ESA Earth Observation

Recent Achievements & Space19+

57th European Space Sciences Committee Plenary Meeting

Amsterdam, 9 May 2019

Maurice Borgeaud, ESA

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

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ESA Vision for EO

“Taking the Pulse of our Planet”

A successful Track-Record

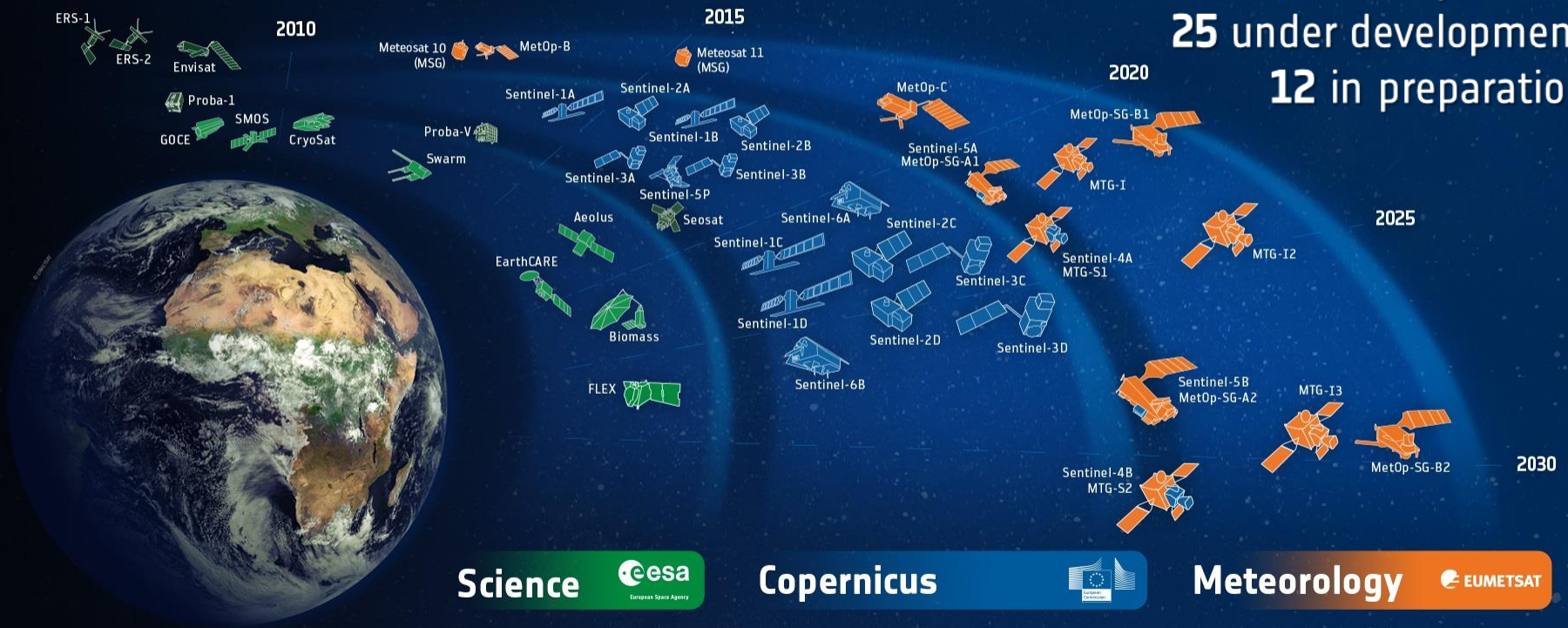
ESA-Developed Earth Observation Missions

