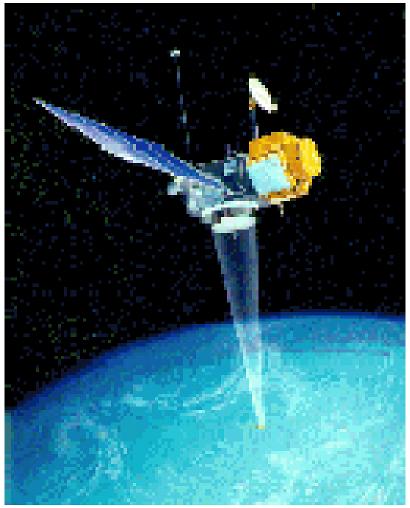
# POD SPLINTER SUMMARY and round table discussion

JASON POD TEAM

OSTST
Oct. 11th, 2013, Boulder (CO)

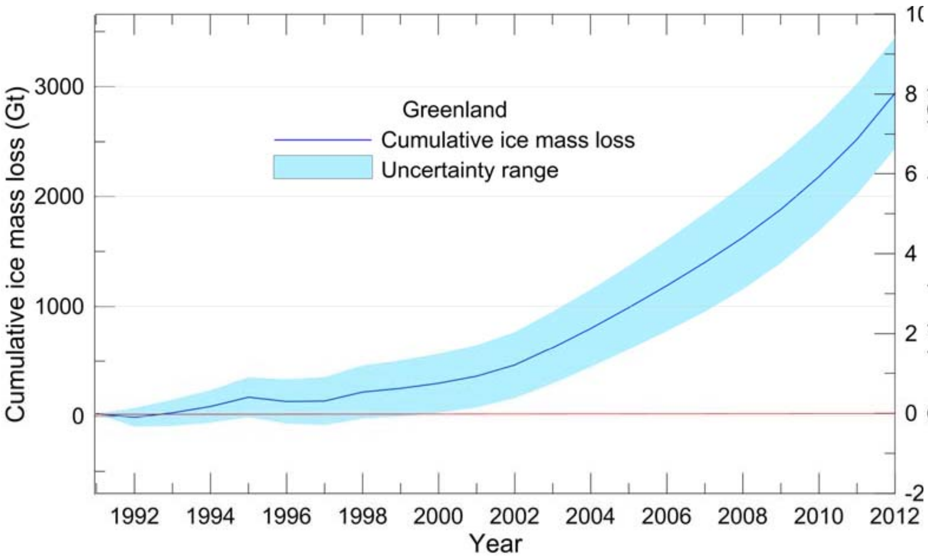


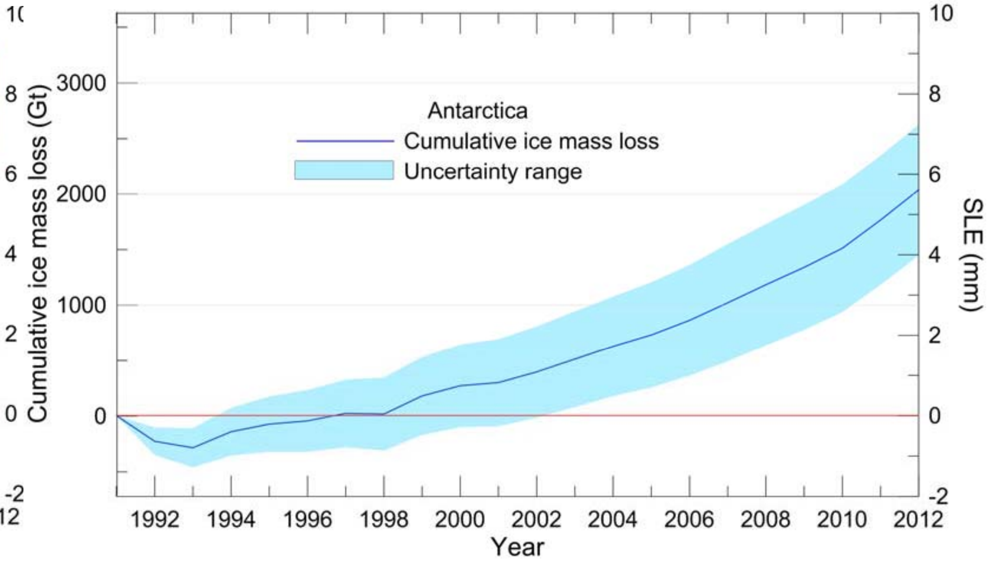
# ERROR BUDGET OF JASON GDRD ORBITS

| Error Source | Global | Regional |
|---|---|---|
| **Tracking Data residuals consistency (SLR Vs GPS/DORIS orbits)** | / | Annual term:<br>SLR range biases oscillations from *3* to *9 mm*<br>Long-term evolution:<br>Drifts in SLR range biases (5-10 years)<br>< *2 mm/y* |
| **Reference Frame** | GMSL long-term trend (ITRF2008 – ITRF2005):<br>Drifts (10 years) < *0.05 mm/y* | Annual term:<br>North/South oscillations < *8 mm*<br>Long-term evolution:<br>- Jason2 (5 years) < *0.6 mm/y* at extreme latitudes<br>- Jason1 (10 years) < *0.3 mm/y* at extreme latitudes |
| **Time Variable Gravity (TVG)**<br><br>Couhert et al. | GMSL long-term trend:<br>Jason-1 (10 years) ,<br>Jason-2 (5 years) < *0.10 mm/y* | Annual term:<br>East/West patterns < *4 mm*<br>**Long-term evolution:**<br>**East/West patterns < *2 mm/y*** |

