Access to SPIRE as ESA's Third Party mission

Terms of Applicability

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1   General

Within the Third Party Mission scheme, ESA provides to Earth Observation users data from non-ESA missions, so-called Third Party Missions, to complement the data from ESA EO missions and to support and build up the scientific user community for those data in Europe.

A Third Party Mission (TPM) is a mission

- that is operated by any legal body, governmental or non-governmental entity other than ESA or
- for which ESA assumes some formal responsibility towards the mission operator or to which ESA contributes financially, usually through sharing of Ground Segment facilities or operations cost or
- for which ESA assumes a data distribution responsibility, usually towards European Users, but sometimes towards a worldwide user community for a subset of the geographic coverage of this mission.

The implementation of a new Third Party Mission follows a Selection Procedure approved by the Program Board on Earth Observation in 2004. This procedure evaluates a yearly list of Third Party Candidate Missions according to a set of criteria (e.g. European User benefits and excellence, accessibility etc.). In order to gain access to the TPM data, ESA establishes co-operation schemes with the owners/operators of the Third Party Missions. In these co-operation schemes, one option foresees to provide ground segment support to the TPM owner/operator in exchange for access to the TPM data (e.g. share acquisition or archiving facilities or support respective operations).

Spire Constellation, developed and operated by Spire Global, is a Third Party Mission part of the Earthnet Programme since 2020.

Within the ESA CAT-1 TPM Scheme, Spire offers the ESA CAT-1 community:
➢ Delivery of on-demand Spire products (historical and live data) for category-1 use to Category-1 Users located in ESA Member States and ESA Cooperating/Associate States.

ESA tries to support as many high-quality and innovative projects as possible within the quota limit available, therefore only a limited amount of products can be made available to each project.
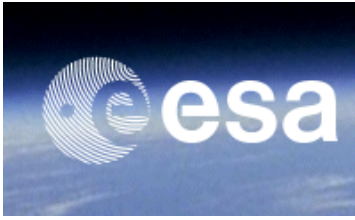
2 Data Accessibility Conditions

The data available as part of the ESA TPM are the following:

- **Polarimetric Radio Occultation (PRO) measurements**
  [leoOrb.sp3, proObs, h(v)(c)atmPhs, polPhs, patm.PRF]
  The measurements observe the properties of GNSS signals as they pass through by Earth's atmosphere, similar to regular RO measurements. The polarization state of the signals is recorded separately for H and V polarizations to provide information on the anisotropy of hydrometeors along the propagation path

- **Near-Nadir GNSS Reflectometry (NN GNSS-R) measurements**
  [gbrRCS.nc, gnrNRCS.nc, gbrSSM.nc, gbrOcn.nc]
  Tracks of surface reflections as observed by the near-nadir pointing GNSS-R antennas, based on Delay Doppler Maps (DDMs). Available from December 2020 to the present

- **Grazing angle GNSS Reflectometry (GA GNSS-R) measurements**
  [grzRfl.nc, grzIce.nc, grzAlt.nc]
  Tracks of surface reflections as observed by the limb-facing RO antennas, based on open-loop tracking outputs: 50 Hz collections of accumulated I/Q observations. Available from May 2019 to the present

- **GNSS Radio Occultation (RO) profiles**
  [podObs.rnx, leoOrb.sp3, leoAtt.log, opnGns*ro.bin, opnGns*rst.bin, atmPhs.nc, atmPrf.nc, bfrPrf.bufr]
  GNSS atmospheric radio occultation (GNSS-RO) relies on the detection of a change in a radio signal as it passes through a planet's atmosphere, i.e. as it is refracted by the atmosphere. This data set contains precise orbit determination (POD) solutions, satellite attitude information, high-rate occultation observations, excess phase, and derived atmospheric dry temperature profiles. Both historical and live data available

- **Ionosphere total electron content**
  [podTec.nc]
  The total electron content (TEC) data represents the line-of-sight integration of electron density between a Spire satellite and a GNSS satellite. Each file contains line-of-sight ionospheric total electron content (TEC) estimates derived for a 'single viewing arc' contained in the POD observation file. Viewing arcs are at least 10 minutes in duration.

- **Ionosphere scintillation**
  [scnLv1.nc]
  The scintillation index for each GNSS frequency, computed onboard the spacecraft, provides a measure of the fluctuations of the GNSS signal over the course of 10 seconds caused by propagation of the radio signals through electron density irregularities in the ionosphere. The raw indices are packaged along with associated metadata such as orbit position to create the final scintillation data product.

- **Electron density profile**
  [ionPrf.nc]
  Electron density profiles are retrieved as a function of altitude and processed from podTec netcdf files, which span a sufficient elevation angle range. A standard Abel inversion algorithm is applied to retrieve the profiles.

- **Raw IF samples from GNSS-RO satellites**
  [rocRIF.zip]
  Raw intermediate frequency (IF) sampled data (I/Q) from the GNSS receiver front-end of GNSS-RO satellites. The frequencies are notably high (10 MHz) compared to regular downlinked products (50 Hz).

- **Raw IF samples from GNSS-R satellites**
  [gbrRIF.zip]
  Raw intermediate frequency (IF) sampled data (I/Q) from the GNSS receiver front-end of conventional GNSS-R satellites. The frequencies are notably high (10 MHz) compared to regular downlinked products (1 to 2 Hz).

