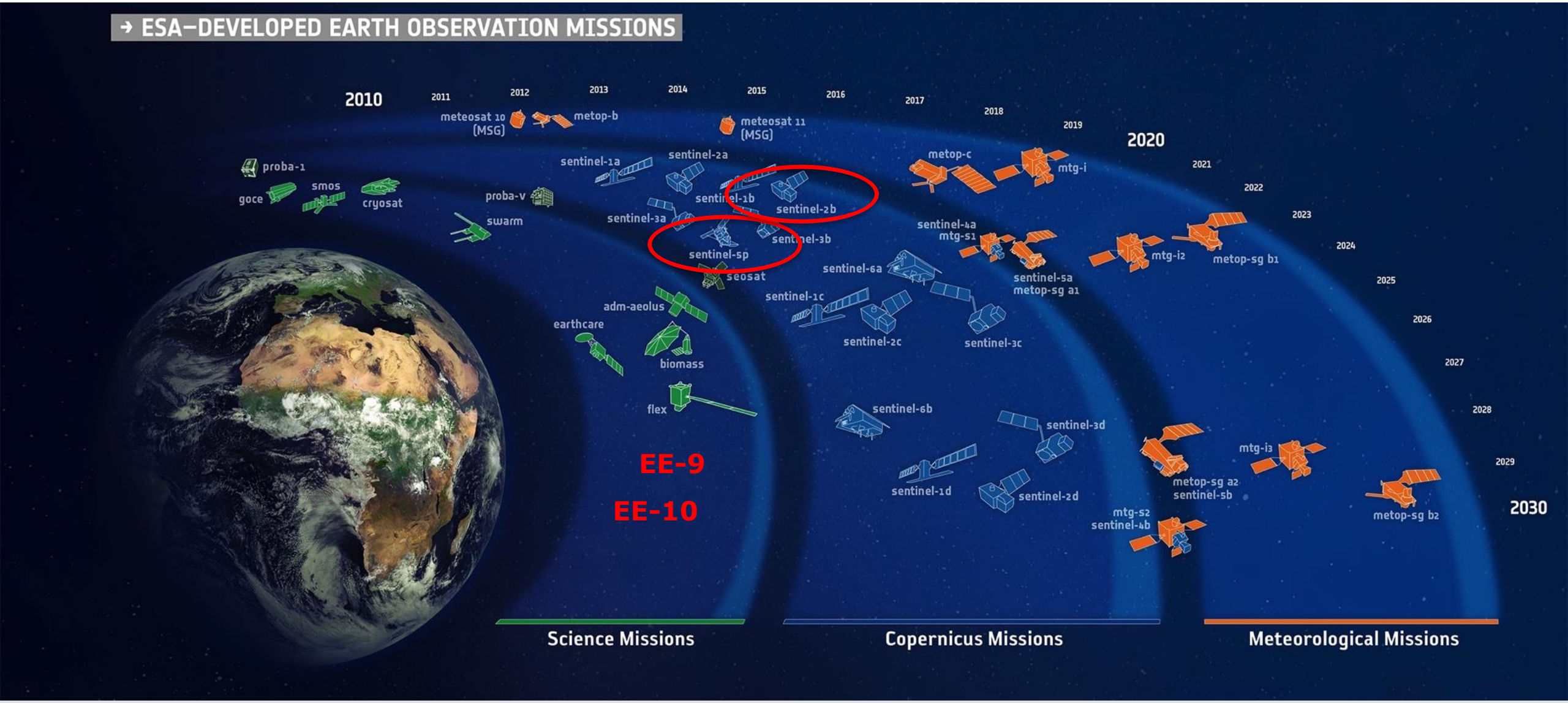
Status of ESA EO Programmes

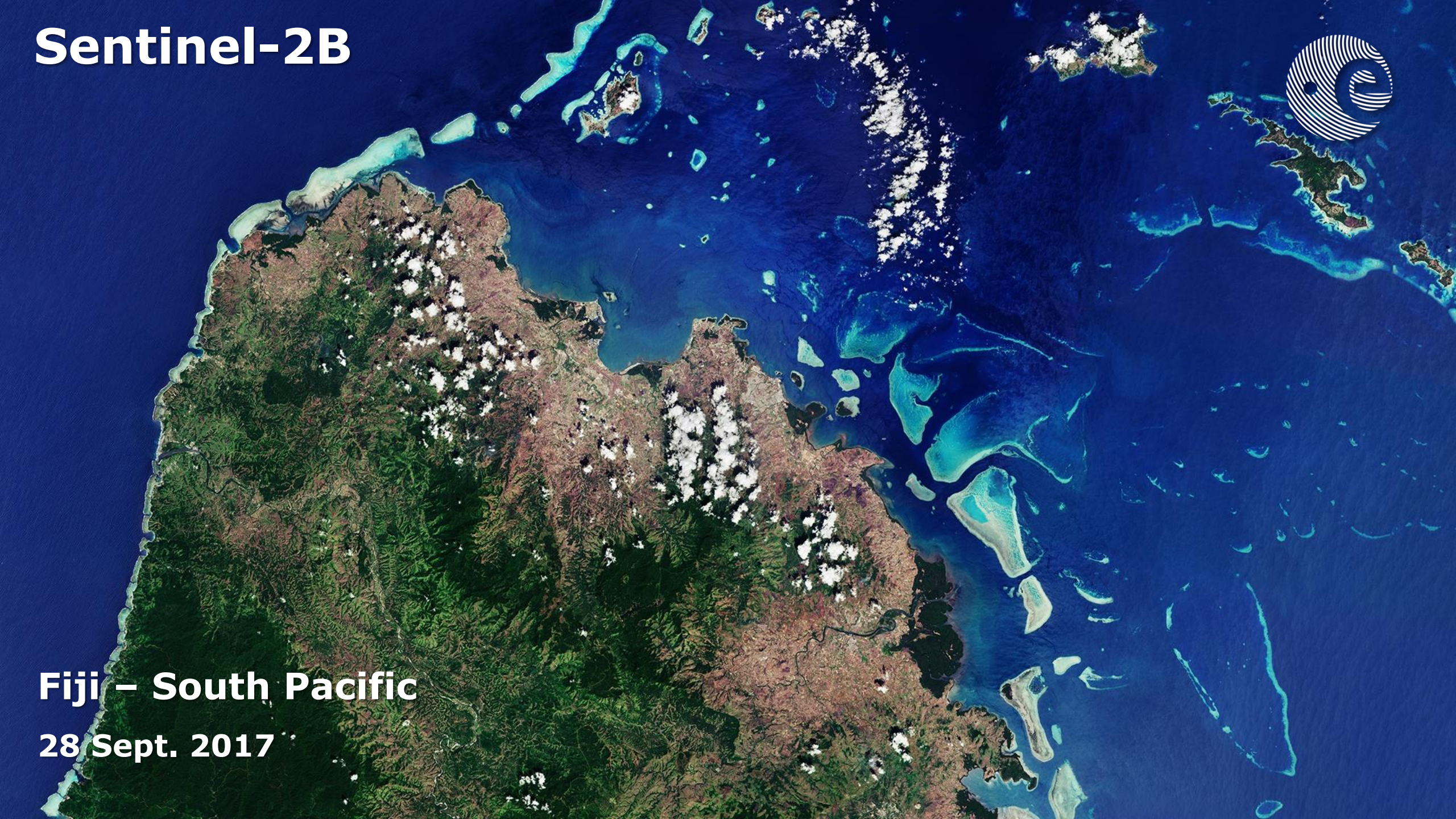
54th ESSC Plenary Meeting
24 November 2017