# TVG-INDUCED ORBIT ERRORS

- **Non Tidal Time Varying Gravity (TVG)** - induced orbit error has a largely geographically correlated signature affecting regional MSL trends and Tide Gauges calibration
- Mostly due to melting of Greenland and Antarctica ice sheets




Courtesy of S. Nerem, OSTST 2013

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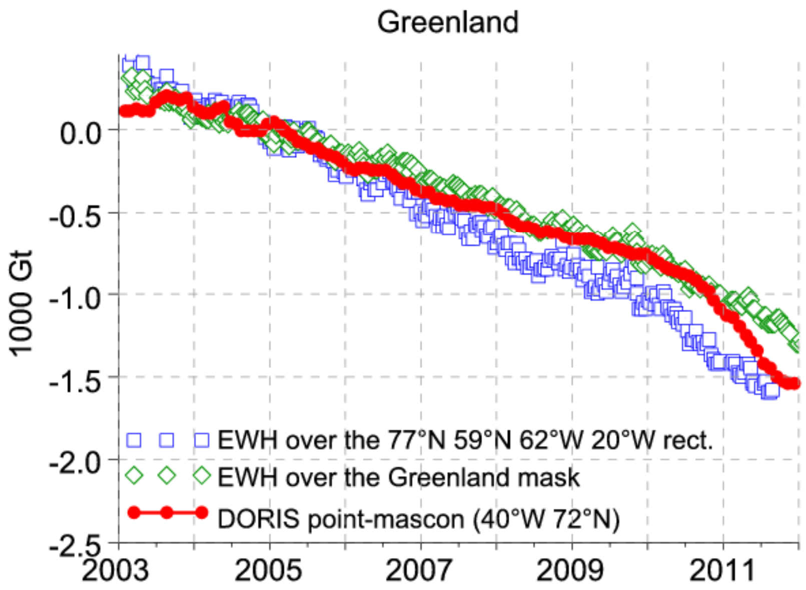
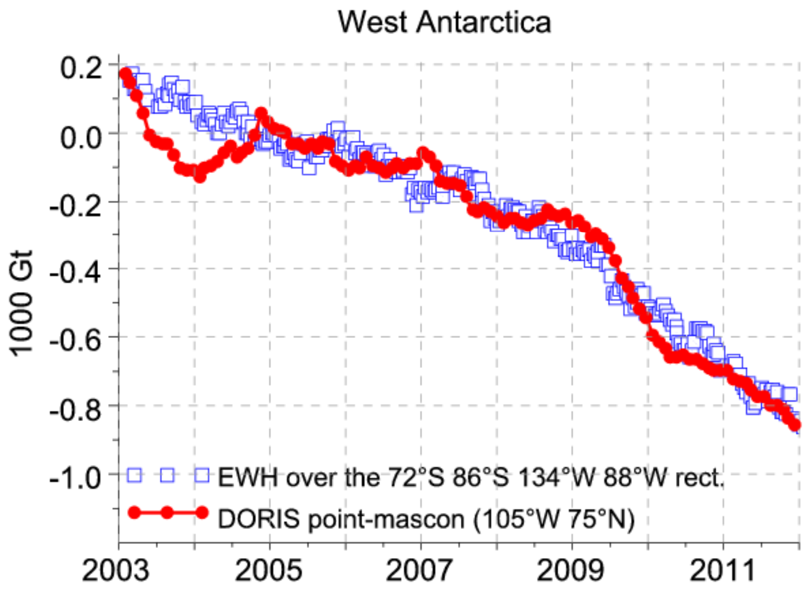
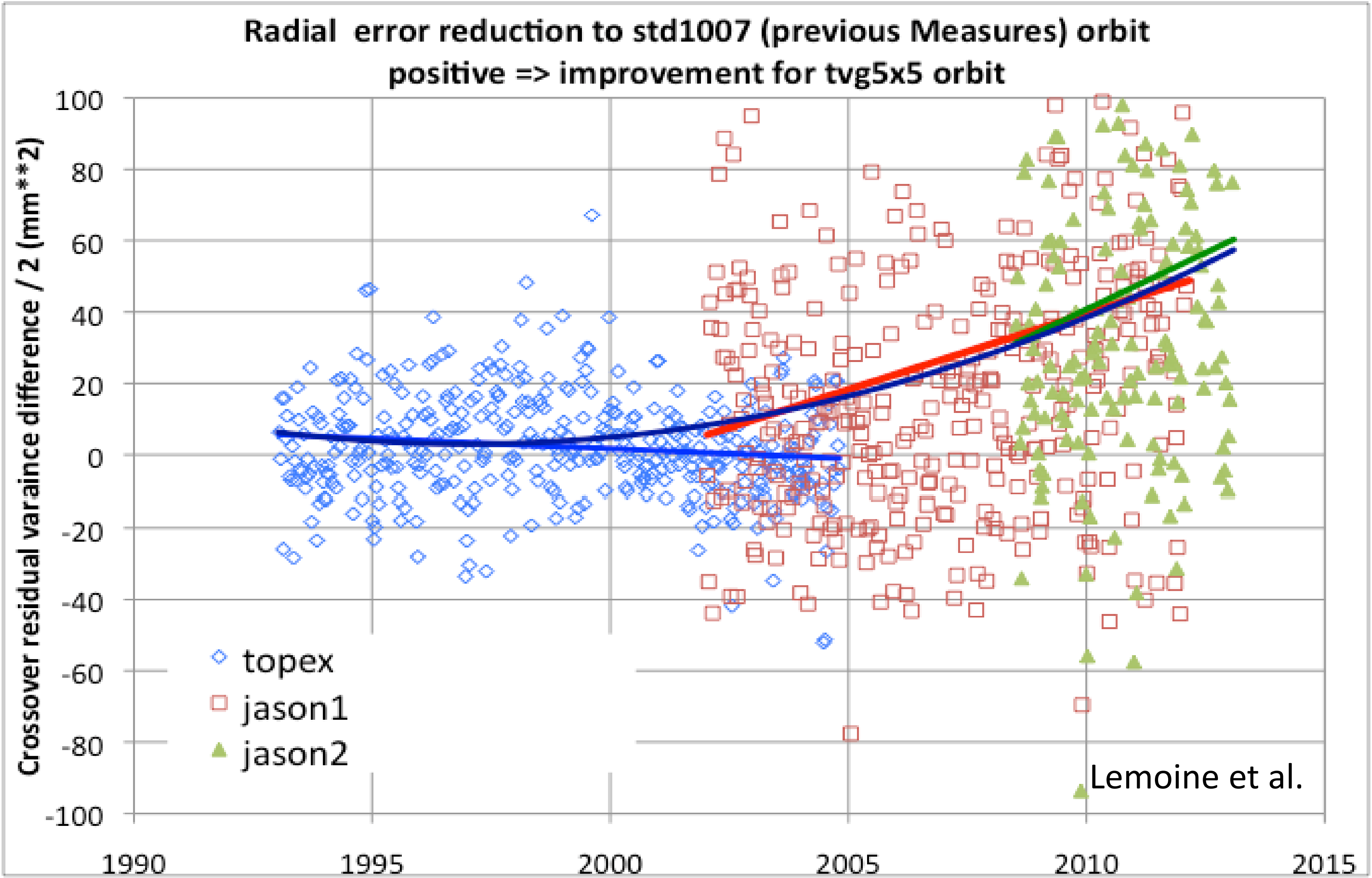



