Instantaneous Reference Frame Realization by Means of Combination of Space Geodesy Techniques Onboard JASON-2 Satellite

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Introduction

What is Instantaneous Reference Frame?

- Reference frame realized by epoch-wise solution of GPS orbits and clocks
- Typically realized by 7-8 GPS satellites in the field of view of a ground station or a LEO satellite
- Errors in the GPS orbits and clocks directly map into gravity field estimation (GOCE), radio-occultation, altimetry, PPP, etc…
- Can we use LEO GPS data to improve Instantaneous Reference Frame in the re-processing?

Introduction
Why JASON-2?

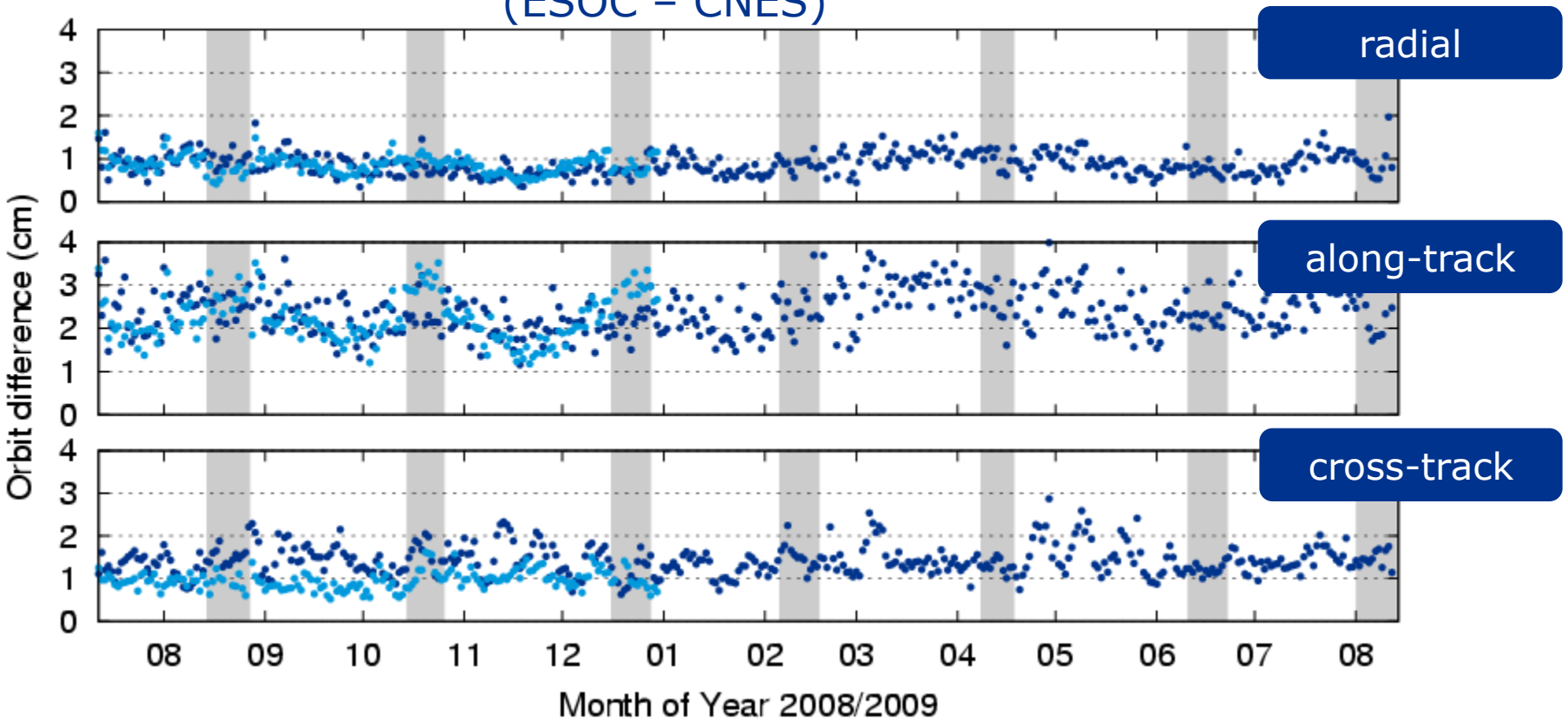
- JASON-2 is like an orbiting stations connecting all GPS satellites in only 90 min – **de-correlation of all global parameters**
- Compared to CHAMP and GRACE, the JASON-2 orbit is about 10x less sensitive to J_2 and other low degree harmonics of the Earth's gravity field
- Number of orbit parameters similar to GPS satellites
- The only satellite with all three techniques: **GPS, SLR, DORIS**
- No significant near-field multipath (compared to JASON-1)
- JASON-2 has the most accurate LEO orbits

JASON-2: Daily RMS of orbit differences

ESOC: GPS+DORIS+SLR

Can 5-mm in the radial component improve global GPS parameters?

