Australian Government

Geoscience Australia

# DORIS System Time Bias: Envisat-1 and Jason-2


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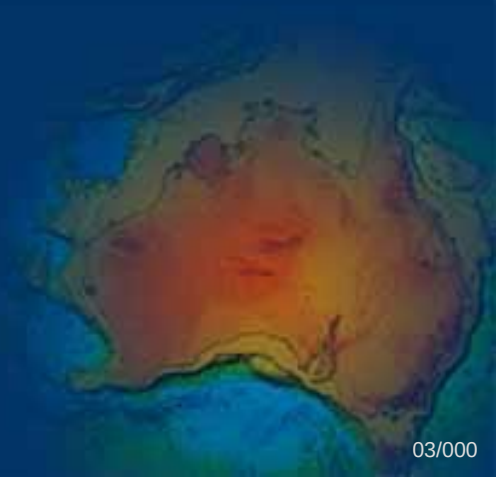
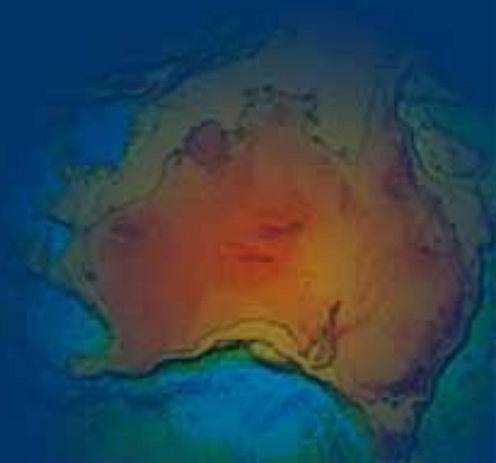


IDS Workshop 21st October 2010, Lisbon

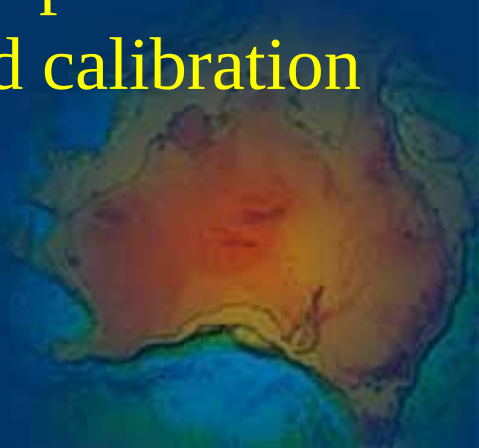
# Overview

- Rationale
  - DORIS and SLR orbit results
    - Envisat
    - Jason-2
- DORIS Time Bias estimates
- Effect of Time Bias on DORIS Orbits
- Discussion



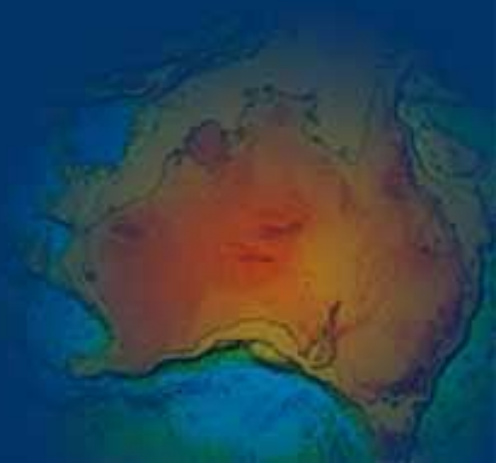
# Rationale

- For altimetry applications the measure of orbit accuracy is expressed as the RMS of the radial component
- However, for geodetic applications – reference frame, estimates of geocentre location etc. -- the accuracy of other components is of importance
- Multiple data types DORIS, GPS and SLR provide opportunity for verification, validation and calibration of orbit quality

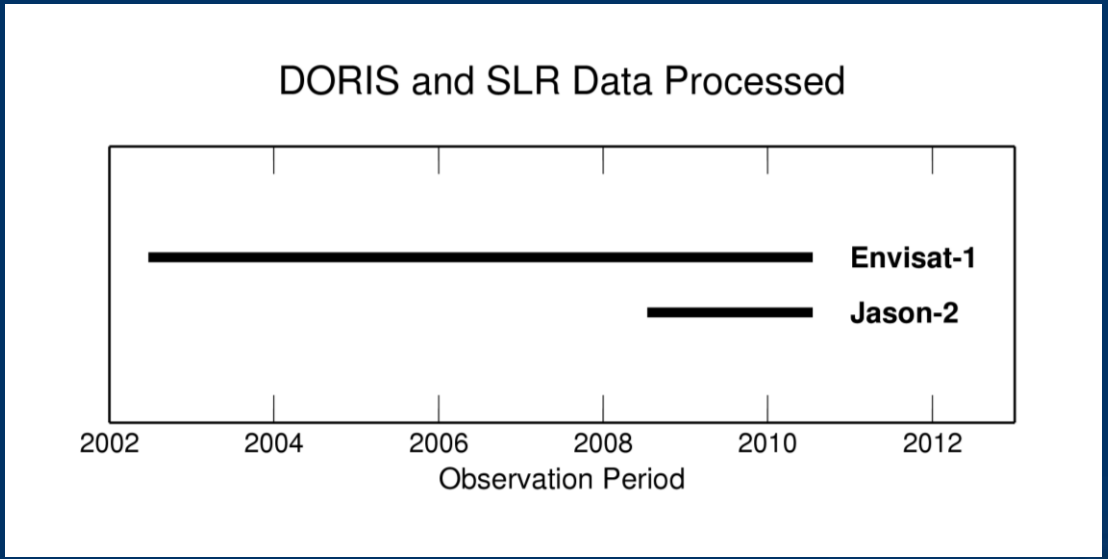


# Rationale

- DORIS and SLR determined orbits show differences in orbit trajectories in the along track component for identical force modelling
- Basic premise is that if all is equal the results of the two observable types should produce similar results for all parameters

