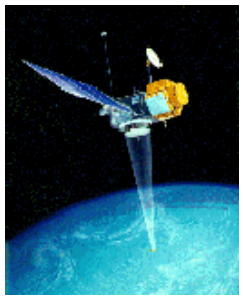
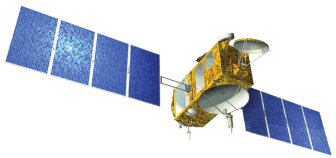


A new time series of orbits (std1504) for TOPEX/Poseidon, Jason-1, Jason-2 (OSTM)

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Introduction:

From the previous OSTST (2014):
The outstanding issues pertained to
(1) a consistent and improved time-variable geopotential model over the entire (1993-2015) time span;
(2) how to reduce evident force model error in the dynamic orbits;
(3) how to improve consistency between the different orbit types and techniques.
Therefore, we have focused our work on the past year to
(1) Refine & Update our 5x5 SLR-DORIS-based time-variable gravity time series.
(2) Develop a derivative that could be used for routine TVG computations.

In addition we have implemented specific improvements:
(1) Use direct modeling of solar array attitude changes (using quaternions) for Jason-1 and Jason-2.
(2) Implement a priori forward model for Earth geocenter variations (Ries, 2013).
(3) As per tests from last year, incorporated VMF1 to correct (DORIS) troposphere.

➔**We have also tested processing RINEX (DORIS) data to prepare for Jason-3.** (*See presentation by N. Zelensky in the POD splinter*).
➔ **We have done preliminary tests with ITRF2014P.**

GSFC POE Description

GSFC SLR + DORIS orbits	Description
std1204	GDR-D comparable. (stk4x4) Parameter fit to 4x4 from previous TVG SLR+DORIS solutions.
std1404	Time-wise parameter fit (5x5) to tvg5x5
std1404_reddyn	SLR+DORIS Reduced-dynamic orbit.
std1504	**GDR-E comparable. New TVG modeling & modeling of solar array deviations from nominal. (SLR+DORIS dynamic)**
std1504_reddyn	**GDR-E comparable. SLR+DORIS, reduced-dynamic.**

General Model Summary (std1504)

Model Summary	std1404 (OSTST-2014)	std1504 (new: OSTST-2015)
Station coordinates	SLRF2008, DPOD2008	Some updates
Geocenter motion	not applied	annual model (Ries, 2013)
Dynamic tides	GOT4.8 (20x20)	GOT4.10 (50x50)
Ocean loading	GOT4.8	GOT4.10
J2 Cr	Tuned 2011	Same
Solar array orientation	Nominal Attitude Law	Quaternions
DORIS Troposphere	VMF1	Same
J1/J2 OPR	12-hr	Same
Pole Model	IERS2010	Same
Static gravity	GOCO2S (> L=5)	Same
TVG	Harmonic piecewise fit to 5x5 weekly solutions	Updated

Lemoine et al., 2015; New POD Standards (std1504), OSTST, Reston, VA, U.S.A.

GSFC POD Test Summary

(SLR+DORIS dynamic orbits)

satellite	test	mean RMS residuals		
		DORIS (mm/s)	SLR (cm)	Xover * (cm)
TOPEX cyc 1-446	std1204	0.4962	1.597	5.605
	std1404	0.4960	1.579	5.610
	std1504	**0.4953**	**1.553**	**5.607**
Jason1 cyc 1-374	std1204	0.3694	0.851	5.458
	std1404	0.3673	0.794	5.445
	std1504	**0.3664**	**0.758**	**5.445**
Jason2 cyc 1-226 (*xover 1-216)	std1204	0.3778	0.934	5.350
	std1404	0.3779	0.907	5.332
	std1504	**0.3778**	**0.855**	**5.339**

Lemoine et al., 2015; New POD Standards (std1504), OSTST, Reston, VA, U.S.A.

Jason-2 POD Comparison

Orbit cycles 1-260	DORIS (cm)	SLR (cm)	XOVER (cm)
std1204	0.4267	0.968	5.337
std1504	**0.4265**	**0.956**	**5.323**
red1504	**0.4260**	**1.020**	**5.293**
gdrd (to cycle 253)	0.4267	1.261	5.323
gdre	0.4262	1.159	5.239
jpl14a	**0.4269**	**1.131**	**5.251**

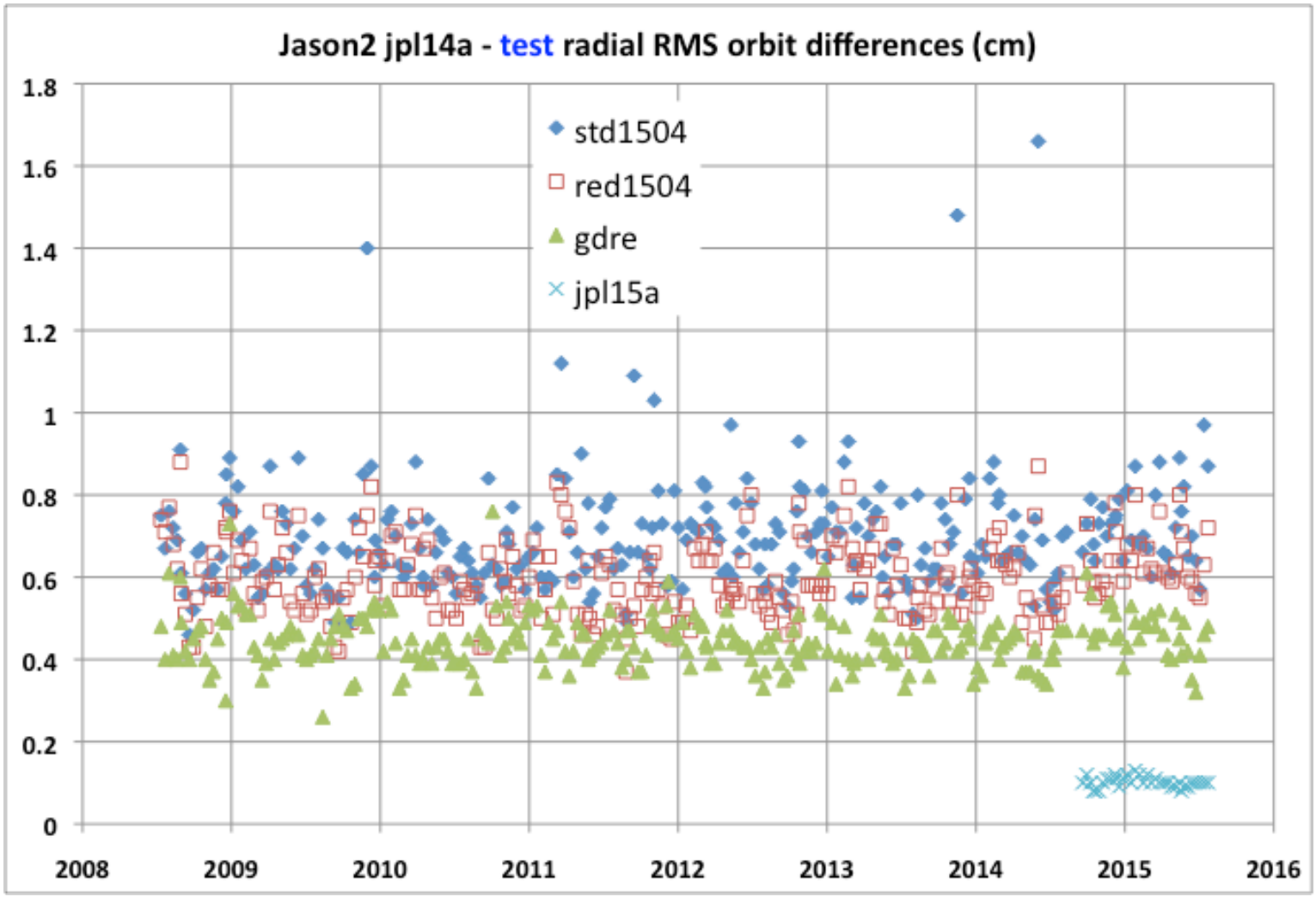
Orbit tests with GEODYN. Use External ephemeris for gdrd, gdre, jpl14a.

