2-P-204

ESA Living Planet Symposium 2013
9-14 September 2013, Edinburgh, U.K.

Four Years of Orbit Determination for the GOCE Satellite

H. Bock[1], A. Jäggi[1], U. Meyer[1], J. van den IJssel[2], P. Visser[2], M. Heinze[3]

[1] Astronomical Institute, University of Bern, Bern, Switzerland
[2] Faculty of Aerospace Engineering, Delft University of Technology, The Netherlands
[3] Institut für Astronomische und Physikalische Geodäsie (IAPG), Technische Universität München, Germany

Introduction

The GOCE High-level Processing Facility is providing the Level 2 orbit products, namely Rapid Science Orbit (RSO) and Precise Science Orbit (PSO) since the beginning of the mission in March 2009. Both products consist of a reduced-dynamic and a kinematic orbit. The RSO is generated at the Delft University of Technology and the PSO at the University of Bern.

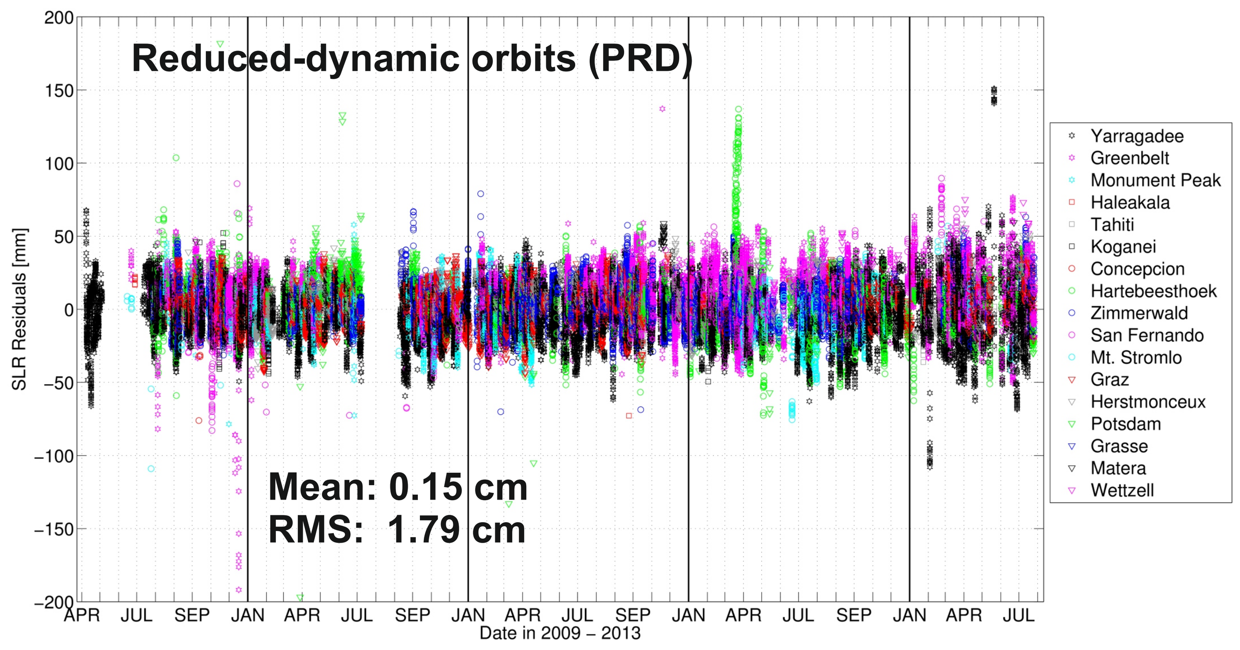
The quality of these orbit products is assessed and validated based on satellite laser ranging (SLR) measurements and by comparison of the different solutions. The impact of increasing solar activity and the lowering of the orbit on the orbit quality is discussed.

