Ocean Surface Topography Science Team Meeting

*Precise Orbit Determination Splinter*

# JASON-2 POD STATUS

J. Moyard, E. Jalabert , A. Couhert, S. Rios-Bergantinos, F. Mercier, S.Houry[(1)]

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Lake Konstanz,
GERMANY

*(1) CNES POD Team, Toulouse, France*

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- GDR STANDARD EVOLUTION
- PRELIMINARY GDR-E VS GDR-D
- GDR / JPL 14.A / GSFC 1404 COMPARISONS

# GDR STANDARD EVOLUTION

## *MEASUREMENTS MODELS*

| | GDR-D<br>*Jan 2012* | Preliminary GDR-E<br>*Oct 2014* |
|---|---|---|
| *Reference Frame* | ITRF 2008<br>Pole Tide from IERS2010 conventions<br>Solid Earth Tides : from IERS2003 conventions<br>Atmospheric gravity : 6hr NCEP pressure fields + tides from Biancale-Bode models | ITRF 2008<br>Pole Tide from IERS2010 conventions<br>Solid Earth Tides : from IERS2003 conventions<br>Atmospheric gravity : 6hr NCEP pressure fields + tides from Biancale-Bode models |
| *Loading* | Ocean loading FES2004 | Oceans loading FES 2004<br>**S1-S2 atmospheric pressure loading, implementation of Ray & Ponte (2003) by van Dam** |
| *Geocenter* | | **Seasonal non-tidal geocenter motion from J.Ries model, for DORIS/SLR stations**<br>**Ocean tidal and S1-S2 atmospheric geocenter motion, for DORIS/SLR stations and GPS constellation following IERS2010 recommendations** |
| *Others* | | **new DORIS beacons phase map corrections** |

# GDR STANDARD EVOLUTION

## *DYNAMIC MODELS*

| | GDR-D<br>*Jan 2012* | Preliminary GDR-E<br>*Oct 2014* |
|---|---|---|
| *Geopotential* | EIGEN-GRGS_RL02bis_MEAN-FIELD(2011)<br>Non-tidal TVG : Annual, Semi-annual and drifts up to deg/ord 50 | **EIGEN-GRGS.RL03.MEAN-FIELD**<br>**Non-tidal TVG : Annual, Semi-annual, bias and drifts for each year up to deg/ord 80 ⇒ accounts for interannual variability**<br>**Estimated harmonic 3 1 *(GDR-E JASON dynamic only)***<br>**C21/S21 modelled according to the IERS 2010 Conventions** |
| *Third bodies* | Sun, Moon, Venus, Mars and Jupiter | Sun, Moon, Venus, Mars and Jupiter |
| *Tides* | FES2004<br>Solid Earth Tides : from IERS2003 conventions<br>Pole tides from IERS 2010 | FES2004<br>Solid Earth Tides : from IERS2003 conventions<br>Pole tides from IERS 2010 |
| *Surfaces forces* | Drag from atmospheric model DTM 94 for JASON-1 JASON-2 HY2A missions | **Drag from atmospheric model DTM 2013 for JASON-1 JASON-2 HY2A missions**<br>**Calibrated semi-empirical solar radiation pressure models for JASON-1 & JASON-2** |
| *Others* | | **Improved stochastic solutions *(GDR-E reduced dynamic only)*** |



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# GDR STANDARD EVOLUTION

## *FINAL GDR-E STANDARD*

- **Measurements Models, as soon as available :**

  ITRF 2013

  Update of SLR stations measure weights

  (FES 2012 for ocean tides/loading)

- **Dynamic Models, if available:**

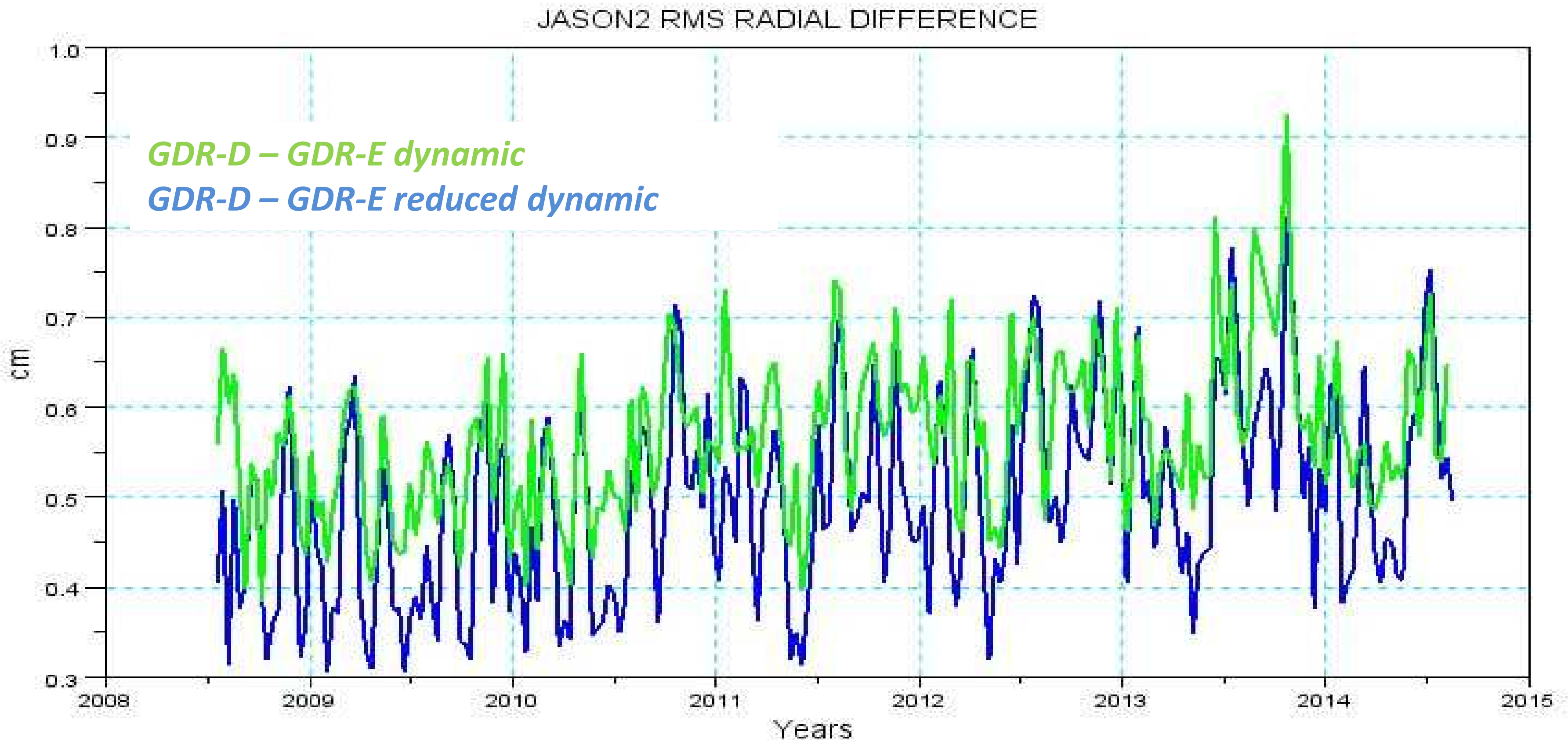
  Drag from atmospheric updated model DTM 2013 for JASON-1 JASON-2 HY2A missions *'altimetry version'*

  → *presentation of S.BRUINSMA about atmospheric model DTM 2013, IDS WORKSHOP*

- **Objective : operational orbits switch to GDR-E standard in 2015, expected before next OSTST**

