Ocean Surface Topography Science Team Meeting

Precise Orbit Determination Splinter

JASON-2, SARAL AND CRYOSAT-2 STATUS

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Reston, USA

CONTENTS

GDRE STANDARD

	GDR-D	GDR-E
Surface forces	Atmospheric model : DTM-94 for Jason1&2 Solar radiation pressure model : pre-launch box and wing model	Atmospheric model : **DTM-13** for Jason1&2 Solar radiation pressure model : **calibrated solar radiation pressure model**
Geopotential	EIGEN-GRGS_RL02bis_MEAN-FIELD Non-tidal TVG: annual, semi-annual, and drift up to deg/ord 50 Atmospheric gravity: 6hr NCEP pressure fields (20x20) + tides from Biancale-Bode model	EIGEN-GRGS.**RL03-v2**.MEAN-FIELD Non-tidal TVG: one annual, one semiannual, one bias and one drift terms for **each year** up to **deg/ord 80**; **C21/S21** modeled according to IERS2010 conventions Atmospheric gravity: 6hr NCEP pressure fields (**72x72**) + tides from Biancale-Bode model
Geocenter		Tidal: ocean loading and S1-S2 atmospheric pressure loading **Non-tidal: seasonal model from J. Ries**

GDRE STANDARD

	GDR-D	GDR-E
Loading	Ocean loading: FES2004	Ocean loading: **FES2012** **S1-S2 atmospheric pressure loading**, implementation of Ray & Ponte (2003) by Dr. Van Dam
Pole tides	Pole tide: solid earth pole tides	Pole tide: solid earth pole tides and **ocean pole tides** (Desai, 2002)
GPS constellation	JPL solution at IGS (orbits and clocks) – fully consistent with IGS08	**JPL solution in "native" format** (orbits and clocks), referenced to the CoM of the solid Earth/Ocean system – fully consistent with IGS08 **New phase correction maps** (see poster F. Mercier)
Propagation delays		DORIS beacons phase center correction
Types of measurement	DORIS + GPS + SLR Or DORIS + SLR	DORIS + GPS Or DORIS-only **SLR is now used independently to evaluate orbit precision and stability**

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SARAL

Saral/AltiKa

French/Indian satellite, launched in 2013

DORIS + SLR measurements

GDR-E (delivered orbit):

- Dynamic orbit (no reduced dynamics)
- DORIS only

Results

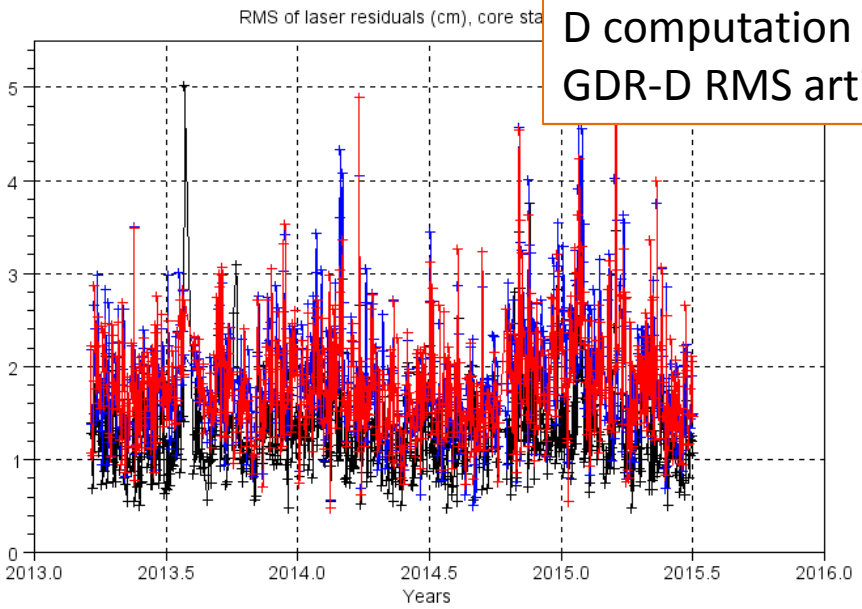
- SLR residuals
- Geographically correlated radial differences

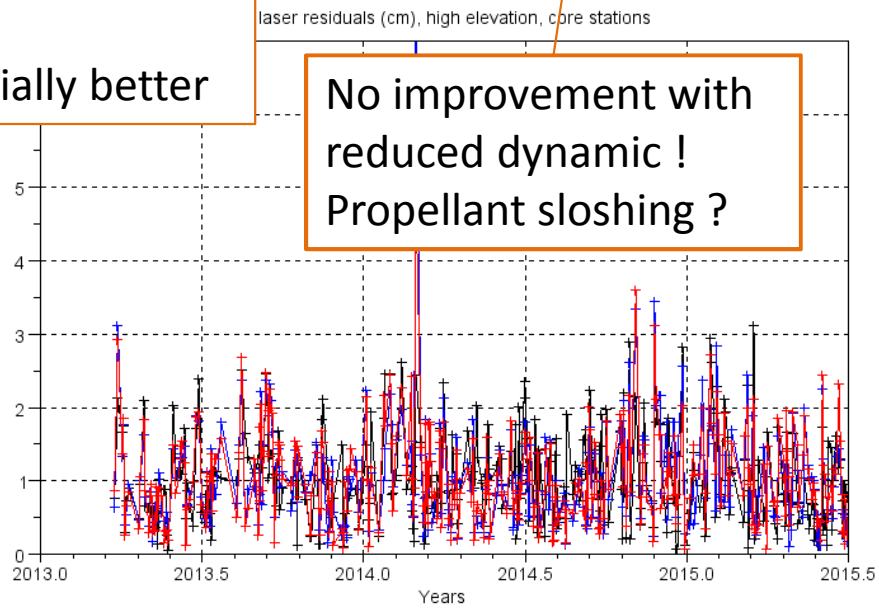
SARAL – SLR RESIDUALS

Core network ✦ RMS SLR residuals	**GDR-D** : Doris + SLR, Stochastic orbit	**GDR-E** : Doris, Dynamic orbit	**GDR-E** : Doris, Reduced dynamic orbit
All elevation	1,2 cm	1,8 cm	1,7 cm
High elevation	0,9 cm	0,9 cm	0,9 cm

Remember : SLR used in GDR-D computation !
GDR-D RMS artificially better

No improvement with reduced dynamic !
Propellant sloshing ?

