Precise orbit determination for the CryoSat-2 mission

status of CNES GDR solutions

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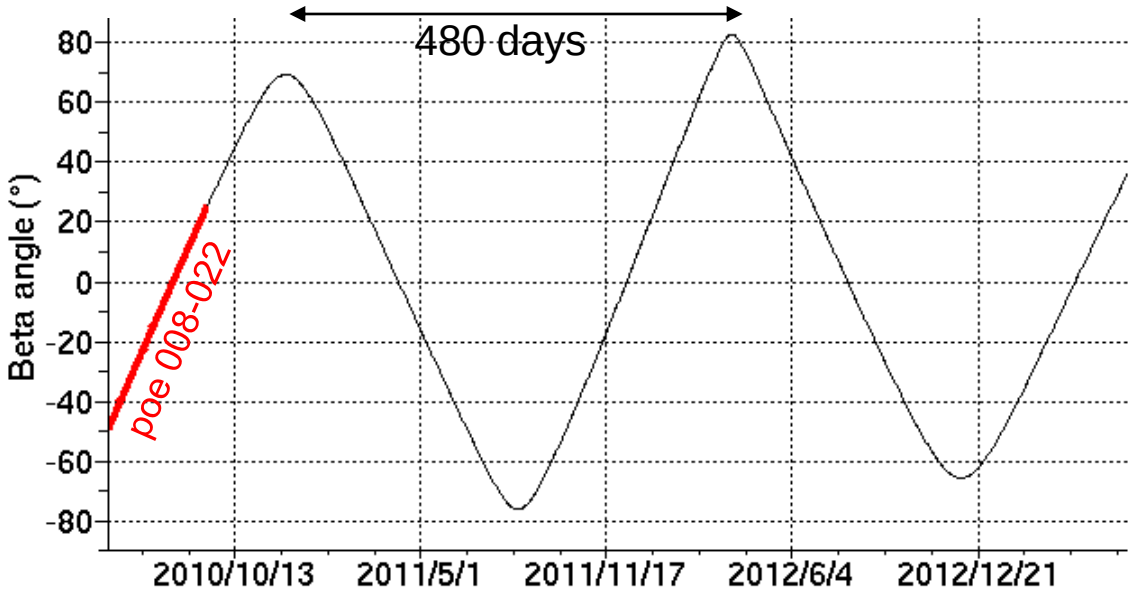
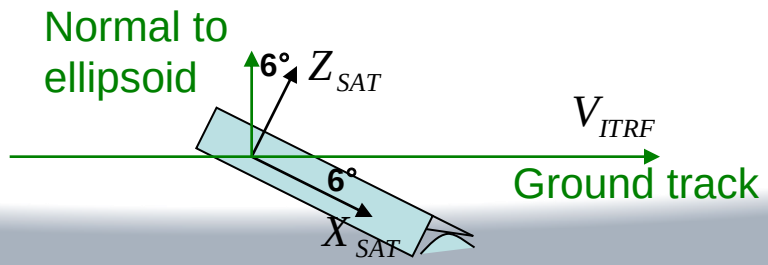
Orbit geometry and attitude law

- 92° inclination, 720 km altitude
- Beta angle has a 480-day period
- Attitude law
  - Satellite Z axis normal to ellipsoid
  - X towards V in Earth-fixed frame





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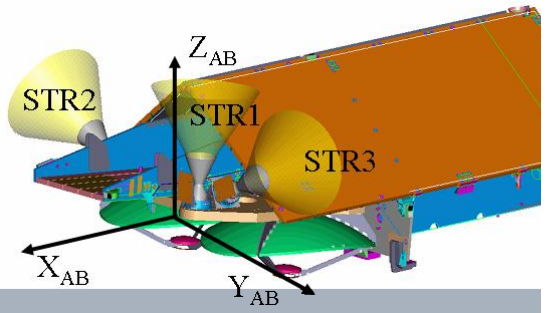
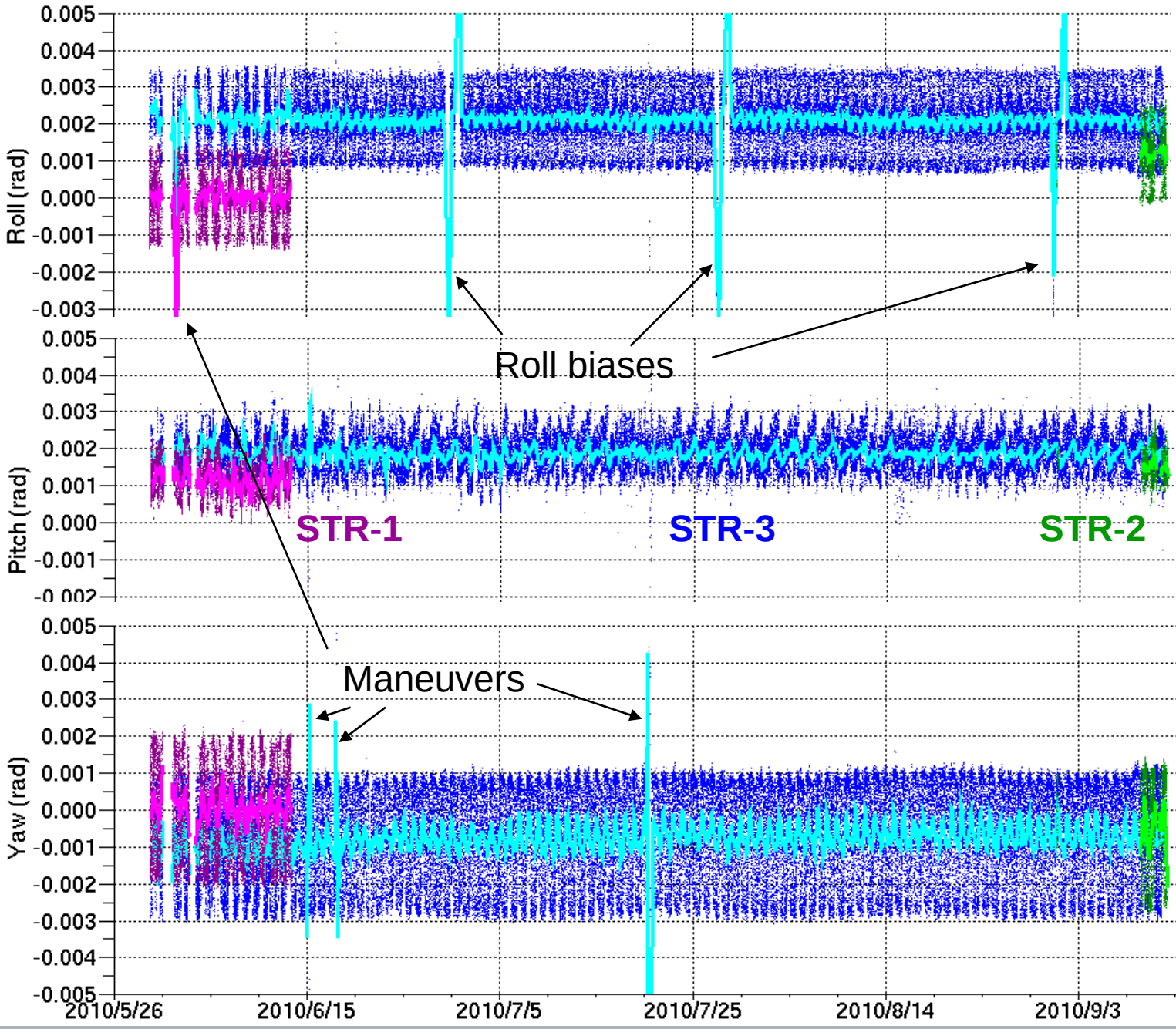
- Nominal attitude is normally consistent with STR data to within 0.2°
- Sufficient for POD purposes, but systematic errors could be further reduced



