# GOCE – Validation of last days' orbits with kinematic PPP

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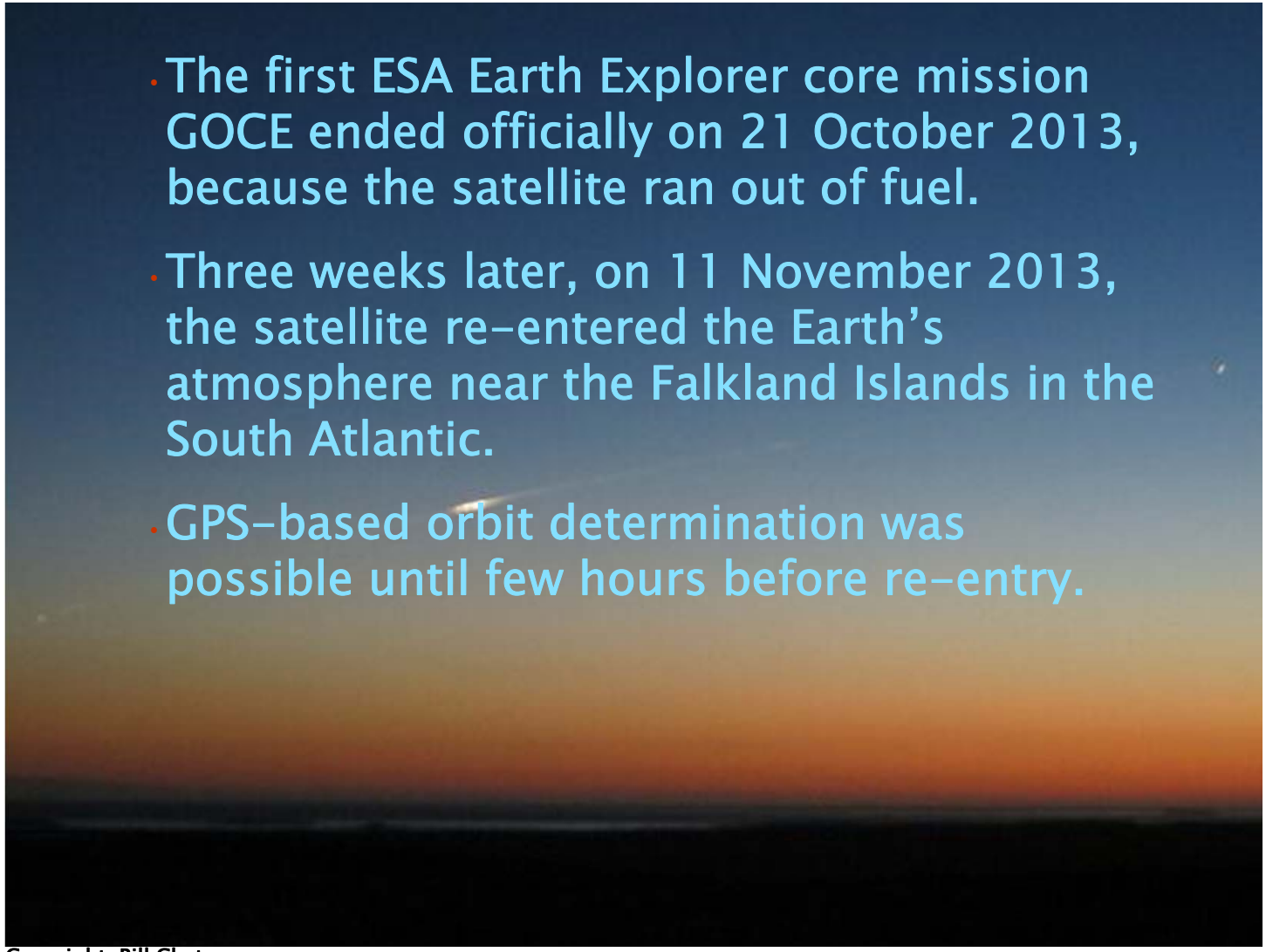
G1.3

