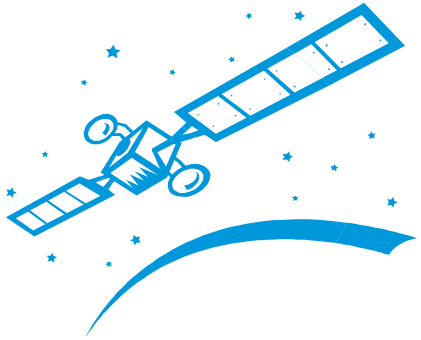

ESOC Integer Ambiguity Resolved Precise and Homogeneous Orbits for ~~Jason-1~~ and Jason-2

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Motivation

- There is a need for high-quality homogenous altimetry products
  → i.e. precise and homogeneous orbits for altimetry satellites.

- The Navigation Support Office at ESOC is involved in the processing and validation of the ESA altimeter missions:
  ERS-1/2, Envisat and Cryosat-2 since the launch of each mission.

- This presentation is a continuation of our OSTST-2012 talk on the same subject

- Preparation for the processing of Sentinel-3A data

Introduction

- At the 2012 OSTST meeting we presented our first result from ambiguity fixed Jason-2 orbits in this presentation we will give an overview on the improvement made since then and the open issues that still exist

- Beside this (new) solution we still generate on a regular basis for Jason-2 orbits based on SLR+DORIS+GPS data.

- The first slides will give an overview of this solution (solution 4) while the major part of this presentation will focus on the integer ambiguity resolved orbits for Jason-2.

Processing strategy Jason-1/2

ESOC solution 4

- Loosely based on the GDR-D standards
- Modeling according to (IERS2010) conventions
- GPS + DORIS + SLR used, technique-specific weighting
- ESA IGS repro GPS orbits and clocks (30s) introduced (kept fixed)
- Estimated parameters
  - Orbit parameter (3-day arcs)
    - SV
    - 4 CPRs (sin/cos in along-track/cross-track) every 12h
    - 5 Drag parameters every 24h
  - GPS phase ambiguites
  - Jason-1/2 clock bias (30s)
  - DORIS station frequency bias, time-tag bias, atmospheric zenith delay correction