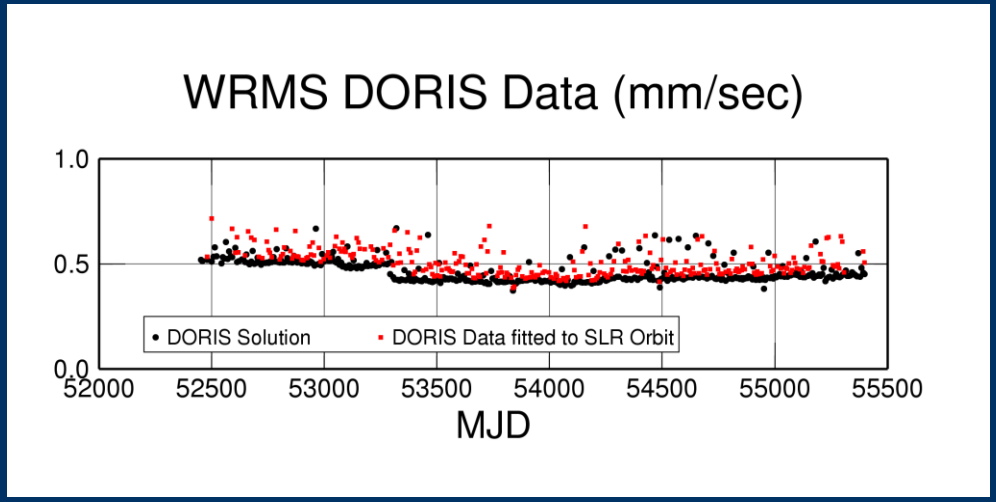


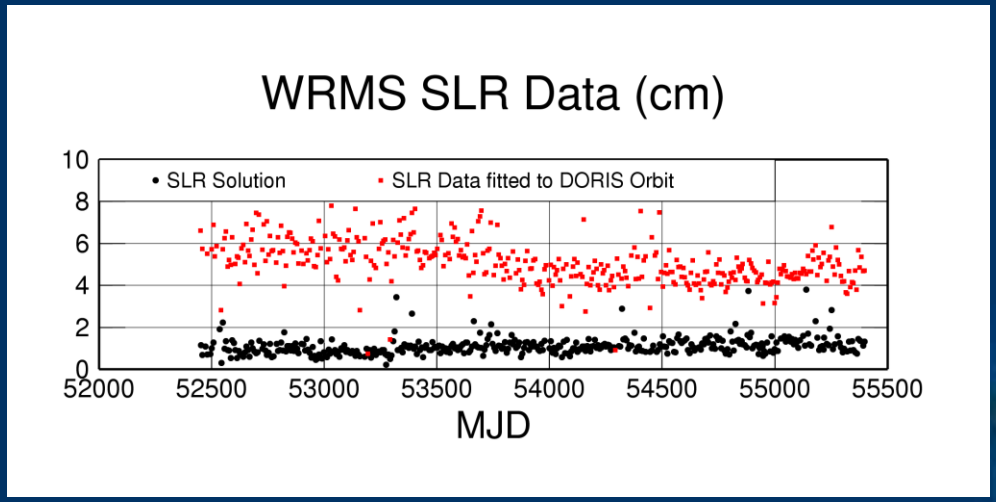
# DORIS and SLR data processed
# Envisat July 2002 – July 2010
# Jason-2 July 2008 – July 2010



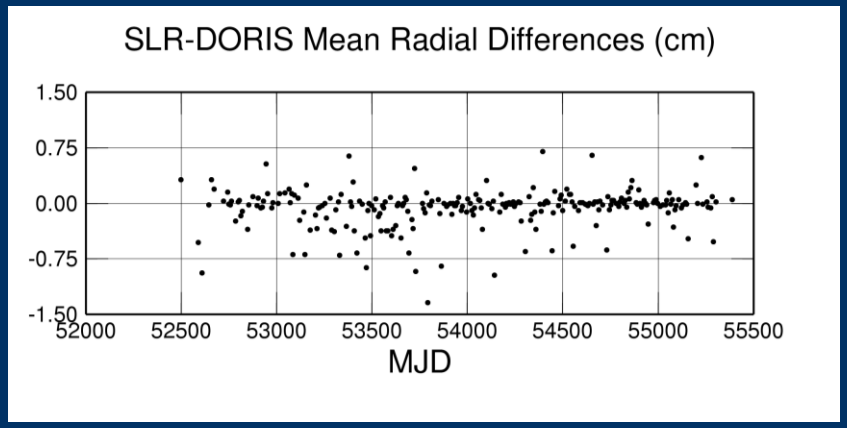

- 7-day arcs
- Identical force modelling

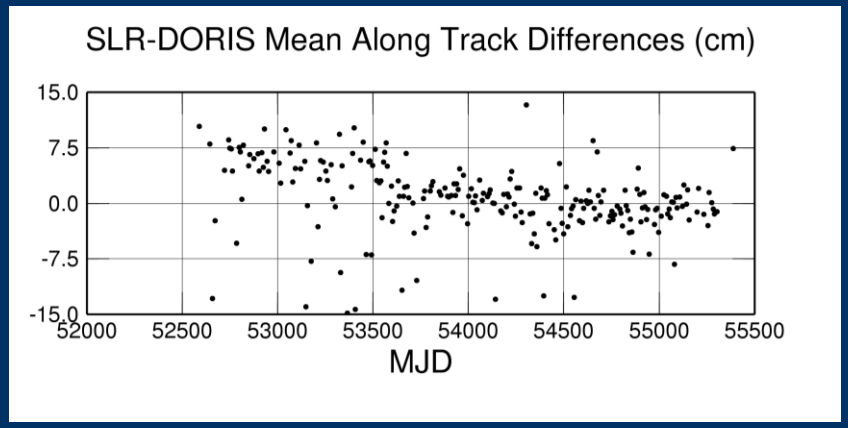
# Envisat

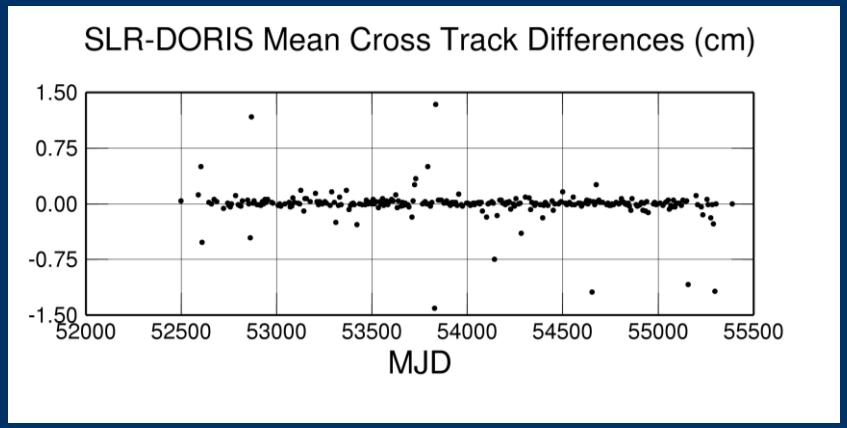

WRMS DORIS Data (mm/sec)
1.0
0.5
0.0
• DORIS Solution
▪ DORIS Data fitted to SLR Orbit
52000
52500
53000
53500
54000
54500
55000
55500
MJD

