The European Space Sciences Committee

Sindy Sterckx

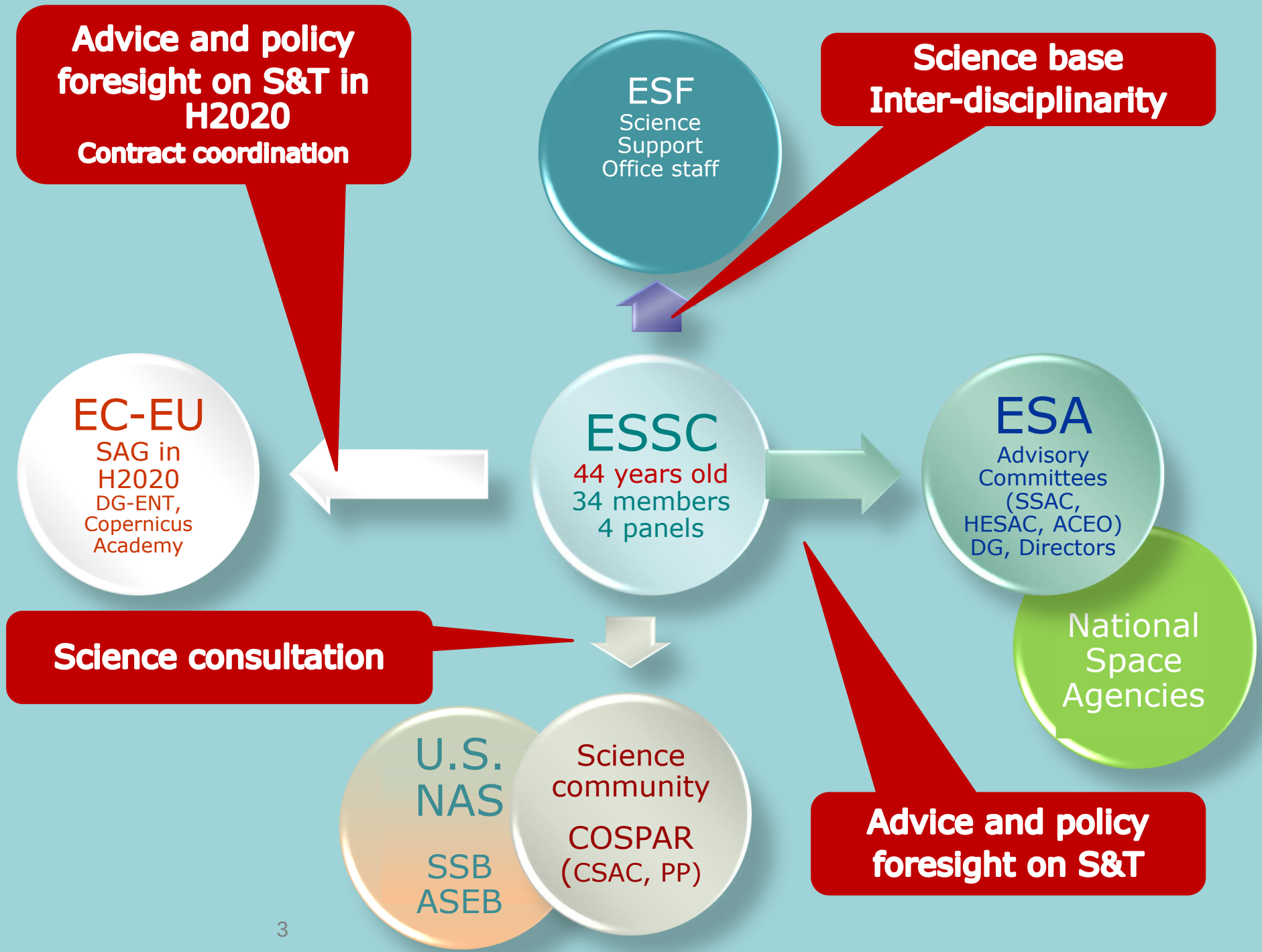
ESSC Earth Science Panel

27 March 2019
Space Science week

Outline

- ESSC role and activities

- European Earth Observations mission
  - Status & highlights (e.g. Aeolus)
  - Future mission


Advice and policy foresight on S&T in H2020
Contract coordination
ESF
Science Support Office staff
Science base Inter-disciplinarity
EC-EU
SAG in H2020
DG-ENT, Copernicus Academy
ESSC
44 years old
34 members
4 panels
ESA
Advisory Committees (SSAC, HESAC, ACEO)
DG, Directors
National Space Agencies
Science consultation
U.S. NAS
SSB
ASEB
Science community
COSPAR
(CSAC, PP)
Advice and policy foresight on S&T

ESSC Chair: Athena Coustenis

Solar System Exploration

Panel Chair : **Hermann Opgenoorth**

- **Mahesh Anand**
- **Ester Antonucci**
- **Antonella Barucci**
- **Luisa M. Lara**
- **Gerhard Paar**
- **François Raulin**
- **Petra Rettberg**
- **Robert Wimmer-Schweingruber**

Life and physical Sciences in Space

Panel Chair : **Dominique Langevin**

- **Sarah Baatout**
- **Alexander Chouker**
- **Berndt Feuerbacher**
- **Helen Fraser**
- **Marc Heppener**
- **Anny Pavy Le Traon**
- **Roberto Piazza**
- **Peter Preu**
- **Hubertus Thomas**

Astronomy and Fundamental physics

- Panel Chair **: Stéphane Udry**

- **Conny Aerts**
- **Nabila Aghanim**
- **Paolo De Bernardis**
- **Michael Perryman**
- **Manolis Plionis**
- **Juri Poutanen**
- **Alexander Tielens**

Earth Sciences

Panel Chair : **Ian Brown** (glaciology,SAR)

- **Andreas Käab** (glaciology)
- **Maarten Krol** (Atmospheric Chemistry)
- **Rosemary Morrow** (ocean altimetry)
- **Sindy Sterckx** (Cal/Val, optical missions)
- **Pepijn Veefkind** (Climate, Sentinel-5P)

essc.esf.org

ESSC PLENARY MEETINGS IN 2018

21-23 May 2018
Univ. Geneva,
Switzerland

26-28 Nov 2018
Royal Society,
London, UK

THE ROYAL SOCIETY

Attending : ESA HRE, SCI and EO directors

EC representatives

SSB director

High-level representatives from JAXA, IKI, CAS

ESSC and ESA

Interactions with ESA

- ESSC Recommendations and advice on the ESA programmes
  - **Science Mandatory programme**
  - **Human and Exploration programme**
  - **Earth Observations programme**
  - **Space Situation Awareness programme**

- *The ESSC Chair* has on these occasions expressed the views and recommendations of the committee's different panels/expertise on issues of the agency's programs in preparation and after the ESA Councils at Ministerial Level.
- In particular, this year the ESSC contributes with scientific inputs to drafts of proposals by the different directorates for CMIN19+ and other programme aspects

ESSC and EC

ESSC is an active contributor to the regular EC consultation on innovation, science and technology development.

ESSC is a member of the Copernicus Academy

International Links

- **US National Academies Space Studies Board**
  - Attendance of ESSC Chair and secretary to SSB meetings (most recent May 2018) – Update on European space sciences landscape
  - Attendance of the SSB director to the two Plenary ESSC meetings – Update on US space sciences landscape

  - ESSC members invited to attend the SSB Space Sciences Week (March 2017, 2018, 2019)
  - ESSC Members invited (*ad-personam*) in SSB studies
  - Collaborations: Planetary protection, ExoOceans
  - ESSC prepared to bring European perspectives to any relevant US studies/decadals?

Cooperation and collaboration in space discussed between SSB & ESF since 1976

10 joint reports, several collaborations

ESSC Studies – CalVal Copernicus

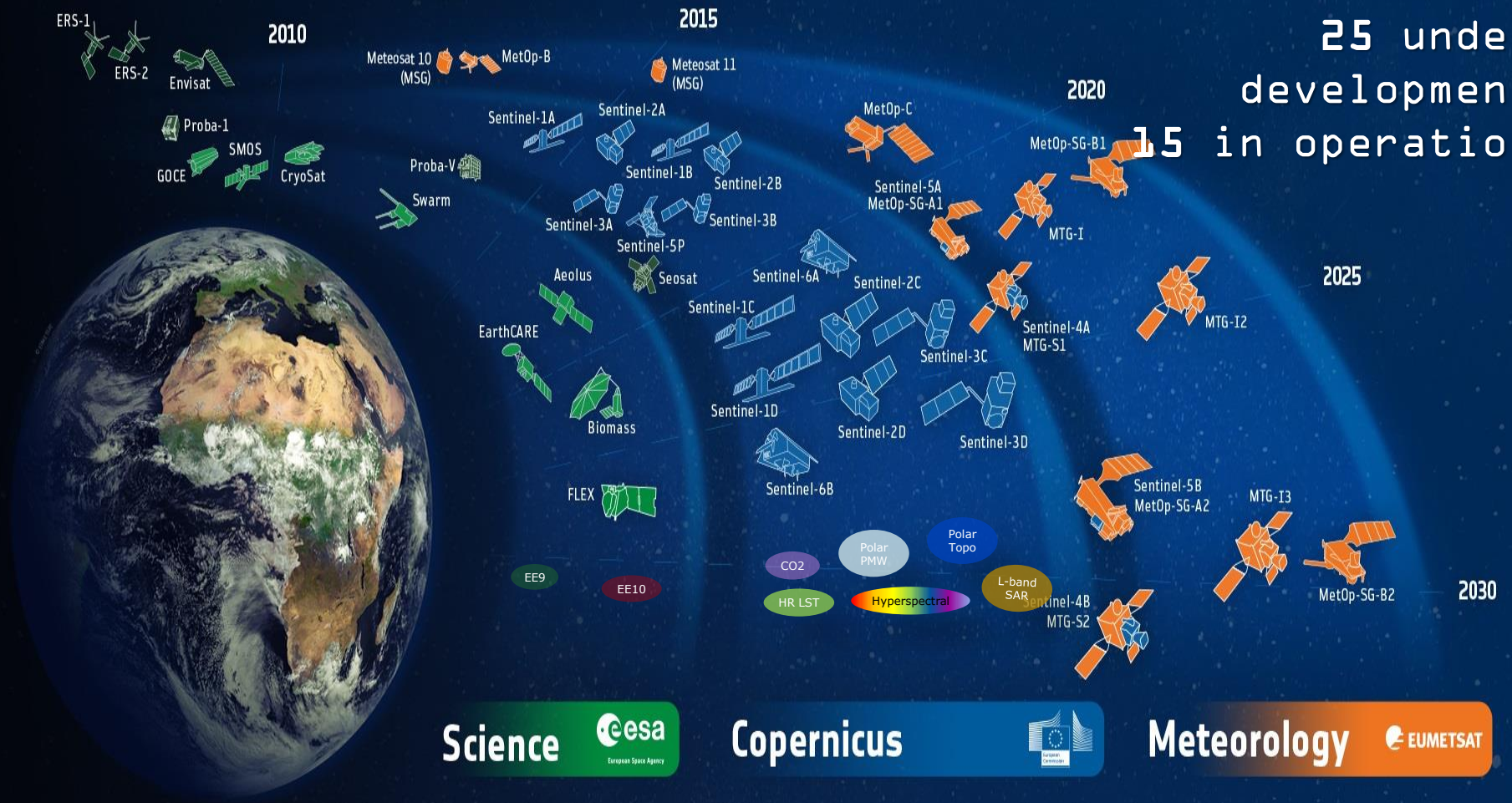
- Objective: address the Copernicus Calibration/Validation issues in the context of the scientific exploitation of Copernicus data
- WG primarily composed of ESSC Earth Sciences Panel, I. Brown, S. Sterckx, (+4 external experts)
- The started in 2018 with telecons and three meetings.
- Early outcome (executive summary) provided to EC, ESA and WMO, feedbacks collected and considered for the finalisation of the report.
- Report to be ready by May 2019 and provided to relevant stakeholders
- Relevance of link with Copernicus Academy

ESA Earth Observation programme

Our Vision

Taking the Pulse of our Planet

ESA Developed Earth Observation Missions



Earth Explorers & FutureEO

Flying Missions

GOCE	SMOS	CryoSat	Swarm	Aeolus
2009-2013	2009	2010	2013	2018

Future Missions

EarthCare	Biomass	FLEX	EE-9	EE-10
2021	2022	2022	2025	2027
			2 Cand.	3 Cand.