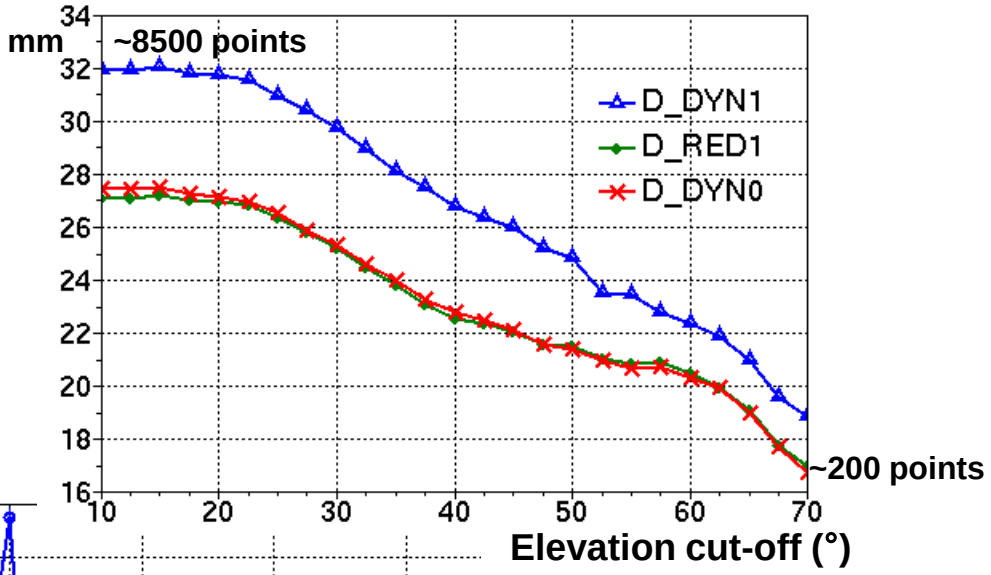


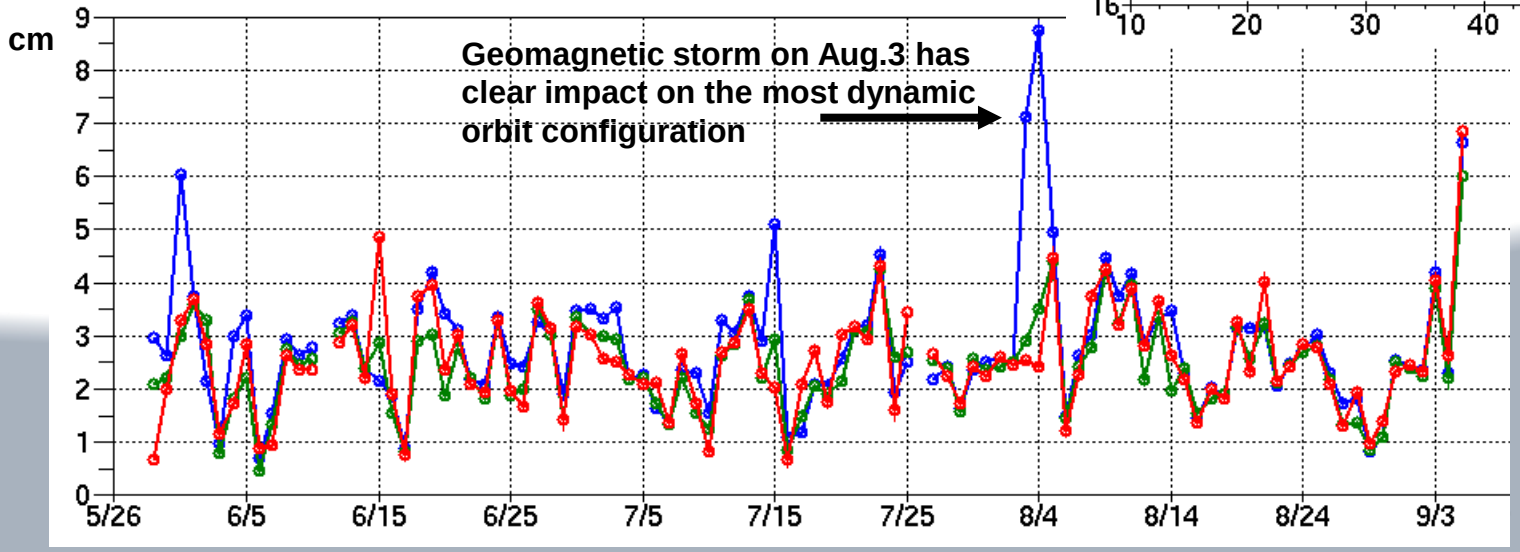
SLR Residuals on different Doris-only orbits