Satellites

15 in operation

25 under development

12 in preparation



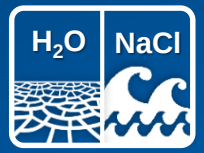
Recent ESA EO Results

Future EO – Continue Successful R&D and Science

Flying Missions

GOCE
2009-2013

SMOS
2009



Cryosat
2010

Swarm
2013

Aeolus
2018

Future Missions

EarthCare
2022

Biomass
2022

FLEX
2023

EE-9
2025

2 Cand.

EE-10
2027

3 Cand.

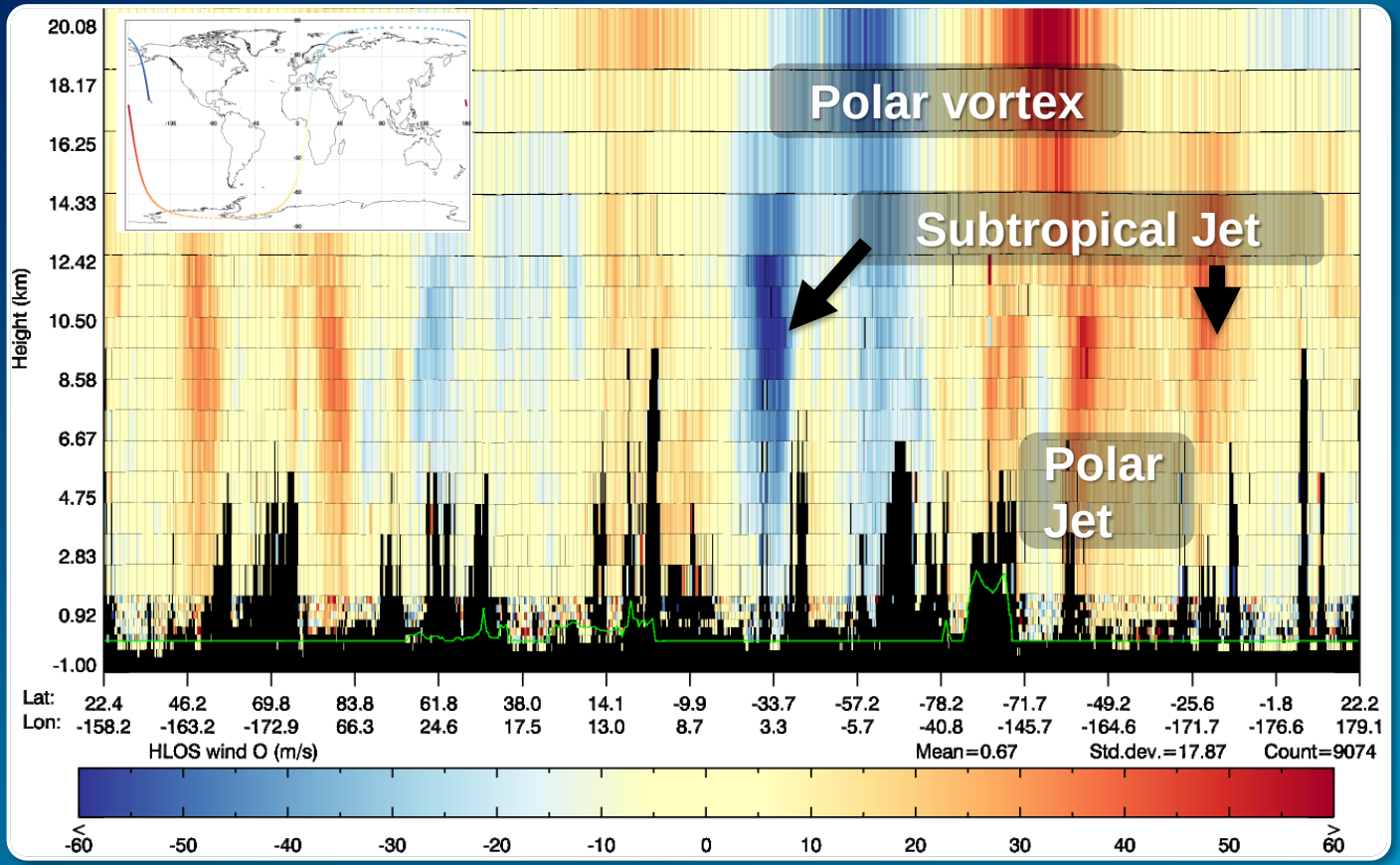