EGU General Assembly 2014

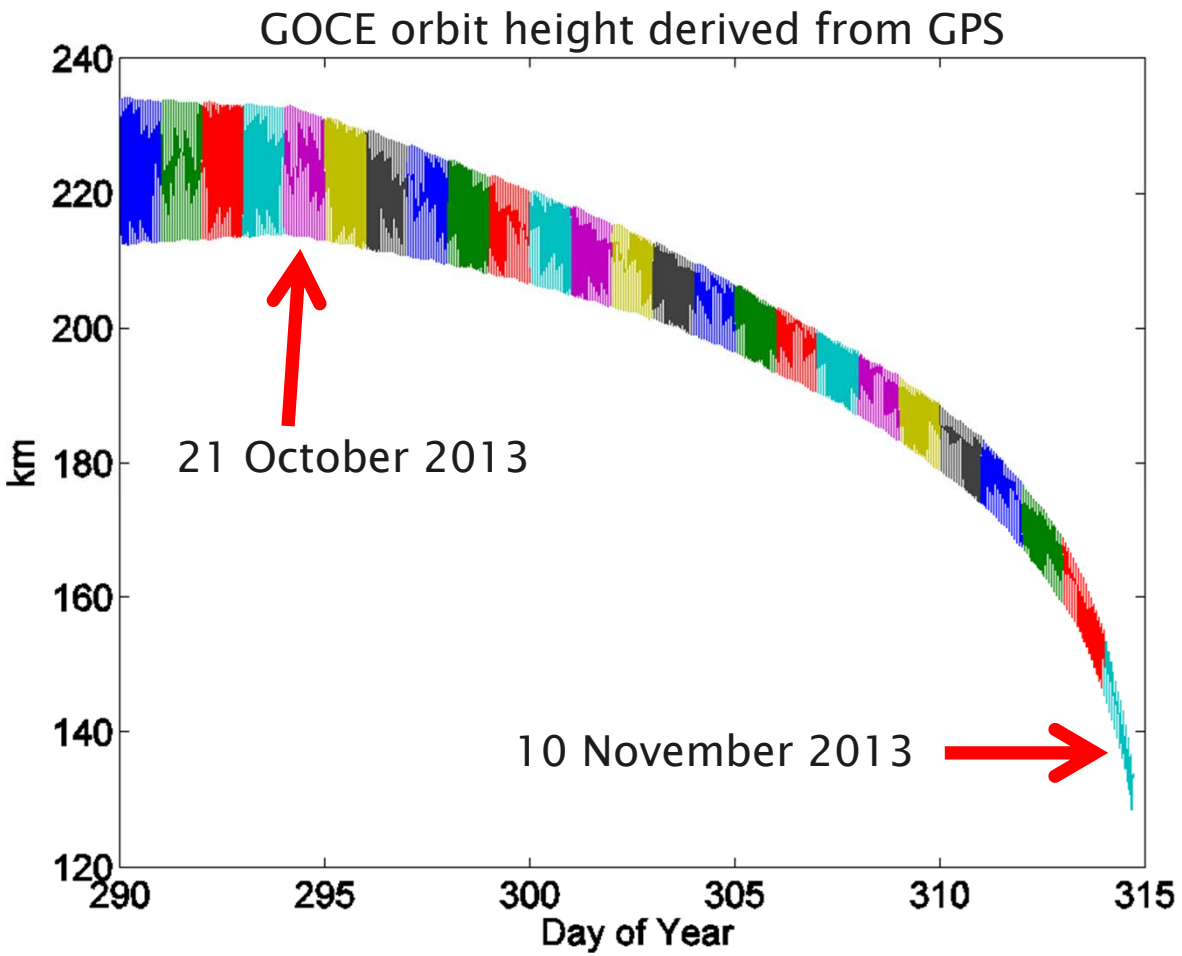
27 April –2 May 2014

Vienna, Austria

# Background and Motivation



# Background and Motivation




- Last available GPS measurements: **10 November, 17:15:20 UTC**

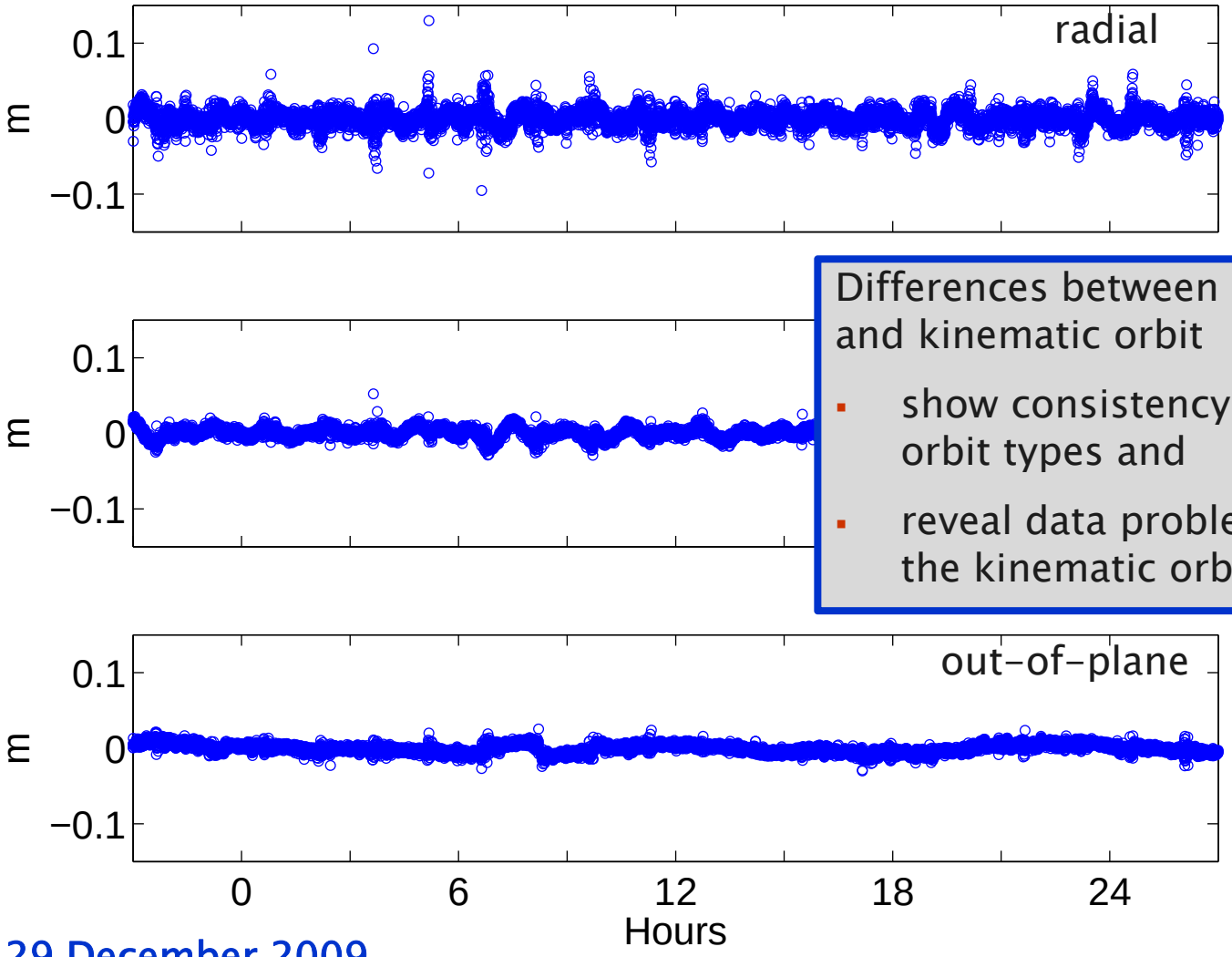
# Background and Motivation

- In the frame of the European GOCE Gravity Consortium (EGG-C) AIUB was responsible for the generation of the GOCE Precise Science Orbit (PSO) product.
- The PSO product consists of a reduced-dynamic and a kinematic orbit (comparable to a kinematic PPP of a ground station).
- Internal validation: Orbit overlap analysis and differences between reduced-dynamic and kinematic orbits for consistency checks.