- **High elevation SLR residuals indicate that the doris-only orbit radial accuracy is below 2 cm**

  (similar results are obtained on Envisat Doris-only orbits)

Residuals over arcs 008-022 from YARR_L7090, WASH_L7105, MONU_L7110, GRAZ_L7839, FORT_L7080, HERS_L7840, ZIMM_L7810





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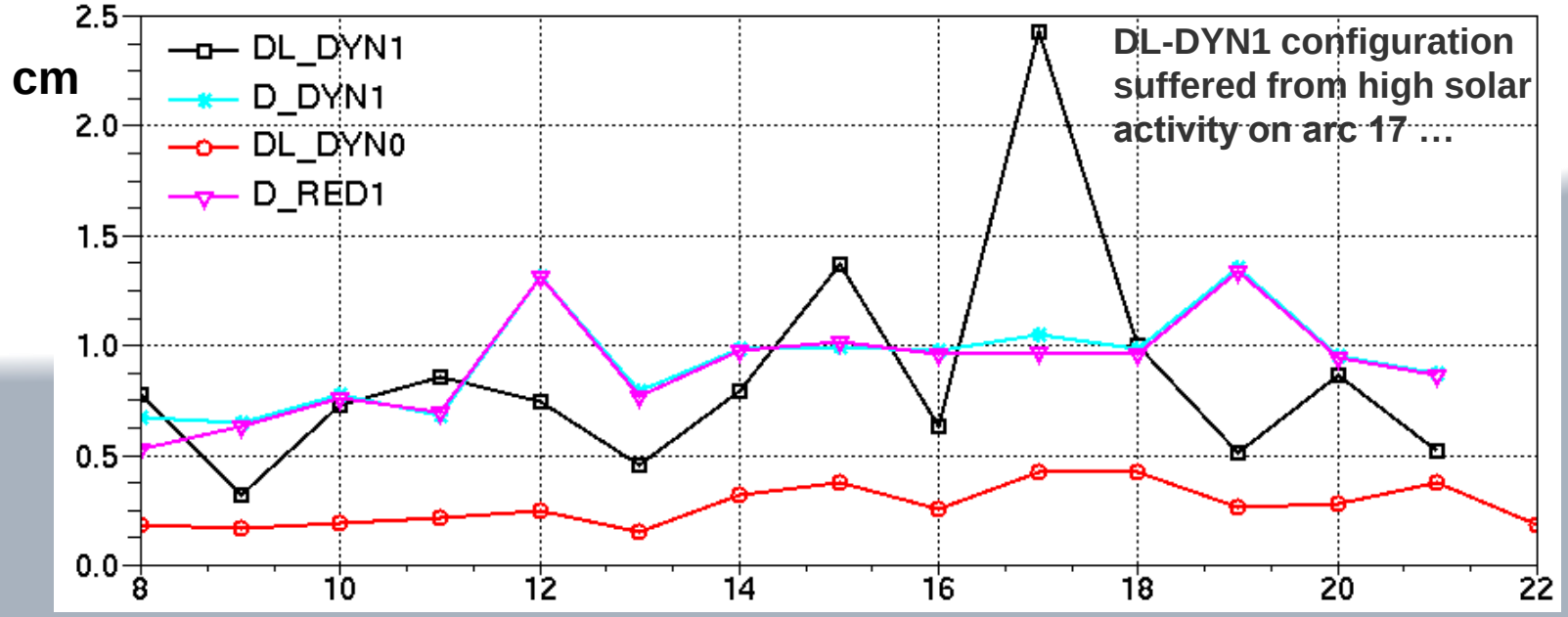
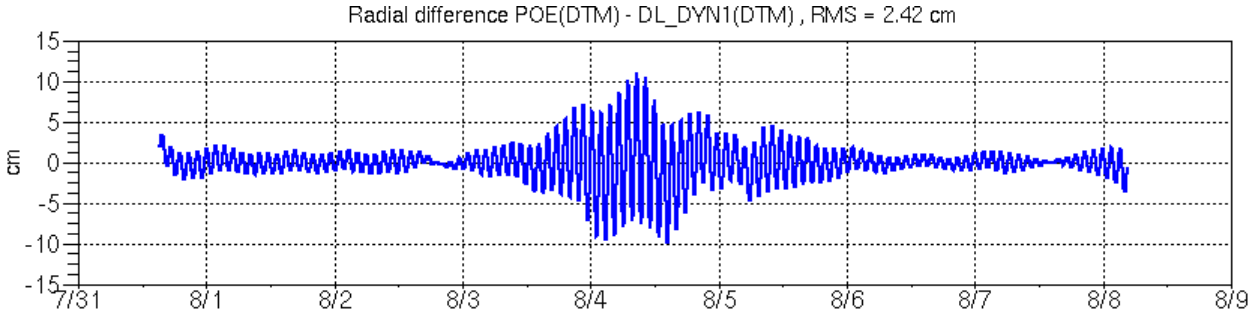
Radial comparison of different internal solutions