Cerri et al. 2013

# TVG-INDUCED ORBIT ERRORS



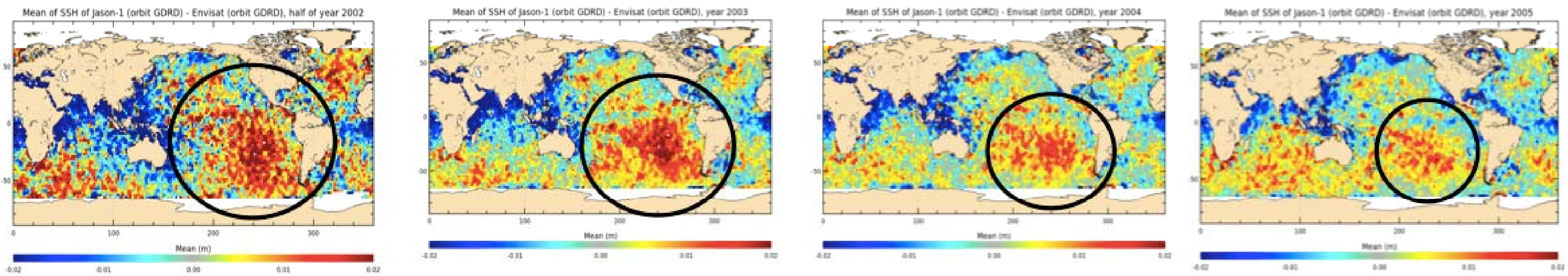
# TVG MODELING APPROACHES

- Several different approaches exist in modeling the time varying gravity field making possibly the best use of all available tracking data (from either altimeter and/or other missions)
  - **GRACE BASED TVG**: GDR approach (EIGEN6S2 improves the GDRD model)
  - **SLR+DOR+GPS geopotential complements (SH or mascon)**
  - **GPS-based reduced dynamic orbits**

# GRACE-BASED TVG : EIGEN6S2 vs GDRD

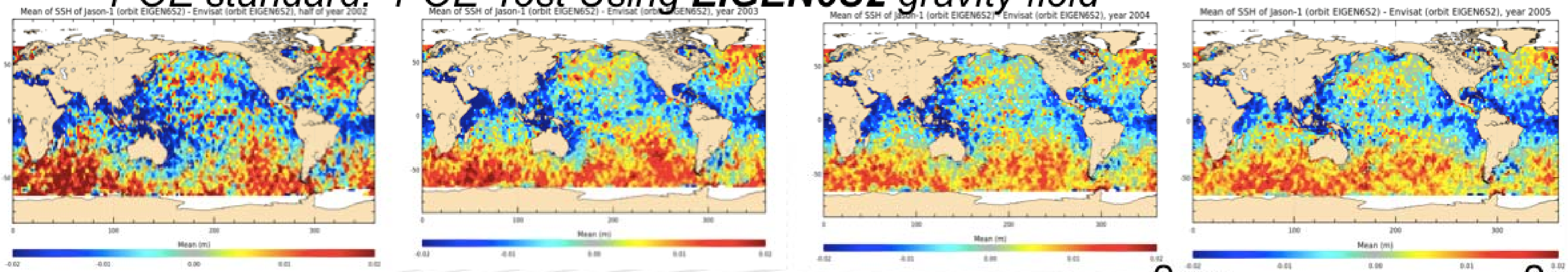
Interannual signal East/West patches remaining on EN-J1 mean difference per year at crossovers efficiently removed!