- External validation: Satellite Laser Ranging (SLR) measurements.
- Reduced-dynamic orbits were generated with the same orbit parameterization for the entire mission.

Two main questions for this study:

- Can the kinematic orbits/PPP be used for validation, because SLR measurements are no longer available (only three passes)?
- Is the orbit parameterization of the reduced-dynamic orbit still reasonable for the last three weeks of GOCE?

# Differences red.–dyn. ⇔ kinematic orbits

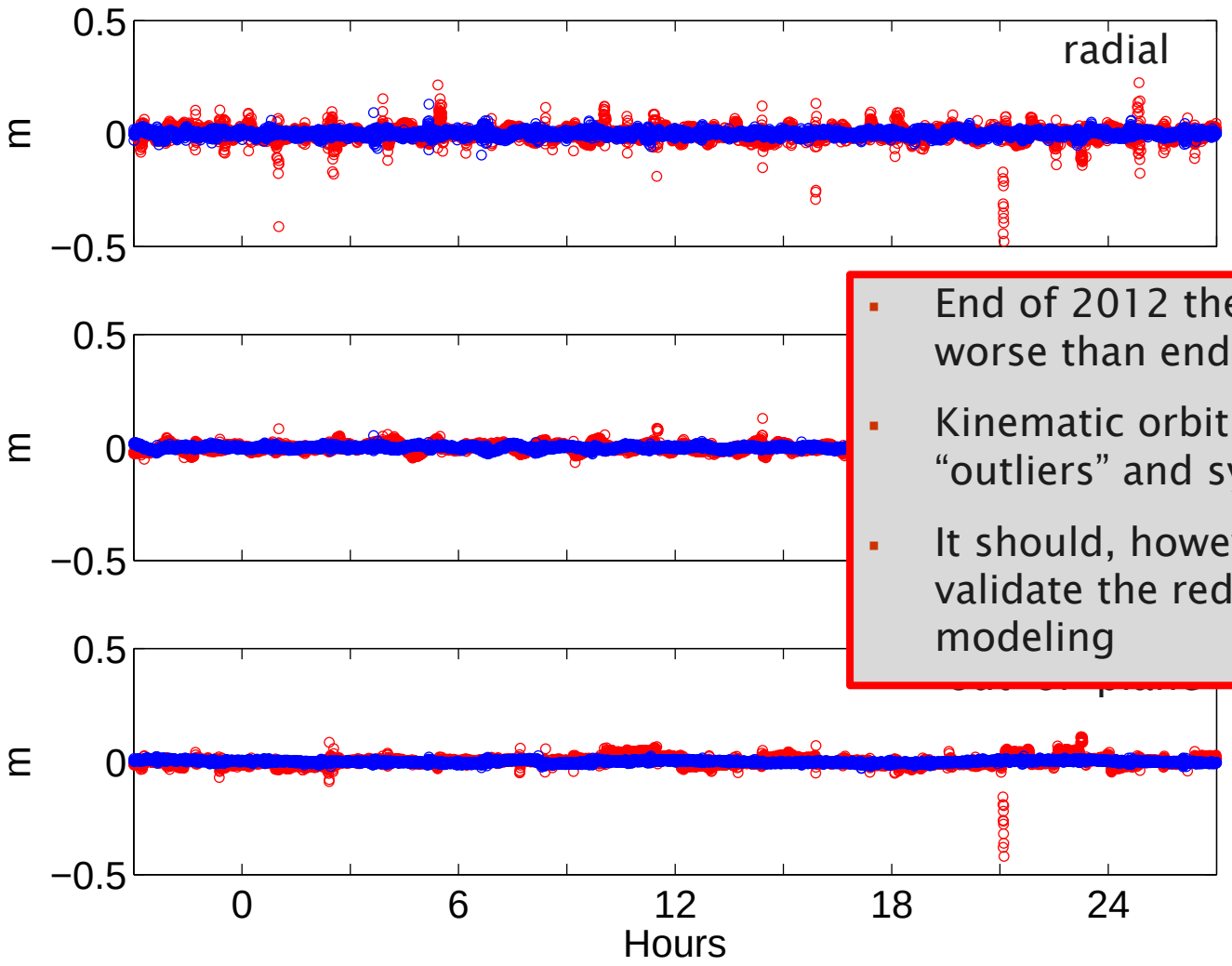



Differences between reduced–dynamic and kinematic orbit

- show consistency between the two orbit types and
- reveal data problems and gaps in the kinematic orbit