# PRELIMINARY GDR-E VS GDR-D

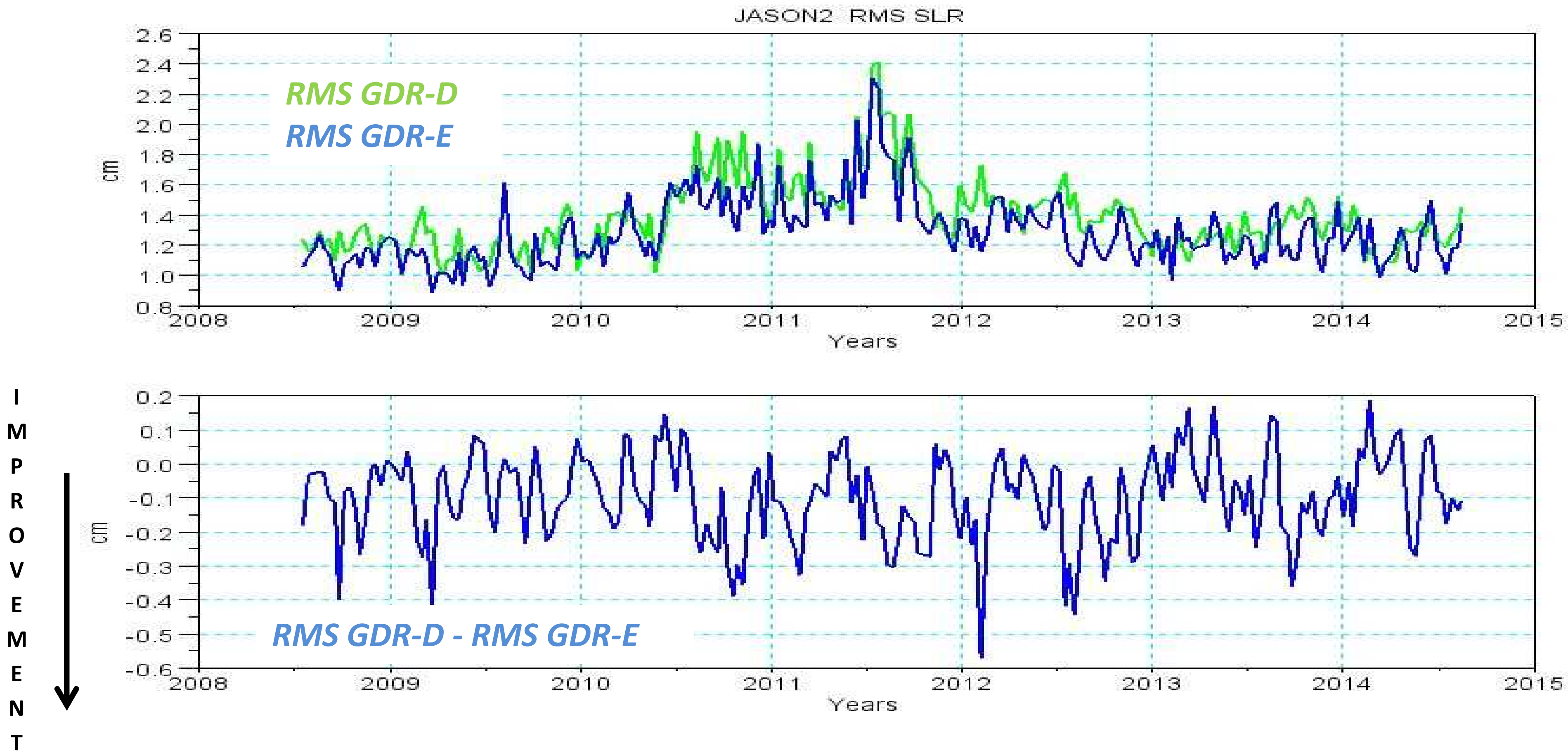
## *ORBITS COMPARISONS, RADIAL COMPONENT*




- **GDR-E reduced dynamic differs more from GDR-D than GDR-E dynamic**
- **RMS differences increase with time,  likely reasons : aging of gravity field GDR-D model**

# PRELIMINARY GDR-E VS GDR-D

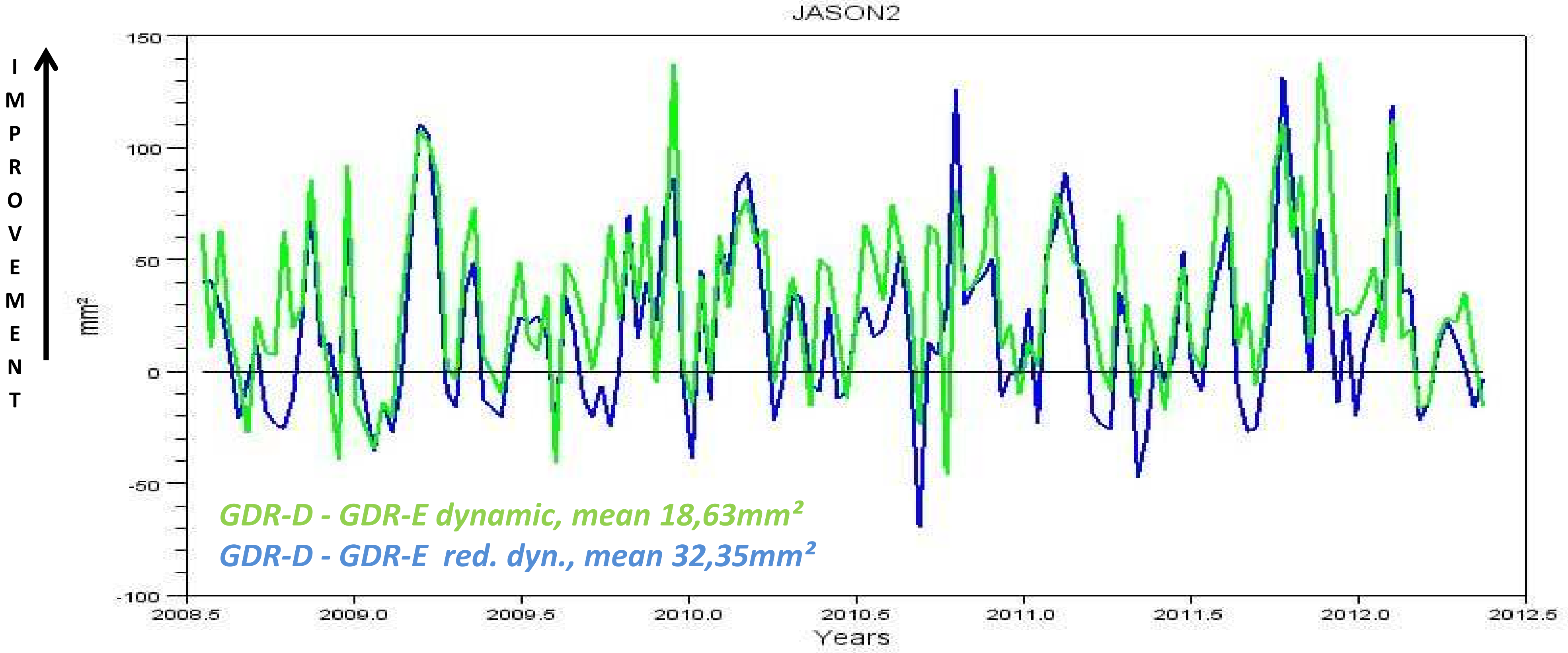
## *RMS SLR POST-FIT RESIDUALS*




- **RMS SLR post-fit residuals of GDR-E is better than GDR-D on the whole period**
- **SLR is down weighted in order to have an external verification**

# PRELIMINARY GDR-E VS GDR-D

## *DIFFERENCE CROSSOVER VARIANCE*




- **GDR-E reduced dynamic gives a good improvement in crossing points criteria**
- **Improvement due to new SRP model and new solar array thermo-optical coefficients**



