JASON-2 GPS BASED OGDR PRODUCTS

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Introduction

EUMETSAT is responsible for processing, jointly with NOAA, the Operational Geophysical Data Records (OGDR) of the OSTM/Jason-2 mission and distributing them in Near Real Time (NRT) to European users. The OGDR is the fastest product delivered to the users, with a short delay of 3 to 5 hours, and currently achieving a radial orbit accuracy of 3 cm RMS. The product takes advantage of the precise orbit computed on board by the DORIS navigator DIODE (DORIS Immediate Orbit on-board Determination).

OSTM/Jason-2 product family

	OGDR	IGDR	GDR
Timeliness	3 hours	1 to 1.5 days	40 days
Orbit	DORIS Navigator	Preliminary MOE (DORIS + Laser)	Precise POE (DORIS + Laser + GPS)
RMS Orbit (Radial)	10 cm – Required 3.0 cm – Actual	2.5 cm – Required 1.5 cm – Actual	1.5 cm – Required 1.0 cm – Actual

EUMETSAT has started generating experimentally 'GPS based' OGDR products, which make use of the GNSS Receiver for Atmospheric Sounding Ground Support Network (GRAS GSN) data and the GPSP data from the OSTM/Jason-2, to compute a GPS-based orbit in NRT. This allows a NRT monitoring and validation of the OGDR orbit computed on-board by the DIODE. The product is derived by adding two fields to the official OGDR (GPS orbit altitude and GPS-based sea surface height anomaly) in a similar way to the JPL produced GPS OGDR products [1]. These NRT products are monitored using the NRTAVS (Near Real Time Altimeter Validation System) [2].

The **GRAS GSN** is a system operated by ESA´s European Space Operation Centre (ESOC) to deliver supporting data to EUMETSAT for the processing of the GRAS instrument data and for METOP precise orbit determination (POD) [3], operationally. The system is subjected to very stringent requirements in terms of availability (99% asymptotic availability), reliability (6 hours maximal interruption, less than 3 interruptions of service per 30 days period) and accuracy (1m for position and 1ns for clock bias, both 2-sigma). The relevant auxiliary data for Low Earth Orbit (LEO) POD include:

- NRT GPS estimated orbits, including 36h of prediction; update frequency of1 hour
- NRT GPS estimated clock corrections at 0.2Hz; update frequency of 15min and available 45 min. after sensing time
- NRT Earth Orientation parameters

Fig. 1 Primary GSN stations (courtesy of ESA/ESOC)

Jason-2 NRT POD System

In the frame of the precise ephemerides computation of GRAS, and taking into account the importance of POD for LEO satellites in future meteorological and climate monitoring missions where EUMETSAT will be involved (such as Sentinel-3), EUMETSAT has designed a POD environment in which several components for validation, monitoring, reprocessing and calibration are centralized. The EUMETSAT POD environment has been instantiated for the Jason-2 NRT POD case and its architecture is depicted in Fig. 2.

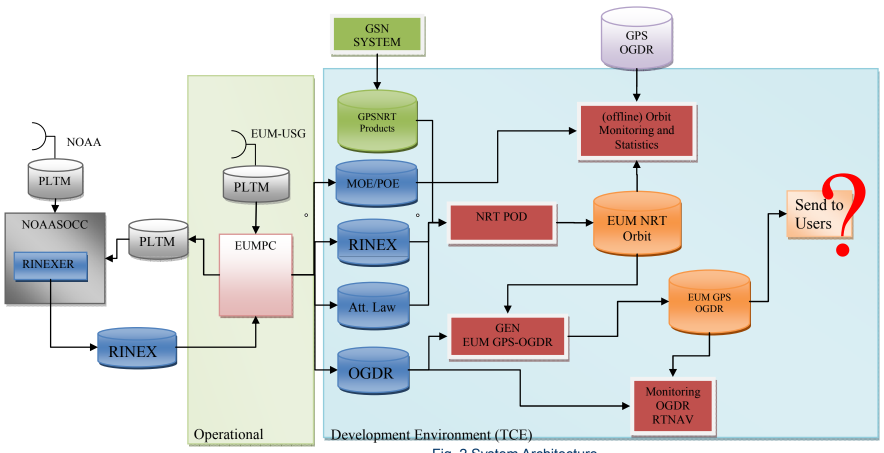

Fig. 2 System Architecture

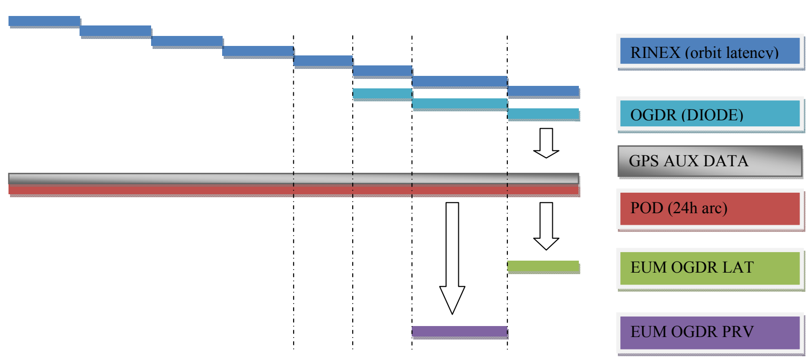

Fig. 3 Timeline of GPS EUM OGDR products generation

Two types of product are being produced:

- The first one has a similar latency to the official OGDR but usually a more accurate orbit (EUM_OGDR_LAT)
- The second one has approx. two hours larger latency (one orbit lag) and reaches a higher accuracy (EUM_OGDR_PRV)

The generation of both products is triggered by the arrival of a new RINEX file covering the data since the last data dump. Fig. 3 depicts the timeliness of both products. ESA's Navigation Package for Earth Observation Satellites (NAPEOS) infrastructure is used as the POD core software (e.g. batch filter, data screening…) [4]. The Simple, Scalable, Script-Based Science Processor (S4P) [5] is used for the implementation of a data driven process through the use of different stations.

Results

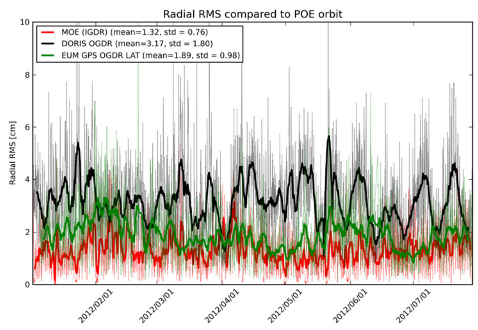

Fig. 4 Radial RMS accuracy of operational OGDR, EUM GPS OGDR LAT, and MOE orbits against Final POE orbit. Both OGDR have similar timeliness (~3 hours, cf. Fig. 6). Note that a small number of outliers in the experimental products have been removed due to issues with the onboard GPS receiver.

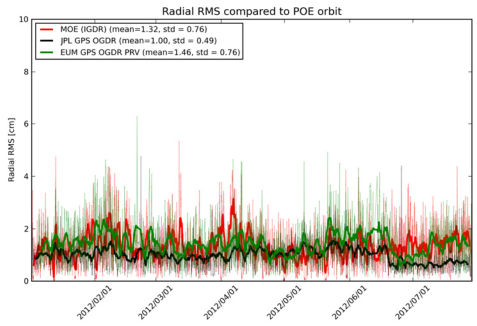

Fig. 5 Radial RMS accuracy of JPL GPS OGDR, EUM GPS OGDR PRV and IGDR orbits against final POE(GDR) orbits. Both NRT products have similar timeliness (~5 hours , cf. Fig. 6), while IGDR product has one day lag. Note that a small number of outliers in the experimental products have been removed due to issues with the onboard GPS receiver.

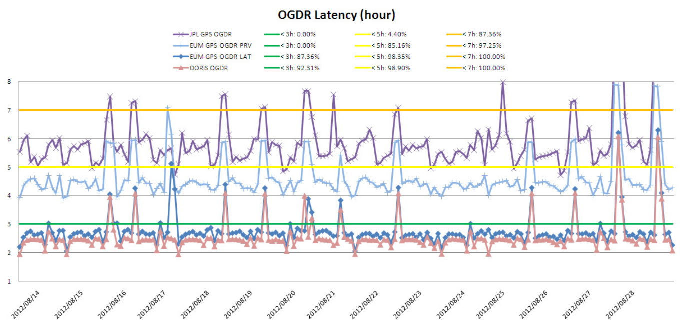

Fig. 6 Latency of all NRT OGDR products

Latency requirements are (J2GS-PROPRO-005):

- at least 75% of OGDRs available within 3 hours

- at least 95% of OGDRs available within 5 hours

Examples / Conclusions

On ground POD processing permits handling manoeuvres and therefore improves significantly the radial accuracy during such events. Fig. 7 and 8 show the difference in sea surface height anomaly estimation during the manoeuvre (generated with NRTAVS), while Fig. 9 shows the radial difference of the different NRT products, during the event.