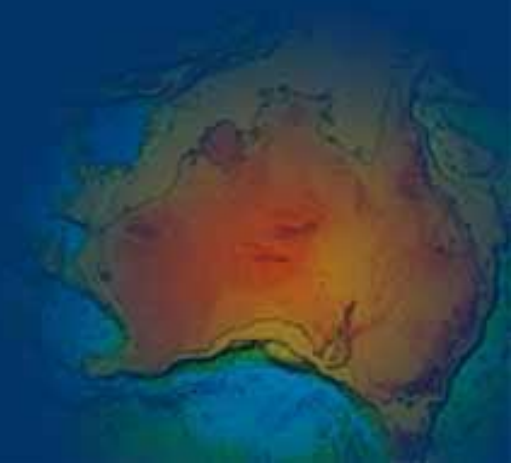

WRMS SLR Data (cm)
10
8
6
4
2
0
• SLR Solution
▪ SLR Data fitted to DORIS Orbit
52000
52500
53000
53500
54000
54500
55000
55500
MJD

# Envisat

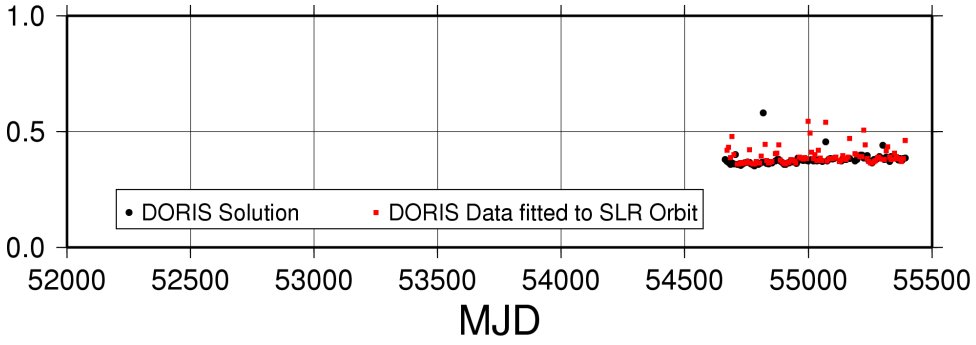

SLR-DORIS Mean Radial Differences (cm)
1.50
0.75
0.00
-0.75
-1.50
52000
52500
53000
53500
54000
54500
55000
55500
MJD

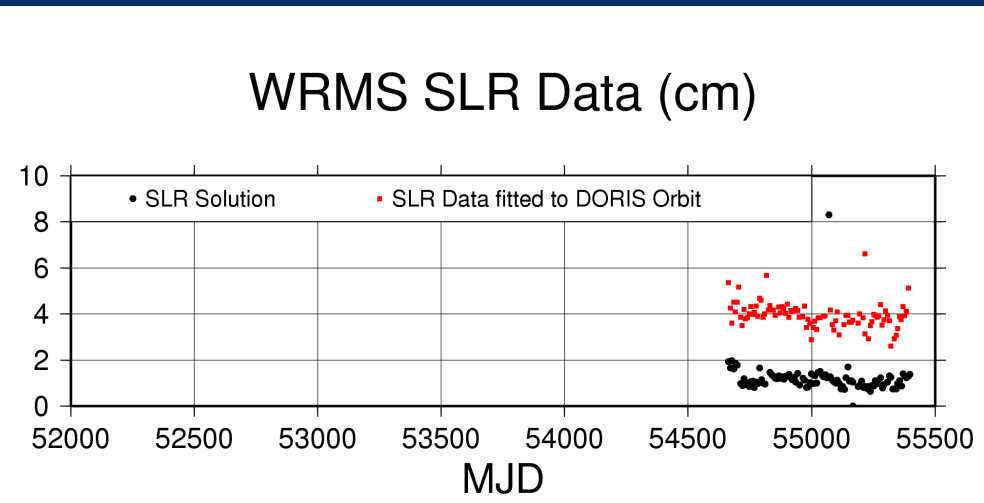

SLR-DORIS Mean Along Track Differences (cm)
15.0
7.5
0.0
-7.5
-15.0
52000
52500
53000
53500
54000
54500
55000
55500
MJD


SLR-DORIS Mean Cross Track Differences (cm)
1.50
0.75
0.00
-0.75
-1.50
52000
52500
53000
53500
54000
54500
55000
55500
MJD

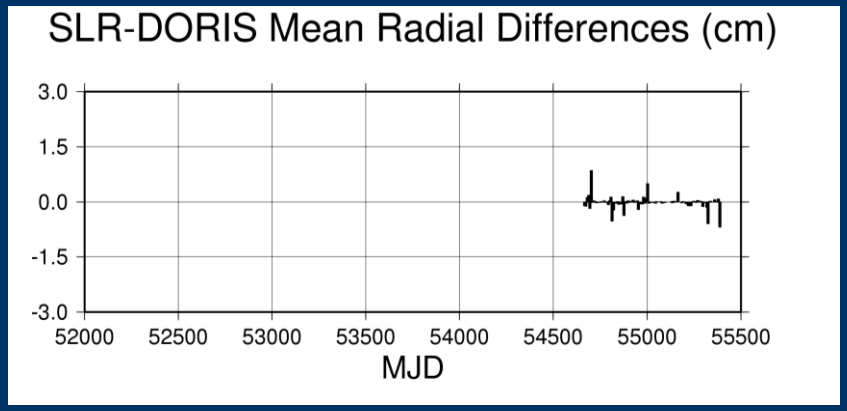


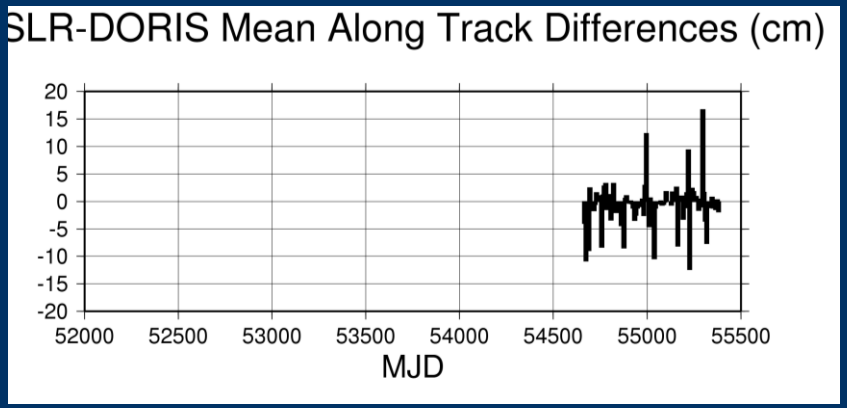
# Jason-2

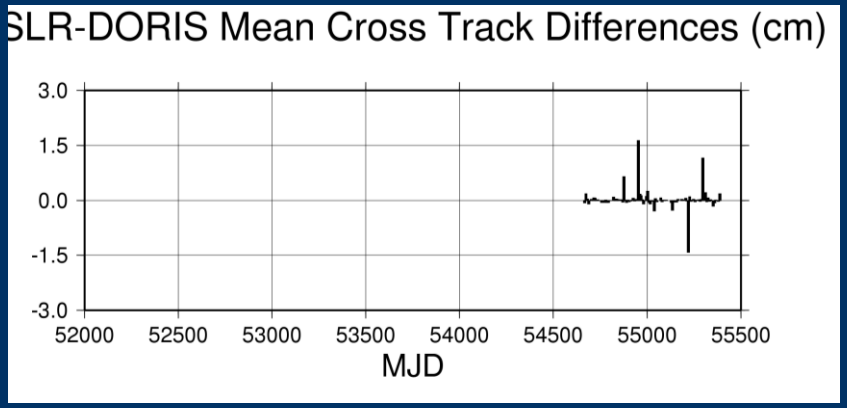

WRMS DORIS Data (mm/sec)
1.0
0.5
0.0
• DORIS Solution
▪ DORIS Data fitted to SLR Orbit
52000
52500
53000
53500
54000
54500
55000
55500
MJD

