ESA Earth Observation Programmes for Space19+

Finnish Space Industry Days

4 April 2019

Maurice Borgeaud

Head of the Science, Applications & Climate Department

ESA Vision for EO

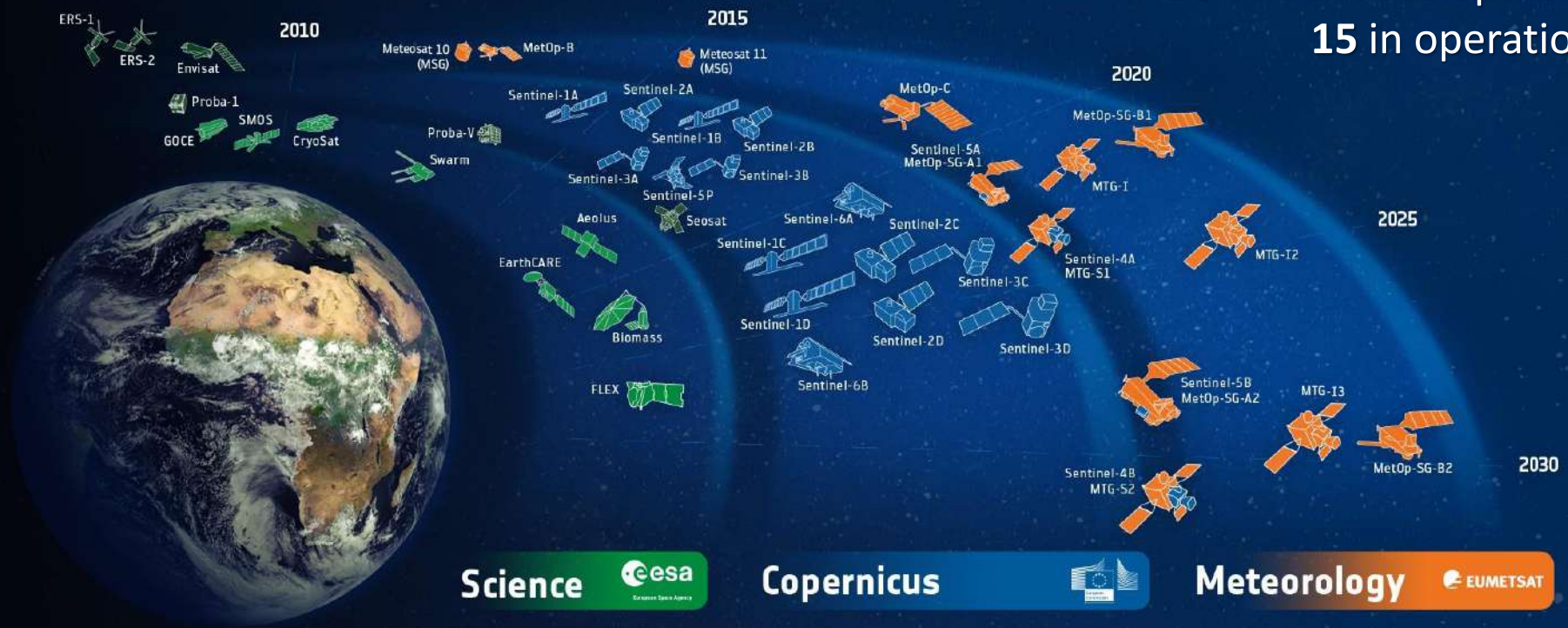
Taking the Pulse of our Planet