Jason-2 Orbit Difference Summary (1)

Orbit jpl14a-test RMS differences cycles 1-260	radial (mm)	cross-track (mm)	along-track (mm)
std1204	8.0	23.4	31.0
std1504	**6.9**	**22.3**	**28.5**
red1504	**5.9**	**19.4**	**24.7**
gdrd **(to cycle 253)**	6.3	13.3	18.0
gdre	**4.4**	**7.0**	**11.5**

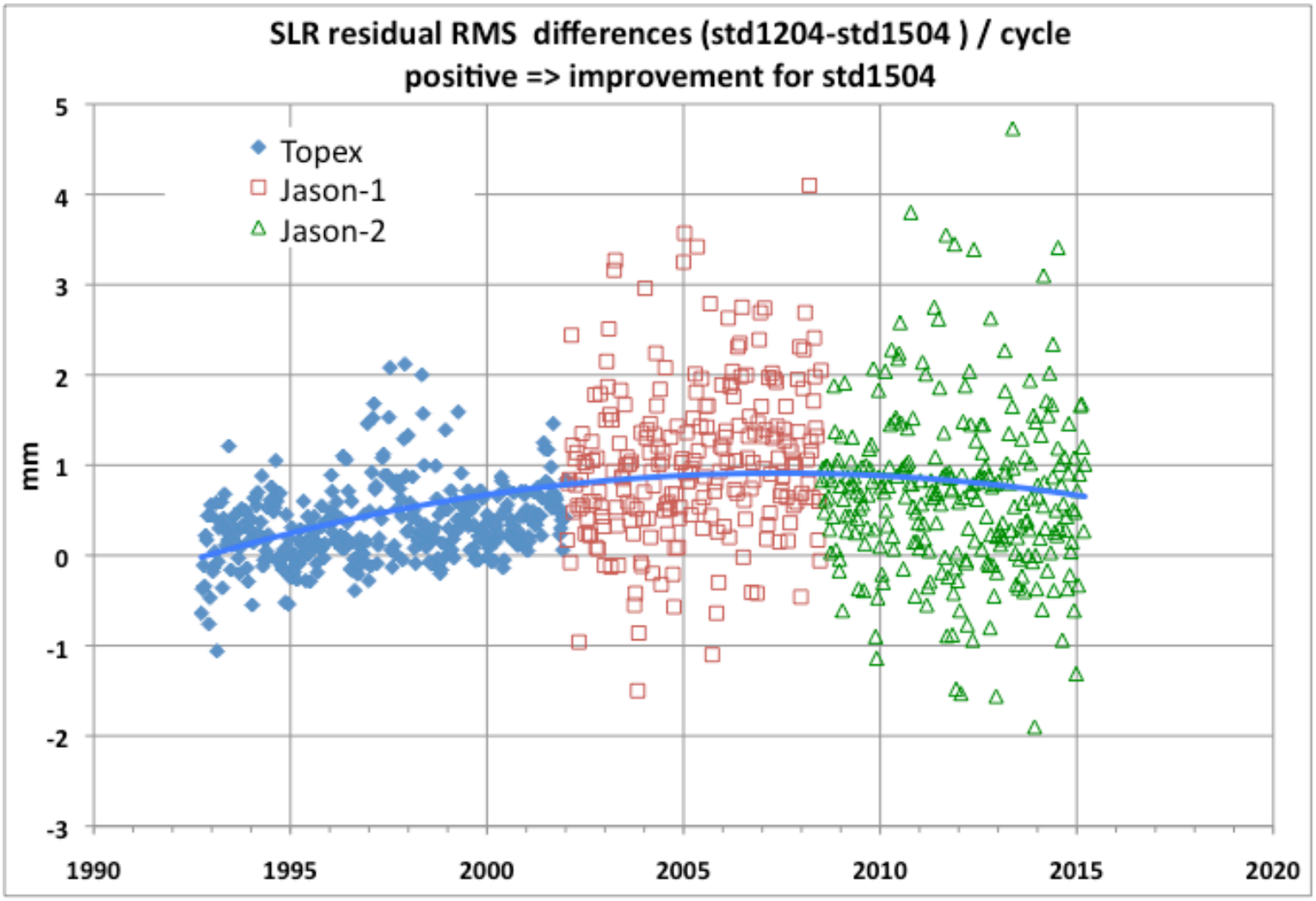
Lemoine et al., 2015; New POD Standards (std1504), OSTST, Reston, VA, U.S.A.

Jason-2 Orbit Difference Summary (2)



Lemoine et al., 2015; New POD Standards (std1504), OSTST, Reston, VA, U.S.A.