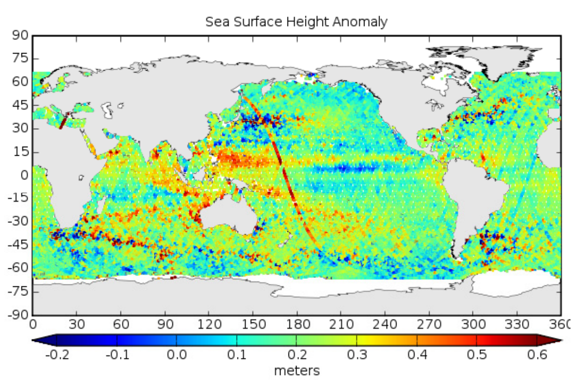

Fig. 7 Sea Surface Height Anomaly using operational OGDR products

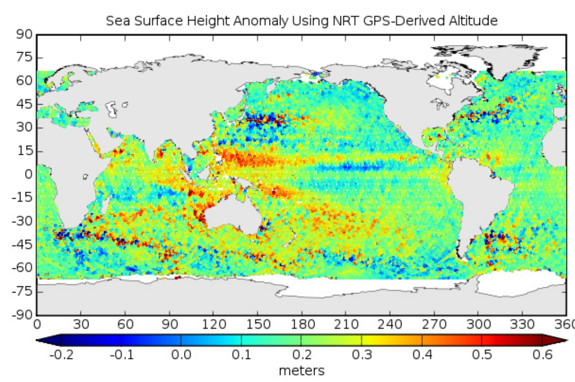

Fig. 8 Sea Surface Height Anomaly using EUM GPS OGDR LAT products

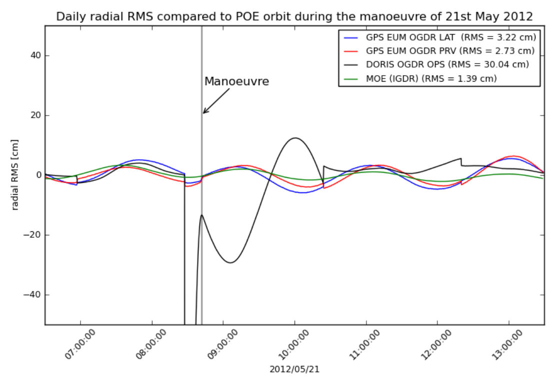

Fig. 9 Radial difference of different products compared to POD during manoeuvre

File Name	Median (m)	Mean (m)	Std. Dev. (m)
JA2_OPN_2PcS143_032_20120521_065712_20120521_082744	0.19820	0.19889	0.09368
JA2_OPN_2PcS143_033_20120521_082744_20120521_102425	0.23665	**0.32320**	**0.40928**
JA2_OPN_2PcS143_035_20120521_102424_20120521_122011	0.18545	0.18957	0.11429

File Name	Median (m)	Mean (m)	Std. Dev. (m)
JA2_EUMOPN_2PcS143_032_20120521_065712_20120521_082744	0.18400	0.18616	0.09580
JA2_EUMOPN_2PcS143_033_20120521_082744_20120521_102425	0.21950	**0.21433**	**0.10836**
JA2_EUMOPN_2PcS143_035_20120521_102424_20120521_122011	0.20500	0.20711	0.11084

The method described in this poster is generic and may be applied to compute operational NRT GPS-based orbits for similar LEO Earth Observation missions like Sentinel-3, Jason-3, Jason-CS, etc.

Different independent computation of POD in NRT may enable a better quality control and improve the flagging of the products in case of degradation, etc. E.g. starting in August 2012 a degradation occurred due to the use of a wrong TAI-UTC auxiliary file which was identified thanks to these NRT products [2].

Future Improvements

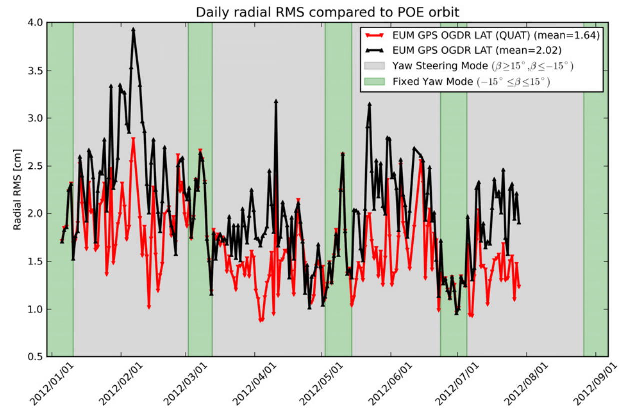

Fig. 10 Radial Accuracy of NRT product using experimentally nominal attitude law and quaternions produced by CNES

- Adding the real satellite attitude in NRT from the available telemetry improves the accuracy (Fig. 10)
- Adding the real solar panel angle, might also further improve results [6]
- Adding some missing models implemented in GDR-D standard might also provide improvements.

References

[1] One-centimetre orbits in near-real time : the GPS experience on OSTM/JASON-2, Haines, Bruce. et al., AAS George H. Born Symposium, Boulder, Colorado, May 14, 2010

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[5] Simple, Scalable, Script-Based Science Processor (S4P), Lynnes, C. et al., Geoscience and Remote Sensing Symposium, Vol. 1, IEEE, 2001, pp. 1465-1467.

[6] L. Cerri, et al. (2010): Precision Orbit Determination Standards for the Jason Series of Altimeter Missions, Marine Geodesy, 33:S1, 379-418. http://dx.doi.org/10.1080/01490419.2010.488966

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