Science & Innovation

4.700+ Reg. Users

300+ Publ. per Year

High Risks for Great Rewards

Aeolus

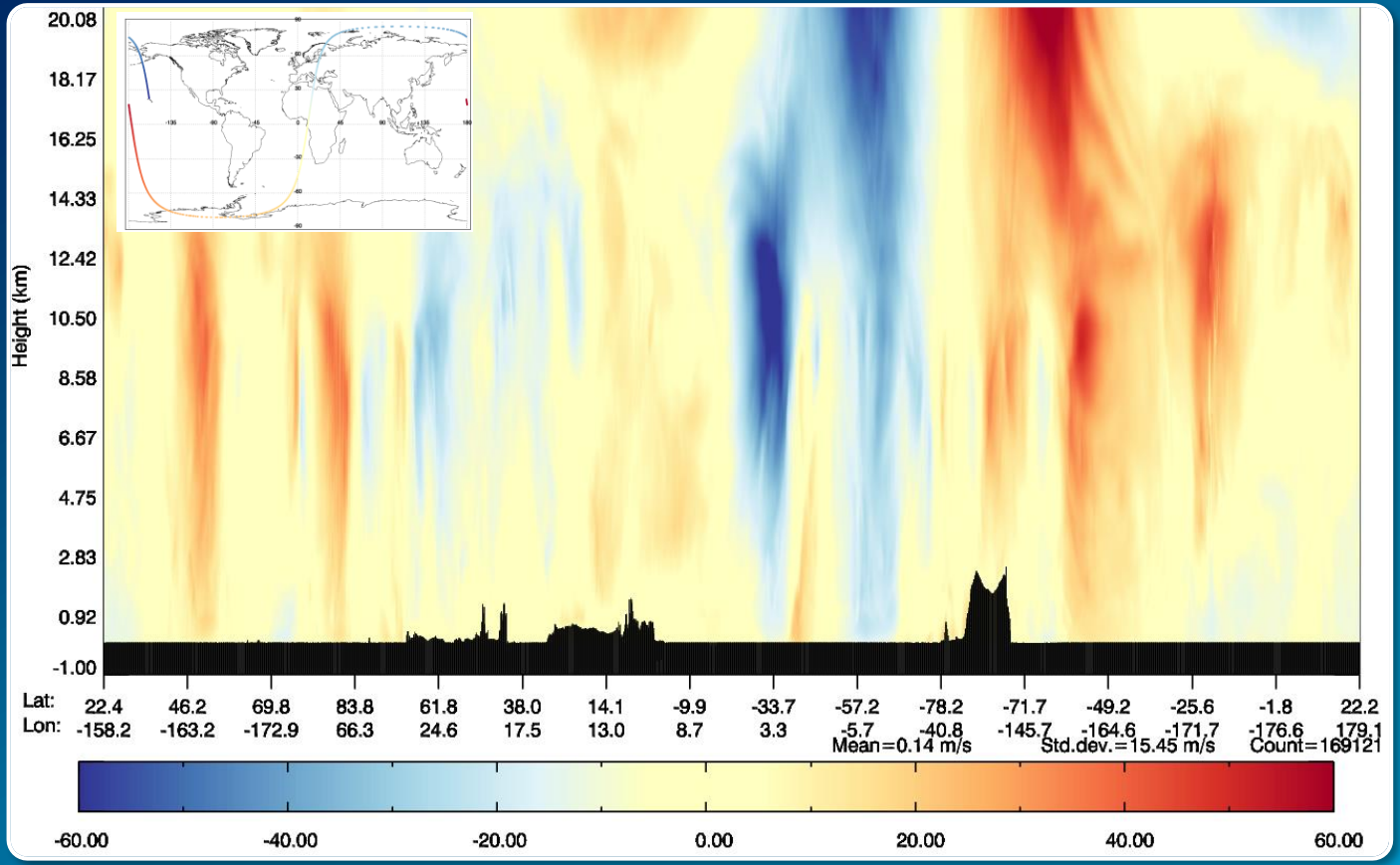


L2B Rayleigh-clear and Mie-cloudy HLOS winds

15 Sept. 2018

ECMWF

Aeolus



ECMWF model
HLOS winds

15 Sept. 2018

Copernicus – global European leadership in EO

> 225.000
registered users
= tip of the iceberg

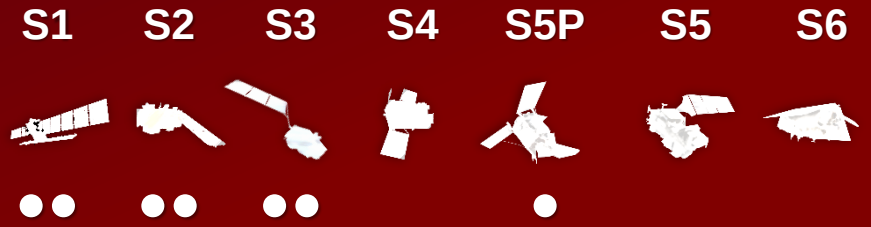