ESA Developed Earth Observation Missions

Satellites

25 under development

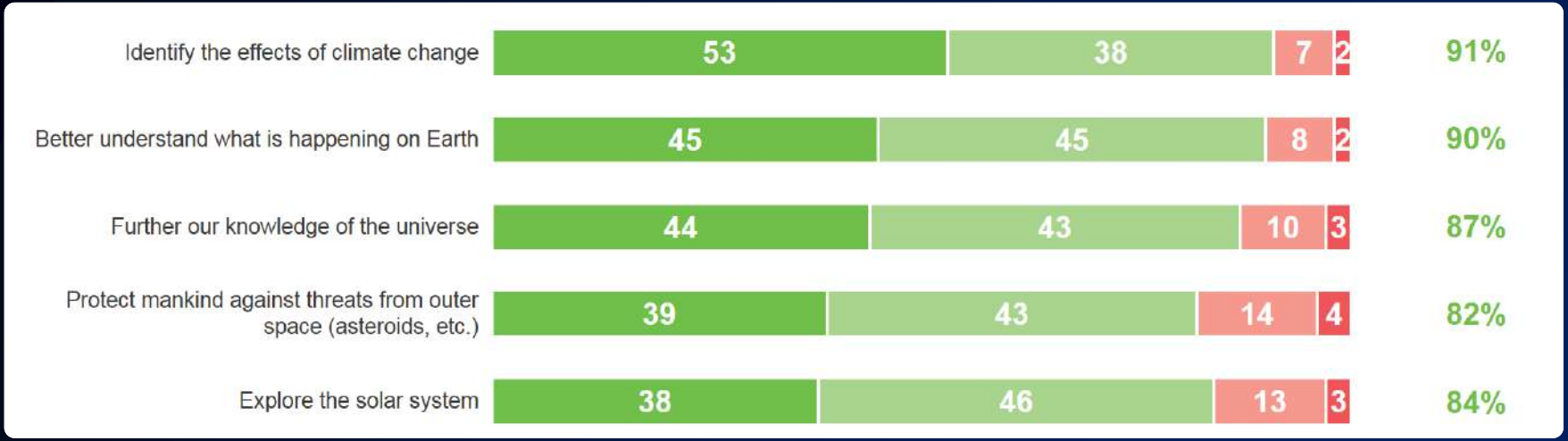
15 in operation



European Citizens' Priorities in Space

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

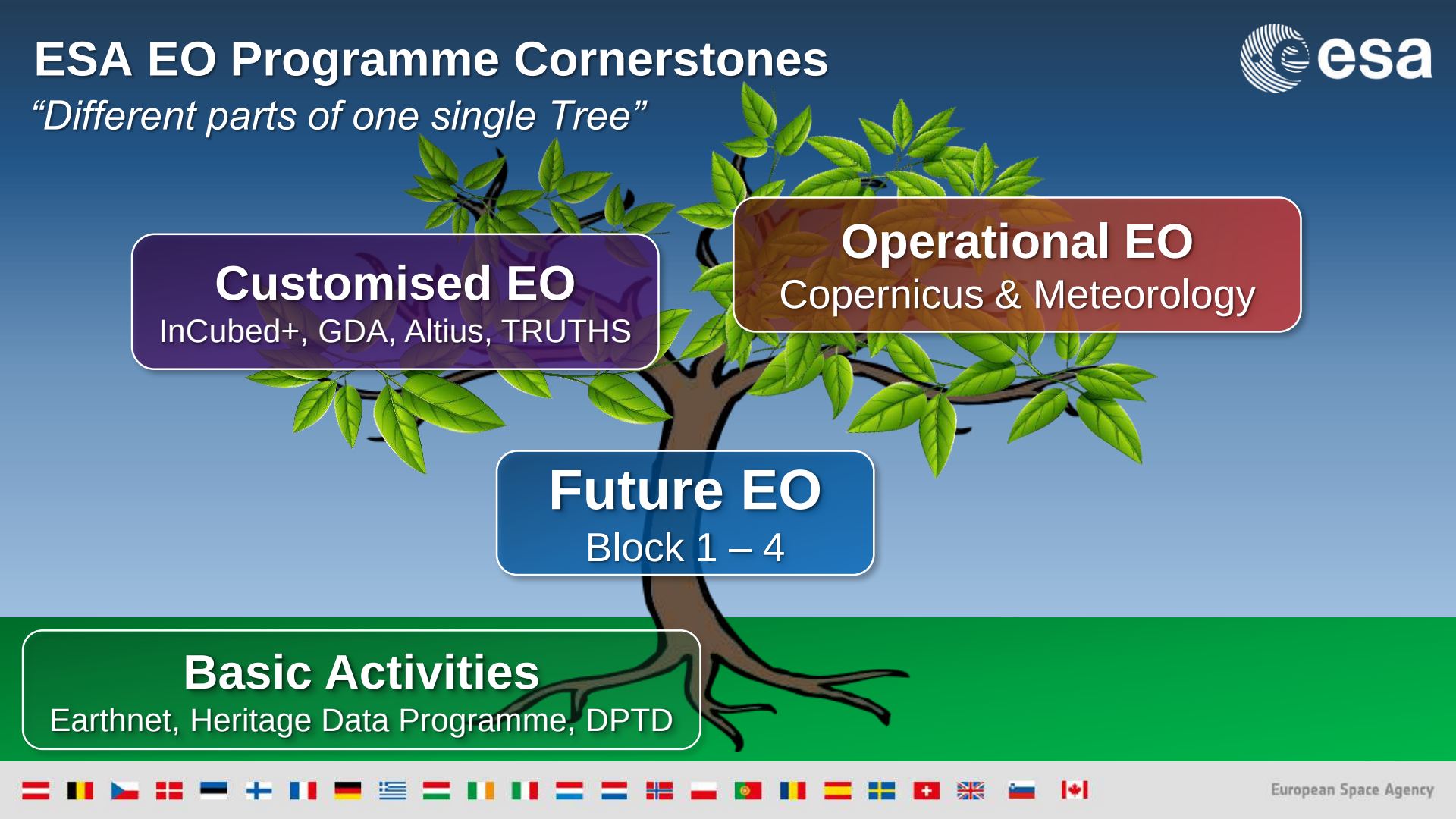
TOP 5 Priorities:



"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**"

ESA EO Programme Cornerstones

"Different parts of one single Tree"



Future EO

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 – 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

Block 1 – Foundations, Concepts and Technology

End-to-end preparation of EO missions – incl. tech developments and science activities to raise TRL/SRL and mitigate risks

- Call for technology/science studies
- Early phases of EE-11, Sentinel-1/2/3-topo/3-opt NG, future Meteo Missions, Mission of Opportunity, including related IPD and science/campaign activities
- Other Instrument Pre-developments
- Cross-cutting technology pre-developments, e.g. for small instrument concepts, platforms (equipment miniaturisation, standardisation, ...) and new enabling technologies

Block 2 – Research Missions

Completion of Earth Explorer-9

Earth Explorer-10 phase B1

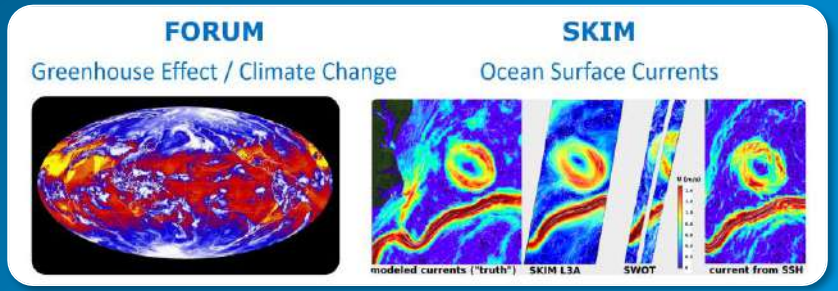
Up to 2 Explorer ‘Scouts’ (‘smallsats’)

- Valuable science for ~30 M€
- Challenge issued in early 2019
- Mission(s) selected after Space19+, for development and launch within 3 years

Timely early development activities

- A future operational wind measurement mission

Phase A/B1 Industrial Teams



Team A
ADS-UK (prime)

Team B
TAS-UK (prime)

Team A
ADS-ES (prime)

Team B
OHB (prime)

Block 3 – Mission Management

smos cryosat swarm aeolus earthcare biomass flex + EE-9 + EE-10

Mission Operations

- Phase E2 of Earth Explorer missions (Phase F if relevant) in 2022 and part of 2023

Generic Fiducial Reference Measurements

Payload Data Ground Segment

Generic elements and Services for data accessibility, archiving, network, etc.