Abbreviations of the orbit solutions:

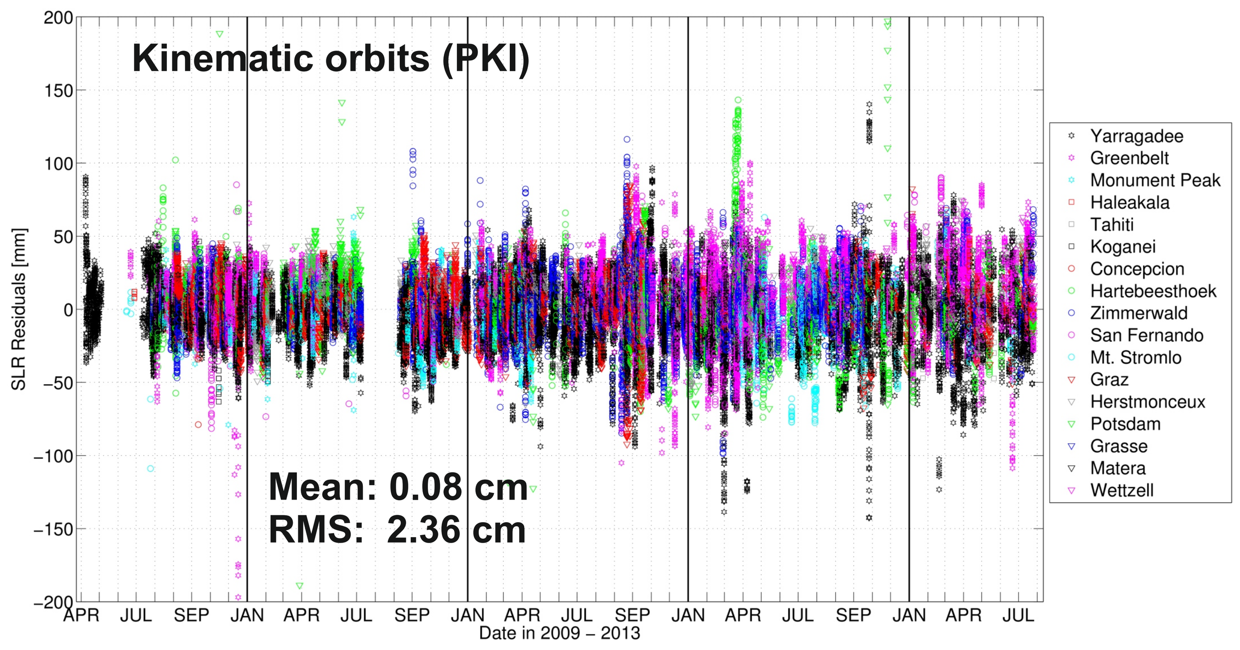
PRD: Reduced-dynamic orbit of the PSO
PKI: Kinematic orbit of the PSO