*POE standard: POE-D Using* ***EIGEN-GRGS_RL02bis_MEAN*** *gravity field*



2002 2003 2004 2005

*POE standard: POE-Test Using* ***EIGEN6S2*** *gravity field*



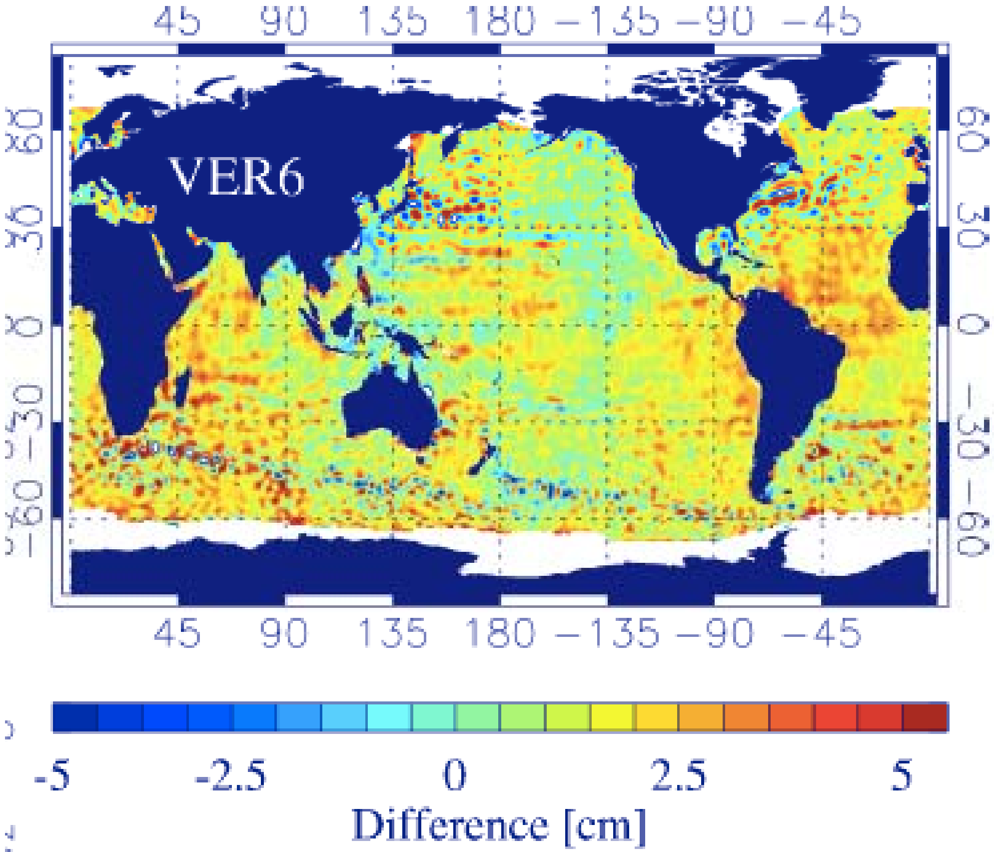
-2cm 2c

Remaining signals now dominating between those missions are most probably due to a mix of other sources (wet tropospheric correction, SSB solutions...)

Ollivier et al.

# GRACE-BASED TVG : EIGEN6S2 vs GDRD

Differences of the mean sea level calculated from ERS-2 and TOPEX (June 1995 – June 1996)

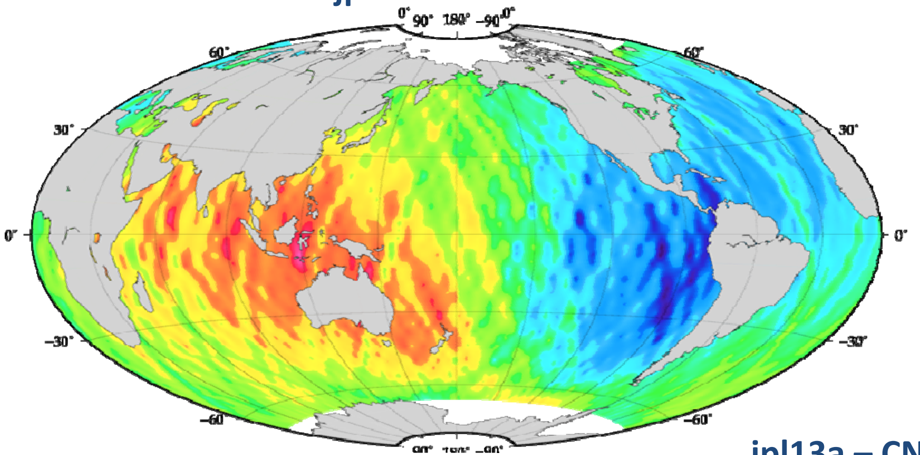



Rudenko et al.

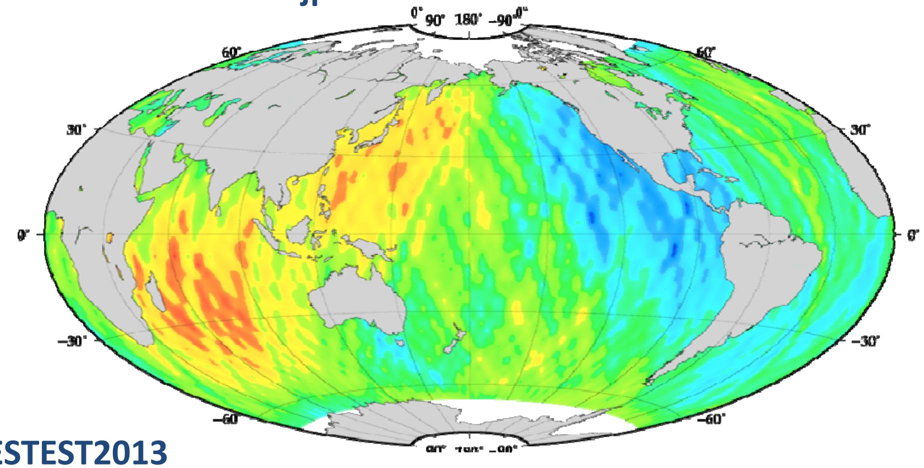
Extrapolates well before the GRACE period (zero drifts for degree 3-50 )