Geophysical Products

- Development & maintenance of ‘Level 2’ products
- For missions in Phases B/C/D/E (9), including cal/val campaigns

Block 3 - Finnish opportunities with Mission Management

- *SMOS and Swarm*: Geophysical processing / validation

- Earth Explorer missions ground segment: development of concept of *Mission Algorithm and Analysis Platforms* (MAAP)
- *Ground segment generic service contracts*, e.g. for EO data quality (QA4EO), for EO data hosted processing or for EO data archiving

- Development of quality concept of *Fiducial Reference Measurements* with adaptation to a range of EO products

Block 4 – Earth Science for Society

- Address Grand Science Challenges (incl. ESA-EC/RTD Initiative)
- Bring EO Solutions for:
  - Environmental Threats (adaptation, mitigation)
  - Sustainable Development (targets & indicators)
- Pioneer Artificial Intelligence for EO (Big Data)
- Consolidating the Regional Initiatives (focus on user needs)
- EO Africa (users engagement & uptake of EO solutions)

Earth System Science

Regional Initiatives

Platforms & AI

SDG Indicators

EO for Resilient Society

Operational EO

Copernicus – continue global leadership in EO

> 215.000
registered users
= tip of the iceberg

6 operational services

Land | Atmosphere | Ocean | Climate | Disaster | Security

150 TB satellite data distributed per day

full, free & open data policy

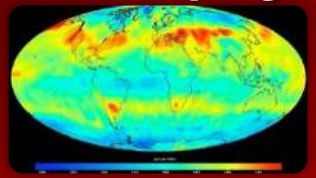
7 satellites flying

S1 | S2 | S3 | S4 | S5P | S5 | S6

preparing Copernicus 2.0

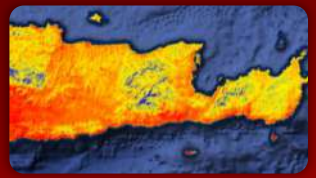
Copernicus 4.0 – New Monitoring Missions (6 HPCM)