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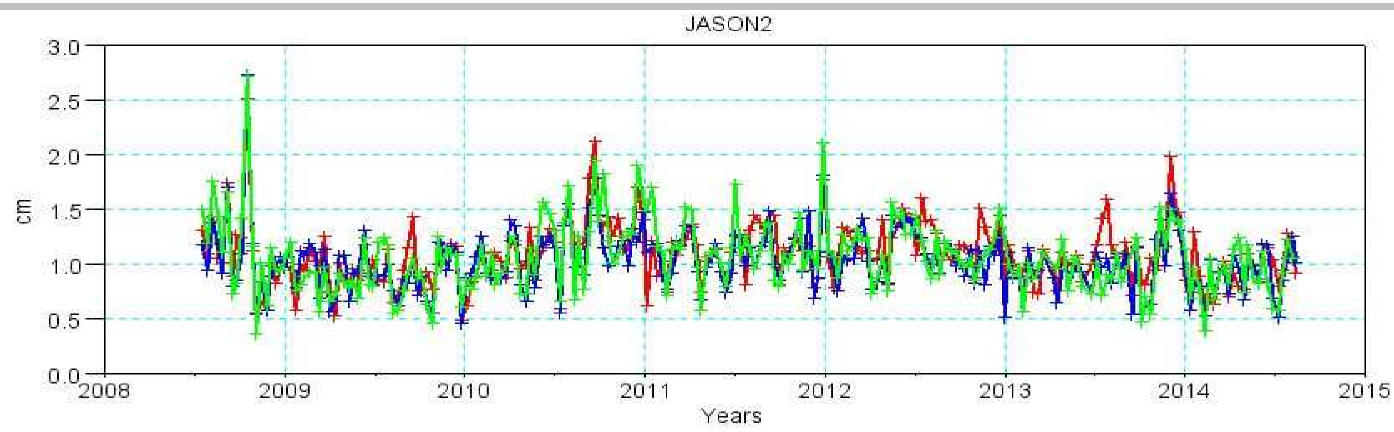
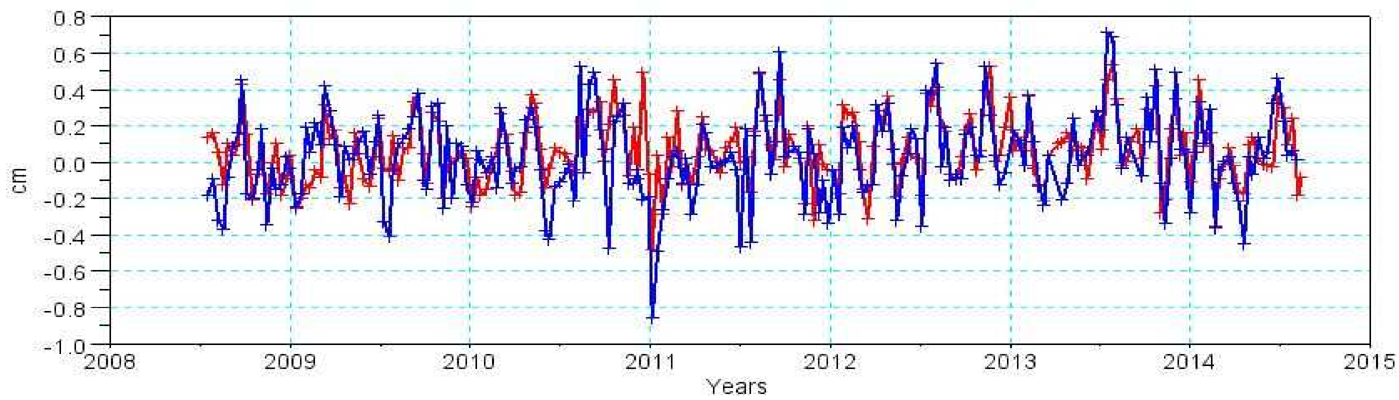
# PRELIMINARY GDR-E VS GDR-D