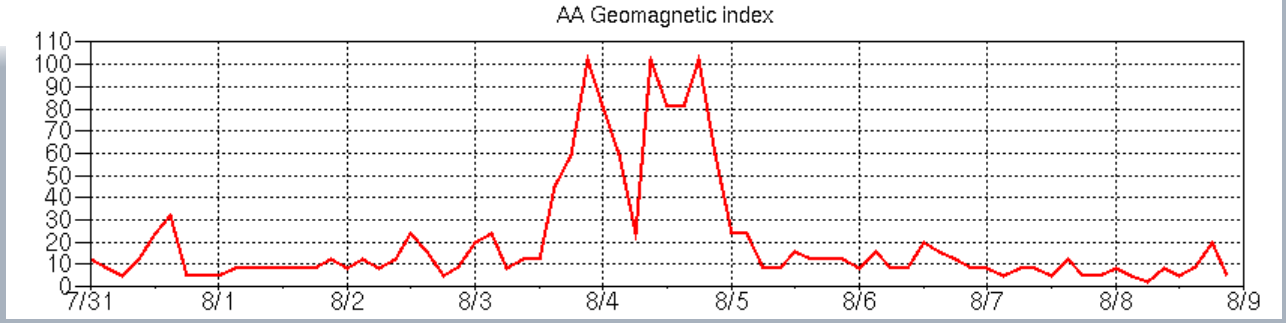
- **Comparison of different internal solutions to POE at the 1-cm level**
  - **POE: Dynamic step (1 drag every 3 revs + 1/revs every 24 hours) + stochastic constant along-track**
  - **DYN0: POE Dynamic step**
  - **DYN1: 1 constant along track every 8 hours + 1/revs every 24 hours**
  - **RED1: DYN1 + stoch. constant along track + stoch. 1/rev along track**



Impact of the atmospheric density model on arc 017



- Use of DTM94 strongly degrades the orbit with a dynamic parameterization



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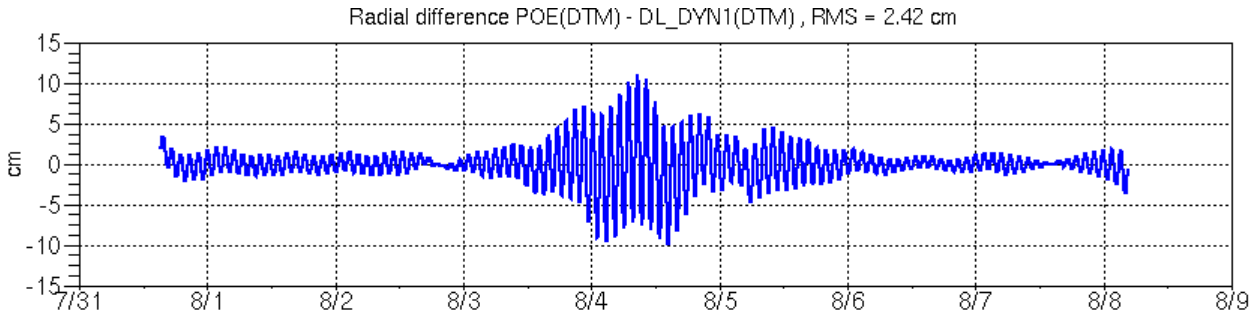