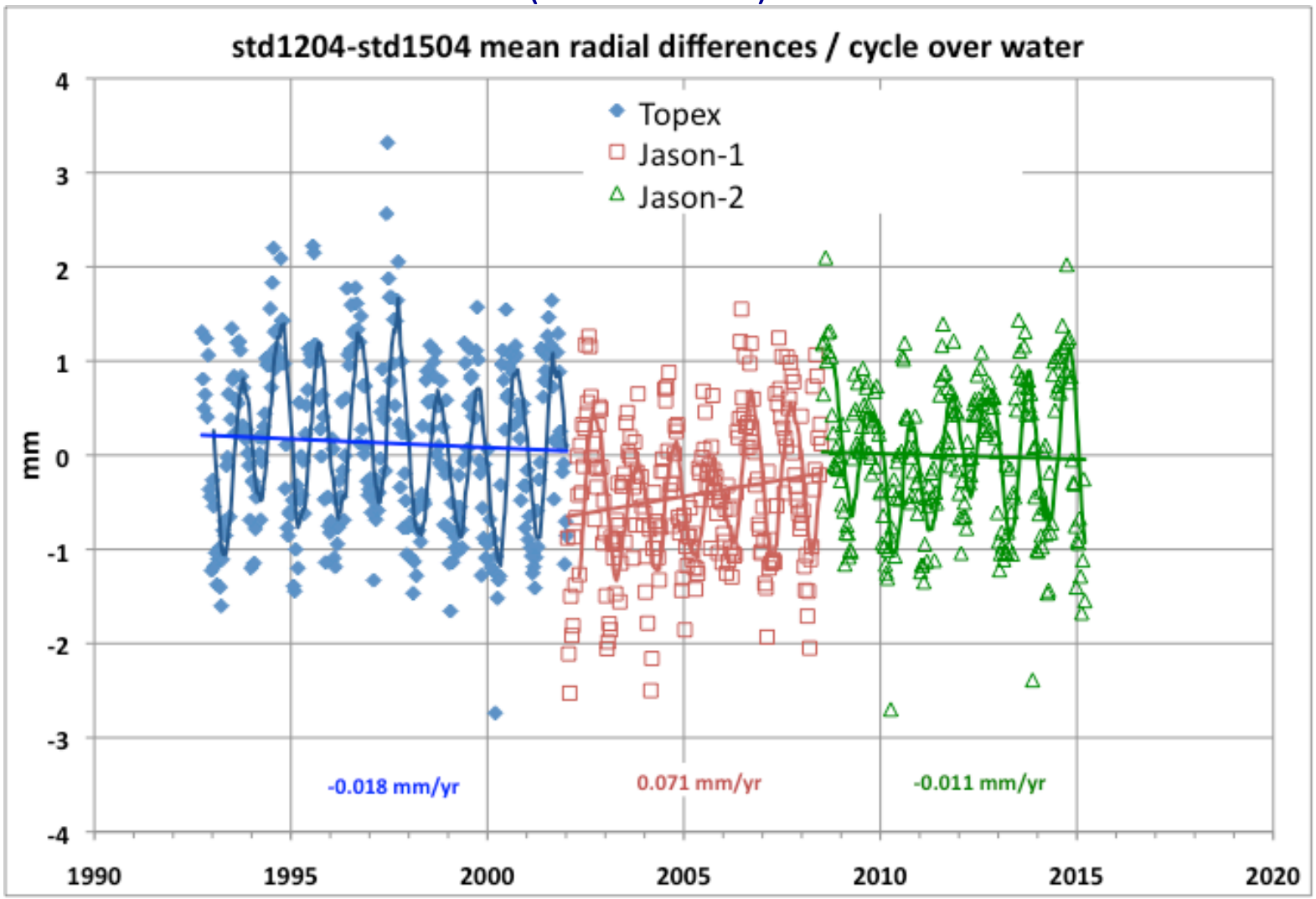
Orbit Improvement seen by SLR



Lemoine et al., 2015; New POD Standards (std1504), OSTST, Reston, VA, U.S.A.

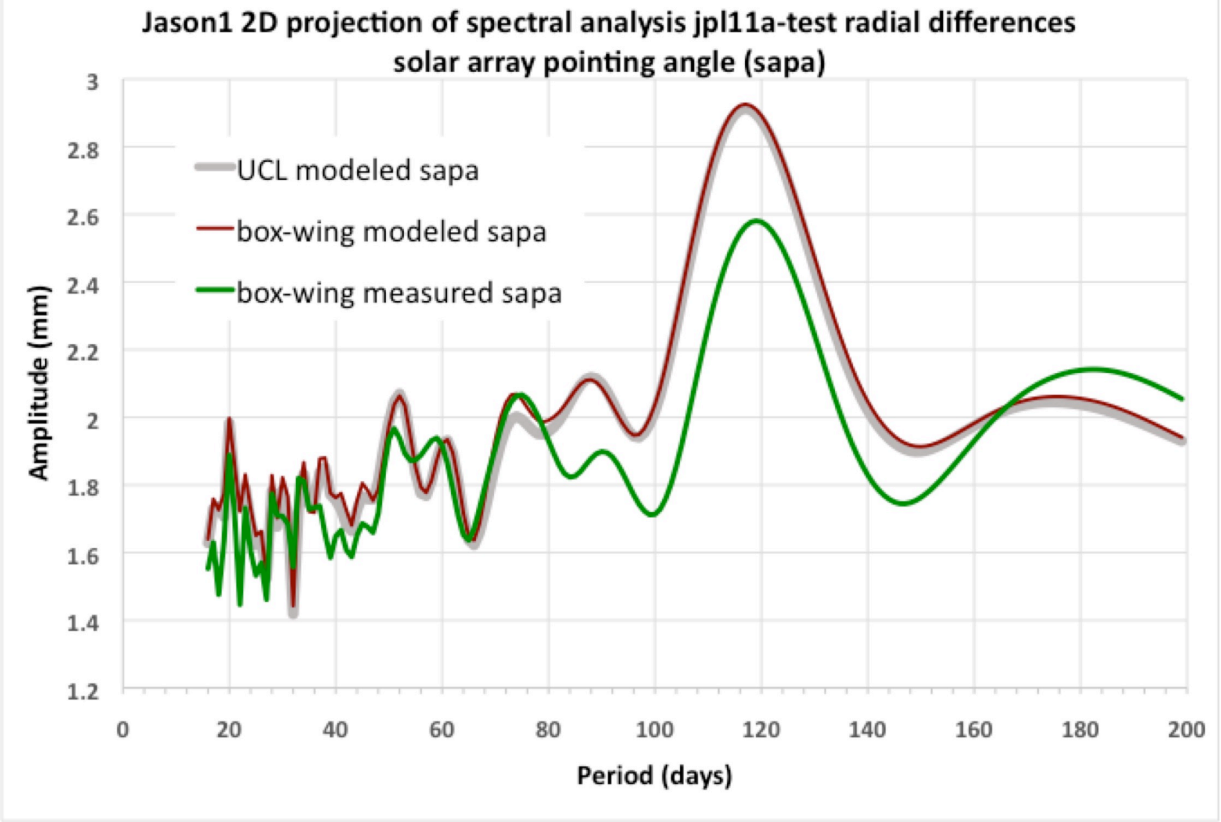
RMS orbit differences (std1204-std1504)

