Precise orbit determination for the CryoSat-2 mission

status of CNES GDR solutions

L. Cerri(1), A. Couhert(1), S. Houry(1), F. Mercier(1)

(1) CNES, Toulouse

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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

Graph showing Beta angle over time with 480-day period.
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

Geomagnetic storm on Aug.3 has clear impact on the most dynamic orbit configuration

~8500 points

Elevation cut-off (°)
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

DL-DYN1 configuration suffered from high solar activity on arc 17 ...
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
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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.
ITRF2008 test

RMS of radial difference D+L orbits
ITRF2005 – ITRF2008

Mean radial difference D+L Orbits
ITRF2005 – ITRF2008 arcs 008-022
RMS of Post fit Doris residuals per station

ITRF2008 – DPOD2005
crs 8 → 22
RMS of Post fit SLR residuals per station

ITRF2008 – LPOD2005/SLRF2005
arcs 8 → 22
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)