Science & Innovation

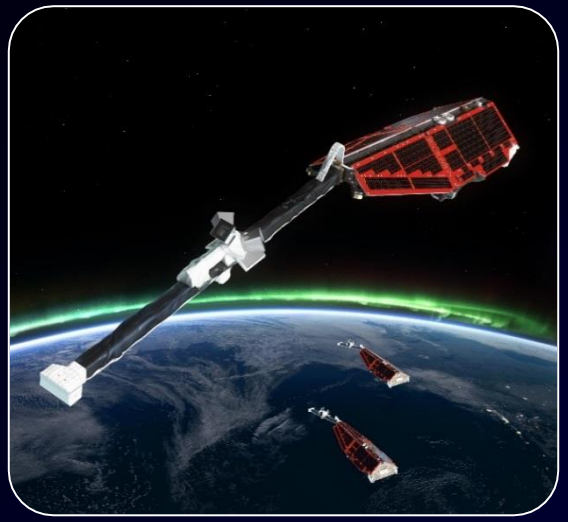
4.700+ Reg. Users

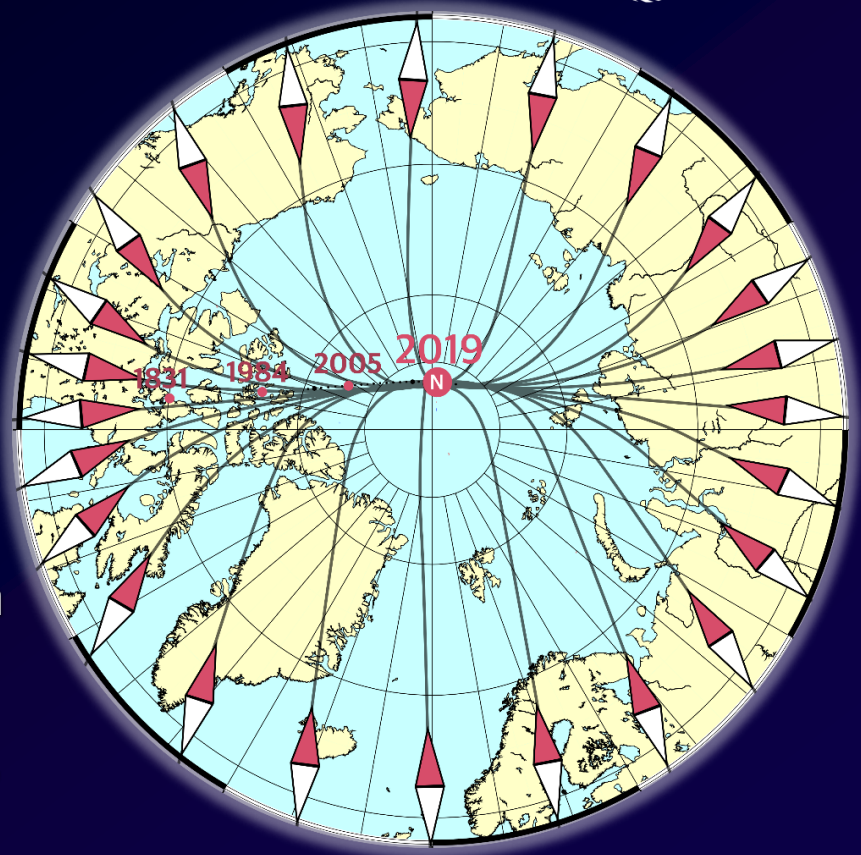
300+ Publ. per Year

High Risks for Great Rewards

CryoSat and SMOS mission extensions were approved until 2021 at the last PBEO following ACEO's recommendation

Earth Explorers – Swarm tracking magnetic north

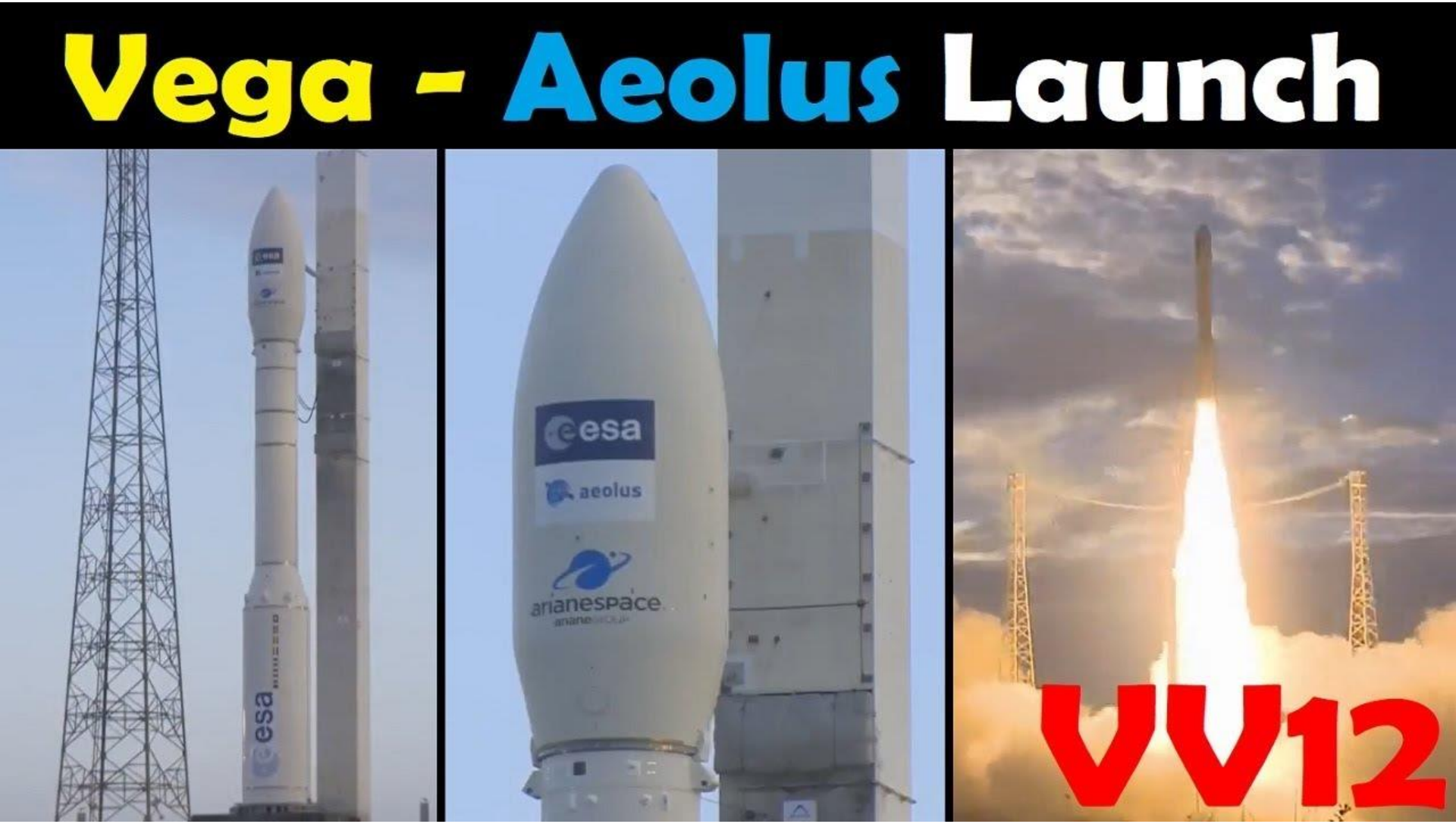




- Swarm tracks wandering magnetic north
- Now moving at 55 km per year
- Data crucial for daily applications: ships, google maps on smartphones

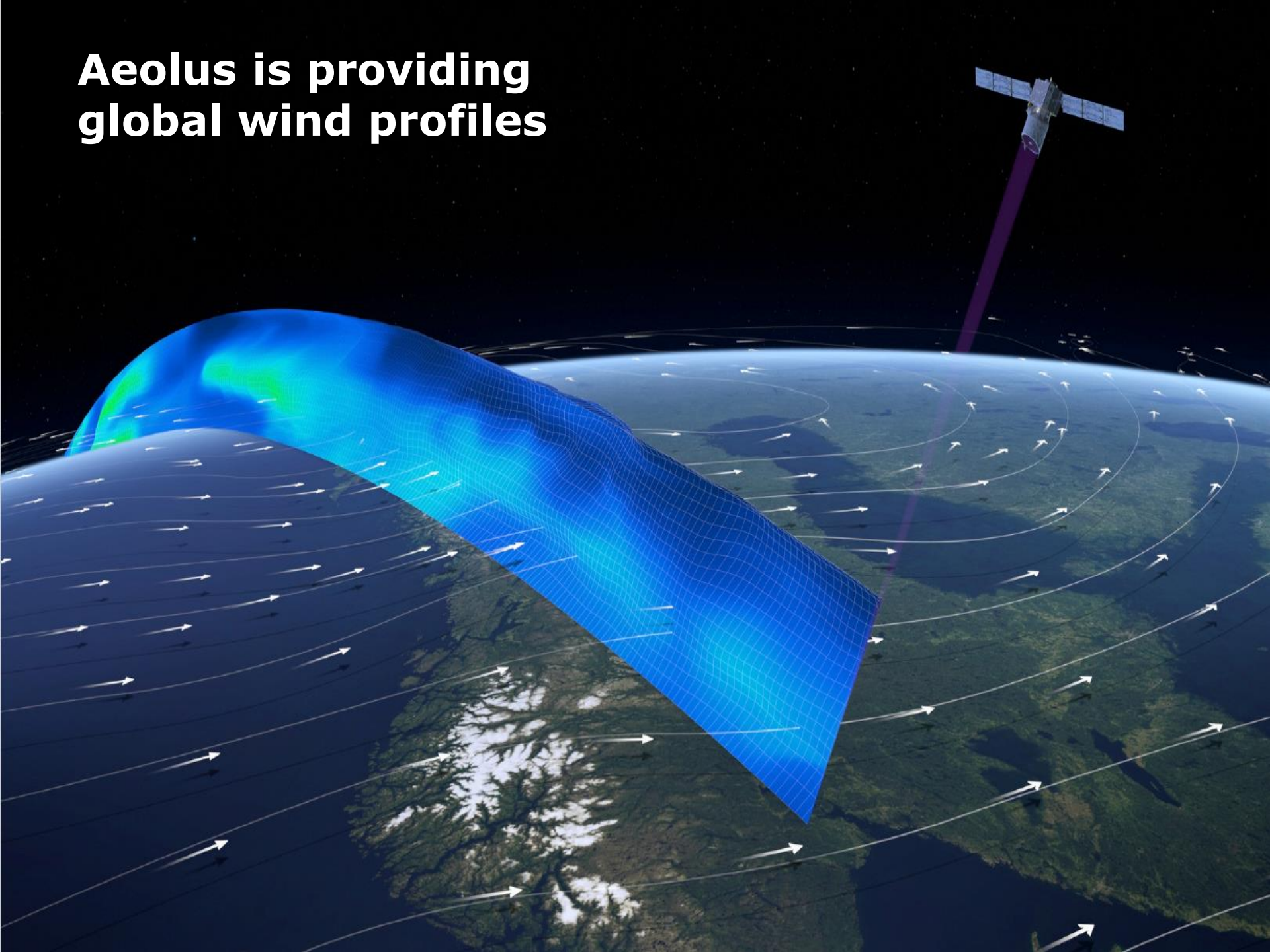
Based on this, NATO and US DoD have decided for an intermediate (out-of-cycle) **update of the World Magnetic Model**

Without Swarm this would be IMPOSSIBLE!