Anthropogenic CO_2 Monitoring



Causes of
Climate Change

Land Surface Temp. Mission

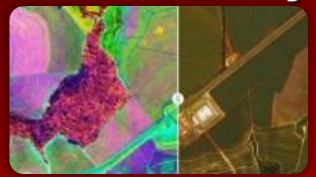


Agriculture & Water
Productivity

CRISTAL – Polar Ice & Snow

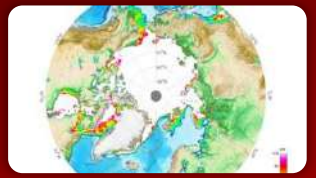
Effects of
Climate Change

CHIME – Hyperspectral Mission



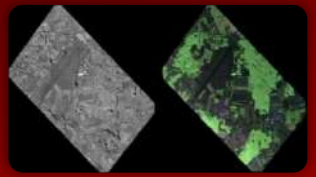
Food Security, Soil,
Biodiversity

CIMR – Microwave Radiometer



Sea: Surface Temp.
& Ice Concentration

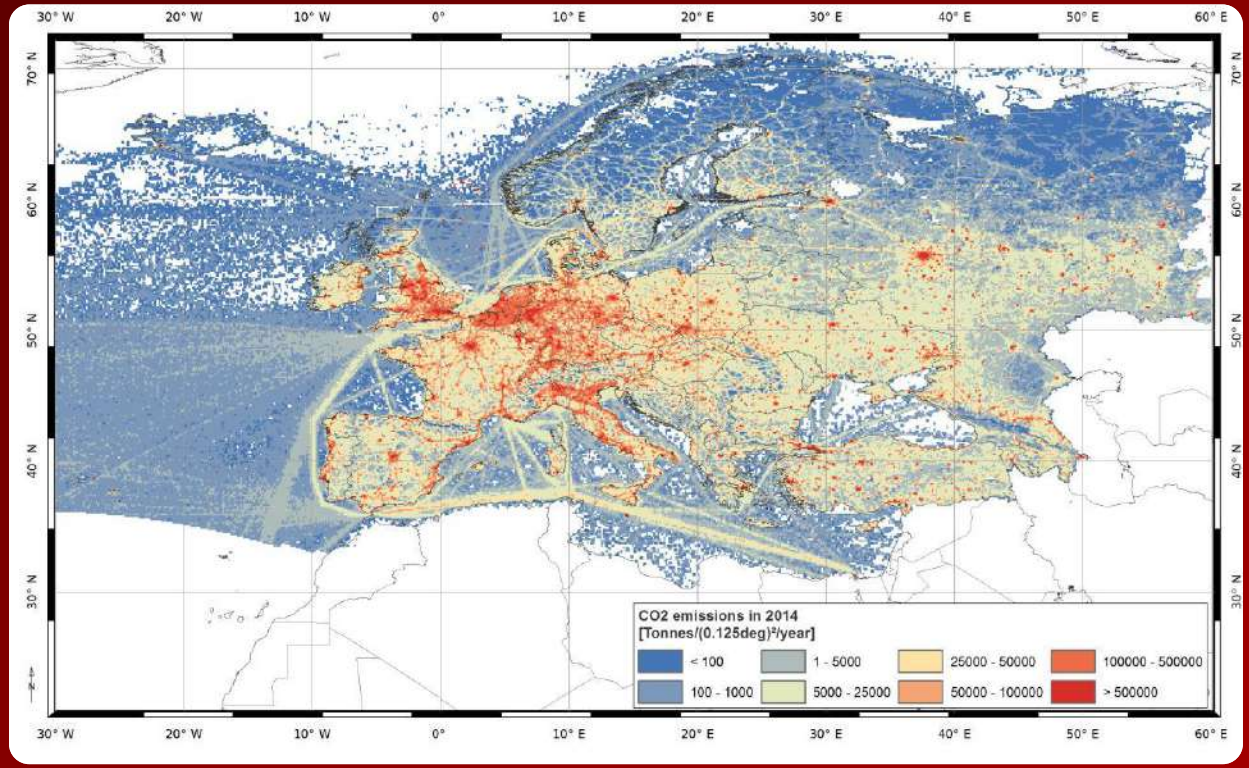
L-band SAR Mission



Vegetation & Ground
Motion & Moisture

Anthropogenic CO_2 Monitoring Mission (CO_2M)

- Analyse man-made CO_2 emissions and overall CO_2 budget
- Assess the effectiveness of the relevant COP21 decisions
- Through the use of CO_2 satellite imagers
- At country and regional/megacity scales

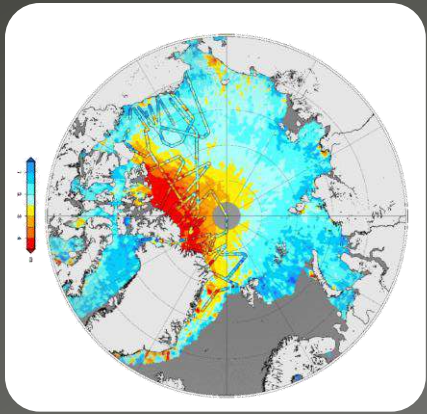


European total CO_2 emissions - Kuenen et al., 2014 and 2015

Copernicus polaR Ice and Snow Topography Altimeter Mission (CRISTAL)

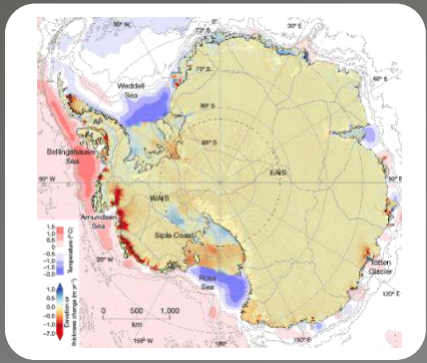
Primary Monitoring & Measuring Goals

- Variability of Arctic and Southern Ocean sea-ice thickness and its snow depth
- Surface elevation and changes of glaciers, ice caps and the Antarctic and Greenland ice sheets



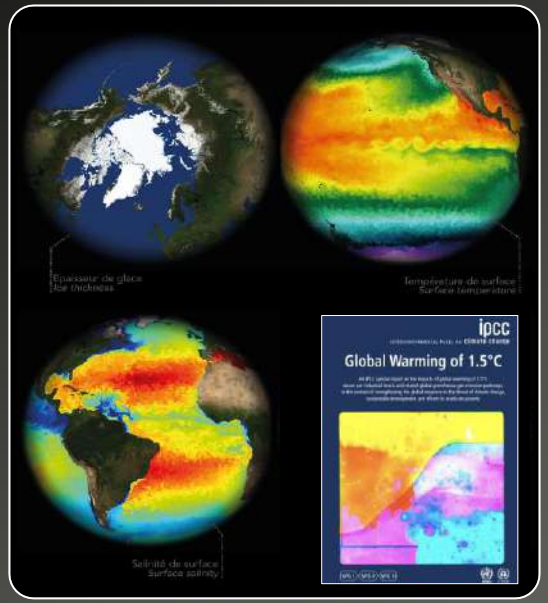
Secondary Goals

- Contribute to the observation of global ocean topography as a continuum up to the polar seas
- Support coastal and inland waters applications
- Support snow cover and permafrost applications