(over oceans)



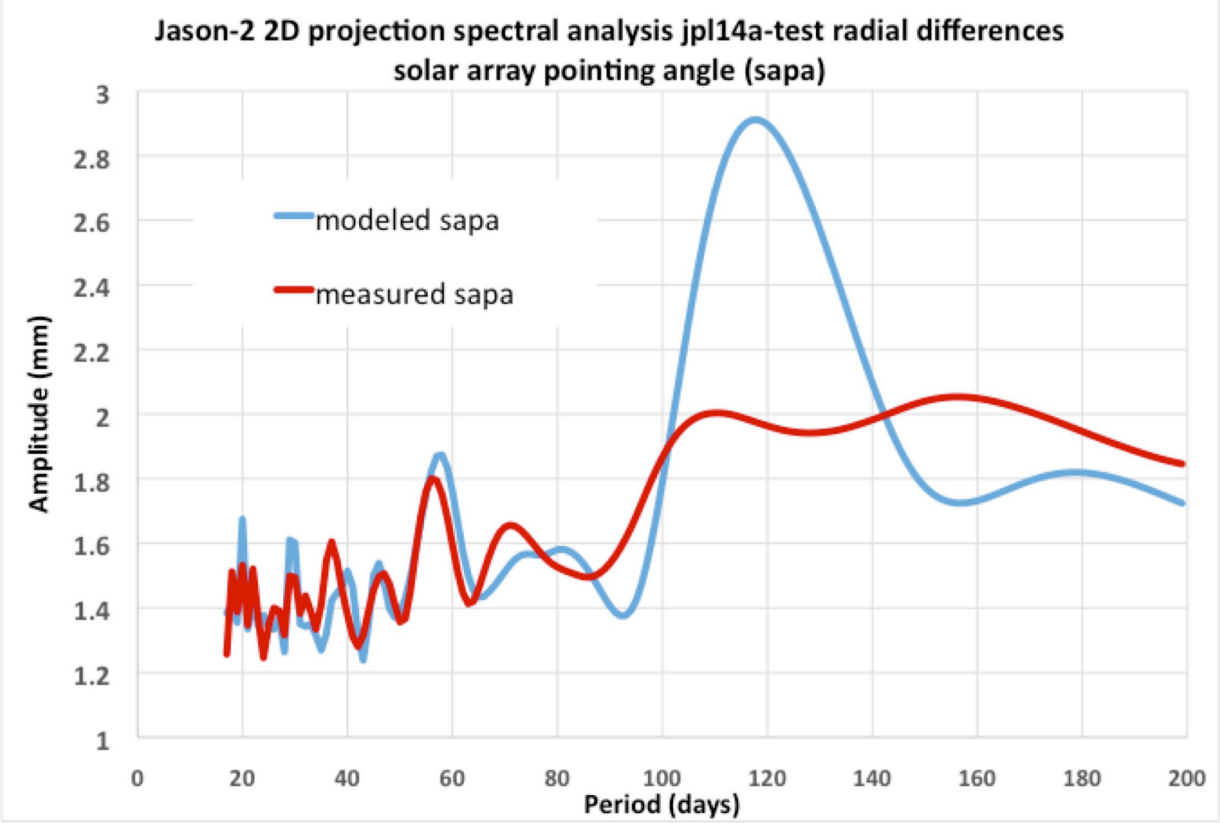
Lemoine et al., 2015; New POD Standards (std1504), OSTST, Reston, VA, U.S.A.

Jason-1 jpl11a/GPS – GSFC/SLR+DORIS test orbits 118-day signal (cycles 9-60)



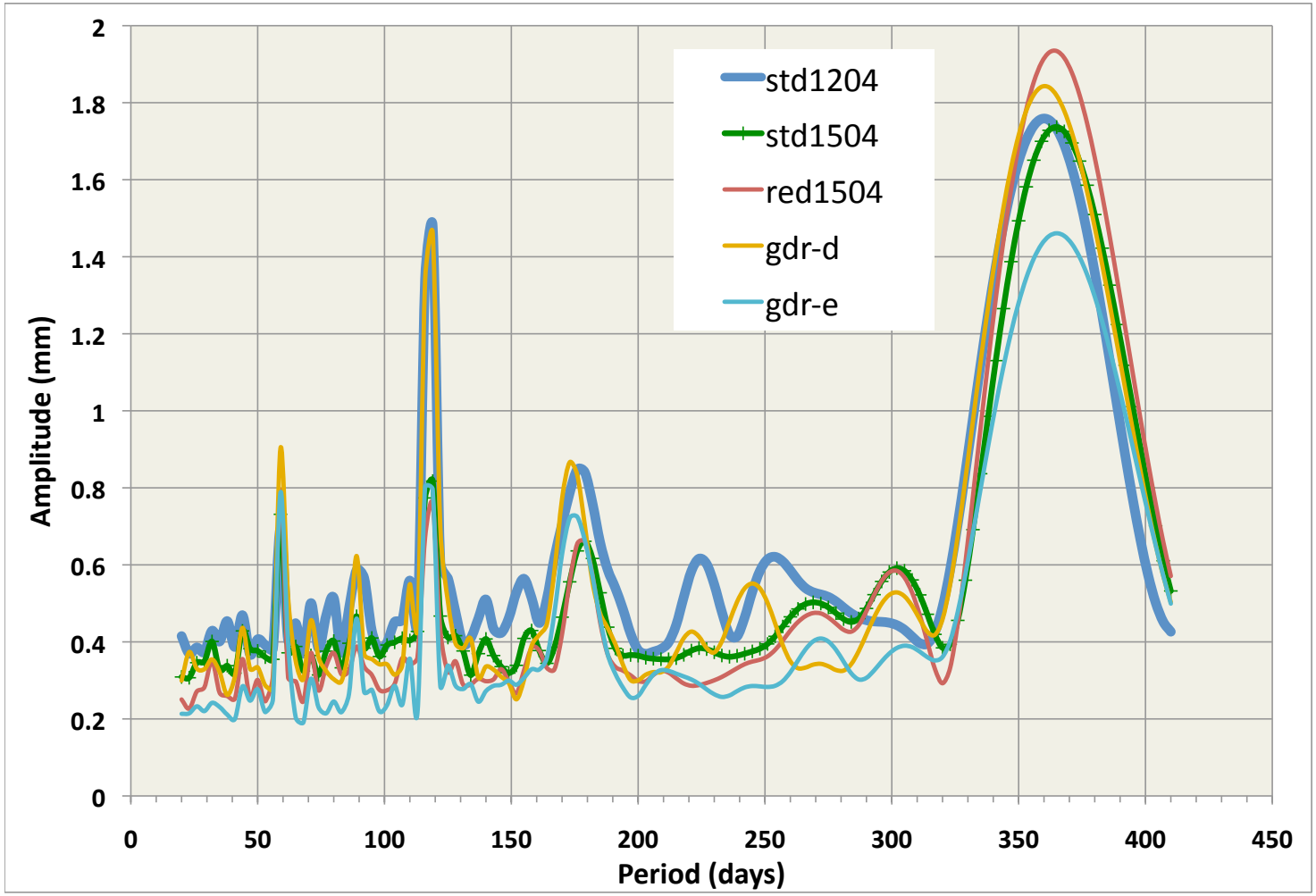
Lemoine et al., 2015; New POD Standards (std1504), OSTST, Reston, VA, U.S.A.