29 December 2009

# Differences red.–dyn. ⇔ kinematic orbits

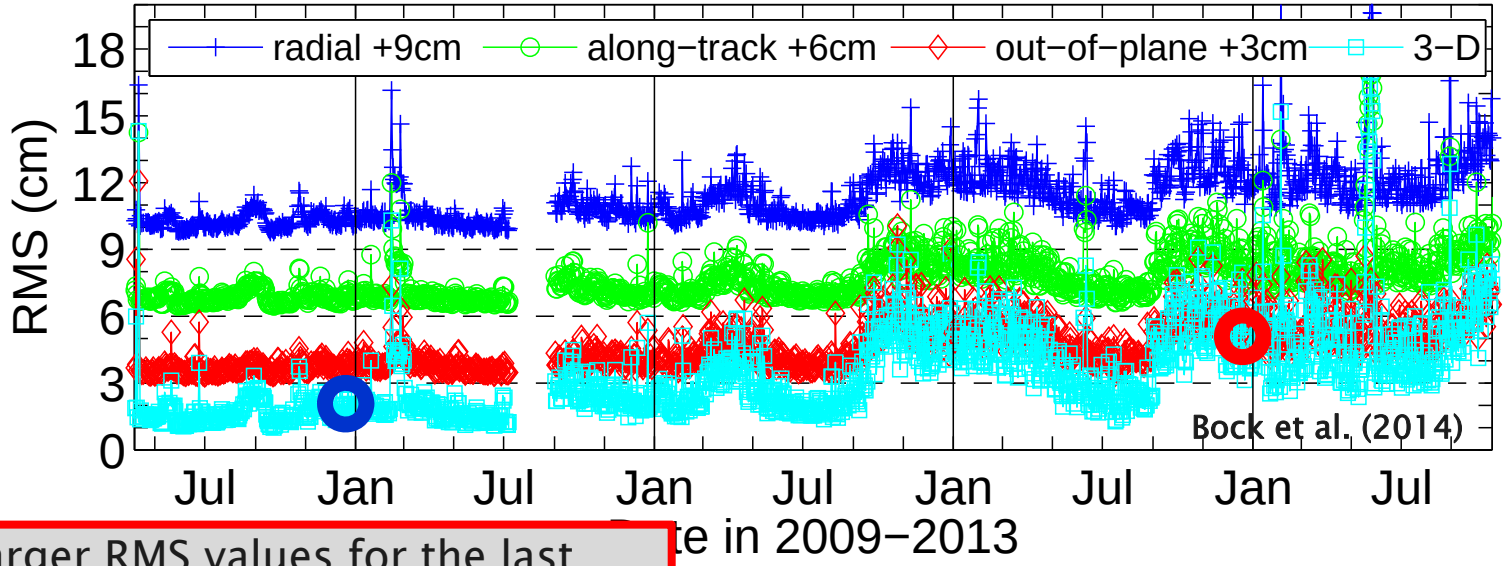



- End of 2012 the data quality is worse than end of 2009
- Kinematic orbit shows more “outliers” and systematic effects
- It should, however, be possible to validate the reduced-dynamic orbit modeling

