POD considerations concerning the 60-day signal between Jason and Topex MSL

L. Cerri, Lisbon OSTST meeting, Oct. 20, 2010

Starting point of the discussion…

- signal in the MSL difference of Jason-1&2 with respect to other satellites
- Amplitude ~ 5 mm
- Period ~ 60 days
- Phase ~ Max when |Beta-prime| is max

Can this be due to the orbit computation ?

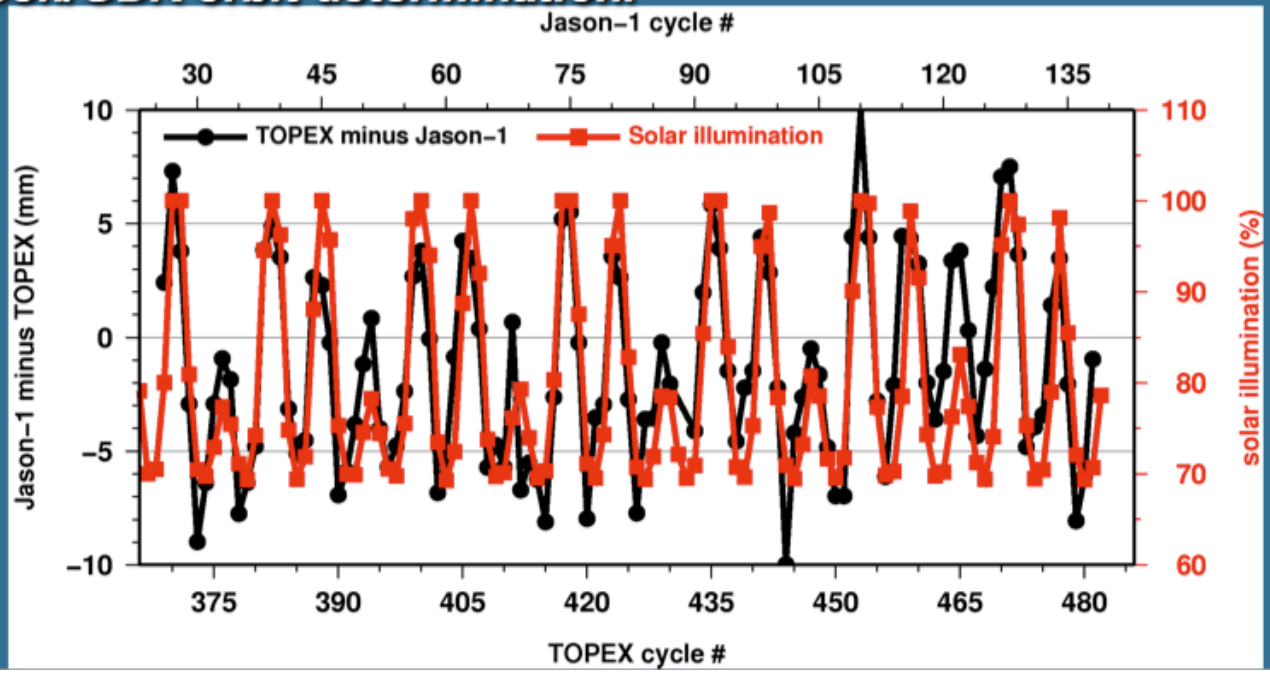
Possible errors common to all solutions

- Global, 60-day radial orbit error over ocean can result from
  - A 60-day period radial force globally affecting the orbit scale
  - Geographically distributed radial differences
    - Mean over ocean might not be zero due to non uniform distribution of continental surface (ex. ITRF differences in the N/S direction)
    - Scaled by a factor of ~20% for N/S radial difference

Jason-1/TOPEX Comparison

J1–TX differences are highly correlated with solar illumination.