Jason-2 jpl11a/GPS – GSFC/SLR+DORIS test orbits 118-day signal (cycles 5-45)



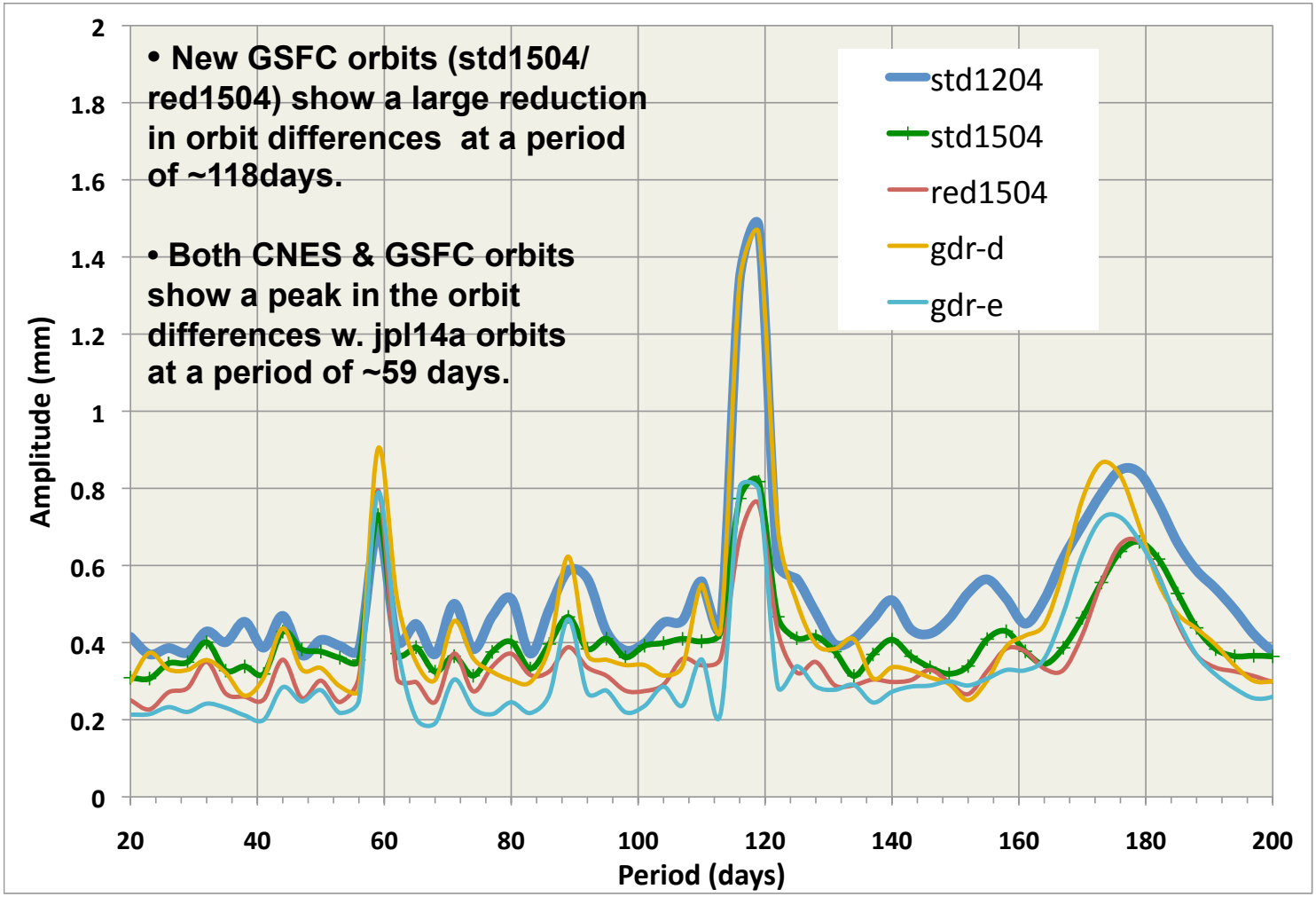
Lemoine et al., 2015; New POD Standards (std1504), OSTST, Reston, VA, U.S.A.

2D projection spectral analysis jpl14a-test radial orbit differences sampled at fixed geographic locations



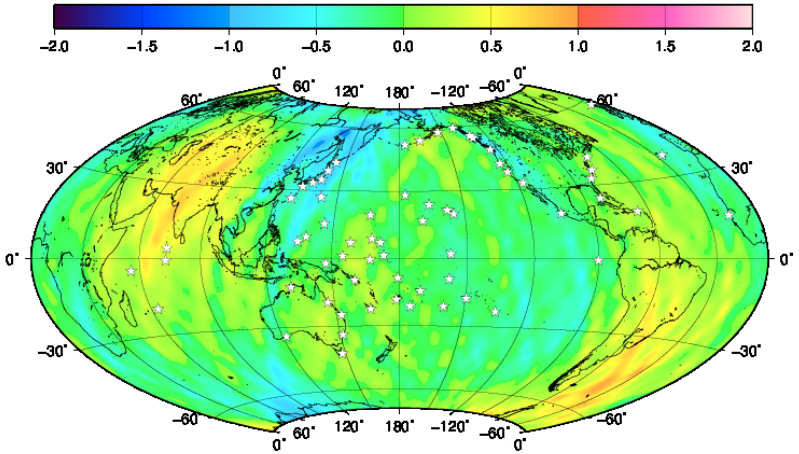
Lemoine et al., 2015; New POD Standards (std1504), OSTST, Reston, VA, U.S.A.