28 December 2012 and 29 December 2009

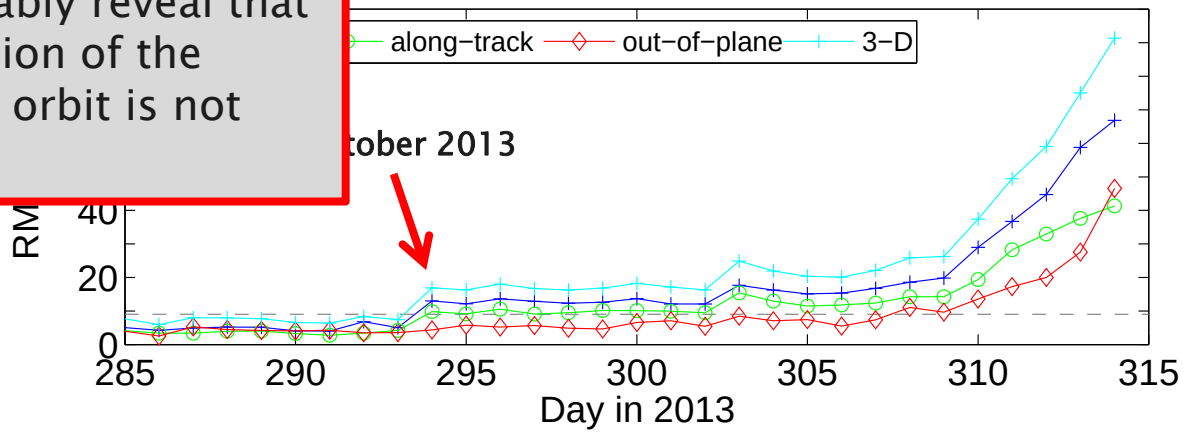
# GOCE internal orbit validation

RMS of differences between red.-dyn. and kinematic orbits for official mission

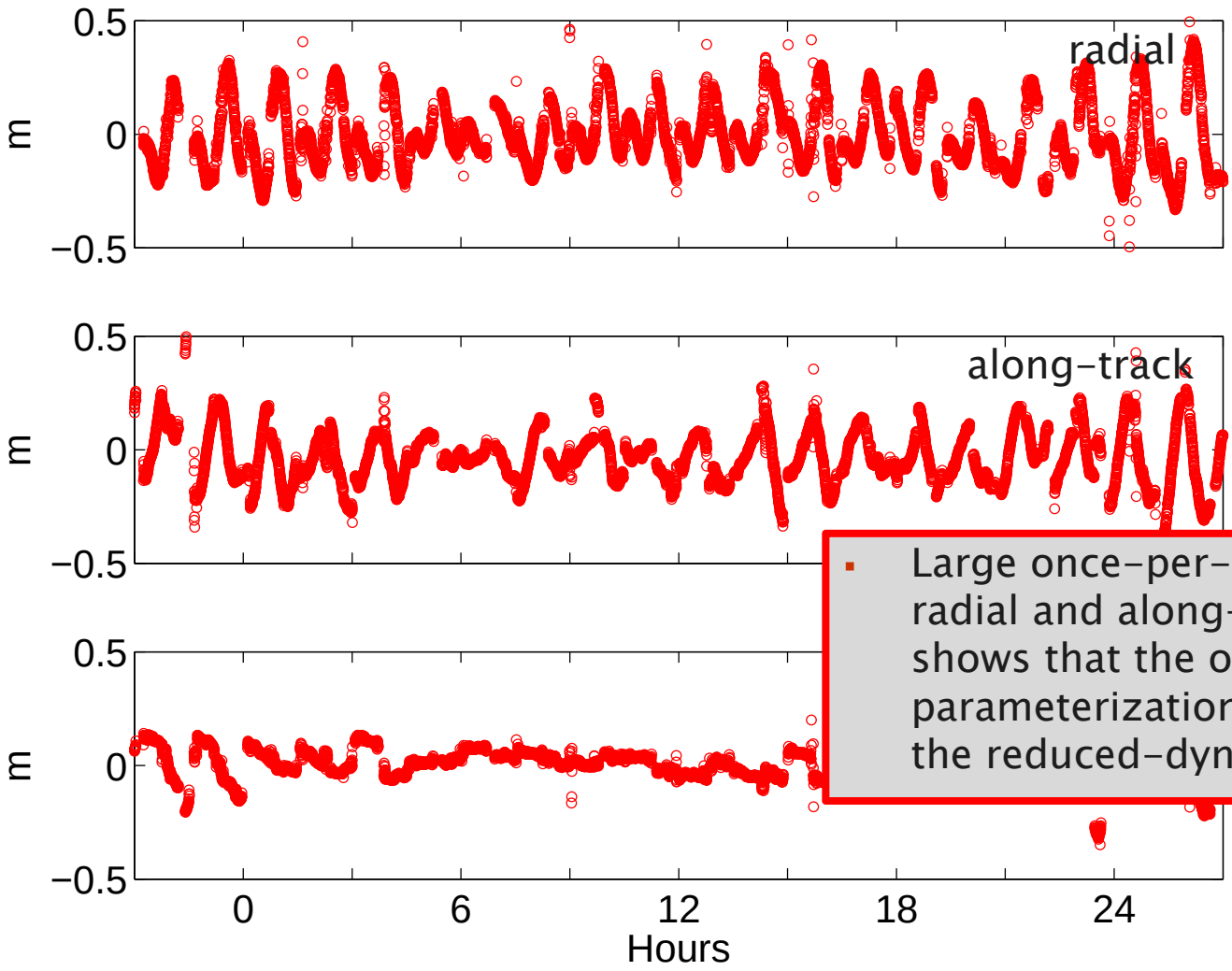



te in 2009-2013

- Larger RMS values for the last three weeks probably reveal that the parameterization of the reduced-dynamic orbit is not ideal at all



# Differences red.–dyn. ⇔ kinematic orbits

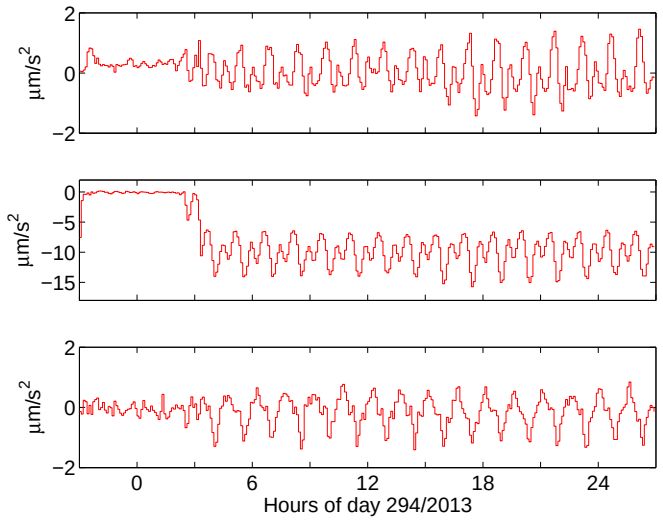



- Large once–per–revolution signal in radial and along–track component shows that the orbit parameterization is not ideal for the reduced–dynamic orbit

