Acknowledgements

References

Contact

We want to thank Dr. Srinivas Bettadpur from the UTCforS for providing combined SCA1B (Repro) data, which is then used as input for our sensor fusion approach (SCAFusion). Additionally, the high frequent noise within the instrument data is an essential information needed to make use of the corrected SCA1B (Repro) data, which is then used as input for our sensor fusion approach (SCAFusion).

Outlook

Further research - SCA Sensor fusion:
- Direct use of SCA heads within Sensor fusion
- Optimal combination (weighting)
- SCA orientation & alignment (thermal effects)
- Comparison with SCA1B RL03 data product (1)
- Extension to 3 SCA heads for GRACE-FO

Further research - ACC:
- Outlier detection
- ACC data calibration (4)
- Additional years, particularly later and nosier years (>2011-01), need to be further analyzed.

Onboard each GRACE satellite is a three-axis capacity accelerometer, measuring the non-conservative forces acting upon the satellites. In order to make use of the uncalibrated ACC1B data during gravity field recovery, bias and noise parameters have to be estimated (4).

Fig. 4: Processing scheme from ACC1A to ACC1B according to SCA (compressor(7) for linear and angular accelerations, respectively.

Fig. 6: Comparison of the arc-wise mean of the post-fit range rate residuals for one month (2011-09).


Recovered gravity field solutions show no significant improvement
Post-fit range rate residuals show a small reduction

Accelerometer data processing - ACC1B (Repro)

High-frequency noise (cross-track, radial) related to the geophysical equator seems to be "amplified" during ACC1A to ACC1B processing (CRN Filter)
Fig. 5:
- ACC1B (Repro)
- ACC1B (RL02)
- SCAFusion (RL02)

Sensor fusion - SCA1B (RL02) vs. SCA1B (Repro) vs. SCAFusion

Sensor fusion - ACC and SCA combination [5]

Combination of angular accelerometer & star camera data in a Least Squares Adjustment (LSA):

Functional relationship established through:

- Angular accelerometer bias estimation
- Effect of non-quadratic accelerometer proof mass taken into account
- Optimal weighting (angular accelerations, quaternions) by Variance Component Estimation (VCE)

Antenna offset correction (AOC)

Reduction of high-frequency attitude noise SCA1B (Repro): switches between SCA heads lead to discontinuities (jumps) in derived AOCS (e.g., GRACE-S1B switches SCA2, Ref. [3] (a)).

Fig. 6: Grace range rate antenna offset corrections (AOCs) for a 2h segment on 2011-09-01, (b) Range rate AOCs computed from the re-processed SCA1B (Repro) data for one month (2011-09), (c) SCA heads used for the computation of the SCA1B (Repro) data.

Fig. 3: (a) GRACE range rate antenna offset corrections (AOCs) for a 2h segment on 2011-09-01, (b) Range rate AOCs computed from the re-processed SCA1B (Repro) data for one month (2011-09), (c) SCA heads used for the computation of the SCA1B (Repro) data.

[5] Klinger, B., Mayer-Gürr, T., 2014. Combination of GRACE star camera and angular accelerometer data for a 2h segment on 2011-09-01, (b) Range rate AOCs computed from the re-processed SCA1B (Repro) data for one month (2011-09), (c) SCA heads used for the computation of the SCA1B (Repro) data.
[6] Klinger, B., Mayer-Gürr, T., 2014. Combination of GRACE star camera and angular accelerometer data for a 2h segment on 2011-09-01, (b) Range rate AOCs computed from the re-processed SCA1B (Repro) data for one month (2011-09), (c) SCA heads used for the computation of the SCA1B (Repro) data.

Fig. 2: Power spectral density (PSD) of angular accelerations in cross-track (a) and radial (b) direction for a 2h segment on 2011-09-01 for GRACE-A.

Sensor fusion - SCA1B (RL02) vs. SCA1B (Repro) vs. SCAFusion

Angular accelerations

Spacecraft attitude (a) and orbit (b) information are derived using the SCA1B (Repro) data, and ACC1B (Repro) data, respectively.

Fig. 5: SCAFusion (RL02) vs. SCA1B (Repro) vs. SCA1B (RL02) for a 2h segment on 2011-09-01 for GRACE-A.

Star camera data processing - SCA1B (Repro)

The attitude of the GRACE spacecrafts w.r.t. the inertial frame is an essential information needed for the gravity field recovery (cf. Fig. 1). As shown by [2] and [3], the current SCA (RL02) data product contains several errors, which propagate to the gravity field solutions. Additionally, the high frequent noise within the instrument data can be reduced by combining the star camera and angular accelerometer data as shown by [5] and [1]). Therefore, we reprocessed the SCA1A data to derive correctly combined SCA1B (Repro) data, which is then used as input for our sensor fusion approach (SCAFusion).

Fig. 1: Processing scheme from SCA1A to SCA1B according to SCAFusion (RL02).