2D projection: Spectral analysis of jpl14a - *"test"* radial orbit differences sampled at fixed geographic locations

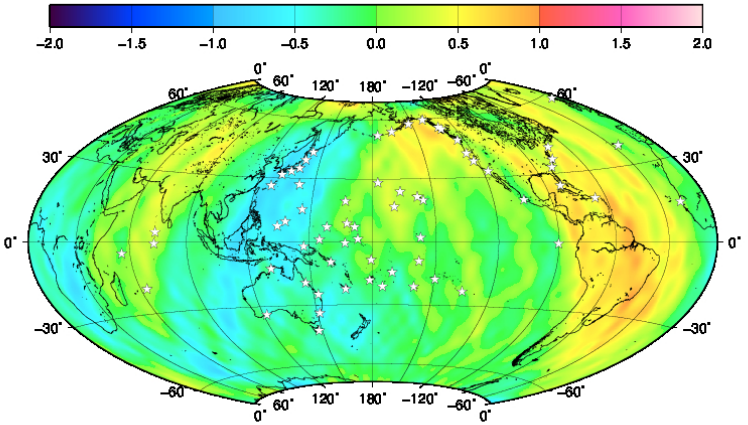


Orbit difference rates (1)

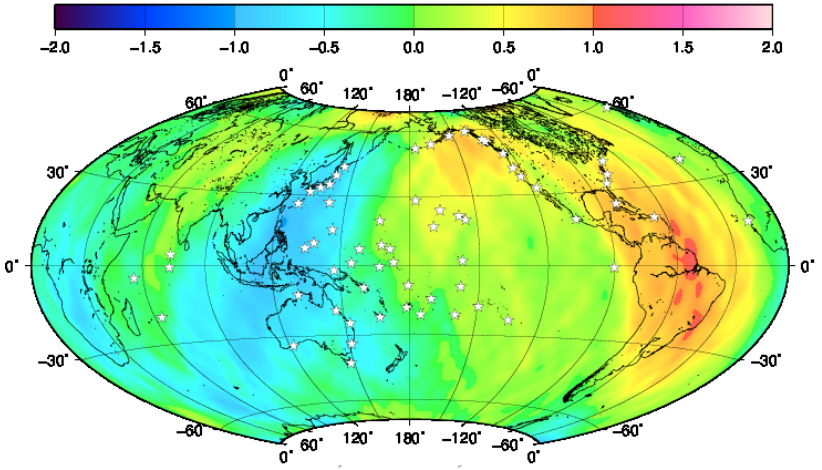
gsfc-std1204 **vs jpl14a (mm/yr)**



gsfc-std1504 vs jpl14a (mm/yr)



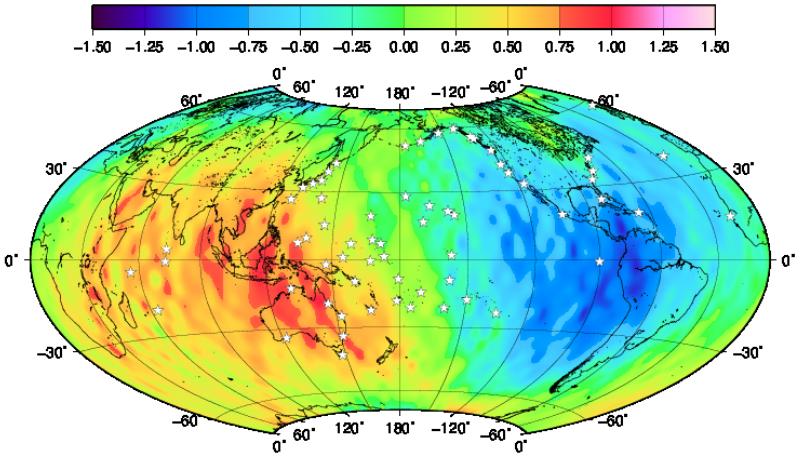
gsfc-red1504 vs jpl14a (mm/yr)



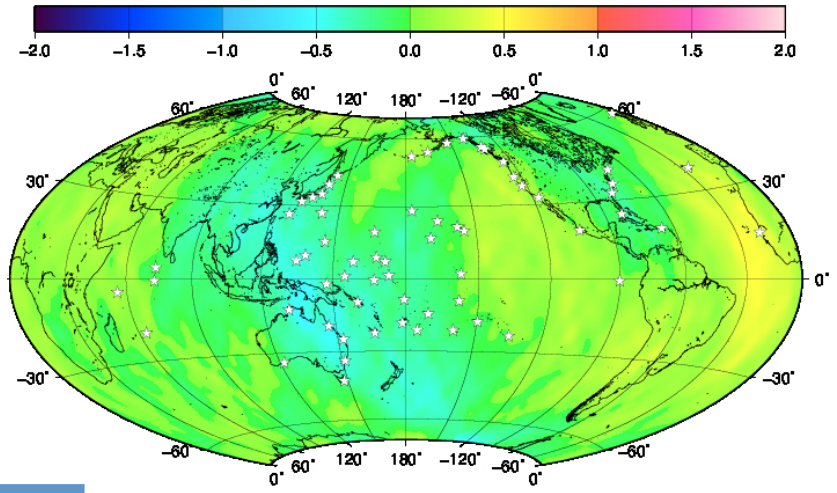
(std1504), OSTST, Reston, VA, U.S.A.