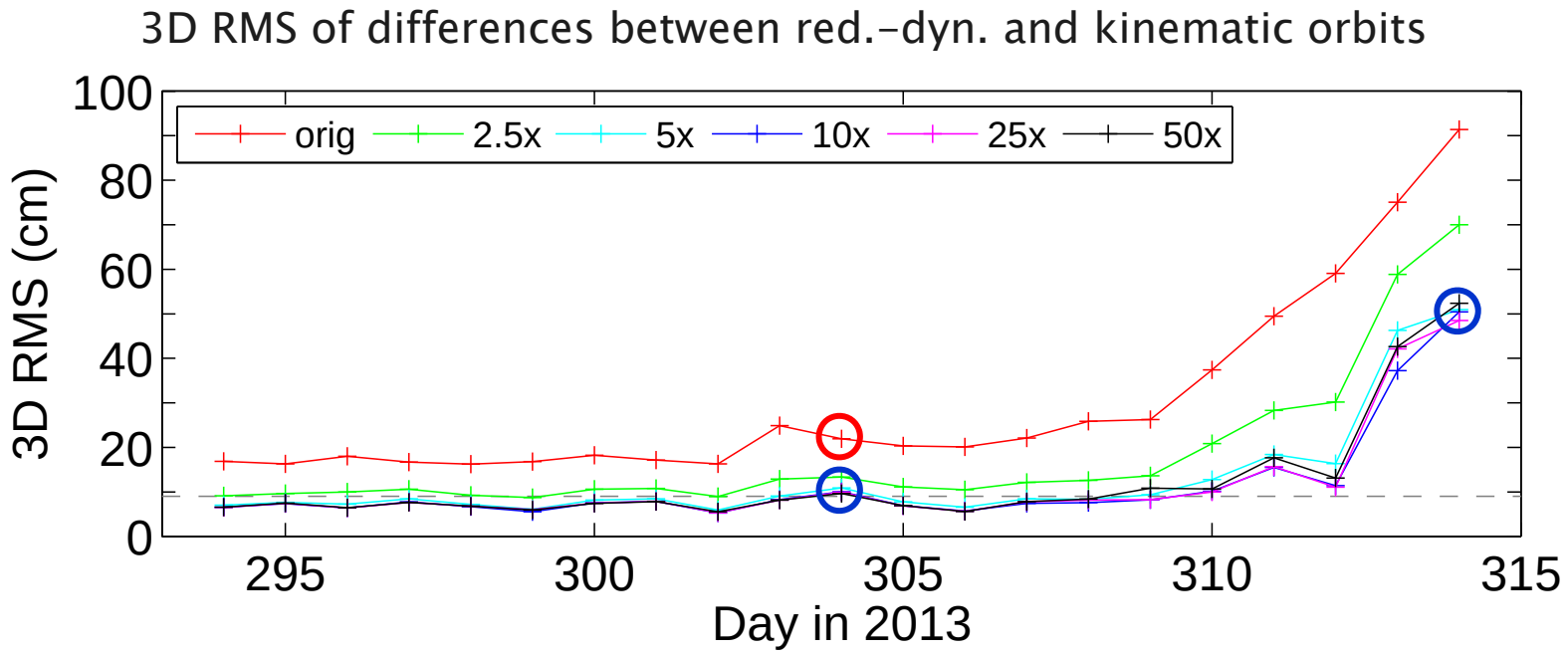
Original solution; 31 October 2013

# Reduced-dynamic orbit determination

- 30 h processing batches (not for the last 10 days), 10 s sampling, undifferenced processing, ionosphere-free linear combination, CODE Final GNSS orbits and clocks (5 s) and Earth Rotation Parameters
- Orbit models and parameterization:
  - EIGEN5S 120x120, FES2004 50x50 (fixed by GOCE Standards)
  - Six initial orbital elements
  - Three constant accelerations in radial, along-track, out-of-plane
  - 6-min piece-wise constant accelerations in radial, along-track, out-of-plane ($2*10^{-8}$ m/s$^2$)
- Test solutions with weaker constraints:
  - 2.5 x $2*10^{-8}$ m/s$^2$
  - 5 x
  - 10 x
  - 25 x
  - 50 x