Processing strategy Jason-1/2

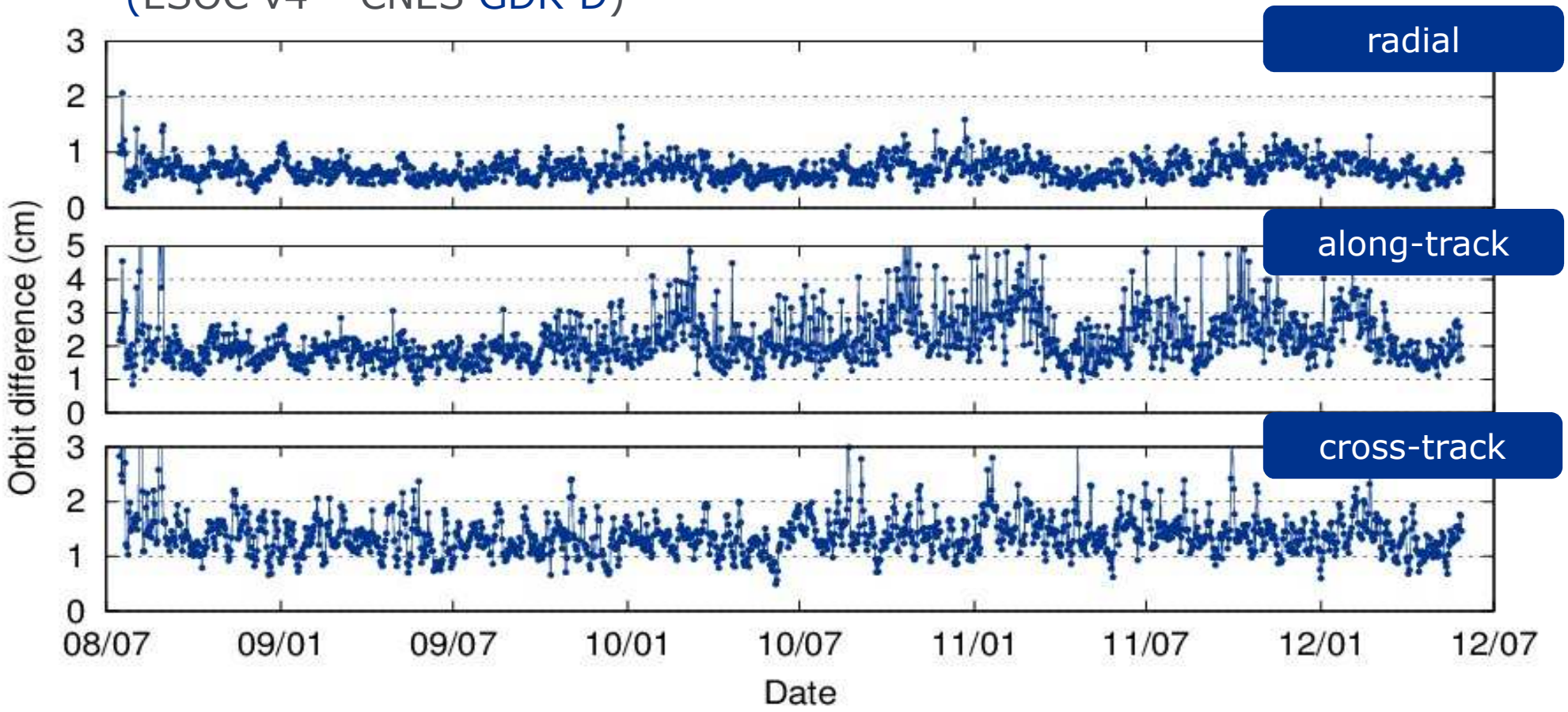
ESOC solution 4

- Gravityfield
  - GFZ-GRGS EIGEN-6S.extv2 (120x120) + annual, semi annual and piece wise linear drifts up to degree and order 50
- Station Coordinates
  - DORIS DPOD2008 and for SLR ITRF2008
- Macro model for non conservative forces
  - ESA model (average of CNES GDR-A and GDR-C model)
- GPS antenna phase centre modeling
