JASON-2 NRT POD BASED ON GRAS GSN

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Introduction

OSTM/Jason-2 mission scientific products are provided to the users in different timeliness and accuracy:

- The Operational Geophysical Data Record (OGDR)
- The Interim Geophysical Data Record (IGDR)
- Geophysical Data Record (GDR)

	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	2.5 cm	1.5 cm

GRAS (GNSS Receiver for Atmospheric Sounding) instrument ground processing produces operationally Metop precise orbits of similar accuracy (10 cm radial RMS) in similar timeliness (2h 15min after sensing time).

NRT orbits are computed thanks to the GRAS GSN (Ground Support Network) system, which provides precise GPS ephemerides in NRT.

EUMETSAT is currently setting up an experimental Jason-2 dedicated POD environment for assessing the possibility of using GPS measurements from Jason-2 in combination with GRAS GSN precise GPS ephemerides to compute a NRT Jason-2 precise orbit.

This would allow a NRT monitoring and validation of the OGDR orbit computed on-board by the DIODE.

GRAS GSN (Ground Support Network)

System designed and operated by ESA´s European Space Operation Centre (ESOC) to deliver supporting data to the Metop core ground segment (CGS) for processing of atmospheric sounding data delivered by the Metop GRAS instrument and for Metop precise orbit determination.

The system is subjected to very stringent requirements in 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 support data consists of:

- GPS orbit and clock bias estimation
- Ground tracking data of GPS spacecrafts by GPS receivers globally distributed
- Auxiliary files (i.e. Earth Orientation Parameters)

The GRAS GSN can be divided into 2 main blocks:

- GPS receiver station network; operated by different providers (i.e. NRCan, GFZ, FS and ESOC), collecting GPS and meteorological data and transferring the information in Near Real Time to the GRAS GSN Processing Centre.
- The GRAS GSN Processing Centre (GRAS GSNPC); in charge of monitoring, processing, formatting, archiving and distributing the products to the Metop Core Ground Segment (CGS).

GSN receiver station network

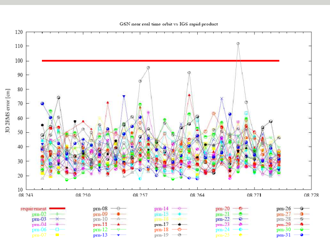
- Set of approximately 40 redundant stations (25 primary and 15 back-up)
- Geographically distributed
- 15 minutes of 1Hz RINEX files continuously provided by at least 25 stations.

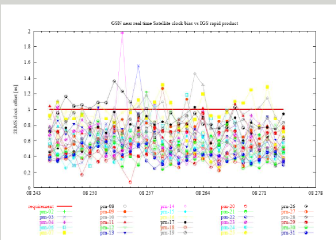
Primary GSN stations (courtesy of ESA/ESOC)

GSN Processing Centre

- Operated from ESOC´s Navigation Facility
- Hardware divided into two independent chains for redundancy
- Relevant products for POD:
  - NRT GPS estimated orbits, including 36h of prediction; update frequency of 3 hours
  - NRT GPS estimated clock corrections at 1Hz; update frequency of 15min and available 1 hour after sensing time
  - NRT Earth Orientation parameters

Navigation office at ESOC (courtesy of ESA/ESOC)





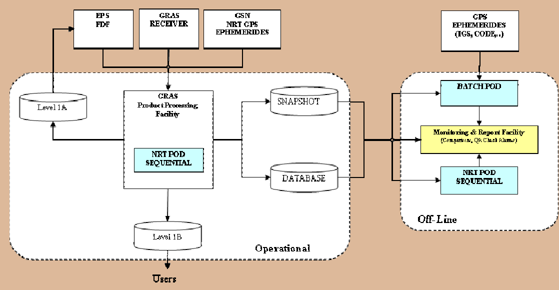
2 RMS GSN orbit and clock bias statistics for July 2008

Metop NRT POD

In the frame of the precise ephemerides computation of GRAS, and taking into account the importance of POD for Low Earth Orbit (LEO) satellites in future meteorological and climate monitoring missions where EUMETSAT will be involved (as Sentinel-3 part of Kopernikus - former Global Monitoring for Environment and Security, GMES), EUMETSAT has designed a POD environment in which several components for validation, monitoring, reprocessing and calibration are centralized.