## *RMS OF SLR RESIDUALS (REFERENCE STATIONS, HIGH ELEVATION)*

*GDR-D*
*GDR-E dynamic*
*GDR-E red. dyn.*



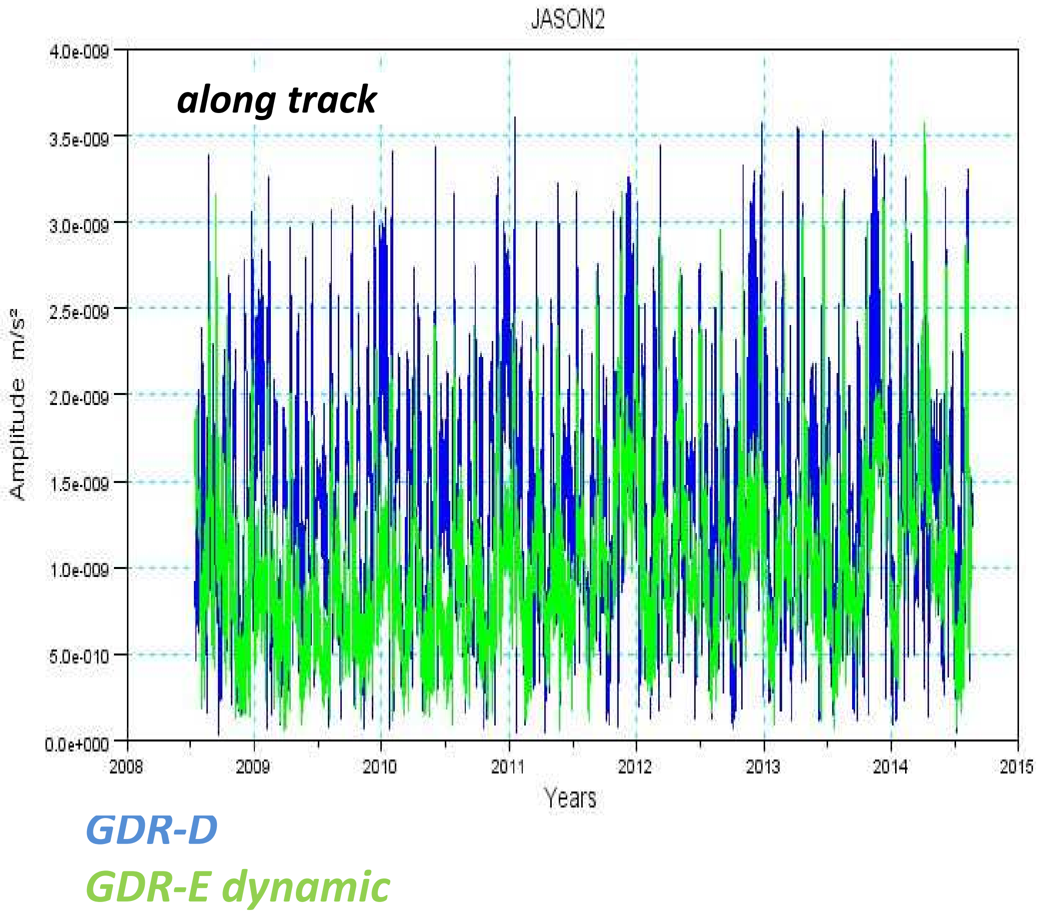

*GDR-D - GDR-E dynamic*
*GDR-D - GDR-E red. dyn.*

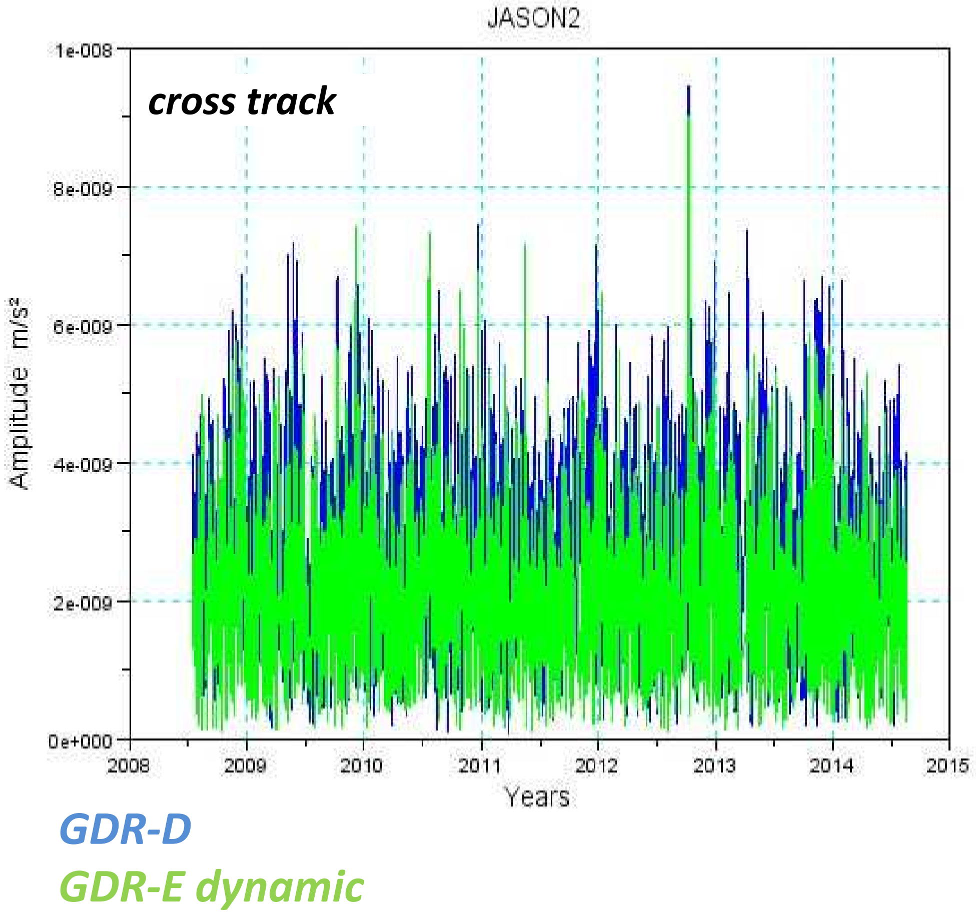



- **SLR reference stations: L7090Yarr, L7105Wash, L7810Zimm, L7839Graz, L7840Hers, L7941Mate**
- **High elevation inclination > 70°→ residuals reflects the orbit radial accuracy**
- **RMS of SLR residuals is stable and close to 1.0 cm, slightly improvement with GDR-E standards**

# PRELIMINARY GDR-E VS GDR-D

## *EMPIRICAL 1/REV ACCELERATIONS*



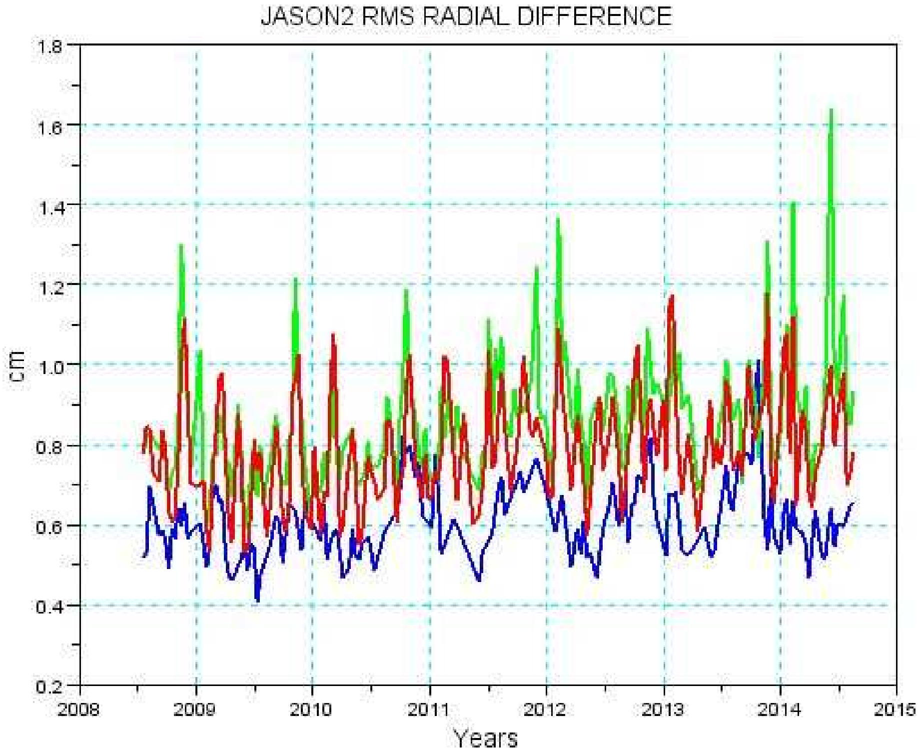

- **New Solar Radiation Pressure model improves the level of empirical 1/rev accelerations**

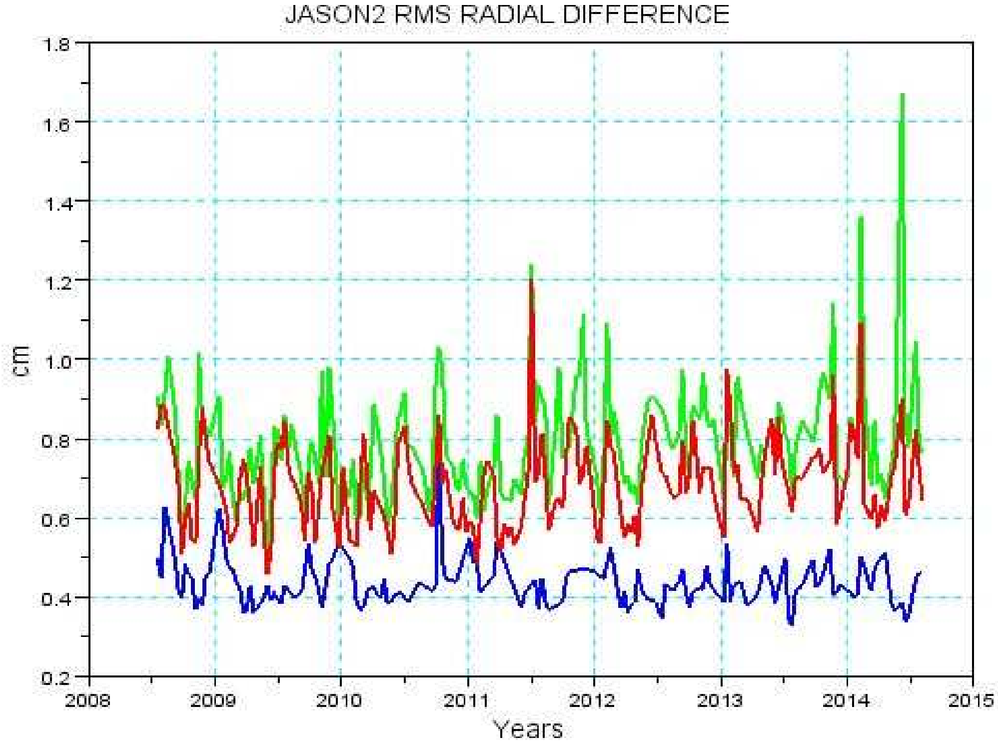
# GDR / JPL 14.A / GSFC 1404 COMPARISONS

## *ORBITS DIFFERENCE, RADIAL COMPONENT*

*GDR-D – JPL GPSR RLSE 14A*
*GDR-D – GSFC LD STD1404*
*GDR-D – GSFC LD RED STD1404*

*GDR-E red. dyn. – JPL GPSR RLSE 14A*
*GDR-E red. dyn. – GSFC LD STD1404*
*GDR-E red. dyn. – GSFC LD RED STD1404*




