GOCE Precise Science Orbits

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H. Bock[1], A. Jäggi[1], U. Meyer[1]

[1] Astronomical Institute, University of Bern, Bern, Switzerland

Introduction

ESA's first Earth Explorer Core Mission GOCE is equipped with a 12-channel, dual-frequency GPS receiver for precise orbit determination, instrument time-tagging, and the determination of the long wavelength part of the Earth's gravity field. A precise science orbit (PSO) product with 2-cm accuracy is provided by the GOCE High-level Processing Facility (HPF) with a latency of 1-week for final analyses. We present the reduced-dynamic and kinematic PSO results obtained from almost two years of operations. Internal orbit comparisons and external validations with independent Satellite Laser Ranging (SLR) measurements demonstrate that the PSO product fully meets the mission requirements.

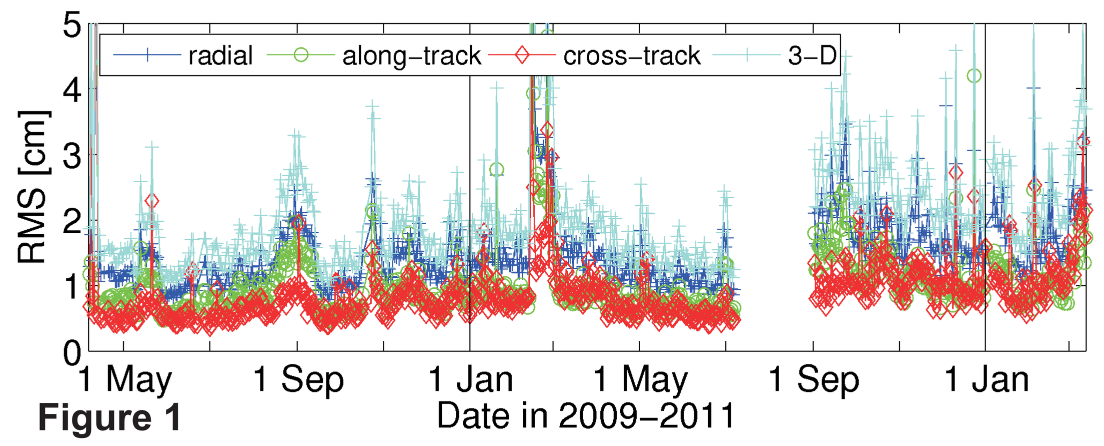

Figure 1

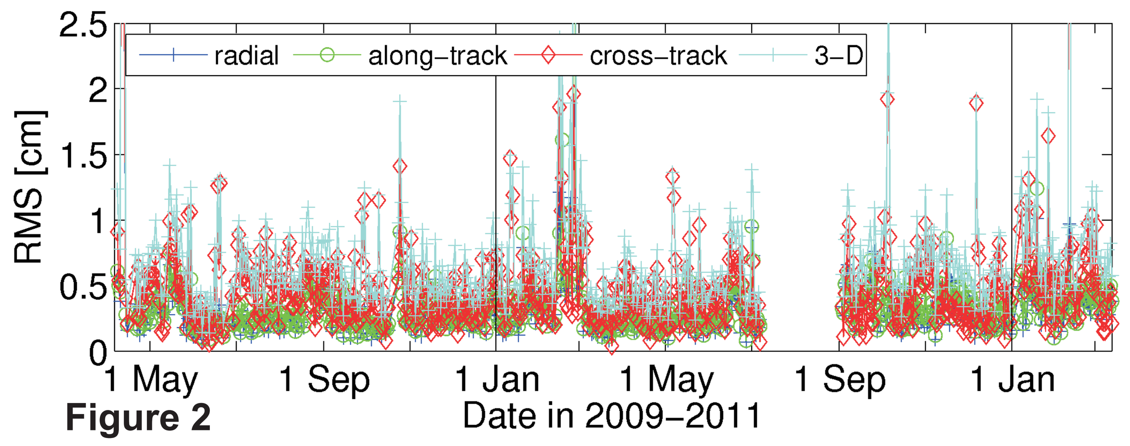

Figure 2

Internal and external orbit validation

The RMS values from the differences between the reduced-dynamic and the kinematic PSO (Figure 1) show the good consistency between the two orbit types (mean 3D-RMS: 2.07 cm). After the data gap in summer 2010, however, the RMS values obviously increase. Figure 3 shows the orbit differences for a day before (21 Jun 2010) and after (29 Sep 2010) the break. The larger differences mainly occur at polar regions close to the geomagnetic poles. Figure 4 shows the RMS of the differences between reduced-dynamic and kinematic orbits per 1°x1° geographical bins. For further investigations on this phenomena we refer to the poster **EGU2011-3561 "Issues of GOCE SSTI processing"**.