Maurice Borgeaud, ESA
Head of the ESA Earth Observation Science, Applications and Climate Department

ESA Earth Observation Programmes

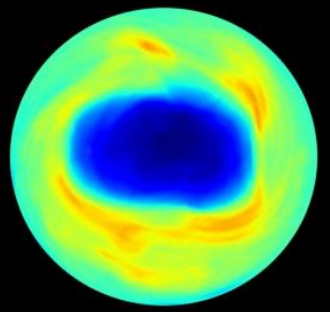


Two Successful Sentinel Launches

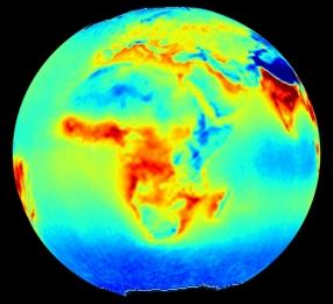

Sentinel-2B
Fiji – South Pacific
28 Sept. 2017

Sentinel-5P Air Quality Monitoring

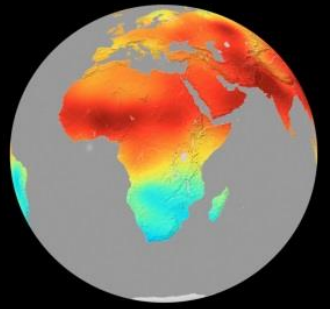
Nitrogen dioxide



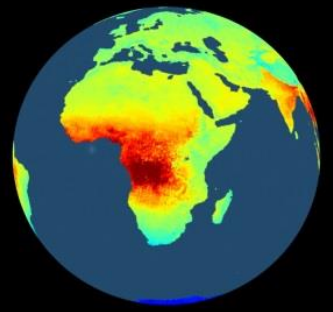
Ozone



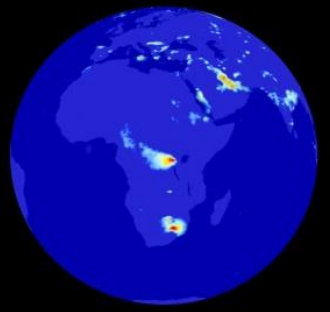
Formaldehyde



Methane



Carbon monoxide



Sulphur dioxide

Sentinel-5 Precursor

The ESA **Sentinel-5 Precursor (S-5P)** is the first atmospheric Sentinel 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 be 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 **13 October 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: 7x3.5 km^2
- Global daily coverage at 13:30 local solar time

Sentinel-5 Precursor Products

Product	Description
Level 1B	Calibrated, geo-located Earth radiance & solar irradiance spectra
Level 2	*Column Densities/Profiles for Sentinel-5 Precursor Primary Species:* *UVN Channel Products* O_3 total & tropospheric columns, profiles NO_2 total & tropospheric columns SO_2, HCHO total columns aerosols aerosol index & aerosol layer height clouds cloud fraction, top height, optical thickness
	SWIR Channel Products CO, CH_4 total columns

- Near Real Time delivery of unconsolidated L1B and all L2 products except CH4, and Tropospheric Ozone
- Non Time Critical (NTC) delivery of L1B within 12 hours and L2 data within 5 days

Sentinel-5P LEOP all Green after 36 hrs

united space in europe

ESA

Sentinel Launch Overview

S-1

Radar

A 3 Apr. 2014

B 25 Apr. 2016

S-2

High Resolution Optical

A 23 Jun. 2015

B 6 Mar. 2017

S-3

Medium Resolution Optical & Altimetry

A 16 Feb. 2016

B 2018

S-4

Atmospheric Chemistry (GEO)

A 2021

B 2027

S-5P

Atmospheric Chemistry (LEO)

A 13 Oct. 2017

S-5

Atmospheric Chemistry (LEO)

