Status of the routine DORIS data processing

- We processed DORIS2.2 and RINEX data until end September 2018
- Serie grgwd41

ITRF2014 configuration

List of last additions:
- Introduction of Jason-3 and Sentinel-3A&B (RINEX data) in the GRG DORIS processing
- Switch to the ITRF/DPOD2014
- DORIS-only orbits processing and evaluation by SLR processing
- Strategy to mitigate the SAA impact for Jason-2 and Jason-3
  - on the orbit (adjusting of frequency Polynomial on SAA station per pass)
  - on the positioning (renaming of SAA stations)
- Remove the DORIS scale jump in 2012
  - use the new position of the HY-2A CoM given by the Chinese Project
  - make our own pre-processing when using Doris2.2 data
- We provided Sentinel3-A&B orbits to CPOD QWG until end January 2019

Preparation to the next ITRF2020

- We update the new serie grgwd41
- We now use body and solar array quaternions for Jason-2 and Jason-3 satellites
  - ...
- We processed DORIS2.2 and RINEX data from July 2017 to January 2019
## Status of POD

### POD Processing overview

*we take the IERS conventions and the IDS recommendations*

<table>
<thead>
<tr>
<th>Software</th>
<th>GINS/DYNAMO</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>DORIS data</strong></td>
<td>Rinex 3.0 phase measurement converted to DOPPLER for Jason-3 and Sentinel-3&lt;br&gt;DORIS.2.2 for others satellites</td>
</tr>
<tr>
<td><strong>Terrestrial Reference Frame</strong></td>
<td>ITRF2014 (DPOD2014)</td>
</tr>
<tr>
<td><strong>Gravity Field</strong></td>
<td>EIGEN-GRGS.RL04-MEAN-FIELD with mean slope extrapolation&lt;br&gt;C21/S21 coherent with the new linear mean pole model&lt;br&gt;Ocean tides: FES2014</td>
</tr>
<tr>
<td><strong>Displacement of reference Point</strong></td>
<td>Pole tide: solid earth pole tides and ocean pole tides (Desai, 2002), new linear mean pole model</td>
</tr>
<tr>
<td><strong>Attitude Model</strong></td>
<td>For Jason: quaternions for BUS and solar panels and/or nominal law like Topex&lt;br&gt;For Sentinel-3: nominal law like Envisat&lt;br&gt;For all other DORIS satellites: nominal law</td>
</tr>
<tr>
<td></td>
<td>Radiation pressure scale coefficient: 1 coef/day but strongly constrained to: 0.99 for Jason and 1.0 for Sentinel-3&lt;br&gt;OPR empiricals: 2 coef cos-sin/ orbital period in normal direction and 2 coef cos-sin/ orbital period in tangential direction (per arc)&lt;br&gt;Drag coefficients adjusted: 1 coef/4 hour except for Jason: 1 coef/half day</td>
</tr>
<tr>
<td><strong>SAA compensation</strong></td>
<td>Estimation of the beacon frequency Polynomial on SAA station per pass (for Jason-2 and Jason-3)</td>
</tr>
<tr>
<td><strong>Time span processing</strong></td>
<td>From July 2017 to January 2019&lt;br&gt;3.5-day arcs with a cut-off angle of 12°</td>
</tr>
</tbody>
</table>