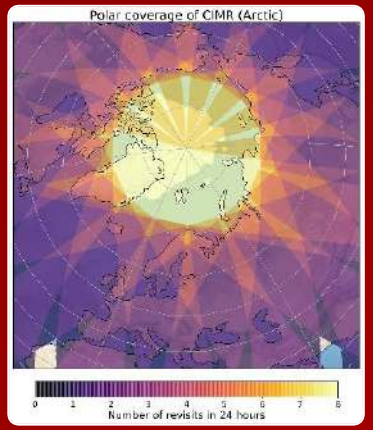
Copernicus Imaging Microwave Radiometer (CIMR)

Polar Oceans are fundamental to understanding the global environment



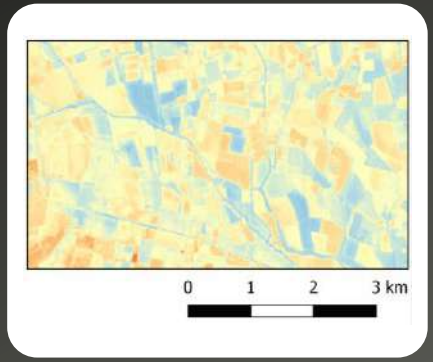
Sea Ice Concentration, Sea Surface Temperature, thin Sea Ice Thickness, Sea Surface Salinity, Wind Speed, Snow Water Equivalent, Soil Moisture

- Prevent data gap & be timely for an ice-free Arctic
- Measurements every ~6 hours in the Polar regions with 95% global daily coverage
- Data application in all Copernicus Services
- Directly addresses the EU Arctic Policy

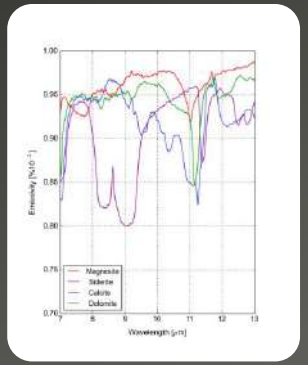


High Spatial and Temporal Resolution Land Surface Temperature Monitoring Mission (LST)

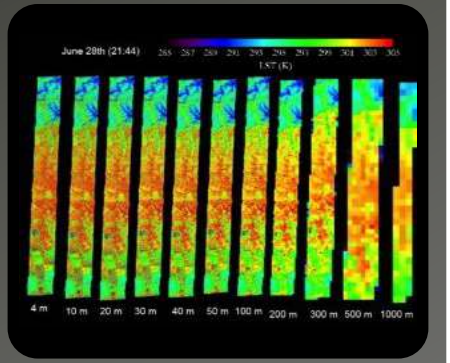
- Complement current S-2 and S-3 visible and near-infrared (VNIR) Copernicus observations with high spatial and temporal resolution
- Thermal Infrared (TIR) observations over land & coastal regions in support of agriculture management services (CAP) and a range of additional services