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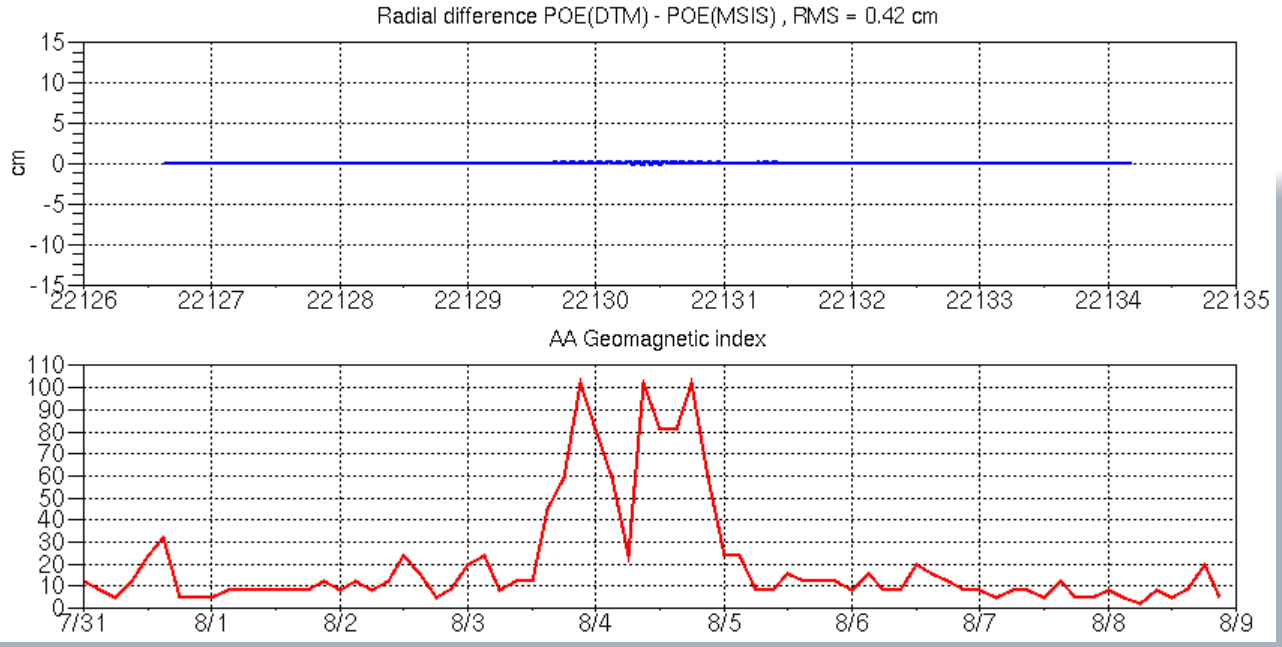
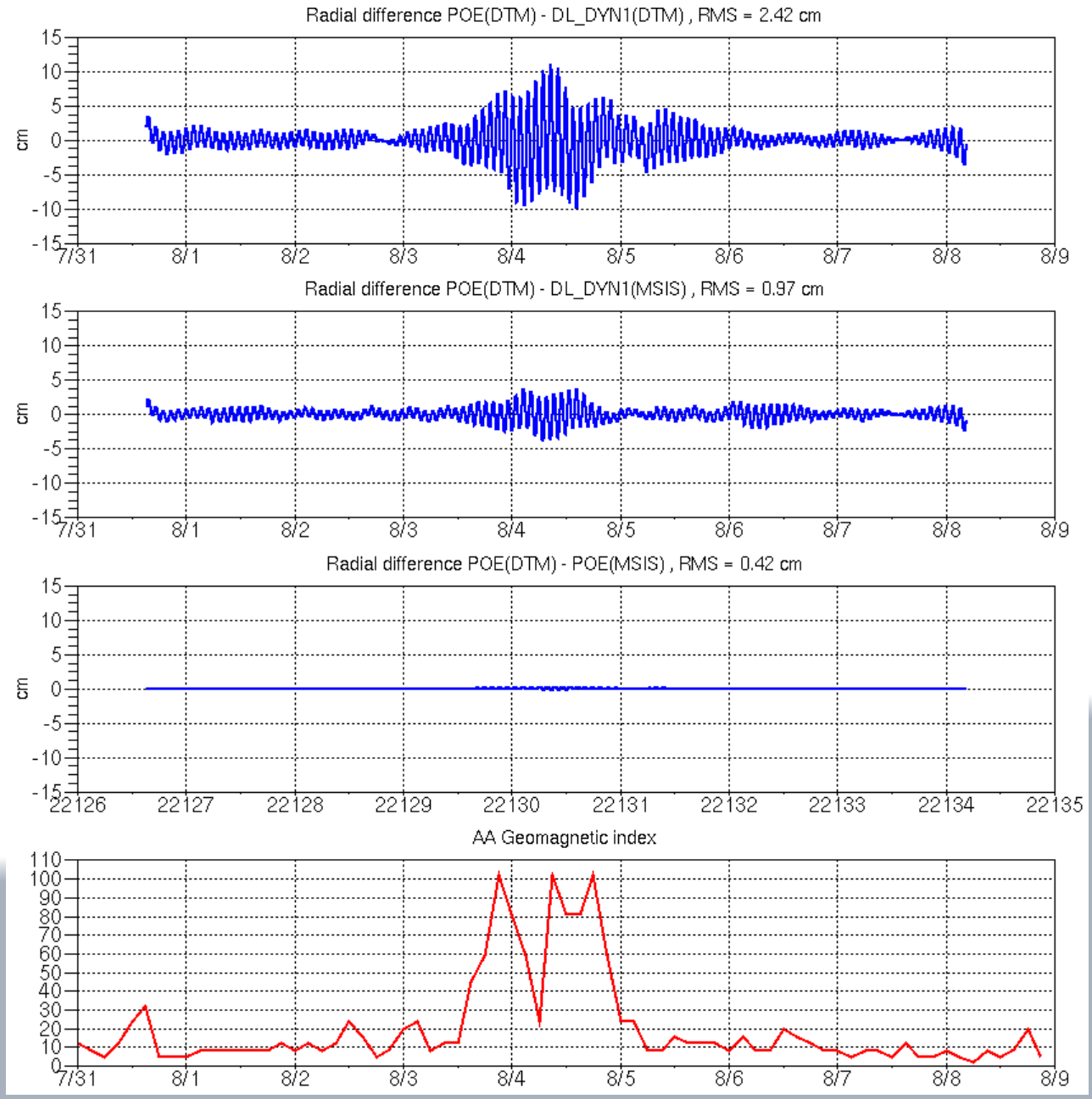