ESA's Aeolus mission launch on a Vega rocket from Europe's Spaceport in Kourou, French Guiana, 22 August 2018

Aeolus is providing global wind profiles



Aeolus Mission Objectives

Scientific objectives

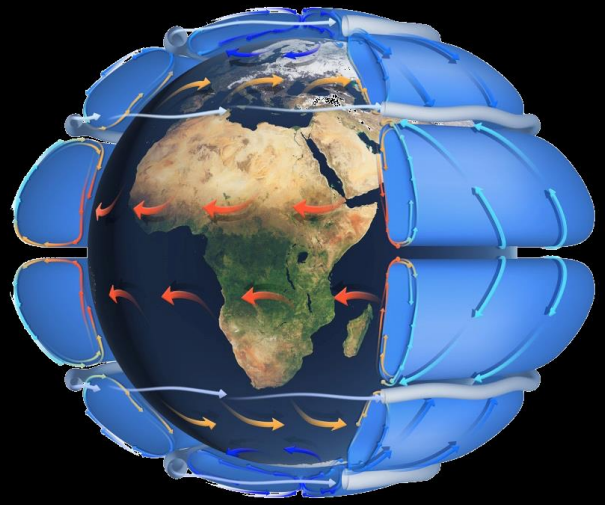
- To improve the quality of weather forecasts
- To improve the quality of air quality forecasts
- To advance our understanding of atmospheric dynamics and climate processes

Explorer objectives

- Demonstrate space-based Doppler Wind LIDARs potential for operational use

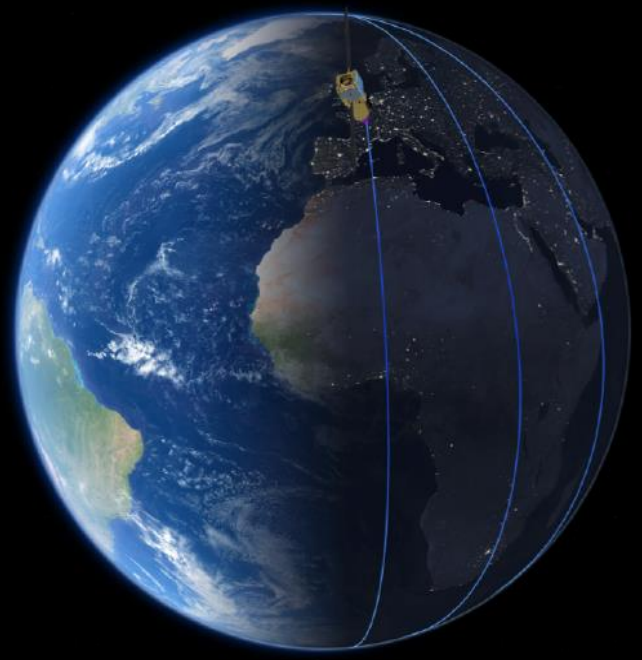
Payload

- ALADIN: Atmospheric LAser Doppler INstrument



Aeolus Orbit Characteristics

- **Orbit:** sun-synchronous
- **Mean altitude:** ~320 km
- **Local time:** 18:00 ascending node
- **Inclination:** 96.97º
- **Repeat cycle:** 7 days / 111 orbits
- **Orbits per day:** ~16
- **Profiles per day:** ~64000
- **Mission lifetime:** 3 years

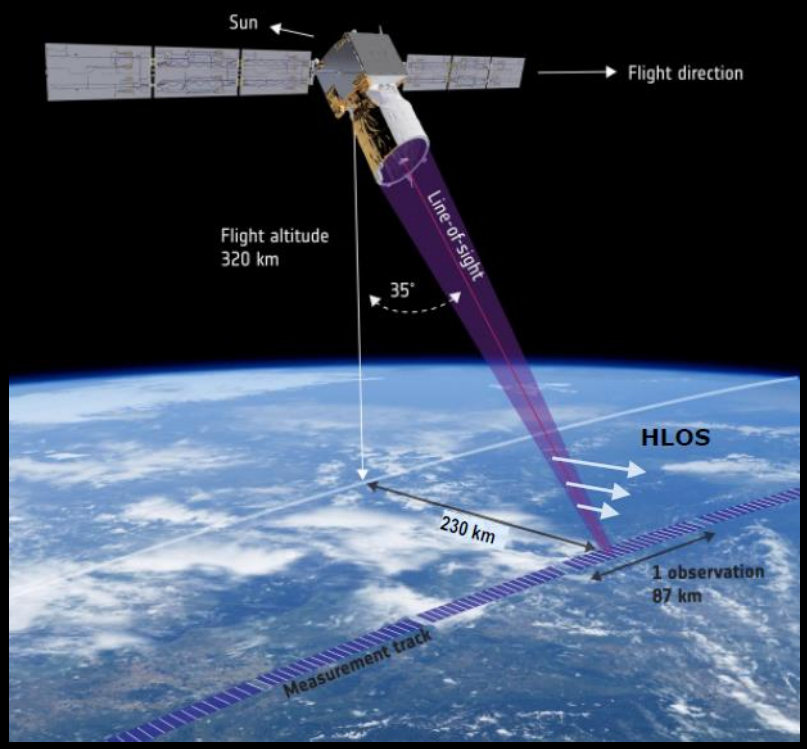


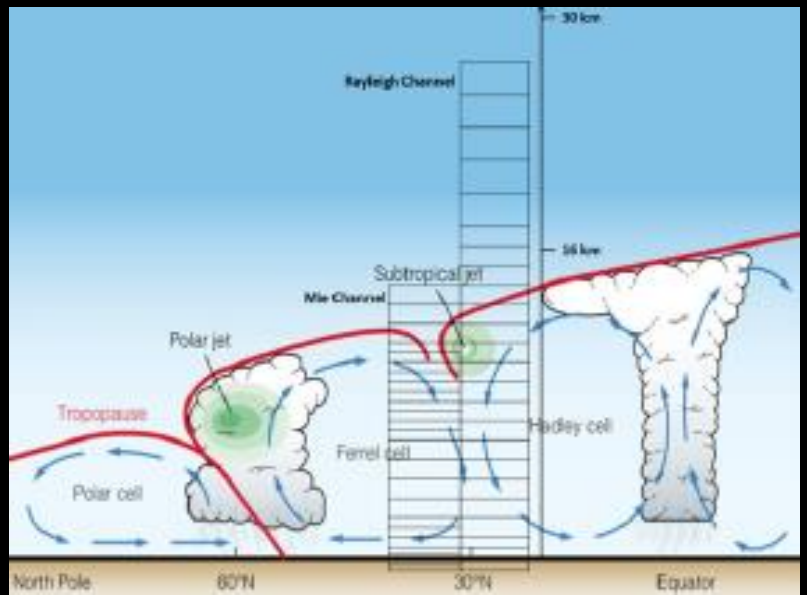
Measurement Principle

- UV Doppler wind Lidar operating at 355 nm and 50 Hz PRF in continuous mode, with 2 receiver channels :
  - Mie receiver (aerosol & cloud backscatter)
  - Rayleigh receiver (molecular backscatter)

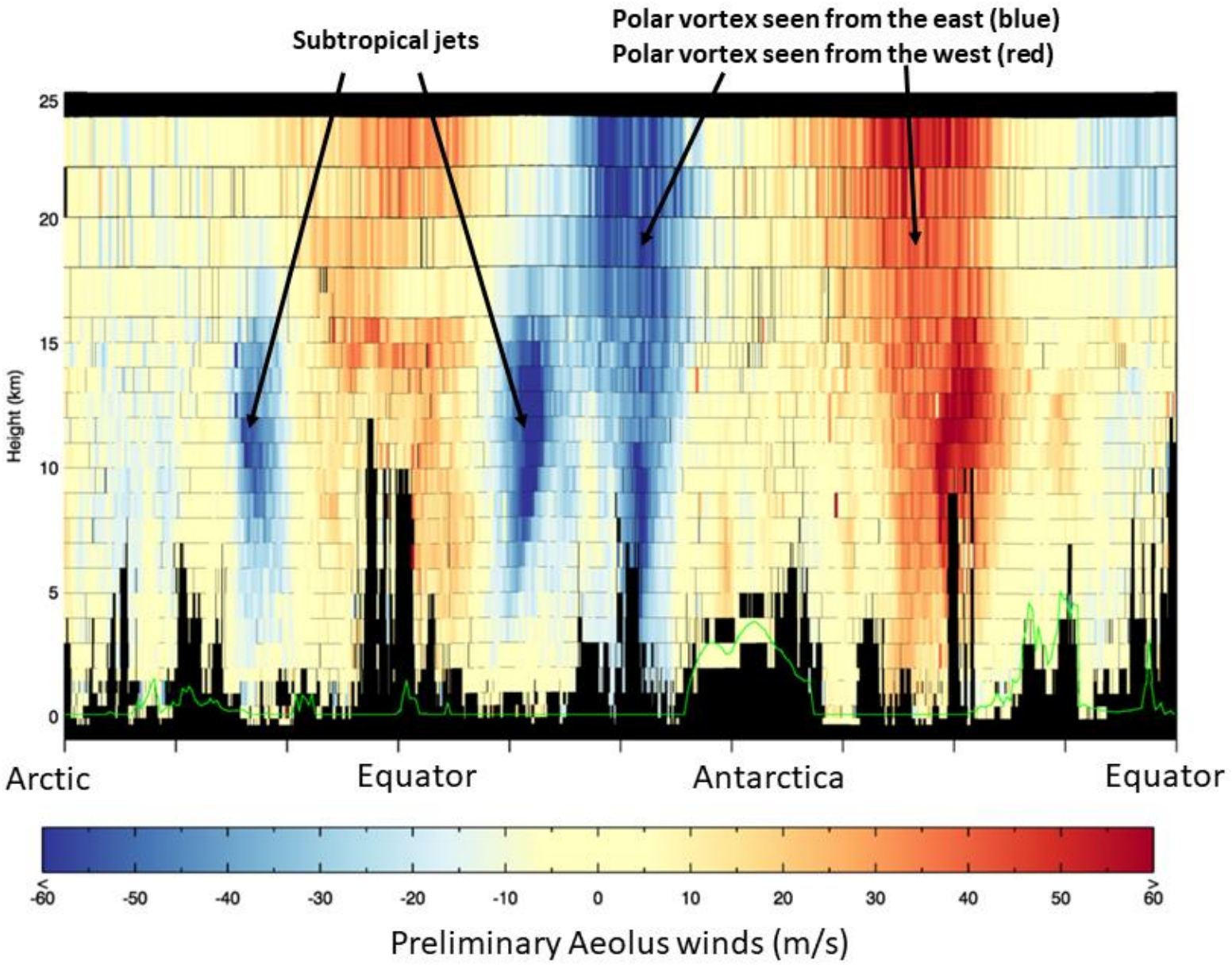
- The line-of-sight is pointing 35º from nadir to derive horizontal wind component

- variable vertical bin size (250 m – 2 km)





First wind data from ESA's Aeolus satellite (sept. 2018)