6 operational services

Land | Atmosphere | Ocean | Climate | Disaster | Security

250 TB satellite data distributed per day

full, free & open data policy

7 satellites flying

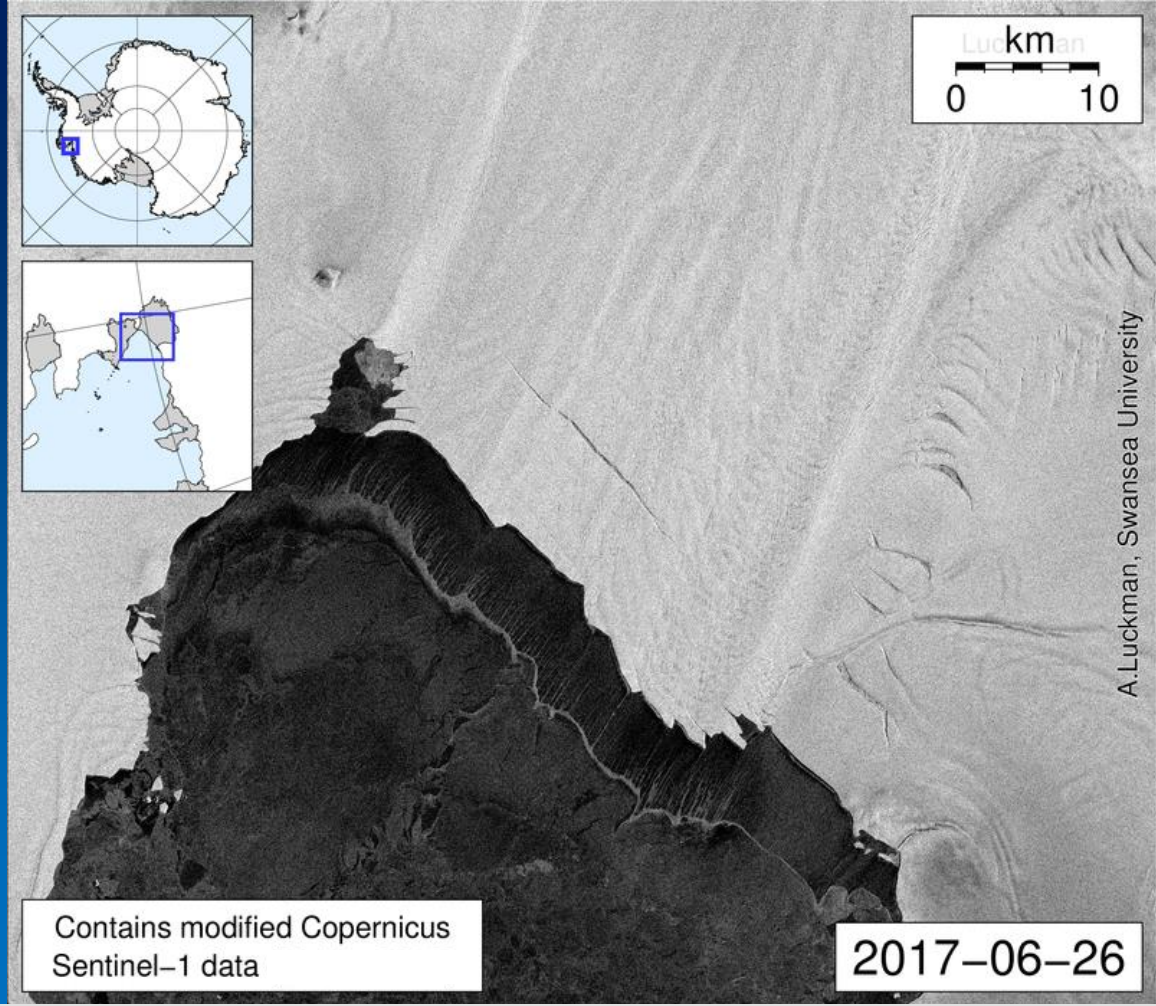


preparing Copernicus 4.0

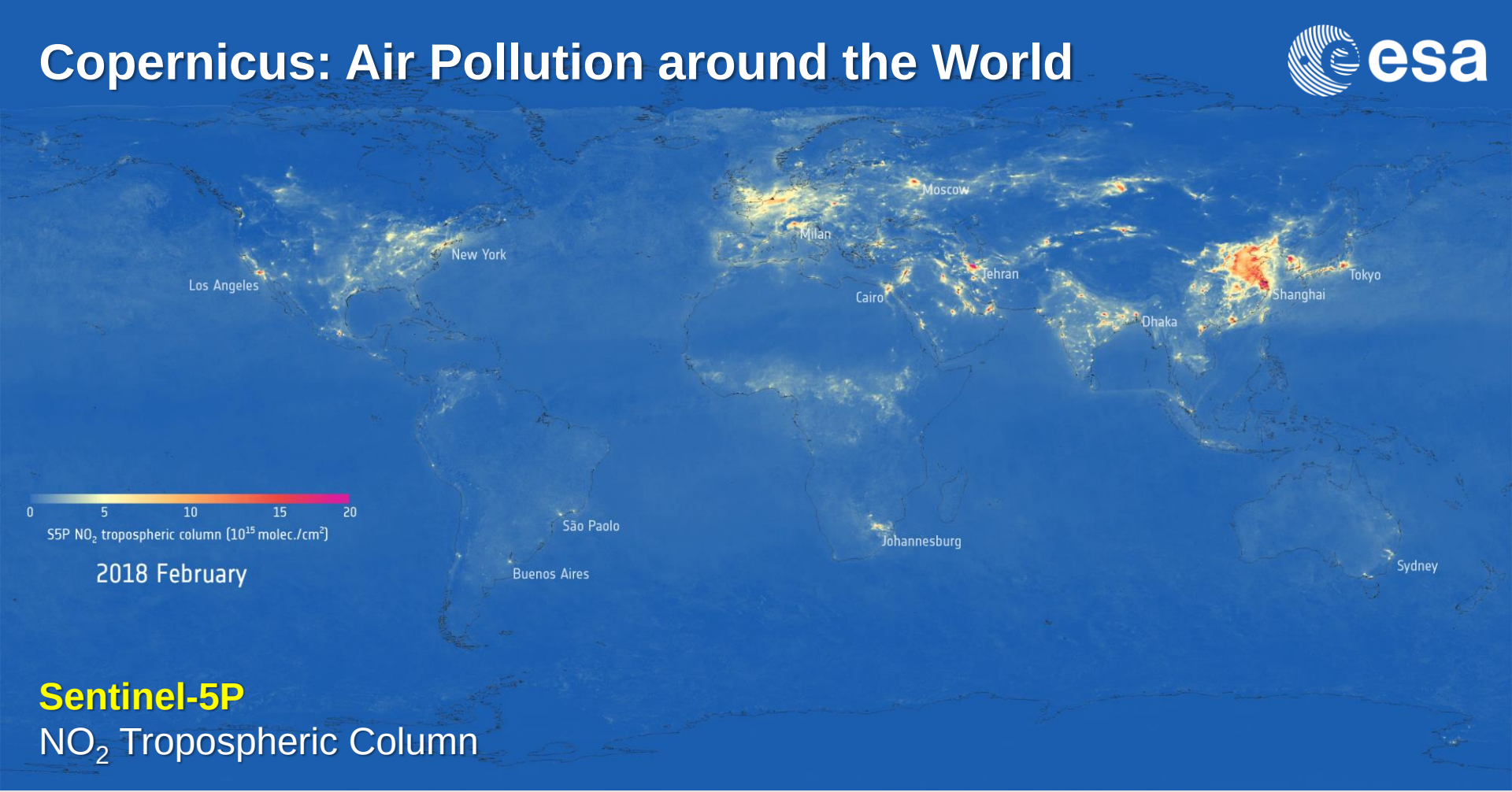
Pine Island Glacier Antarctica

18 months of ice flow & calving

Sentinel-1
June 2017 – January 2019



Copernicus: Air Pollution around the World