- POE parameterization is not very sensitive to atmospheric density model

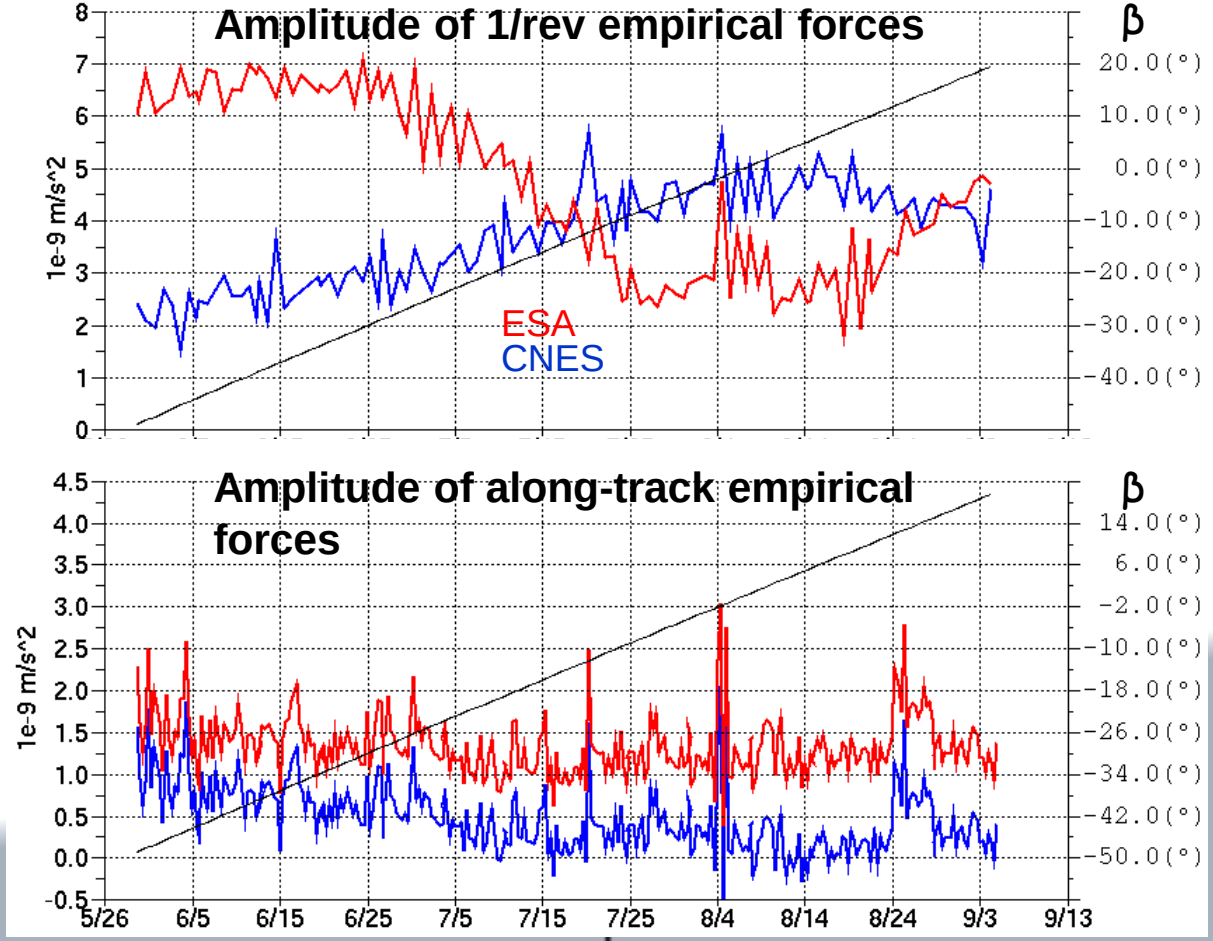
Impact of the atmospheric density model on arc 017

- Use of DTM94 strongly degrades the orbit with a dynamic parameterization
- MSIS86 allows to improve significantly the dynamic solution
- POE parameterization is not very sensitive to atmospheric density model



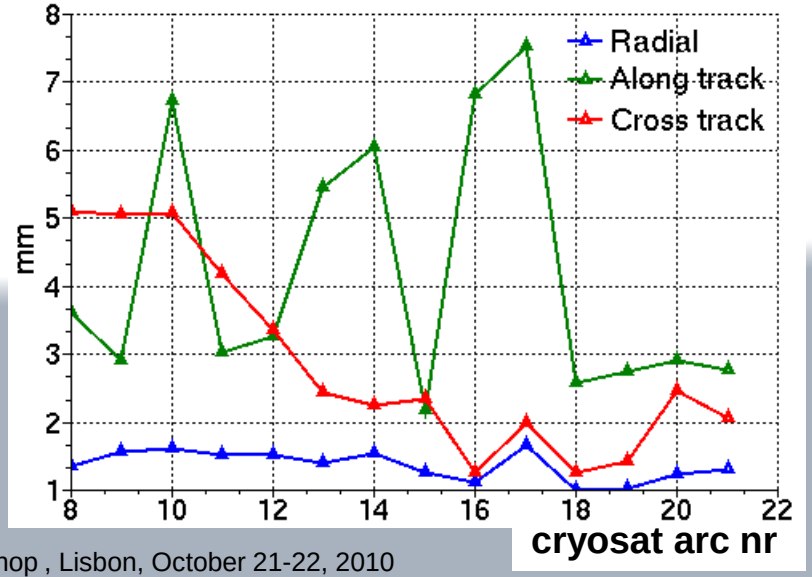
Modeling of solar radiation pressure

- GDR orbits currently use ESA provided model (6-plates)
- CNES produced an independent model (7-plates) based on satellite photographs , drawings, and typical optical properties of external surfaces



Modeling of solar radiation pressure

- Amplitude of empirical forces indicates that CNES model performs better when the sun is out of plane, and worse when the sun is in plane
- Possible explanation: a-priori optical properties used by CNES for the solar array can be improved
- Orbit differences using both models are small