- **GDR-E reduced dynamic closer to GSFC & JPL orbits than GDR-D**



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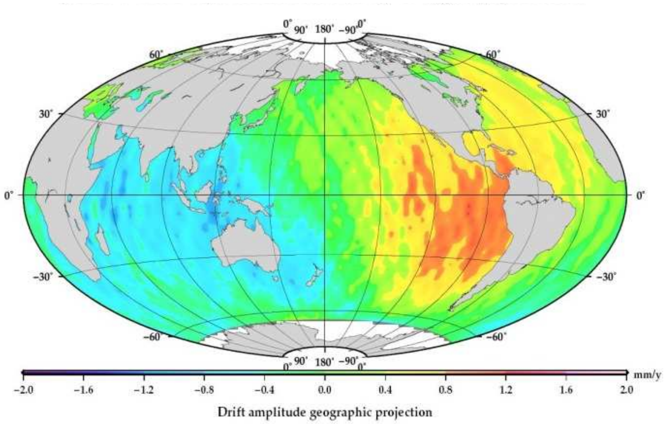
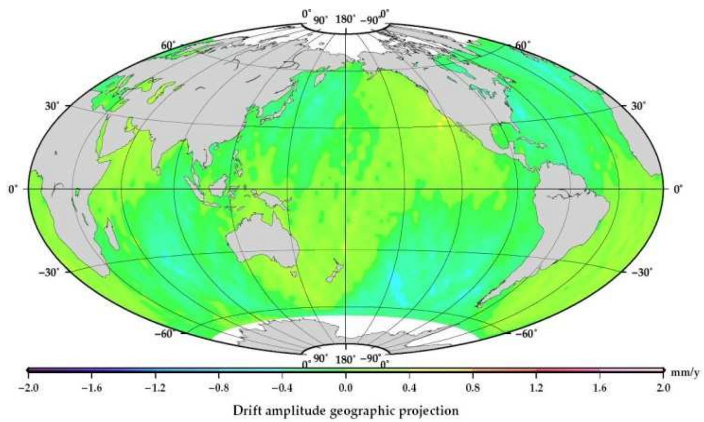
# GDR / JPL 14.A / GSFC 1404 COMPARISONS

## *GEOGRAPHICALLY CORRELATED RADIAL DIFFERENCE DRIFT*

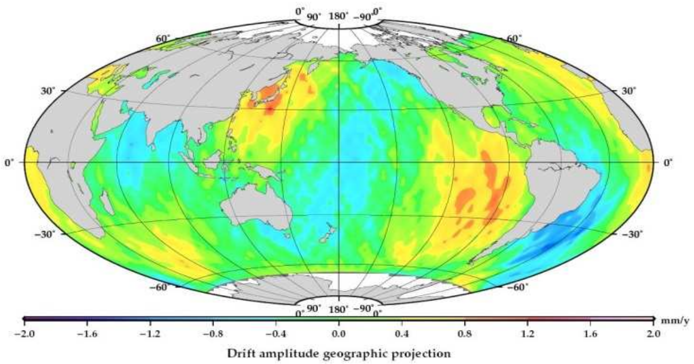
***GDR-D – JPL GPSR RLSE14A***



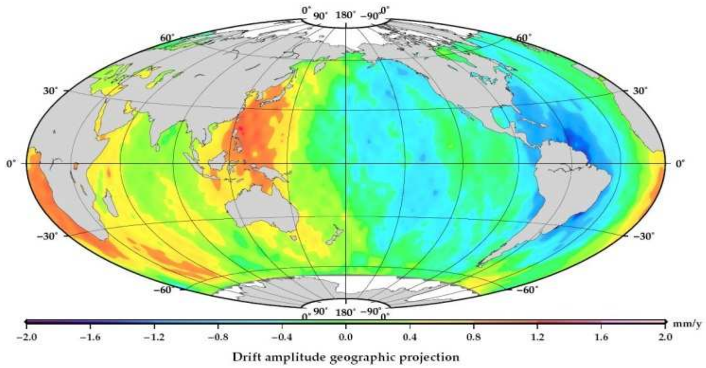

***GDR-E red. dyn. – JPL GPSR RLSE14A***




***GDR-D – GSFC LD RED STD1404***




***GDR-E red. dyn. – GSFC LD RED STD1404***

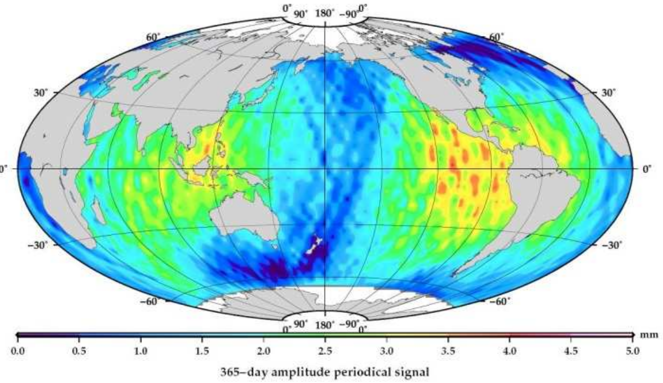



- **GDR-E reduced dynamic very close to JPL GPSR RLSE14A orbits.**
- **Difference between GDR-E reduced dynamic and GSFC LD RED STD1404 orbits : gravity field models ?**

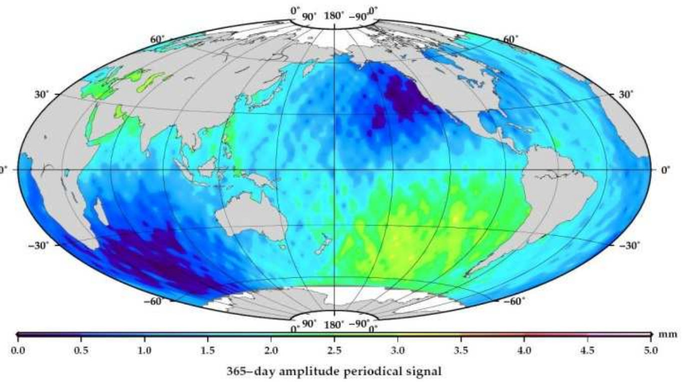
# GDR / JPL 14.A / GSFC 1404 COMPARISONS

## *GEOGRAPHICALLY CORRELATED RADIAL DIFFERENCE 365-DAY AMPLITUDE*

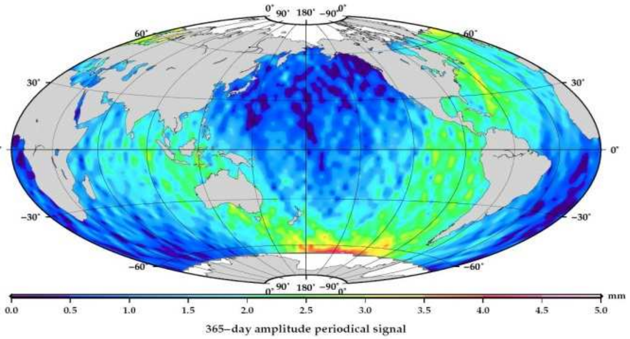
***GDR-D – JPL GPSR RLSE14A***



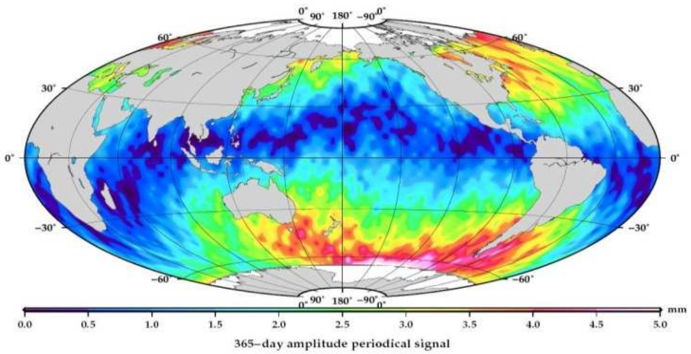

***GDR-E red. dyn. – JPL GPSR RLSE14A***




***GDR-D – GSFC LD RED STD1404***




***GDR-E red. dyn. – GSFC LD RED STD1404***




- **Geometry of the difference between 365-day amplitude change between GDR-D /GDR-E reduced dynamic and JPL GPSR RLSE14A. Now East-West North-South parts appear.**
- **Like drift amplitude, geometry of the difference change between GDR-D/GDR-E reduced dynamic and GSFC LD RED STD1404 orbits**