(ESOC – JPL)
(ESOC – CNES)



Re-Processing of all JASON-1&2 orbits at ESOC, for more see (Flohrer et al. 2010)

Combination Strategy
JASON-2 + GPS Constellation

Time Period:

- CONT08 10.8.-31.8.2008

Software:

NAPEOS 3.5

GPS Satellites:

- IGS-like scenario – daily solutions

JASON-2:

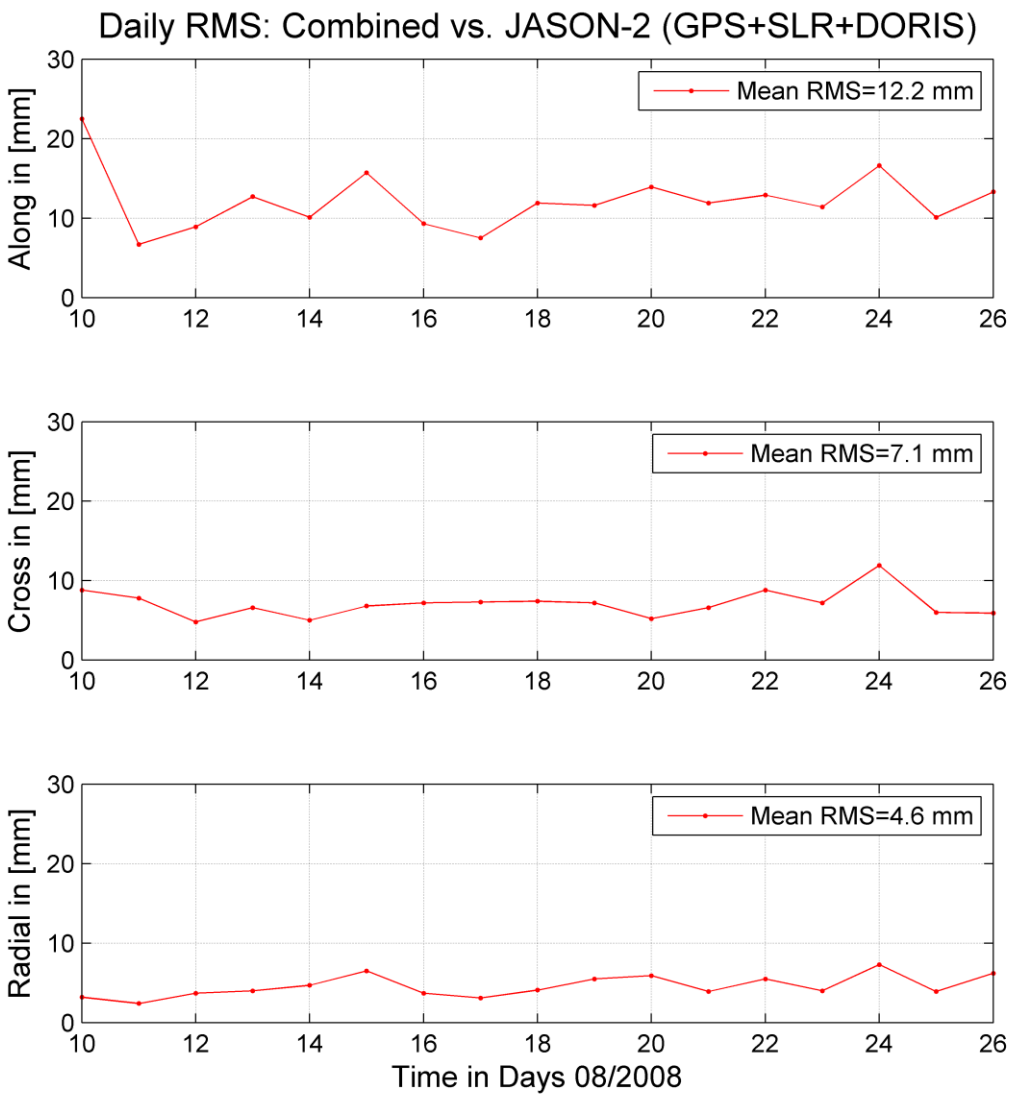
- GPS+DORIS+SLR measurements
- absolute PCVs for GPS antenna from Robot Calibration

Datum Definition:

- ITRF2005
- Scale defined mainly by SLR (high constraints)
- NNR Condition for GPS and DORIS Stations