# GRACE-BASED TVG VS GPS Red. Dyn

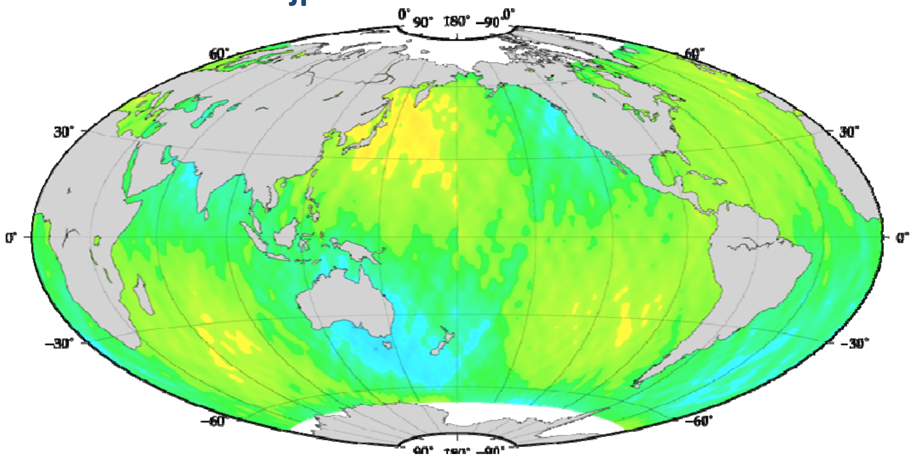
**jpl13a – GDRD**

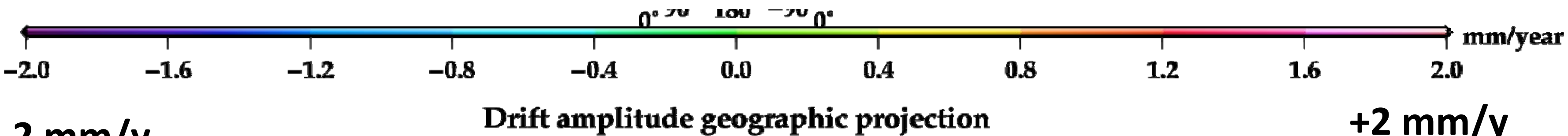


**jpl13a – GDRD EIGEN6S2**



**jpl13a – CNESTEST2013**



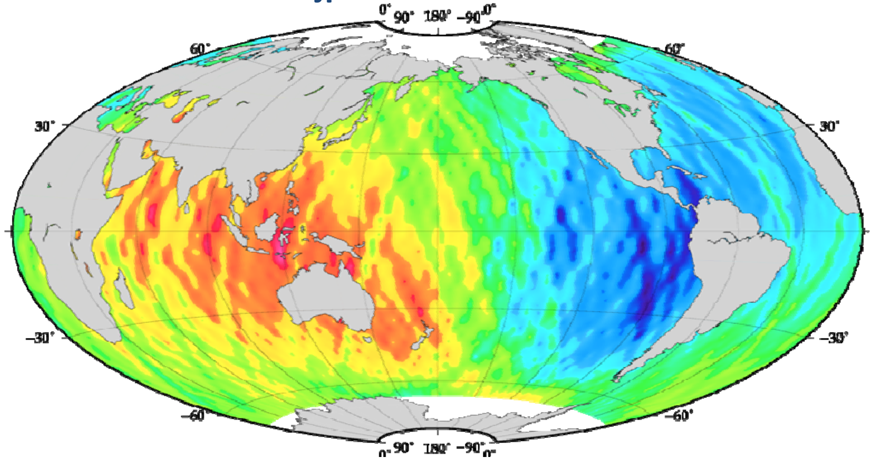



**-2 mm/y**

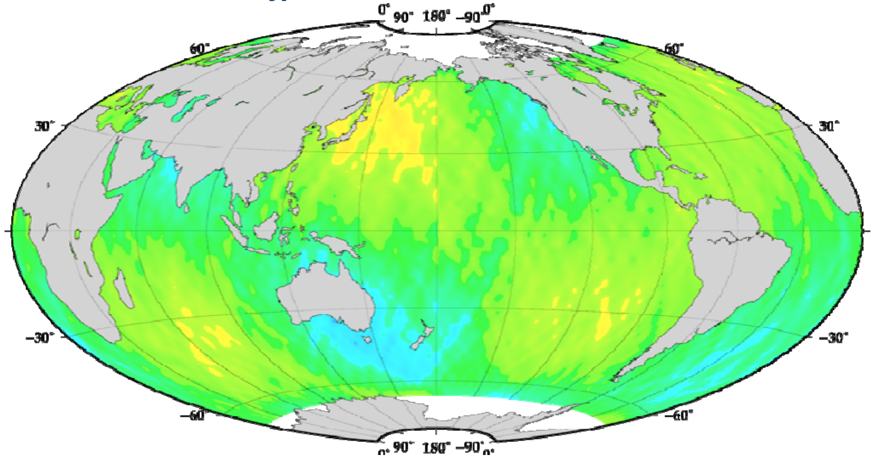
**+2 mm/y**

# GRACE-BASED TVG VS GPS Red. Dyn & DOR/SLR 4x4

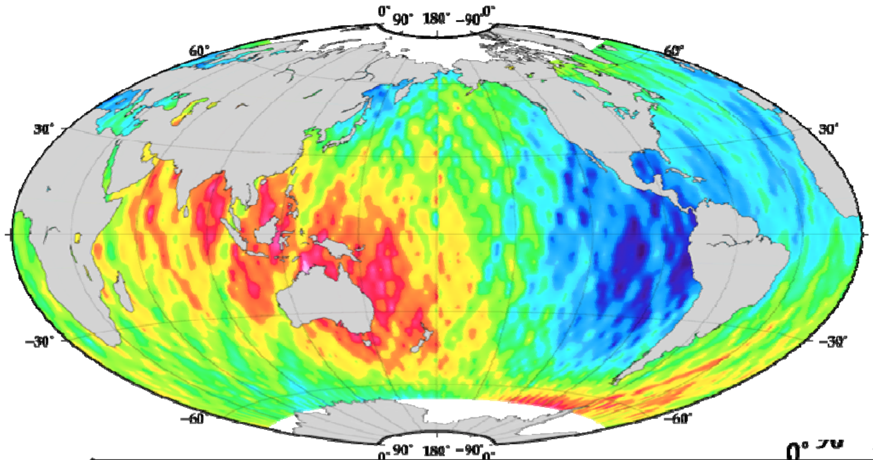
**jpl13a – GDRD**



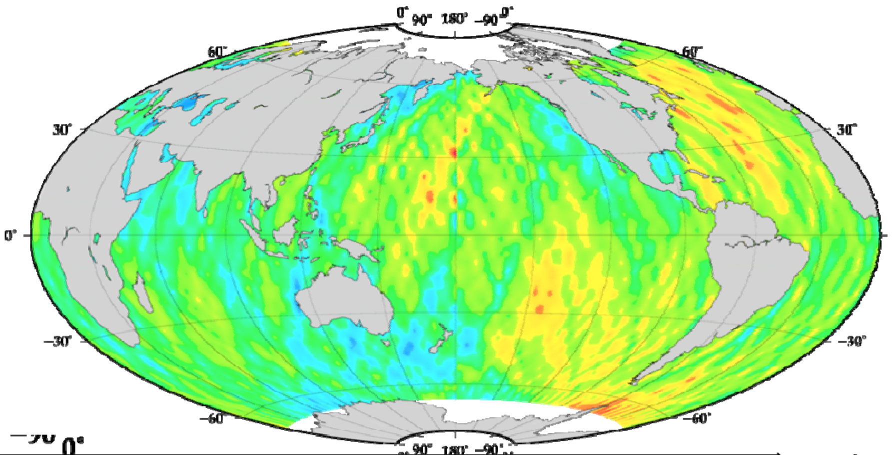