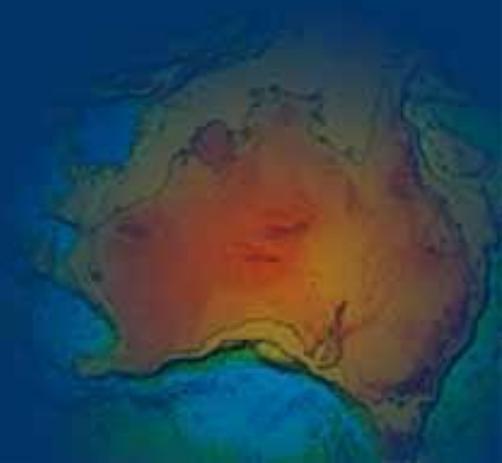

WRMS SLR Data (cm)
10
8
6
4
2
0
• SLR Solution
▪ SLR Data fitted to DORIS Orbit
52000
52500
53000
53500
54000
54500
55000
55500
MJD

# Jason-2


SLR-DORIS Mean Radial Differences (cm)
3.0
1.5
0.0
-1.5
-3.0
52000
52500
53000
53500
54000
54500
55000
55500
MJD

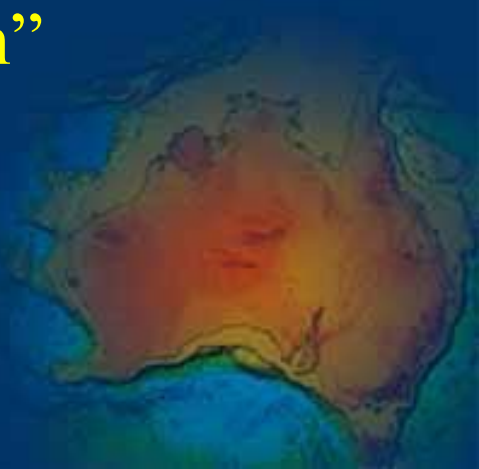

SLR-DORIS Mean Along Track Differences (cm)
20
15
10
5
0
-5
-10
-15
-20
52000
52500
53000
53500
54000
54500
55000
55500
MJD


SLR-DORIS Mean Cross Track Differences (cm)
3.0
1.5
0.0
-1.5
-3.0
52000
52500
53000
53500
54000
54500
55000
55500
MJD



# Measurement Errors

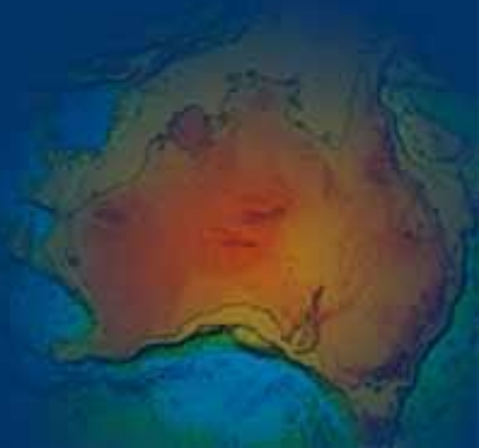
- Differences in DORIS – SLR orbit trajectories imply measurement errors due to:
  - DORIS – SLR network inconsistencies – mapping into the respectiv orbits
  - CoM offset (and attitude model) inconsistencies between DORIS antenna and SLR RRA
  - DORIS antenna “phase centre variation”
  - SLR RRA “depth” in error
  - Refraction corrections



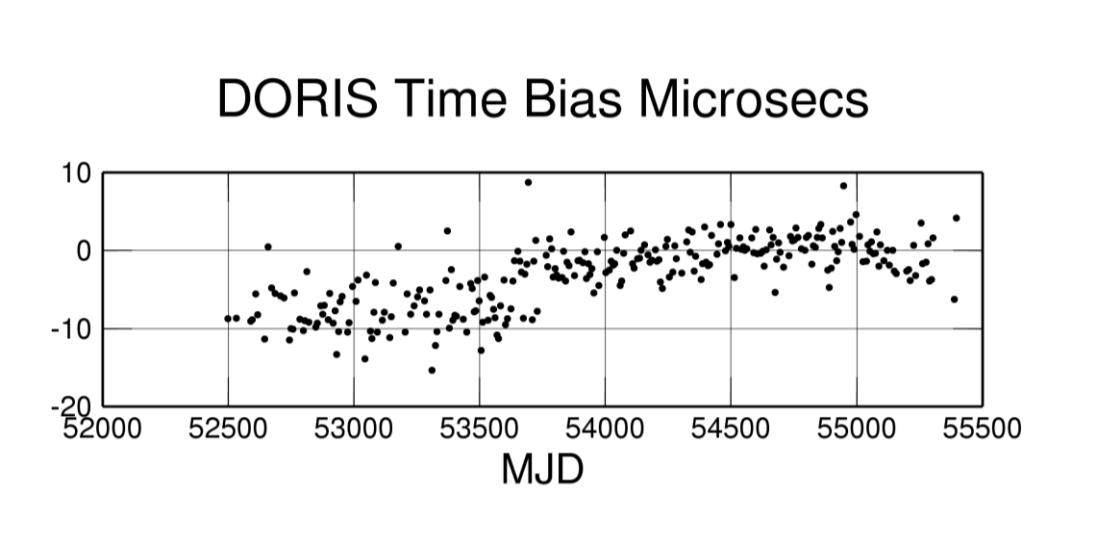
# Measurement Errors

- DORIS receiver clock error
  - Oscillator – Doppler Measurement Biases – estimated pass by pass
  - Time Keeper – Observation Time Tags – Time Bias