  - Estimated based on stacking 2 years of NEQ for Jason-1 and Jason-2. For the GPS satellites we use the IGS extended ANTEX values (up to 17 degrees)
- Attitude modelling
  - Quaternions with fallback on nominal attitude model (with attitude event file) if not available

Daily RMS of orbit differences

Jason-2

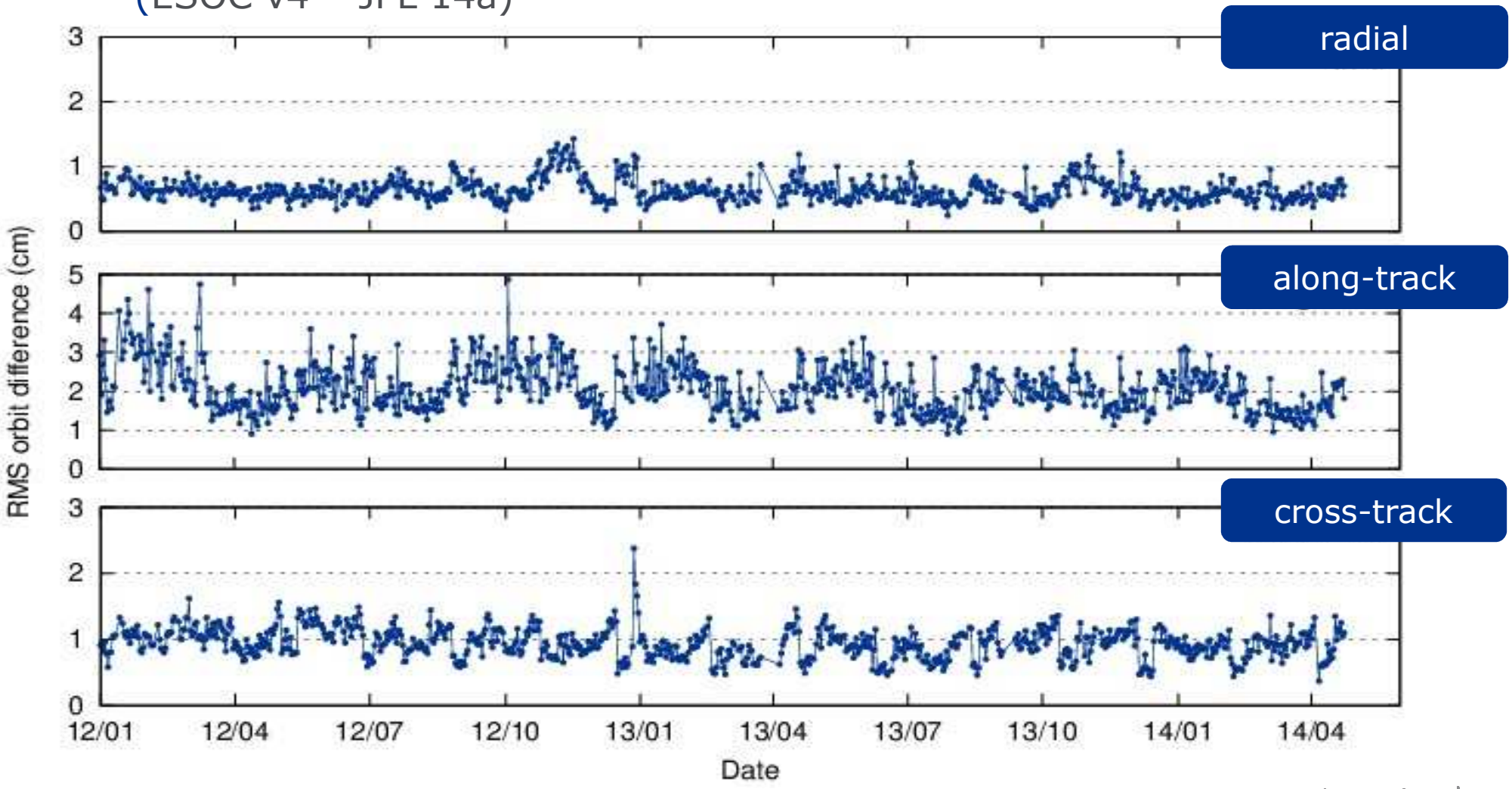
(ESOC v4 – CNES GDR-D)



