IGS WORKSHOP 2017

GNSS DATA AVAILABILITY OF THE SENTINELS SATELLITES

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S-3 FOS

OVERVIEW OF THE COPERNICUS PROGRAM

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

S-1 FOS

S-2 FOS

Copernicus POD Service facts: - Part of the **PDGS Ground Segment** of the

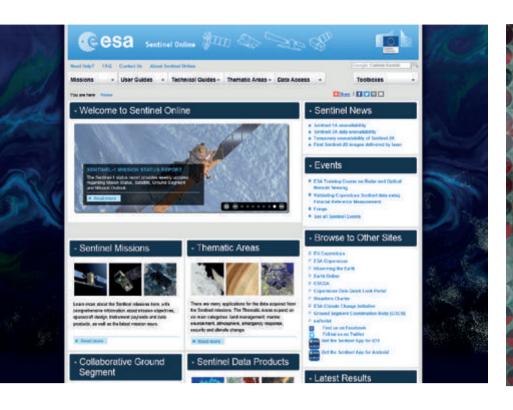
- Sentinel missions - Developed and operated by a GMV-led
- consortium
- External GNSS data Provider (EGP): VERIPOS & MagicGNSS
- CPOD Quality Working Group (CPOD QWG): AIUB, CNES, DLR, ESA, EUM, GMV, TU Delft, TU Munich
- Responsible for the interface with the **ILRS** Community
- In charge of the generation of precise orbital products and auxiliary data files

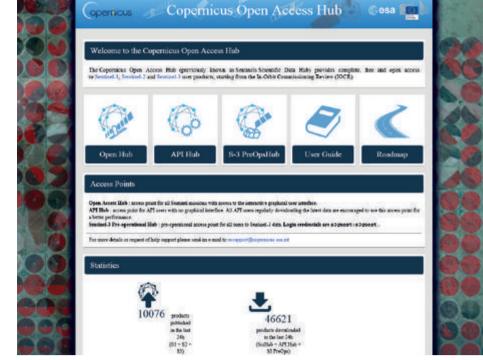
Although the main target of the CPOD Service is to provide Precise Orbital Products, it is very important to point out the role of the auxiliary data files derived from (or needed by) the determination process. These cannot be understood as an end in themselves, but as an intermediate stage to achieve further scientific aims as well as to fulfil academic purposes. The auxiliary data associated to the CPOD Service covers (in relation with the Sentinels missions):

- GNSS measurements (Rinex Observations)
- Manoeuvre information (Manoeuvre Acceleration Profile files, MACP)
- Mass properties and Centre of Mass (Mass History File, MHF)
- The Phase Centre Variations (PCV) map of the antennae (ANTEX files)

GNSS AUXILIARY DATA ACCESIBILITY

Copernicus project and ESA made available two websites to provide data and information to users. The Sentinels Online provides generic information about the Sentinels missions, including documentation, while the Copernicus Scientific Data Hub provides open access to Sentinel-1, -2 and -3 user products.





Sentinels Online

https://sentinel.esa.int/web/sentinel/home

POD info to be available:

- Manoeuvre information (MACP)
- Mass history files (MHF)
- PCO/PCV map (ANTEX)
- Technical notes on satellite characteristics

Copernicus Scientific Data Hub https://scihub.copernicus.eu

POD data to be distributed:

- Rinex observations files of

Sentinel -1, -2 and -3

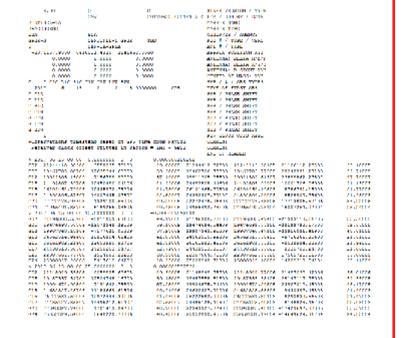
- Operational precise orbits (still pending approval)

GNSS AUXILIARY DATA OVERVIEW

RINEX OBSERVATIONS

- Observations:
 - Codes: C/A, P1, P2, L2C (only Sentinel-X B units)
 - Phases: L1, L2
- S/N0 (on f1, f2)
- Frequency of observations: 0.1 Hz (S-1, S-2); 1 Hz (S-3) ■ Time scale: GPS time (S-1, S-2); fit to IMT time (S-3)
- Coverage: daily files; from beginning of each mission:

06/04/2014 27/06/2015 23/02/2016 27/04/2016 10/03/2017 Q2 2018



MANOEUVRE ACCELERATION PROFILE FILES (MACP)

- Data:
- Start / End epoch of each manoeuvre - Acceleration in RAC
- Coverage: a single file per satellite, with the whole history Frequency of updates: after each manoeuvre

0.49089620D 00	0.476488730 06 0.162690990 21	O.
0.98124529D 10	0.1930766EB 06 0.64782201D 22	1
0.981245290 10	0.493076628 06 0.647822048 22	0
0.287499190 08	0.95355003D 11 0.50617459D 06	1
0.287499190 08	0.95355003D 11 0.50617459D 06	0
-0.37917079D-09	0.32757172B-06 0.41360931B-22	1
-0.37917079D-09	0.32757172B-06 0.41360931B-22	0
-0.37910094D-09	0.327497010-06 0.152957900-21	1
-0.37610064D-09	0.327497010-06 0.152957900-21	0
-0.07021999D-09	0.327423900-06-0.110747370-21	1
-0.07021999D-09	0.327423900-06-0.110747370-21	0
0.399070970+09	0.32735014B-06 0.14394045B-22	1
0.36087997D 09	0.82735014D D6 0.14896049D 22	0
0.372611560 00	0.927276398 06 0.647822048 22	1
0.972611960 00	0.927276398 06 0.647822048 22	0
0.974659180 09	0.927202568 06 0.287920910 22	1
0.974659180 09	0.927202568 06 0.287920910 22	0
0.554825290 00	0.493530528 06 0.289720418 21	1
0.554825290 00	0.493530528 06 0.289720418 21	0
0.218446840.10	0.826867110 06 0.129564410 21	1
-0.21344934D-10	0.326362410-06 0.129564410-21	0
-0.19200074D-10	0.326209100-06 0.575041020-22	1
-0.19200074D-10	0.326209100-06 0.575041020-22	0
-0.22107900D-10	0.326215920-06 0.207926910-22	1
-0.22107900D-10	0.326215920-06 0.207926910-22	0
-0.29909035D-10	0.326142900-06-0.063742730-22	1
-0.29909035D-10	0.326142900-06-0.063742730-22	0
	0.881295200 10 0.881295200 10 0.881295200 10 0.881295200 08 0.881295200 08 0.381295200 08 0.376170520008 0.376170520008 0.376170520008 0.37617052008 0.37617052008 0.386875670 06 0.37621560 00 0.37261160 00 0.3726	0.49089200 00 0.49089780 00 0.102892020 12 0.89124520 00 0.49927820 12 0.49927820 00 0.49927820 02 02 0.49927820 02 02 0.49927820 02 02 02 02 02 02 02 02 02 02 02 02 0

2017/08/21 10:00:05.870 F81 2013/03/05 05:14:44.80F 0.49089820D 00 0.47848878D 06 0.18289099D 21

MASS HISTORY FILE (MHF)

- Data:
 - Epoch
- The mass of the Sentinel - The Centre of Mass (CoM) of the satellite
- Coverage: a single file per satellite, with the whole history
- Frequency of updates: after each manoeuvre
- 2017 3 27 0 24 0.000 2146.601 0.00400 -0.00900 2.01100 0 24 0.000 2146.679 0.00400 -0.00900 2.01100 4 10 0 24 0.000 2146.564 0.00400 -0.00900 2.01100 4 17 0 24 0.000 2146.561 0.00400 0.00000 2.01100 0 24 0.000 2146.431 0.00400 -0.00900 2.01100 2017 5 15 0 24 1.000 2146.428 0.00400 -0.00900 2.01100 2017 5 20 0 24 0.000 2146.298 0.00400 0.00900 2.01100 2017 6 5 0 24 0.000 2146.296 0.00400 0.00900 2.01100 2017 6 19 0 24 0.000 2146.293 0.00400 -0.00900 2.01100

GNSS AUXILIARY DATA APPLICATIONS

IONOSPHERE CHARACTERIZATION

The dual-frequency GPS measurements contain information about the TEC (Total Electron Content) in the ionosphere. In the case of the Sentinels, there is global coverage of the observations along with an excellent availability.

GRAVITY FIELD MODELLING

Beside the dedicated missions, as many LEO missions as possible are used to determine the time-variable part of the gravity field. Along with the ESA Earth Explorer Swarm mission, the Sentinel satellites have proven to be able to contribute on the low terms of the gravity field, which are the most important ones for time-variable gravity field modelling.