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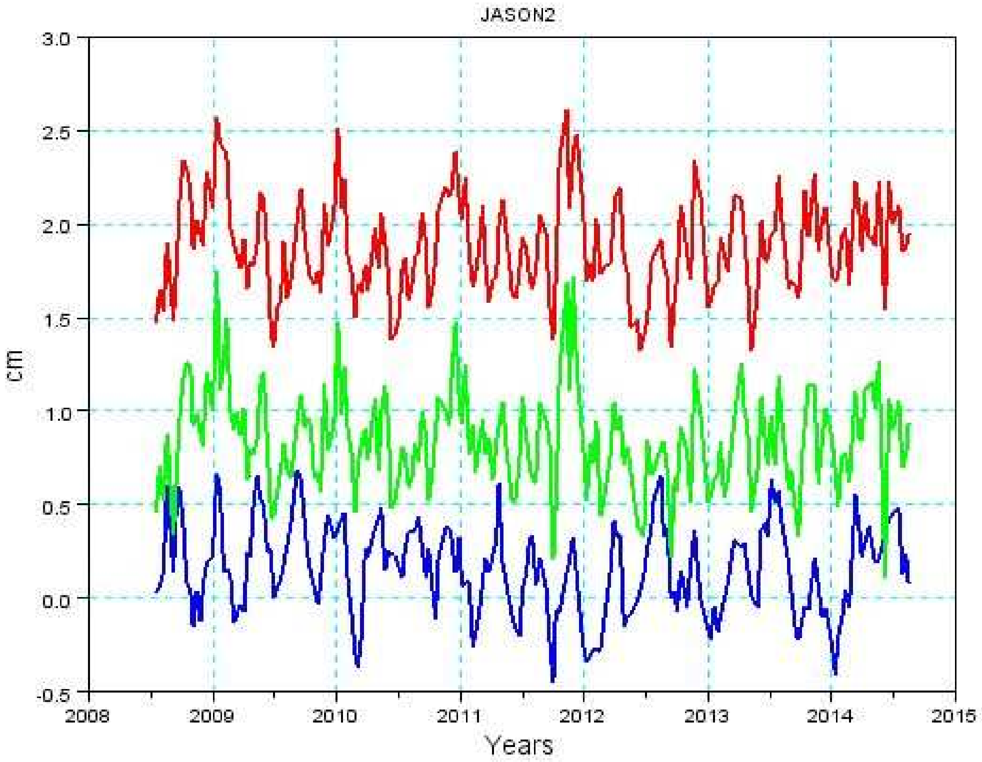
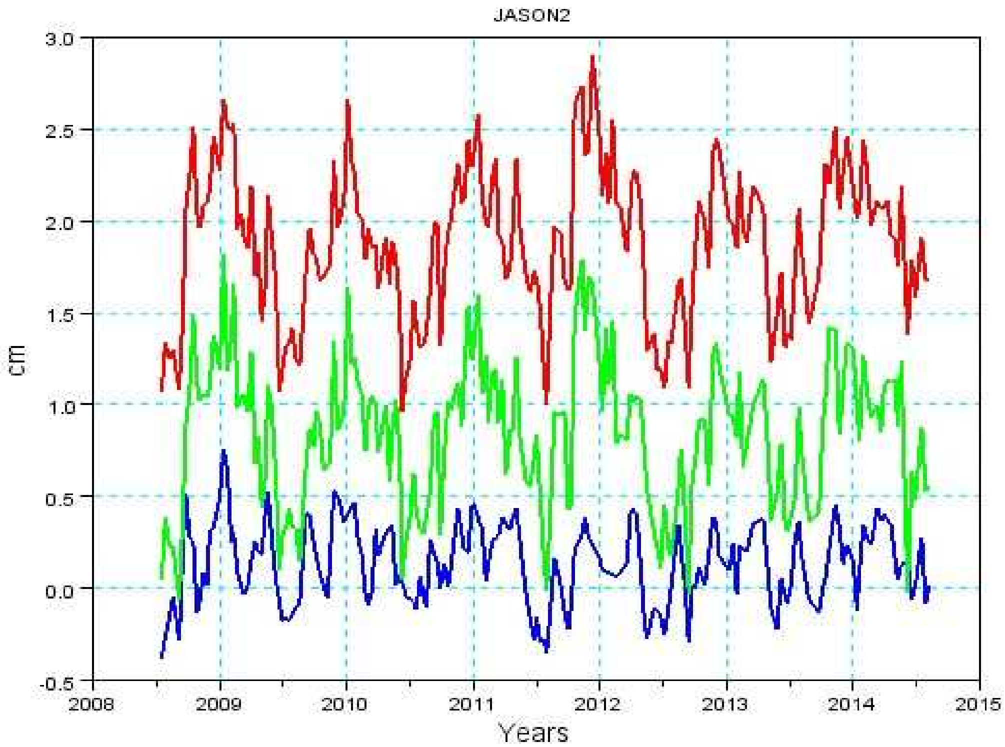
# GDR / JPL 14.A / GSFC 1404 COMPARISONS

## *NORTH-SOUTH ORBITS DIFFERENCE, MEAN RADIAL*

*GDR-D – JPL GPSR RLSE 14A*
*GDR-D – GSFC LD STD1404*
*GDR-D – GSFC LD RED STD1404*

*GDR-E red. dyn. – JPL GPSR RLSE 14A*
*GDR-E red. dyn. – GSFC LD STD1404*
*GDR-E red. dyn. – GSFC LD RED STD1404*




**Difference representative of the orbit centering in Z terrestrial referential**

**⇒ GDR-E reduced dynamic orbits are closer to JPL GPS RLSE 14A**



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# CONCLUSIONS

- These preliminary GDR-E standards improve the orbit radial performance.

- Most efficient evolutions :
  - New potential with estimated 3 1 harmonic (dynamic solution)
  - New Solar Radiation Pressure model
  - Reduced dynamic solution

- Some questions remain : for example annual geographical correlated comparisons between GDRE-E reduced dynamic and JPL/GSFC orbits