A 2021

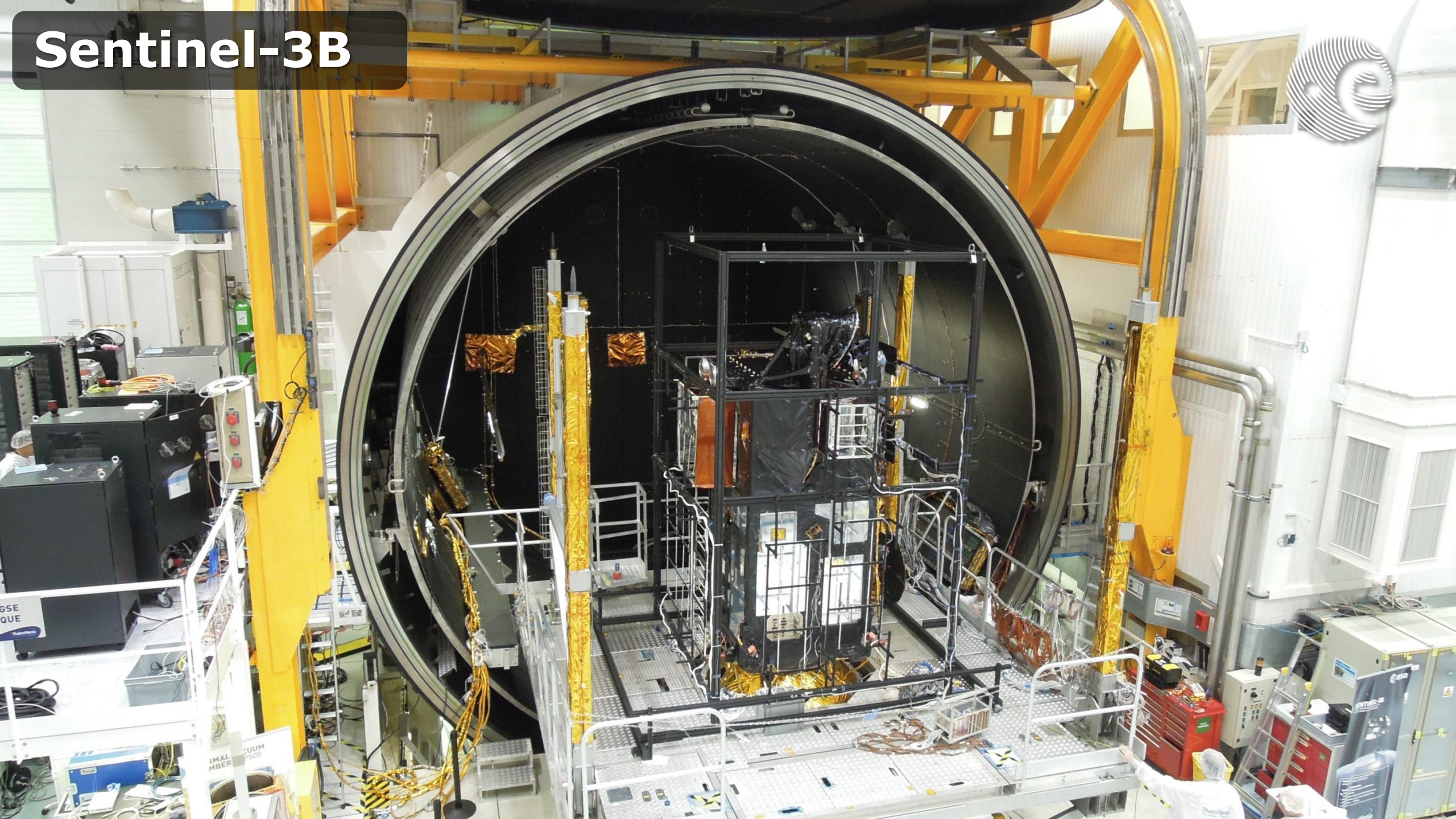
B 2027

S-6

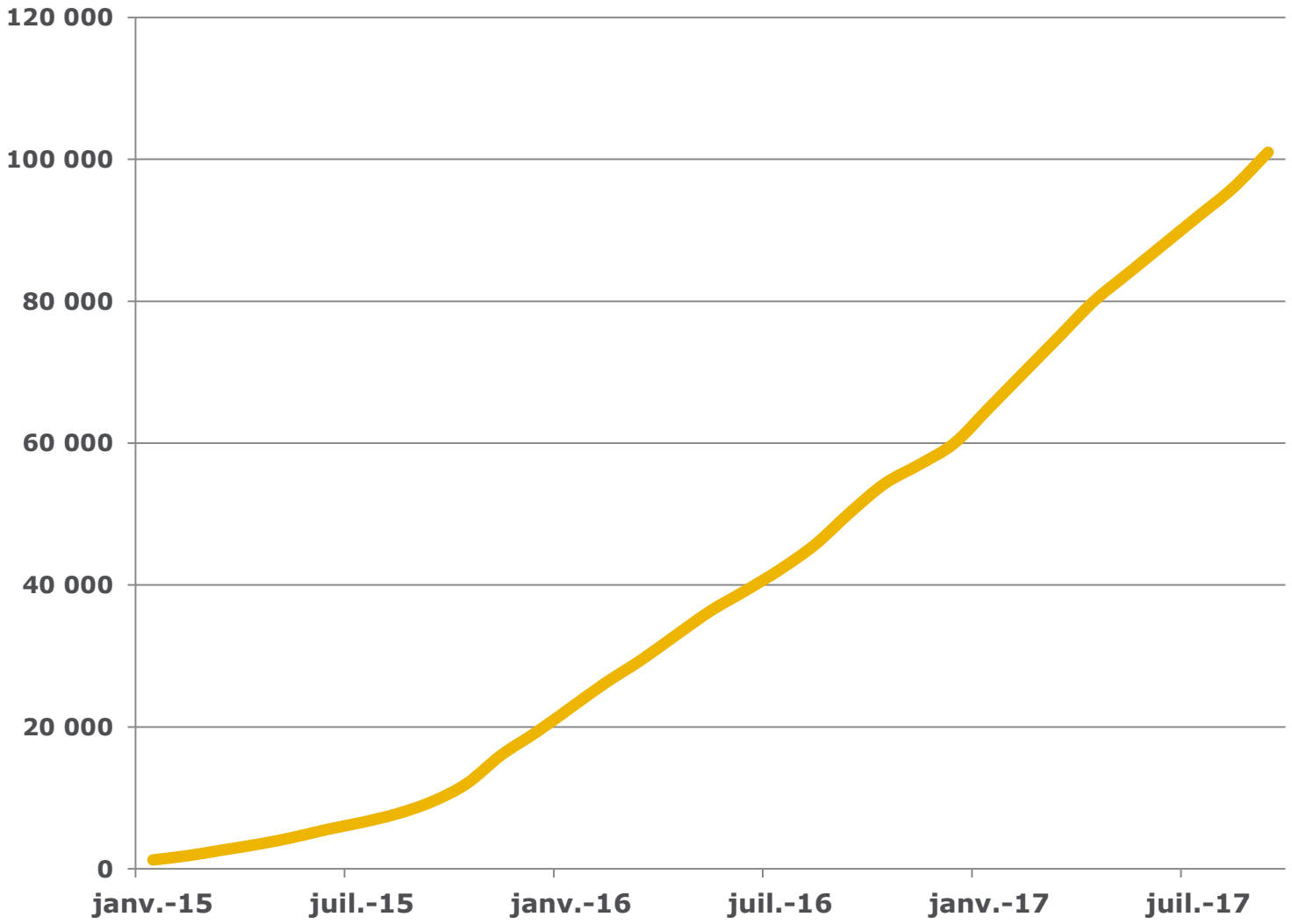
Altimetry

A 2020

B 2025


Sentinel-3B

Copernicus User Uptake