Orbit difference rates (2)

cnes-gdrd **vs jpl14a (mm/yr)**



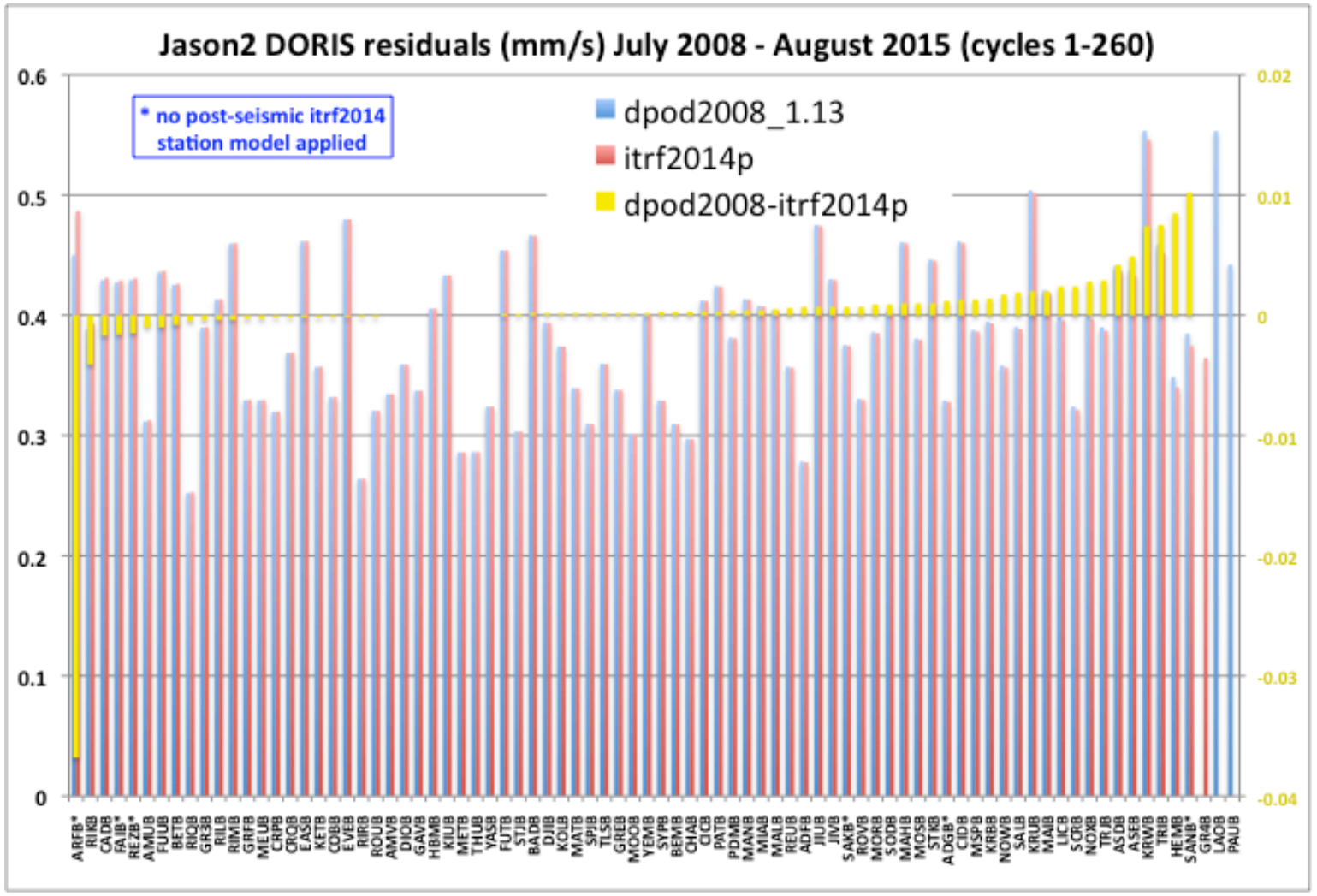
cnes-gdre vs jpl14a (mm/yr)



Test series	Mean rate over H_2O (mm/y)	std dev (mm/y)	cycles
std1204	-0.059	0.024	1-260
std1504	**-0.033**	**0.021**	**1-260**
red1504	**-0.029**	**0.022**	**1-260**
gdrd	-0.023	0.017	1-253
gdre	**-0.027**	**0.020**	**1-260**

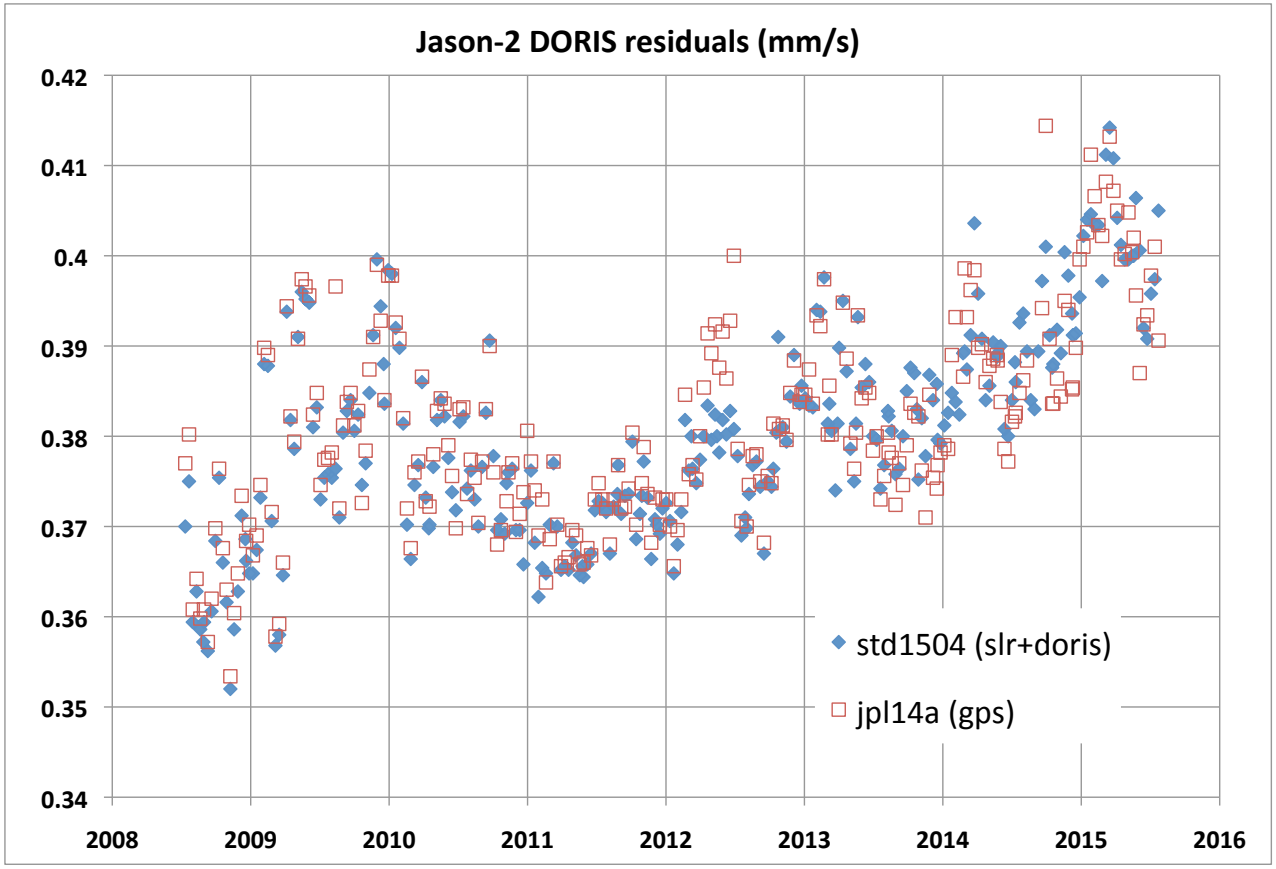
Good agreement for gdre vs. jpl14a because both sets of orbits are reduced-dynamic; (GPS-only for jpl14a; GPS +DORIS for gdre)

Preliminary Tests w. ITRF2014P



Lemoine et al., 2015; New POD Standards (std1504), OSTST, Reston, VA, U.S.A.