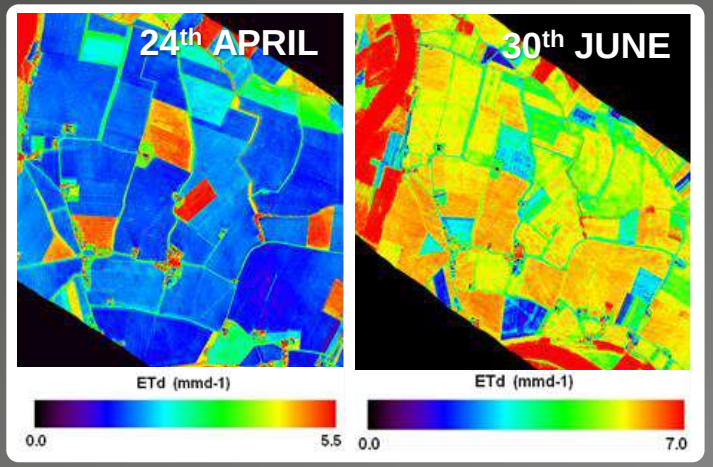
Water Stress



Mineralogy



Urban Heat

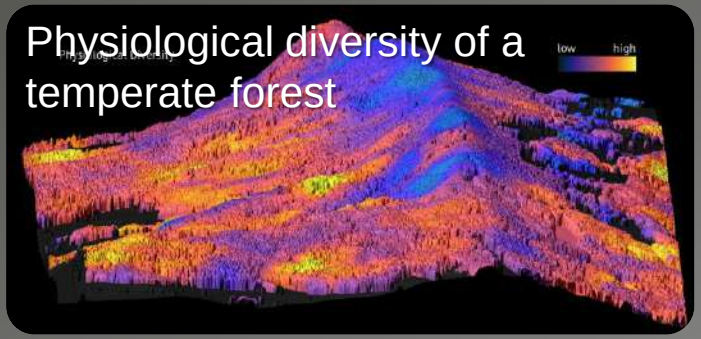


Copernicus Hyperspectral Imaging Mission (CHIME)

Provide routine hyperspectral measurements in support of EU- and related policies for the management of natural resources & assets

- Support food security, agriculture and raw materials, soil properties
- Secondary Applications: biodiversity and ecosystem sustainability, forestry management, environmental degradation, lake/coastal ecosystems and water quality, snow grain size/albedo, snow impurities)

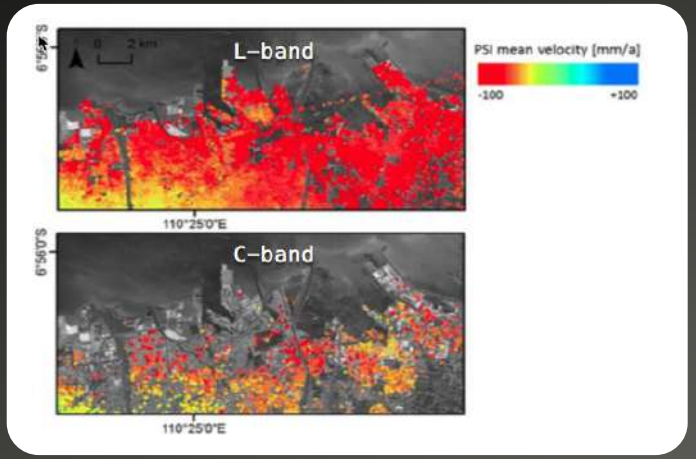
Hyperspectral data cube
(courtesy DLR)



(Airborne imaging spectroscopy APEX data - Schaepman, Jehle et al. 2015)

Radar Observing System for Europe L-band (ROSE-L)

Temporal variations in Soil moisture & Crop type



Mapping fast subsidence rates of Semarang (Indonesia) using point scatters at L-band & C-band

New information for services in Disasters & Geohazards, Forests, Agriculture and high-resolution monitoring of Arctic & Cryosphere

- L-band SAR payload
- Sea ice mapping (e.g. deformed ice, icebergs) and ice drift information to support Arctic ship navigation
- Ice sheet velocity: robust information
- New Snow Water Equivalent (SWE) information with applications to hydrology, meteorology and climate


esa
Customised EO

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 2040

Altius PhE

Operational O_3 Monitoring
2020-2024
Extend existing element

TRUTHS

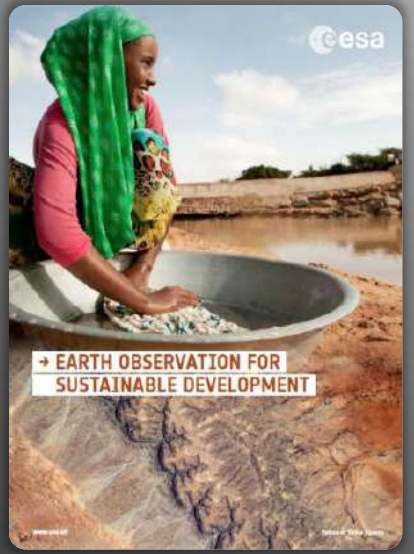
Calibration to support
Climate Forecasting
New element