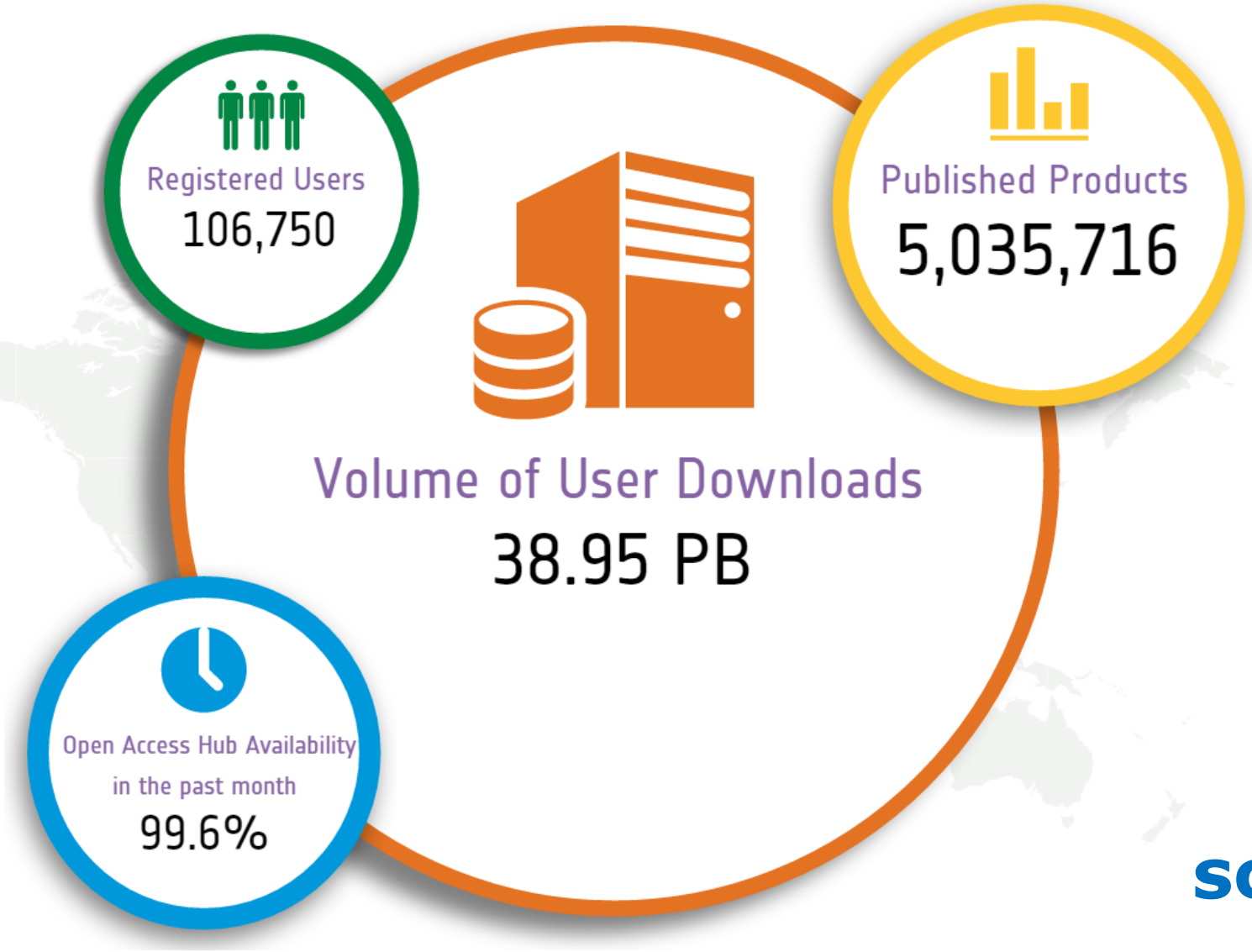


Sentinel Registered Users

Real number of users is much higher but unknown due to the "open" data policy.

