

Status of the Sentinel-5 Precursor

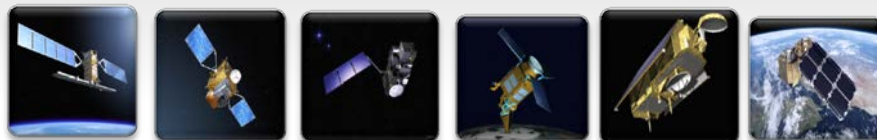
*Presented by C. Zehner
S5p, S4, and S5 Missions Manager - ESA*

European response to global needs:

- to manage the environment,
- to mitigate the effects of climate change and
- to ensure civil security

European independence, contribution to global system (GEOSS)

Copernicus Space Component



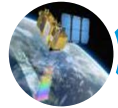
Copernicus Services Component

Sentinel Launches



S1A/B: Radar Mission

3 Apr 2014/25 Apr 2016



S2A/B: High Resolution Optical Mission

23 June 2015/6 March 2017



S3A/B: Medium Resolution Imaging and Altimetry Mission 16 Feb 2016/2017



S4A/B: Geostationary Atmospheric Chemistry Mission

2022



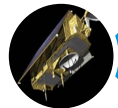
S5P: Low Earth Orbit Atmospheric Chemistry Mission

2017



S5A/B/C: Low Earth Orbit Atmospheric Chemistry Mission

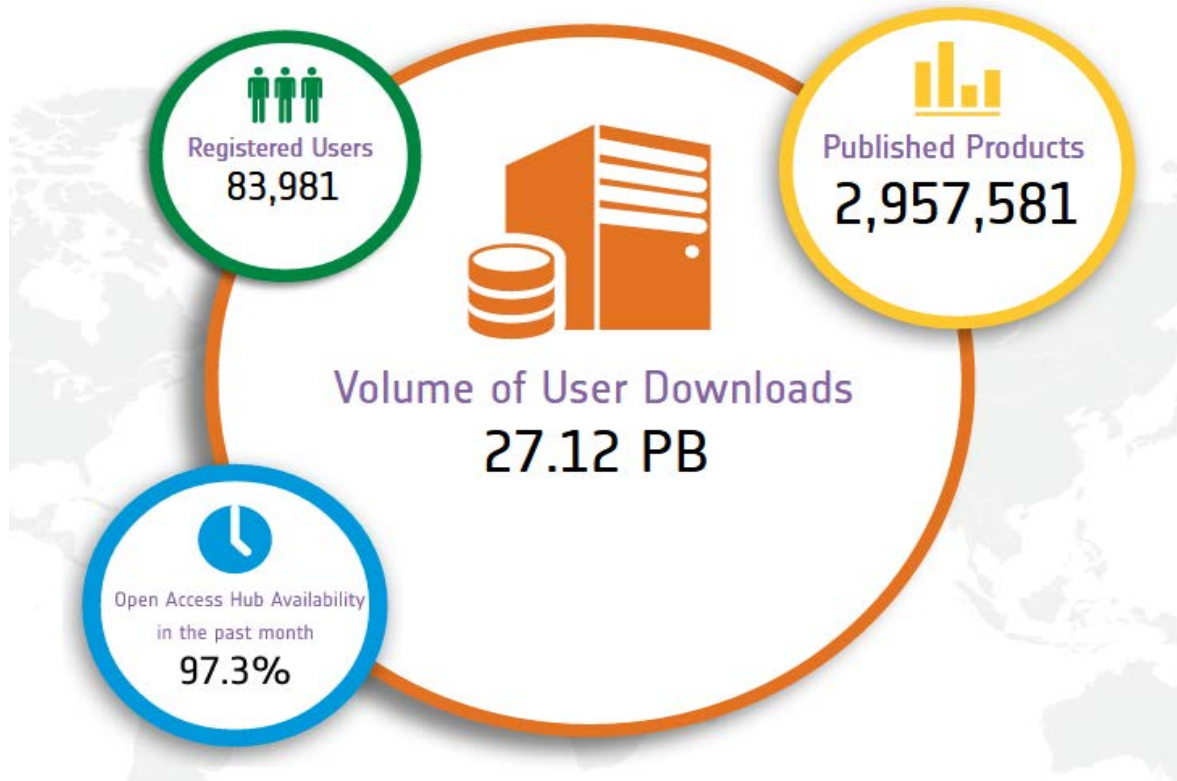
2021



S6A/B: Altimetry Mission

2020

**Statistics on 15
June 2017**



Sentinel-5 Precursor

COPERNICUS ATMOSPHERE MISSION IN POLAR ORBIT



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**.

S-5P will provide **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 September **2017**.

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.



Improved Spatial Resolution



GOME
OMI

SCIAMACHY
TROPOMI

GOME-2



S-5P vs SCIAMACHY, GOME-2, OMI:

- Smaller pixels: $3.5 \times 7 \text{ km}^2$
- Larger swath-width (2600 km) with daily global coverage

S-5P Data Volume:

- ~1.5 million ground pixels/orbit
- L1: ~35 Gbyte/orbit
- L2: ~3.5 Gbyte/orbit
- Total: ~ 640 Gbyte/day