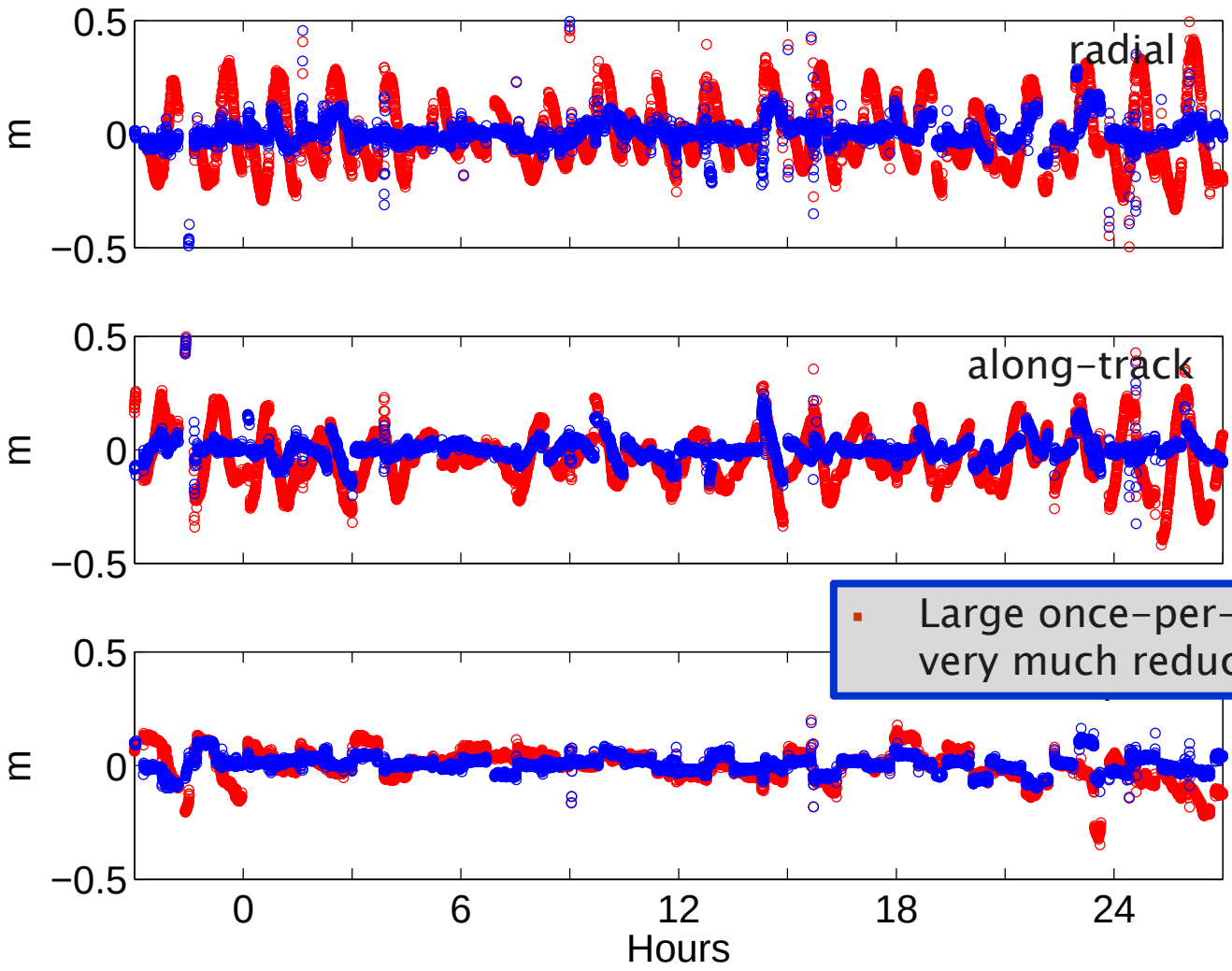


# Solutions with weaker constraints




- Test solutions with weaker constraints show better consistency with kinematic orbits.
- Differences between 5x and 50x weaker constraints are marginal.
- Except the very last days, these solutions are acceptable.

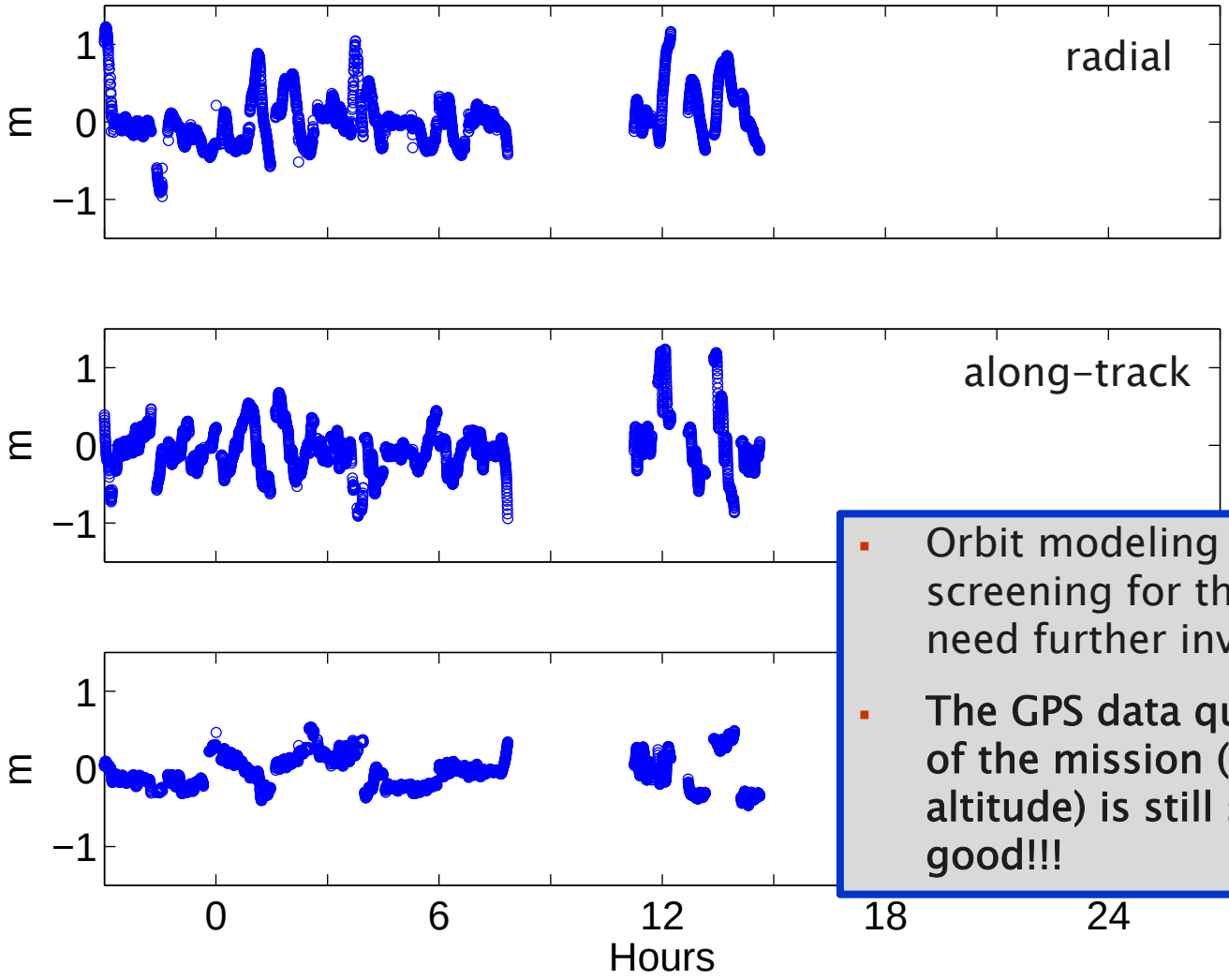
# Differences red.–dyn. ⇔ kinematic orbits