The 5h-overlap analysis (21:30 - 02:30) of the reduced-dynamic PSO (Figure 2, mean 3D-RMS: 0.98 cm) indicates a very good internal orbit quality. No significant increase is visible after the data gap in summer 2010.

External orbit validation is done with SLR measurements (Figures 5 and 6). The RMS values of 1.71 cm and 2.00 cm for the reduced-dynamic and kinematic orbits, respectively, confirm that the mission requirements are met.

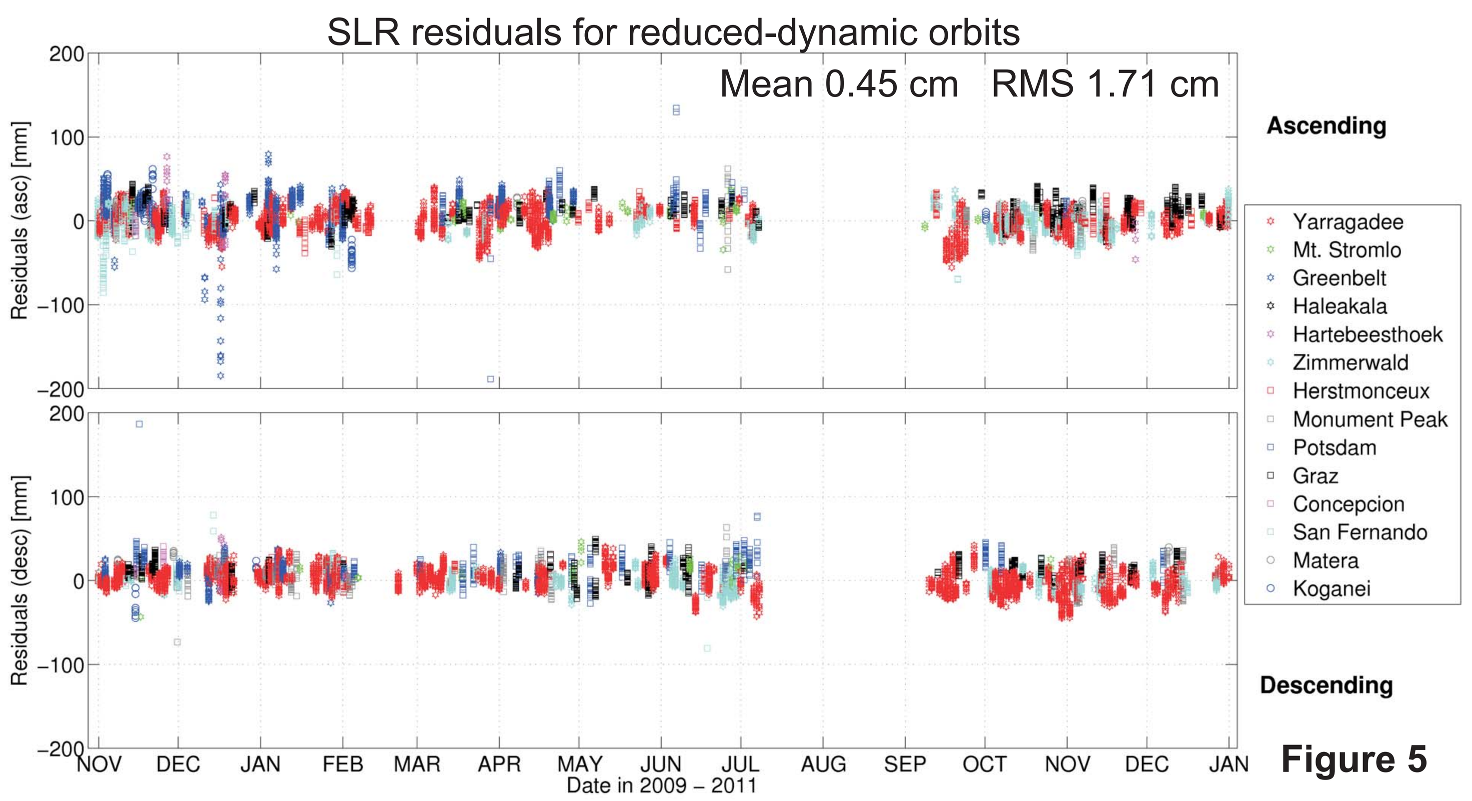

Figure 5

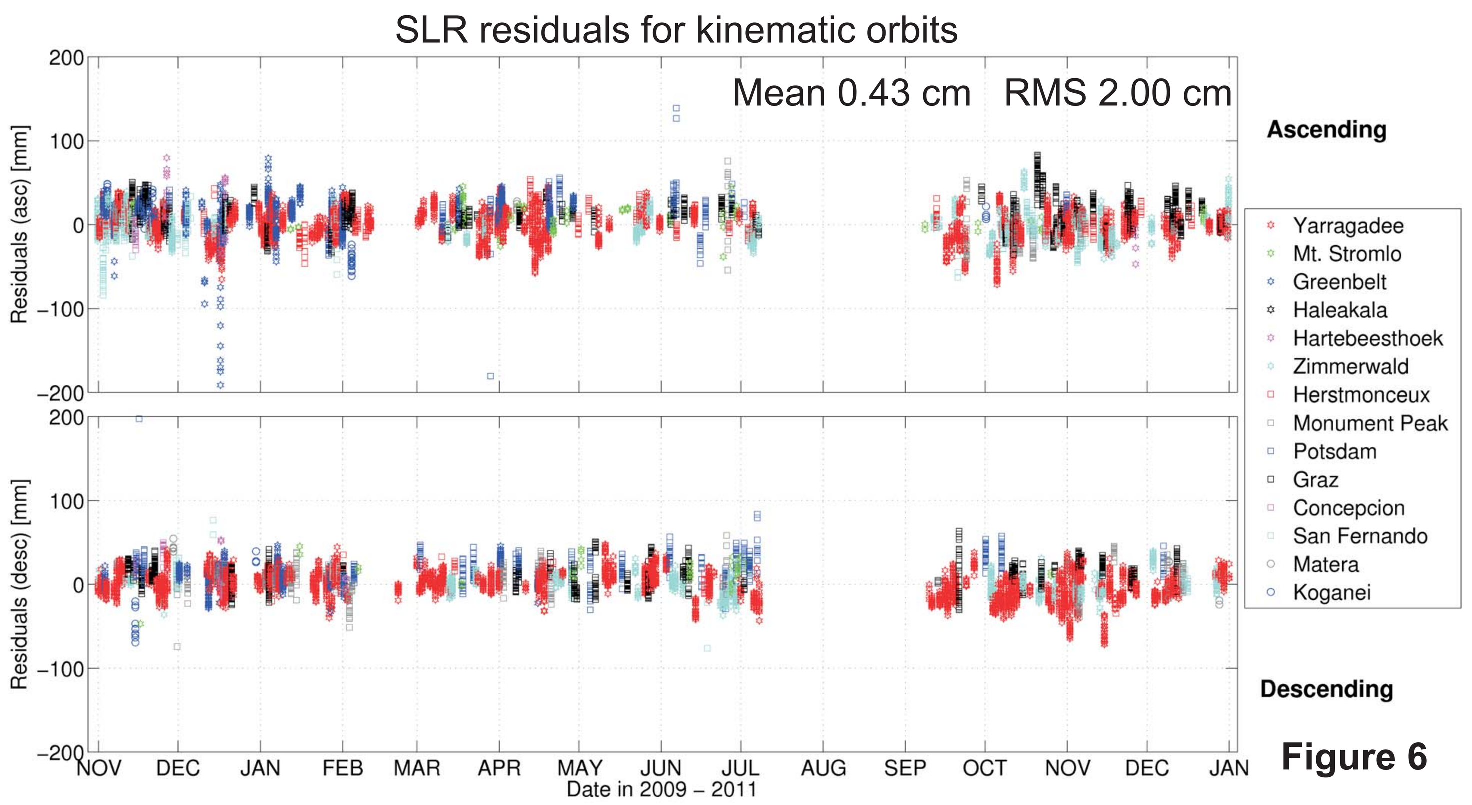

Figure 6

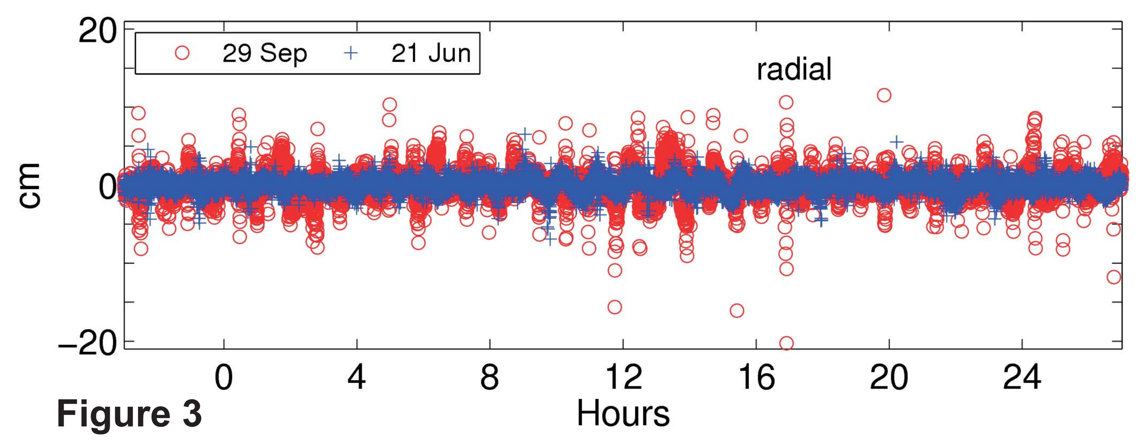

Figure 3

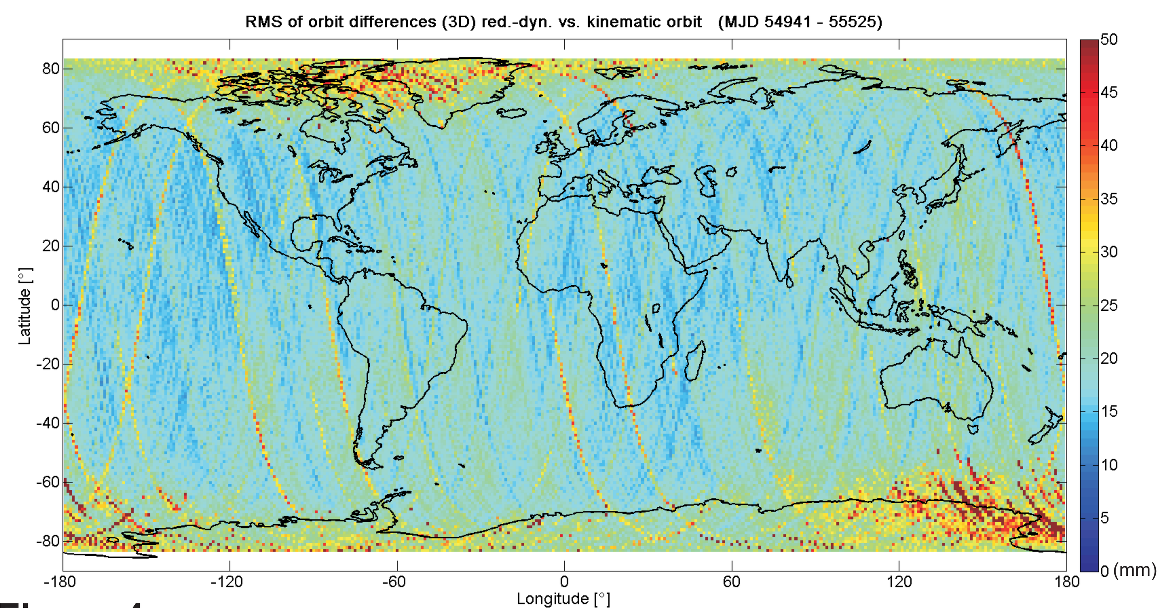

Figure 4

Comparison of SSTI-A and SSTI-B

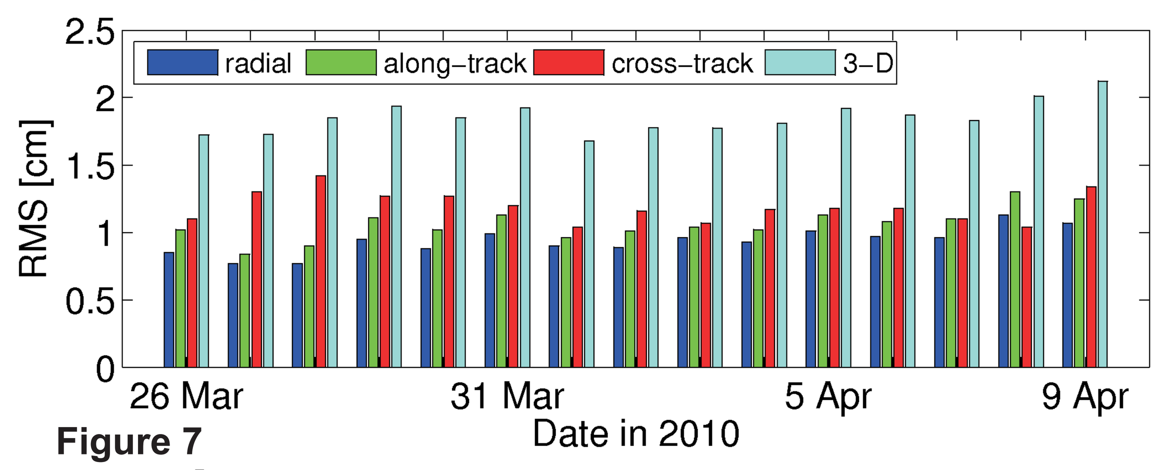

Figure 7

