Short description for the MDC basic 2

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The following description is only valid for the simulated data of the basic challenge 2. More information on different challenges and different levels can be found at:

www.geoq.uni-hannover.de/mock

The simulated GRACE Follow-On data including Laser Ranging Interferometry (LRI) data as well as KBR and orbit products for two GRACE Follow-On satellites are available and can be downloaded from:

www.geoq.uni-hannover.de/bmdc2

The data are the results of a pure dynamic orbit integration, in which only a static Earth’s gravity field model is taken as the force model. Hence other disturbing forces such as tides, drag, solar radiation pressure etc. are not included.

The LRI data, provided in daily files with 5-second sampling rate contain 16 columns. The first four columns are: GRACE time, \( \rho \), \( \dot{\rho} \), \( \ddot{\rho} \). Columns 5 through 16 shall not be used and contain zero values for different corrections and the value 700 for LRI A and LRI B SNR. The format is meant to be consistent with the future GRACE Follow-On LRI1B format.

The KBR data, provided in daily files with 5-second sampling rate contain 16 columns. The first four columns are: GRACE time, \( \rho \), \( \dot{\rho} \), \( \ddot{\rho} \). Columns 5 through 16 shall not be used and contain zero values for different corrections and the value 700 for K and Ka SNR. These columns are kept in the data to maintain the consistency with the official GRACE KBR1B format.

The orbit products also contain 16 columns just similar to official GRACE GNV1B products. Nevertheless, these orbits are meant to be kinematic orbits and could be used as observations too. The entries are: GRACE time, satellite id, coordinate frame, \( x \), \( y \), \( z \), \( \sigma_x \), \( \sigma_y \), \( \sigma_z \), \( v_x \), \( v_y \), \( v_z \), \( \sigma_{vx} \), \( \sigma_{vy} \), \( \sigma_{vz} \), quality flag. The standard deviations are formal errors for the orbit positions and the velocities.

The orbits are provided in the Earth-fixed frame. To obtain the rotation matrix for the transformation between the inertial and Earth-fixed frames, use the following Z-rotation:

\[
\mathbf{R}_{i \rightarrow e} = \begin{bmatrix}
\cos(\theta) & \sin(\theta) & 0 \\
-\sin(\theta) & \cos(\theta) & 0 \\
0 & 0 & 1
\end{bmatrix}.
\]  

(1)

The rotation angle \( \theta \) [rad] is:

\[
\theta = (t_{jd} - 2453491.5) \times 86400 \ [s] \times w_e [\text{rad/s}] - 2.46276246875459 \ [\text{rad}],
\]  

(2)
with $t_{jd}$ being the time in Julian date and $w_c = 7.29211514670698 \times 10^{-05}$ rad/s.

The Julian date for 2005.05.01 at 00:00:00 is 2453491.5. To convert the GRACE
seconds into Julian date use the following relation:

$$t_{jd} = \frac{t_{GRACE}}{86400 \text{ [s]}} + 2451545.\tag{3}$$

Other constants needed for gravity field recovery are: $a = 6378136.3$ m and
$GM = 0.3986004415 \times 10^{15}$ m$^3$/s$^2$.

The full description of the MDC challenges as well as data entries, format
and conventions can be found in the data handbook for GRACE follow-on mock
data challenges. This document is available online on the MDC webpage:

[www.geoq.uni-hannover.de/bmdc2](http://www.geoq.uni-hannover.de/bmdc2)

**Mock Data Challenge 2 (basic):**

**Given:** Orbit, LRI and KBR data for a month

**Find:** The normalized spherical harmonic coefficients $\overline{c}_{nm}$ and $\overline{s}_{nm}$.

**Hint:** The $N_{max}$ of the desired gravity model is between 65 < $N_{max}$ < 85.

Submit your estimated spherical harmonic coefficients via our webpage. The
format should be the same as the ICGEM [icgem.gfz-potsdam.de/ICGEM/](http://icgem.gfz-potsdam.de/ICGEM/) gravity field models. Please also provide all information concerning your results
including processing strategy, constraints, constants etc. in the header of the
file.