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European Space Agency

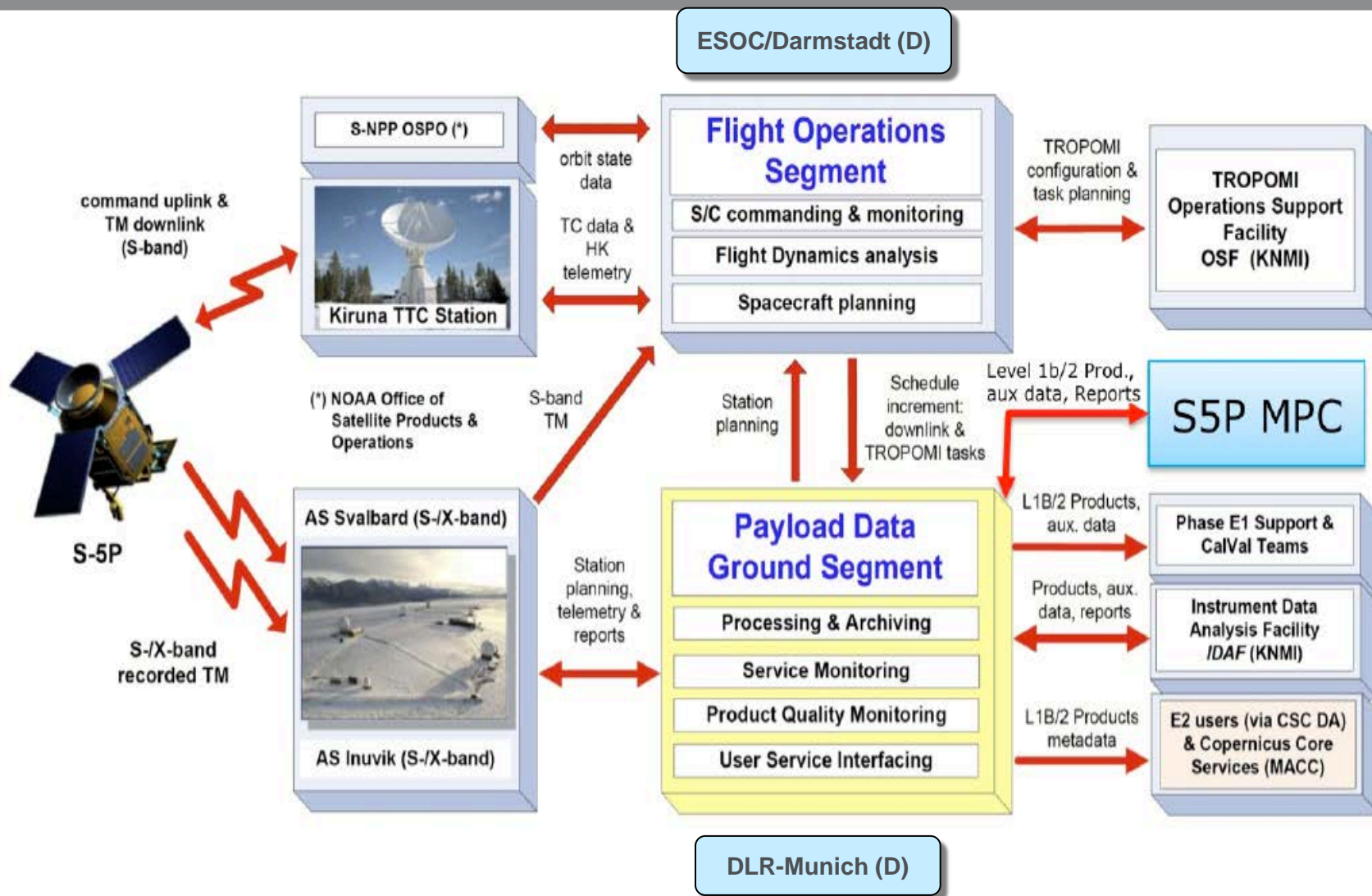
Sentinel-5P Mission Status



- A test for characterising TROPOMI out-of-band straylight performance of NIR has been successfully concluded:
 - the test set-up exercise took place before the Christmas break with an intensive test programme immediately afterwards from 4th January to the 12th
 - data analyses/development of straylight corrections for the L0-L1b ground processor for NIR measurements is ongoing
- As of 26th January the satellite was returned to storage at Stevenage
- Until end of July 2017 to be shipped to Plesetsk (Russia – Rockot Launcher)
- **Launch:** planned during September 2017