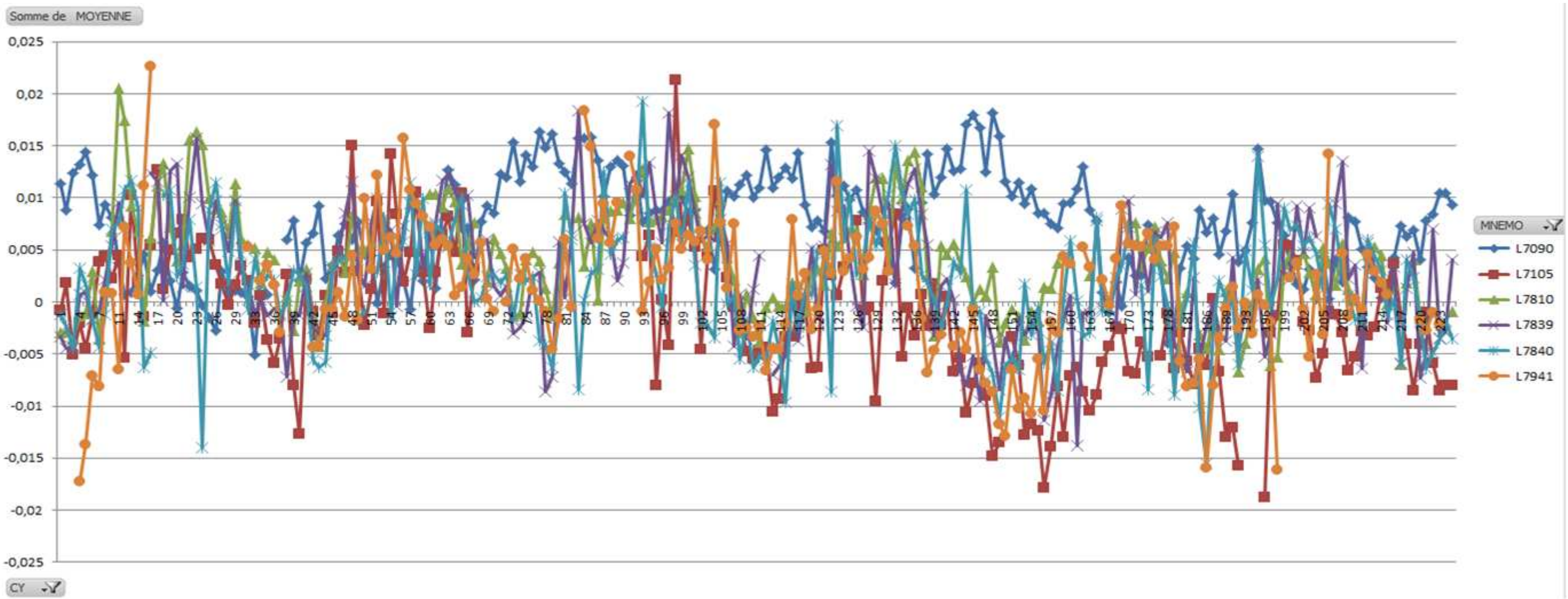
- Final GDR-E standard to be finalized in 2015.

- Further tests to be performed on others missions (SARAL CRYOSAT-2 HY2A)

# BACKUPS

# GDR-D JASON-2 ORBITS

## RMS of SLR post residuals, choice of 'good stations'

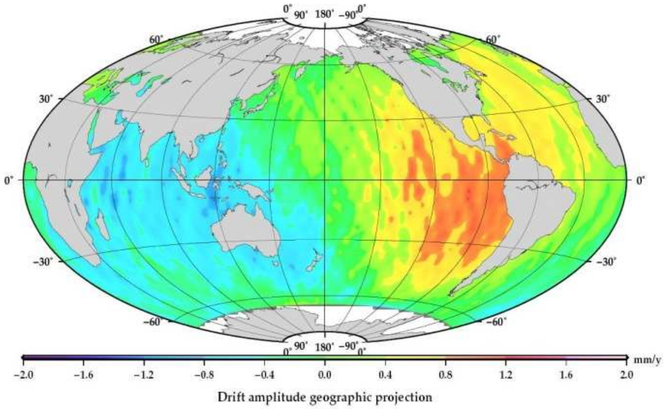



- Choice of Good SLR stations' : L7090 L7105 L7810 L7839 L7840 L7941

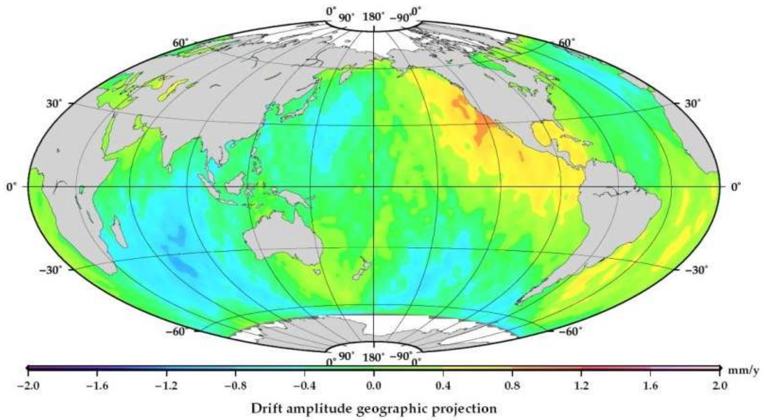
# GDR / JPL 14.A / GSFC 1404 COMPARISONS

## *GEOGRAPHICALLY CORRELATED RADIAL DIFFERENCE DRIFT*

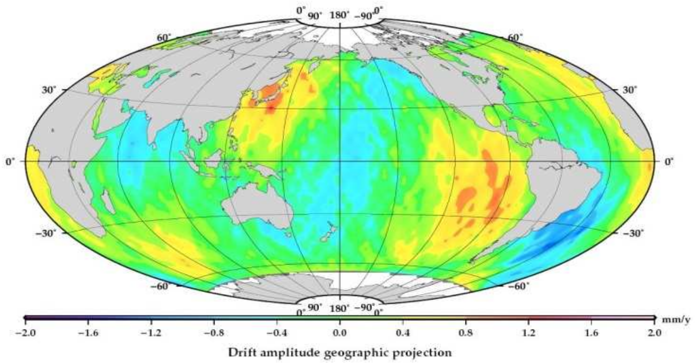
***GDR-D – JPL GPSR RLSE14A***



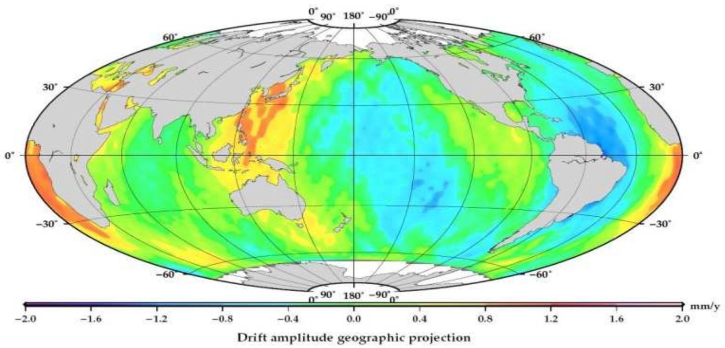

***GDR-E dyn. – JPL GPSR RLSE14A***




***GDR-D – GSFC LD RED STD1404***




***GDR-E dyn. – GSFC LD RED STD1404***




- **Difference between GDR-E dynamic and GSFC LD RED STD1404 orbits : gravity field models ?**

# GDR / JPL 14.A / GSFC 1404 COMPARISONS

## *GEOGRAPHICALLY CORRELATED RADIAL DIFFERENCE 365-DAY AMPLITUDE*

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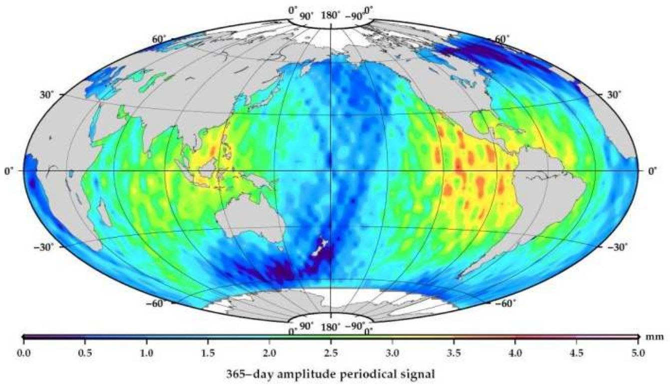
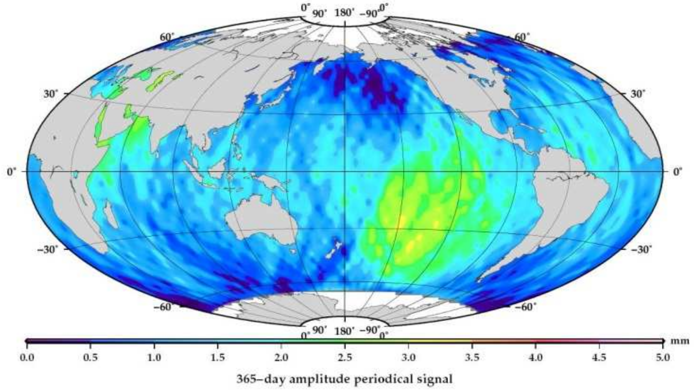
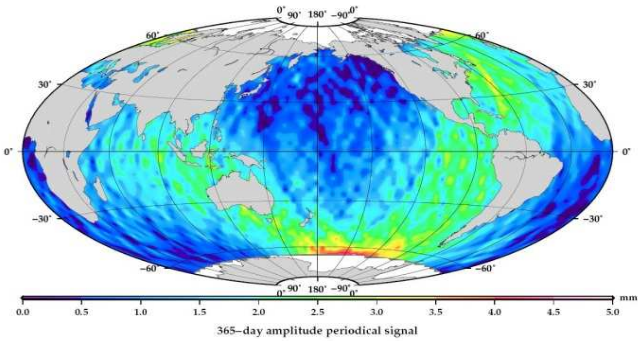