RRD: Reduced-dynamic orbit of the RSO
RKI: Kinematic orbit of the RSO

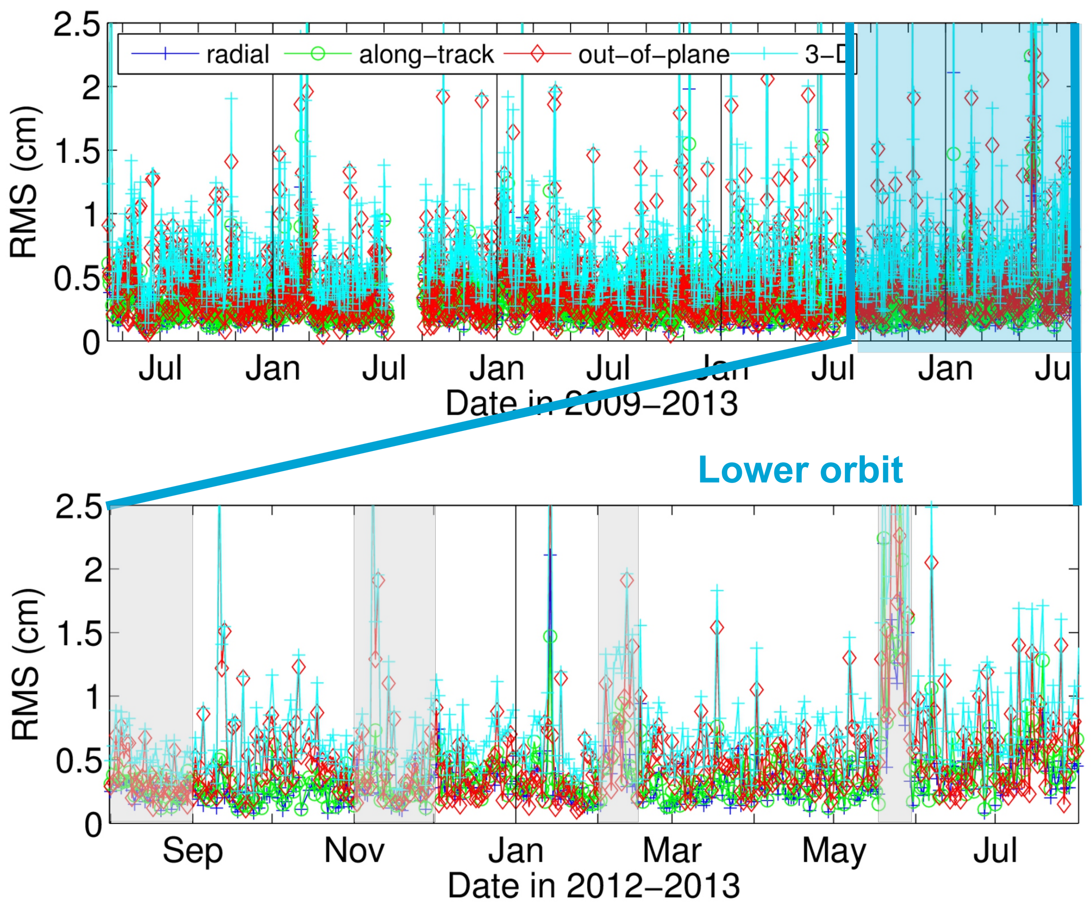
SLR validation



SLR measurements are used for the external validation of the GPS-derived GOCE orbits.
The quality of the reduced-dynamic orbits (left) is on a similar level for the years 2009-2012. Starting with 2013 the scatter gets larger.
The scatter of the SLR residuals for the kinematic orbits (right) is not that constant as for the reduced-dynamic orbits and shows several intervals with increased scatter, e.g., autumn 2011 or spring 2012. The kinematic orbits are more sensitive to data problems, e.g., data gaps.