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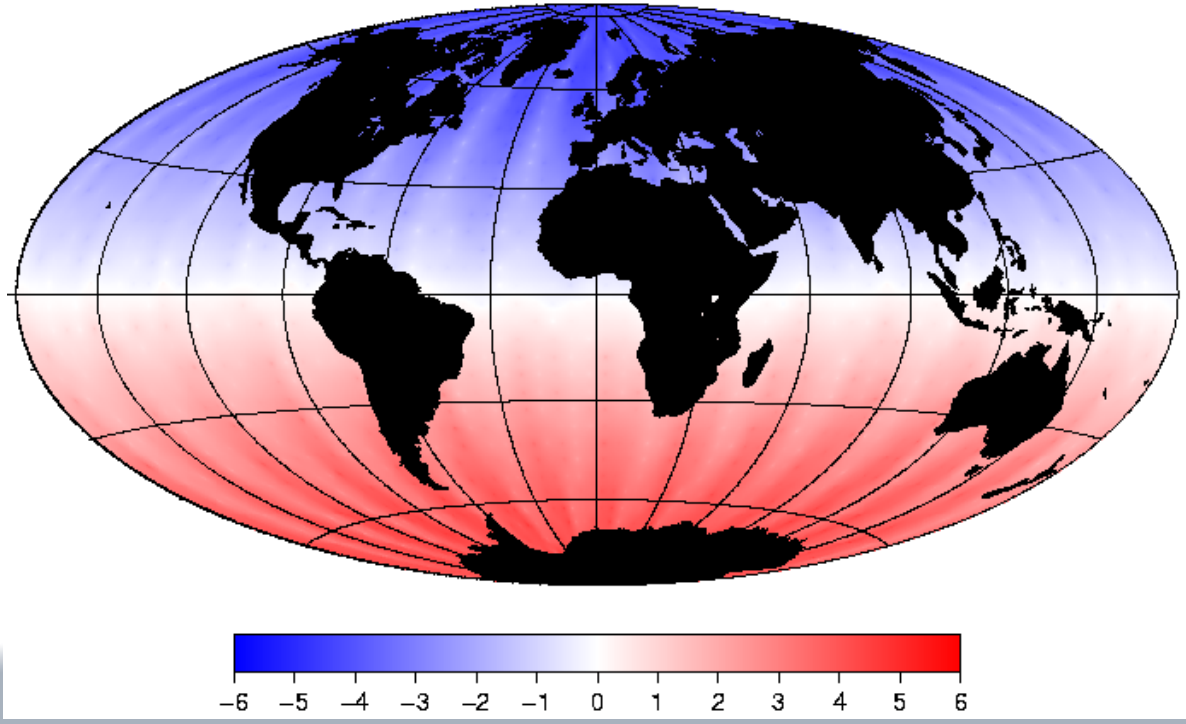
ITRF2008 test

