Analysis of Newly-Released GOCE EGG_NOM_1B Data

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Outline

1. Background
2. Motivation
3. Analysis of EGG_NOM_1B Data
4. Conclusions
**GOCE Mission**

- first core mission
- SGG and SST-hl
- high accuracy and resolution

GOCE satellite
Introduction of GOCE Mission

- **GOCE Mission**
  - first core mission
  - SGG and SST-hl
  - high accuracy and resolution

- **EGG NOM_1B Data**
  - Gravity Gradients
  - CM (Common Mode) Accelerations
  - DM (Differential Mode) Accelerations
  - GAR (Gradiometer Angular Rates)
  - ...

Gravity gradiometer
Motivation

- November, 2011: an update version of EGG processor was adopted
  - angular rates reconstruction (Kalman → Wiener)
  - interpolation of calibration matrix
  - ...
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July, 2012: reprocessed GOCE data released
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July, 2012: reprocessed GOCE data released

the differences of the old and new EGG_NOM_1B data have been explored ...

Version Number: “old”—04.04; “new”—05.06;
Gravity Gradients

- recover the medium and short wavelength part of the gravity field
Gravity Gradients

- recover the medium and short wavelength part of the gravity field
- time series of gradients

Time series of gravity gradients (November, 2009)
Gravity Gradients

- recover the medium and short wavelength part of the gravity field
- time series of gradients

Time series of $V_{zz}$ and its orbit parameters (November 1, 2009)

<table>
<thead>
<tr>
<th>$\Delta V$ [E]</th>
<th>MEAN</th>
<th>STD</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\Delta V_{xx}$</td>
<td>0.2656</td>
<td>0.5854</td>
</tr>
<tr>
<td>$\Delta V_{yy}$</td>
<td>-1.3792</td>
<td>0.1930</td>
</tr>
<tr>
<td>$\Delta V_{zz}$</td>
<td>1.8313</td>
<td>0.6745</td>
</tr>
<tr>
<td>$\Delta V_{xy}$</td>
<td>-2.1497</td>
<td>0.3040</td>
</tr>
<tr>
<td>$\Delta V_{xz}$</td>
<td>-0.0302</td>
<td>0.0999</td>
</tr>
<tr>
<td>$\Delta V_{yz}$</td>
<td>-14.8581</td>
<td>0.5043</td>
</tr>
</tbody>
</table>

$\Delta V_{ij} = V_{ij}^2 - V_{ij}^1 \quad i,j = x, y, z$
Gravity Gradients

- recover the medium and short wavelength part of the gravity field
- time series of gradients
- psd of gradients

Power spectral densities of gravity gradients
(Left: original gradients; Right: simulated gradients from EGM2008, d/o 720)
Gravity Gradients

- recover the medium and short wavelength part of the gravity field
- time series of gradients
- psd of gradients

Power spectral densities of the trace of gravity gradients
Gravity Gradients

- recover the medium and short wavelength part of the gravity field
- time series of gradients
- psd of gradients
- spatial analysis of gradients

Spatial distribution of filtered \( V_{zz} \)
(Left: filtered \( V_{zz} \); Right: difference of filtered \( V_{zz} \) between original and simulated ones)
Common Mode Accelerations

- non-conservative accelerations of the satellite

<table>
<thead>
<tr>
<th></th>
<th>$P_{14}$</th>
<th>$P_{25}$</th>
<th>$P_{36}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>U</td>
<td>U</td>
<td>U</td>
</tr>
<tr>
<td>Y</td>
<td>L</td>
<td>U</td>
<td>L</td>
</tr>
<tr>
<td>Z</td>
<td>U</td>
<td>L</td>
<td>U</td>
</tr>
</tbody>
</table>

U: Ultra-Sensitive
L: Less-Sensitive

Gravity gradiometer
Common Mode Accelerations

- non-conservative accelerations of the satellite
- time series of CM accelerations
- psd of CM accelerations

Time series (November 1, 2009) and power spectral densities of $a_y$
Common Mode Accelerations

- non-conservative accelerations of the satellite
- time series of CM accelerations
- psd of CM accelerations

Power spectral densities of $a_x$, $a_y$, $a_z$
Angular Rates

- used for gravity gradients determination
Angular Rates

- used for gravity gradients determination
- time series of angular rates

Time series of angular rates (November 1, 2009)

<table>
<thead>
<tr>
<th>ω [rad/s]</th>
<th>MEAN</th>
<th>STD</th>
</tr>
</thead>
<tbody>
<tr>
<td>ω_x</td>
<td>5.68e-6</td>
<td>6.27e-5</td>
</tr>
<tr>
<td>ω_y</td>
<td>-1.17e-3</td>
<td>4.87e-6</td>
</tr>
<tr>
<td>ω_z</td>
<td>-3.94e-6</td>
<td>6.31e-5</td>
</tr>
</tbody>
</table>
Angular Rates

- used for gravity gradients determination
- time series of angular rates
- PSD of angular rates

Power spectral densities of angular rates
relationship between GGs, DM accelerations and Gradiometer Angular Rates

\[ V_{xx} = - \frac{2a_{d,14}^x}{L_x} - \omega_z^2 - \omega_y^2 \]

\[ V_{yy} = - \frac{2a_{d,25}^y}{L_y} - \omega_z^2 - \omega_x^2 \]

\[ V_{zz} = - \frac{2a_{d,36}^z}{L_z} - \omega_x^2 - \omega_y^2 \]
GGT, DM and GAR

- relationship between GGs, DM accelerations and Gradiometer Angular Rates

Left: time series of DM accelerations; Right: square of angular rates (from November 1 to November 15, 2009)
relationship between GGs, DM accelerations and Gradiometer Angular Rates

Power spectral densities of GGs, terms of DM accelerations and GAR
Conclusions

- **Gravity Gradients**
  - improvement of trace of gradients in the lower frequency part
  - original gradients have more energy above 0.02 Hz
  - typical geographical features are visible in the high frequency part

- **CM Accelerations**

- **Angular Rates**
  - higher rotational instability in flight and radial directions
  - the update processor cuts off the angular rates above 0.2 Hz

- **GGs, DM accelerations and Angular Rates**
  - the DM accelerations are dominant in the high frequency part of the gradients, and angular rates affect more in the lower frequency part
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