Jason-2 DORIS RMS of fit Summary



Quasi-secular increase in DORIS RMS of fit not removed with new ITRF.
Is it effect of DPOD2008, TVG modelling, or something else?
Needs further investigation.

Summary

(1) We have developed a new time series of orbits (*std1504*) for TOPEX, Jason-1, Jason-2.

(2) The orbit series include improvements in the radiation pressure modeling for J1 & J2 that reduce radial orbit error at the beta-prime period of ~118days.

(3) RMS radial orbit agreement between the centers is below 8 mm radial RMS.

(4) We need to monitor & understand the performance of the DORIS instrument of Jason-2 in view of recent secular increase in RMS of fit.

(5) Future work will include detailed testing of different ITRF2014 realizations (IGN, DGFI, JPL).

Backups

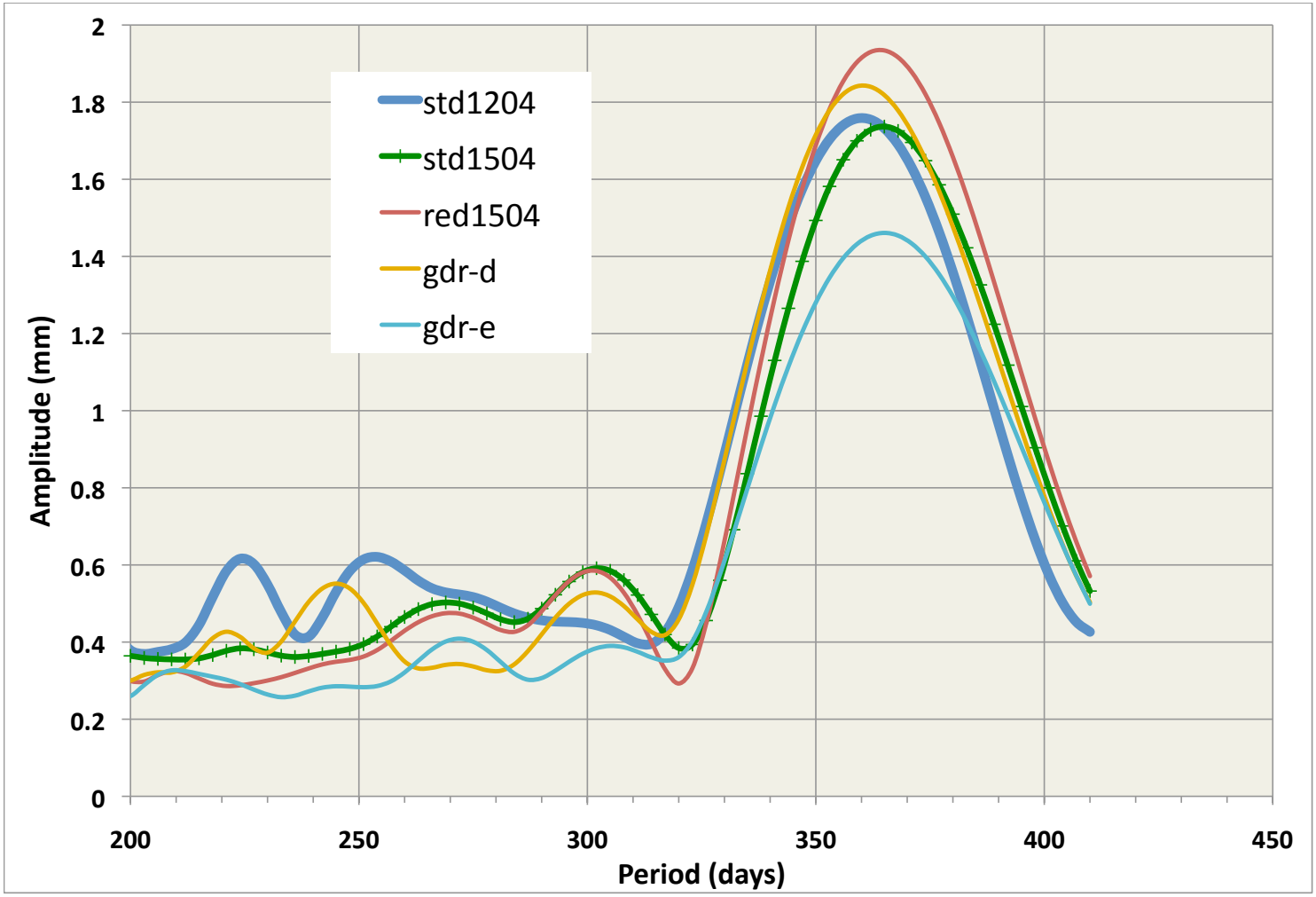
tvg5x5 time series description

- **20 SLR+DORIS satellites, mostly 7-day arcs (1993-2014).**
(Lageos1, Lageos2, Starlette, Stella, Ajisai, TOPEX, Jason-1, Jason-2 SPOT-2, SPOT-3, SPOT4, Envisat, Larets, Cryosat-2, Blits, Westpac, Lares, Etalon-1, Etalon-2)
- **Subset solution analysis to converge on adopted weights.**
- **Smoothed with a moving window over several solution periods.**
- **Used for ITRF2013 @ NASA GSFC for IDS submission.**
- **Solution compares well with independent solutions to 4x4; Order 1 terms (C_{31}/S_{31}, C_{41}/S_{41}) not so well determined.**

stk5x5 description

Harmonic fit to tvg5x5 time series by time period.
1992.0 to 2003.0; 2003.0 to 2007.0; 2007.0 to 2014.0

2D projection spectral analysis jpl14a-test radial orbit differences sampled at fixed geographic locations



Lemoine et al., 2015; New POD Standards (std1504), OSTST, Reston, VA, U.S.A.