Status of the **Sentinel-3 DORIS** processing at the **Copernicus POD Service**

IDS AWG meeting  
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PosiTIm UG
Overview of Copernicus POD Service

- **Payload Data Ground Segment (PDGS):**
  - Processing the scientific data
  - Provider of GPS and attitude data to the CPOD Service
  - User of the orbits and platform files from the CPOD Service

- **Sentinels Flight Operations Segment (FOS):**
  - Orbits, manoeuvre and satellite mass evolution
  - ESOC for S1 and S2; EUMETSAT for S3

- **Centre National d’Études Spatiales (CNES):**
  - S-3 orbital and attitude products, DORIS data

- **ILRS - SLR data provider:**
  - International Laser Ranging Service – ILRS- centres

- **External Validation:**
  - AIUB, CNES, DLR, ESOC, TU Delft, TUM, EUM, CLS, (JPL)
  - provision of independent orbital products

- **External GNSS data Provider (EGP):**
  - VERIPOS; provider of high accurate GPS orbits and clocks products
  - *magicGNSS:* in-house back-up GPS provider

- **External Auxiliary providers:**
  - Atmospheric gravity models, EOPS and leap seconds, etc.

- **CPOD Quality Working Group (CPOD QWG):**
  - Monitoring the quality of CPOD products
  - Definition of enhancements (algorithms, standards, etc.)
General information (1)

- The Sentinel-3 orbits delivered to the PDGS (Payload Data Ground Segment) from the Copernicus POD Service are all GPS-only derived solutions.
- S-3A & S-3B **DORIS-only** and GPS+DORIS orbit solutions are routinely generated but not routinely checked/controlled.
- Most results shown in this presentation are from a post-processing at PosiTim.

Unfortunately, only few progress has been made since IDS Workshop last year:
  - BUT: a small bug in the ionosphere correction has been found, which had quite a large impact on the orbits.
  - Inconsistencies between ocean tide model (EOT11a) and ocean loading (FES2004) removed.

- For S-3A the ARPs are adopted to CNES POE-F standards for all three observation techniques (GPS, DORIS, SLR).
- First tests with EIGEN-GRGS RL04 gravity field model and GFZ AOD Level 1B products.
The key data of the DORIS processing are:

- DORIS Doppler observations (converted from the phase available in the DORIS RINEX)
- Three-day arc length (72 hours)
- Estimation of
  - 1 radiation pressure coefficient
  - 10/24h atmospheric drag scale factors
  - 2/24h sets of CPR along-track sine+cosine and cross-track sine+cosine parameters
- Elevation cut-off angle of 10° for DORIS observations, no elevation-dependent weighting

- Comparisons to other solutions:
  - GRGS/CLS orbits
  - Combined QWG orbits (weighted average of several orbit solutions)
  - Operational CPOD GPS orbits
  - CNES DORIS-only orbits
S-3A DORIS orbits: Comparisons

Daily mean offsets (m) between S-3A DORIS orbits and CLS/GRGS orbits (left) and QWG combined orbits (right)

- Small radial offset between CLS/GRGS and CPOD DORIS orbits, variable along-track offsets, significant cross-track offsets
Daily mean offsets (m) between S-3A DORIS orbits and CLS/GRGS orbits (left) and QWG combined orbits (right)

- Cross-track offsets could significantly be reduced
Daily radial and 3D RMS (cm) of S-3A DORIS orbits w.r.t different orbit solutions

- All comparisons are similar
S-3A DORIS orbits: Comparisons

Daily radial and 3D RMS (cm) of S-3A DORIS orbits w.r.t different orbit solutions

- All comparisons are similar
- Radial and 3D RMS are significantly reduced
S-3A DORIS orbits with updated ARPs: Comparisons

Daily radial and 3D RMS (cm) of S-3A DORIS orbits w.r.t different orbit solutions

- Updated ARPs for DORIS
- Consistent ocean tide model and ocean loading values

=> No changes in the comparisons, results are equivalent to before
Daily radial and 3D RMS (cm) of S-3B DORIS orbits w.r.t different orbit solutions

- Comparisons are equivalent to the results from S-3A
S-3A & S-3B DORIS orbits in RSR comparisons

- Regular Service Review (RSR) comparisons within the Copernicus POD Service
- Comparisons of all available orbit solutions to combined orbit (weighted average from all orbit solutions, except CPOD DORIS)
- CPOD DORIS orbits are slightly worse than other DORIS-only GRGS/CLS orbits
### S-3A & S-3B DORIS orbits in RSR comparisons

#### Comparison to QWG combined orbit

<table>
<thead>
<tr>
<th>Radial RMS (cm)</th>
<th>Radial RMS (cm)</th>
<th>3D RMS (cm)</th>
<th>Radial RMS (cm)</th>
<th>3D RMS (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Year 2018</td>
<td>CPOD DORIS</td>
<td>CLS/GRGS</td>
<td>Year 2018</td>
<td>CPOD DORIS</td>
</tr>
<tr>
<td>----------------</td>
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</tr>
<tr>
<td>S-3A</td>
<td>0.71</td>
<td>0.71</td>
<td>0.72</td>
<td>0.62</td>
</tr>
<tr>
<td>S-3B</td>
<td>0.67</td>
<td>-</td>
<td>0.70</td>
<td>0.66</td>
</tr>
<tr>
<td>S-3A</td>
<td>3.54</td>
<td>2.75</td>
<td>2.87</td>
<td>2.74</td>
</tr>
<tr>
<td>S-3B</td>
<td>3.55</td>
<td>-</td>
<td>2.99</td>
<td>3.03</td>
</tr>
</tbody>
</table>

- Radial component is very similar to CLS/GRGS
- In 3D the CPOD DORIS orbits are still inferior, but we are working on it …
**S-3A & S-3B DORIS orbits: SLR validation**

- Nine SLR stations: 7090, 7105, 7119, 7501, 7839, 7840, 7841, 7941, 8834

<table>
<thead>
<tr>
<th></th>
<th>Mean (cm)</th>
<th>RMS (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>S-3A</td>
<td>0.71</td>
<td>2.14</td>
</tr>
<tr>
<td>S-3B</td>
<td>0.40</td>
<td>2.19</td>
</tr>
</tbody>
</table>

- Second listed solutions are obtained with
  - updated gravity field model (EIGEN.GRGS RL03 => RL04)
  - GFZ AOD L1B instead of atmosphere gravity products from massloading.net

- SLR observations above 70° are only 2.3 % (S-3A) and 2.2 % (S-3B) of the available observations!!
Summary

• S-3A & S-3B POD based on DORIS observations is set up at the Copernicus POD Service and runs automatically in parallel to the operational POD processing

• Recent small software corrections and consistency updates in the processing led to improved orbit quality

• The results from S-3A & S-3B are equivalent

• Background model updates are ongoing (for all CPOD processing chains)

Some future work:
• Inclusion into RSR comparisons to better monitor the performance
• Detailed look at “problematic” days
• ...
Thank you for your attention!

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