IGS WORKSHOP 2017

THE COPERNICUS POD SERVICE

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Jaime Fernández (1) Carlos Fernández (1) Emilio J. Calero (1) Luis J. Gallardo (1) Heike Peter (2) Pierre Féménias (3)

(1) GMV AD., Isaac Newton 11, 28760 Tres Cantos, Spain
(2) PosiTim UG, In den Löser 15, 64342 Seeheim-Jugenheim, Germany
(3) ESA/ESRIN, Via Galileo Galilei, I-00044 Frascati, Italy

OVERVIEW OF THE COPERNICUS POD SERVICE

Copernicus program facts:
- A joint initiative of the **European Commission** and the **European Space Agency**
- Aims to establish an autonomous European Earth Observation capacity based on Low Earth Orbiting satellites from different missions: Sentinel-1 to -6
- Copernicus POD Service is in charge of Sentinel-1, -2 and -3

Copernicus POD Service facts:
- Part of the **PDGS Ground Segment** of the Sentinel missions
- In charge of the generation of **precise orbital products** (with different accuracies and latencies, see table) and auxiliary data files
- **Developed** and **operated** by a **GMV-led consortium**
- External GNSS data Provider (EGP):
  - VERIPOS: provider of high accurate GPS orbits and clocks products
  - MagicGNSS: in-house back-up GPS provider
  - IGS: IGS finals products used for NTC orbits
- **CPOD Quality Working Group (CPOD QWG)**:
  - AIUB, CNES, DLR, ESA, EUM, GMV, TU Delft, TUM
  - External validation: **combined solution**
- Responsible for the interface with the **ILRS Community**:
  - In charge of generating S3 CPF orbit files
  - Operational user of S3 SLR measurements for independent orbit validation

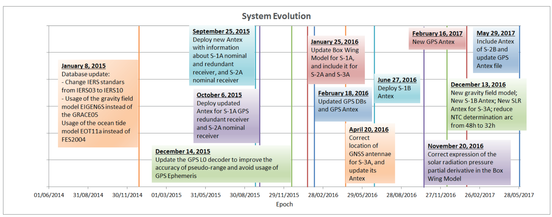
CPOD requirements

Mission	Timeliness	Orbit Accuracy (RMS)	Timeliness
S-1	NRT	10 cm (2D)	180 min.
	NTC	5 cm (3D)	20 days
S-2	NRT (predicted)	3 m (2D)	90 min. before ANX
	NRT	1 m (3D)	30 min.
S-3	NRT (S3PODIPF)	10 cm radial (target: 8 cm)	30 min.
	STC	4 cm radial (target: 3 cm)	1.5 days
	NTC	3 cm radial (target: 2 cm)	25 days

CPOD SYSTEM EVOLUTION

The POD system is in a continuous evolution. The different developments encompass:
- Operational improvements to automatize the processes
- Creation of new tools intended to analyse the results
- Enhancement of the processing techniques and keeping the databases up-to-date

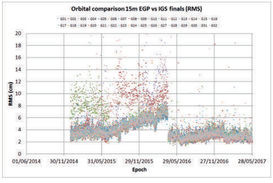
The graphic below shows those improvements which have a direct impact on the orbital solutions

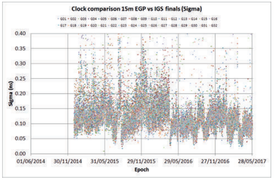


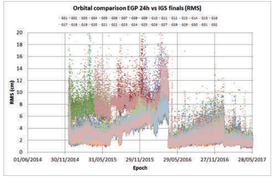
EXTERNAL GPS PROVIDER (EGP) ACCURACY

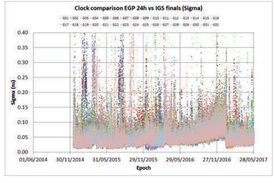
VERIPOS provides three kinds of solutions: 15M, 24H and STC solutions

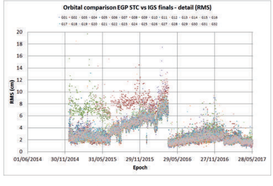
- **15M** orbits and clocks: a SP3 file with orbits and clocks; coverage of 15 min; timeliness of 10 min (since end of coverage); rate of 30 seconds. Used in NRT products
- **24H** orbits and clocks: a SP3 orbit file (with a rate of 15 min) and a RINEX clocks file (with a rate of 30 s); coverage of 24 h (including 24H prediction in case of orbits); timeliness of 1 h (since end of coverage). Used in NRT and STC products
- **STC** orbits and clocks: a SP3 orbit file (with a rate of 15 min) and a RINEX clocks file (with a rate of 30 s); coverage of 24 h; timeliness of 12 h (since end of coverage). Used in STC products