S-5P Ground Segment



Sentinel-5 Precursor Products



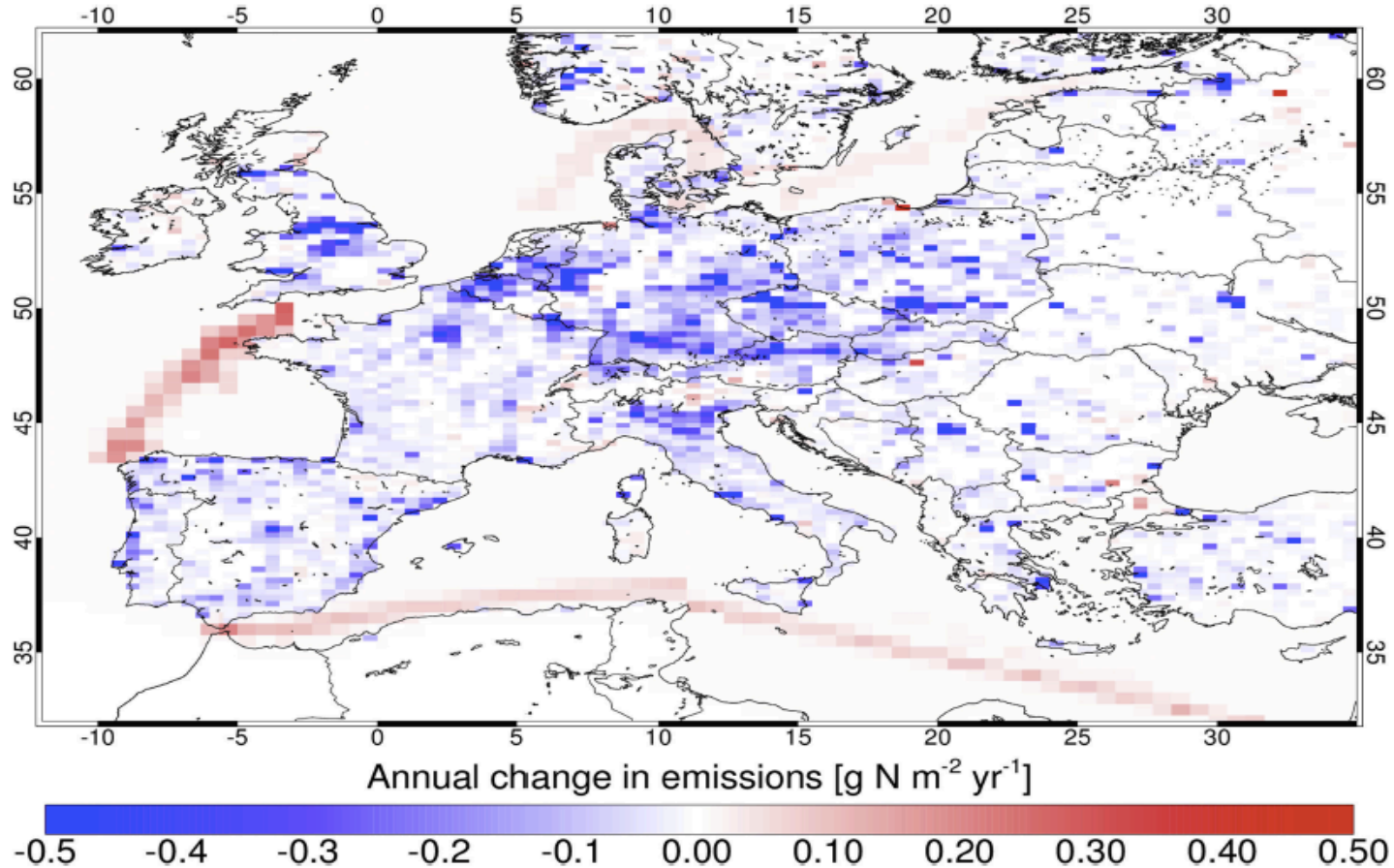
Product	Description
Level 1B	Calibrated, geo-located Earth radiance & solar irradiance spectra
Level 2	<p><i>Column Densities/Profiles for Sentinel-5 Precursor Primary Species:</i></p> <p><i>UVN Channel Products</i></p> <p>O₃ total & tropospheric columns, profiles NO₂ total & tropospheric columns SO₂, HCHO total columns aerosols aerosol index & aerosol layer height clouds cloud fraction, top height, optical thickness</p>
	<p><i>SWIR Channel Products</i></p> <p>CO, CH₄ total columns</p>

- Routine dissemination of global L1B & 2 products over design lifetime of 7 years
- Near real time service for most data products (e.g. Not Time Critical: CH₄, Tropospheric Ozone)



NO_x Pollution over Europe - OMI Data

Annual changes in OMI NO_x emissions (2005-2008)