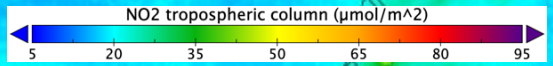


Sentinel-5P

NO_2 Tropospheric Column

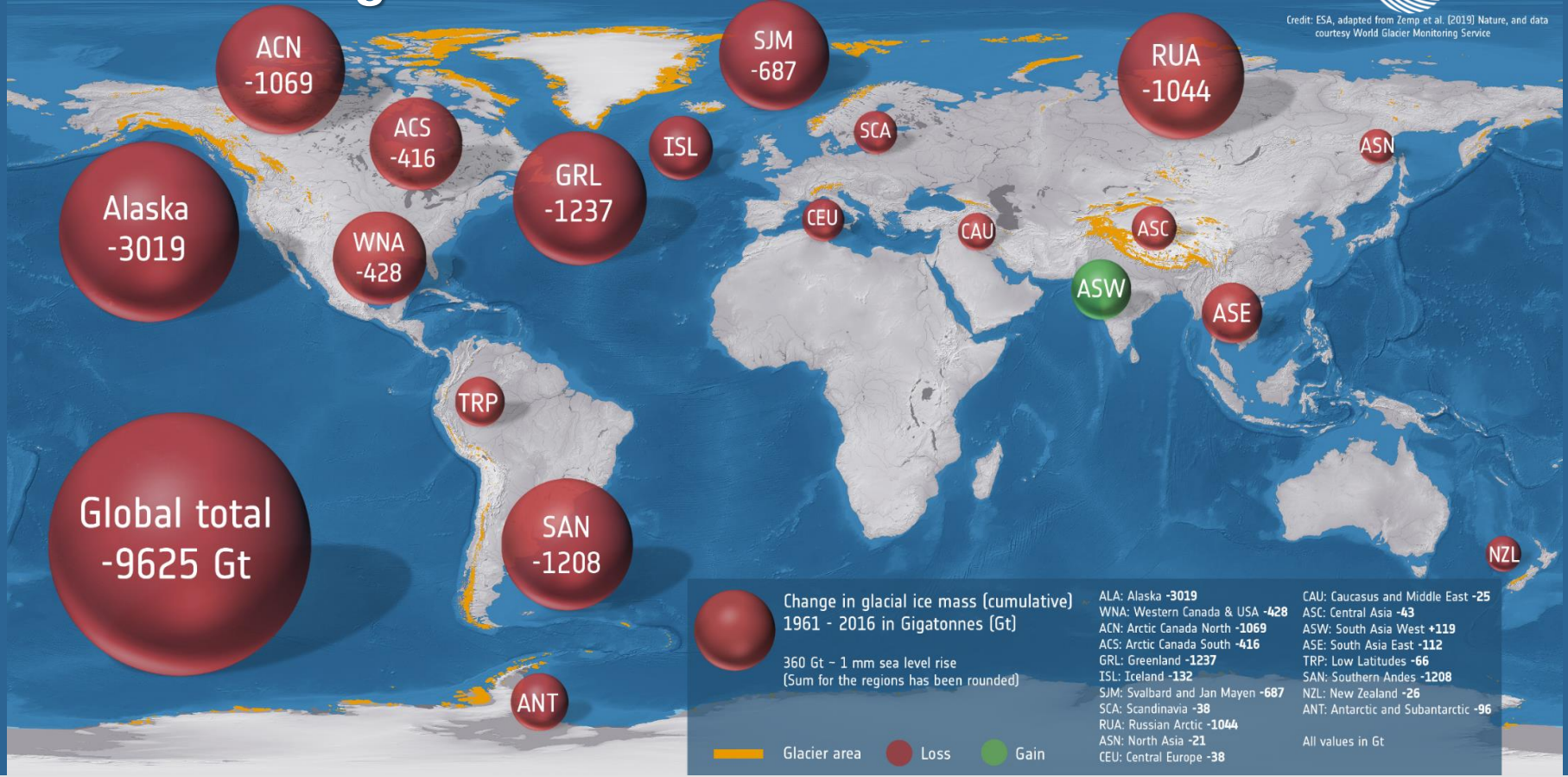
Air Pollution Monitoring

NO_2 average April - September 2018
Sentinel-5P data



© Contains modified Copernicus data (2018), processed by KNMI

Climate Change: Glacial Ice Loss



EO at Space19+

Six Mega Trends in Earth Observation

Earth as the ‘Human Planet’