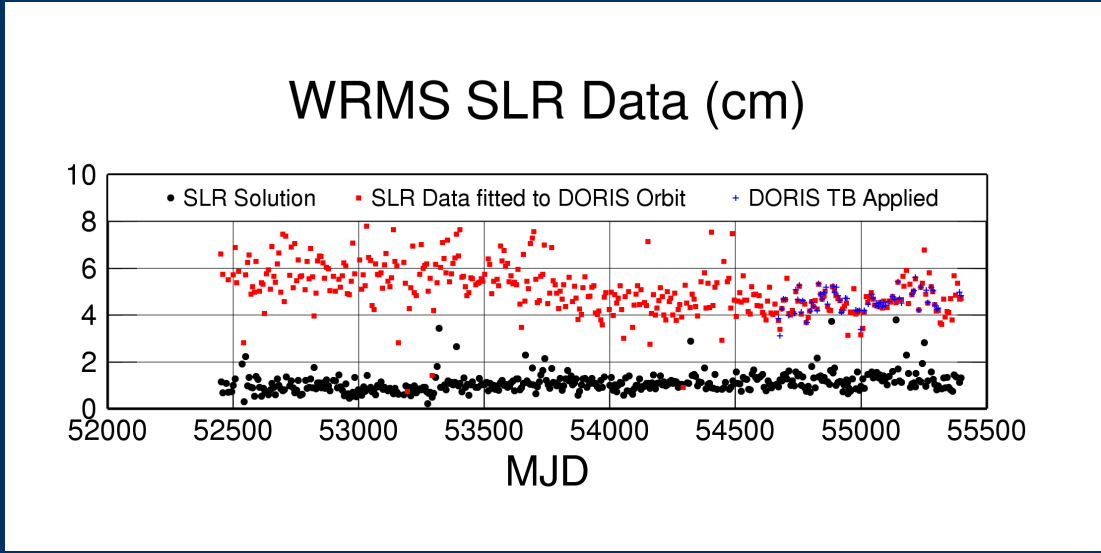
*Since the largest differences are in the along track component – effect of time bias is examined initially – satellite cannot be in two places at the same time*



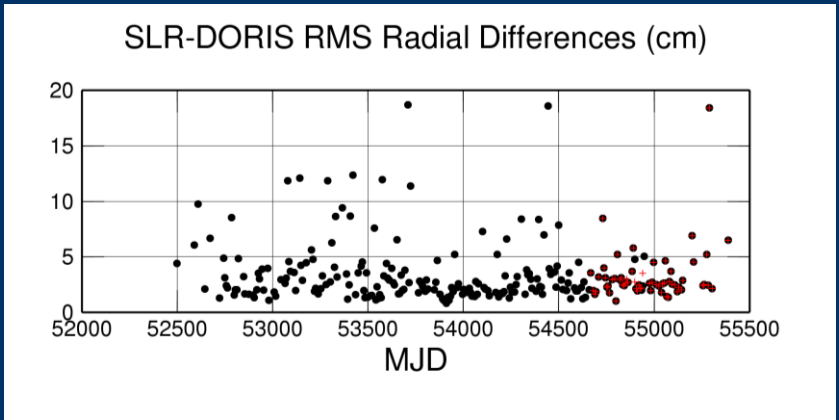
# Envisat -- DORIS Time Bias

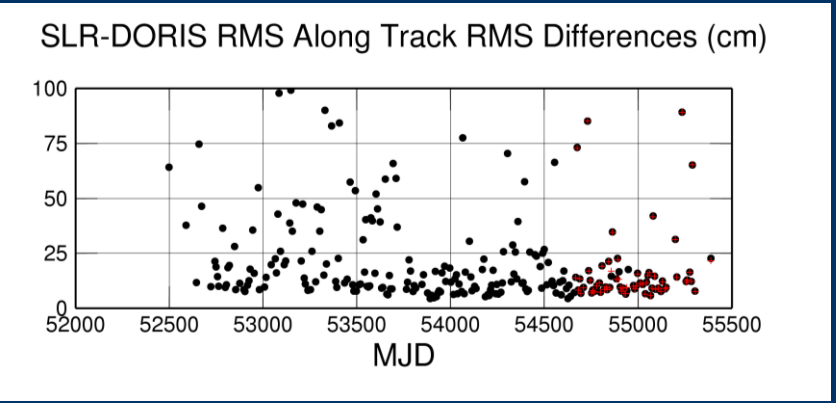


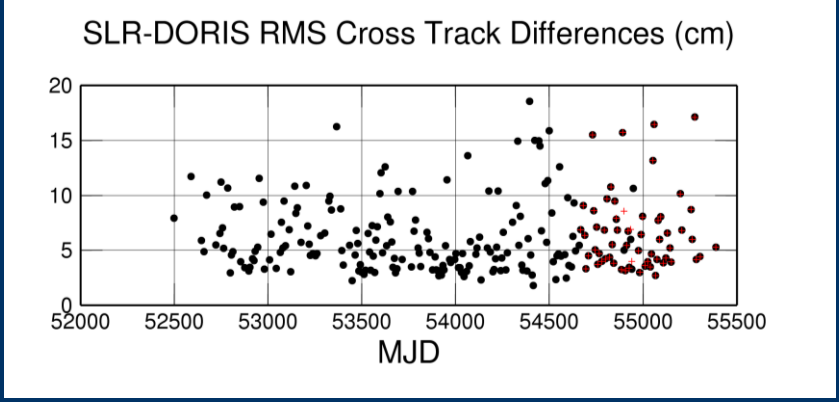
# Envisat Orbits – DORIS Time Bias applied