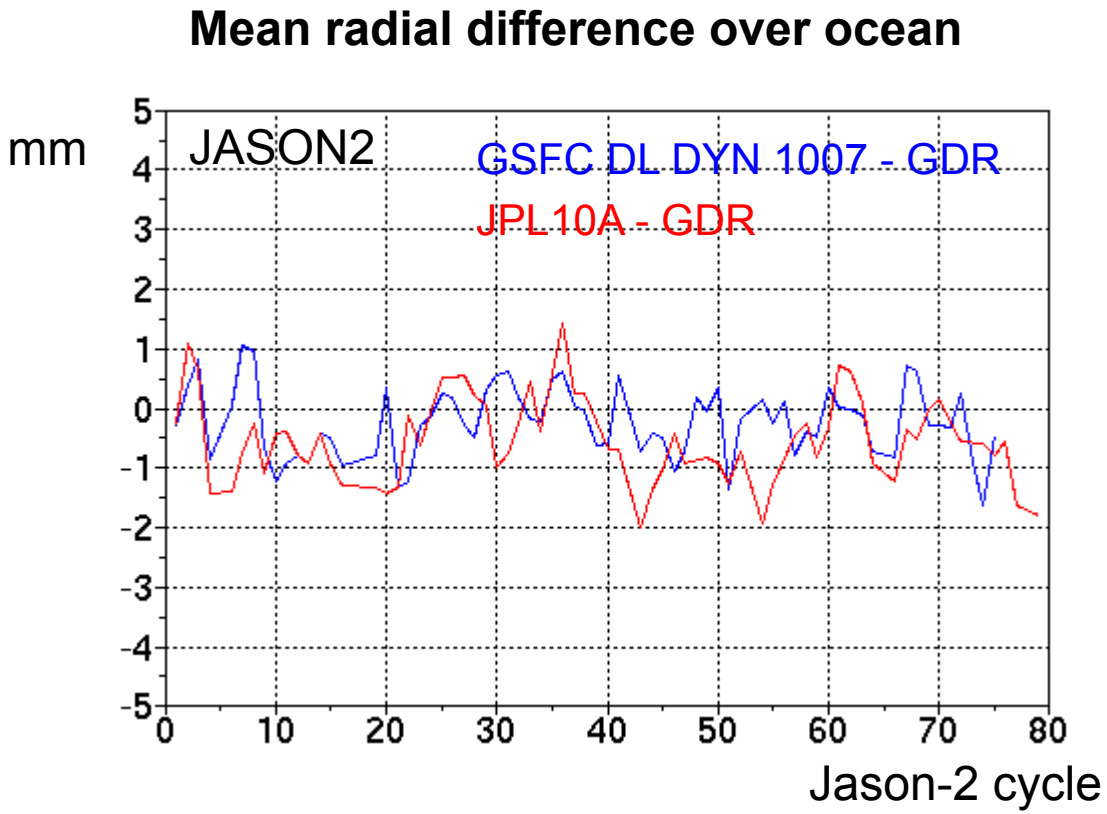
- **Result of deficiencies in non-conservative force modeling in Jason/GDR orbit determination.**



From E. Leuliette et al. 2010 Ocean Sciences Meeting • Portland, Oregon • 26 February 2010

Inter-center orbit comparison

- No evidence of signal above 1 mm amplitude in the mean radial difference over ocean