JASON-2 Orbit

Impact of the global network on JASON-2 POD

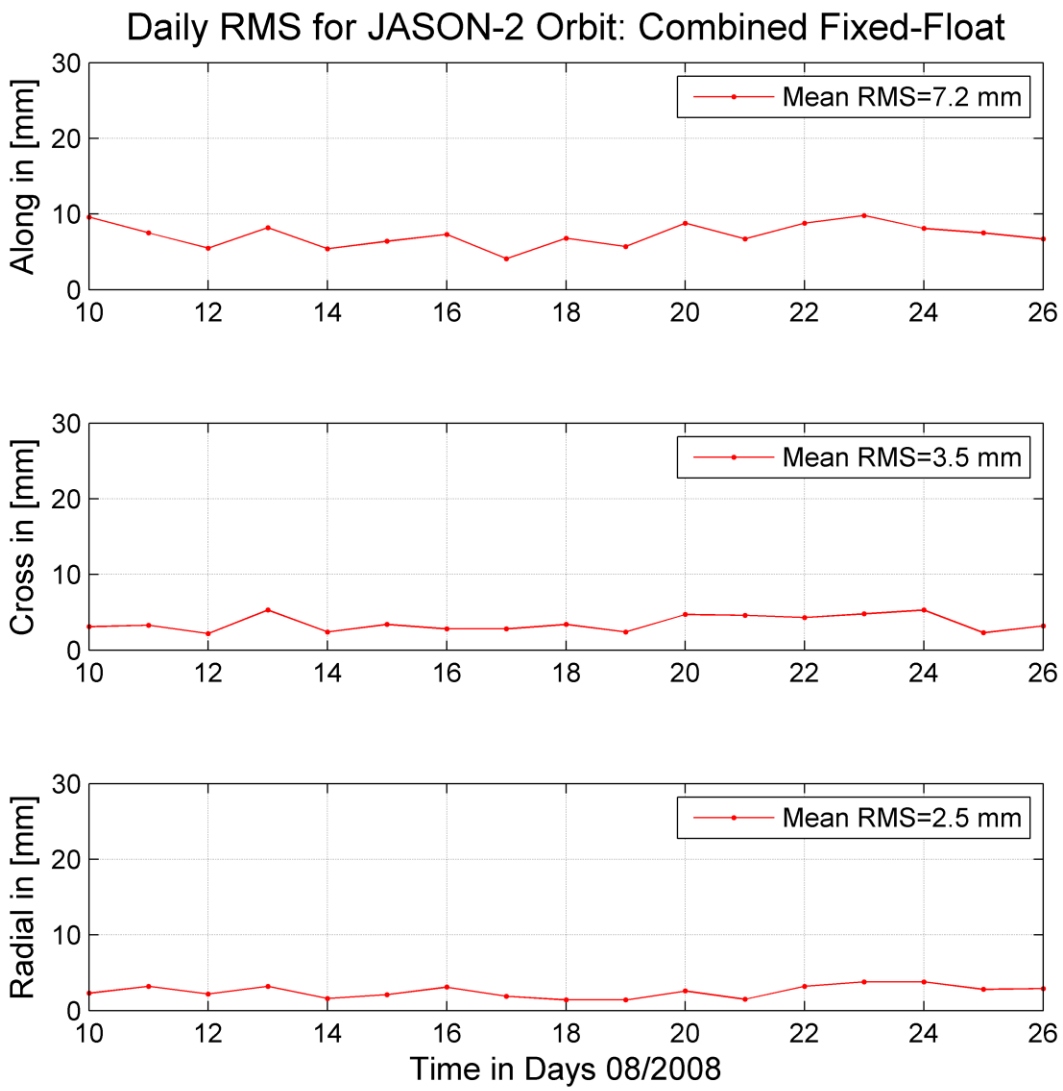


Main effect in the along-track

5-mm RMS in radial

JASON-2 Orbit

Combined solution with fixed and float ambiguities

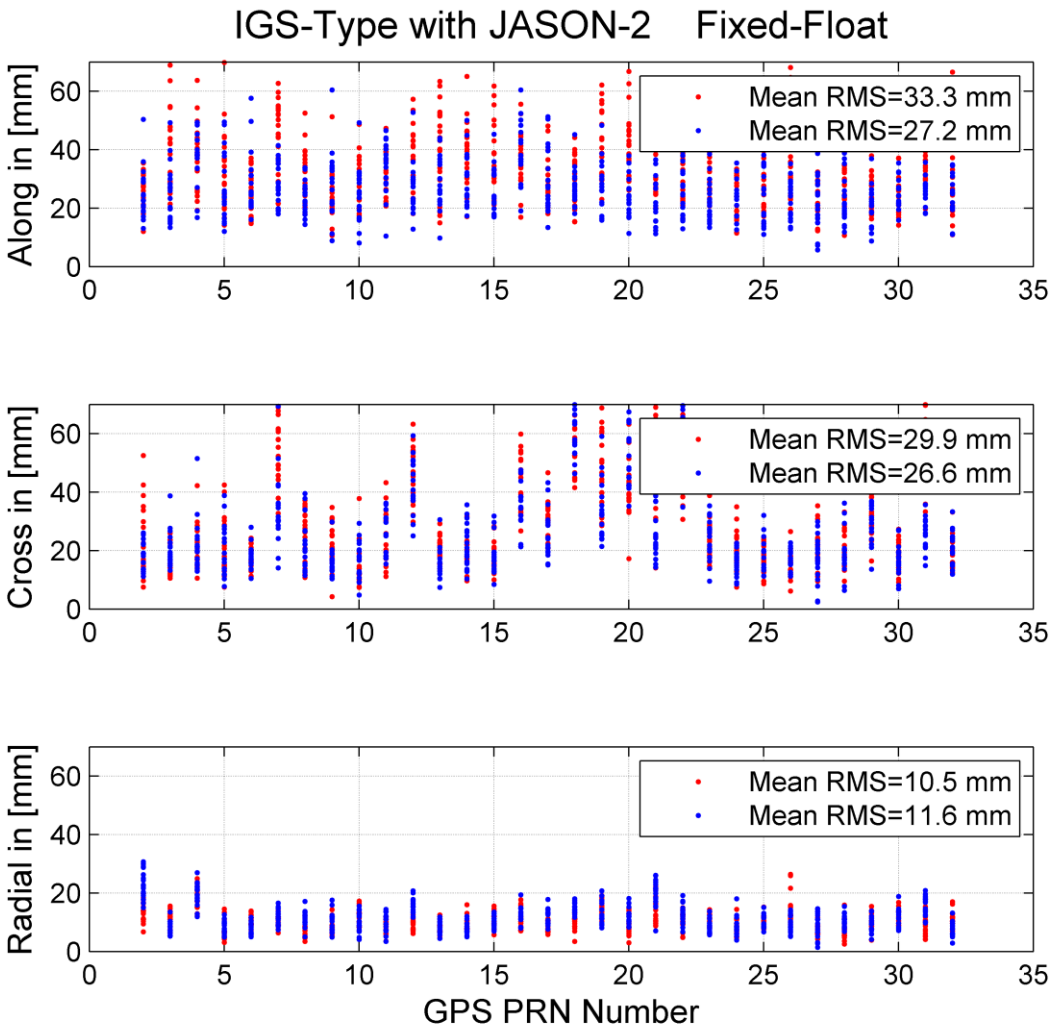