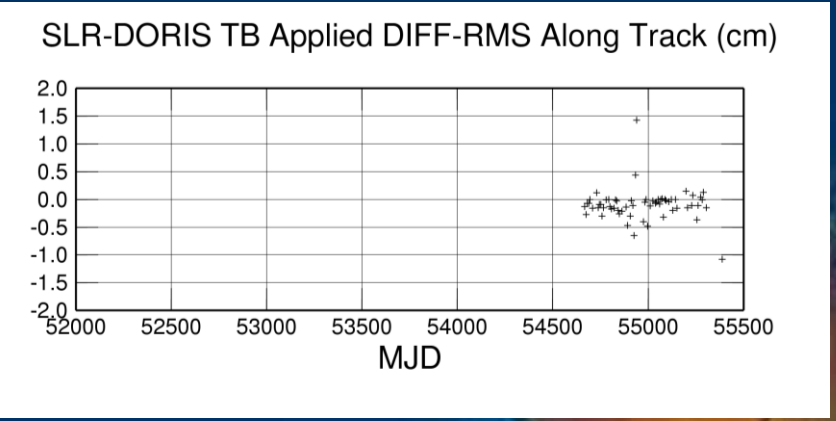


# Envisat Orbits – DORIS Time Bias applied

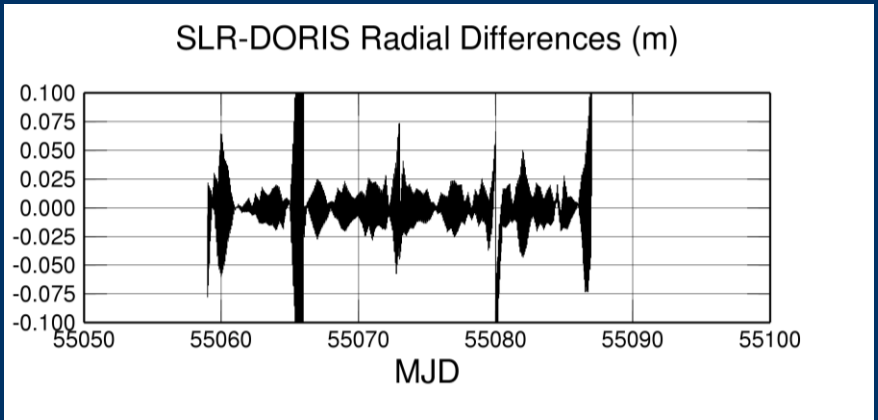


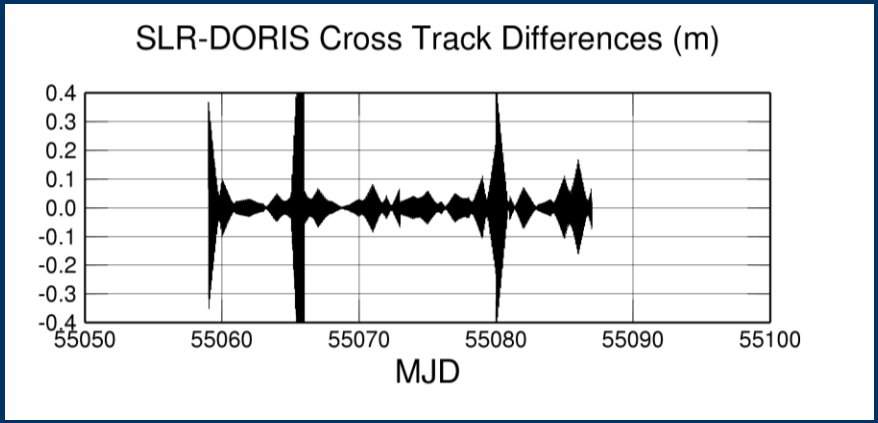



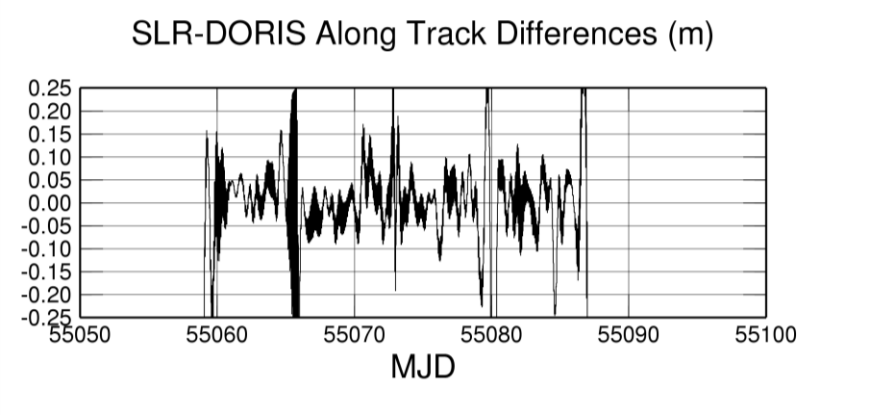



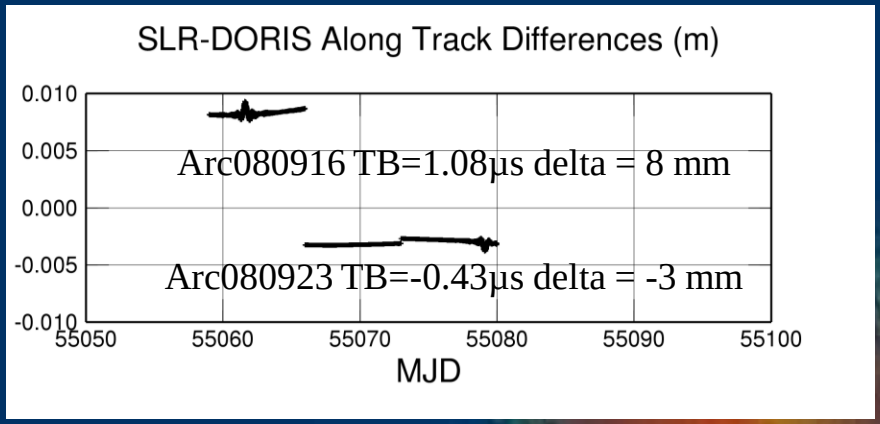