Daily RMS of orbit differences

Jason-2

(ESOC v4 – JPL 14a)



Ambiguity Fixing – Two techniques

- Currently we have in our software (NAPEOS) two possible ways of fixing the ambiguities for the LEO satellites:

1. The integral approach in which the LEO is included into an IGS like scenario (including GPS station data) and the LEO is treated as another (although orbiting) station and the integer ambiguities are resolved at the double difference level together with the station ambiguities.
2. In the second approach the un-calibrated phase delays (UPD) are saved from our IGS runs and later reintroduced into the LEO ambiguity resolution processing. In this processing the UPDs are used together with two single differences to resolve the integer ambiguities of the LEO.

Processing strategy Ambiguity fixing

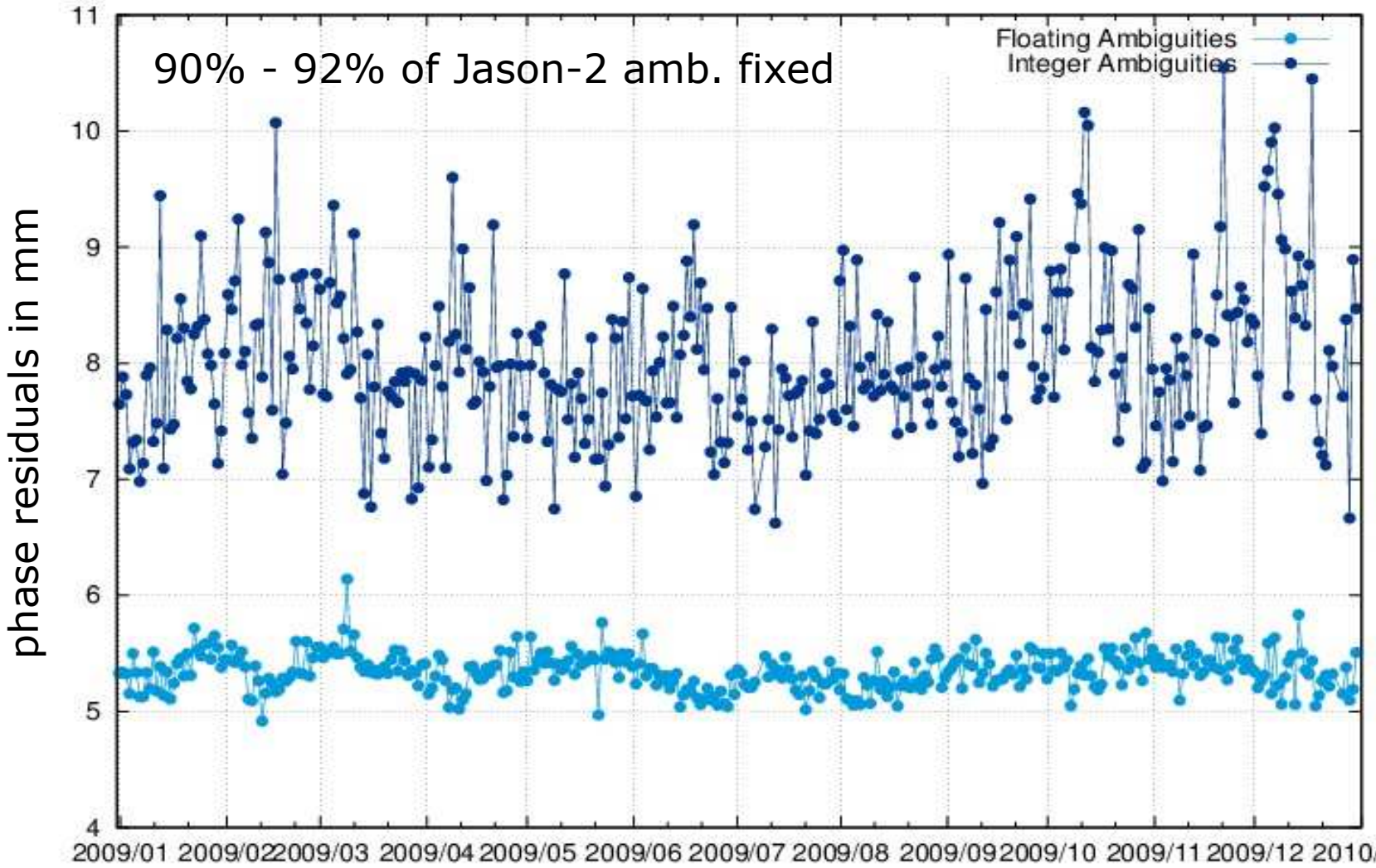
- This first method that we tested was the combined processing (method 1) and all results that will be shown are based on this method.
- For the test period we have used the year 2013.
- We included 60 globally well distrusted stations.
- We used 30 second sampling for the ground stations and Jason-2.
- We computed 24hr arcs without overlap.
- Estimate the same number of orbit parameters for Jason-2 as in our ESOC solution 4 (SLR/DORIS/GPS).