Main effect in the along-track

JASON-2 has similar effect as ambiguity resolution in the global network de-correlates parameters

2.5-mm RMS in radial

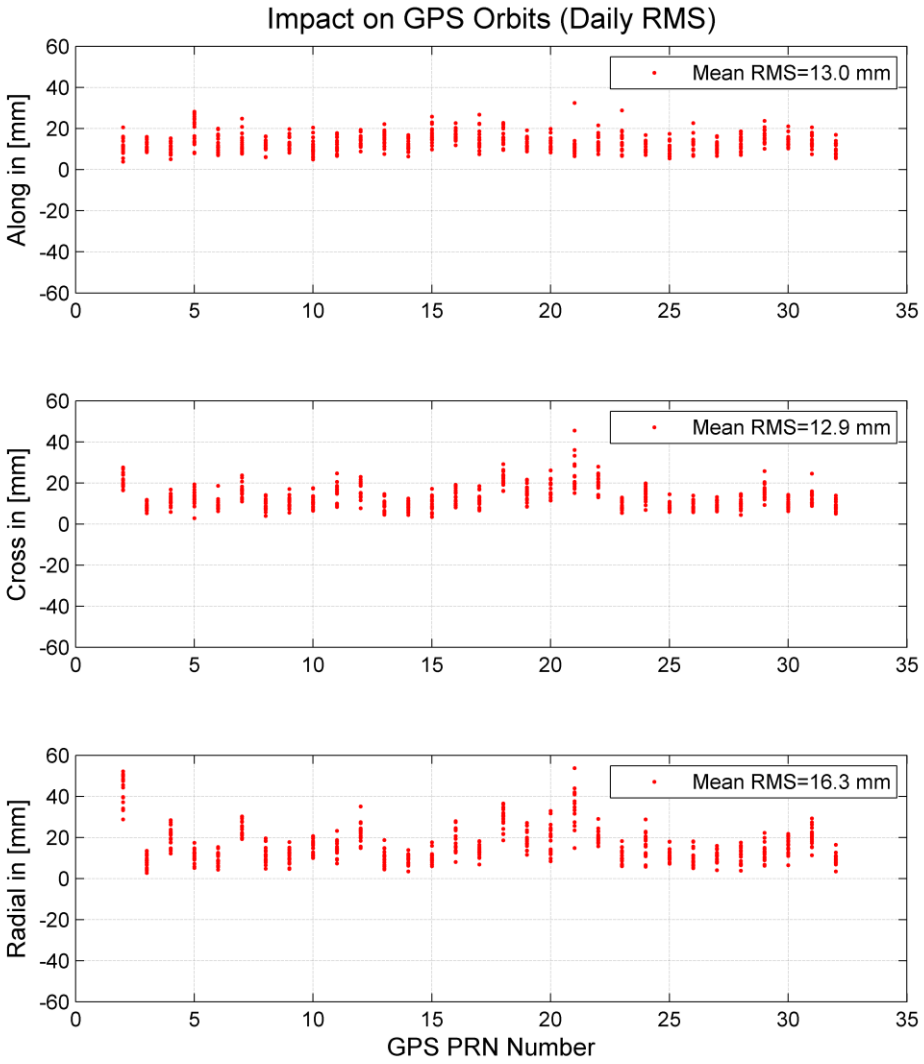
GPS Orbits
Combined solution with fixed and float ambiguities



