ESTIMATION OF THE DORIS PHASE CENTER LOCATIONS FOR THE CURRENTLY FLYING ALTIMETER MISSIONS

Ait-Lakbir H. (CS SI), Couhert A. (CNES), Mercier F. (CNES), Moyard J. (CNES), Jalabert E. (CNES), Houry S. (CNES)

IDS Analysis Working Group, London, May 2017
Scope of the study

• Estimation of the distance between the satellite CoM and the DORIS receiver phase center

• Check the consistency between DORIS and the other tracking systems (SLR or/and GPS)

• Missions/Arcs
  • CryoSat-2, HY-2A, OSTM/Jason-2, Saral/AltiKa over 2015
  • Jason-3: 1-26
  • Sentinel-3A: 1-29
Radial and cross-track offsets
Estimation

DORIS
- Adjustment of a constant acceleration over an arc
  \[\rightarrow \text{Perturbation in displacement, from the Hill equations}\]
- DORIS-only dynamic orbits
- + empirical accelerations

GPS, SLR
- Adjusted GPS phase center or LRA reference point offsets
- GPS-only or SLR-only dynamic orbits
Radial and cross-track offsets
Effect of the low-elevation measurements

<table>
<thead>
<tr>
<th>Mean (cm)</th>
<th>Saral</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A</td>
</tr>
<tr>
<td>Radial</td>
<td>-3.3</td>
</tr>
<tr>
<td>Cross-track</td>
<td>-0.5</td>
</tr>
</tbody>
</table>

Test A: Initial processing
Test B: Processing with
  • low-elevation measurements + weighting function
  • estimation of horizontal tropospheric gradients

The estimated radial bias is sensitive to whether the low-site measurements are used or not.

→ Overestimation of 1cm for Saral
# Radial and cross-track offsets

**Effect of the SAA**

<table>
<thead>
<tr>
<th>Mean (cm)</th>
<th>Jason 2 (FY)</th>
<th>Jason 3 (FY)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A</td>
<td>B</td>
</tr>
<tr>
<td>Radial</td>
<td>-2.1</td>
<td>-1.1</td>
</tr>
<tr>
<td>Cross-track</td>
<td>-0.3</td>
<td>-0.2</td>
</tr>
</tbody>
</table>

Test A: With all DORIS stations  
Test B: With adjusted frequency drifts for the SAA stations  
Test C: Excluding SAA stations

The sensitivity to the SAA affects the estimation in radial.  
→ Gain of 1.0 cm for Jason-2  
→ Gain of 2.6 cm for Jason-3
Radial and cross-track offsets
Consistency between the tracking systems

- A - 2.5cm DORIS offset is observed
  → No effects on the radial orbit performances
  → Effects on the estimation of DORIS stations heights?
  → Effects on the reference frame scale factor?

- For HY-2A, a - 4.7cm DORIS bias is observed (→ 4.41cm).

- No GPS or SLR offset, except for HY-2A (SLR) and Sentinel3-A (GPS)
Radial and cross-track offsets
Consistency between the tracking systems

For Sentinel-3A, the 3 tracking systems observed a “large” bias
→ Errors in the solar radiation pressure model ?
→ Errors in the location of the CoM ?

No significant DORIS, SLR or GPS offsets for the other missions.
Relative along-track offsets

Estimation

• Use the other tracking systems to observe the DORIS phase center location
  • DORIS + SLR, DORIS + GPS and SLR + GPS
  • Dynamic orbits

• Adjusted parameters
  • Location of the GPS phase center
  • Location of the LRA optical center
Relative along-track offsets
Consistency between the tracking systems

- Good consistency for Cryosat, Jason-2, Saral (and HY-2A?).
- For Jason-3, DORIS and SLR are consistent but the GPS phase center seems biased (or may be due to GPS data screening).
- For Sentinel-3A, DORIS and GPS are consistent but the LRA optical center position seems biased.
Conclusion

• A DORIS phase center offset of -2.5 cm, observed radially for several missions may affect the reference frame scale factor.

• DORIS is consistent with the other tracking systems along-track.

• There is no significant cross-track offset, except for Sentinel-3A, probably due to a bias in the location of the CoM.
THANK YOU FOR YOUR ATTENTION
ADDITIONAL MATERIALS
Radial and cross-track offsets

Estimation

• Hill equations solved for a constant acceleration adjusted over an arc

\[
\delta_R(t) = -\frac{C_R}{3n^2} + \frac{2 C_T}{n} t
\]

\[
\delta_T(t) = -\frac{3C_T}{2} t^2
\]

\[
\delta_N(t) = \frac{C_N}{n^2}
\]

— Along-track unobservable

— Coupling between the radial and along-track directions

\[\rightarrow\text{Constrain } C_T\]

• Coupling between the cross-track direction and the solar radiation pressure model

\[\rightarrow\text{Empirical accelerations}\]
Effects of low-elevation measurements

Saral

![Graphs showing radial and cross-track measurements over time with and without L-E measurements.](image)
Effects of the SAA (1)
Jason-2 (Fixed-Yaw regime)
Effects of the SAA (2)
Jason-3 (Fixed-Yaw regime)

Graphs showing Radial (cm) and Cross-track (cm) adjusted offsets over the years 2016 to 2017.
Radial and cross-track offsets
DORIS phase center offsets
Relative along-track offsets

- DORIS seen by GPS
- DORIS seen by SLR

Graphs showing along-track (cm) and adjusted offsets from 2014.8 to 2017.0, with different colors representing various satellites.
Relative along-track offsets

SLR seen by GPS

Year

Along-track (cm)

Adjusted offsets

-2.5
-2.0
-1.5
-1.0
-0.5
0.0
0.5
1.0
1.5
2.0
2.5

2014.8 2015.0 2015.2 2015.4 2015.6 2015.8 2016.0 2016.2 2016.4 2016.6 2016.8 2017.0

Cryosat
Hy2a
Jason-2
Saral
Jason-3
Sentinel-3A