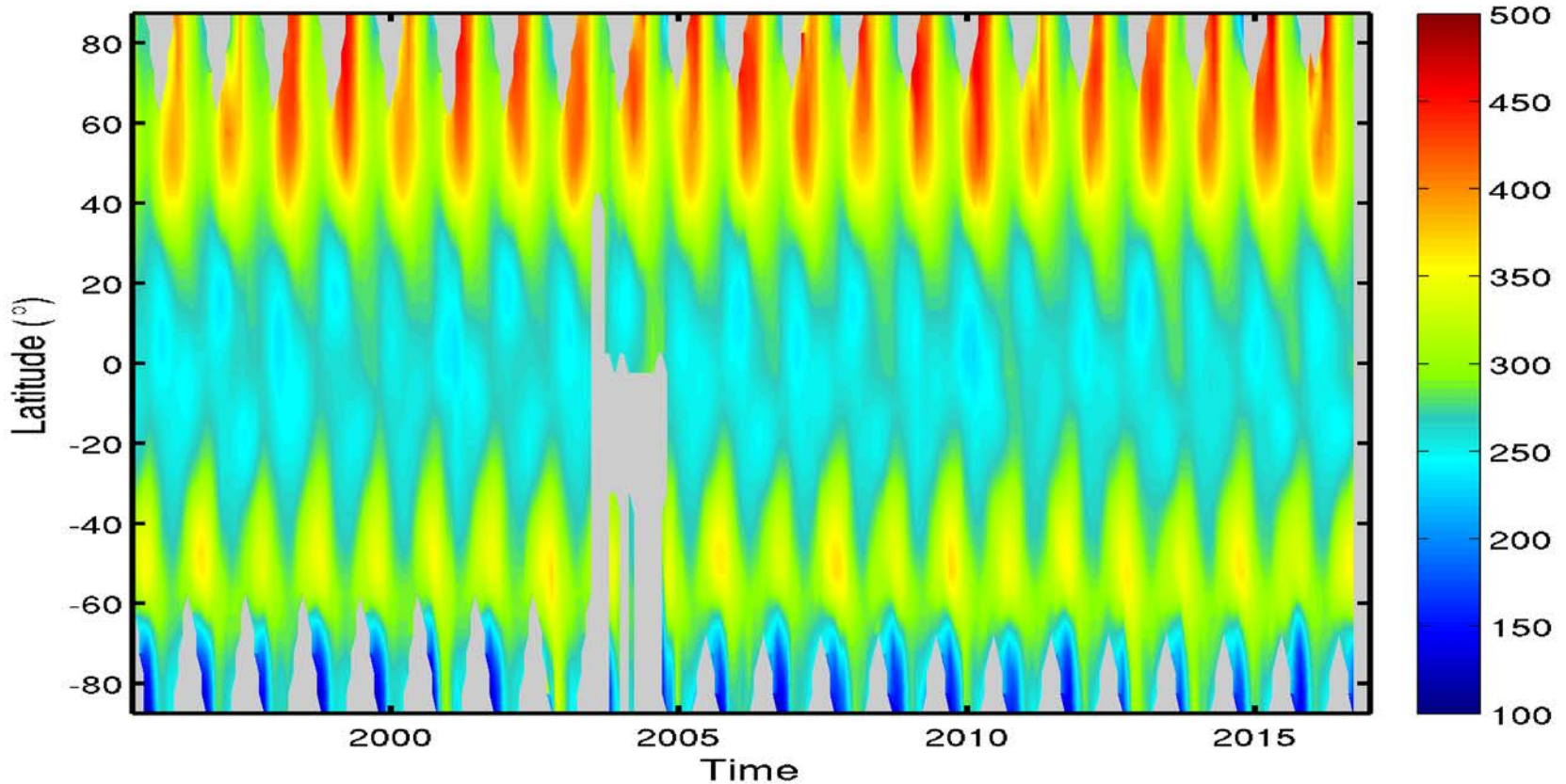
Quality Assurance for Essential Climate Variables (EU FP7 project QA4ECV, lead by KNMI (F. Boersma), www.qa4ecv.eu

Total Ozone Time Series



Ozone Climate Change Initiative Project: esa-ozone-cci.org

GOME/ERS2+OMI/AURA Total O₃ zonal means (DU)



produced by BIRA/IASB (C. Lerot)