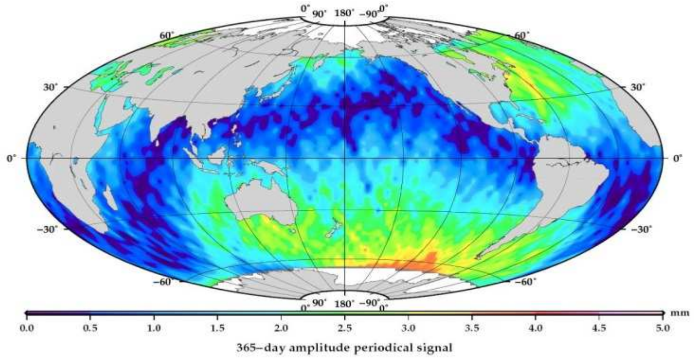

***GDR-E red. dyn. – JPL GPSR RLSE14A***




***GDR-D – GSFC LD RED STD1404***




***GDR-E red. dyn. – GSFC LD RED STD1404***




- **Geometry of the difference between 365-day amplitude change between GDR-D /GDR-E reduced dynamic and JPL GPSR RLSE14A. Now East-West North-South parts appear.**
- **Like drift amplitude, geometry of the difference change between GDR-D/GDR-E reduced dynamic and GSFC LD RED STD1404 orbits**



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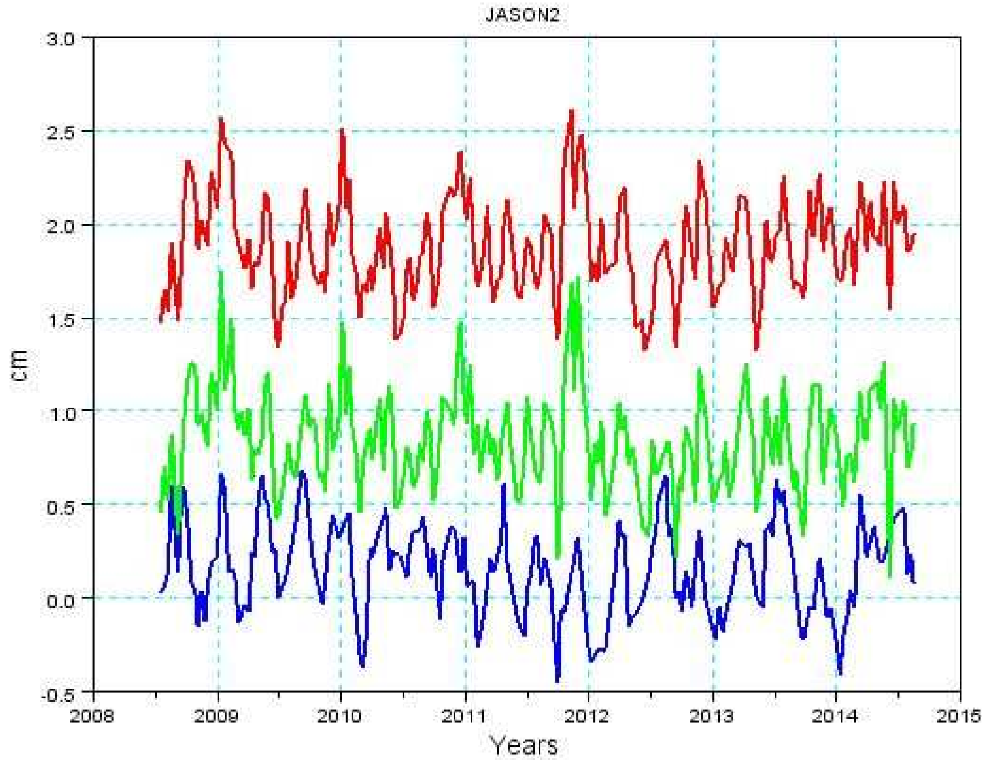
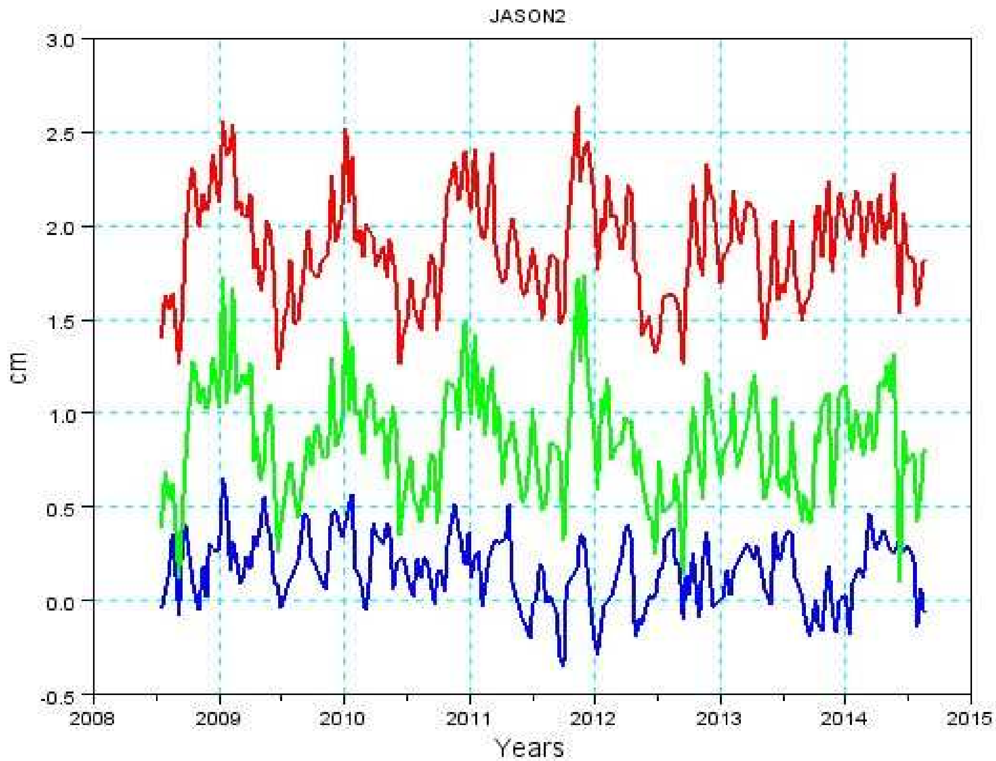
# GDR / JPL 14.A / GSFC 1404 COMPARISONS

## NORTH-SOUTH ORBITS DIFFERENCE, MEAN RADIAL

*GDR-D – JPL GPSR RLSE 14A*
*GDR-D – GSFC LD STD1404*
*GDR-D – GSFC LD RED STD1404*




*GDR-E dyn. – JPL GPSR RLSE 14A*
*GDR-E dyn. – GSFC LD STD1404*
*GDR-E dyn. – GSFC LD RED STD1404*




**Difference representative of the orbit centering in Z terrestrial referential**

$\Rightarrow$ **GDR-E dynamic orbits are closer to JPL GPS RLSE 14A**