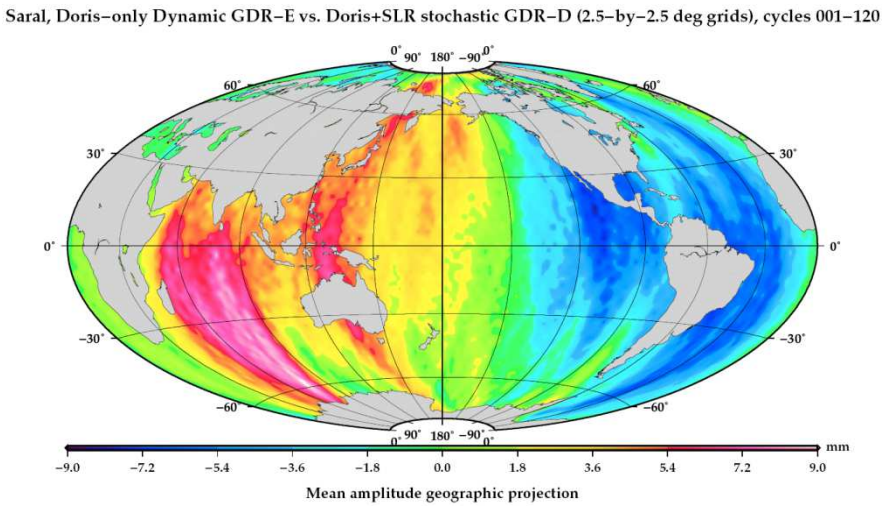




✦ *Core network* : L7090 L7105 L7810 L7839 L7840 L7941

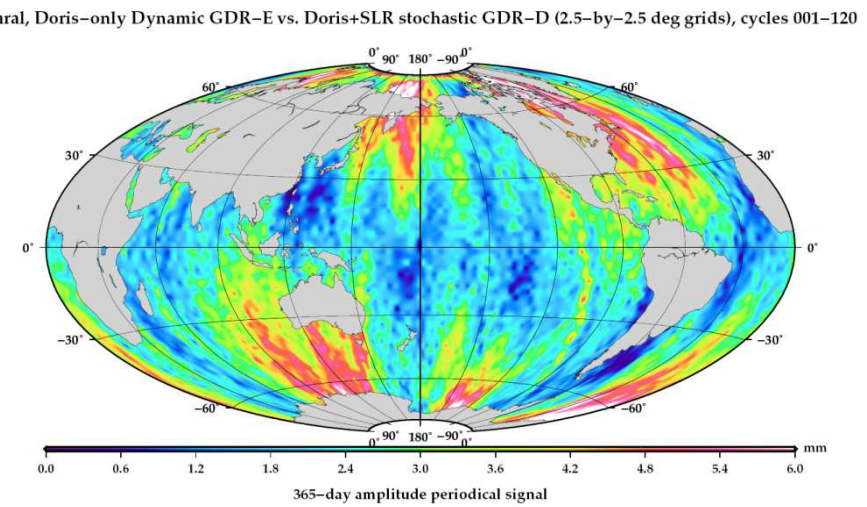
SARAL – GEOGRAPHICALLY CORRELATED RADIAL DIFFERENCES
GDR-E - GDR-D

Mean :



9 mm

Annual signal :



3 mm

SARAL – CONCLUSION

SARAL RMS radial component (SLR) : **0,9 cm**

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CRYOSAT2

Cryosat2

ESA satellite, launched in 2010

DORIS + SLR measurements

GDR-E (delivered orbit):

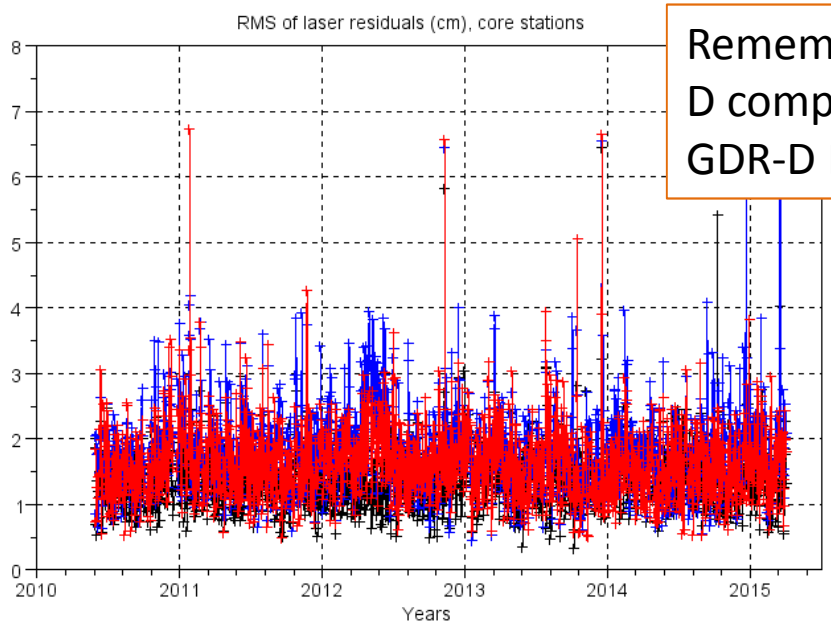
- Reduced dynamic orbit
- DORIS only

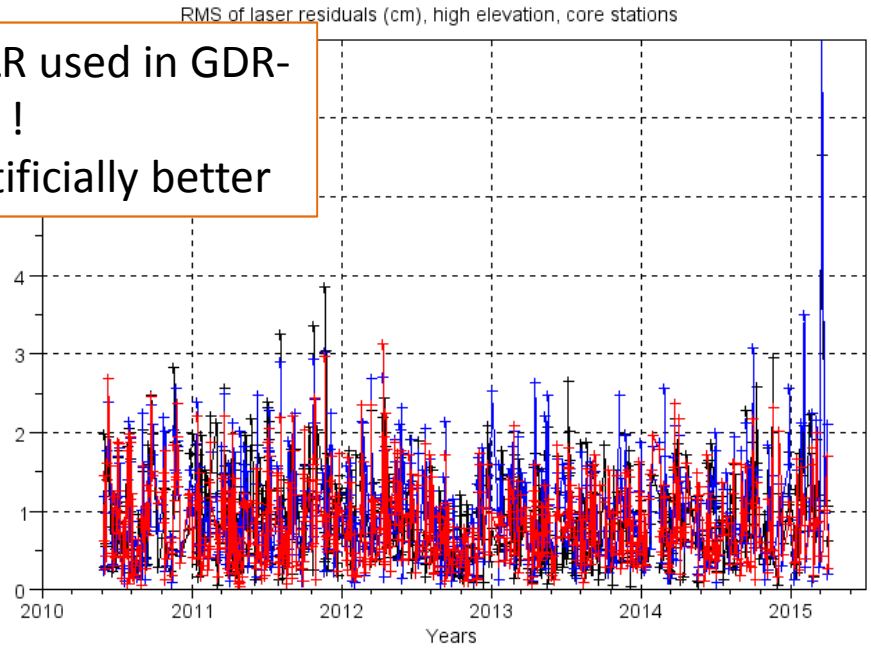
Results

- SLR residuals
- Geographically correlated radial differences

CRYOSAT2 – SLR RESIDUALS

Core network ✦ RMS SLR residuals	**GDR-D** : Doris + SLR, Stochastic orbit	**GDR-E** : Doris, Dynamic orbit	**GDR-E** : Doris, Reduced dynamic orbit
All elevation	1,3 cm	1,7 cm	1,6 cm
High elevation	0,9 cm	0,9 cm	0,8 cm