SUPPORT TO THE GNSS PROCESSING

The inclusion of LEO measurements into global GNSS processing is supposed to be advantageous for the determination of global parameters.

ACADEMIC PURPOSES

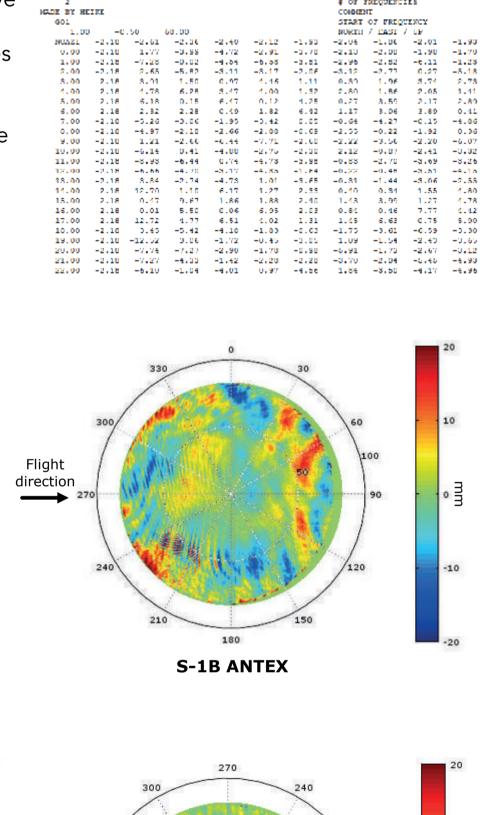
Universities and research centres do not usually have the capability to carry out every single step involved in the determination process (from the initial data treatment to the final orbit product). Thus, they can take advantage of the intermediate data to perform their deeper analysis and researches in a particular field

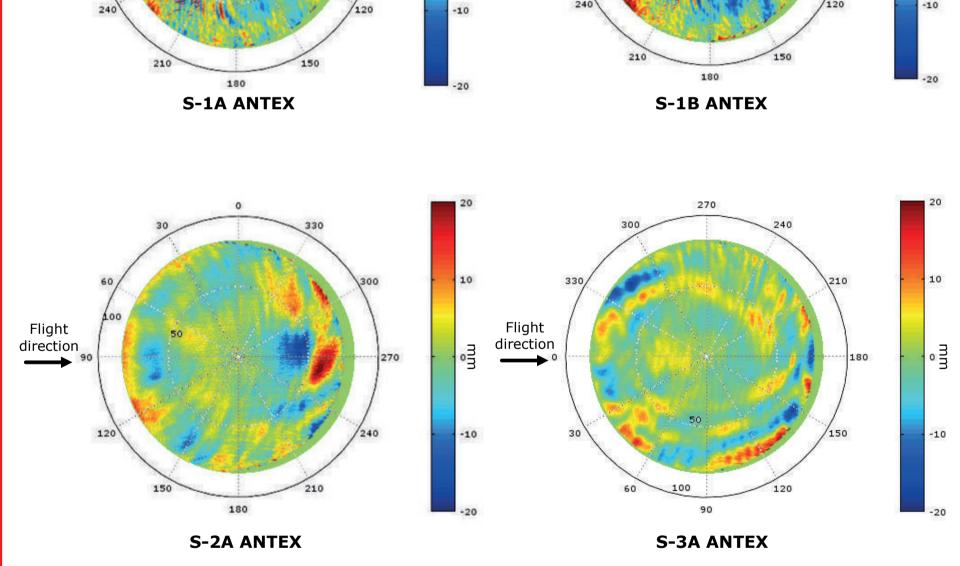
ANTEX PCV FILES

Flight

direction

- The ANTEX file consist of
 - Phase Centre Offset (PCO): Eccentricities of the mean antenna phase centre relative to the antenna reference point
 - Phase Centre Variations (PCV): The values of an azimuth- and elevation-dependant pattern
- They are computed with the Iono-free phase residuals derived from orbit determination process → in-flight calibration
- A single file contains information about all the Sentinels, their receivers (nominal and redundant)





CONCLUSIONS

It has been presented an overview of the different auxiliary data generated by the Copernicus POD Service. ESA and the CPOD Service are aware of the importance of such data and foresee to make it accessible from the Copernicus Online and the Copernicus Scientific Data Hub, with the aim of satisfying the needs of the potential users.

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