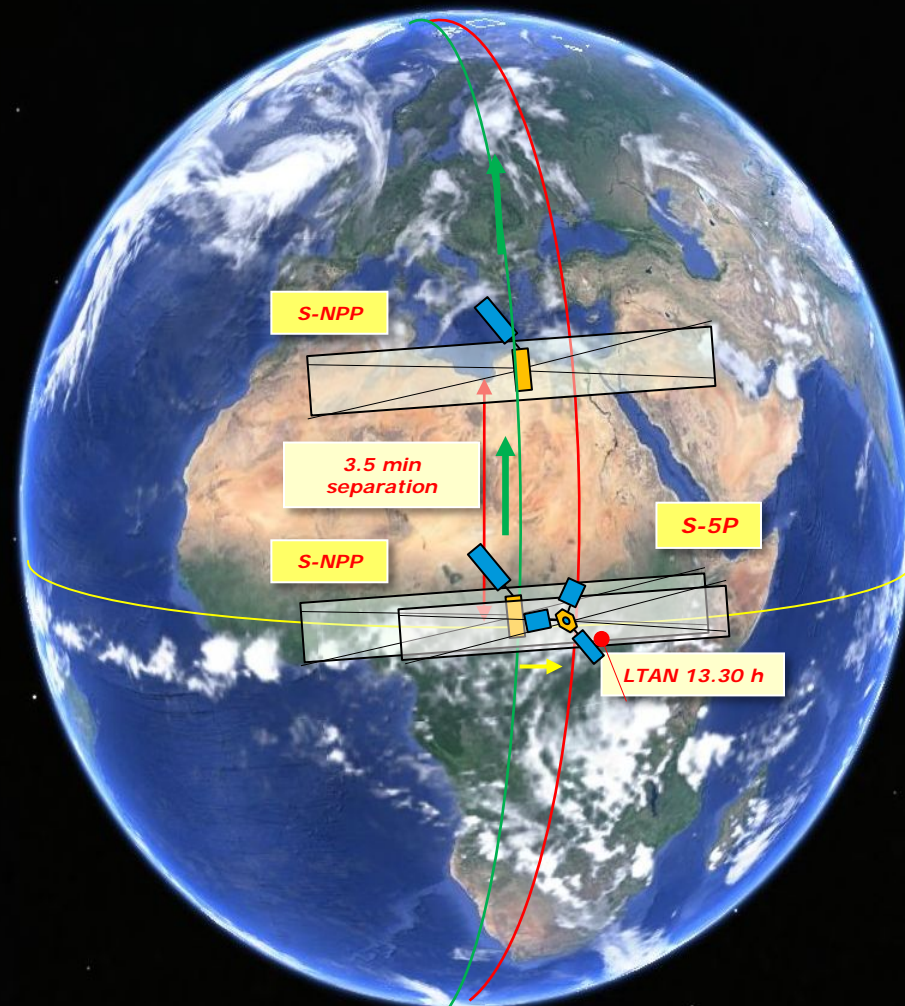
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Joint Operation S-NPP + Sentinel 5P

- **CH₄ challenging accuracy requirement (< 2 % TC) -> select only cloud-free pixels**
- **Use Suomi-NPP / VIIRS cloud mask data at high resolution covering TROPOMI SWIR & NIR pixels**
- **'loose' formation S5P + S-NPP -> along track separation 3.5 min**

