The ESA Sentinel-5 Precursor (S-5P) is a pre-operational mission focusing on global observations of the atmospheric composition for **air quality** and **climate**.

The TROPOspheric Monitoring Instrument (**TROPOMI**) is the payload of the S-5P mission and is jointly developed by **The Netherlands and ESA**.

Enhanced radiometric sensitivity & spatial resolution enabling sampling of small-scale variabilities specifically in the lower troposphere.

The planned launch date for S-5P is during **2017** with a 7 year design lifetime.

**TROPOMI**

- UV-VIS-NIR-SWIR nadir view grating spectrometer.
- Spectral range: 270-500, 675-775, 2305-2385 nm
- Spectral Resolution: 0.25-1.1 nm
- Spatial Resolution: 3.5x7km²
- Global daily coverage at 13:30 local solar time.

**Contribution to Copernicus**

- Total column
  - O₃, NO₂, CO, SO₂, CH₄, HCHO
- Tropospheric column
  - O₃, NO₂
- O₃ profile
- UV Aerosol Index & Aerosol layer height
- Clouds
**Sentinel 5 Precursor**
COPERNICUS ATMOSPHERE MISSION IN POLAR ORBIT

**S-5P Satellite**

**Spacecraft**
- Mass: ~ 930 kg (TROPOMI ~204 kg)
- SA peak power 1,500 W
- Mass Memory: 480 Gbit

**Launch & Orbit**
- launcher: Rockot (Plesetsk)
- Near-polar, sun-synchronous
- MLTAN: 13:30 h
- Repeat cycle: 227 orbits / 16 days

**Downlink (‘science TM’)**
- downlink rate: 310 Mbps
- data volume: ~ 140 Gbits / orbit
- Ground stations: Svalbard (N) / Inuvik (Ca)
**TROPOspheric Monitoring Instrument**

**TROPOMI/UV-VIS-NIR** spectrometers developed as national contribution by The Netherlands Space Office (NSO)

Contractor: Airbus D & S NL (former Dutch Space)

SWIR module provided by ESA
The TROPOMI Measurement Principle

- Across track (swath)
- Wavelengths
- Flight direction
- ~7 km (1s flight)
- ~2600 km
### Improved Spatial Resolution

<table>
<thead>
<tr>
<th></th>
<th>UV</th>
<th>UVIS</th>
<th>NIR</th>
<th>SWIR</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Band</strong></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td><strong>Spectral coverage [nm]</strong></td>
<td>270 – 320</td>
<td>320 – 495</td>
<td>675 - 775</td>
<td>2305 – 2385</td>
</tr>
<tr>
<td><strong>Full spectral coverage [nm]</strong></td>
<td>267 - 332</td>
<td>303 - 499</td>
<td>660 - 784</td>
<td>2299 - 2390</td>
</tr>
<tr>
<td><strong>Spectral resolution [nm]</strong></td>
<td>0.49</td>
<td>0.54</td>
<td>0.38</td>
<td>0.25</td>
</tr>
<tr>
<td><strong>Spectral sampling ratio</strong></td>
<td>6.7</td>
<td>2.5</td>
<td>2.8</td>
<td>2.5</td>
</tr>
<tr>
<td><strong>Spatial sampling [km²]</strong></td>
<td>7 x 28</td>
<td>7 x 3.5</td>
<td></td>
<td>7 x 7</td>
</tr>
</tbody>
</table>
Improved Spatial Resolution

**S-5P vs SCIAMACHY, GOME-2, OMI:**
- Smaller pixels: 3.5x7 km²
- Larger swath-width with daily global coverage

**S-5P Data Volume:**
- ~1.5 million ground pixels/orbit
- L1: ~35 Gbyte/orbit
- L2: ~3.5 Gbyte/orbit
Improved Spatial Resolution

From OMI to TROPOMI

Data from the ISOTROP project
Atmospheric Composition Monitoring with European Sensors

- E39C-A, Stenke et al., ACP 2009
- GOME/SCIAMACHY/GOME-2, Loyola et al., IJRS 2009 – CCI data set

- GTO–ECV_v0
- E39C-A SCN–B2d

June 1995

~35 years

Ozone Anomaly [DU]
S5-P is planned to observe within 5 min. of Suomi-NPP.