Processing strategy Ambiguity fixing

- We first generate a solution in which all the ambiguities are estimated as float together with all the other parameters
- From this solution we then resolve for both the stations and Jason-2 the integer ambiguities at the double difference level
- We generate then again a new solution identical to the first step but now we keep all the ambiguities fixed that could be resolved in the previous step
- We do this last step to be able to edit out wrongly fixed ambiguities

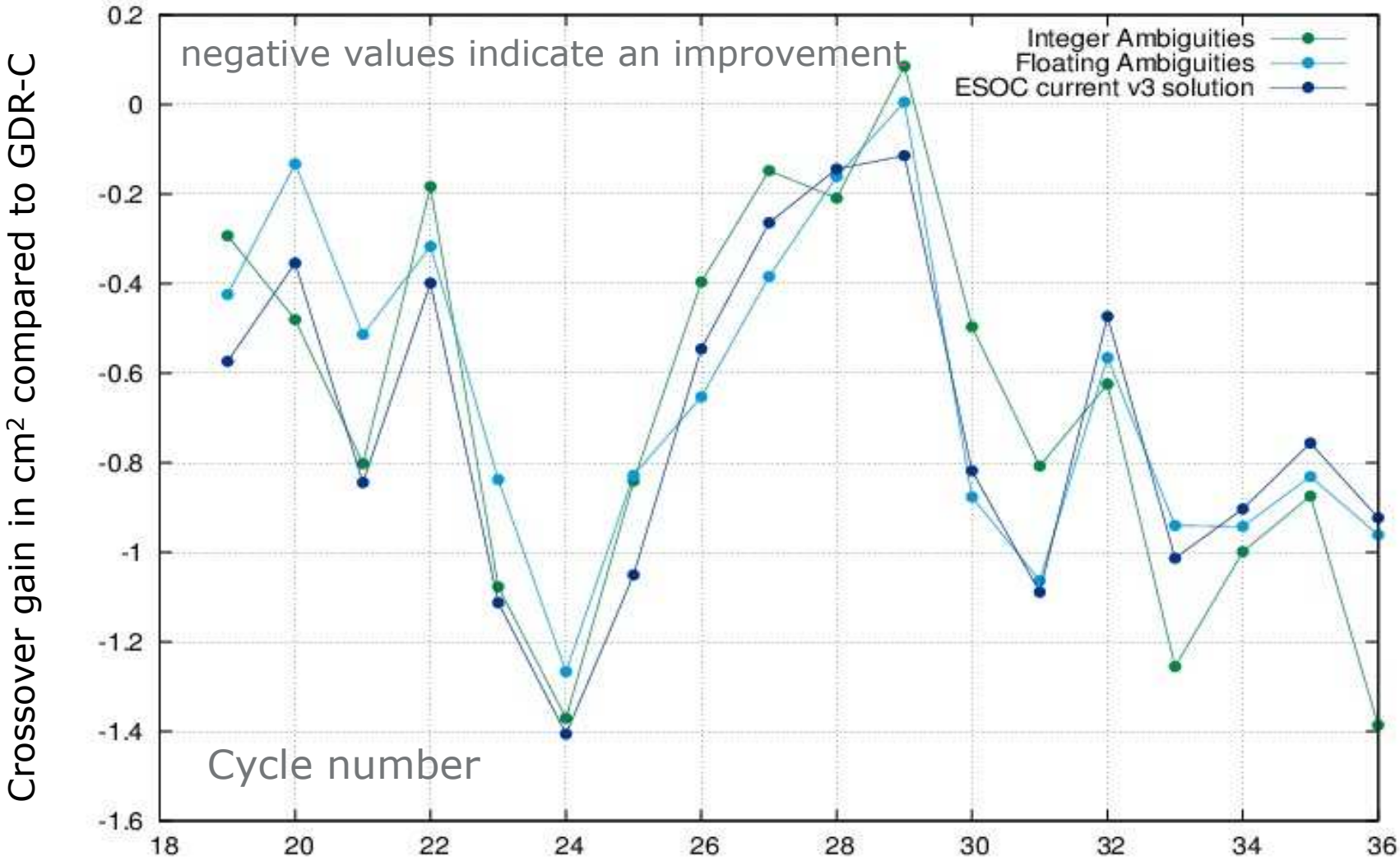
From OSTST 2012 Presentation