# Envisat Arc Differences

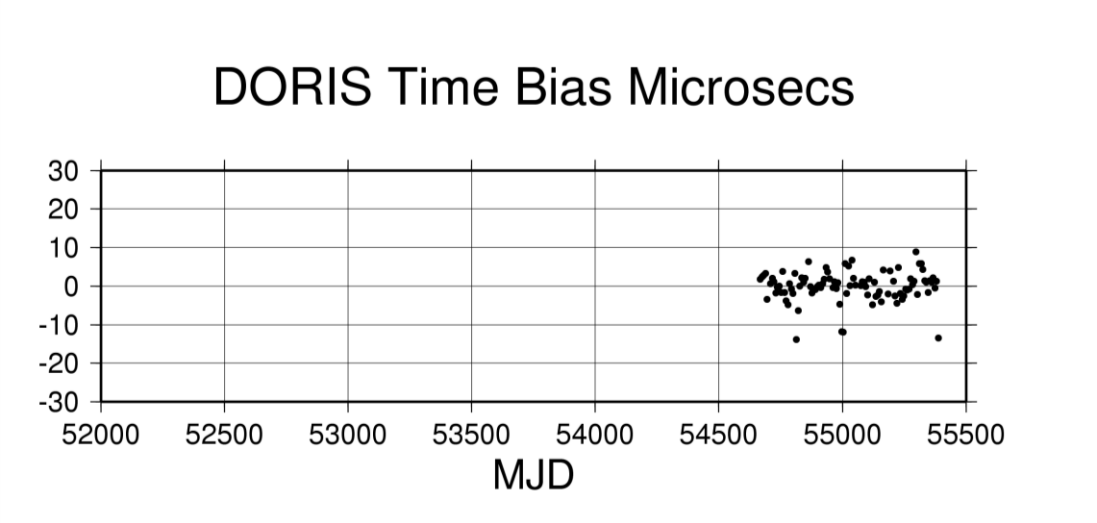


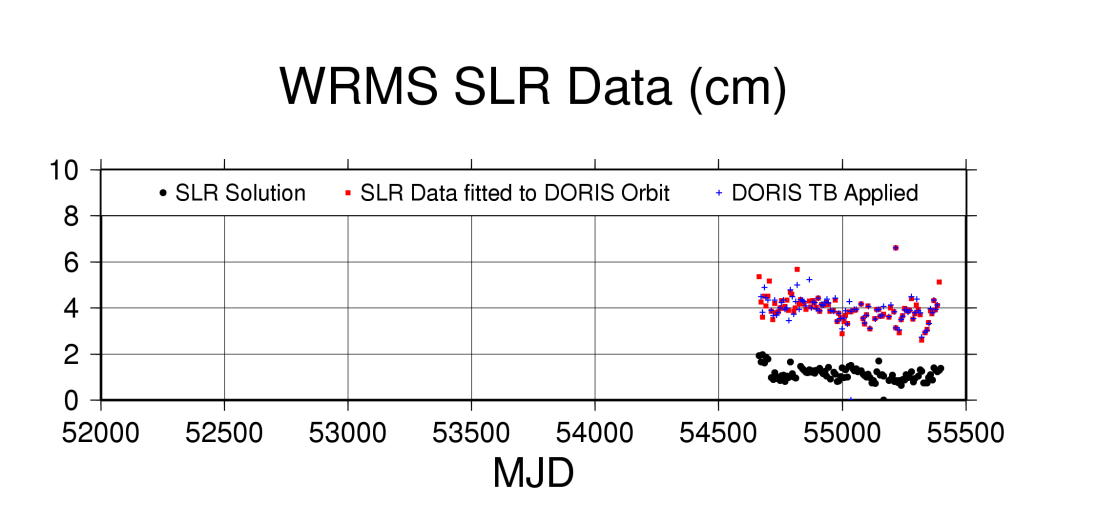



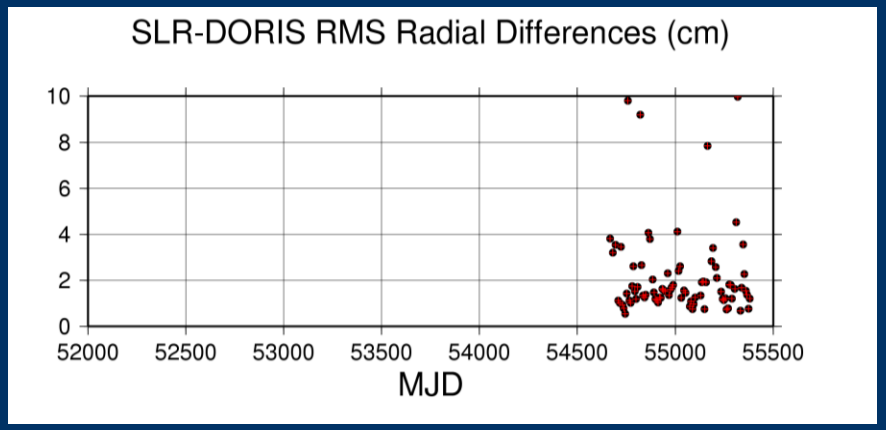
# Jason-2 – DORIS Time Bias

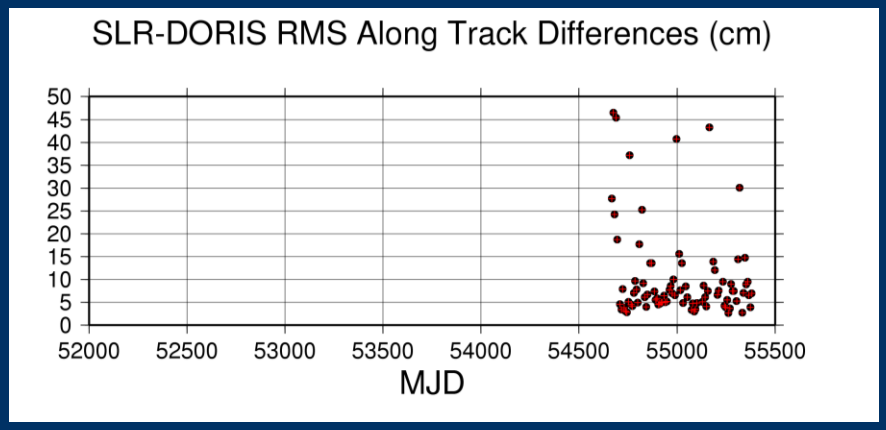


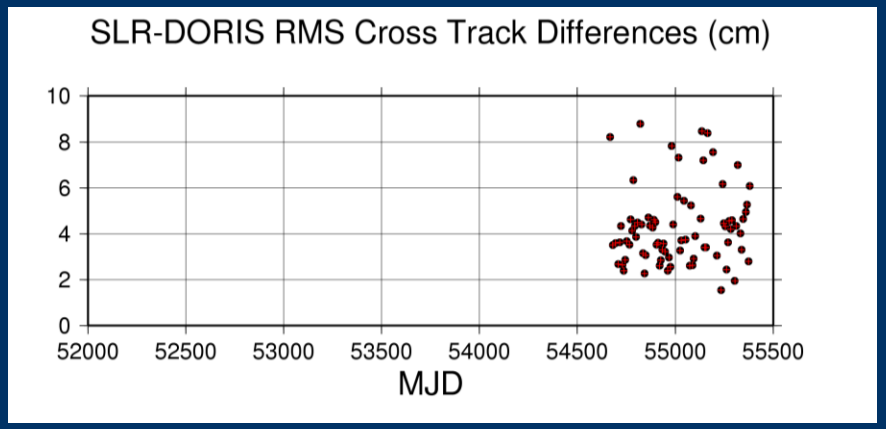
# Jason-2 Orbits – DORIS Time Bias applied

