Gravity field models derived from Swarm GPS data

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Introduction

The **Swarm satellites** collect **hl-SST data** data, which can be exploited to derive the **monthly temporal variations** of Earth's gravity field.

A number of institutes (see table) is **routinely producing gravity field models** representing the mass transport processes at long wavelengths. Each institute uses a **different gravity field inversion approach**. This study illustrates how those approaches compare when **the same kinematic orbit solution is considered**, from AIUB.

The **individual models** (estimated with data from all three Swarm satellite) are analysed as well as the **combined model**, computed as the arithmetic average. The **GRACE KBR-derived models** are regarded as the "truth" to derive **error estimates** (Figure 1).

Swarm gravity field models

Inst.	Location	Approach	Max. Degree	Ref. Gravity Field	Reference
AIUB	Bern, Switzerland	Celestial Mechanics Approach (Beutler et al., 2010)	90	EGM2008	Jäggi et al. (2016)
ASU	Prague, Czech Rep.	Acceleration approach (Bezděk et al., 2014)	40, 60	ITG-Grace2010s	Bezděk et al. (2016)
IfG	Graz, Austria	Short-arc approach (Mayer-Gürr, 2006)	60	GOCO05S	Zehentner and Mayer-Gürr (2015)

Error estimates

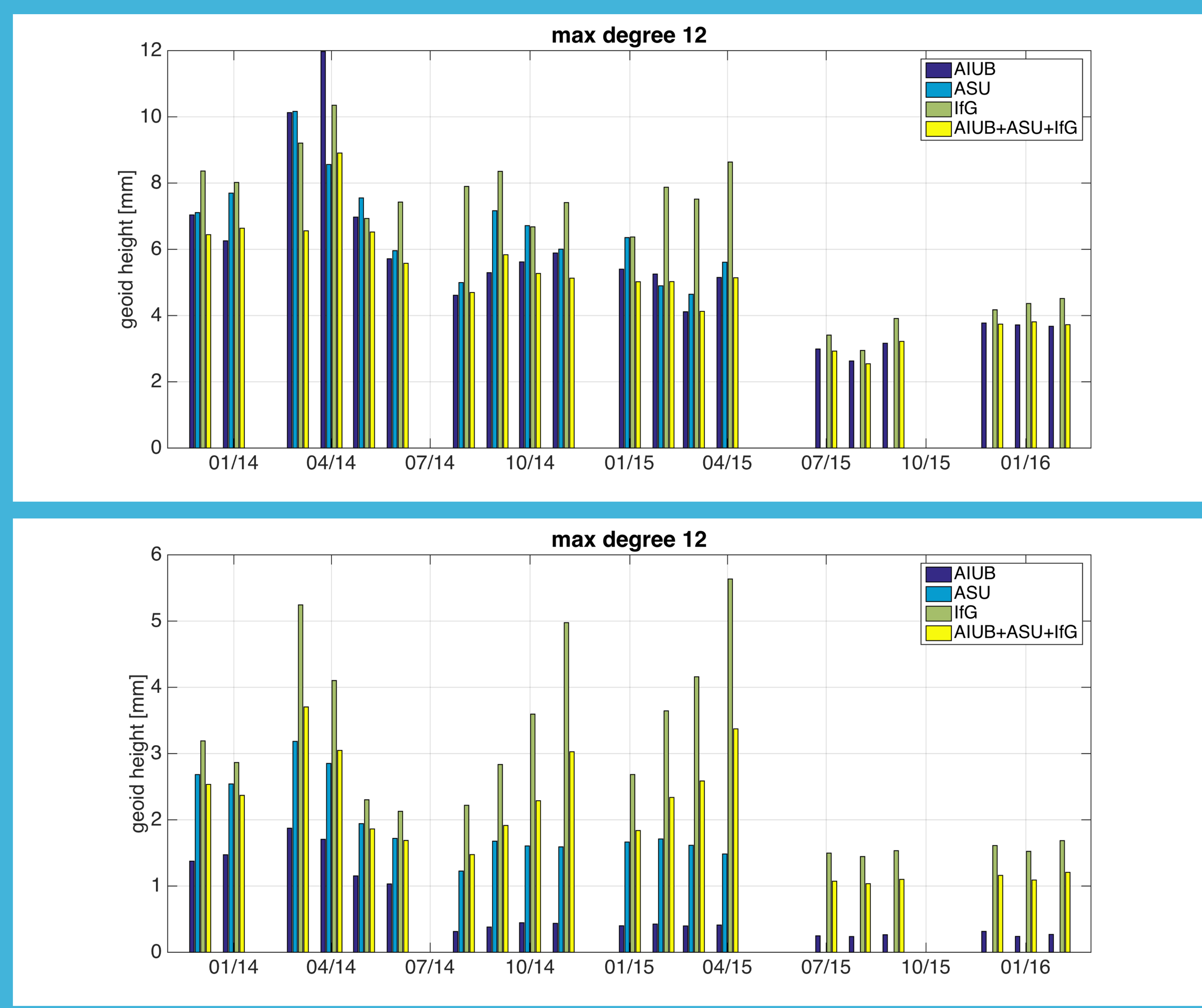

Figure 1 – Time series of the cumulative amplitude of the error truncated at degree 12 (i.e. no smoothing considered) of the gravity field models considered in the study, for the considered months, estimated from GRACE data (top) and provided with the Swarm models (bottom).