Jason-2



From OSTST 2012 Presentation

Jason-2



Changes made to our processing

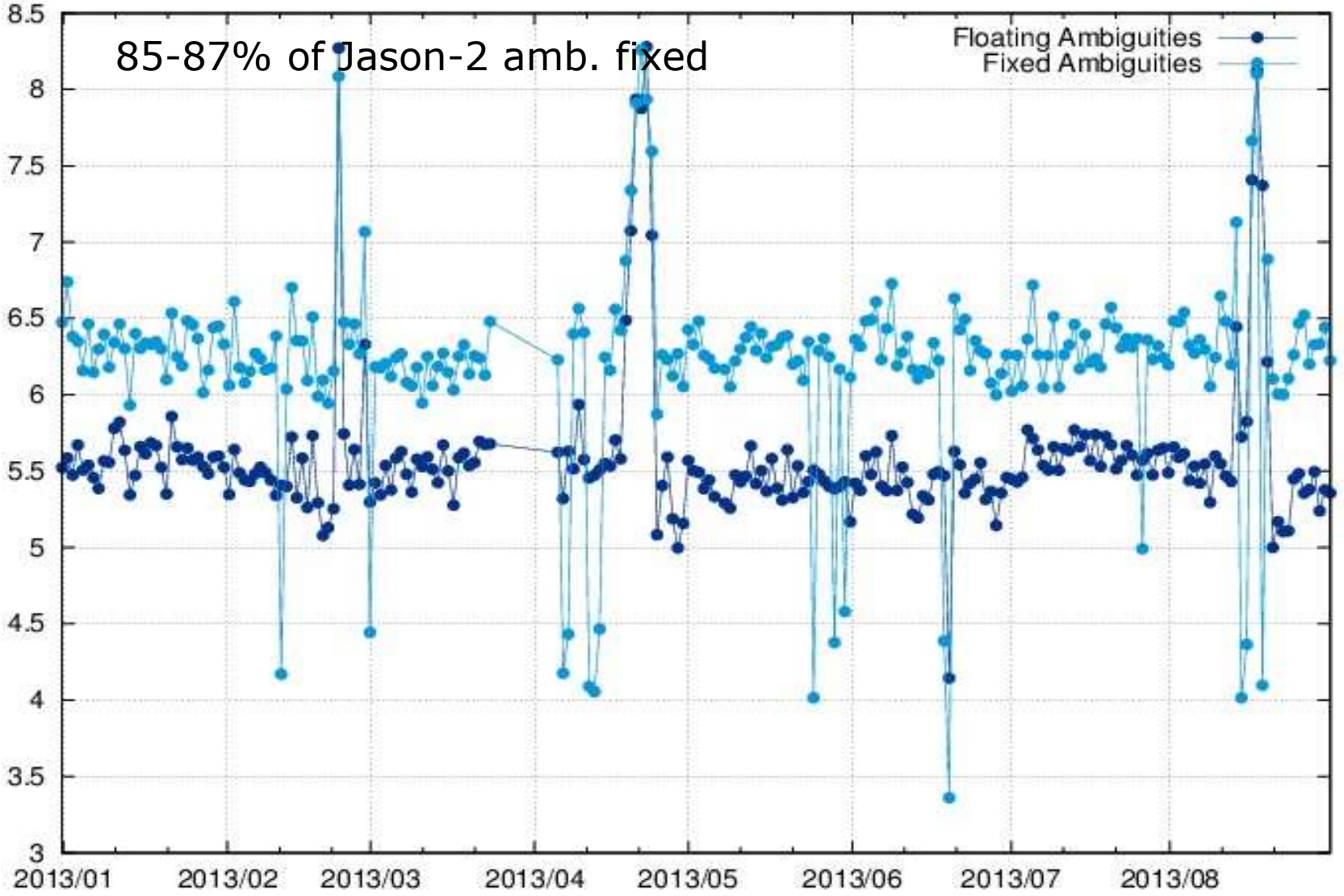
- Better cleaning of the data at the preprocessing level for instance we now clean the data using the 10 second measurement (mainly for cycle-slip detection) but still process the data every 30 seconds

- When resolving the integer ambiguities we used to perform 2 iteration in which both the station and Jason-2 ambiguities are resolved. We now perform 3 iterations but in the first iteration only resolve the station ambiguities.