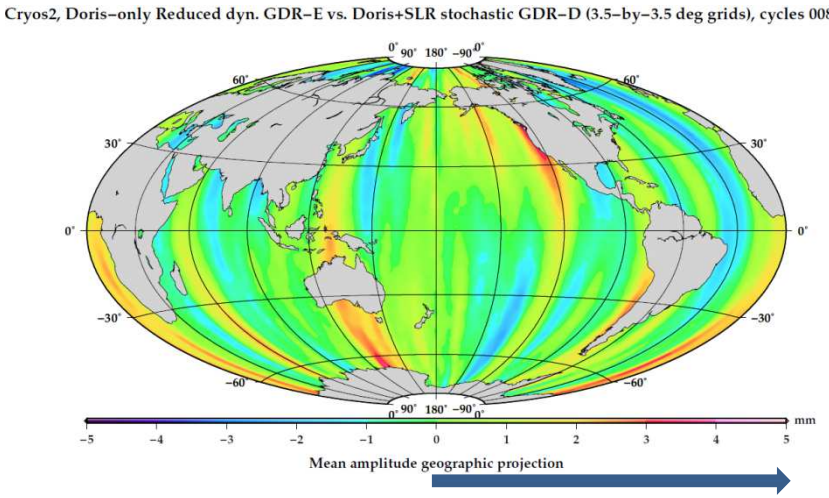


Remember : SLR used in GDR-D computation !
GDR-D RMS artificially better

✦ *Core network* : L7090 L7105 L7810 L7839 L7840 L7941

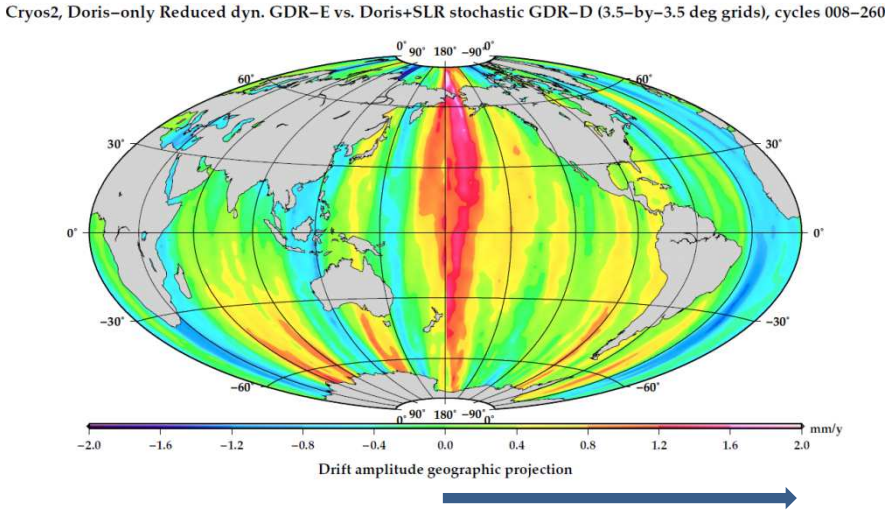
CRYOSAT-2 – GEOGRAPHICALLY CORRELATED RADIAL DIFFERENCES
GDR-E - GDR-D

Mean :



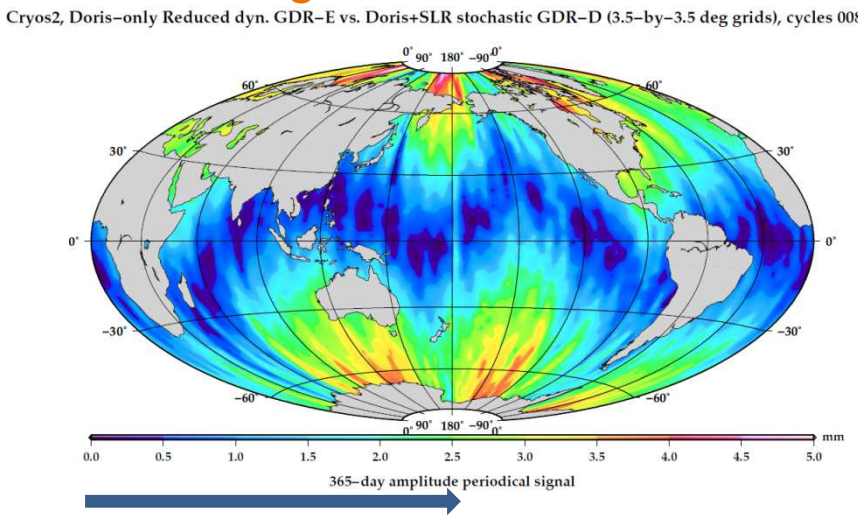
5 mm

Drift :



2 mm

Annual signal :



2,5 mm

CRYOSAT2 – CONCLUSION

CRYOSAT2 RMS radial component (SLR) : **0,8 cm**

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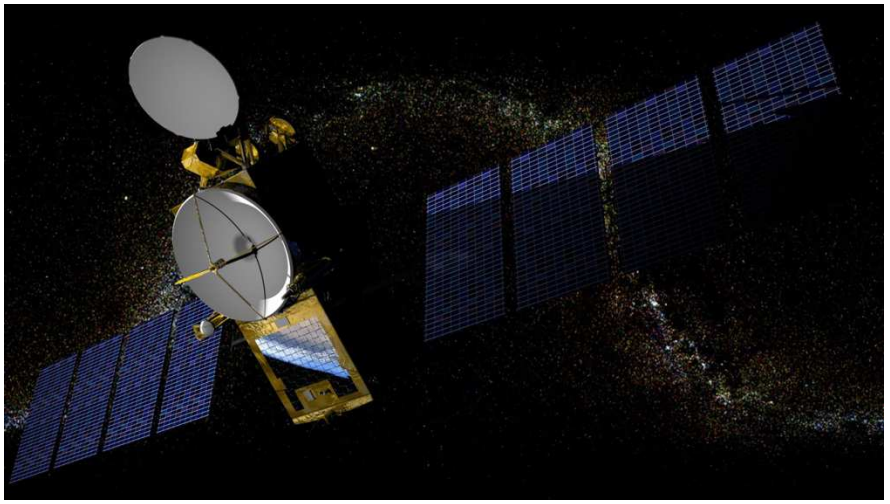
JASON-2



Jason-2

French/American satellite, launched in 2008

DORIS + SLR +GPS measurements

GDR-E (delivered orbit):

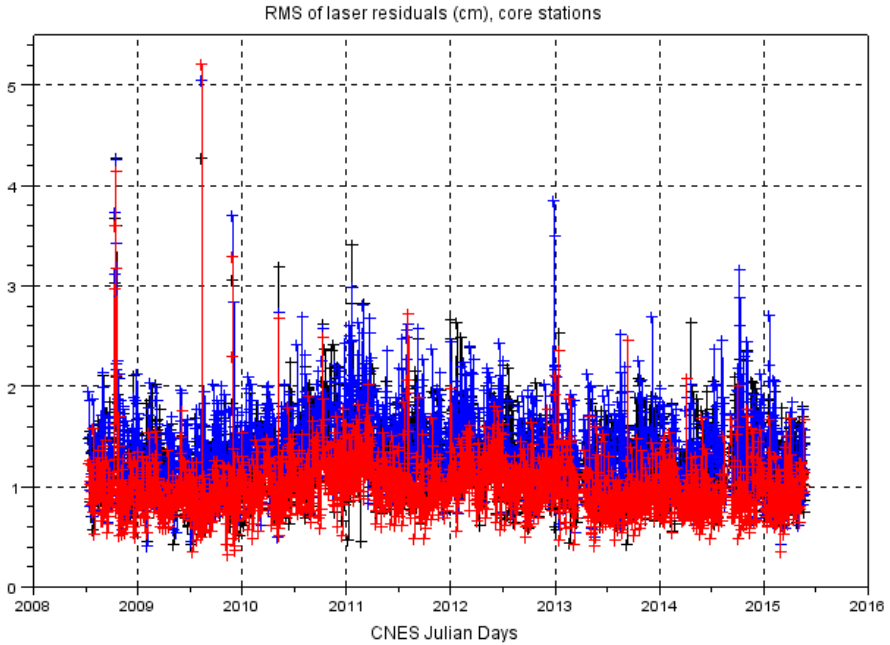
- Reduced dynamic orbit
- DORIS + GPS
- Only for cycles 226 and 227 (no GPS) : DORIS-only dynamic orbit