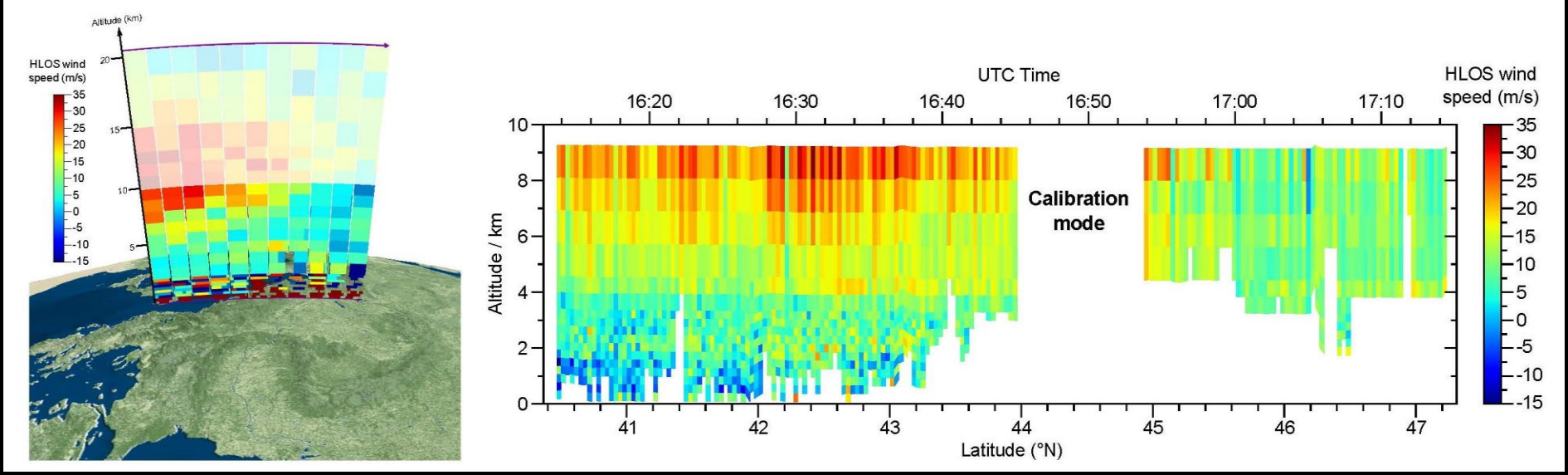


Status

- Aeolus measurements already improve the weather prediction from ECMWF (mainly in tropics and Southern hemisphere) (even without proper Cal/Val !)
- IOCR took place on 31 Jan. 2019
- Laser A energy output around 50-65 mJ (now at about 50 mJ)
- Discussions ongoing to switch on Laser B
- 1st instrument interruption on 14 Jan. likely due to GPS reconfiguration

Status

- Cal/Val phase has started, e.g. a spacecraft “under-flying” campaign has been carried out by DLR using the A2D(ALADIN Airborne Demonstrator) instrument on the Falcon aircraft.



ESA/NASA cooperation

Aeolus definition and development phase

- NASA participation in ESA's Mission Advisory Group
- US Wind Lidar Working Group, scientific conferences and workshops.

Aeolus Cal/Val phase

- Airborne campaigns : opportunity to join the US and European airborne wind Lidar systems

aeolus cal/val & science workshop

26-29 March 2019 | ESA-ESRIN | Frascati (Rome), Italy

esa

Programme and Themes

The workshop program will be organised according to the following themes:

- Mission Status from ESA and partners
- Aeolus Commissioning & first CAL/VAL results from ESA and partners
- Aeolus AO Cal/Val teams - first results and outlook
- Aeolus CAL/VAL - Airborne Campaigns
- Scientific exploitation - NWP impact assessments
- Scientific exploitation - use of Aeolus data for air quality models
- Scientific exploitation of Aeolus observations (wind, aerosol/cloud, new data products)
- Scientific exploitation - Synergetic use of Aeolus data (with other satellite and/or ground based data)

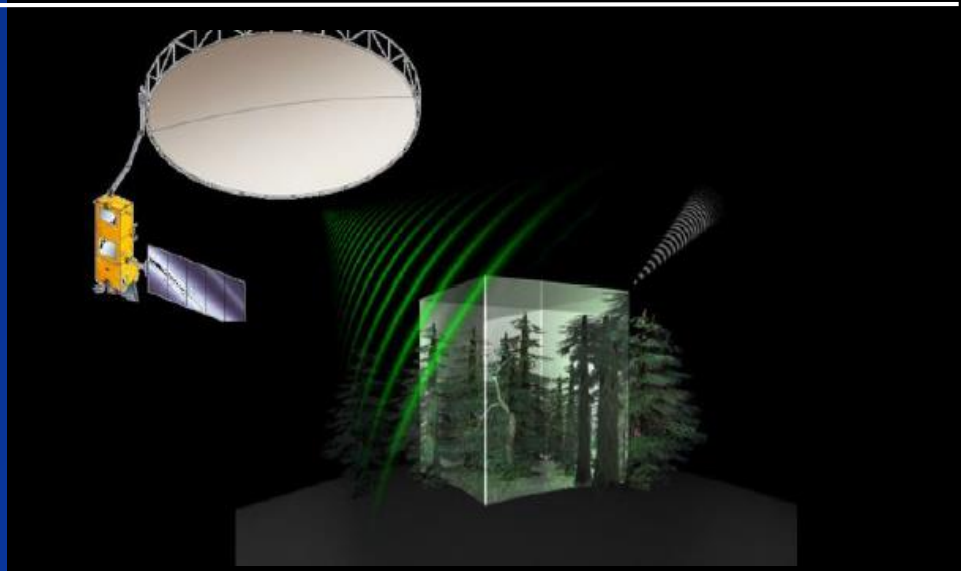
Upcoming Earth Explorers

(6) EarthCARE

- Clouds, aerosols & radiation
- A joint Audit was organised with JAXA on the CPR for EarthCARE
- Regular Tracking Committee meetings at bilateral level to monitor progress
- Launch planned 2021

(7) Biomass

- Biomass estimates
- First P-band SAR in space
- Launch planned 2022



Upcoming Earth Explorers

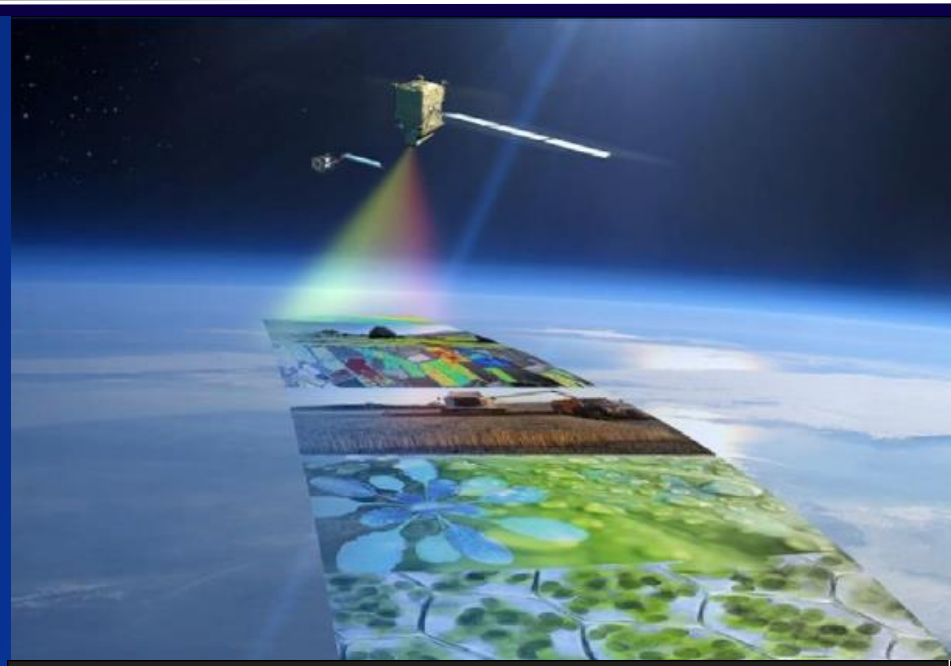
(8) FLEX

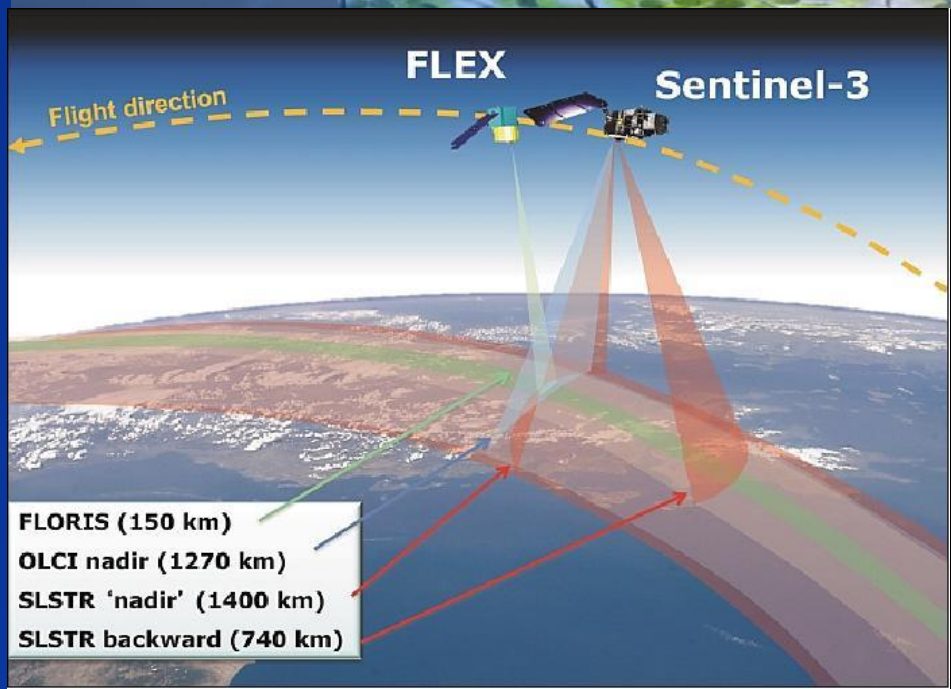
Direct measurements of vegetation fluorescence to

- Quantify actual photosynthetic activity of terrestrial ecosystems
- Provide physiological indicators for vegetation health status

FLEX mission will orbit in tandem In Tandem with Sentinel-3

Launch planned 2022



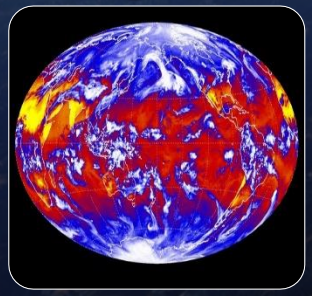


Earth Explorer 9 – Two Candidates

Launch around 2025

FORUM

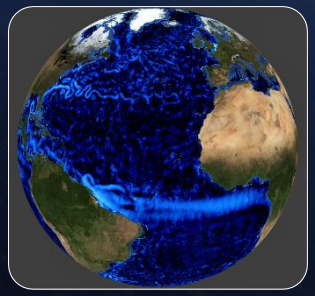
Far-infrared Outgoing Radiation Understanding and Monitoring



Benchmark measurements will improve our understanding of the greenhouse effect and contribute to climate change assessments accuracy

SKIM

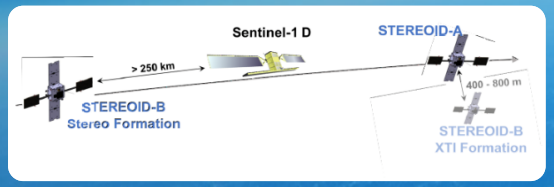
Sea-surface Kinematics Multiscale monitoring



Will carry novel wide-swath scanning multibeam radar altimeter to measure ocean-surface currents with Doppler technique