- **Combined Surface Soil Moisture**
  [COMB-SSM.nc]
  Combined data product containing measurements from both CYGNSS and SMAP reported on a 6 km global Equi7Grid grid. netCDF-4 format.

- **ADS-B (Automatic Dependent Surveillance-Broadcast) data stream**
  [csv.gz]
  Global ADS-B satellite data stream observed by Spire satellites and processed through the ground stations network; Historical data from December 2008 or Live; distribution by monthly subscription as data cuts containing CSV file(s) accessible through a Web Service or Cloud storage solutions for Historical, via API for Live data, via REST API for recent historical data

- **AIS (Automatic Identification System) messages**
  [parquet.gz]

The automatic identification system (AIS) is an automatic tracking system that uses transponders on ships and is used by vessel traffic services. Spire data includes satellite AIS (S-AIS) as observed by Spire satellites and terrestrial AIS (T-AIS) from third party sensor stations. Historical data available from June 2016 or Live data; distribution by monthly subscription via CSV file or API for Historical, via TCP or API for Live;

To be noted that:

- STRATOS products (all but ADS-B and AIS) are available only as '>30 days' historical data, 30 days old (or more) since the date of order submission with the exception of GNSS Radio Occultation (RO) profiles for which also '<30 days' live data can be requestedDistribution of GNSS-RO data is based on profile provision: each profile is a 'snapshot' of the conditions of the atmosphere in a specific location at a specific point in time and it contains several different information and observation files.
- PRO measurements are distributed per track
- Standard product delivery is completed within a maximum of three working days from the date of order submission for archive data, within one working day from the date of data acquisition for tasking orders
- Data are delivered to customers mainly via API
- Distribution of ADS-B and AIS is based on monthly subscription: the month is considered as "live product" if part of it is after the order submission date
- Order for ADS-B and AIS live data have to be finalized and sent to Spire in advance, at least 3 days before the sensing

3 Data users

- ➢ Access to data can be provided by ESA to users located in the territory of ESA Member States and ESA Cooperating/Associate States
- ➢ Access to Spire data is subject to further Spire control which might introduce limitations or even the rejection of the order: in this case, Spire will interact with the user to find the best possible solution

4 Assignment and usage of quota

Project Proposal submission and evaluation

A user requesting access to Spire products in the frame of the TPM shall submit a project proposal to ESA. During the project submission, the user shall specify their need as

- Type of data and amount of data
  - Polarimetric Radio Occultation (PRO)
    - Number of tracks
  - Grazing angle GNSS Reflectometry (GA GNSS-R) measurements
    - Number of tracks collections (older than 30 days)
  - Near-Nadir GNSS Reflectometry (NN GNSS-R) measurements
    - Number of tracks collections (older than 30 days)
  - GNSS-Radio Occultation profile
    - Number of profiles older than 30 days
    - Number of profiles no older than 30 days
  - Raw IF samples from GNSS-RO satellites
    - Number of collections (older than 30 days)
  - Raw IF samples from GNSS-R satellites
    - Number of collections (older than 30 days)
  - Ionosphere total electron content
    - Number of observations (older than 30 days)
  - Ionosphere scintillation
    - Number of observations (older than 30 days)
  - Electron density profile
    - Number of profiles (older than 30 days)
  - Combined Surface Soil Moisture
    - Number of grid cells (older than 30 days)
  - ADS-B Data Stream monthly subscription
    - Number of monthly subscriptions of Historical data
    - Number of monthly subscriptions of Live data
  - AIS messages monthly subscription
    - Number of monthly subscriptions of Historical data
    - Number of monthly subscriptions of Live data
- Time of interest
- Area of interest

During the evaluation process, the scientific content of a submitted project proposal is evaluated by ESA and Spire against the data requirements of the PI and a respective quota is granted to the PI allowing getting the requested data.

Order submission and data delivery

Upon acceptance of the project proposal by ESA, the PI is entitled to submit the order request, via email, to philip.jales@spire.com. Spire only requires a brief description of the type of data required, the region of interest, data time frame (start and end date) and a description of what the data will be used for.

The PI is not strictly constrained to order exactly the products requested into the proposal. The ordered products can change in type, AOI or TOI with respect to the original proposal provided that the new request is within the original assigned credits (e.g. if a Project has a quota per specific data type, the Project can exchange such quota for other data types if the total quota is not exceeded).

In case of request for live data, the order is evaluated by Spire's Maritime, Aviation and/or Weather teams and within 5 working days a feedback is provided to the user (if it is accepted or possible alternatives). The acceptance procedure is based on a quick cross-check of the end-user, data availability and verification that the data will not be used for commercial use or to develop commercial applications, Once approved by both parties, the acquisition event is scheduled.

In case of request for historical data, the order is submitted and confirmed to the PI via email within 5 working days from the order submission.

The quota shall be consumed within a year from assignment. After the validity period of 1 year, ESA reserves the right to remove the credits or to extend the end date.

Products are delivered via API. As soon as the requested data are available, the PI is notified by email about the data availability and instructed on the data retrieval procedure including instructions and keys to access the API. The retention time for data download is 30 days. Spire can also support the delivery of data via TCD and csv files if the API mechanism cannot be supported by the user.