Free, full & open data policy

Sentinels: Data Access Stats

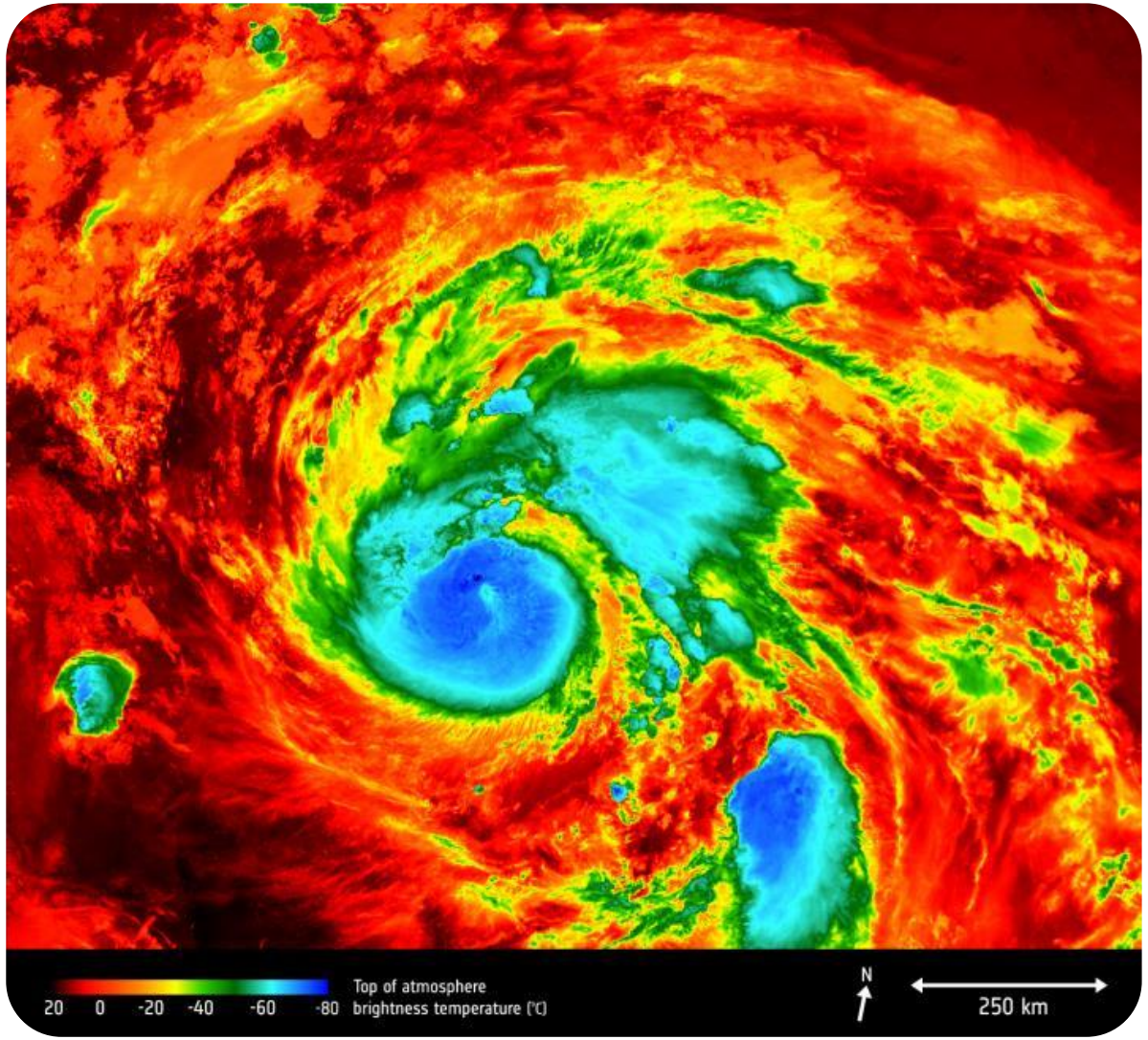


16 Nov. 2017

Source: Open Access Data Hub

scihub.copernicus.eu

Hurricane Harvey

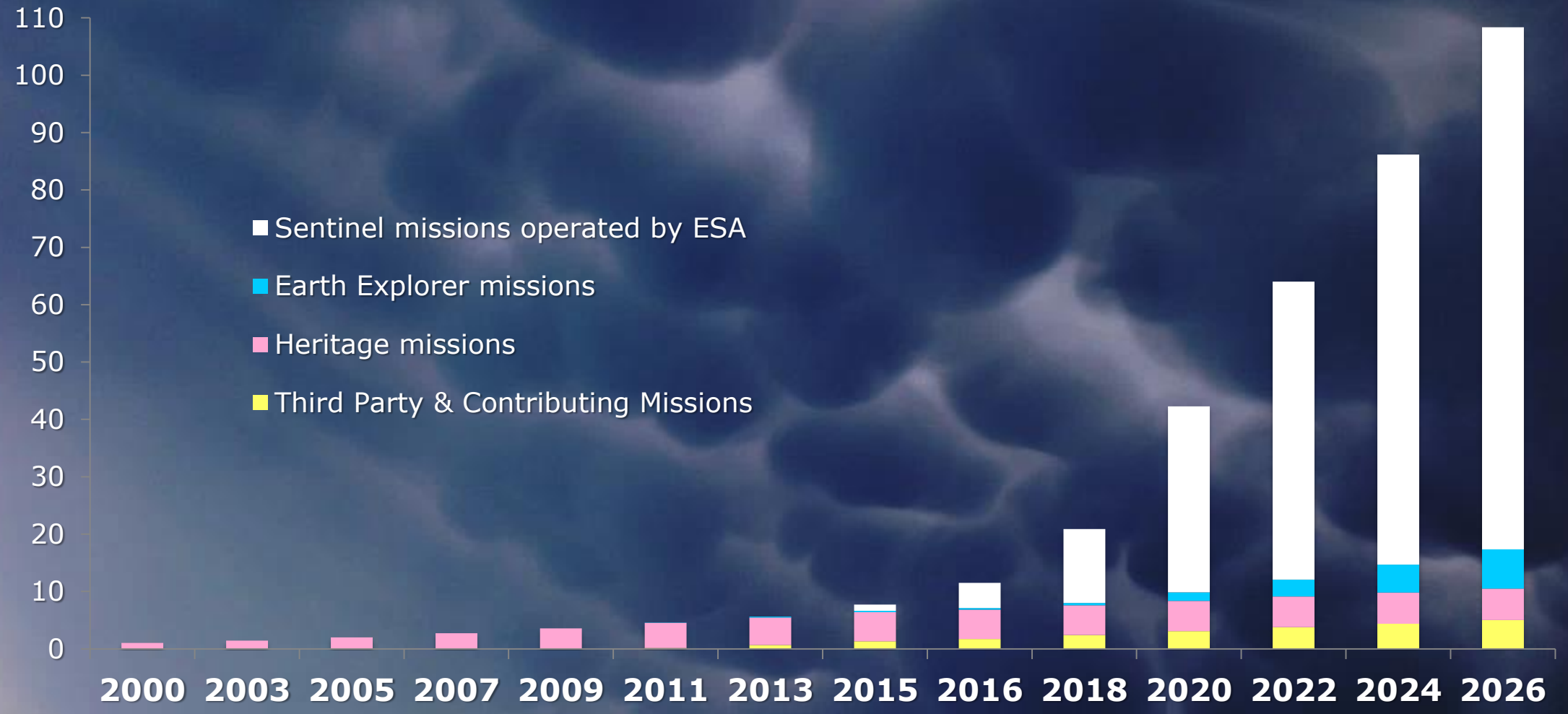


< Temperature at the top of the storm as it approaches Texas

25 August 2017
Based on Sentinel-3A data

Big Data Revolution

ESA EO Data Archive, in Petabyte



Expansion Copernicus (Sentinel 7, 8, 9, …)