Earth Explorer 10 –three Candidates

STEREOID

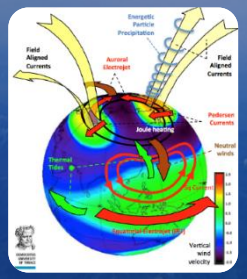


Bistatic SAR as passive followers of Sentinel-1
Two <500kg spacecraft

Applications

- Cryosphere
- Oceanography
- Geosphere

Daedalus



Explore mesosphere, lower thermosphere & Ionosphere

Four cubesats
at 120 km altitude

Focus on temperature, heating processes & composition structure

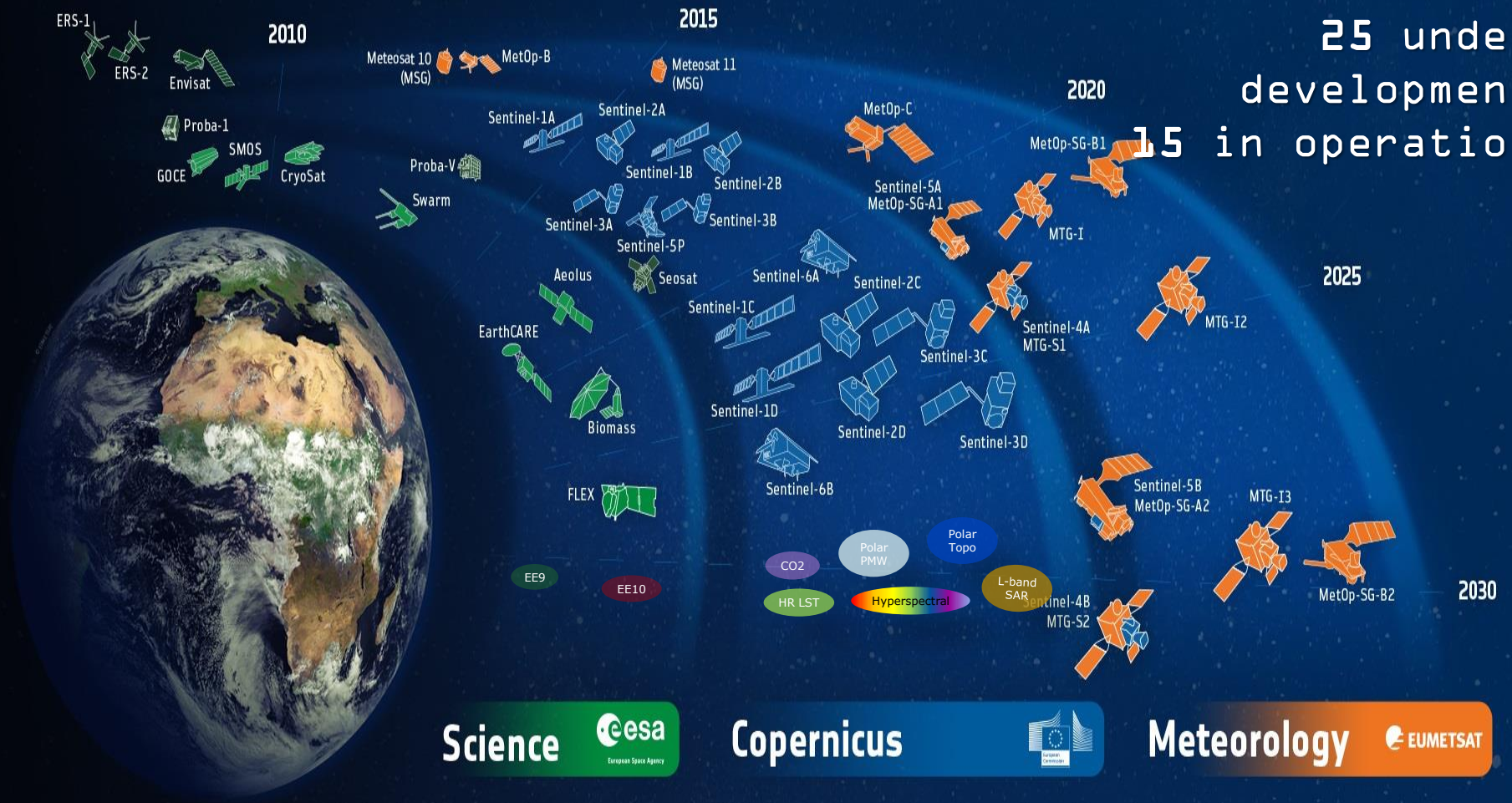
G-CLASS

Science on daily water cycle

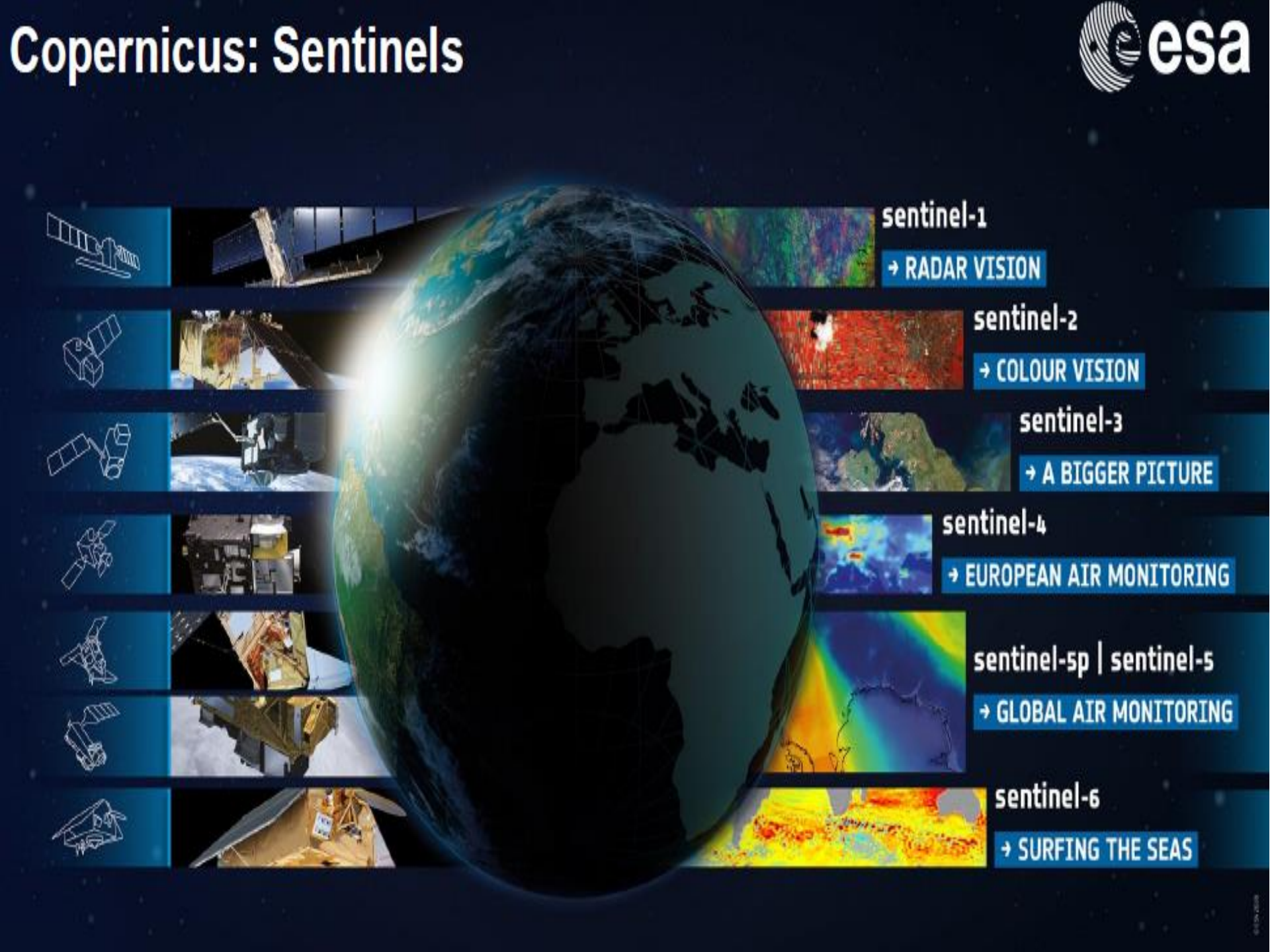
Geostationary
C-band SAR

Benefits for weather forecasting, hydrology, mountain cryosphere

ESA Developed Earth Observation Missions



Copernicus: Sentinels



Sentinel Status

S-1

Radar

A	3 Apr. 2014
B	25 Apr. 2016
C	2022/23
D	> 2022/23

S-2

High Res. Optical

A	23 Jun. 2015
B	6 Mar. 2017
C	2022/23
D	> 2022/23

S-3

Medium Res. Optical & Altimetry

A	16 Feb. 2016
B	25 Apr. 2018
C	2023
D	> 2023

S-4

Atmospheric Chemistry (GEO)

A	2022
B	2027

S-5P

Atmospheric Chemistry (LEO)

A	13 Oct. 2017

S-5

Atmospheric Chemistry (LEO)