Tech Revolution, vast EO Potential

Climate Change

New Players & Partners

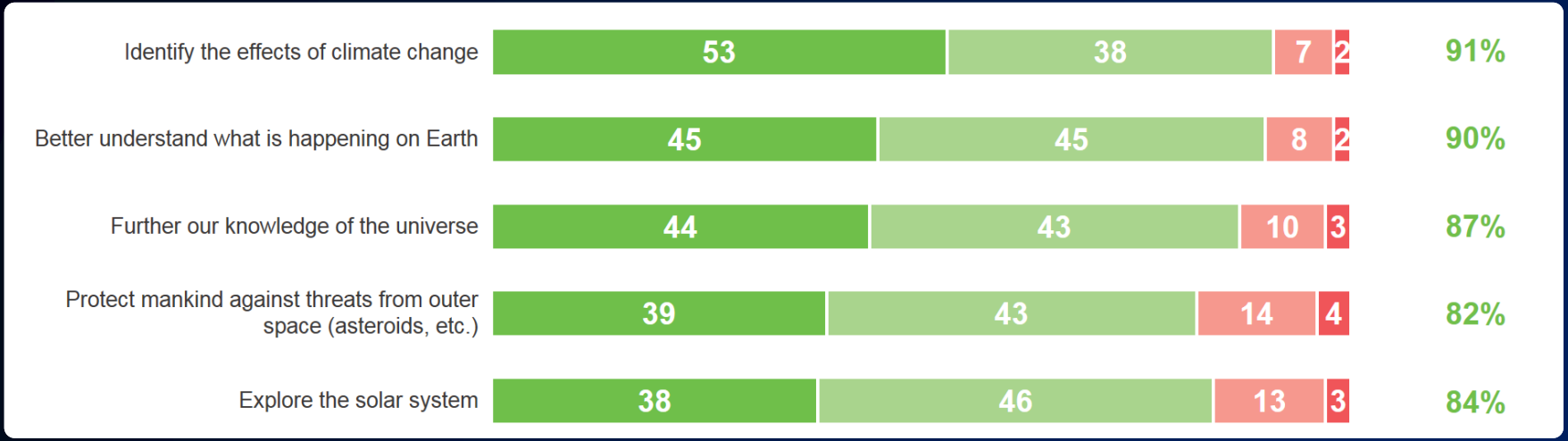
Shifting Citizen Values

Data-Driven Economy

EO is the European Citizens' Priority in Space

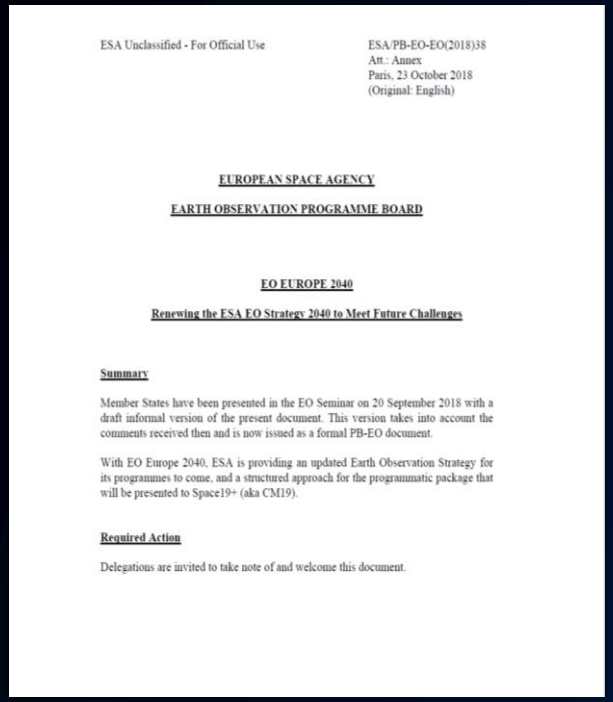
Q: In the future, do you believe that priority should be given or not to space activities that allow us to ... ?

TOP 5 Priorities:



"In the eyes of Europeans, the **primary area of progression** for space activities would be to **foster a better understanding of what is happening on Earth**, particularly regarding the **climate**"

Starting Point: EO Europe 2040 Strategy



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ESA/PB-EO-EO(2018)38
Att.: Annex
Paris, 23 October 2018
(Original: English)

EUROPEAN SPACE AGENCY

EARTH OBSERVATION PROGRAMME BOARD

EO EUROPE 2040

Renewing the ESA EO Strategy 2040 to Meet Future Challenges

Summary

Member States have been presented in the EO Seminar on 20 September 2018 with a draft informal version of the present document. This version takes into account the comments received then and is now issued as a formal PB-EO document.

With EO Europe 2040, ESA is providing an updated Earth Observation Strategy for its programmes to come, and a structured approach for the programmatic package that will be presented to Space19+ (aka CM19).

Required Action

Delegations are invited to take note of and welcome this document.

Four Objectives by 2040

1. Address key societal challenges & deliver excellent science for Europe through novel observations from space

2. Expand the use of space products and services into non-space sectors, both institutional and commercial

3. Foster synergies between national, commercial and European programmes through a system-of-systems perspective

4. Make the European EO sector the strongest and most competitive in the world

➔ End-to-end Approach for World-class Earth Science and Operational Earth Observation