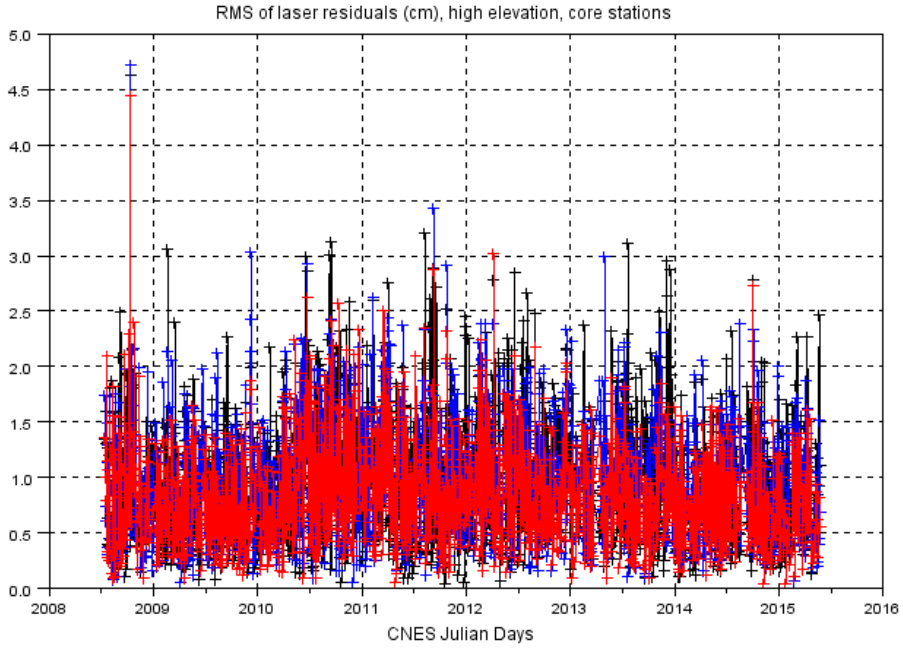
Results:

- SLR residuals
- Geographically correlated radial differences
- Orbits comparison (GSFC and JPL)
- Crossover variance

JASON2 – SLR RESIDUALS

Core network ✦ RMS SLR residuals	**GDR-D** : Doris+SLR+GPS, Dynamic orbit	**GDR-E** : Doris+GPS, Dynamic orbit	**GDR-E** : Doris+GPS, Reduced dynamic orbit
All elevation	1,2 cm	1,3 cm	1,0 cm
High elevation	0,9 cm	0,9 cm	0,8 cm

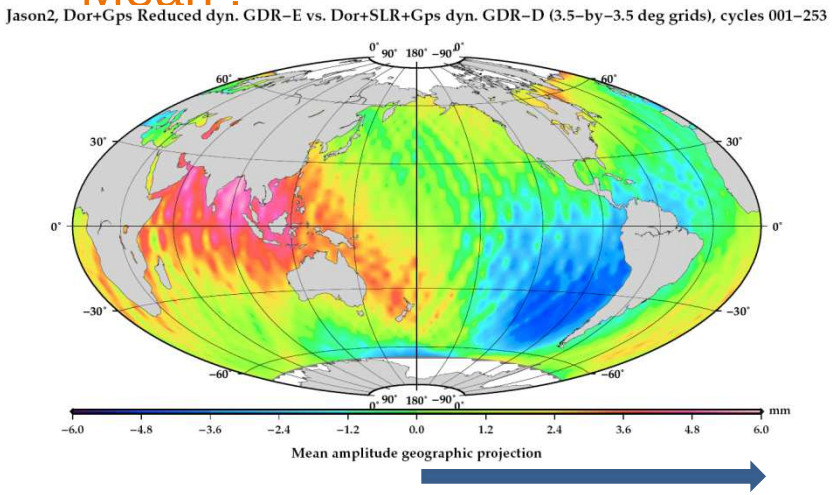




✦ *Core network* : L7090 L7105 L7810 L7839 L7840 L7941

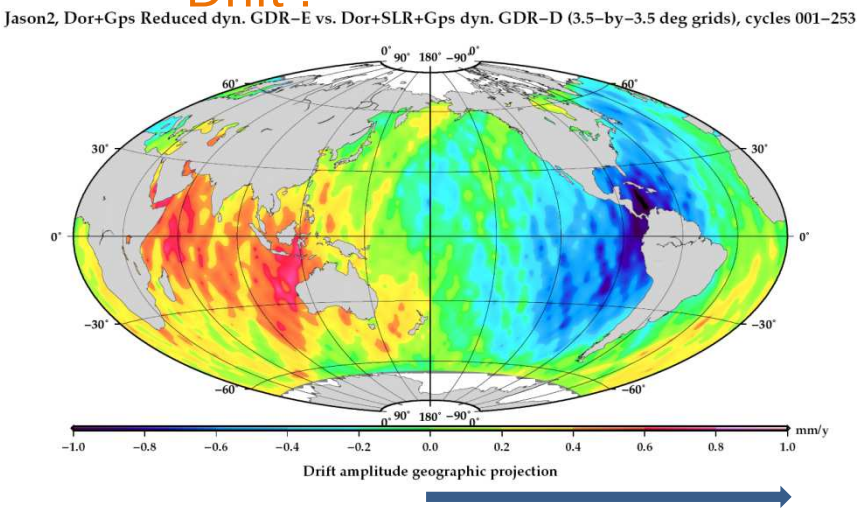
JASON2 – GEOGRAPHICALLY CORRELATED RADIAL DIFFERENCES
GDR-E - GDR-D

Mean :



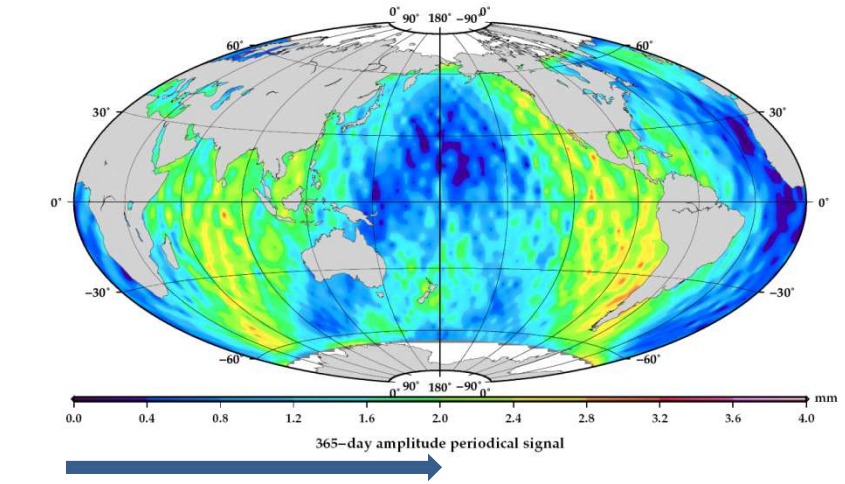
6 mm

Drift :



1 mm

Annual signal :