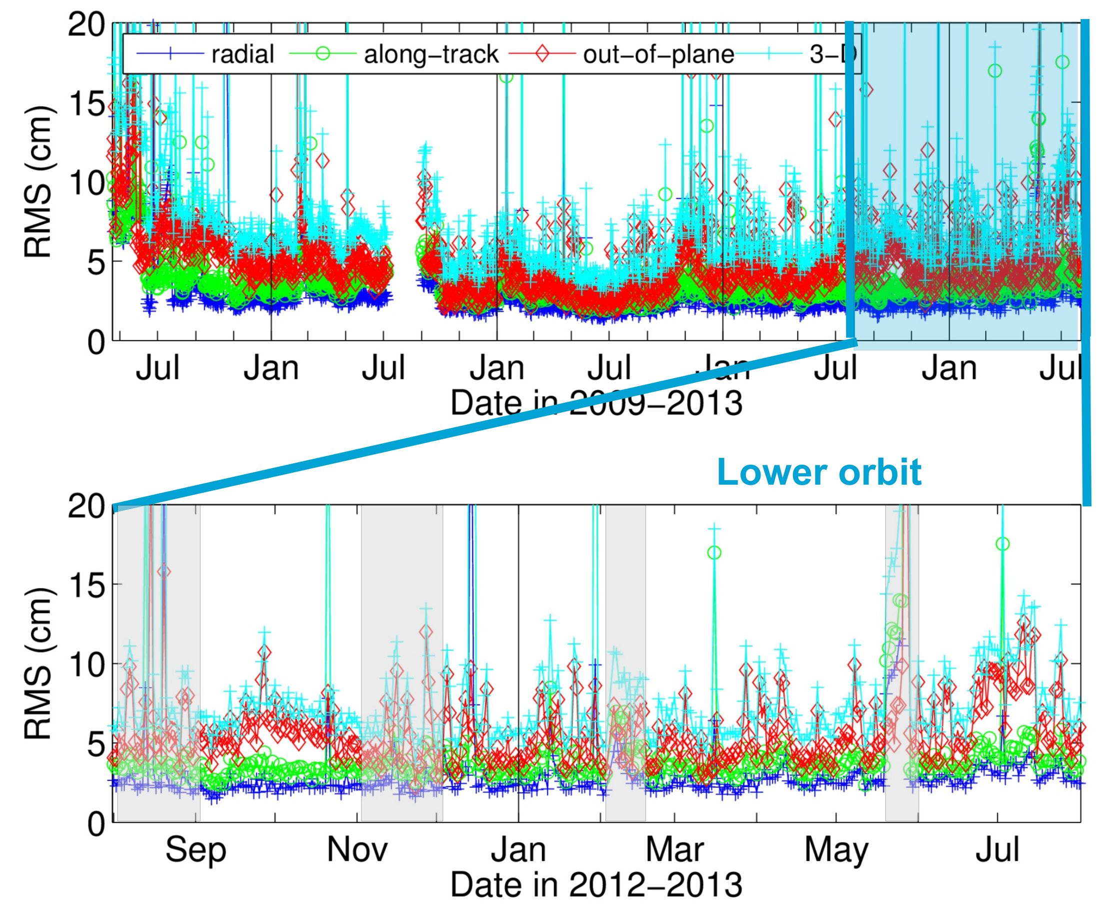


Orbit overlap analysis (PRD)



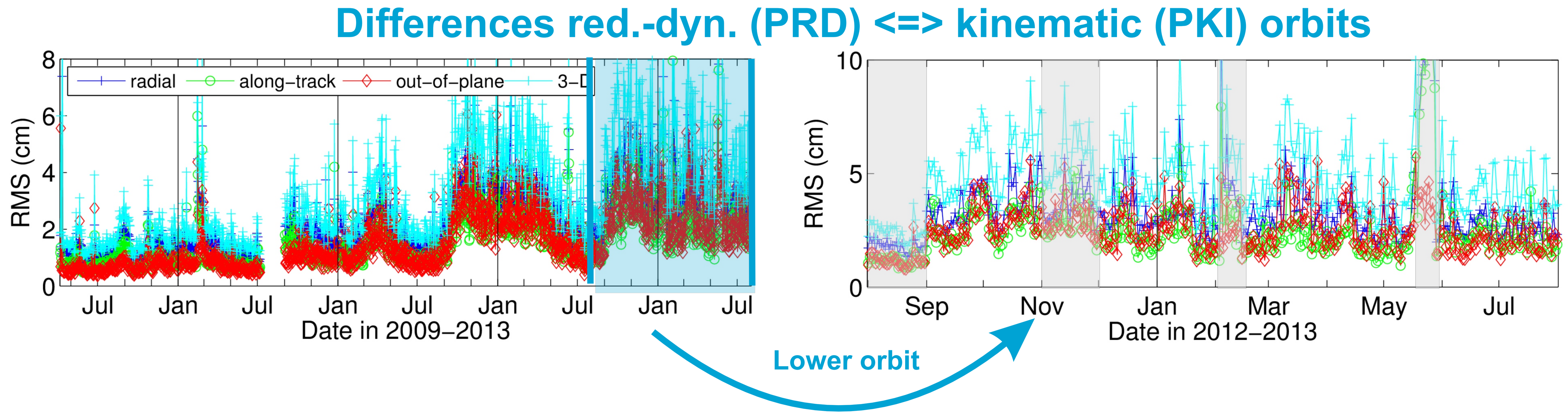
The orbit overlap analysis (5 h overlaps) for the reduced-dynamic orbit of the PSO solution (PRD) is very consistent over the four years of operation. Short periods show larger RMS values corresponding to non drag-free periods. The reduced-dynamic orbit parametrization is not optimized for these periods, because the constraints of the piece-wise constant accelerations might be too tight. Not all non drag-free periods during the lowering of the orbit (grey boxes in bottom plot), however, are affected.

