Possible improvement for the Sentinel-3A NRT POD towards the end of the interval

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Introduction

The Sentinel-3 Precise Orbit Determination (POD) Instrument Processing Facility (IPF) computes the GPS-based Near Real Time (NRT) precise orbit (ROE), that will be used for the NRT Altimetry processing in the S-3 PDGS operated by EUMETSAT. The system has been developed as part of the Copernicus POD service by GMV S.A. from Spain and uses precise GPS orbits and clocks provided by Veripos.

The NRT products have an accuracy requirement of 10 cm (8 cm goal) in the radial direction and shall be generated 30 minutes after level0 availability at the processor. The system is by far outperforming the requirement providing typically a radial accuracy below the 2cm.

Currently, the GPS data is downloaded (together with all the science data) at the beginning of each pass. This may be the reason of the degradation observed in last part of the orbit (Fig 1. & Fig 2.), in an area with high interest for European users.

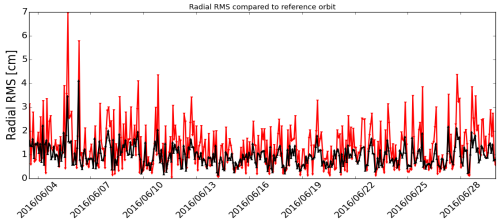

Fig 1. Radial RMS difference per orbit between the operational product from the Marine Centre at EUMETSAT (ROE) and the Non Time Critical (NTC) orbits published by GMV. Black line has been calculated comparing the complete orbit, whereas for the red line, only the last 15 minutes of the orbit have been used. This clearly shows that the last part of the orbit is worse than the average orbit.

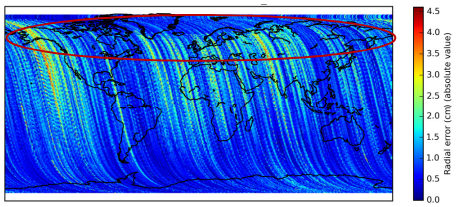

Fig 2. Projection of the radial comparison between the ROE orbits and the NTC orbits in a map. In order to clearly show the effect in the last part of the processing arc, only ascending passes are shown. The degradation at the end of the pass is also observable here.

The purpose of this poster is to analyze if it is possible to improve the accuracy of the orbit in the north hemisphere by downloading GPS data at the end of the pass, adding extra measurements at the end of the Precise Orbit Determination process.

Experimentational Set-up

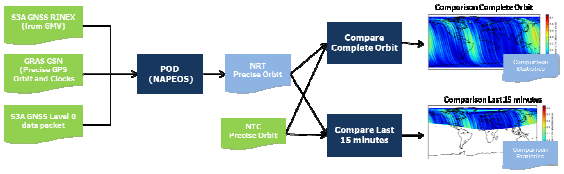

Fig 3. Simulation of the NRT process. Rinex files downloaded from GMV and precise GPS products from GRAS GSN are used. GRAS GSN is a service provided by ESA's European Space Operations Centre (ESOC) for supporting the Radio-occultation mission for EPS/Metop similar to the service provided by Veripos for Sentinel-3.

A 24 hours POD is run (similar to the operational IPF), with the end of the determination arc set relative to the end of the L0 data (which is approximately the beginning of the pass) and depends on the extra GPS downloaded data to be simulated (see Fig 4). This "delay" represents how much later would the GPS data be downloaded. The obtained orbits are compared with the NTC orbits, obtaining two different statistics, one referring to the complete orbit and another taking into account only the last 15 minutes of the orbit, where the improvement should be expected.

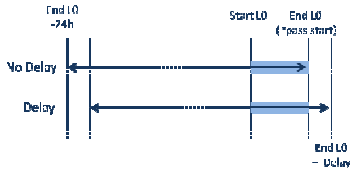

Fig 4. Simulation of the delay in the GPS data dump

Results

The figure below shows the radial RMS per orbit, when comparing the last 15 minutes of the orbit against the NTC solution for different simulated delays. In this plot, no clear improvement is observed when simulating few minutes (up to 15 minutes) delays. These delays simulate the dump of the GPS data at the end of a pass. An extreme case, would be if the orbit is computed on the next pass (similar to what is done for JASON-2 by JPL for the GPS-OGDR products), having data for one complete orbit. This case is shown with the blue line, showing that, if this was the case, the improvement would be significant.
Same effect is seen in the table, showing the average or the radial RMS for the complete period. The value of the same comparison for the operational products (ROE_MAR) is also shown for completeness.

Solution	Mean (cm)
Simulated NRT	1.70
Simulated 7 min delay	1.55
Simulated 10 min delay	1.59
Simulated 15 min delay	1.60
Simulated 1 orbit delay	0.89
ROE_MAR (Operational)	1.37

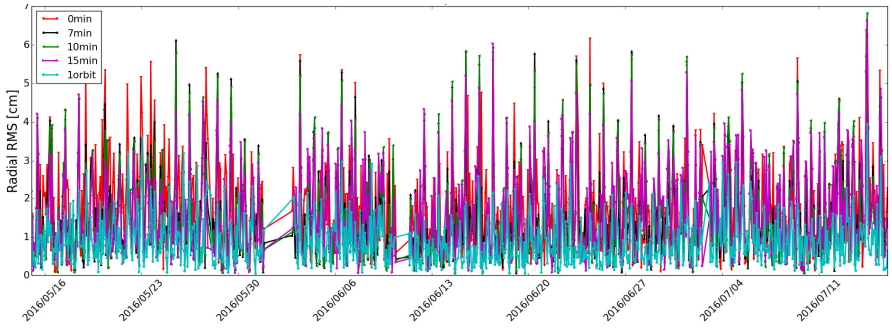

Fig 5. Radial accuracy (wrt NTC orbit) of the orbits obtained simulating different delays. Only last 15 minutes of the orbit are compared.

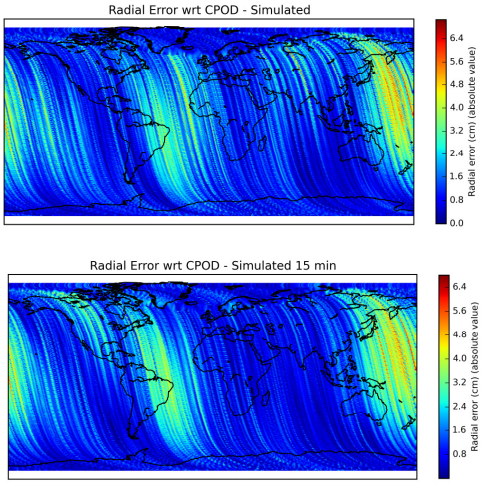

Fig 6. Projection of the radial comparison obtained in the simulations without delay (above) or with 15 minutes delay (below) vs. NTC orbit. Improvement is seen in some areas of the northern hemisphere

Conclusions

- A testing environment has been set up which is able to simulate the behavior of the NRT IPF, although the accuracy of the products is not yet at the same level as the ROE.
- Using this scenario, the usage of extra GPS data at the end of the processing arc has been simulated, obtaining marginal improvement when adding data. This improvement is smaller than expected and is only observed in some geographical areas. The reason of these geographical differences is still to be understood.
- The improvement observed does not justify a change in the operational set up.

Future Work

- Improve the used models in order to achieve the same accuracy as the IPF.
- Analyze the evolution of the radial error with respect to the time till the end of pass.
- Analyze a longer period of data, in order to discard possible seasonal effects.
- Use the operational precise products from Veripos instead of GRAS GSN.
- Once the IPF is made available to the POD group at EUMETSAT, repeat this analysis using the IPF software.

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