Envisaged Candidates

Anthropogenic CO_2

Agriculture/Urban

Agriculture/Mining

Agriculture/Polar

Polar Ice & Snow

Polar Floating Sea Ice

Copernicus Space Component Evolution

2014

Current Sentinels

Sentinel **Expansion**

Next-Gen. missions will replace current & expansion missions

Sentinel **Next Generation**

Copernicus **for Security**

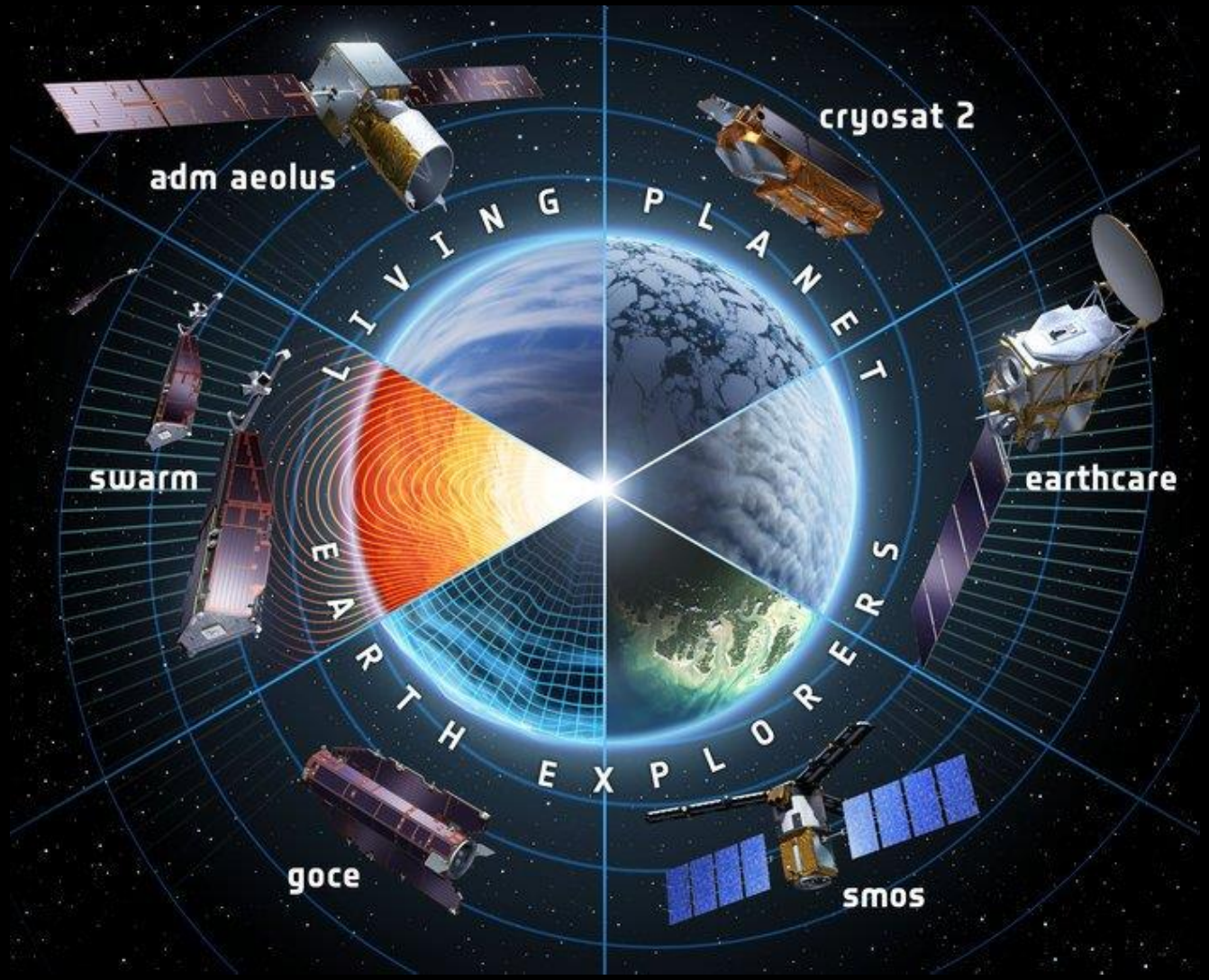
Climate Change Initiative Extension (CCI+)

Four Lines of Activity

- R&D on existing ECV
- New ECV
- Knowledge Exchange
- Cross-ECV Scientific Exploitation

ESA's Climate Change Initiative

Earth Explorers: EO Science Missions



GOCE	2009 - 2013
SMOS	2009 - Present
Cryosat	2010 - Present
SWARM	2013 - Present
ADM - Aeolus	2018
EarthCARE	2019
Biomass	2021

Upcoming Earth Explorers

5

Aeolus

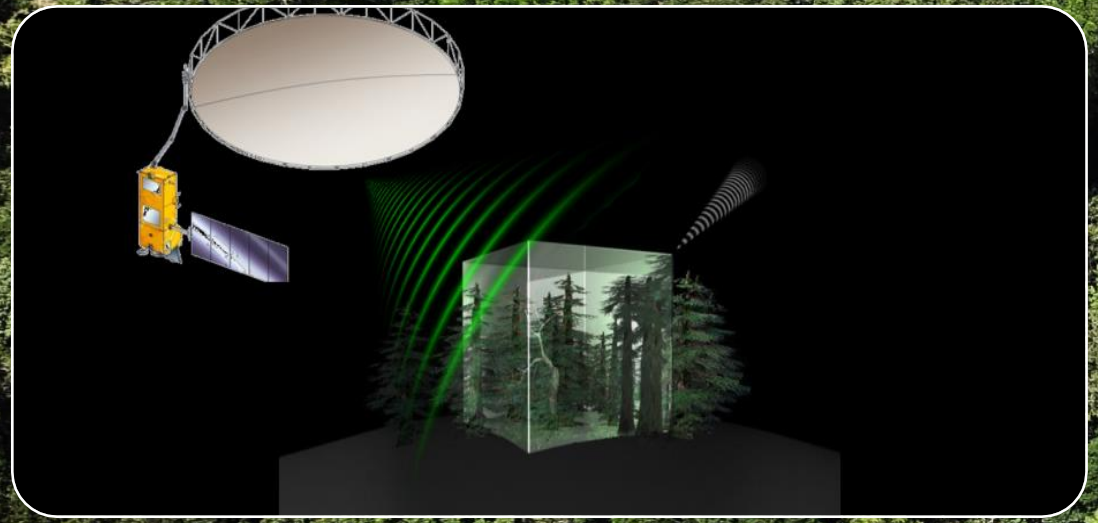
- Global observations of wind profiles for analysis of global 3D wind field
- Launch planned for 2018

6

EarthCARE

- Global observations of clouds, aerosols & radiation
- Cooperation with JAXA
- Launch planned for 2019