Orbit differences PRD <=> RRD: RMS



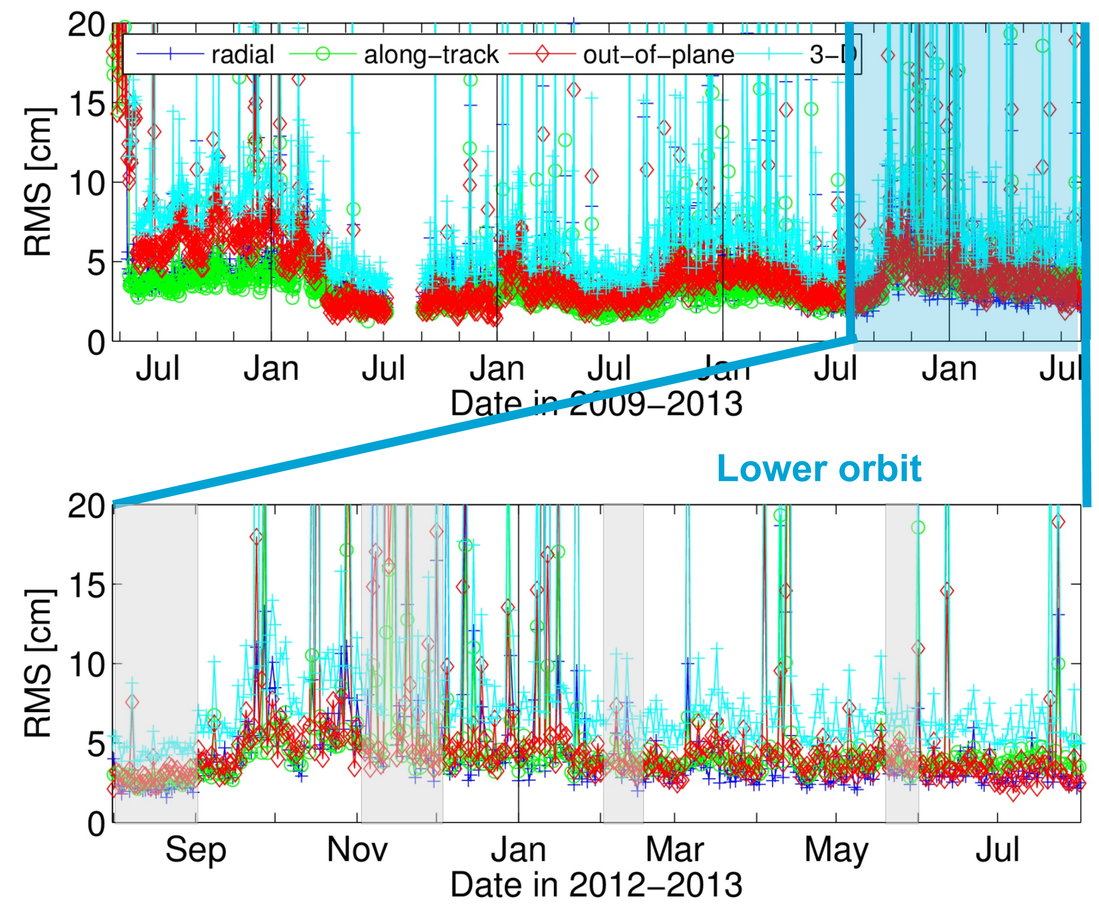
The orbit differences between PRD and RRD show that the quality of the RRD is below the 10 cm level for most of the time. Improvement steps in the time series are related to improvements in the RSO processing, e.g., adoption of the phase center variation map.