6 mm in along-track

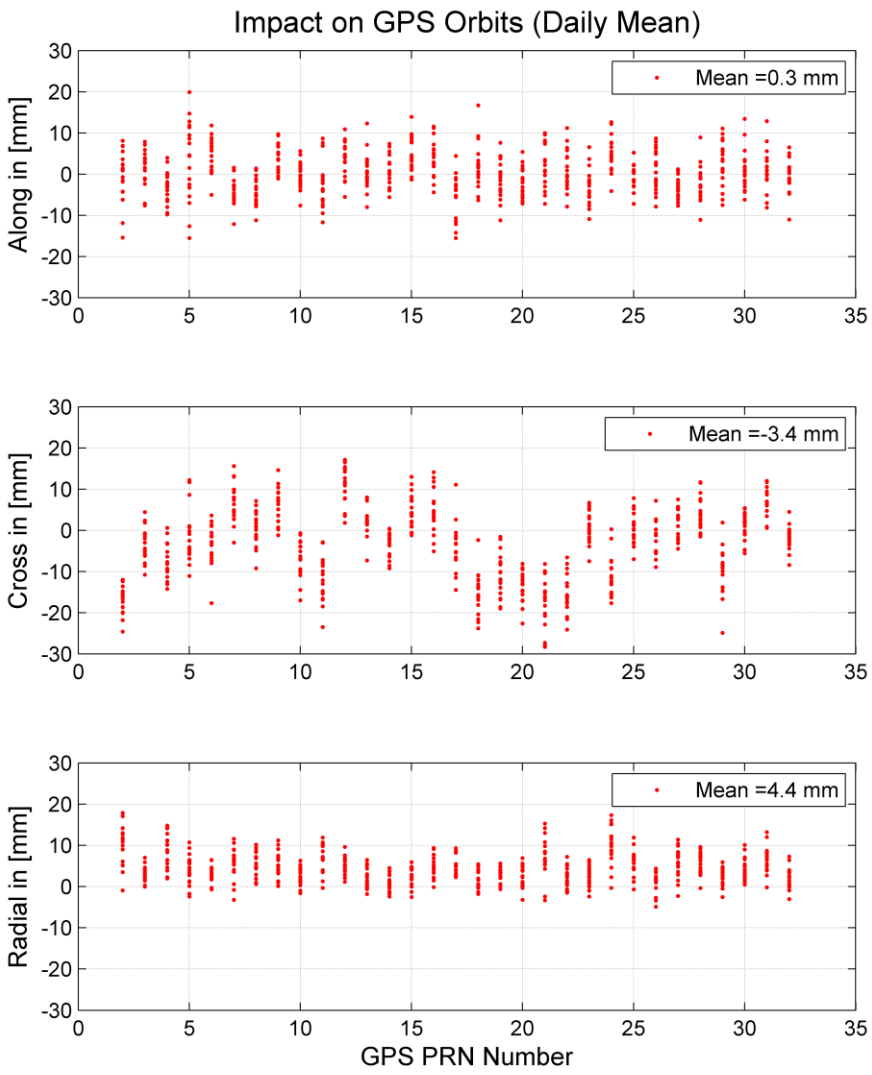
JASON-2 has similar effect as ambiguity resolution in the global network – decorrelates parameters

Impact on GPS Orbits
Daily Solutions



13-16 mm in all components!!!

Impact on GPS Orbits
Daily Solutions



Small biases in Radial and Cross-track

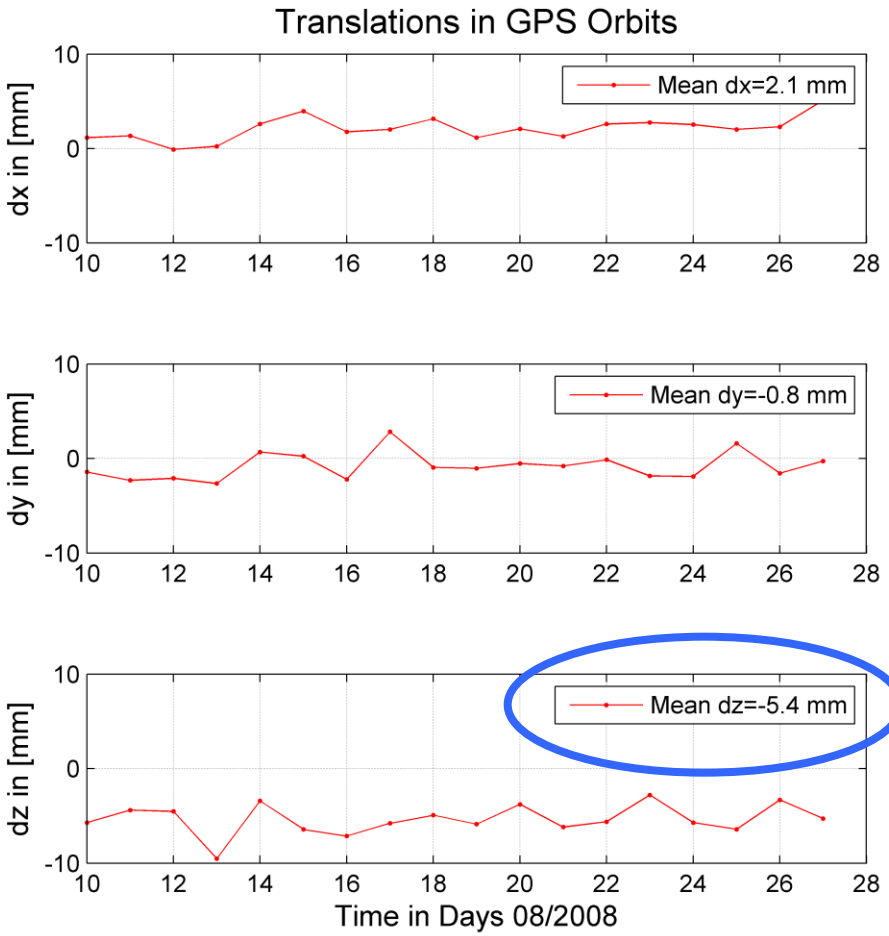
Helmert Transformation
Weekly Solutions: Station Coordinates