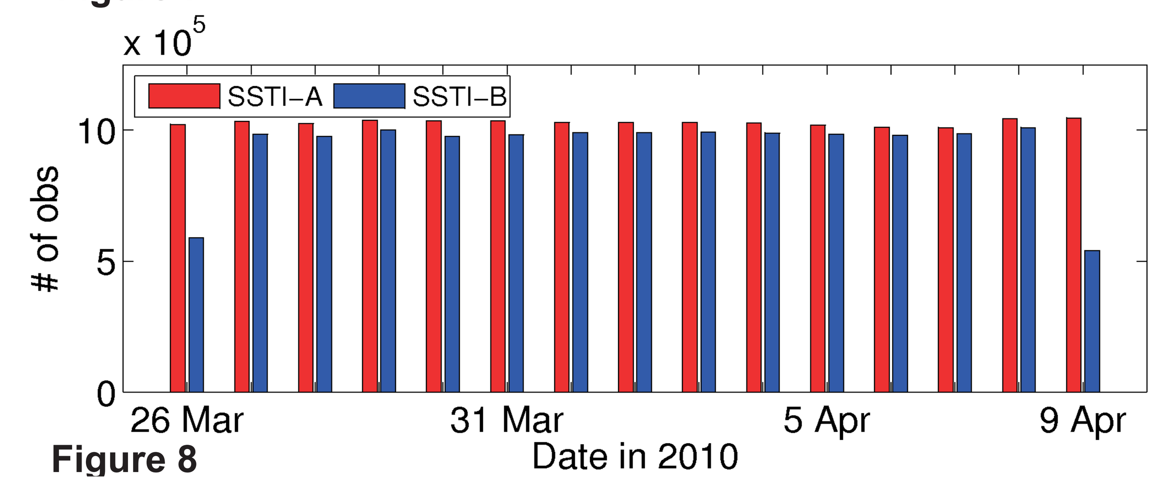

Figure 8

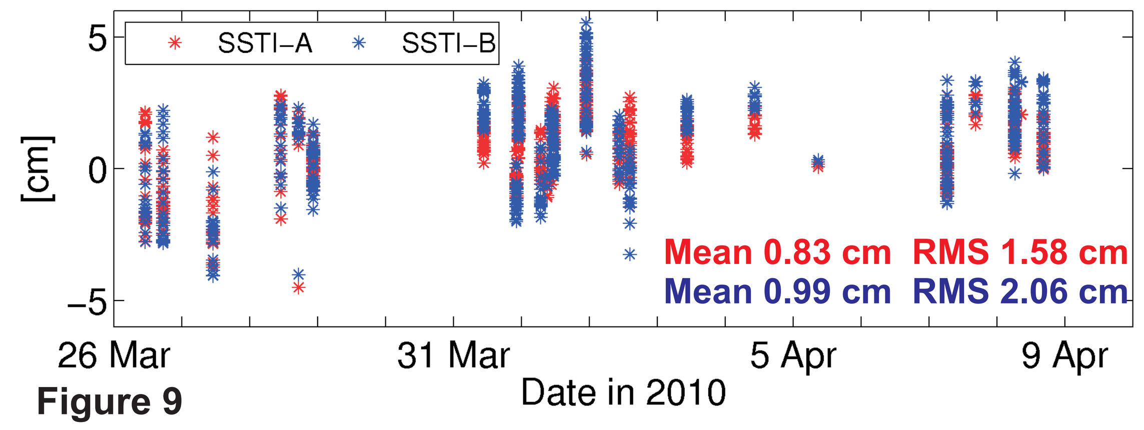

Figure 9

Both SSTIs (satellite-to-satellite tracking instruments) were running in parallel from 26 March to 9 April 2010. An orbit determination has been performed with both antennas separately. Figure 7 shows the RMS values for the differences of the reduced-dynamic orbits (mean 3D-RMS: 1.85 cm) from SSTI-A and SSTI-B. The number of observations (Figure 8) is smaller for SSTI-B, which is mainly due to later acquisition and earlier loss of L2 at beginning and end of satellite passes.

Orbit validation with SLR (Figure 8) indicates a slightly inferior performance for the SSTI-B antenna whereas the data set is quite short for a comprehensive conclusion.

