IGS WORKSHOP 2017
GNSS DATA AVAILABILITY OF THE SENTINELS SATELLITES
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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**

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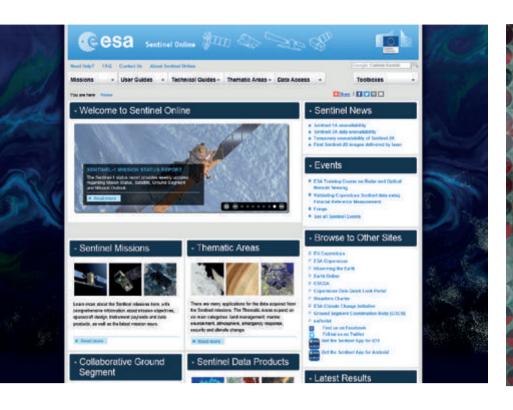- Part of the **PDGS Ground Segment** of the Sentinel missions
- **Developed** and **operated** by a **GMV-led consortium**
- External GNSS data Provider (EGP): VERIPOS & MagicGNSS
- **CPOD Quality Working Group (CPOD QWG):** AIUB, CNES, DLR, ESA, EUM, GMV, TU Delft, TU Munich
- Responsible for the interface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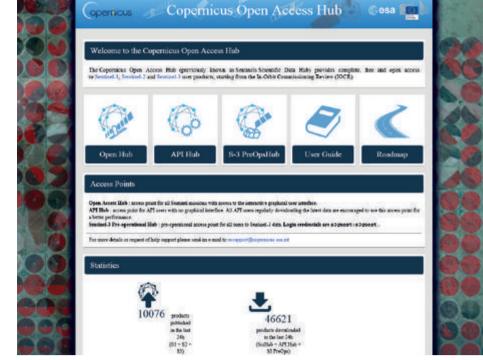- In charge of the generation of **precise orbital products** and **auxiliary data files**

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 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:

S-1A	S-2A	S-3A	S-1B	S-2B	S-3B
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

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

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

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:
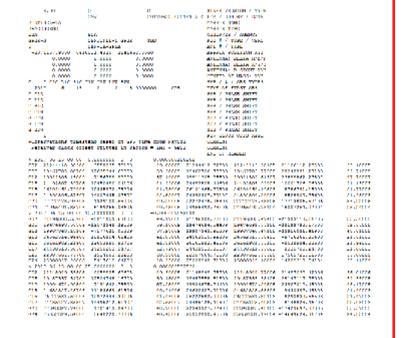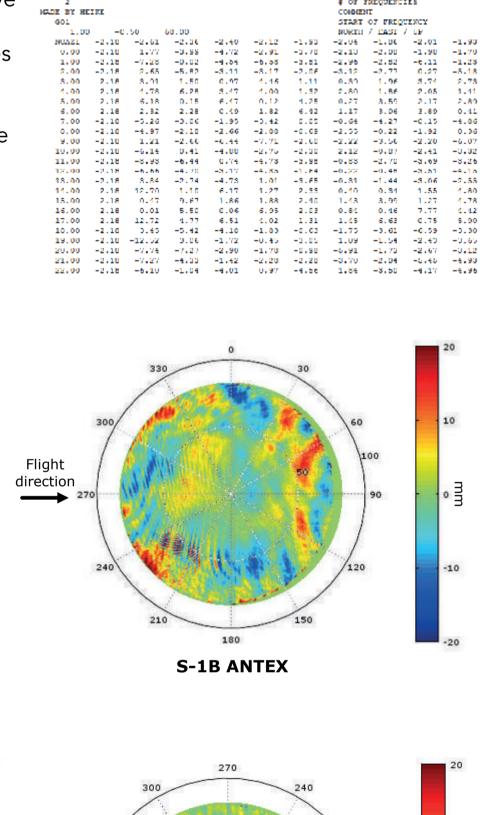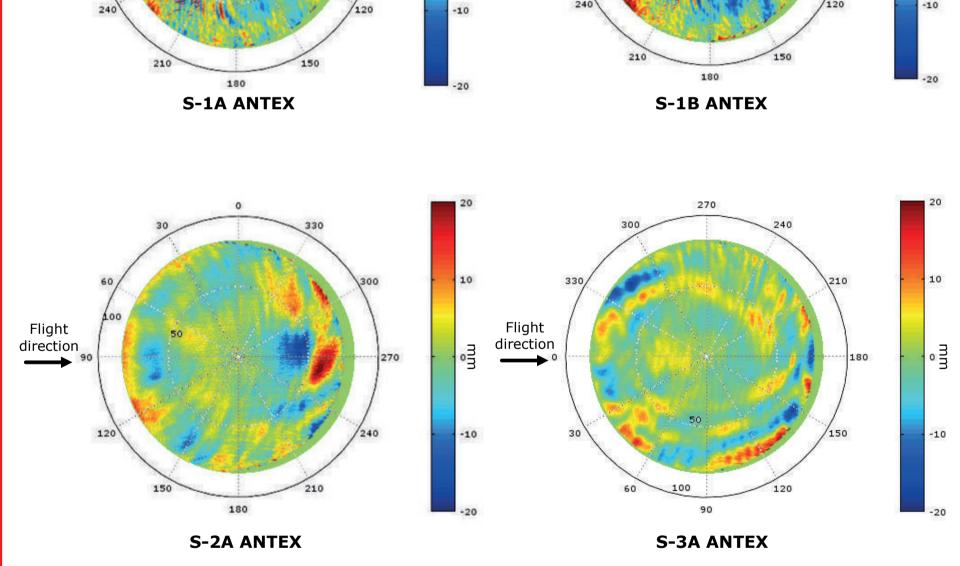- **Rinex observations** files of Sentinel -1, -2 and -3
- **Operational precise orbits** (still pending approval)

ANTEX PCV FILES
- 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)

S-1A ANTEX

S-1B ANTEX

S-2A ANTEX

S-3A ANTEX

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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