Further Earth Explorers



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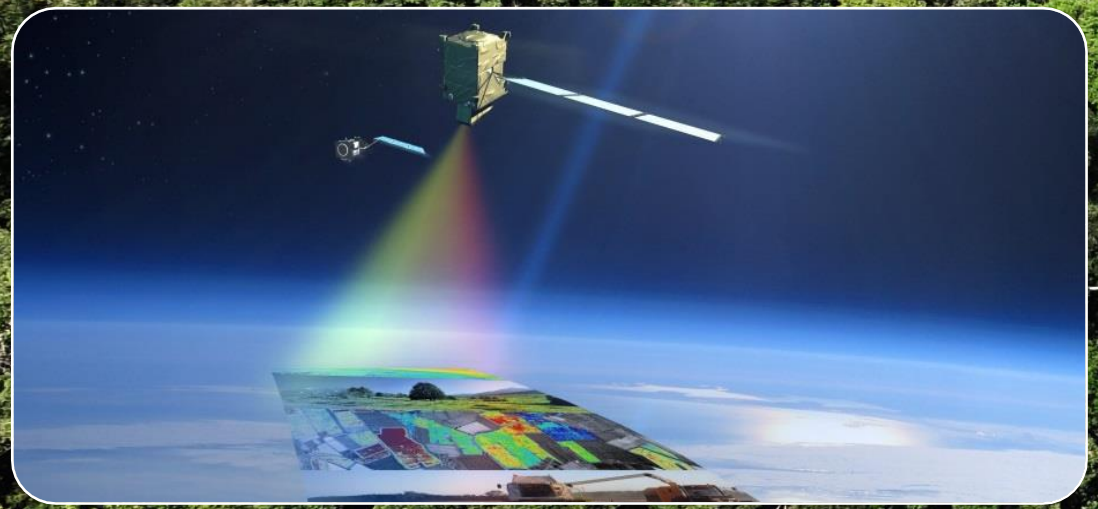
Biomass

- Biomass estimates based on global radar observations
- Launch planned for 2021



8

FLEX

- Global maps of vegetation fluorescence, an indicator of photosynthetic activity
- Launch planned for 2022

Earth Explorers 9 & 10

9

2 Candidates

- **FORUM**
- **SKIM**

Launch around 2025

10

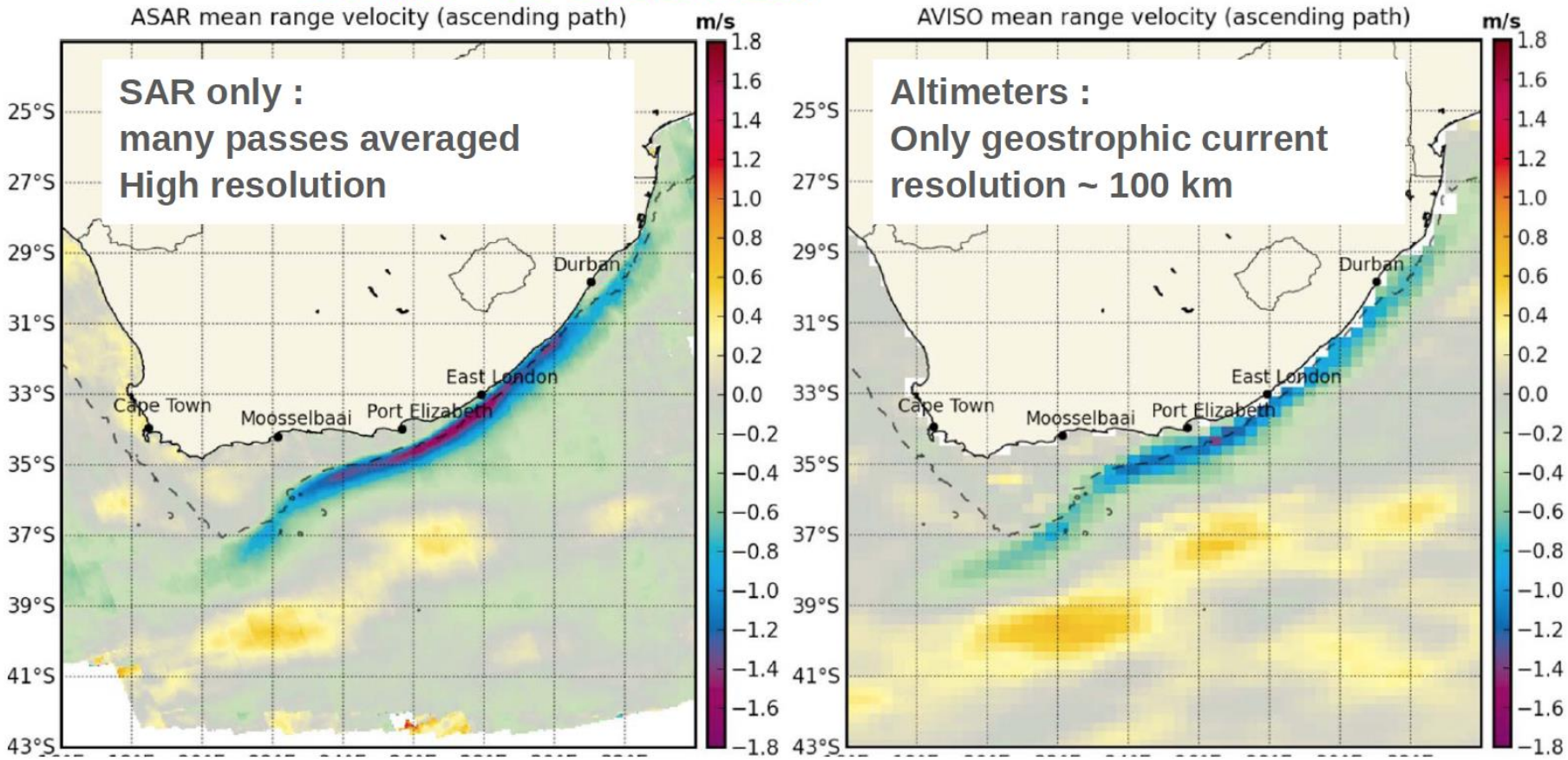
- Call for Ideas Phase
- Letters of intent due in Dec. 2017
- Mission idea proposals by Mar. 2018
- Launch around 2027/28

EE-9 Candidate: SKIM

SKIM will give total surface current on each pass at high resolution

Accuracy ~ 0.3 m/s on 6 km footprint (~ 0.7 m/s with Envisat, ?? with S1)