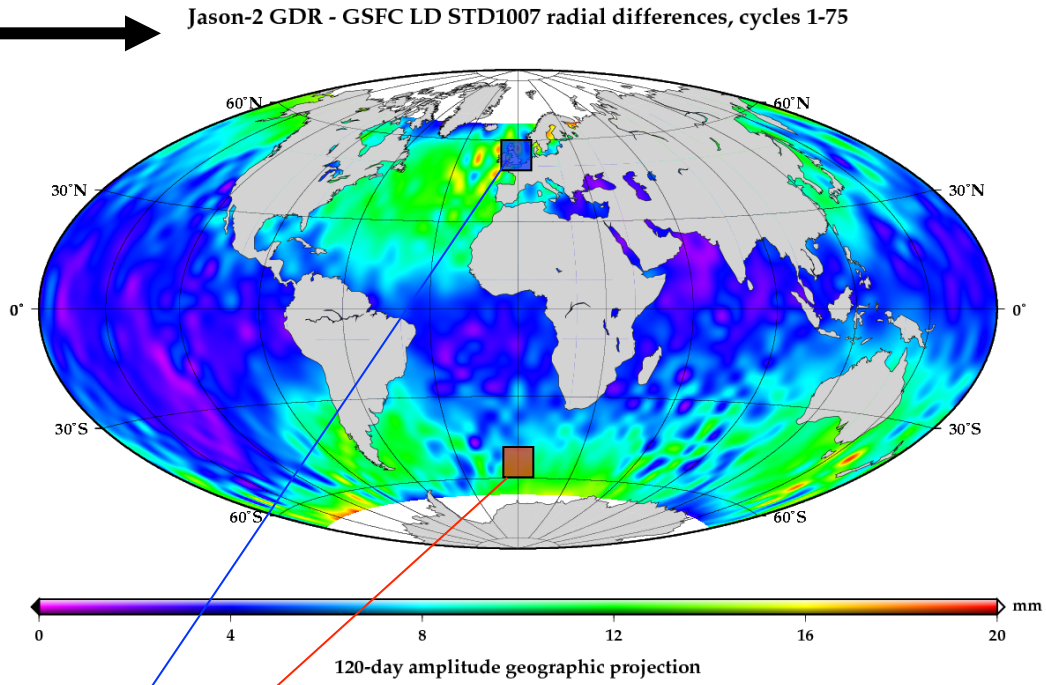
Solar Radiation Pressure

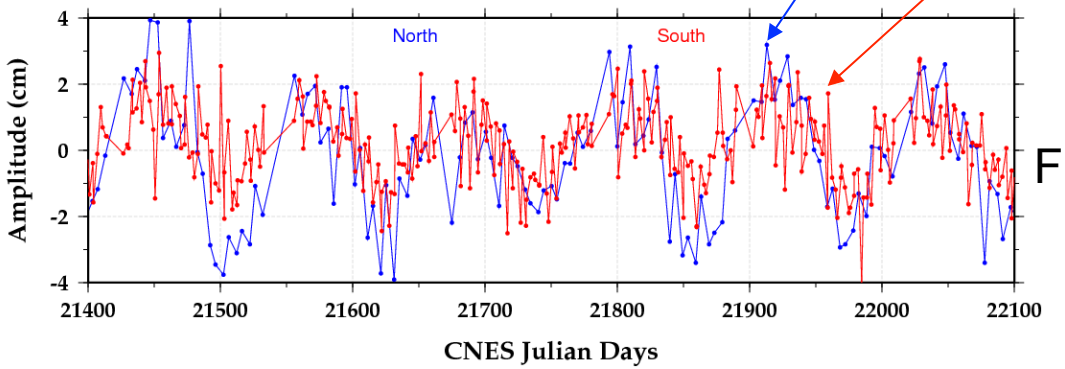
- Patterns induced by SRP modeling differences are at ~120-day period
- UCL Vs CNES B&W models have been independently obtained and show only small orbit difference (< 3mm rms with CNES current parameterization and negligible effects on the radial mean)

Solar Radiation Pressure

- …strongest observed signals today are is at 120-day frequency
- Typical of SRP modeling differences

  (likely a problem in GSFC dynamic orbit)

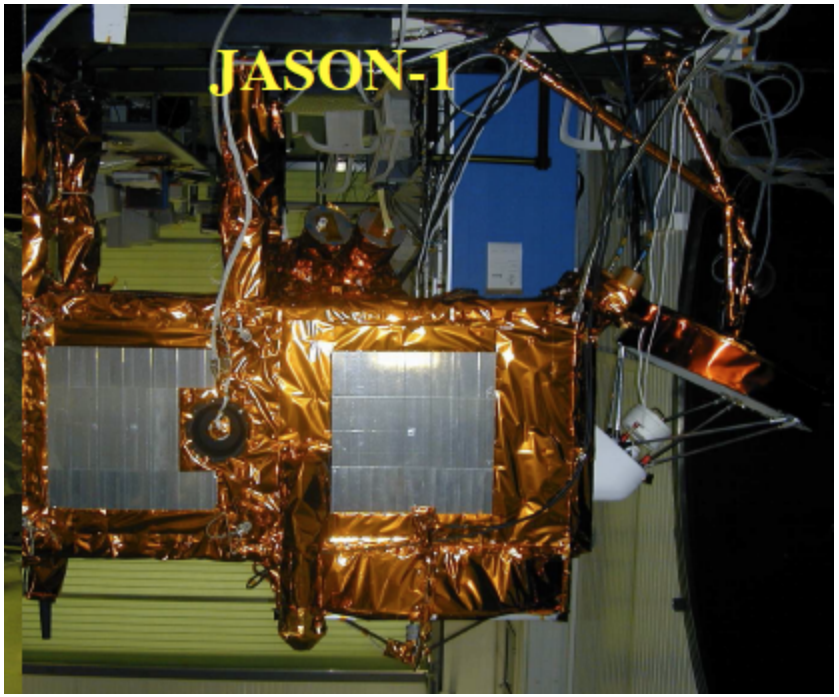




From Couhert et al. in POD splinter

Radiators

- In the POD standards adopted for GDR orbits, satellite thermal emission from radiators is assumed to be constant (thermal control small wrt payload consumption)



Radiators

	Jason-1	Jason-2
X	40 W	0 W
Y	80 W	60 W
Z	0-8 W	100 W

- Heating is driven by solar illumination (60-day period)
- Emitted flux from +Z radiator not accounted for in current POD standards
  - For a 500 kg satellite , 100 Watts of diffused power are needed to obtain a 0,15 mm radial displacement

Radiators

- +/-Y radiators
  - Are in shadow at high beta-prime and facing the along-track direction.
  - Errors in this force are then compensated by along track empiricals
  - dynamic and reduced-dynamic orbits are close

Albedo / Earth Infrared

- This force has a mean 60-day pattern
- A basic planetery radiation model is included in the POD standards
- Max force when the sun is in the orbit plane
- The effects of Earth radiation pressure mis-modeling should be further investigated (expected to be small compared to the 5 mm radial shift we are looking for)
- No conclusive sign of beta-dependent pattern in the high elevation SLR residuals over independent (DORIS, GPS) Jason orbits

Center of Mass knowledge

- "Jason-2 satellite budgets and margins" document:

  the uncertainty in the SA center of mass position and its movement due to thermal warping are the main contributors to the movement of the satellite center of mass.
- However, SA Mass / Sat. Mass ratio = 42/505 = 0,08

SA Center of Mass

- Uncertainty of the SA CoM position
  - Perpendicular to the SA plane: < 21 mm, (1.7 mm on total satellite mass)

    The projection along the radial direction is variable at the orbital period , with no projection at high beta prime
  - In SA plane: only 3 mm, which scales down to 0.24 mm in terms of S/C CoM.
- SA CoM movement due to thermal warping
  - perpendicular to the SA plane (no radial projection at high beta prime)
  - In sunlight, the maximum displacement opposite to the sun is -6.5 mm , in shadow it is +1.5 mm. Effect on the platform CoM is below 1 mm

Conclusions

- an error in Jason non-conservative force models or in the position of Jason CoM can’t explain the 60-day signal observed between Jason and Topex MSL.