**jpl13a – CNESTEST2013**

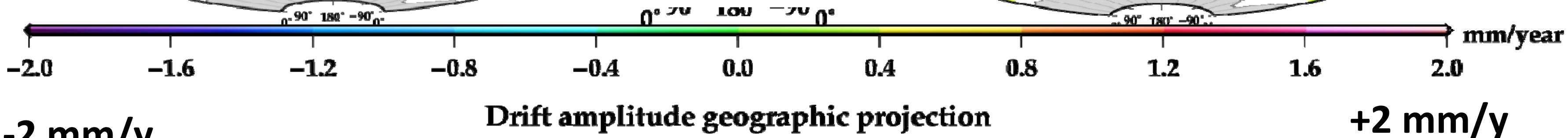


**GSFC gsfc_ja2_poe_ld_std1204 – GDRD**



**GSFC gsfc_ja2_poe_ld_std1204– CNESTEST2013**



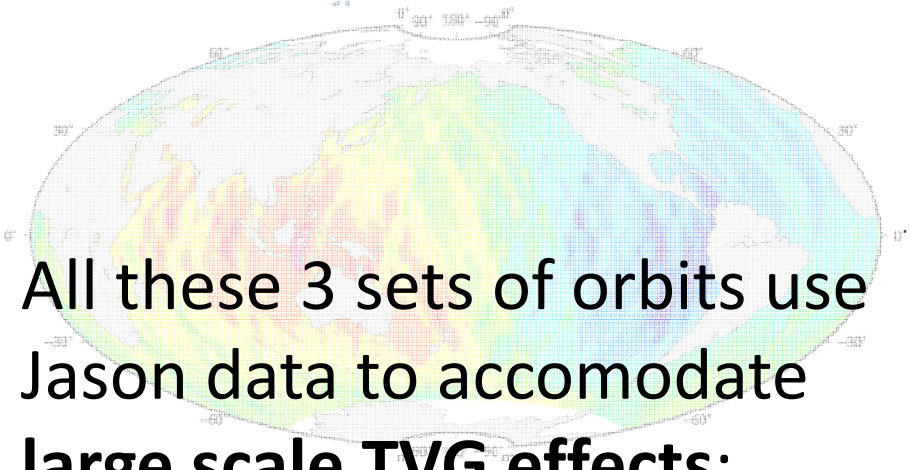



**-2 mm/y**

**+2 mm/y**

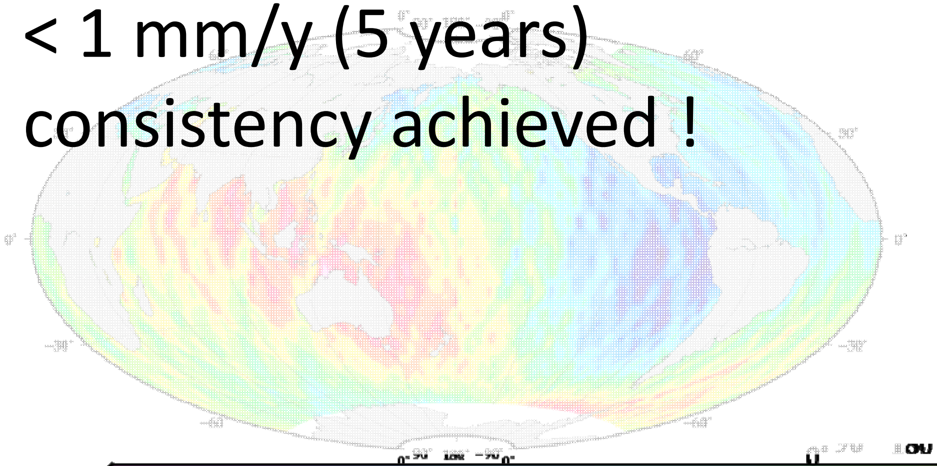
# GRACE-BASED TVG VS GPS Red. Dyn & DOR/SLR 4x4

jpl13a – GDRD

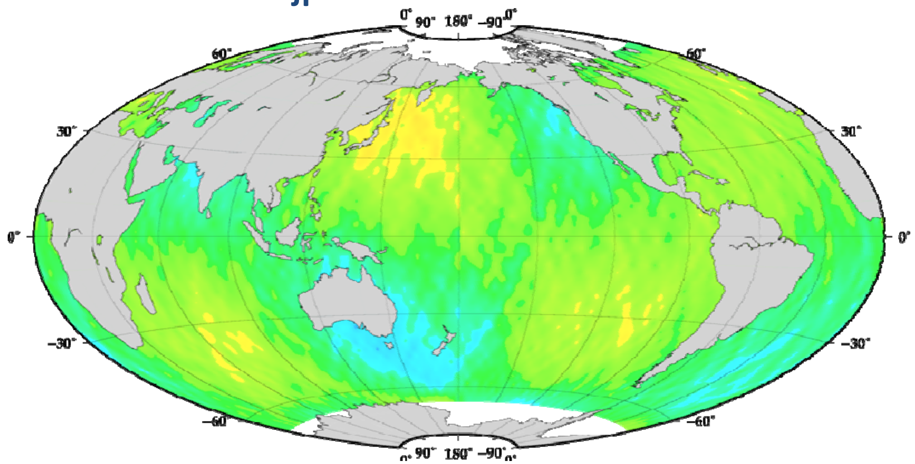


All these 3 sets of orbits use Jason data to accomodate **large scale TVG effects**:
< 1 mm/y (5 years) consistency achieved !