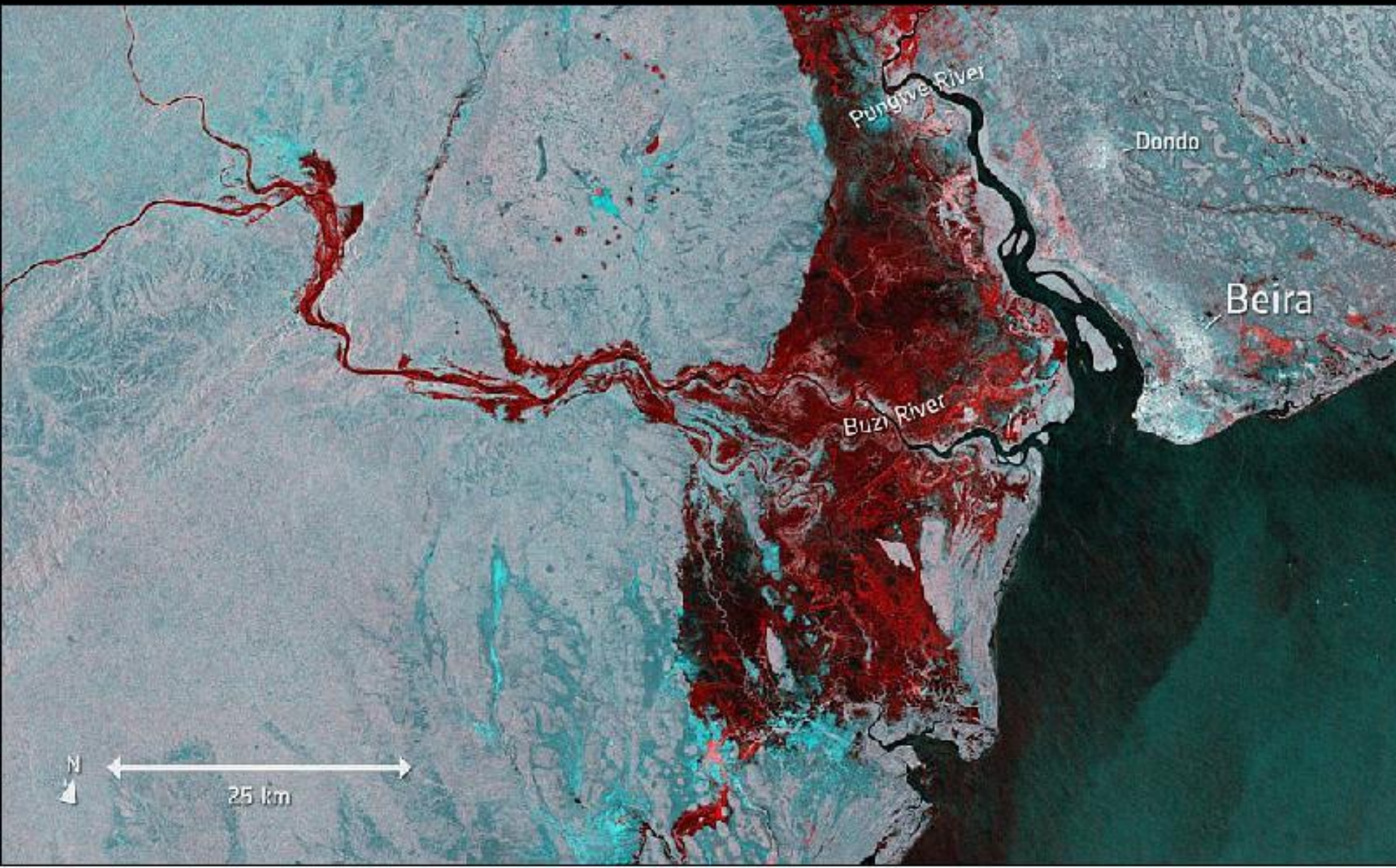
A	2021
B	2027
C	> 2027

S-6

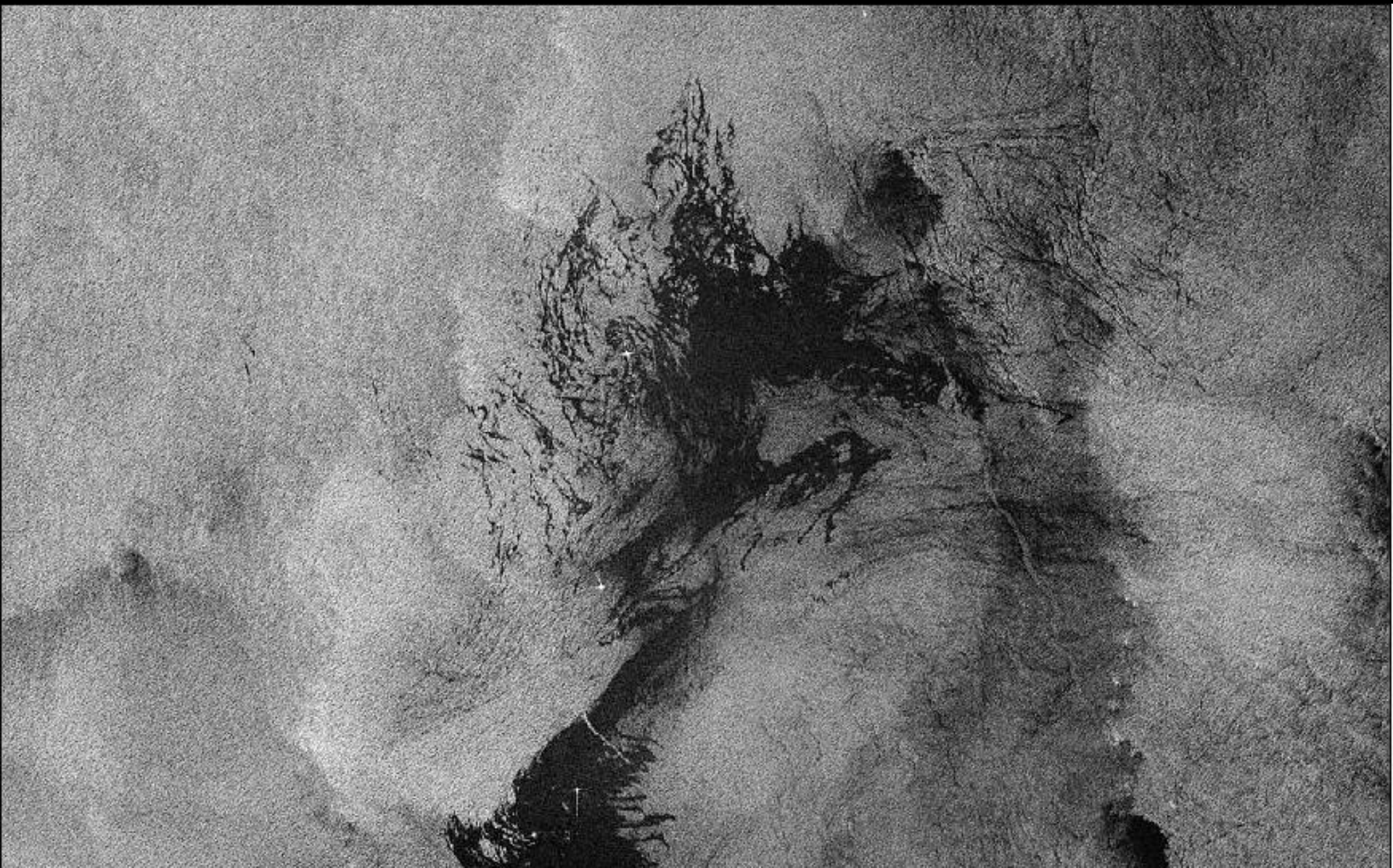
Altimetry

A	2020
B	2025

Sentinel-1 (March 19, 2019)

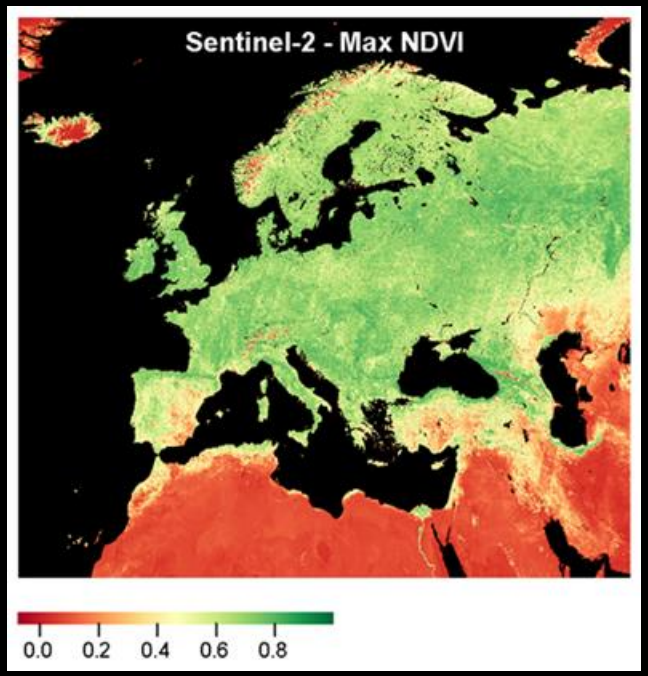


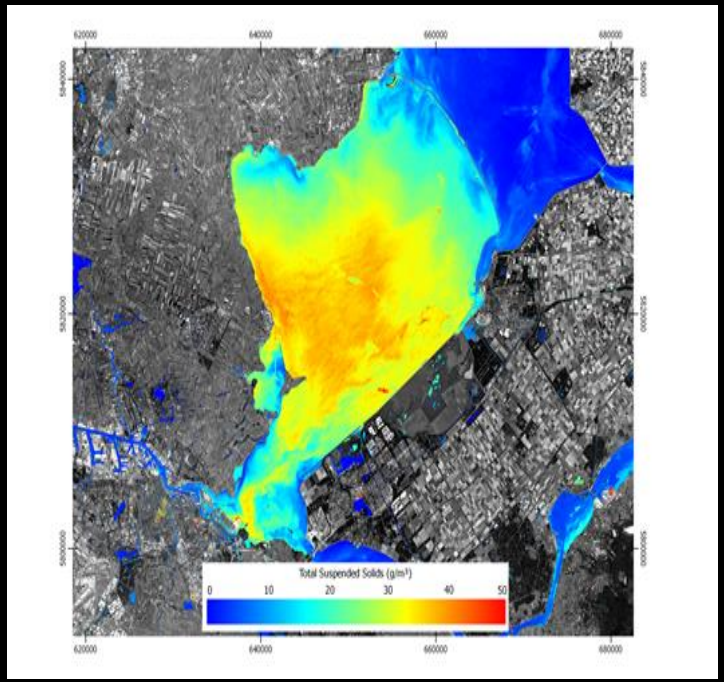
Sentinel-1 (March 19, 2019)



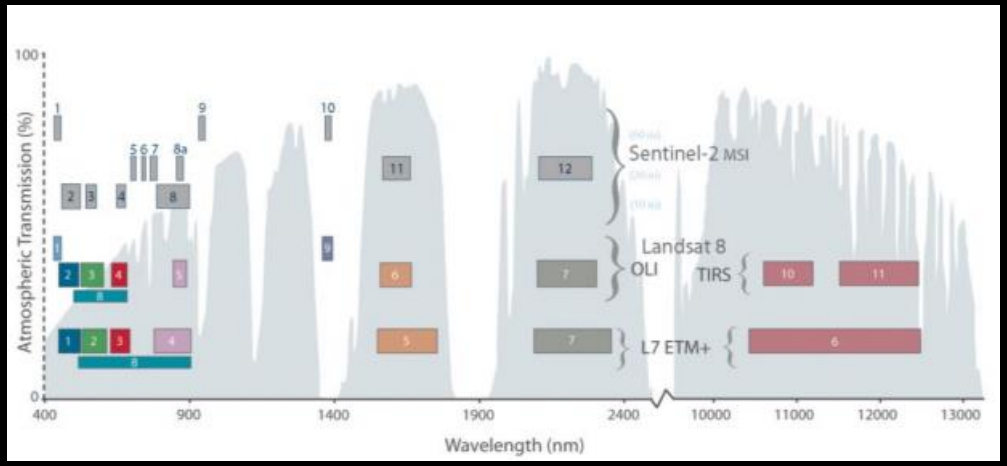
Sentinel-2

- Nominal Sentinel-2 constellation operations with Sentinel-2A and Sentinel-2B.
- Performing global and systematic acquisitions (5-day revisit) since 17 February 2018.
- New core product (Level-2A surface reflectance) generated and distributed since 26 March 2018 for Europe, since 13th of December 2018 globally.





Interoperability between Sentinel-2 & Landsat 8



NASA Harmonized Landsat Sentinel-2

Home | Algorithms | Products Description | Test Sites | Data | QA | Documents

remote sensing

MDPI

Technical Note

Observations and Recommendations for the Calibration of Landsat 8 OLI and Sentinel 2 MSI for Improved Data Interoperability

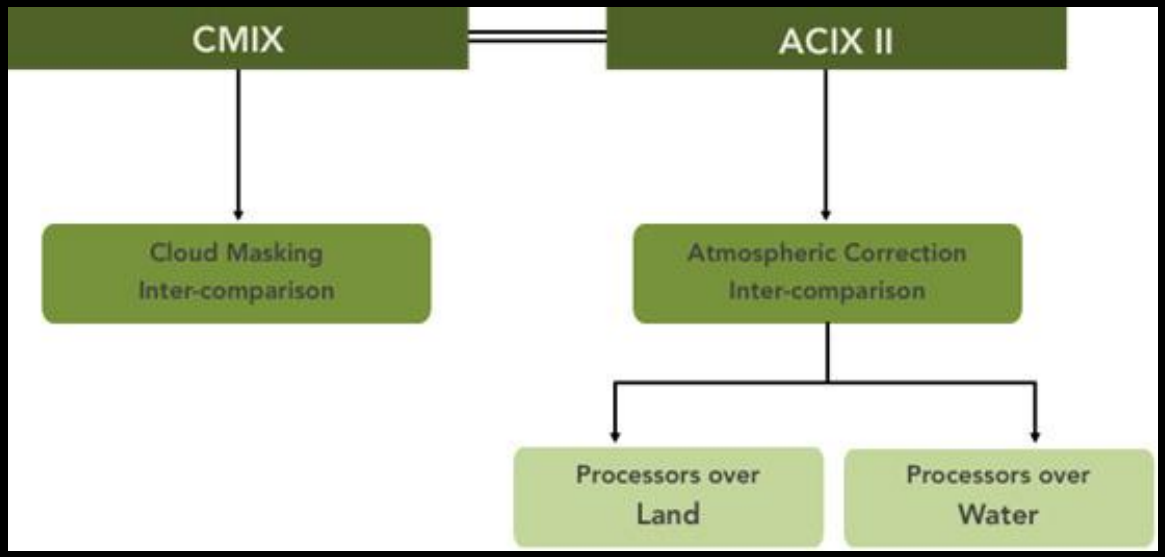
Dennis Helder [1,*], Brian Markham [2], Ron Morfitt [1], Jim Storey [3], Julia Barsi [4], Ferran Gascon [5], Sebastien Clerc [6], Bruno LaFrance [7], Jeff Masek [2], David P. Roy [8], Adam Lewis [9] and Nima Pahlevan [2,4]

3rd Sentinel-2 Validation Team Meeting

12-14 March 2019 - Toulouse, France

ACIX - CMIX

International collaborative initiatives to inter-compare atmospheric correction (AC) and cloud masking (CM) algorithms for Sentinel-2 and Landsat-8 data.