IDS AWG April 2019
### Status of POD

#### POD Summary

DORIS RMS of fit and SLR external validation

**OPR Acceleration Amplitude** Along-track and Cross-track / Radiation pressure coefficient

<table>
<thead>
<tr>
<th>SATELLITE</th>
<th>DORIS RMS (mm/s)</th>
<th>SLR RMS (cm)</th>
<th>OPR amplitude average ((10^{-9} \text{ m/s}^2))</th>
<th>Solar radiation coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Along-track</td>
<td>Cross-track</td>
</tr>
<tr>
<td>Jason-2</td>
<td>0.328</td>
<td>1.9</td>
<td>3.2</td>
<td>2.8</td>
</tr>
<tr>
<td>Jason-3</td>
<td>0.352</td>
<td>2.0</td>
<td>0.9</td>
<td>2.3</td>
</tr>
<tr>
<td>Sentinel-3A</td>
<td>0.361</td>
<td>1.4</td>
<td>2.5</td>
<td>1.6</td>
</tr>
<tr>
<td>Sentinel-3B</td>
<td>0.378</td>
<td>1.4</td>
<td>1.5</td>
<td>1.9</td>
</tr>
<tr>
<td>Cryosat-2</td>
<td>0.347</td>
<td>1.5</td>
<td>2.6</td>
<td>2.4</td>
</tr>
<tr>
<td>HY-2A</td>
<td>0.338</td>
<td>1.8</td>
<td>0.6</td>
<td>2.5</td>
</tr>
<tr>
<td>Saral</td>
<td>0.330</td>
<td>1.4</td>
<td>1.4</td>
<td>2.0</td>
</tr>
</tbody>
</table>

- For the two directions, Along-track and Cross-track, the mean amplitudes are lower than \(4 \times 10^{-9} \text{ m/s}^2\), reflecting a satisfying level in the modeling of the satellite macromodels and the attitude law.
- The DORIS-only orbits have also been evaluated by an independent SLR measurements processing. SLR residuals on DORIS-only orbits are of a good level.
Status of POD for Jason-2 and Jason-3 satellites

- For Jason-3, the level of DORIS RMS residuals is slightly higher compared to Jason-2, explained by its higher sensitivity to the SAA.
- There is a ~59 days periodic signal for both satellites, even when we use quaternions for attitude satellite.
Status of POD for Jason-2 and Jason-3 satellites

- Comparison to CNES POD team (GDR-E) and JPL orbits
  - Independent SLR RMS of fit

Jason-2

Jason-3

- The level is comparable to the other orbits evaluated, precise orbit DORIS+GPS of CNES POD team, GPS-only orbit of JPL (for Jason-3).
There is a good agreement between our orbits and the others but there is a tangential bias ~1 cm which could be explained by a difference in the time tagging of the DORIS and GPS measurements. This bias is present for all GPS orbit comparisons. There is also a signal at ~59 days in the average of the radial component, still present even when we use measured quaternions BUS + solar panels angles.
Status of POD for Jason-3 satellites

- Radial Orbit differences (geographically correlated errors, 2° by 2° grids)
- Jason-3 orbits (from July 2017 to January 2019)

- Impact of new gravity field and new Ocean tide models
- The agreement is better between GRG orbit and CNES POD team orbit than JPL orbit.
Status of POD for Jason-2 and Jason-3 satellites

- Sea Surface Height differences at crossover per cycle
  (from July 2017 to January 2019)

- For Jason-2, the STD and RMS of the SSH differences are at the same level for the CNES POD team orbit and GRG orbit. For Jason-3, the statistical results are also very similar to the external orbits (from CNES POD team and JPL)
The GRG DORIS-only orbit calculated with GINS is at the same level for radial component. The other orbits are all determined from GPS measurements.
Impact on the positioning

Multi-satellite satellite Solution compared to DPOD2014 (computed by CATREF)

Differences between the solution with OLD and NEW configuration

(In red NEW multi-satellite solution)
CONCLUSIONS AND PERSPECTIVES

- For Jason and Sentinel satellites, there is a good agreement between the GRG orbits and other orbits (DORIS+GPS from CNES POD team and GPS-only orbits from JPL and CPOD).
- For Jason satellites, there is a ~59 days periodic signal visible in DORIS RMS and in the radial differences with other orbits for both satellites, even when we use quaternions.

- We plan to make a reduced dynamic orbit for Jason-3 satellite.
- We will continue our preparation to the next ITRF: implementation and tests of models recommended by IERS and IDS as HF EOP model, …

- Improvement of the GRG IDS AC solution
  - Analyze Geocenter and Scale factor from single satellite solutions (in progress)
  - Estimation of the distance between the satellite CoG and DORIS CoP (done for Sentinel satellites and Envisat).
  - Same analysis to be done for the other DORIS satellites
  - GRG orbits evaluation by orbit comparison and by external validations as SLR measurements processing as well as through the use of altimeter crossovers.