Phase center variations

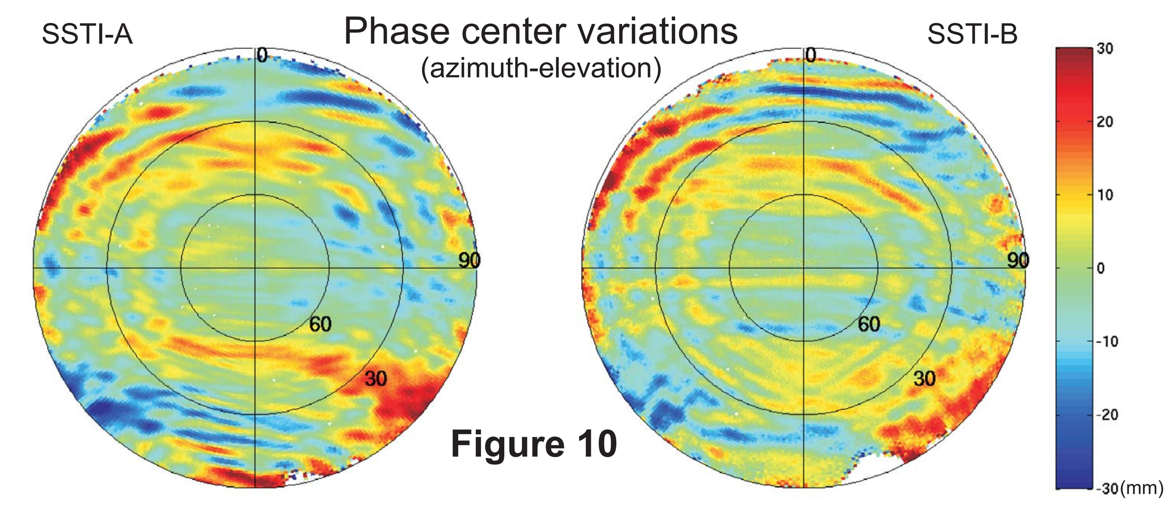

Figure 10

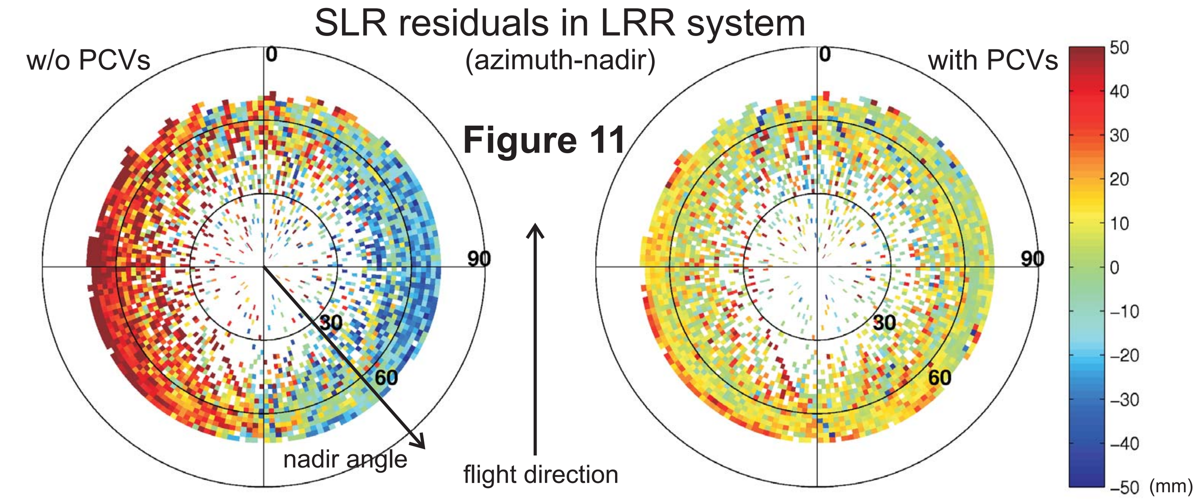

Figure 11

Phase center variations (PCVs) for both SSTIs are empirically derived (10 iterations) from 154 days of data for SSTI-A (Figure 10, left) and from nearly 58 days of data for SSTI-B (Figure 10, right).

Orbit validation with SLR (Figure 11, residuals in laser retro reflector (LRR) system) confirms cross-track orbit shifts due to correction of the PCVs in the orbit determination. Figure 12 shows the cross-track orbit differences for an example day for the iterations N1-N10 of the PCV generation with respect to the orbit solution N0 without corrected PCVs.

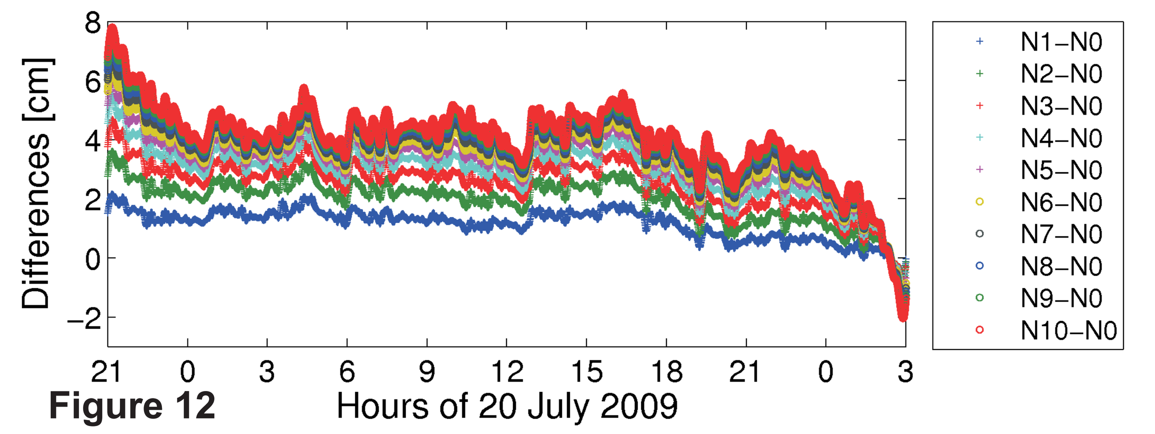

Figure 12

Summary

The GOCE PSO product is available for almost two years. The accuracy requirement of 2 cm is met, which is confirmed by SLR RMS values of 1.71 cm for the reduced-dynamic and 2.00 cm for the kinematic orbits. The orbit quality is partly degraded over the polar regions. Investigations are ongoing to find the root cause for this.

A comparison of orbits generated from both SSTI's separately shows good agreement with an RMS below 2 cm. The performance of SSTI-B is slightly inferior with less delivered observations and slightly worse SLR validation.

PCVs for both antennas have been empirically derived from 154 days (SSTI-A) and about 58 days (SSTI-B) of data. Cross-track shifts of the orbits result when correcting for the PCVs. These cross-track shifts could be confirmed by SLR validation.

Contact address

Heike Bock
Astronomical Institute, University of Bern
Sidlerstrasse 5
3012 Bern (Switzerland)
heike.bock@aiub.unibe.ch

AIUB

Poster compiled by H. Bock, March 2011
Astronomical Institute, University of Bern, Bern
heike.bock@aiub.unibe.ch