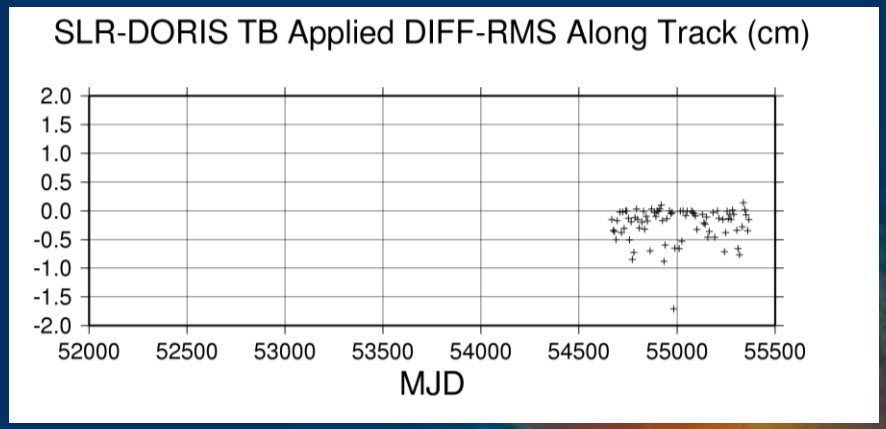


# Envisat Orbits – DORIS Time Bias applied

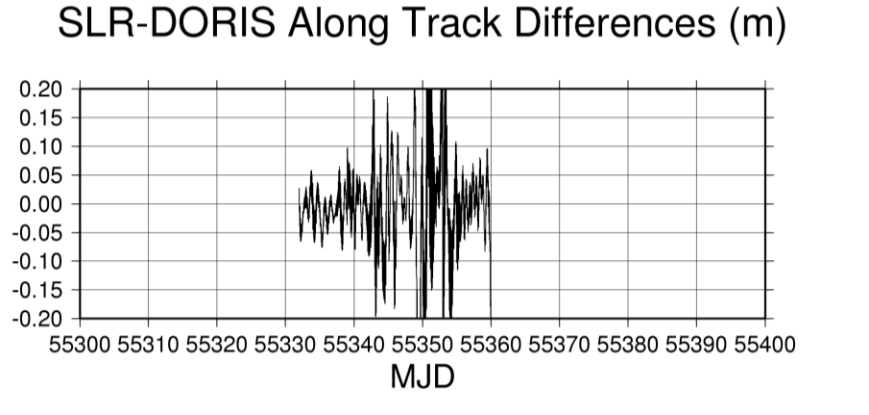


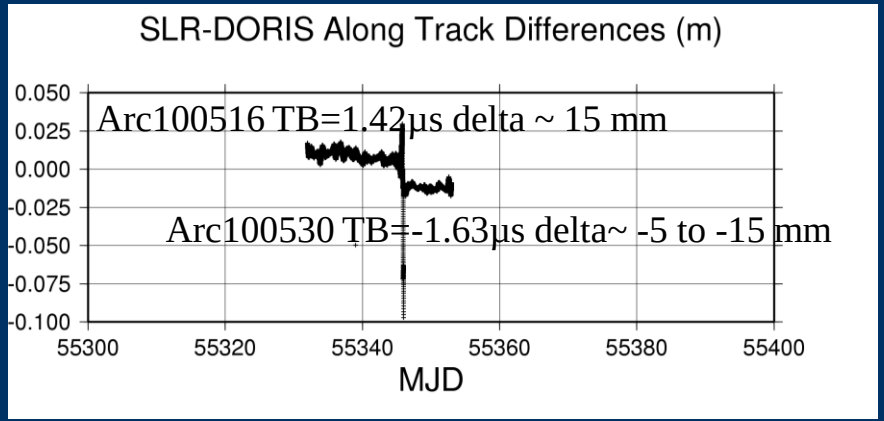



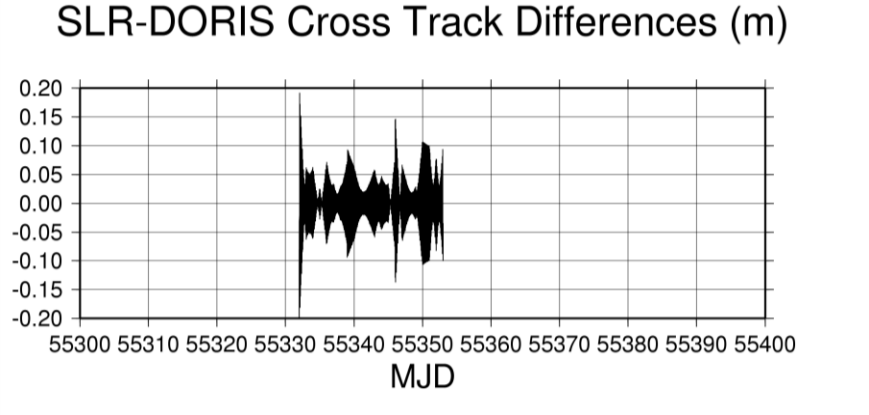



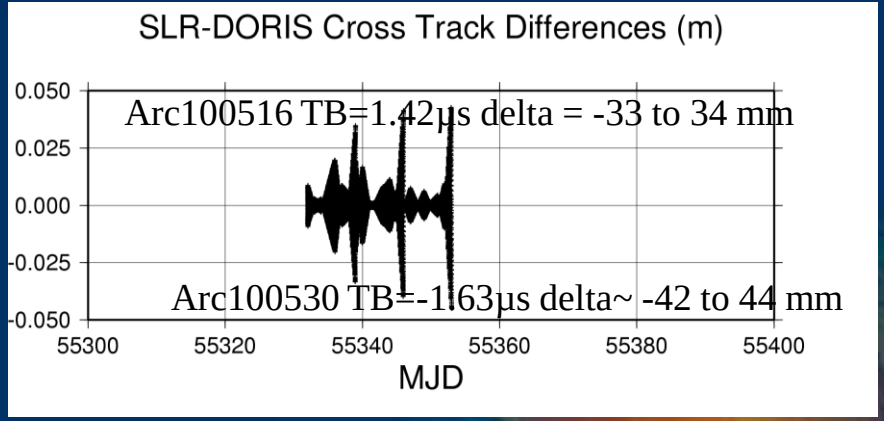



# Jason-2 Arc Differences



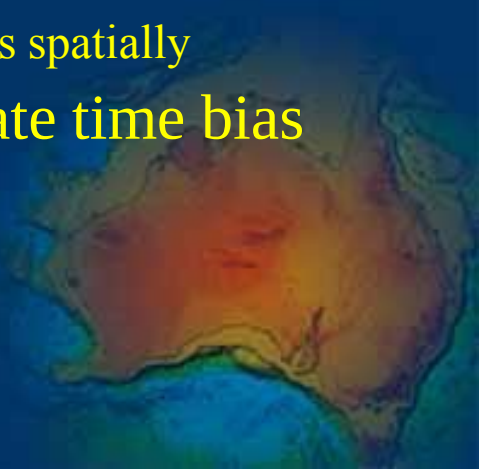
# Discussion

- The estimated time biases per 7-day arc are small at the microsecond level  results in along track orbit trajectory differences at the sub-centimetre level – significantly smaller than the actual orbit differences.

- Does this imply that the effect of DORIS time biases are inconsequential to the orbit quality?

# Discussion

- The no case:
  - 7-day estimates of time biases is too sparse and is non-representative – it respresents a long term mean
  - Require a higher resolution of time bias estimates
    - Once per revolution – which will also provide the geographical correlation in terms of the behaviour of the clocks in space – the effects of general relativity
      - Gravitational potential
      - Satellite velocity
      - Can be achieved by “overlaying” exact repeat tracks spatially
  - Requires sufficient SLR data per arc to estimate time bias (importance of SLR tracking)



# Discussion

- The yes case:
  - DORIS – SLR Network inconsistencies need to be addressed
  - CoM offsets for the DORIS antenna and SLR RRA need to be examined
  - DORIS antenna phase centre modelling
  - SLR RRA “depth” value checked