Week 1	Week 2	Week 3
dx = -0.83 mm	dx = -1.78 mm	dx = -1.72 mm
dy = -0.94 mm	dy = -1.67 mm	dy = -1.22 mm
dz = -5.90 mm	dz = -5.75 mm	dz = -5.60 mm
rx = 0.021 mas	rx = 0.067 mas	rx = 0.059 mas
ry = 0.052 mas	ry = 0.055 mas	ry = -0.011 mas
rz = -0.051 mas	rz = -0.077 mas	rz = -0.051 mas
scale = 0.13 ppb	scale = 0.14 ppb	scale = 0.16 ppb

5-6 mm bias in z-geocenter

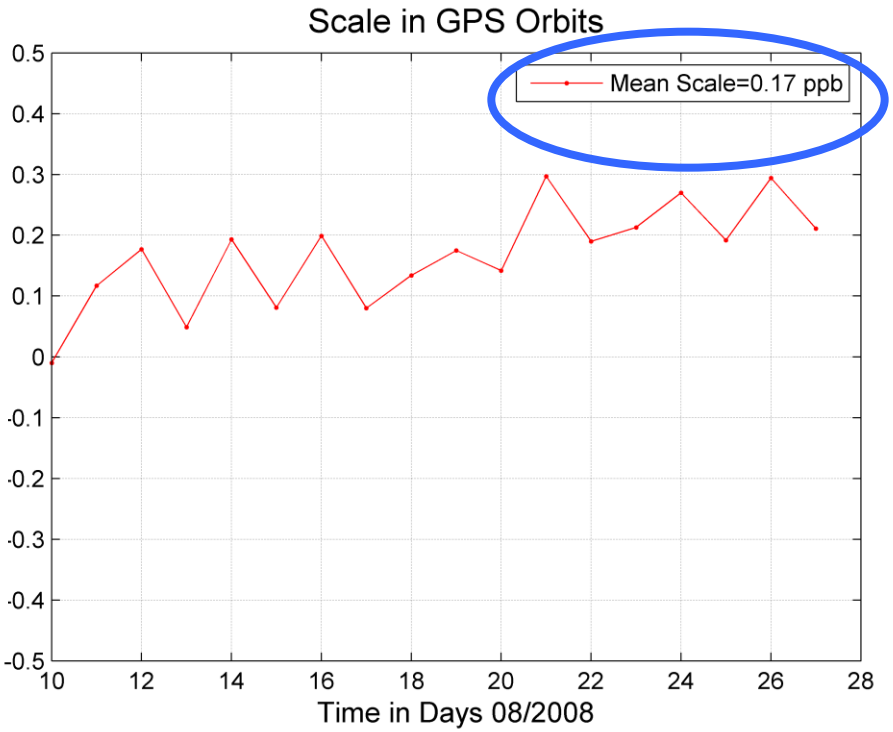
Helmert Transformation: Geocenter and Scale