EO Space19+ blocks for EO Europe 2040

Future EO

New name EOEP, envelope structure & legal basis remain

Bring 21st century innovation to EO

Operational EO

Copernicus & Meteorology

In partnership with European Commission and EUMETSAT

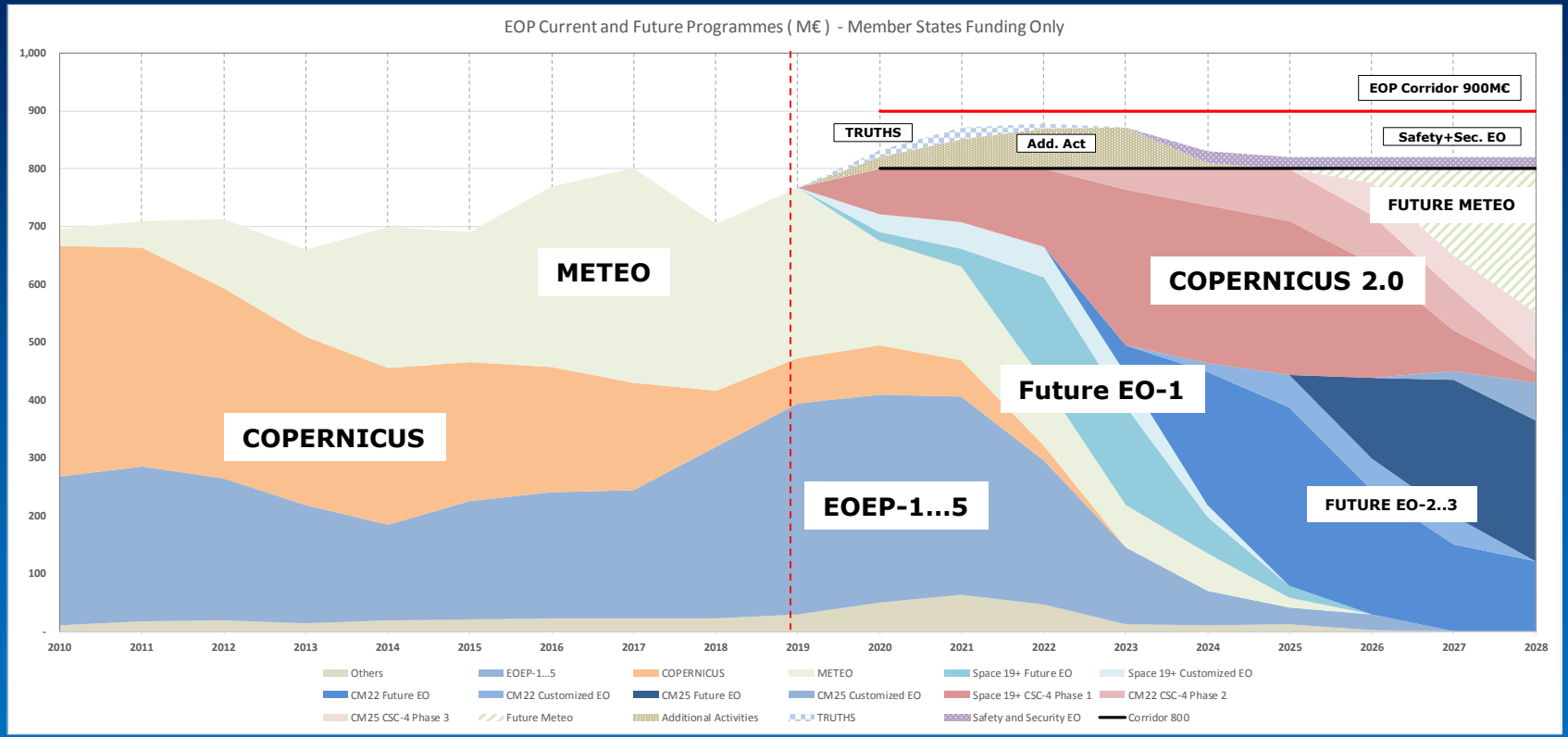
Customised EO

- InCubed+
- Global Development Assistance
- Altius Phase E
- TRUTHS

Basic Activities

- Earthnet
- Heritage Data Programme
- Discovery, Preparation & Technology Development

Stable Member State Funding



Future EO – Structured around 4 Blocks

Future Flagships & Systems

1. **Foundations, Concepts & Technology**

2. **Research Missions**
   - FORUM or SKIM

Operation & Exploitation

3. **Mission Management**

4. **Earth Science for Society**

Future EO – New Approach

Building on Success

- Improving the well-established EOEP Programme
- Continuity of limited adaptation of Declaration, IR, …

Elements of Change

- 3-year segments linked to the “CM cycle”
- Each segment covers in priority the entire development of a new Explorer mission – this offers a long-tern vision for the coming suite of Explorers
- The schedule for new Calls must be synchronised (in order to start phB2 after the coming CMs)
- New Future-EO-1 period would cover 3 segments (with segment-1 being tabled for subscription at Space19+)
- Limited overlap with EOEP-5 in order to initiate “New Space” approaches without delay

Future EO – driving 21st Century Innovation

Hardware & Technology

Big & Small

HAPS

Operations

Increased Data Diversity & Volumes

BIG DATA

EO AFRICA

Safety & Security

EO contribution to ESA-wide pillar

21st Century EO

Software & Applications

Artificial Intelligence
Data Analytics
Internet of Things

Cloud Computing

Future EO – Earth Explorer 9

Two Candidates – Launch around 2025

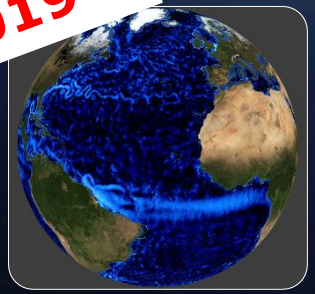
FORUM

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… …e Kinematics … monitoring



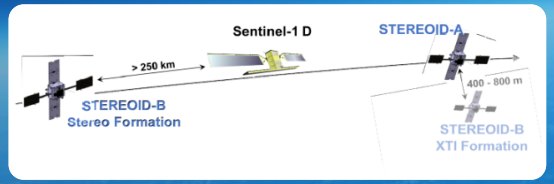
Will carry novel wide-swath scanning multibeam radar altimeter to measure ocean-surface currents with Doppler technique

EE9 Users Consultation Meeting Cambridge, 16-17 July 2019

Future EO – Earth Explorer 10

Three Candidates – Launch around 2027

STEREOID



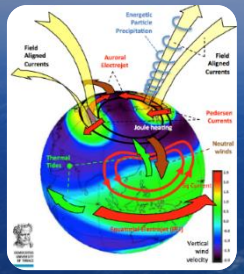
Bistatic SAR as passive followers of Sentinel-1