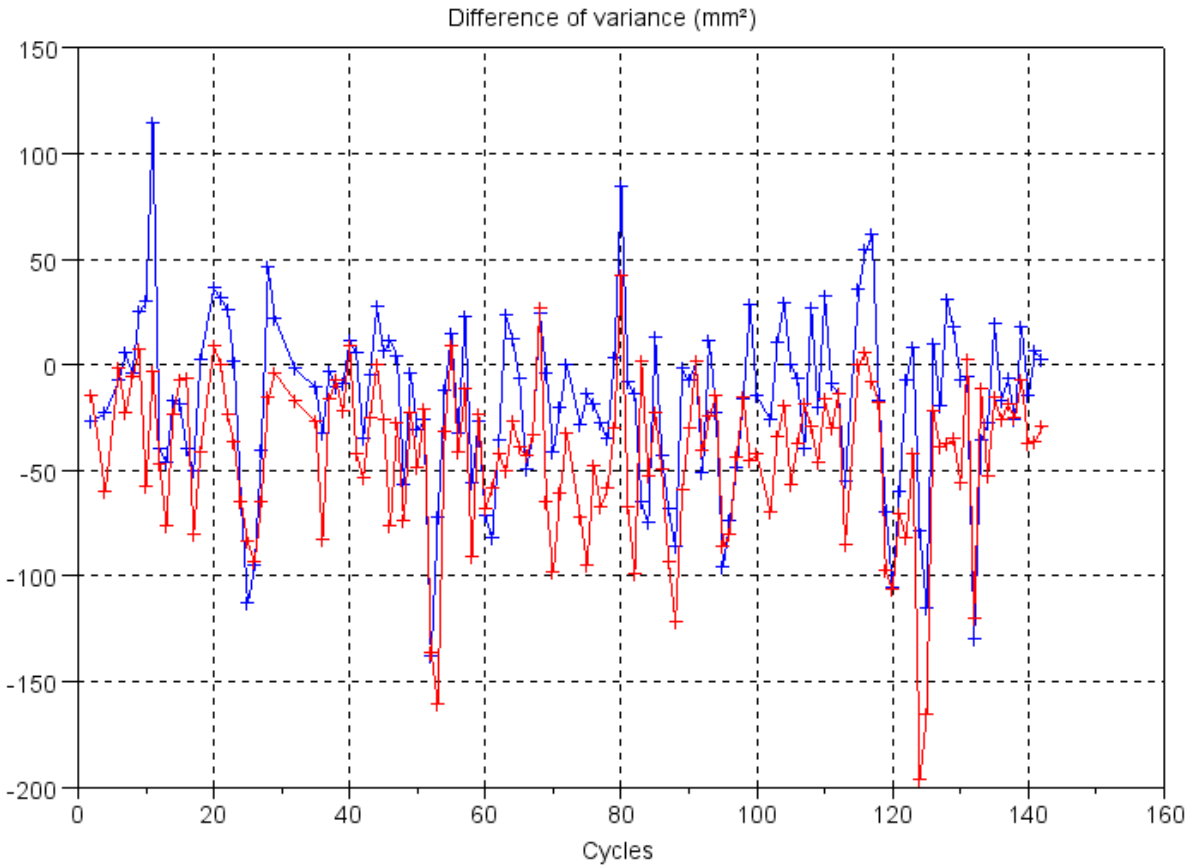


2 mm

JASON2 – CROSSOVER VARIANCE DIFFERENCE W.R.T. GDR-D

GDR-E Doris + Gps, Dynamic orbit. Median = **-12 mm²**

GDR-E Doris + Gps, Reduced dynamic orbit. Median = **-37 mm²**

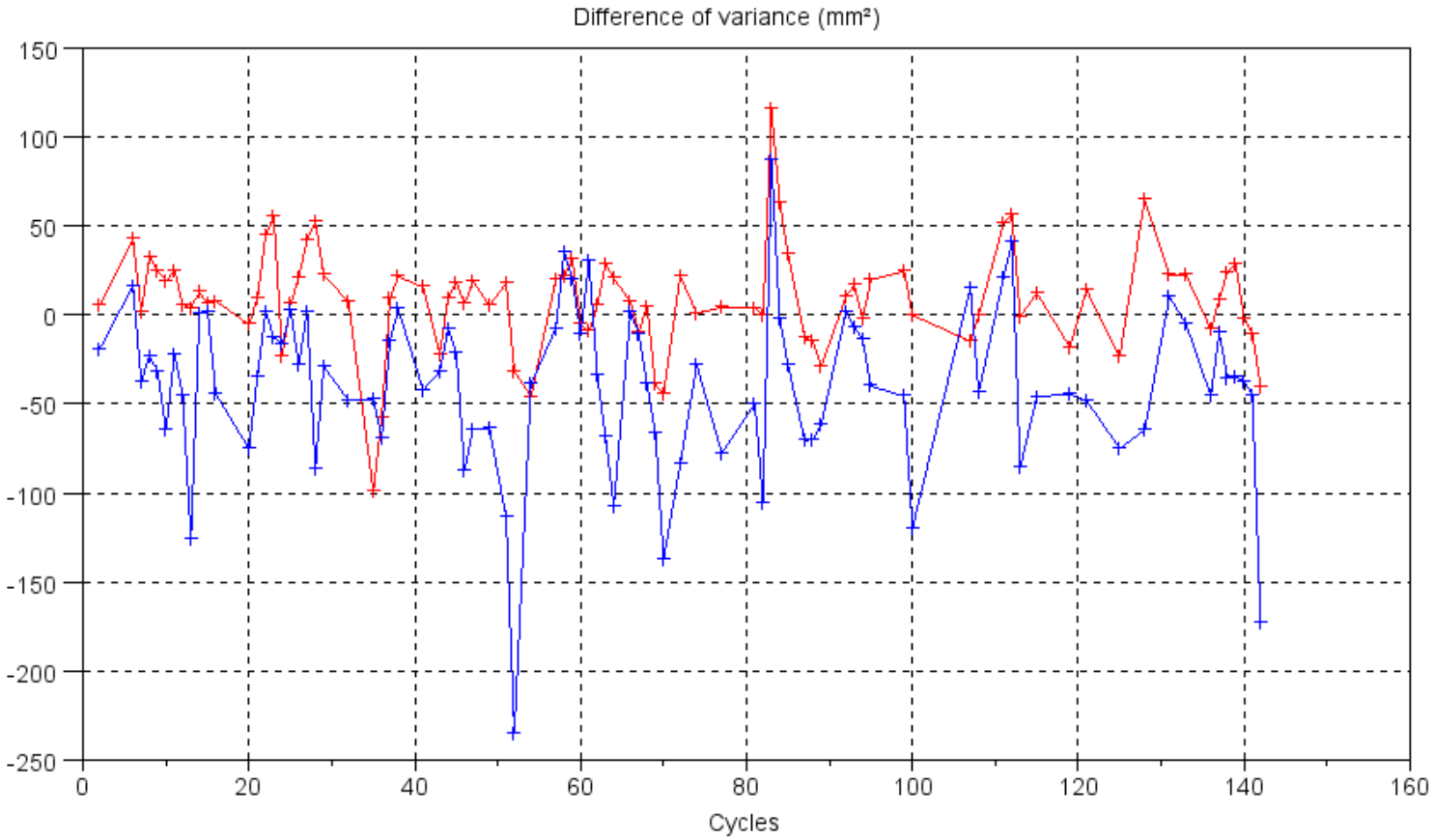


Negative value means improvement

JASON2 – COMPARISON WITH JPL AND GSFC CROSSOVER VARIANCE DIFFERENCE

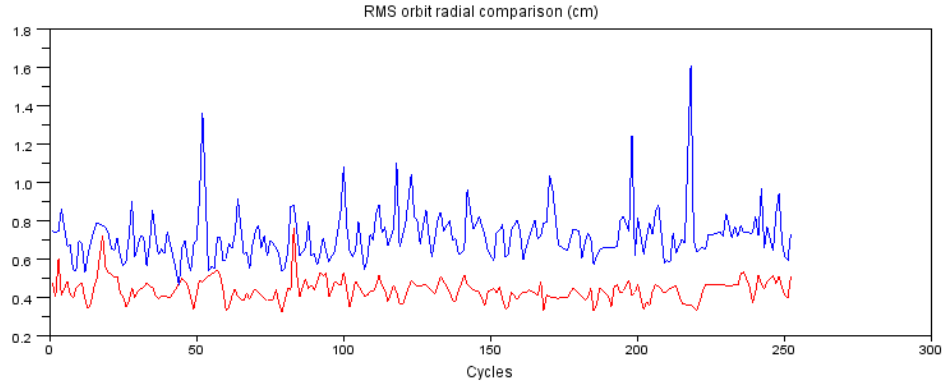
GDR-E - JPL, Median = **8,5mm²**

GDR-E - GSFC, Median = **-36,2mm²**



Negative value means improvement

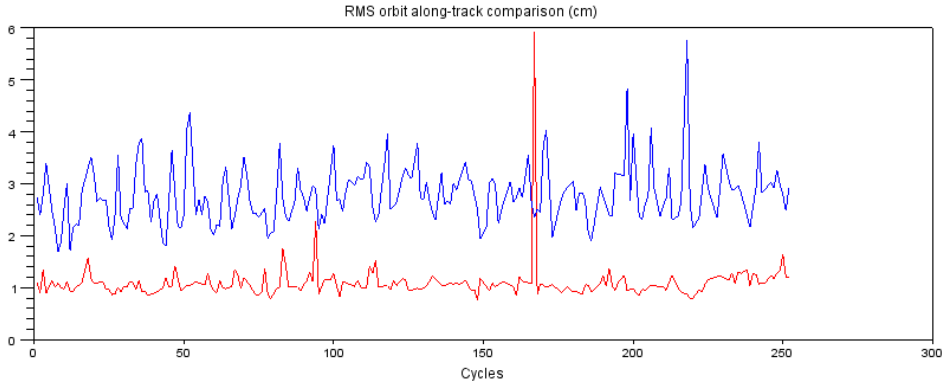
JASON2 – COMPARISON WITH JPL AND GSFC ORBIT COMPARISON



Radial comparison

GDR-E - GSFC, overall RMS = **7,3 mm**