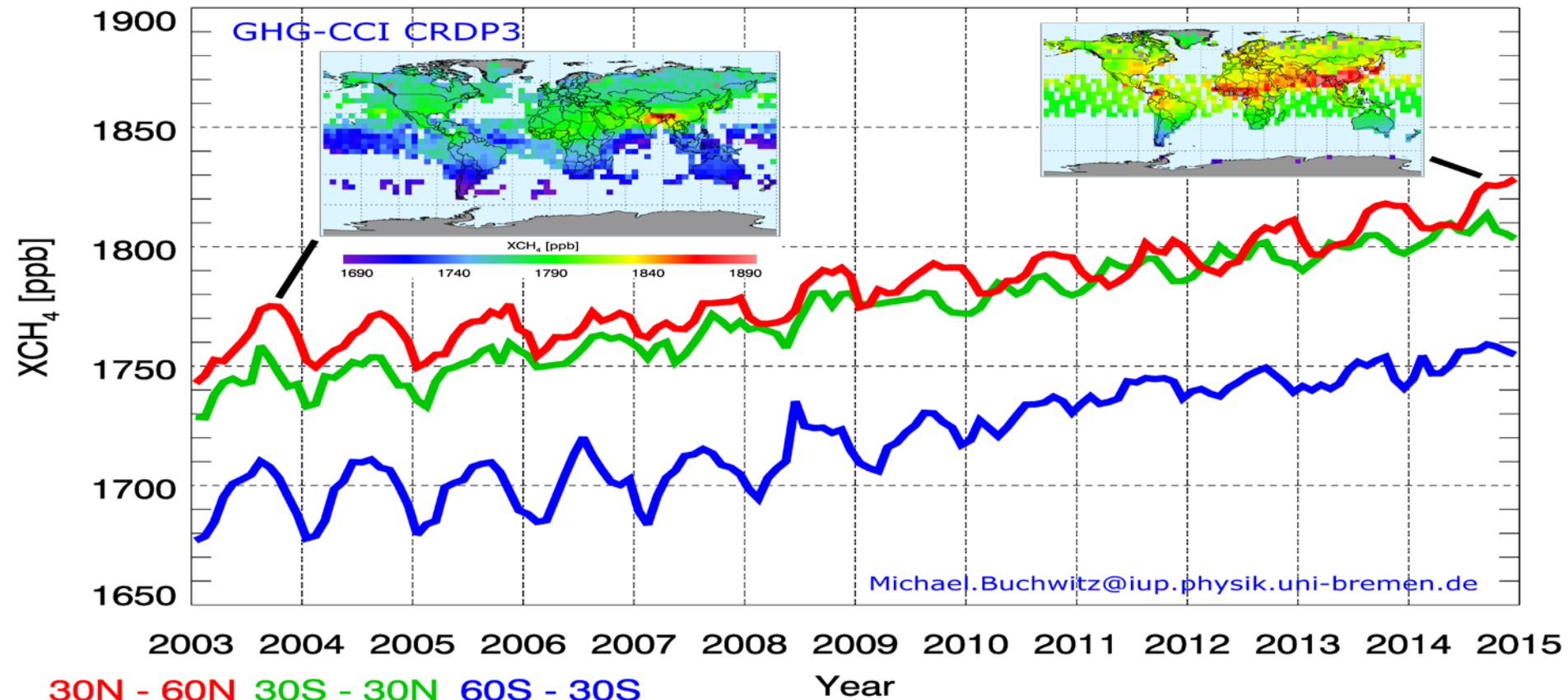


Methane Time Series



GHG Climate Change Initiative Project: esa-ghg-cci.org

Methane SCIAMACHY/ENVISAT & TANSO-FTS/GOSAT



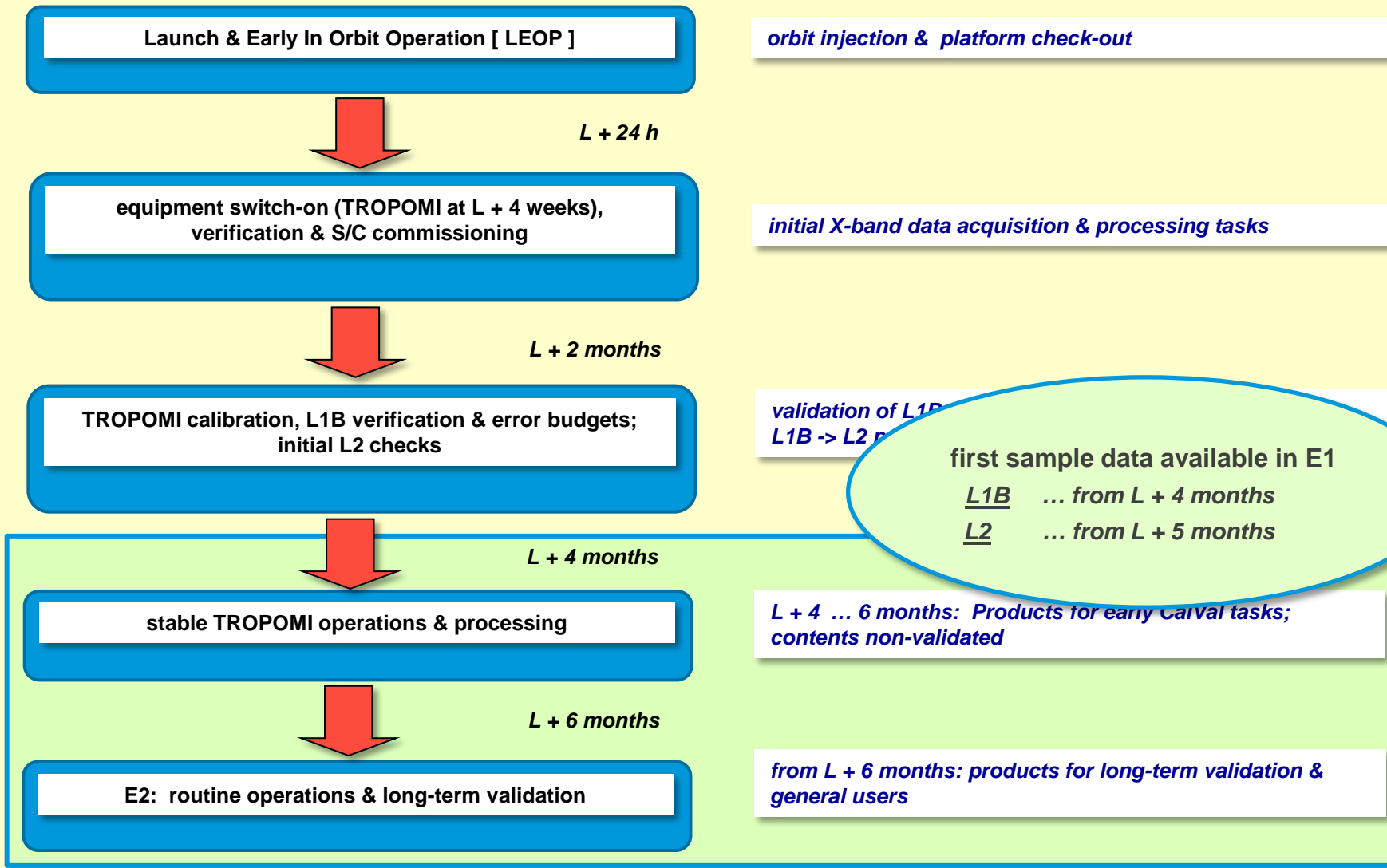
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produced by University Bremen (M. Buchwitz)



European Space Agency

Sentinel-5P: Phase E1 Tasks



Ramp-up Phase Planning



IOCR (launch + 6 months) – In-Orbit Commissioning Phase Review

End of Commissioning Phase



IOCR + 1 month

Release of operational Level 1 data products



IOCR + 4 months – MTR – Mid-Term Review

First release of operational Level 2 data products (OMI-λ)