- Large once-per-revolution signal is very much reduced

Original solution and 10x weaker constraints; 31 October 2013

# Differences red.–dyn. ⇔ kinematic orbits

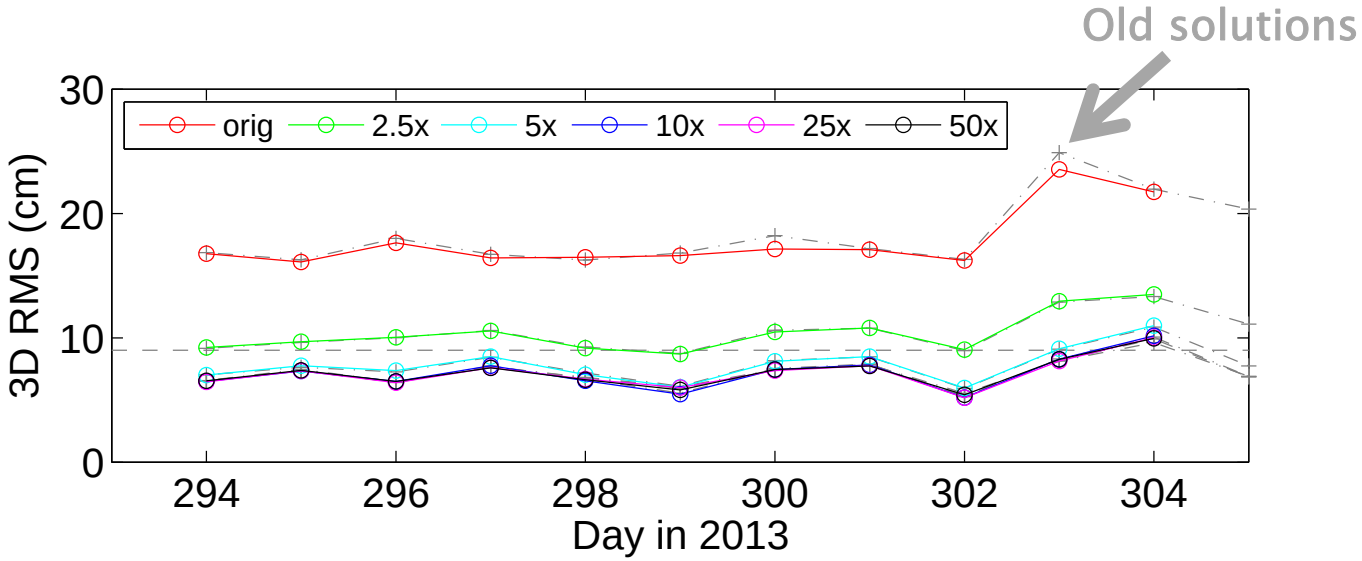



- Orbit modeling and data screening for the very last hours need further investigations
- The GPS data quality at this stage of the mission (150 – 130 km altitude) is still surprisingly good!!!

10x weaker constraints; 10 November 2013

# Improved background modeling

- In order to improve the background models the gravity field model EIGEN5S 120x120 is replaced by GOCO03S 200x200 for the first 11 days of the decay phase.
- Test solutions with original and weaker constraints are repeated.




- No or only small improvements with respect to the old solutions can be noticed with the better gravity field model.

# Summary

- Can the kinematic orbits be used for validation? => Yes, except that the very last hours/days are difficult because of data screening problems leading to larger data gaps.
- Is the orbit parameterization of the reduced-dynamic orbit still reasonable for the last three weeks of GOCE? => No, the constraints are too tight; 10x weaker constraints are reasonable.
- First updates in the background modeling of the reduced-dynamic orbit determination did not improve the results of the reduced-dynamic orbits.

Further work:

- Detailed check of background modeling and sampling of piece-wise constant accelerations.
- Improve data screening procedure for the very last days/hours.
- Comparison with and possibly use of accelerometer data in the reduced-dynamic orbit determination (as long as they are available).