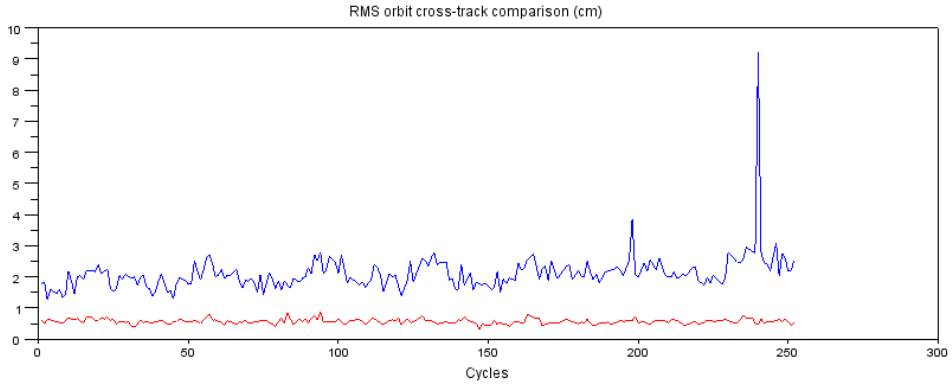
GDR-E - JPL, overall RMS = **4,5 mm**



Along-track comparison

GDR-E - GSFC, overall RMS = **28,4 mm**

GDR-E - JPL, overall RMS = **11,6 mm**



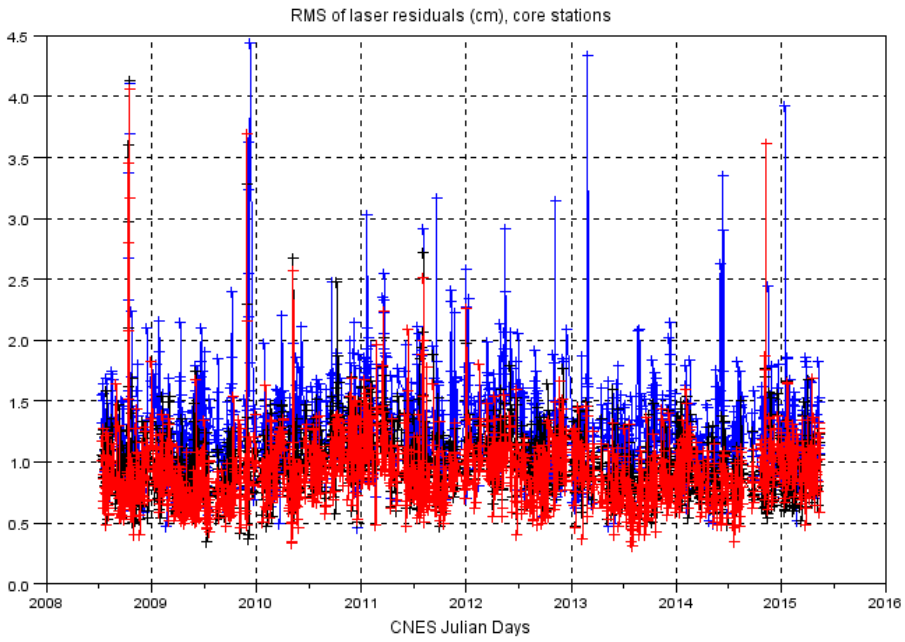
Cross-track comparison

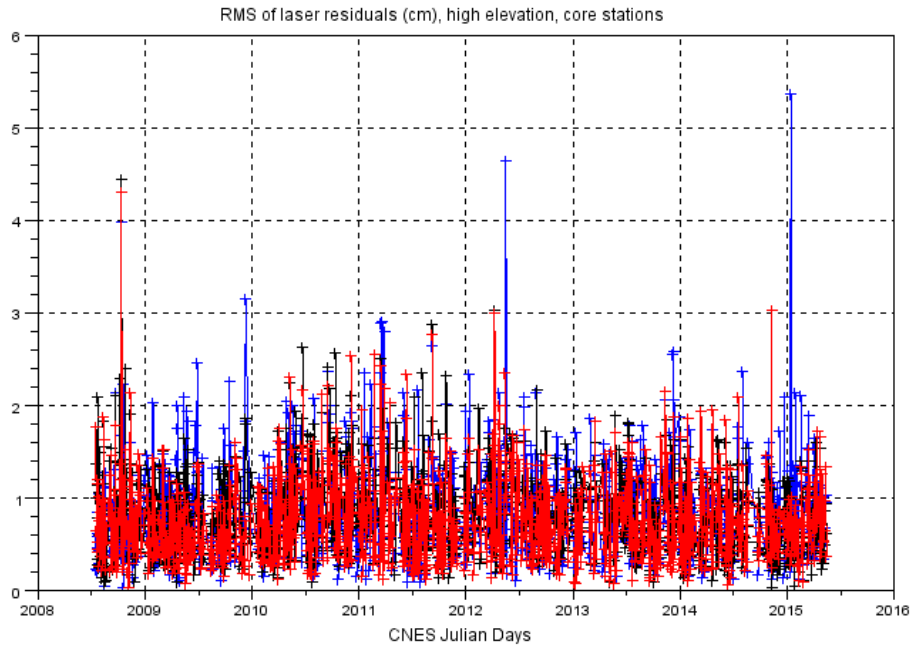
GDR-E - GSFC, overall RM**S** = **22,0 mm**

GDR-E - JPL, overall RMS = **5,8 mm**

JASON2 – COMPARISON WITH JPL AND GSFC
SLR RESIDUALS

Core network ✦ RMS SLR residuals	**GDR-E** : Reduced dynamic orbit	**GSFC** : Dynamic orbit	**JPL** : Reduced dynamic orbit
All elevation	0,95cm	1,19 cm	0,87 cm
High elevation	0,76 cm	0,77 cm	0,66 cm