Two <500kg spacecraft

Applications

- Cryosphere
- Oceanography
- Geosphere

Daedalus



Explore mesosphere, lower thermosphere & Ionosphere

Focus on temperature, heating processes & composition structure

Includes four Cubesats at 120 km altitude

G-CLASS

Science on daily water cycle

Geostationary C-band SAR

Benefits for weather forecasting, hydrology, mountain cryosphere

Block 4 – Earth Science for Society

- Address Grand Science Challenges (incl. ESA-EC/RTD Initiative)
- Bring EO Solutions for environmental threats (adaptation, mitigation)
- Pioneer Artificial Intelligence for EO (Big Data)
- Consolidating the Regional Initiatives (focus on user needs)
- EO Africa (users engagement & uptake of EO solutions)
- Permanent Open Call to investigate latest innovative ideas

Earth System Science

EO for Environment Threat

Platforms & AI

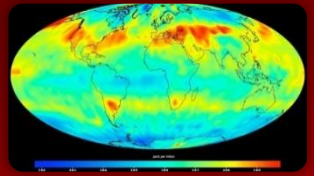
Regional Initiatives

Scouts – SmallSat Challenge

- Respond to the dynamism of a quickly evolving scientific & technological EO environment
- Through new development methodologies, high-risk approaches (e.g. use COTS) and existing assets
- Reduce time & cost to deliver demonstrations of novel EO techniques, results in Earth sciences and non-commercial applications
  - CaC 30 M€ at 2019 e.c.
  - Short schedule of max. 3 years
- Complementary to the EE
- Free-and-open data policy
- ITTs currently under preparation

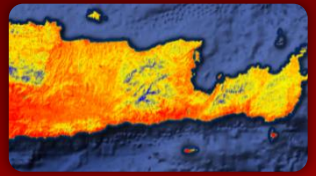
Operational EO – Copernicus 4.0

Anthropogenic CO_2 Mon. Mission



Causes of
Climate Change

Land Surface Temperature Mission

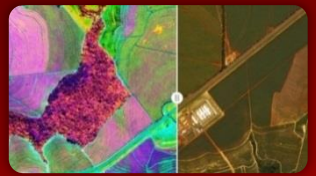


Agriculture & Water
Productivity

CRISTAL – Polar Ice & Snow Topography

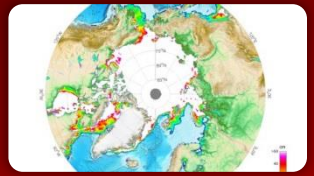
Effects of
Climate Change

CHIME – Hyperspectral Imaging Mission



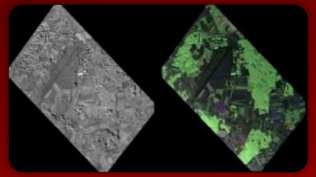
Food Security, Soil,
Minerals, Biodiversity

CIMR – Passive Microwave Radiometer



Sea: Surface Temp.
& Ice Concentration

L-band SAR Mission



Vegetation & Ground
Motion & Moisture

Customised EO – 4 Programme Elements

InCubed+

Continuation of InCubed
2020-2024
InCubed format

Global Development Assistance

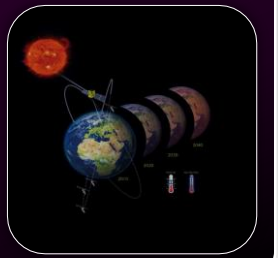
Bring operational EO
solutions in ODA
New element up to 2024

Altius (PhE)

Operational O_3 Monitoring
2020-2024
Extend existing element

TRUTHS (PhA)

Calibration to support
Climate Forecasting
New element



Basic Activities

Earthnet

- Coordinated access to > 35 non-ESA EO missions
- Dialogue & support of NewSpace in EO
- International EO cooperation (CEOS, USA, China, Africa, International Charter)

Heritage Space

- Ensuring all ESA heritage data & information preservation, access & stewardship
- Cross-Directorate
- Covering over 60 ESA space missions

Other Basic Activities

- Innovation (Discovery, Preparation & Technology Development)
- Common infrastructure (ESOC, ICT, test centres, …)
- Networks & Knowledge (Education, ESA_lab@, Communication, …)

EO Calibration and Validation

- Discussed at the recent ESSC plenary meetings
- ESSC Executive Summary sent to EOP Director on 3 Jan. 2019

Towards a European Cal/Val Service for Earth Observation
Executive Summary

- Applies more to Copernicus missions than Earth Explorers and MET missions
- In discussion with EUMETSAT to agree on a common approach captured in a Validation and Fiducial Reference Measurements (FRM) "strategy"
- Essential Cal/Val needs defined at the beginning of a Project/Programme based on UR's and Mission/System Requirements => independent EU funded Cal/Val service might therefore be difficult to implement
- Work under progress at ESA and EUM. Preliminary joint presentation made to EC

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LPS19 in numbers

- Starts next Monday….
- Largest Earth observation event worldwide
- 4200 registered participants
- 1000 oral scientific presentations distributed over 180 sessions
- 50 Agora sessions (round table) distributed over 3 Agoras
- 50 exhibitors and 60 sponsors
- 2100 participating kids to the LPS Educational programme

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