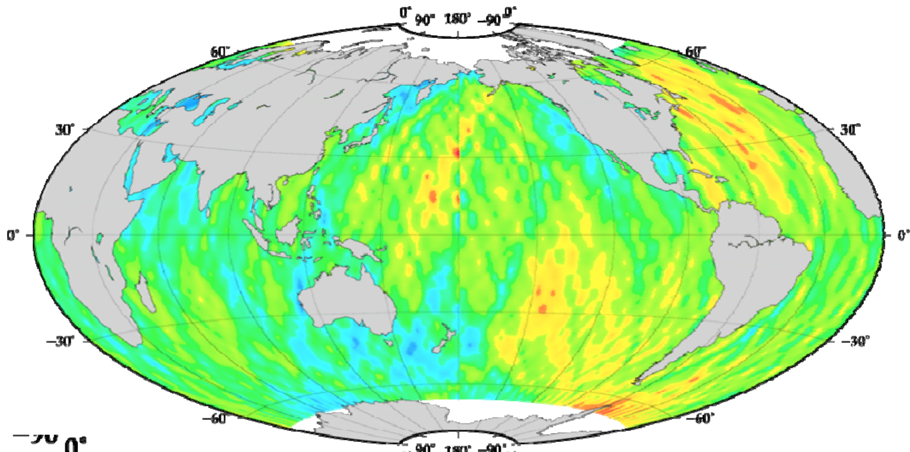
GSFC gsfc_ja2_poe_ld_std1204 – GDRD



jpl13a – CNESTEST2013



GSFC gsfc_ja2_poe_ld_std1204– CNESTEST2013




-2 mm/y

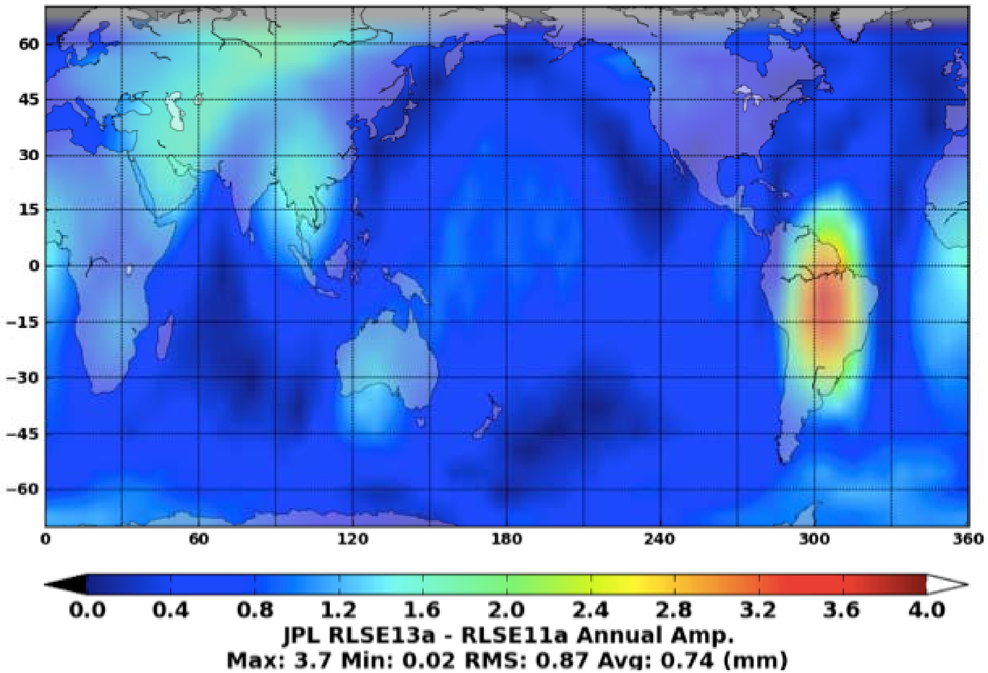
+2 mm/y

# Even most accurate GPS red. dyn. orbit are sensitive to TVG

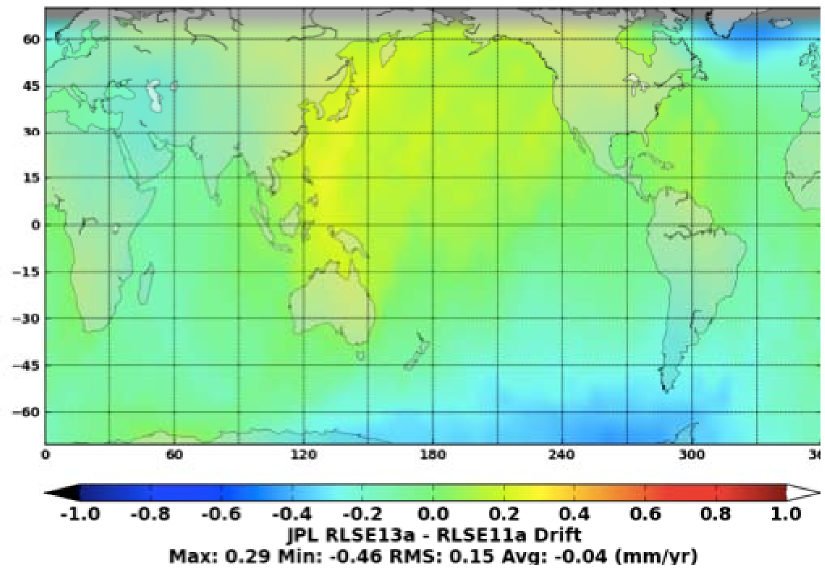
## RLSE13a – RLSE11a Radial Orbit Differences

(JPLRL05 time variable gravity vs. GGM02C static gravity)

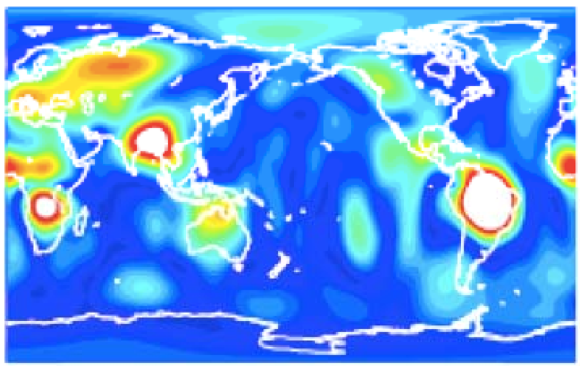
AMPLITUDE OF ANNUAL DIFFERENCES




RATE DIFFERENCES




Amplitude of Annual Differences Highlights Amazon



Annually varying surface mass from GRACE (Wahr et al., 2004)

# PROSPECTS AND PLANS

- **Complete orbit reprocessing for next OSTST (ITRF2013)**
- GOAL: **reduce the radial difference rates between Jason orbits that are caused by different TVG models** to < 1mm/year over 5-year time span
- Analysis of projected Ice-loss from Greenland and Anctartica could help in assessing the capacity of GPS and DORIS/SLR to compensate TVG errors in the future
- **ARGO T/S + GRACE seems a promising approach to quantify geographically correlated orbit errors as a complement to SLR and Tide Gauges**
- Orbit reprocessing must be multimission – especially including the reference missions
- **The POD group wishes to include geocenter motion in POD standards**, as this will improve the consitency between orbits based on different tracking techniques and ensure the delivery of orbits whose origin is the whole Earth center of mass.

# Recommendations 1/2

- Paucity of the current set of tracking stations and occasional biases or data gaps make **SLR questionable do detect orbit regional drifts at the 1 mm/year level over 5 years → Any effort to improve SLR stability and station distribution will be of great benefit to POD**

- **GPS-based reduced dynamic solutions** remain an indispensable tool to validate POD performances and therefore accurate GNSS receivers **should be made a mission critical instrument for ocean topography missions**

# Recommendations 2/2

- **The sensitivity of the altimeter orbits to time varying gravity is demonstrated**, and the use of highest fidelity geopotential models is essential. Therefore
  - We recommend a « best effort » commitment of the GRACE team to **provide GRACE-based time series in a more timely manner** (applies especially to GRACE FO) for operational POD
  - In case of GRACE demise, POD would need operational TVG models using SLR,DORIS and GNSS data from other satellites (current efforts in this sense look promising)

- POD teams should also consider the possibility of
  - improving the accuracy short-latency products
  - at the same time, the possibility of orbit products more suitable for long term studies than current GDR, making use of the best available models and time-series