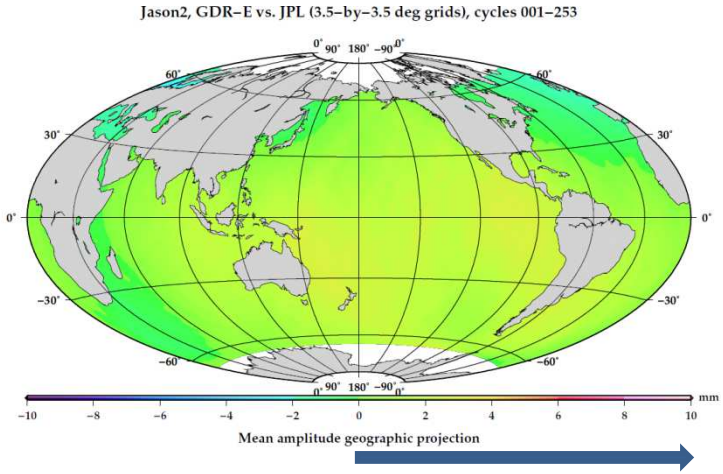


✦ *Core network* : L7090 L7105 L7810 L7839 L7840 L7941

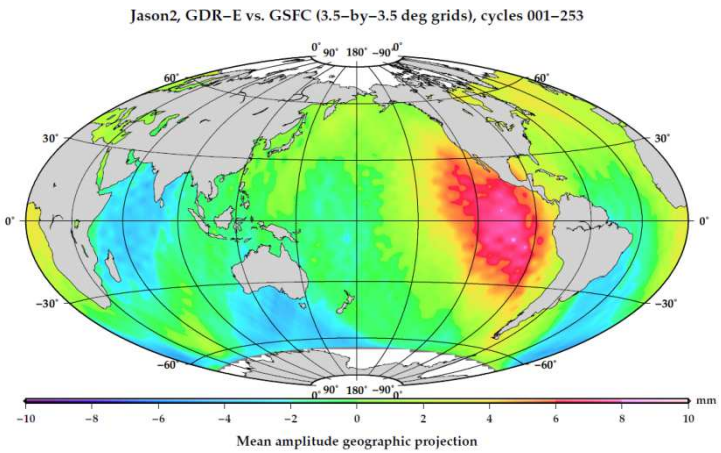
JASON2 – COMPARISON WITH JPL AND GSFC GEOGRAPHICALLY CORRELATED RADIAL DIFFERENCES

Mean

JPL



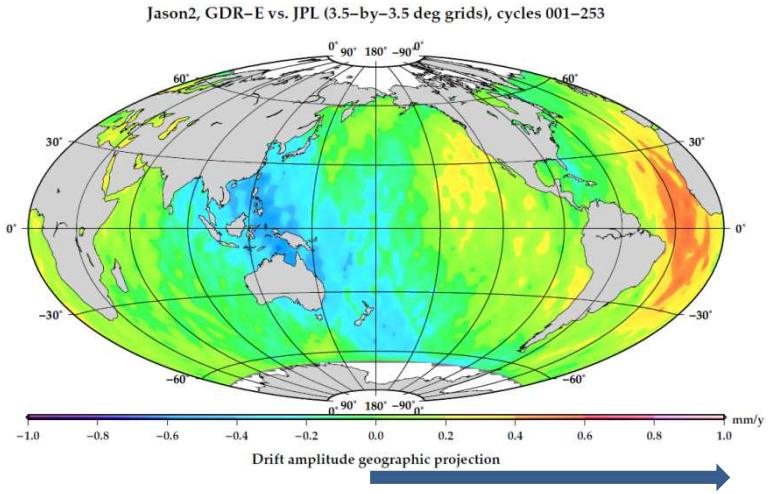
GSFC



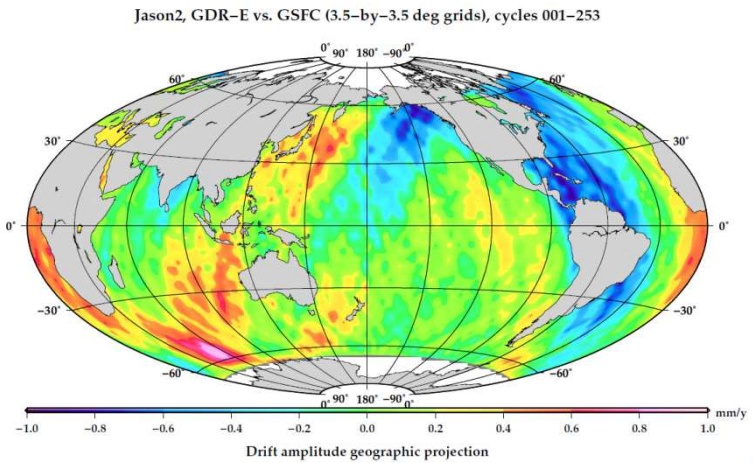
10 mm

Drift

JPL



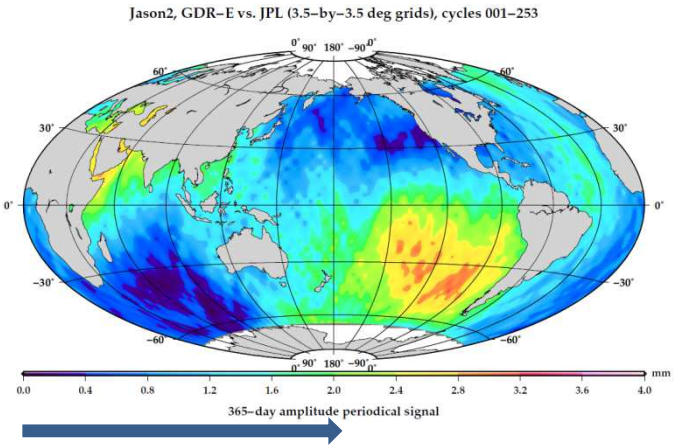
GSFC



1 mm

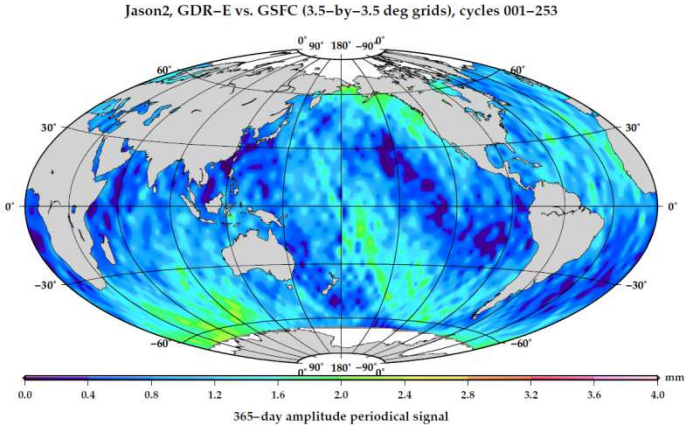
JASON2 – COMPARISON WITH JPL AND GSFC GEOGRAPHICALLY CORRELATED RADIAL DIFFERENCES

