1 – THE IMPROVED STAR CAMERA DATA

Recent analysis of the GRACE Level-1B star camera data (SCA1B RL02) revealed their systematically higher noise than expected (Bandikova et al., 2010). The reason is the incorrect implementation of algorithms for quaternion combination in the 3% processing routines. After correct implementation of the combination method, significant improvement of about a factor 3–4 over the whole spectrum was achieved, cf. Fig. 1 and 2. The combined solution, however, cannot be obtained when valid data from only one camera is available. The data availability for December 2008 is shown in Fig. 3.

As the SCA attitude data are essential for the processing of the K-band ranging data and the accelerometer data, which are fundamental for the gravity field recovery, the quantification of the effect of the improved star camera data on these observations and on the gravity field is needed and presented here.

2 – THE EFFECT ON THE OBSERVATION

A) The effect on the KBR observations

The inter-satellite K-band ranging (KBR) observations (range r, range-rate $\dot{r}$, range-acceleration $\ddot{r}$) are obtained for the imperfect inter-satellite pointing (Bandikova et al., 2010) by applying the KBR antenna offset correction (ADC).

The significant effect of the improved attitude data on the KBR antenna offset correction for range is demonstrated in Fig. 4. Additionally in Fig. 4b, the difference of these two solutions is compared to the KBR system error which is modeled as white noise of 1 mm/s\(^2\) at the range level (Van Dam et al., 2004). Clearly, at frequencies below 2 Hz, the differences are above the expected error level.

B) The effect on the linear accelerations

The linear accelerations sensed by the accelerometer (ACC) represent the non-gravitational forces acting on the satellite. These accelerations are not derived from the position reference system (PRS) or an orbit related reference frame, which in case of the Celestial mechanics approach is the so called true radial reference frame (TRRF).

The differences of the rotated linear accelerations (using the “SCA1B RL02” and “SCA IfE” data) reach up to 1-1.5 mm/s\(^2\) (Fig. 5) which is up to two orders of magnitude above the expected error level (Fig. 6). The ACC error models (Bandikova et al., 2010) are originally defined for the ACC sensor frame (identical to SRF). However, as the TRRF is along the orbit almost aligned with the SRF, the error model can be adopted and is considered as true in TRRF.

3 – THE EFFECT ON THE GRAVITY FIELD

A) Simulation study

The error budget of the current temporal gravity field releases is dominated by errors coming from sources other than from the imperfect quaternion combination in SCA1B RL02.

B) Celestial mechanics approach

The difference degree amplitudes relative to the static field are shown in Fig. 7. Tiny differences are obvious between degree 15 and degree 40. Above degree 30, the difference degree amplitudes are dominated by noise.

C) Variational equations approach

The difference degree amplitudes relative to the static field for the two monthly solutions are again almost identical (cf. Fig. 10). Tiny differences can be found between degrees 25-40.

4 – CONCLUSIONS

The improved star camera data generated by IfE substantially improve the accuracy of the KBR ranging observations and linear accelerations as their noise is decreased by up to 2 orders of magnitude.

The effect on the gravity field is at mm-level in terms of geoid.

The error budget of the current temporal gravity field releases is dominated by errors coming from sources other than from the imperfect quaternion combination in SCA1B RL02.

5 – REFERENCES


6 – ACKNOWLEDGEMENTS

The GRACE Science Team Meeting and on the gravity field is needed and presented here.

The RSES GRACE Simulator was supported by an Australian Research Council grant (DP0874998) and an Australian Space Research Project.