tides (FES2004)
- ECMWF 3D-atmospheric pressure fields every 6 hours
- MOG2D barotropic ocean model

The time-variable gravity field models produced at GRGS therefore only depart from the static gravity field by the unmodeled effects: hydrology, snow cover, baroclinic oceanic signals and post-glacial rebound.

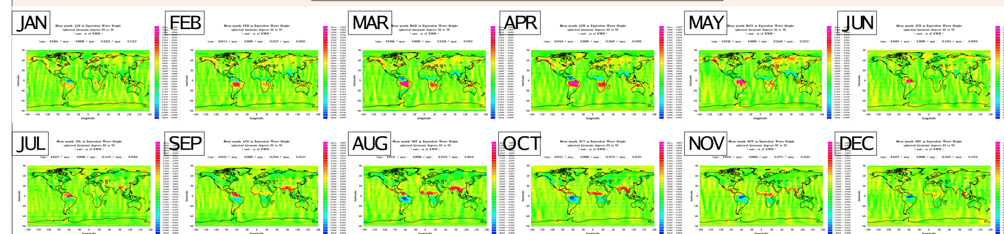
Contrary to some other modeling, the GRGS models are stabilized before inversion by the introduction of a constraint towards the mean field according to the law: $C_{variable}(l,m) = C_{mean}(l,m) \pm eps(l)$ with: $eps(l) = \exp(-(l+264)/10.91) / 2$.

The effect of this stabilization of the signal is a maximal reduction of the noise with a minimal reduction of the signal. On the figure to the right are plotted the spectral comparisons to the mean field of free and constained solutions. Most of the spectral power in the free solution above degree 20 consists in noise.

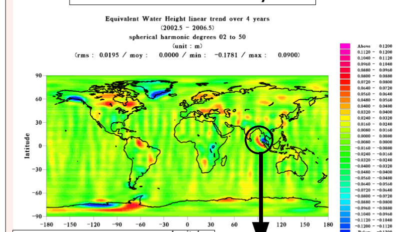


GRACE solutions

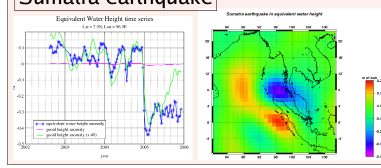
Climatology derived from the 4-year series



Linear trend over 4 years



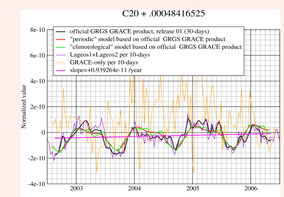
Sumatra earthquake

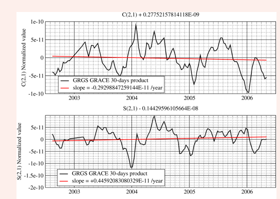


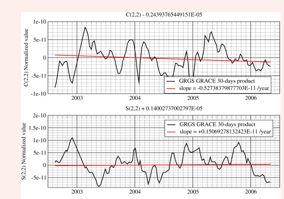
Degree 2

The zonal term of degree 2, C(2,0), is mainly provided by the Lageos data: about 90% of the information comes from Lageos. To the right is plotted the C(2,0) time series from different origins.

Below are plotted the C,S(2,1) and C,S(2,2) time series from the 4-year GRGS GRACE+Lageos solutions.



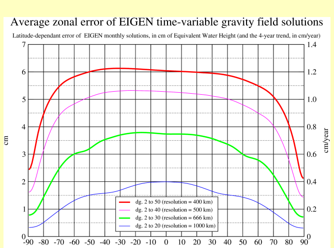


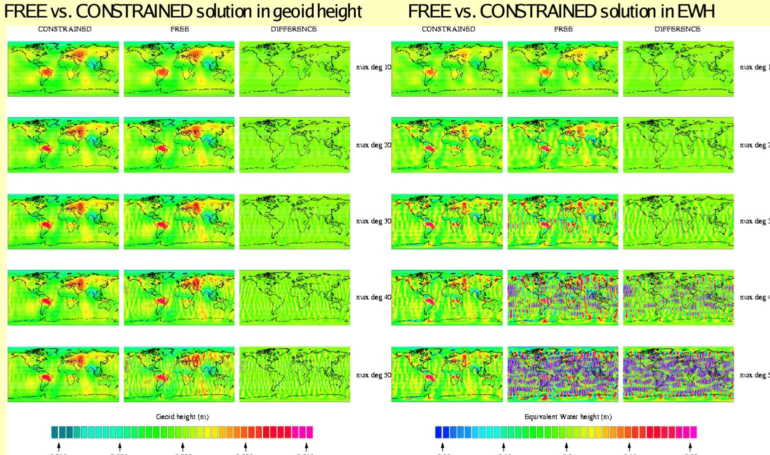


Error assessment of the GRGS GRACE solutions

The error pattern of the GRACE solutions is mainly zonal. The figure below displays the calibrated error of the GRGS solutions in terms of EWH and trend over 4 years.

The stabilization applied to the solutions leads to no perceptible loss of signal, as illustrated by the "free vs. constrained" comparisons on the right: the stabilization removes most of the noise, but no visible amplitude to the signal in the zones where it is strong.





Impact of time-variable gravity field on POD

The computation of one orbit arc per month for four satellites at different altitudes illustrates the impact of the time-variable gravity field in terms of measurement residuals:

- In black: the static gravity field EIGEN-GL04S;
- In red: the "climatological" or mean monthly model derived from the 4-years time series;
- In green: the gravity solution at the epoch of the arc;
- In blue: the "bias+drift+annual and semi-annual" periodic model derived from the 4-years time series.