Daily Solutions: GPS Orbits

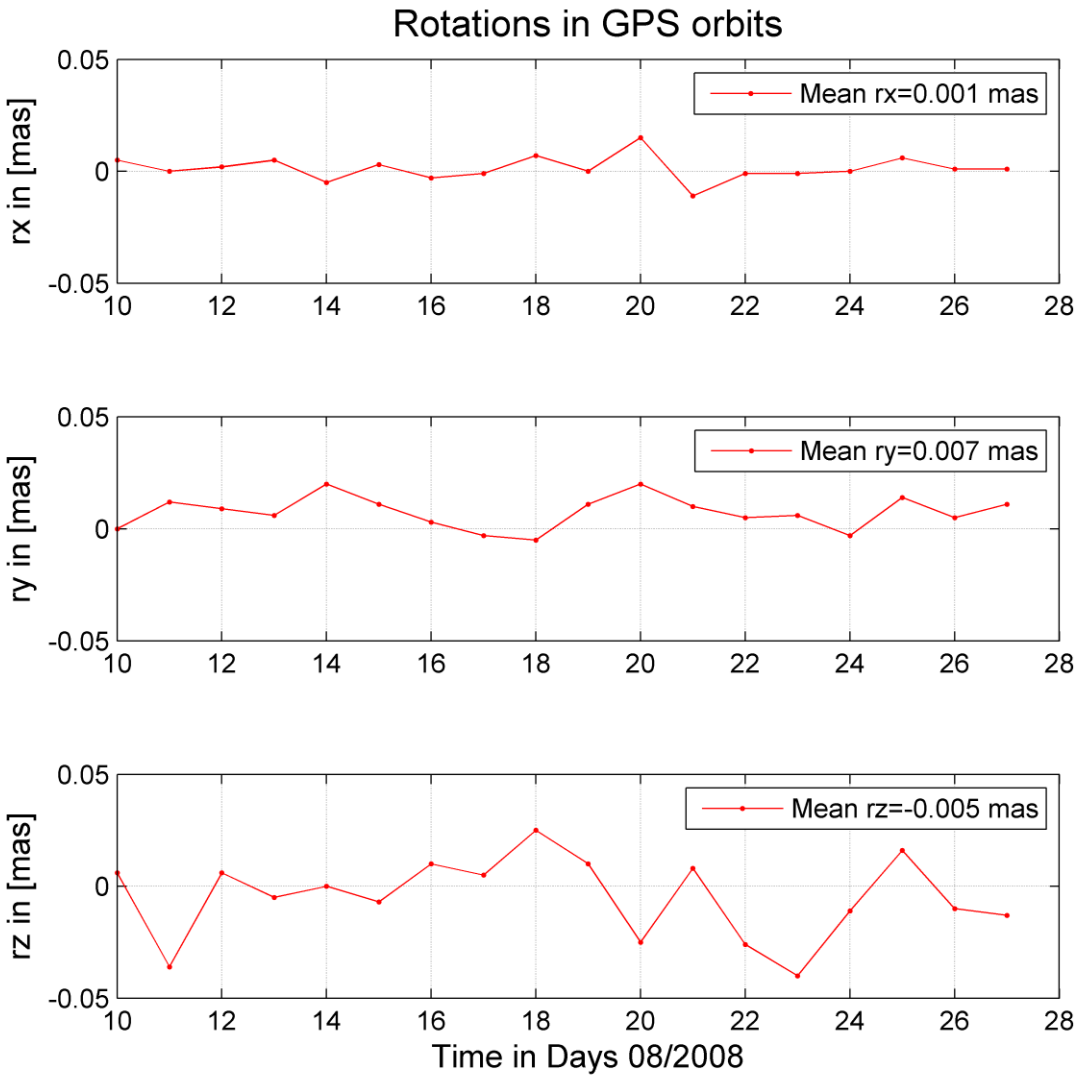


JASON-2 is reducing the SLR bias in GPS orbits!