- When reintroducing the fixed ambiguities for Jason-2 we no longer keep them fixed but constrain them very tightly (apply a 1 mm constrain).

GPS Residuals for 2013

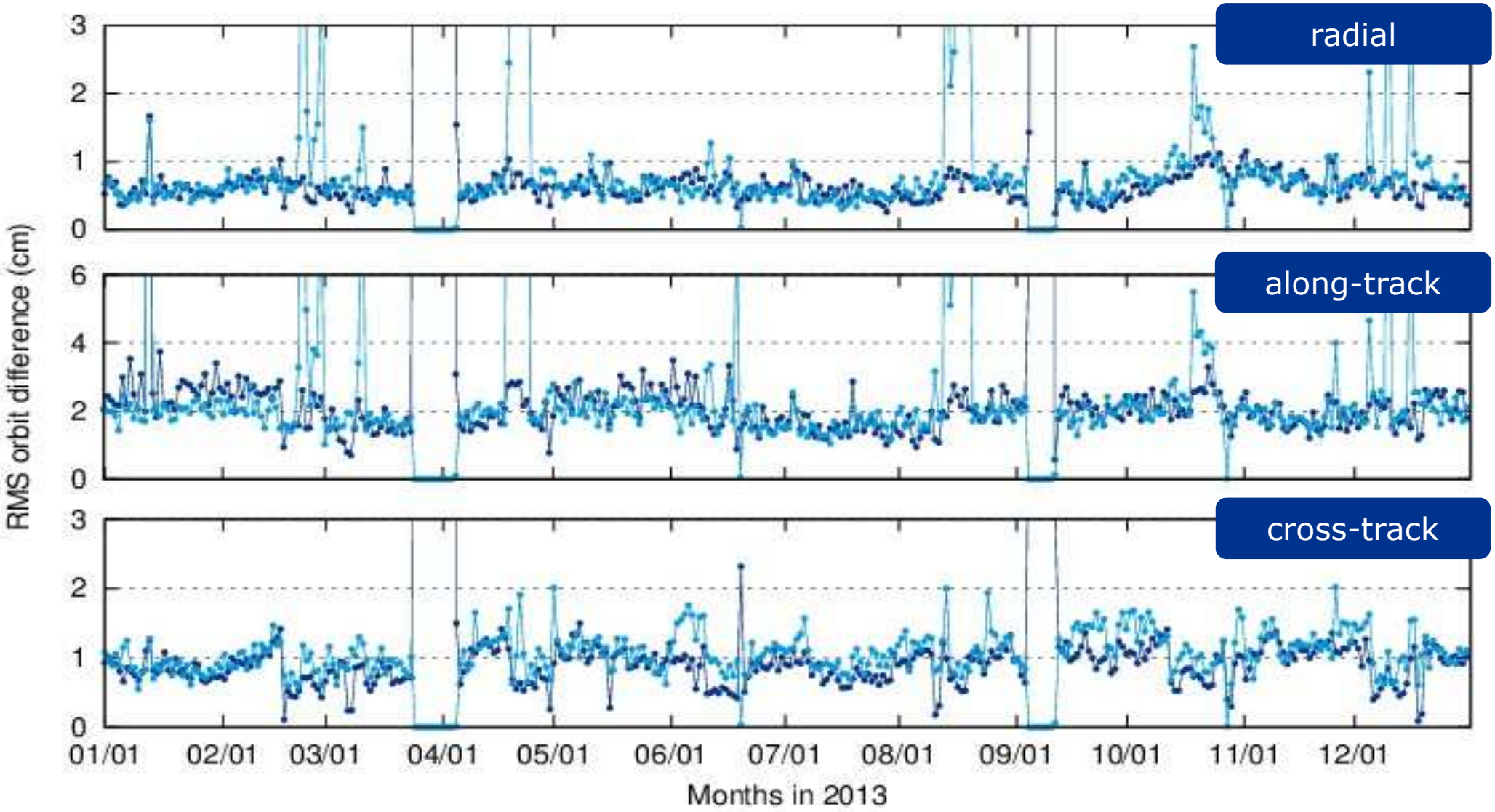
Jason-2



Daily RMS of orbit differences

Jason-2

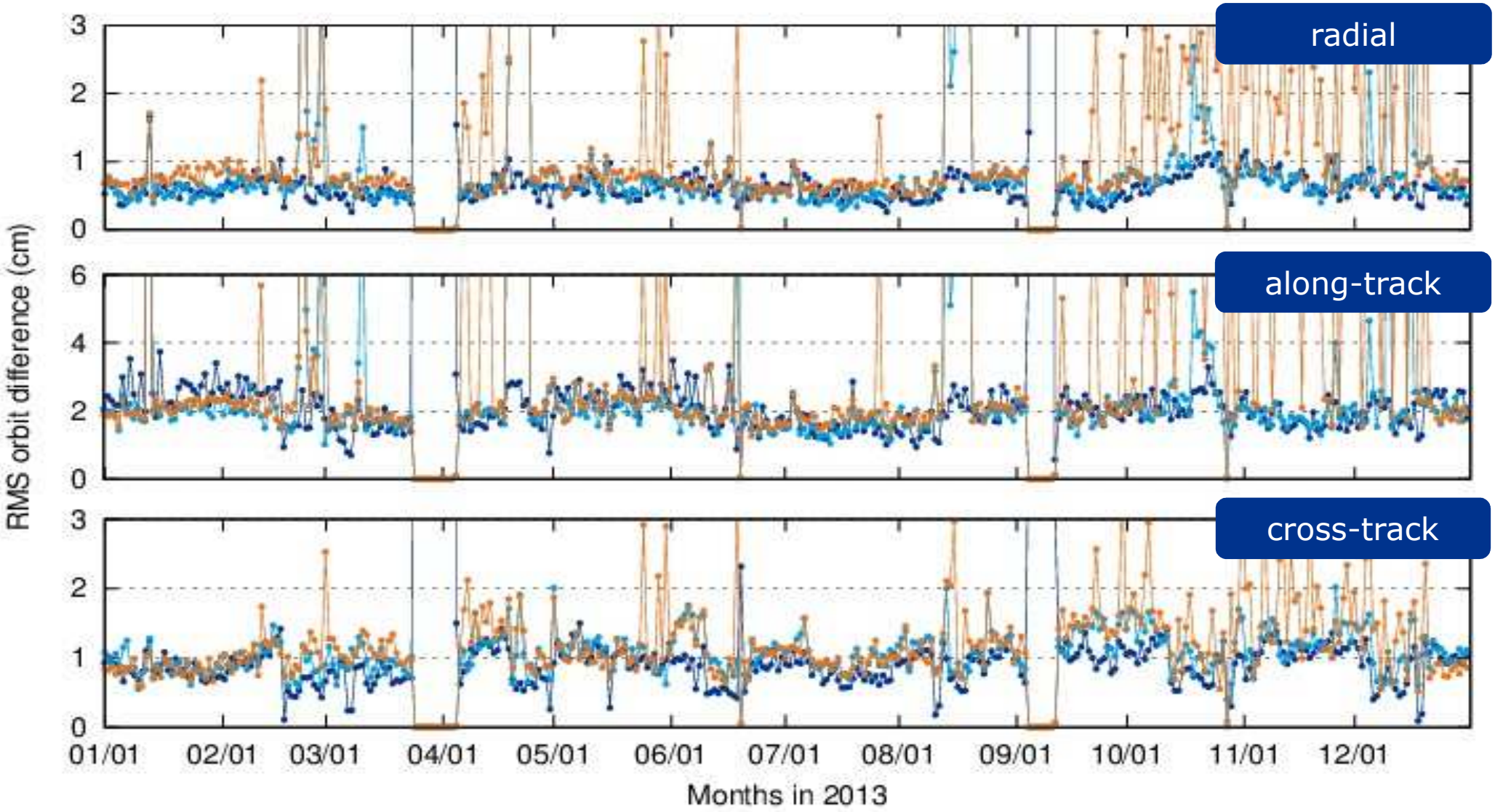
(JPL14a– ESOC SOL4 / Float amb.)