Differences red.-dyn. (PRD) <=> kinematic (PKI) orbits



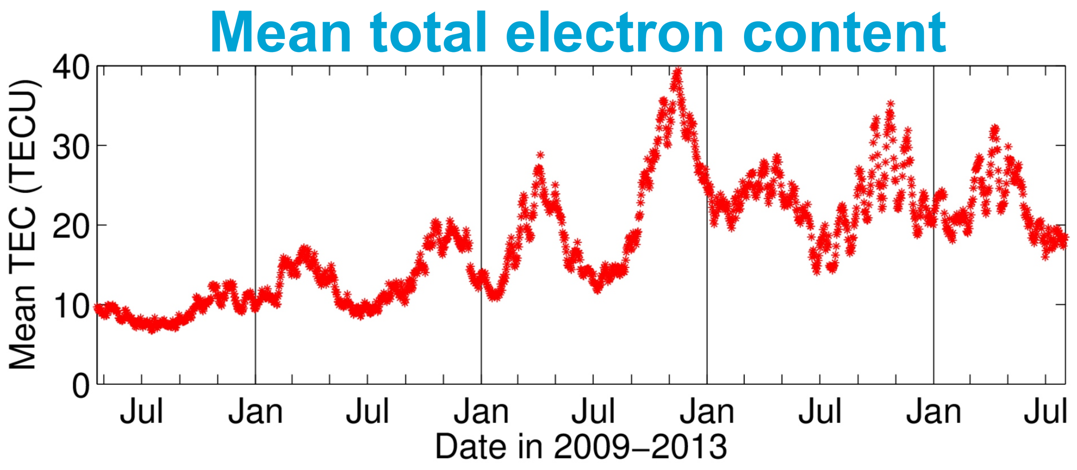
The RMS values of the differences between reduced-dynamic (PRD) and kinematic (PKI) orbits are a measure of the consistency between the two orbit types. They show an increase over the years. Seasonal variations are visible as well but no longer for the low orbit phase in 2013. Except some outliers during non drag-free periods (grey boxes) the RMS values show no significant different behaviour in the low orbit phase.

Orbit differences PKI <=> RKI: RMS

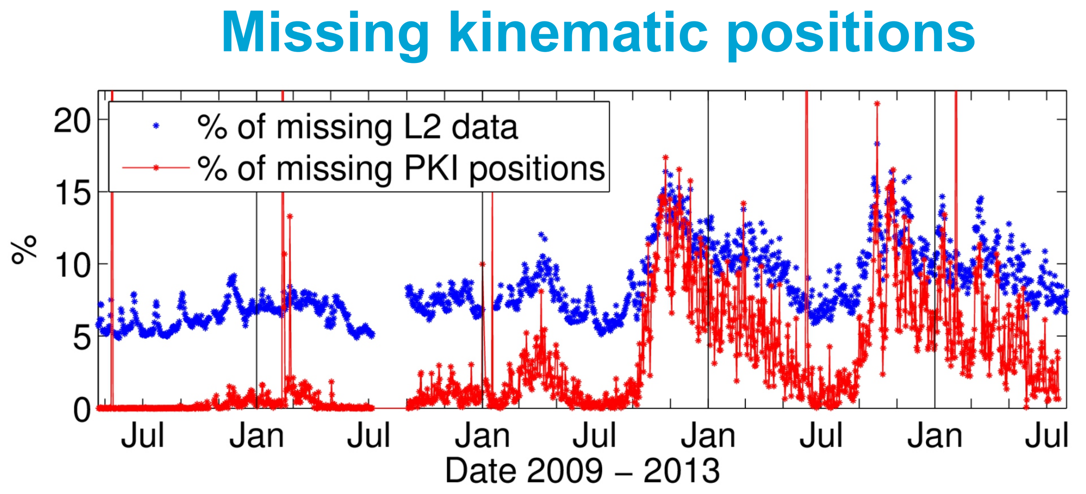


The RMS values of the differences between PKI and RKI orbits are below 10 cm for most of the time as well. The variations are, however, larger than for the RRD <=> PRD comparison. Starting with 1 April 2010 the antenna phase center map computed at AIUB is not only used for the computation of the RRD but also for the RKI at Delft, which is reflected by a jump and a significantly improved consistency of the PKI and RKI solutions. Starting 2 January 2012 data from the redundant antenna had to be used for the operational orbit determination procedures at Bern and Delft until 9 February 2012. No decent-quality PCV map could be used during this time period to compute the RKI solutions, again resulting in larger differences. Other variations of the RMS are mainly related to the issues of data losses caused by the varying ionospheric activity.