RMS of radial difference D+L orbits
ITRF2005 – ITRF2008

Mean radial difference D+L Orbits
ITRF2005 – ITRF2008 arcs 008-022



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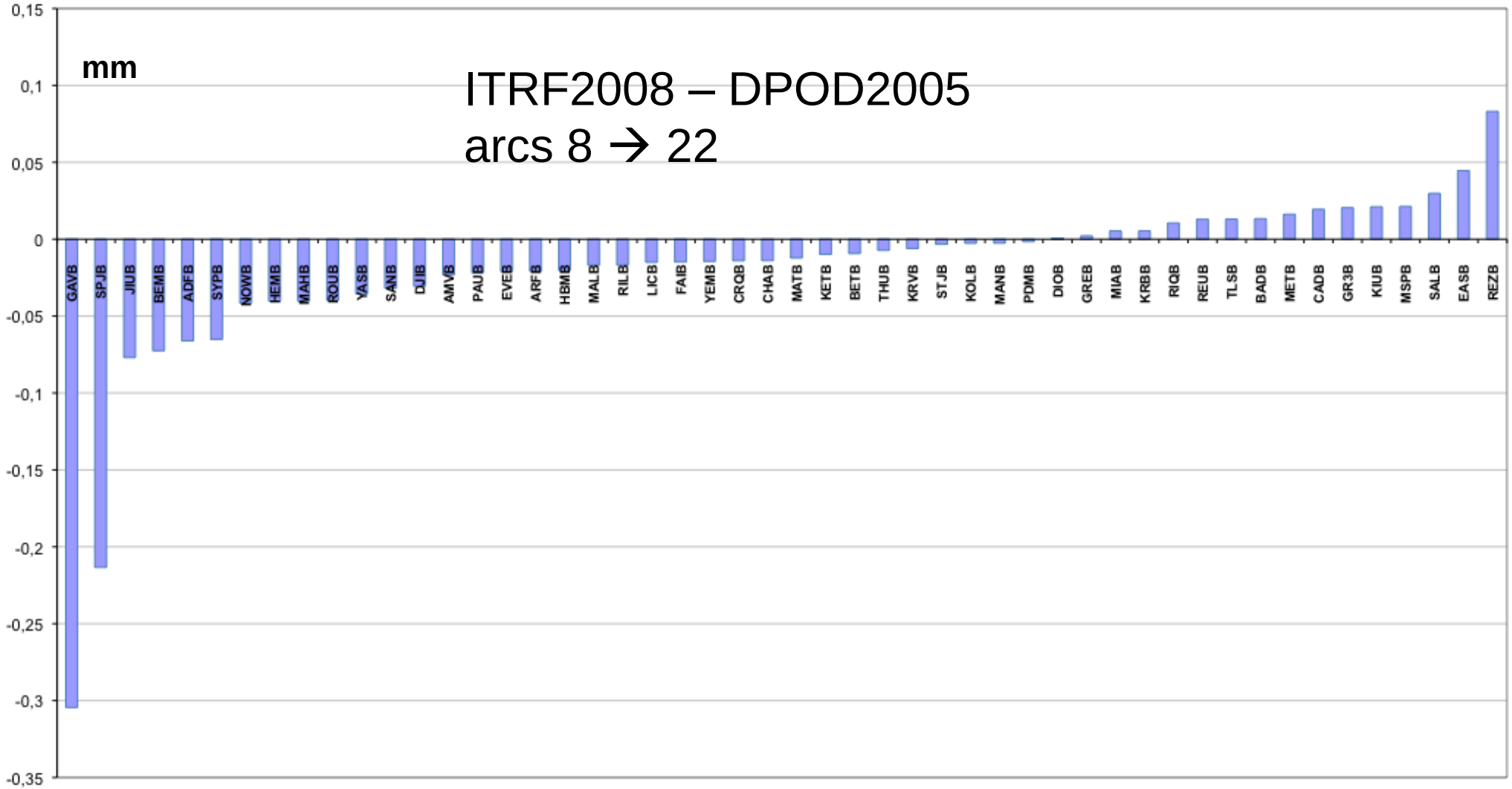
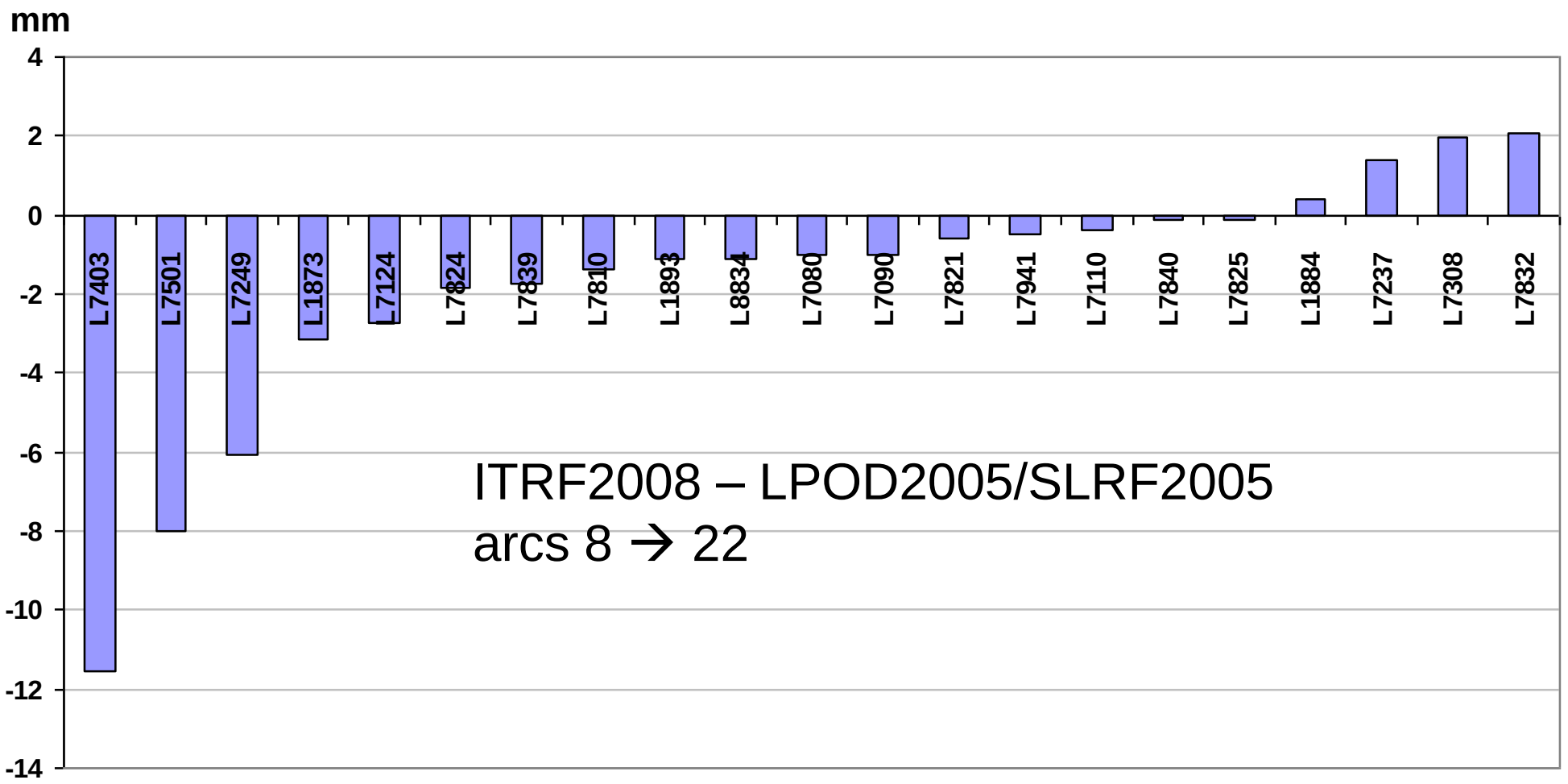
RMS of Post fit Doris residuals per station



RMS of Post fit SLR residuals per station



Conclusions

- Radial accuracy of Doris-only orbits as measured by the RMS of SLR residuals is below 2 cm, in line with what is observed on Envisat
- Agreement between D+L POE and Doris-only solutions generally below 1 cm

→ Radial accuracy of POE orbits is in the order of 2 cm

- Several modeling improvements have been tested
  - Atmospheric density model (MSIS86 to replace DTM94)
  - Solar radiation pressure (CNES macromodel should be tuned before implementation in GDR orbits)
  - ITRF2008 (Z bias + improvement in both DORIS and SLR residuals)

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