5 mm bias in z-geocenter and scale

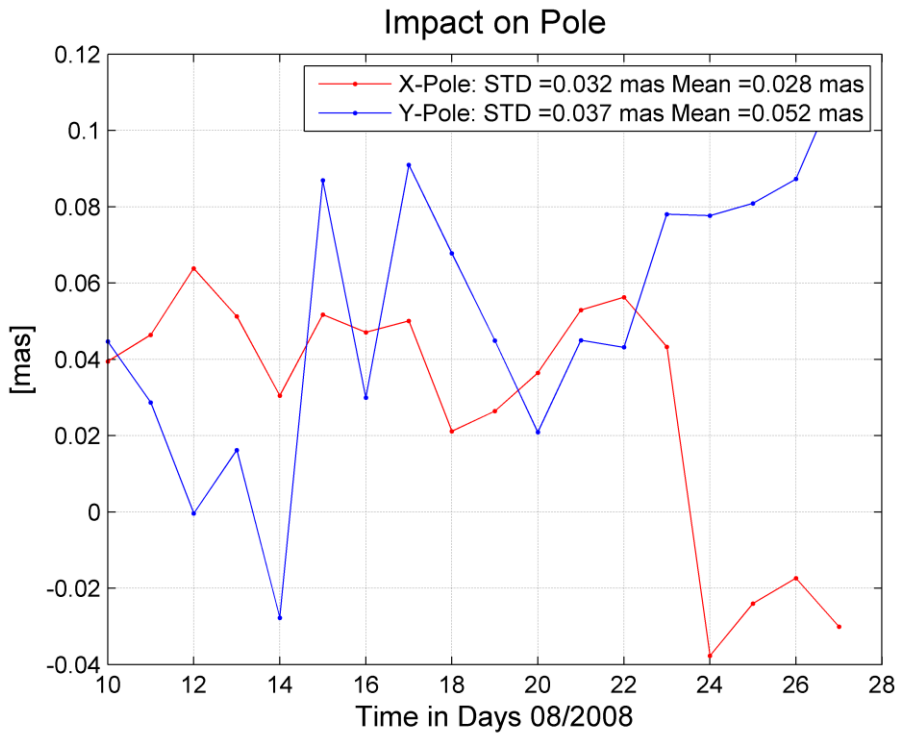


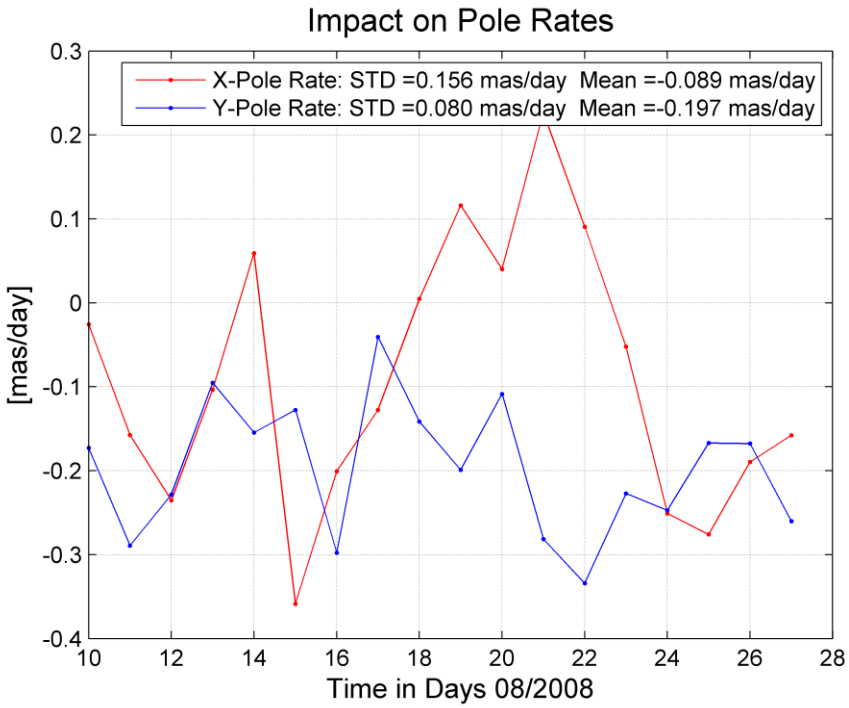
Helmert Transformation
Daily Solutions: GPS Orbits



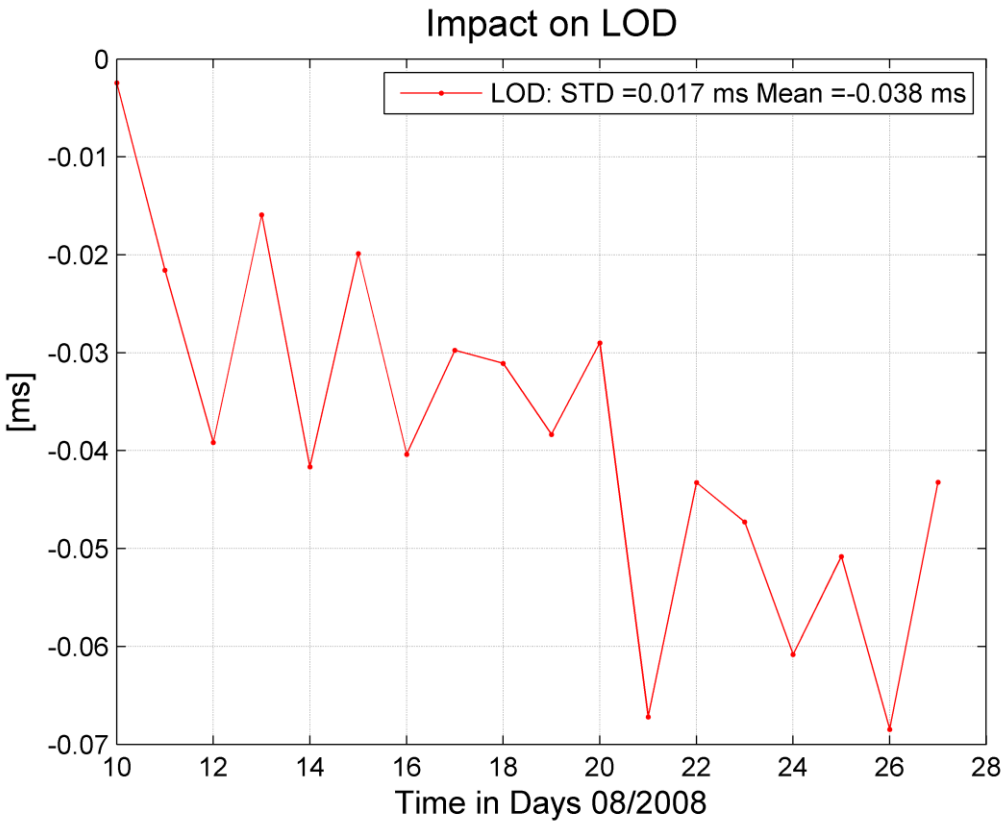
JASON-2 does not see any rotations in GPS orbits

Polar Motion
Daily Solutions





Length of Day
Combined Solutions



First results in stacking of combined NEQs to be improved.

Conclusions

- Is an ideal LEO satellite for the Combination. Compared to CHAMP and GRACE, the JASON-2 orbit is about 10x less sensitive to J_2 and other low degree harmonics of the Earth's gravity field.
- Adding JASON-2 data has similar effect as ambiguity resolution in the global network. Fast changing geometry de-correlates the system.
- Constant 5-mm bias in the z-geocenter and scale.
- The 5-mm bias in z-geocenter most likely driven by SLR.
- JASON-2 is reducing the SLR bias in GPS orbits by 5-mm!