Mean total electron content

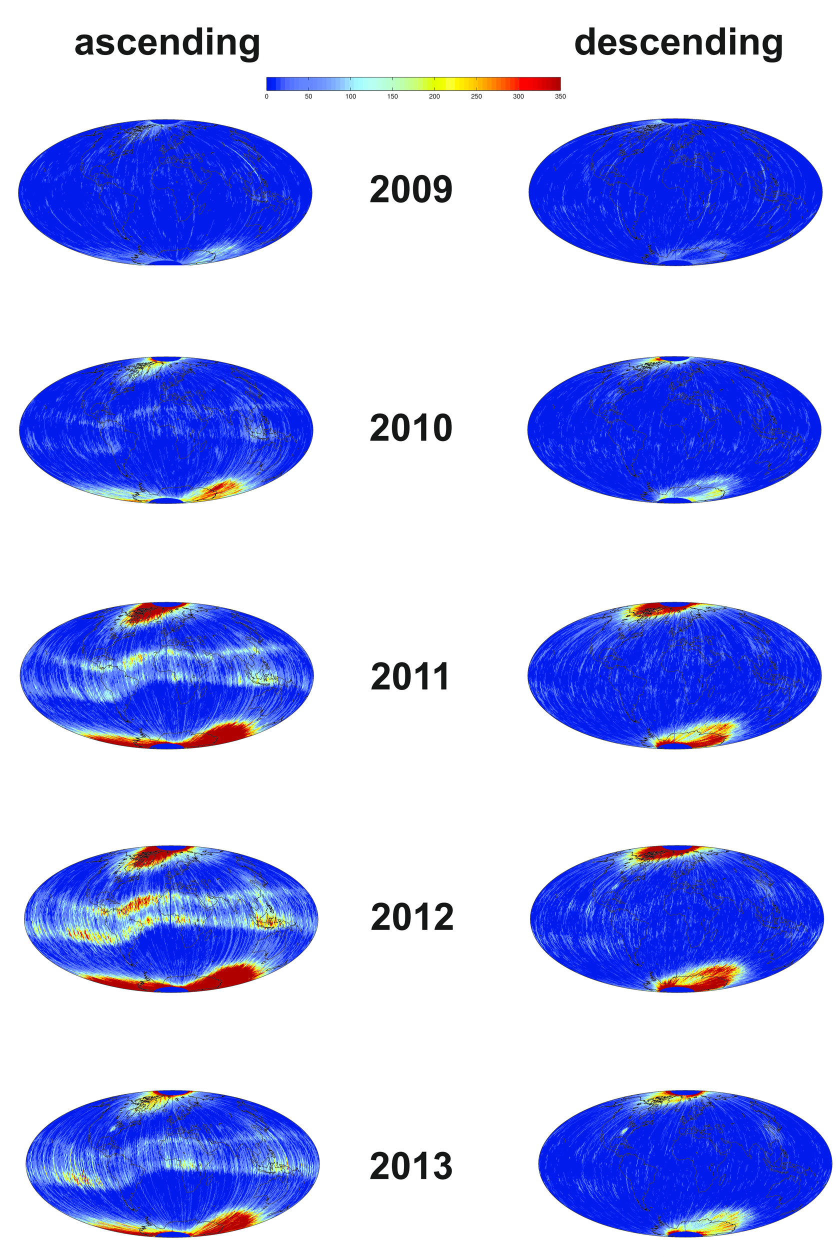


Missing kinematic positions



The correlation between the RMS values of the differences between reduced-dynamic (PRD) and kinematic (PKI) orbits, the mean total electron content, the missing L2 observations, and the missing kinematic positions (PKI) is obvious. The increasing solar activity has an impact on the tracking performance of the GOCE GPS receiver, mainly on the second frequency. Thus not for all epochs enough observations are available to determine a kinematic position. In extreme cases up to 15% of the kinematic positions are missing. This has a considerable impact when using kinematic positions to derive the long wavelength part of the Earth´s gravity field.

L2 data losses



Geographical distribution of L2 data losses for ascending (left column) and descending (right column) arcs over the entire mission duration. The L2 data losses are concentrated over the geomagnetic poles and, for ascending arcs, around the geomagnetic equator.

Summary

The results of four years of GOCE orbit determination are presented. The orbit quality is excellent for the entire mission duration, which is confirmed by SLR validation RMS of 1.79 cm and 2.36 cm for the reduced-dynamic and kinematic orbits of the PSO product, respectively. For the second half of the mission, however, GPS data and orbit quality suffer from increased solar activity resulting in degraded data availability due to L2 data losses and in more missing kinematic positions. The consistency between reduced-dynamic and kinematic orbits is suffering as well. Significant quality losses due to the lower orbit since August 2012 can not be found.

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, August 2013
Astronomical Institute, University of Bern, Bern
heike.bock@aiub.unibe.ch
TUDelft
IAPG