The POD environment consists of two different platforms, the operational platform and the off-line platform. Their architecture is depicted in figure below.

The operational POD, consists of a sequential Square-Root Information Filter (SRIF) that, using the support data from GSN, computes the Metop orbit in 3 minutes segments.



The offline POD consists of a batch filter that, using different GPS support data (IGS, CODE, GSN), computes the Metop orbit on a daily / weekly basis, to asses the different causes for the accuracy degradation (arc length, accuracy of support data, etc).

ESA's Navigation Package for Earth Observation Satellites (NAPEOS) infrastructure is used as the POD core software (e.g. batch filter, data screening…), and some capabilities have been added to it, the most important one being an instance of the NRT POD used in operations.

Position [cm]	AIUB	DLR	EUM
AIUB		R 1.1 (-0.25) T 1.5 (-0.30) N 1.8 (1.10)	R 1.8 (-0.5) T 2.8 (-0.30) N 1.6 (-0.23)
DLR	2.6		R 1.5 (-0.5) T 2.4 (0.07) N 1.6 (1.4)
EUM	3.7	3.3	

Interagency comparison offline products; statistics over 10 days:

Upper right: RTN RMS and mean (brackets)
Lower left: 3D RMS position

AIUB: Astronomisches Institut Universität Bern
DLR: Deutches Zentrum für Luft- und Raumfahrt
EUM: EUMETSAT

Position [cm]	RMS Radial	RMS Tangent	RMS Normal	RMS 3D
NRT 09h arc	6.6	9.1	3.6	12
NRT 12h arc	6.3	9.0	3.4	12

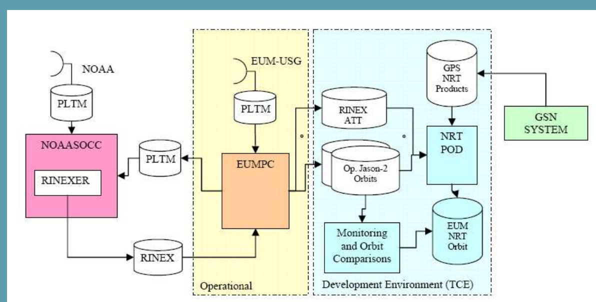
EUMETSAT offline Precise Orbit using CODE final products vs different NRT solutions using GSN supporting data;
statistics over 10 days,
POD processing time ~10min

Jason-2 NRT POD proposed Architecture

EUMETSAT has identified two ways of computing a NRT precise orbit of Jason-2 with the available data:

- Using the GPS observations from the LEO receiver in conjunction with NRT precise GPS ephemerides (as the ones provided by GSN for GRAS)
- Fitting the DIODE solution computed on board with a batch filter (similar to what is currently foreseen for Sentinel-3).

Both ways are envisaged to be studied at EUMETSAT. A possible infrastructure to produce NRT precise orbits of the Jason-2 satellite at EUMETSAT is depicted in the figure below.



Status /Way forward / Improvements

- First off-line runs with Jason-2 data performed; convergence of ~2cm achieved (orbital accuracy TBC)
- Tuning of POD software in order to achieve similar convergenge as Metop

Outstanding issues:

- Comparison with official products (access to OGDR, POE, MOE)
- Attitude input mechanism to be consolidated (quaternions vs. attitude law)
- Assessment of achievable radial accuracy
- Assessment of timeliness due to RINEXER only available at NOAA
- Automatic files transfer from the operational Jason-2 Ground Segment to the TCE (Technical Computing Environment, i.e. development platform) for automation of monitoring.