Primary goal is to use VIIRS cloud mask for S-5P methane observations.

Other opportunities:

- TROPOMI-VIIRS cloud and aerosol combined products.
- TROPOMI-OMPS-CRIS ozone profiles.
- TROPOMI-OMPS inter-calibration.
**Sentinel 5 Precursor**

COPERNICUS ATMOSPHERE MISSION IN POLAR ORBIT

---

**Ground Segment Overview**

- **S-5P**
- **S/X-band recorded TM**
- **AS Svalbard (S/X-band)**
- **AS Inuvik (S/X-band)**
- **Kiruna TTC Station**
- **S-NPP OSPO (*)**

---

**Payload Data Ground Segment**

- Processing & Archiving
- Service Monitoring
- Product Quality Monitoring
- User Service Interfacing

---

**Flight Operations Segment**

- **S/C commanding & monitoring**
- Flight Dynamics analysis
- Spacecraft planning

---

**ESOC (Darmstadt)**

- **TROPOMI configuration & task planning**
- **Station planning**
- **Schedule increment: downlink & TROPOMI tasks**

---

**S-5P Ground Segment status:**

Ready to support launch. Access to S-5P core products will be managed by ESA using the same approach as for the other Sentinels.
**Sentinel 5P Commissioning Phase - E1**

**S-5P: Phase E1 planning**

- **Preparatory tasks** (ongoing)
- **Launch**
- **Launch & Early In Orbit Operation [LEOP]**
  - **L + 24 h**
  - equipment switch-on (TROPOMI at L + 4 weeks), verification & S/C commissioning
  - **L + 6 weeks**
  - initial TROPOMI calibration; L1B check-out
  - **L + 12 weeks**
  - Systematic L1B processing; error budget compilation; L2 functional checks
  - **L + 16 weeks**
  - stable TROPOMI operations & processing
  - **L + 6 months**
  - E2: routine operations & long-term validation

**ESA UNCLASSIFIED - For Official Use**

- **Pre-launch validation & planning**
- **Orbit injection & initial platform check-out**
- **Initial X-band data for PDGS validation tasks**
- **Algorithm checks & verification of PDGS processing chains (L1B & calibration)**
- **Algorithm checks & verification of processing chains (L2 included)**
- **L + 4 ... 6 months: Products for specific applications; contents non-validated**
- **From L + 6 months: Products for CalVal projects; contents non-validated, long-term validation projects**
A S-5P Validation Team (S5PVP) has been established based on an AO Call that was issued during 2014 and includes 36 Projects

A S5PVT Workshop took place during October 2015

An ACVE meeting is planned this month at ESRIN (Oct. 18-20)

The project on the S5P Mission Performance Centre has started early 2016 and a central Validation Data Base (EVDC) has been established

Dedicated ESA projects are ongoing to support the measurements of (e.g. PANDORA, MaxDOAS) atmospheric composition reference validation data sets

Preparation of specific measurement campaigns (e.g. CINDI-2, AROMAT, EMeRGe) is ongoing
Expected Contributions to CCI and C3S

- Extension of existing atmospheric ECVs (e.g. Ozone, Methane, Aerosols, Clouds)
- Providing input data to planned atmospheric CCI+ projects (e.g. Precursors of Ozone and Aerosols ECVs)
- Fill the gap to the upcoming atmospheric Sentinels (e.g. S-5)
- AQ Constellation: S-5P serving as ‘Transfer’ mission among several geostationary Air Quality instruments/missions (EU – S-4, South Korea - GEMS, USA - TEMPO)