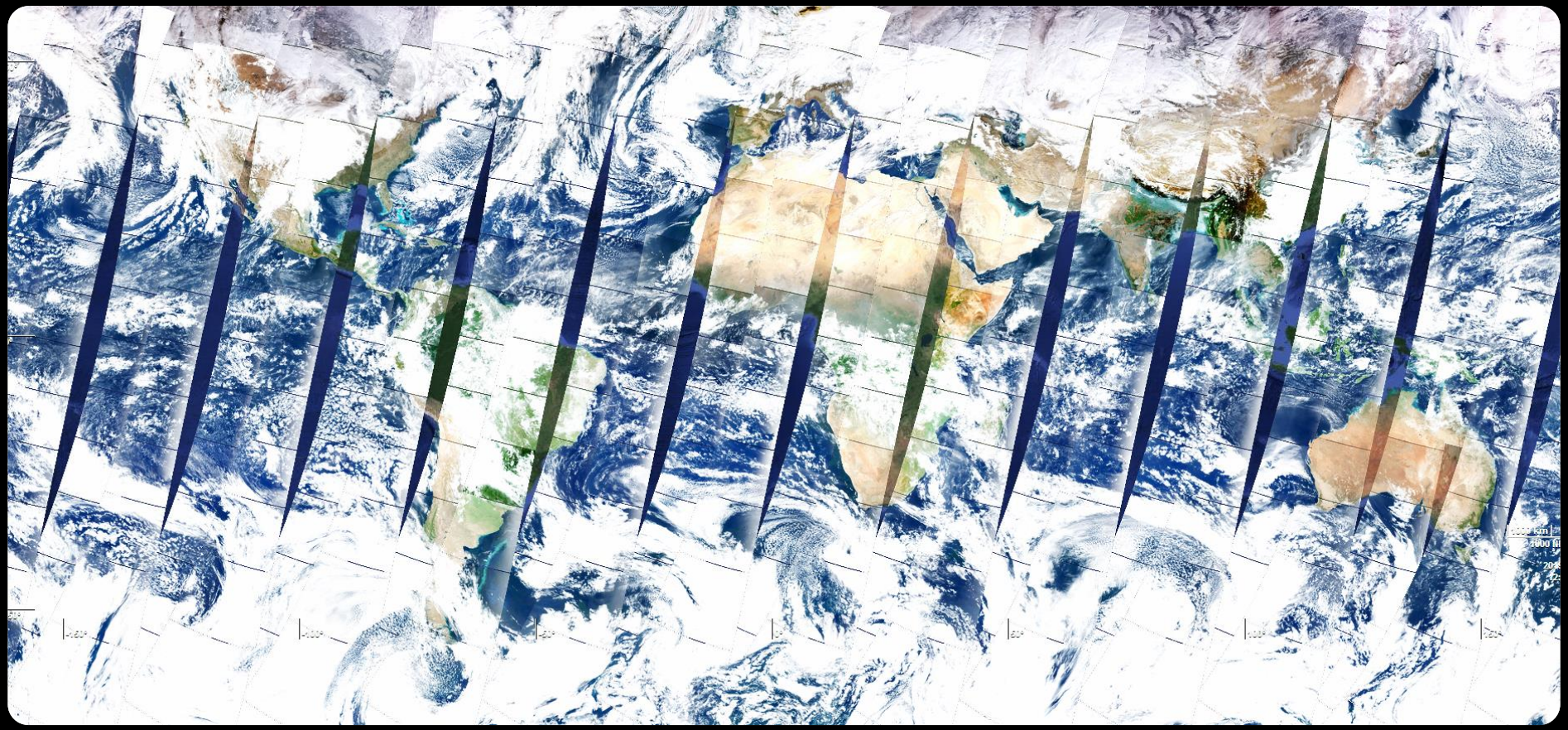


Sentinel-3 (13 March 2019)

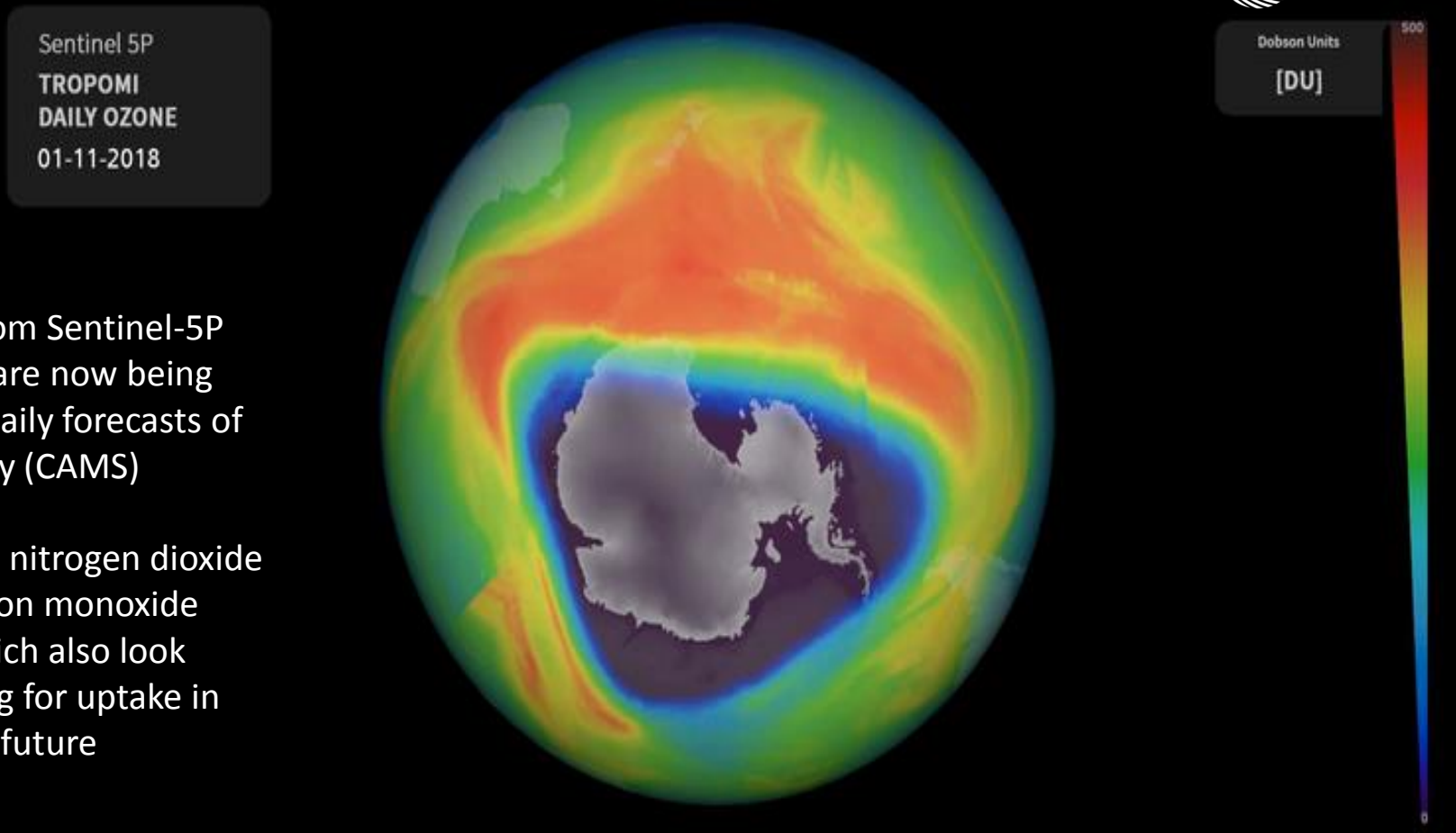
Sentinel-3 Status

- Sentinel-3A is in routine operations since October 2017
- Sentinel-3B (launched 25/04/2018) is in the ramp-up phase
  - Routine Operations Readiness Review planned for 26 March 2019
- The Tandem phase was operated between 6 June 2018 and 16 October with Sentinel-3B 30 seconds in front of Sentinel-3A.
- Sentinel-3B is now in its nominal orbital position 140 degrees in front of Sentinel-3A.

Daily coverage of Sentinel-3A and Sentinel-3B OLCI



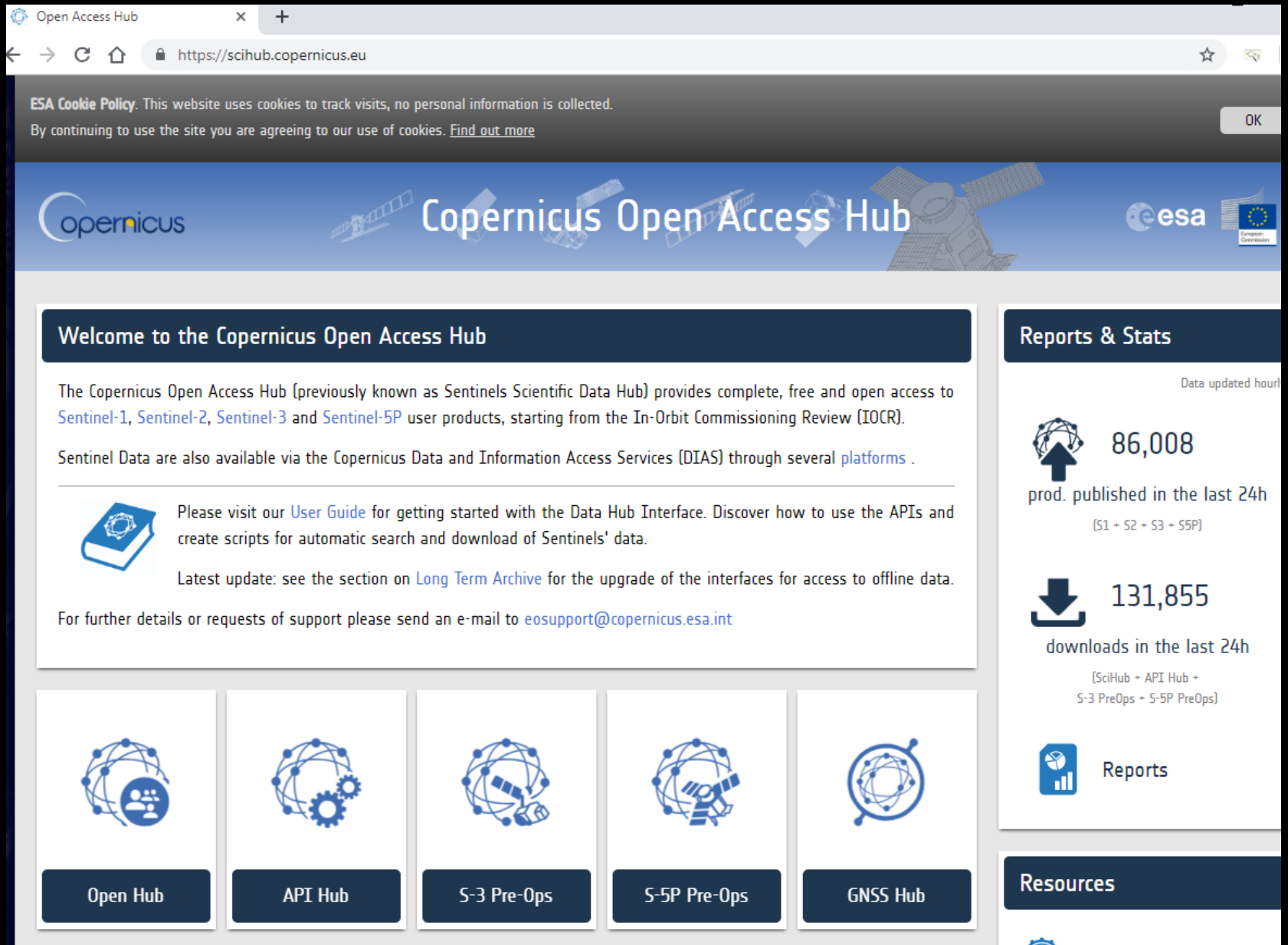
Ozone Monitoring – Copernicus Sentinel-5P



- ozone from Sentinel-5P satellite are now being used in daily forecasts of air quality (CAMS)

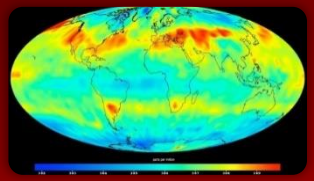
- mission's nitrogen dioxide and carbon monoxide data, which also look promising for uptake in the near future

Open and free data access policy



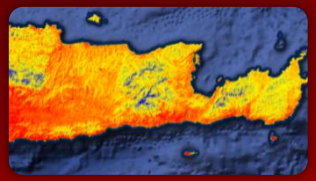
Copernicus 2.0 – New Monitoring Missions