Daily RMS of orbit differences

Jason-2

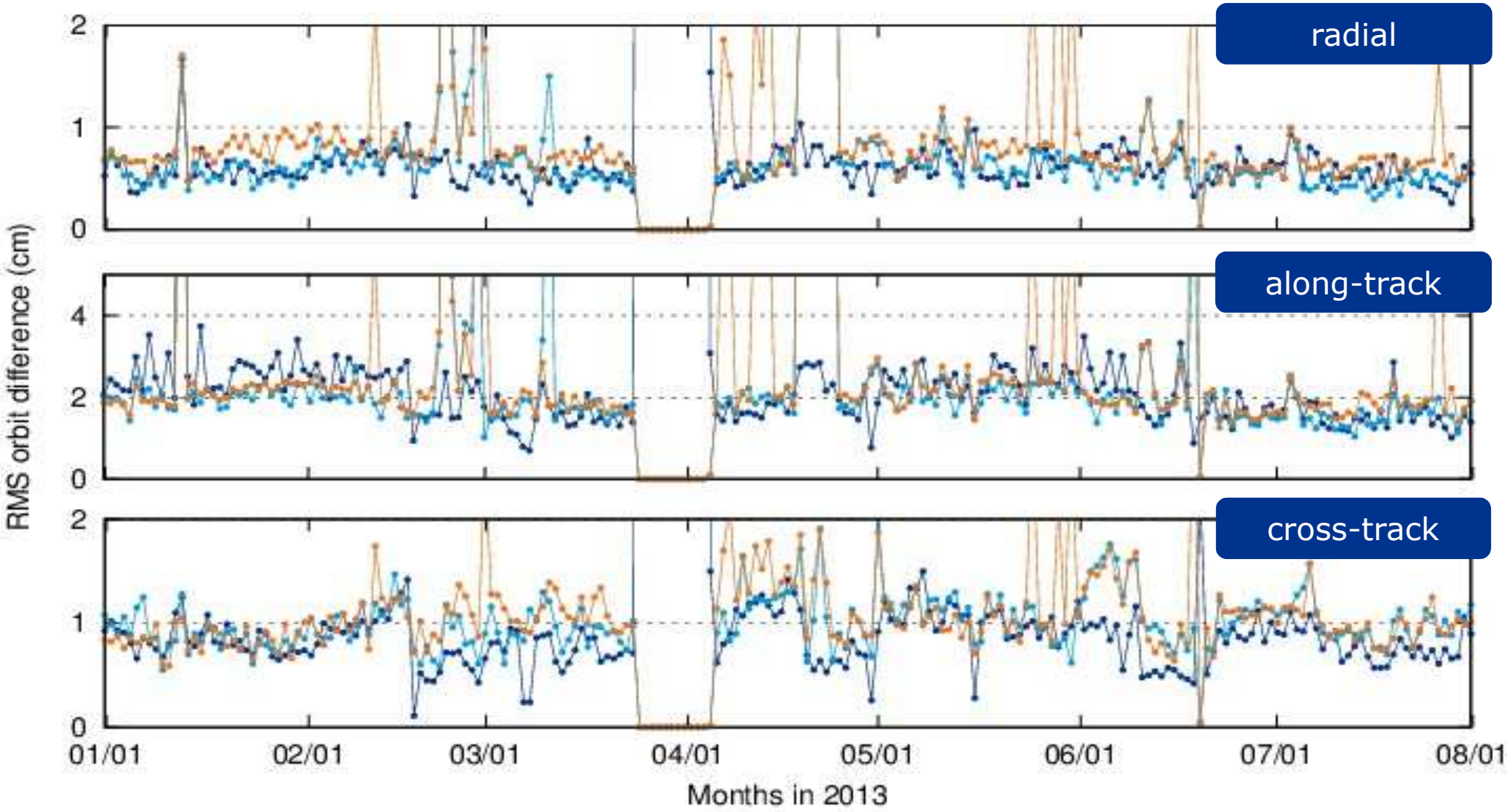
(JPL14a– ESOC SOL4 / Float amb. / Fixed amb.)



Daily RMS of orbit differences

Jason-2

(JPL14a– ESOC SOL4 / Float amb. / Fixed amb.)



SLR residual performance

Jason-2

Solution	>60°	>10°
ESOC Sol. 4	1/22 mm	1/25 mm
ESOC float.	9/25 mm	1/30 mm
ESOC fix.	8/30 mm	0/35 mm
JPL 14a	9/19 mm	2/20 mm

2013 SLR residuals for core network mean/rms

Summary (1)

- The recent improvements made to our ambiguity fixing have resulted in a significant reduction of the GPS residuals for Jason-2 from 8.1mm to 6.4mm for the phase
- Unfortunately the resulting orbits still do not perform better then our 3 day SLR+DORIS+GPS solution (solution 4) mainly due to the higher variation from day to day (more outliers)
- The cause of this higher variation is still under investigation
- Independent SLR evaluation indicates a systematic difference between the GPS fixed orbits and the SLR data. Possible cause is an incorrect (or insufficient detailed) Jason-2 phase centre modelling (ANTEX) which can be absorbed by the float ambiguities

Summary (2)

- Still to be performed in a detailed altimeter XO evaluation of the new solutions
- We will try if increasing the number of satellite parameters for the ambiguity fixed solutions will improve the solution.
- Further we will stack our single day Jason NEQ to generate multiday solutions to see if the day boundary jumps are causing our 24hr solutions to perform worse then our 3-day solutions.
- In conclusion: the technique seems to work well but still needs some fine tuning to outperform our standard 3 day (SLR+DORIS+GPS) orbits.

ESOC POD orbit availability

- Orbit solutions for Envisat, Cryosat-2, Jason-1/2 and ERS-1/2 (as part of REAPER project) are available on our ftp server
  - ftp://dgn6.esoc.esa.int
  - as a service to the altimetry community
  - continues extension/update of time series

- We will keep updating our processing with newer models when they become available.

Thank you

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