Smoothed models

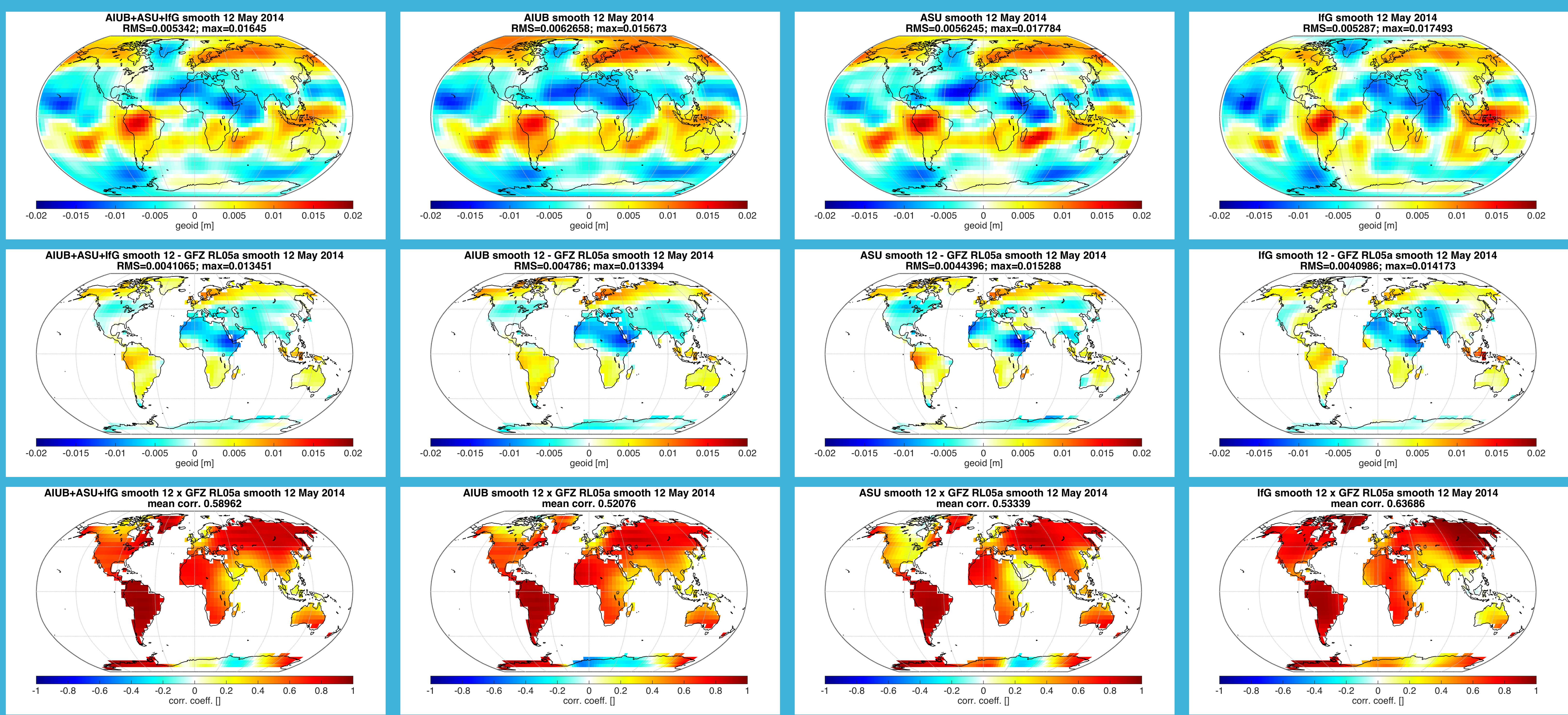

Figure 2 – On the **first row**: geoid height of the time-variable signal represented by the Swarm models after 833 km Gaussian smoothing for May 2014; on the **second row**: difference between Swarm and (smoothed) GRACE models; on the **third row**: 2D correlation between the Swarm models and the GFZ GRACE model (dimensionless coefficients). **Global statistics** are shown in the sub-title for the top row and **continental statistics** for the middle and bottom rows. On the **first column**: the combined Swarm model; On the **second column**: the AIUB Swarm model; on the **third column**: the ASU Swarm model; on the **forth column**: the IfG Swarm model.

Conclusions

- Combined model systematically superior (in general), in spite of the same input data being used
- Exceptionally, individual solutions are in better agreement with GRACE than combined solutions, e.g. Jan and Apr 2014 => better combination scheme desirable
- Variances provided with the Swarm models (Figure 1, bottom) may predict residuals to GRACE (Figure 1, top) but calibration is required
- Residual to GRACE (which can be as low as 4 mm) generally smaller than signal amplitude, cf. Figure 2 first and second rows
- Good agreement in the spatial correlation between the smoothed Swarm and GRACE models (Figure 2, bottom row)

Bibliography

J. G. Teixeira Encarnação, Daniel Arnold, Ales Bezdek, Christoph Dahle, Eelco Doornbos, Jose van den IJssel, Adrian Jäggi, Torsten Mayer-Gürr, Josef Sebera, Pieter Visser, and Norbert Zehentner. **Gravity field models derived from Swarm GPS data**. *Earth, Planets and Space*, in review, 2016

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