Anthropogenic CO_2 Mon. Mission



Causes of
Climate Change

Land Surface Temperature Mission

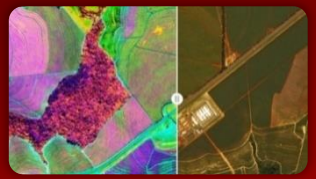


Agriculture & Water
Productivity

CRISTAL – Polar Ice & Snow Topography

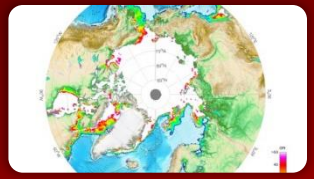
Effects of
Climate Change

CHIME – Hyperspectral Imaging Mission



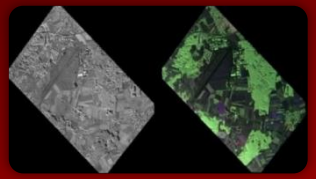
Food Security, Soil,
Biodiversity

CIMR – Passive Microwave Radiometer



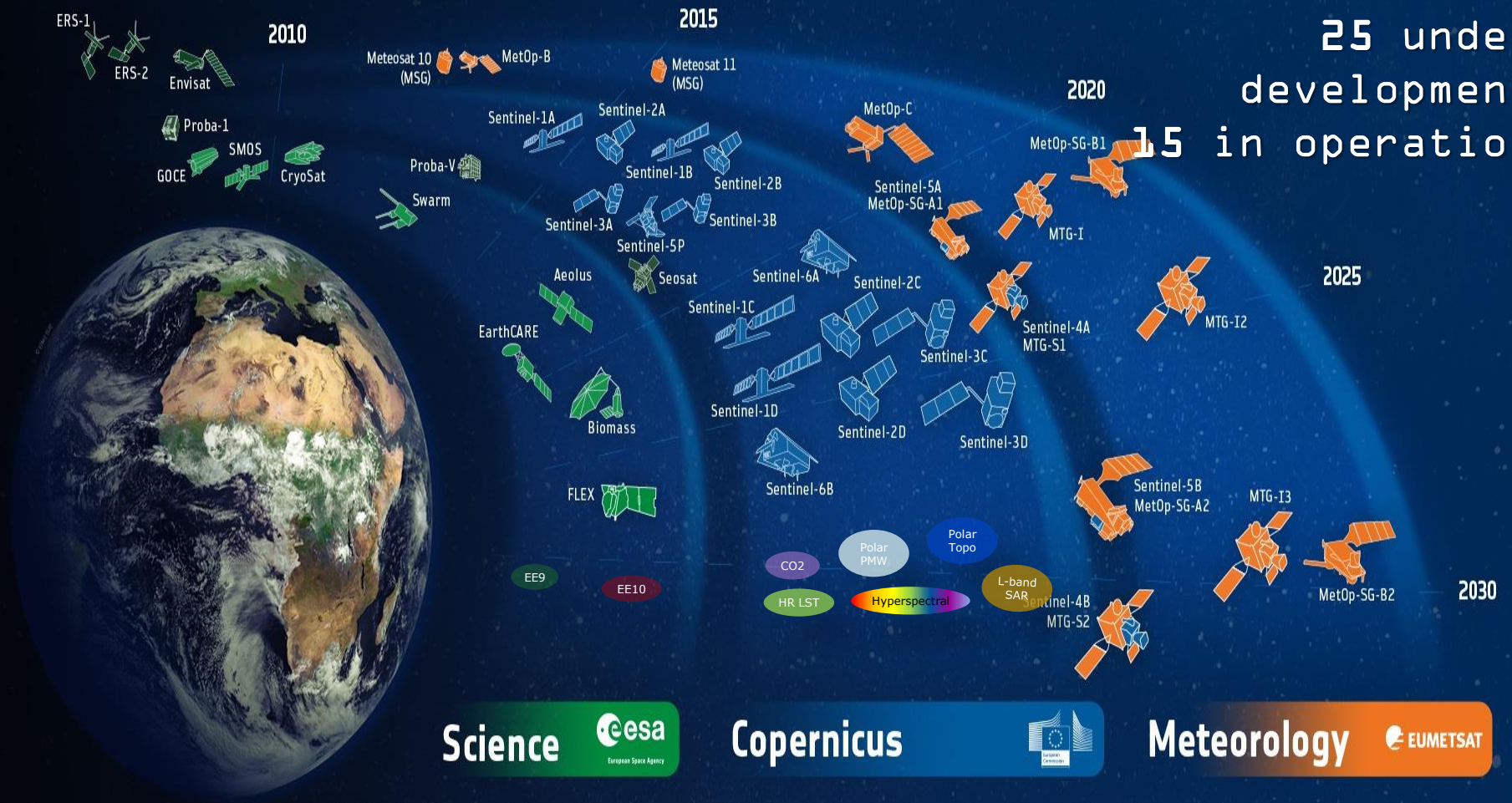
Sea: Surface Temp.
& Ice Concentration

L-band SAR Mission

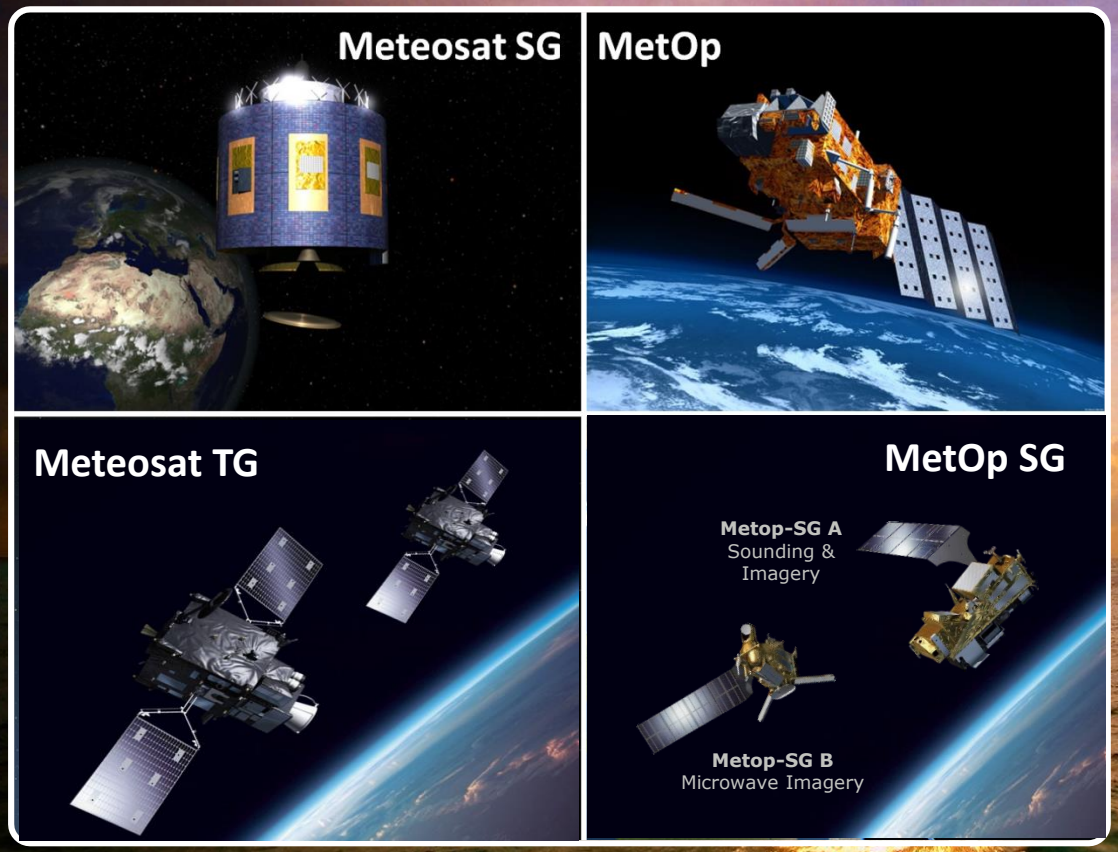


Vegetation & Ground
Motion & Moisture

ESA Developed Earth Observation Missions



Evolution in Meteorological Systems



< Current Systems

< Post-2020 Systems

Meteorology: MTG and MetOp-SG Launch Dates

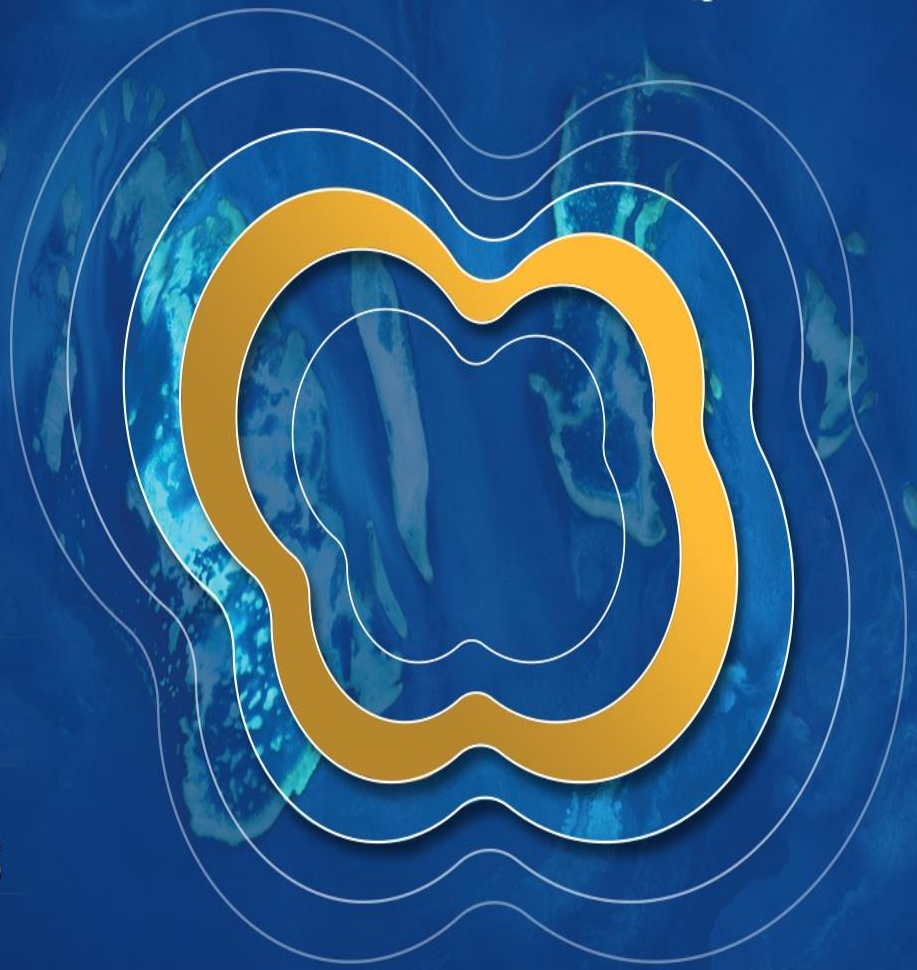
Meteosat Third Generation	
MTG-I-1	2021
MTG-S-1	2023
MTG-I-2	2025
MTG-I-3	2031
MTG-S-2	2033
MTG-I-4	2035

MetOp Second Generation	
MetOp-SG A1	2022
MetOp-SG B1	2023
MetOp-SG A2	2029
MetOp-SG B2	2030
MetOp-SG A3	2036
MetOp-SG B3	2037

Satellites undergo a commissioning phase before being declared operational
Based upon assumptions on Q1 2019

living planet symposium

MILAN
13–17 May
2019



UNDERSTANDING THE EARTH SYSTEM

SPACE 4.0 AND EARTH OBSERVATION

BENEFITS FOR A RESILIENT SOCIETY

PUBLIC AND PRIVATE SECTOR INTERACTIONS

Deadlines

Session Proposals	Abstracts	Registration
17 June 2018	11 November 2018	April 2019

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Thank you for your attention !