IOCR + 8 months - RORR - Routine Operation Readiness Review

Release of all operational Level 2 products (also SWIR)



S-5P/TROPOMI: Ready for Launch!



Sentinel-4 (geo-stationary orbit)



Applications:

- air quality, climate and stratospheric ozone and solar radiation monitoring (e.g. ozone, NO₂, SO₂, BrO, CHOCHO, formaldehyde and aerosol) at high temporal resolution (hourly)
- more insight into tropospheric variability

Narrow field spectrometer covering UV (305-400 nm), visible (400-500 nm) and near-IR (750-775 nm) bands

Spatial sampling 7 x 7 km² and spectral Resolution between 0.12 nm (near-IF) and 0.5 nm (UV, visible)

Embarked on MTG-Sounder Satellite and operated by EUMETSAT

Planned launch: 2022



Sentinel-5 (polar orbit)



Applications:

- air quality, climate and stratospheric ozone and solar radiation monitoring (e.g. ozone, NO_2 , SO_2 , BrO, formaldehyde, CH_4 , and aerosol) at high temporal (daily) resolution
- tropospheric & stratospheric composition

5 channels covering UV (270-400 nm), visible (400-500), NIR (685 -710 nm) & (745-773 nm) and SWIR-1 (1559 – 1675 nm), and SWIR-3 (2305 -2382 nm) bands.

spectral resolution between 0.25 nm and 1.1 nm

Sentinel-5 embarked on post-EPS and operated by EUMETSAT

Planned launch: 2021