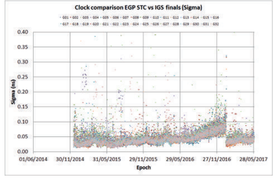










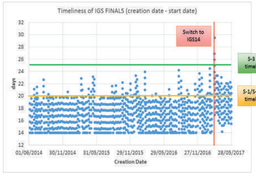


STC products from EGP show same level of accuracy in average than 24H NRT products, with much lower dispersion (both in clocks and in orbits)

IGS FINALS TIMELINESS

IGS provides its **GPS FINAL** orbits and 30 sec clocks with the following characteristics:
- Coverage of 24 hours; latency of 6-8 days with a typical timeliness between 12-20 days
- NTC products, POD QWG solutions and combined solution based on them
- Some of the POD QWG solutions based on AC contribution to IGS Finals (e.g., ESOC, CODE or JPL)

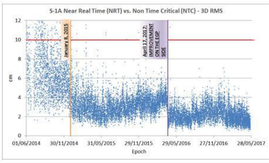
It is vital to ensure NTC products quality that the IGS FINALS are available at processing time – driving factor for determining NTC timeliness requirement. Degradation in timeliness observed after switch to IGS14

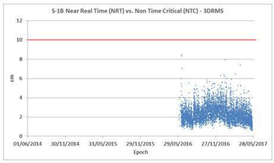


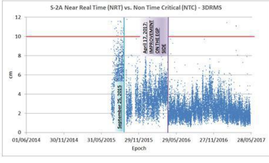
NTC product	3 IGS inputs	2 IGS inputs	1 IGS inputs	No IGS inputs
S-1/S-2	72.7%	12.0%	5.1%	10.2%
S-3	99.4%	0.3%	0.1%	0.2%

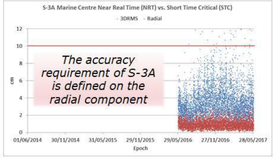
NTC products based on 36h determination period (24h coverage + 6h before/after). They require 3 GPS orbits and clocks files corresponding to the processed day, the day before and the day after

ACCURACY OF THE SENTINELS NRT PRODUCTS

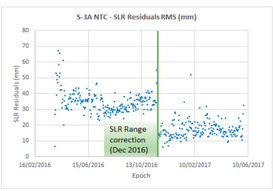


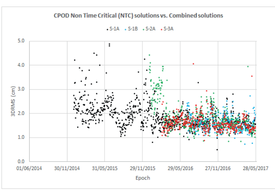






ACCURACY OF THE SENTINELS NTC PRODUCTS





NTC Accuracy

3D RMS	S-1A	S-1B	S-2A	S-3A
<1.5 cm	21.7 %	38.2 %	29.3 %	43.9 %
<3 cm	92.7 %	100 %	90.2 %	98.4 %
<5 cm	95.8 %	100 %	98.6 %	98.9 %
<10 cm	97.3 %	100 %	99.2 %	99.1 %

Outliers due to manoeuvres. Typical accuracy between **1-2 cm**

NRT Accuracy

3D RMS	S-1A	S-1B	S-2A	S-3A
< 3 cm	54.9 %	81.5 %	58.7 %	45.7 %
< 5 cm	87.0 %	99.1 %	89.0 %	83.6 %
< 10 cm	97.4 %	99.8 %	98.2 %	98.5 %
< 20 cm	99.1 %	99.8 %	98.7 %	99.4 %

Outliers due to manoeuvres and L0 data gaps. Typical accuracy between **5-10 cm**

The orbital solutions computed by the institutions conforming the POD QWG (AIUB, CNES, DLR, ESA, EUMETSAT, GMV, TU Delft, TU Munich) are based on different GPS processing schemes, models and SW. Routinely, each centre provides orbits which are used to compute an IGS-like combined solution, against which official Sentinel orbital products are compared for accuracy assessment. Typical accuracy in 3D RMS is in the order of 1.5 cm for all satellites. In the case of Sentinel-3, the availability of SLR measurements allow for an independent means to validate the orbital accuracy. In order to do so, SLR residuals are computed with respect to a fixed orbit based only on GPS (or GPS+DORIS) data. The SLR residuals reveal a good agreement between the CPOD solution and the laser measurements, with RMS values below 2 cm

CONCLUSIONS

The Earth observation capability required by the Copernicus program needs of stringent POD requirements in both accuracy and timeliness. These requirements are fulfilled by the CPOD service, which, thanks to the high-quality of the GPS orbits and clocks provided by Veripos and IGS, and the support provided by the POD QWG members, has developed a robust system regularly meeting these requirements. The system is continuously under improvement by carrying out different analysis with the aim of rising the performance and acquiring new knowledge needed by the future coming challenges.

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