~ 0.15 m/s in ice-covered ocean

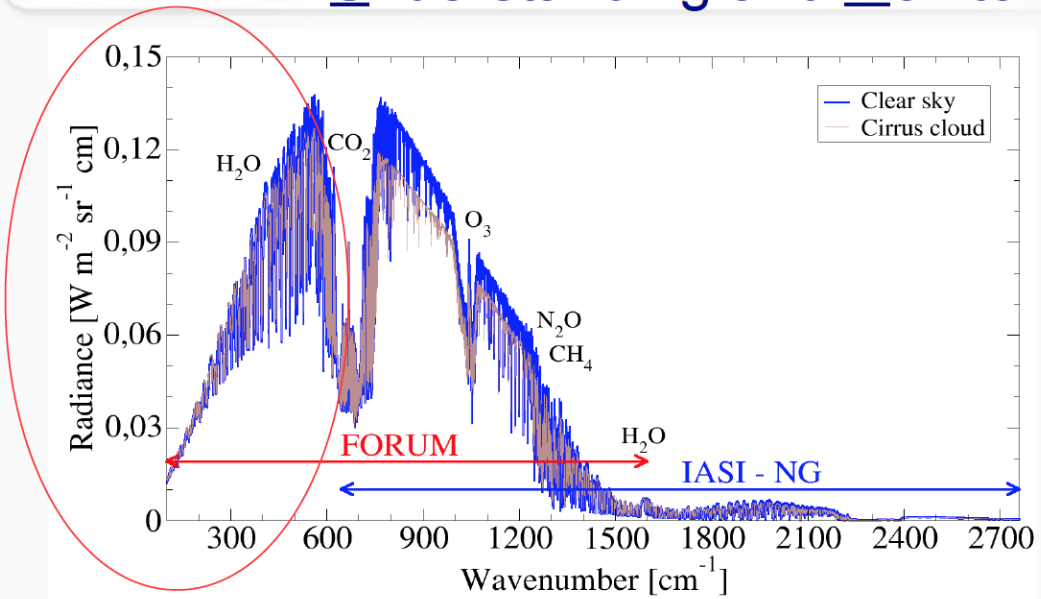


Rouault et al. (J. Geophys. Res. 2010)

EE-9 Candidate: FORUM

INO-CNR NATIONAL INSTITUTE OF OPTICS

Far-infrared-Outgoing-Radiation Understanding and Monitoring



forum

Lead Investigator
Luca Palchetti (INO-CNR)

Partners from 8 ESA countries international partnership (USA)

1) Provide the first global **spectrally resolved observations of the OLR** from 100 to 1600 cm^{-1} (100-6.25μm) with a resolution of 0.3 cm^{-1}
2) Fills the observational gap across the **far-infrared** (FIR: 100-667 cm^{-1}) region, never before sounded spectrally, in its entirety from space
3) By flying FORUM in tandem with Metop-SG it will be possible, for the first time, to observe the entire outgoing infra-red spectrum at high spectral resolution and accuracy
4) Provides a multi-year dataset benchmarked against international standards with an **absolute accuracy of at least 0.1 K** in TOA brightness temperature.

ESA Roadmap for the Arctic

Axis 1: Large satellite missions and experiments

Axis 2: Small/medium satellite missions including micro-launchers to bring these missions into orbit

Axis 3: Exploitation, applications, services, Business Incubators (BIC)

Draft Workplan for Arctic Activities 2018-19

- Based on existing activities approved, particular at CMIN-16, in programmes directorates (EOP, TIA, NAV, TEC, OPS, LAU)
- Workplan based on the ESA Arctic Roadmap
- Take note on MS, scientific, environmental, operational, and commercial needs/requirements
- Include both activities funded by existing ESA programmes and additional new actions to be financed in the frame of the Arctic Task Force
- Workplan under consolidation and to be presented at ESA December 2017 Council for approval

About Cal/Val (1) …

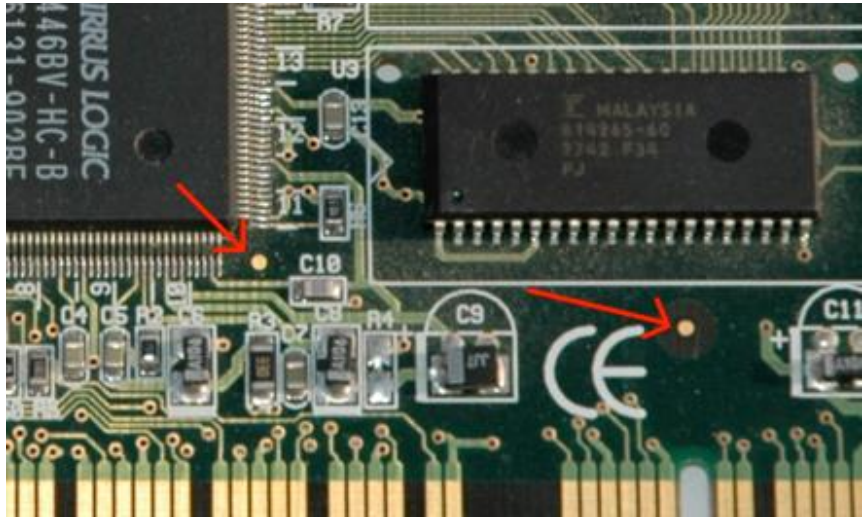
ESA has its own mechanisms for cal/val issues for its own missions

- Huge efforts in the past (developed transponders for ERS, ENVISAT, Flevoland test site)
- Cal/Val of L0 and L1 products (radiance, backscattering coefficient as L1b product)
- Also activities to cal/val L2 (geophysical product, e.g. soil moisture)
- Includes also reprocessing of the data (e.g. for CCI)
- Part of the EOEP (EO Envelope Programme), but underfunded at CM-16
- ESA involved in CEOS Quality Assurance Framework for Earth Observation (QA4EO; http://QA4EO.org/)

About Cal/Val (2) …

For Sentinel and Copernicus data

- Copernicus developed by the EC as an operational system to ansers the needs of the six Copernicus services (not for science purposes, hence different requirements for cal/val)
- Cal/Val are funded though the MPC (Mission Performance Centers)
- Issues in funding in-situ data (FRM: Fiducial Reference Measurement)
- ESA launched in 2016 a 500 K€ activity (FRM4SOC: FRM for satellite ocean color



About Cal/Val (3) …

- ESA+EUM are raising the awareness of the EC to the cal/val issue.
  - To develop a vicarious calibration infrastructure for Sentinel-3 to be proposed for funding to the EC as part of the Copernicus programme.
- International collaboration has been already triggered.
  - S2a and Landsat-8 optical systems have been measured and inter-calibrated before launch
  - Discussions with NASA, JAXA, China for inter-calibration between OCO-2 and TanSAT, and GOSAT

Cal/Val is difficult and expensive. Cost was and is still a driver !


esa
Thank you for your attention!
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