Annual signal JPL

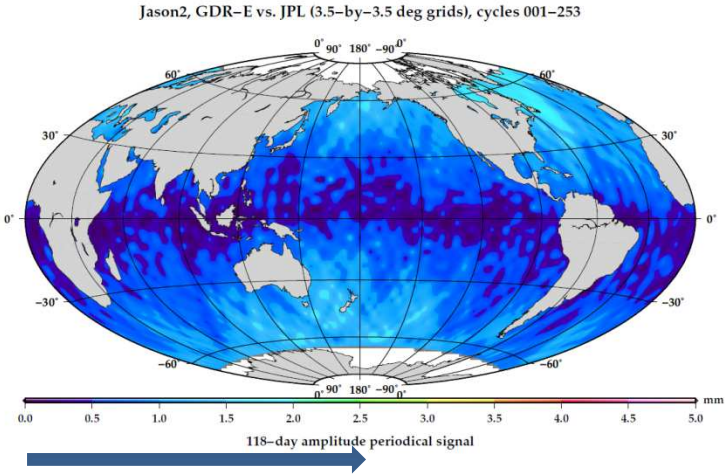


2 mm

GSFC

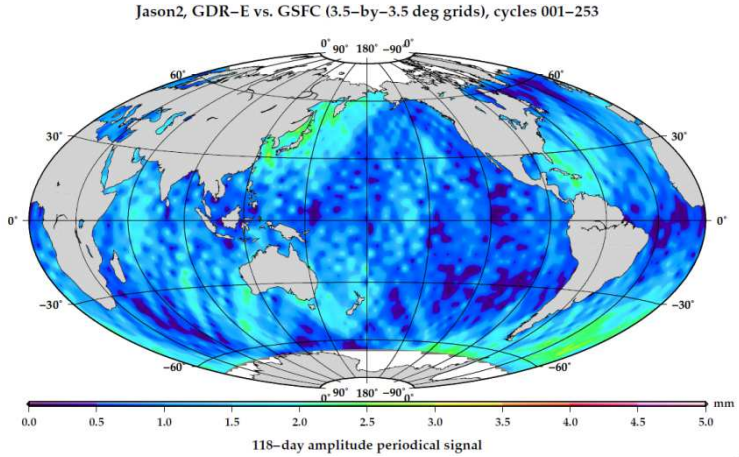


118-days signal JPL



2,5 mm

GSFC



JASON2 – CONCLUSION

JASON2 GDRE RMS radial component (SLR) : **0,8 cm**

GDR-E crossover variance improved of **37 mm²** w.r.t. GDR-D

RMS radial orbit comparison : **7 mm** (GSFC) **5 mm** (JPL)

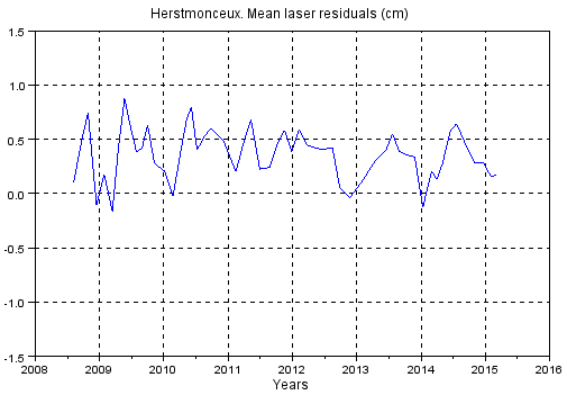
CONTENTS

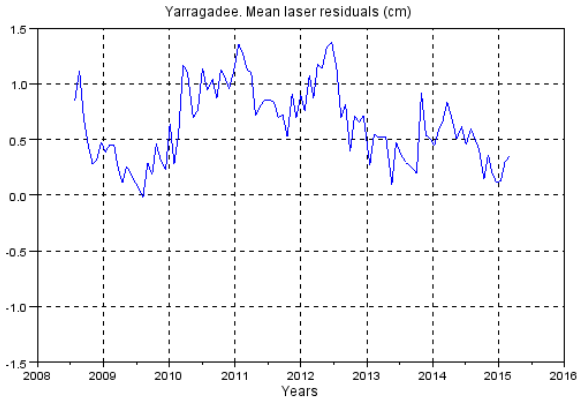
SLR NETWORK (1)

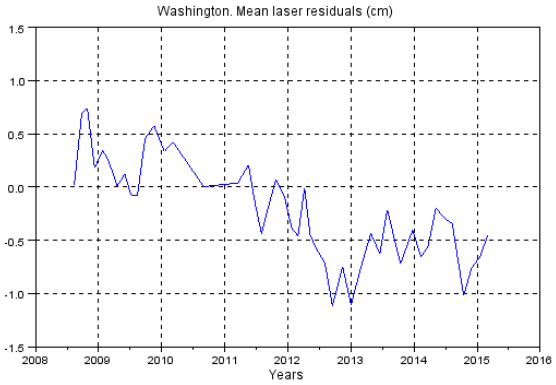
Core network : L7090 L7105 L7810 L7839 L7840 L7941

Best stations (criteria : RMS SLR residuals)

Station bias analysis : ~monthly mean SLR residuals (JASON2)





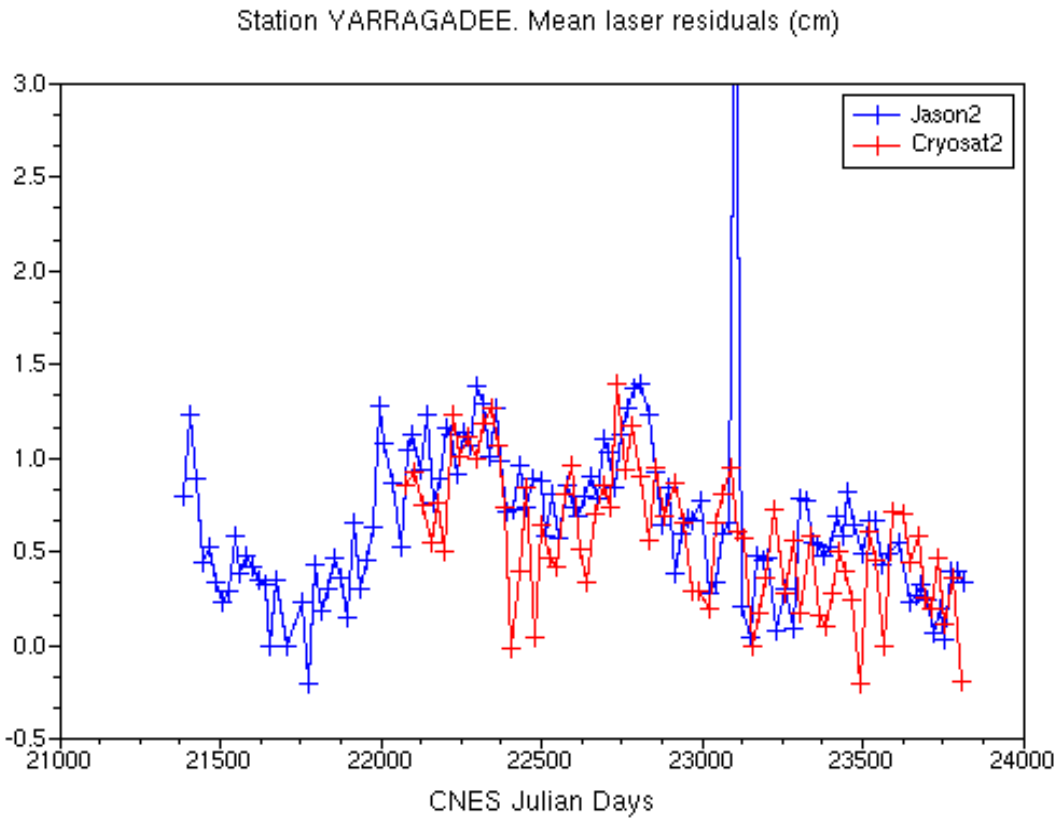


SLR NETWORK (2)

- Station problem : Yarragadee and Washington show similar mean SLR residuals when observed by different satellites

JASON2 (DORIS+GPS reduced dynamics)

CRYOSAT2 (DORIS reduced dynamics)



SLR NETWORK (3)

Possible explanations ?

Measurement bias

- Mail exchanged with Yarragadee Geodetic Observatory
  “No changes occurred in 2010 that should have had any effect on station position metrics. […] It is hard to explain the effect.“

Earth’s crust displacement (hydrological loading effect, oil pumping ….)

- Rainfall data
- Local mass variation
  (EWH time series : Boulder, GRGS; mascons)
- GPS stations position time series
  (IGS Network, Nevada Geodetic Laboratory)

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CONCLUSION

Saral	RMS GDR-E radial performance (SLR) : **0,9 cm**
Cryosat2	RMS GDR-E radial performance (SLR): **0,8 cm**
Jason2	RMS GDR-E radial performance (SLR): **0,8 cm**

RMS radial orbit comparison : **7 mm** (GSFC) **5 mm** (JPL)

Overall good quality of SLR core network (6 stations).

Question about Yarragadee and Washington ?

THANK YOU