InCubed+

- Size & duration: 150 M€, 2020-2024
- Will help industry open new markets
- Revised version of InCubed programme and Declaration taking account of lessons learned so far
- Initiative remains with industry. ESA Executive will advertise fields of opportunity, organise industry days, and supports Delegations
- Time-to-contract within 8 weeks
- Considering 4-week ‘fast track’ for smaller proposals lasting under a year
- ESA Executive will assist with introductions to other sources of funding, e.g. VCs and banks
- IP rules ensure commercial bidders retain all IPR

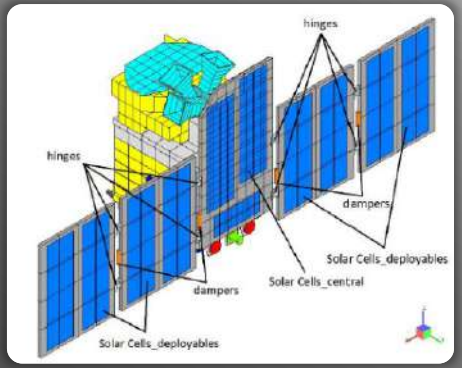
Global Development Assistance

- Size & duration: 150–200 M€, 2020-2024
- Financing composed of:
  - New ESA EO EW element: 50 M€ (conventional ESA financing, will support mainly Knowledge Development activities with the European EO downstream service sector)
  - WB+ADB Trust Fund element: 100–150 M€ (ODA financing from mainly European Aid Agencies/Ministries, will support mainly Capacity Building and Skills Transfer activities in developing countries)
- Joint governance IFI and ESA for the Trust Funds
- For geographic regions in 3 continents: South/Central America, Africa, Asia



Altius Phase E

- Size & duration: 55 M€, 2020-2024
- Extension current Altius phB2CD to include launch procurement & 3 years of operations
- Revision of current EW Declaration element, taking into account under-subscription (7.3 M€ e.c. 2016) and evolution of CaC versus affordability of MS and EOP financial corridor
- Participating States to fund phE1/E2 ‘pro-rata’
- Opportunity for new participating States to subscribe to the full programme (i.e. B2CDE)



Status

- Instrument pre-dev. activities ongoing with instrument prime & subcontractors
- Ground Segment Preparatory Phase produced first results from the E2E Performance Analyses
- Request for Quotation for the Space Segment + FOS phase B2/C/D has been released, bid due by mid May

Altius Phase E

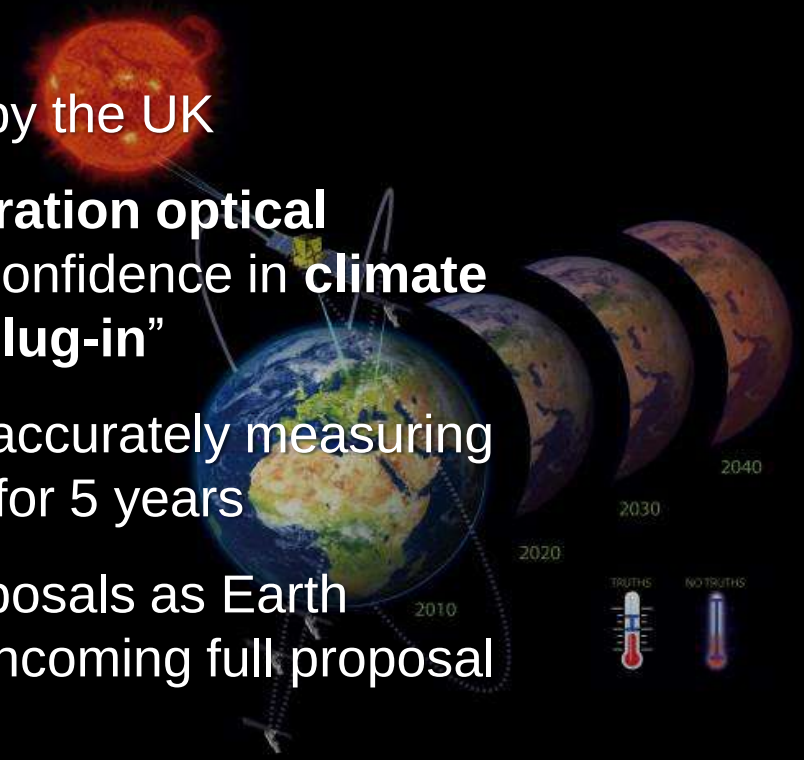
Finnish involvement:

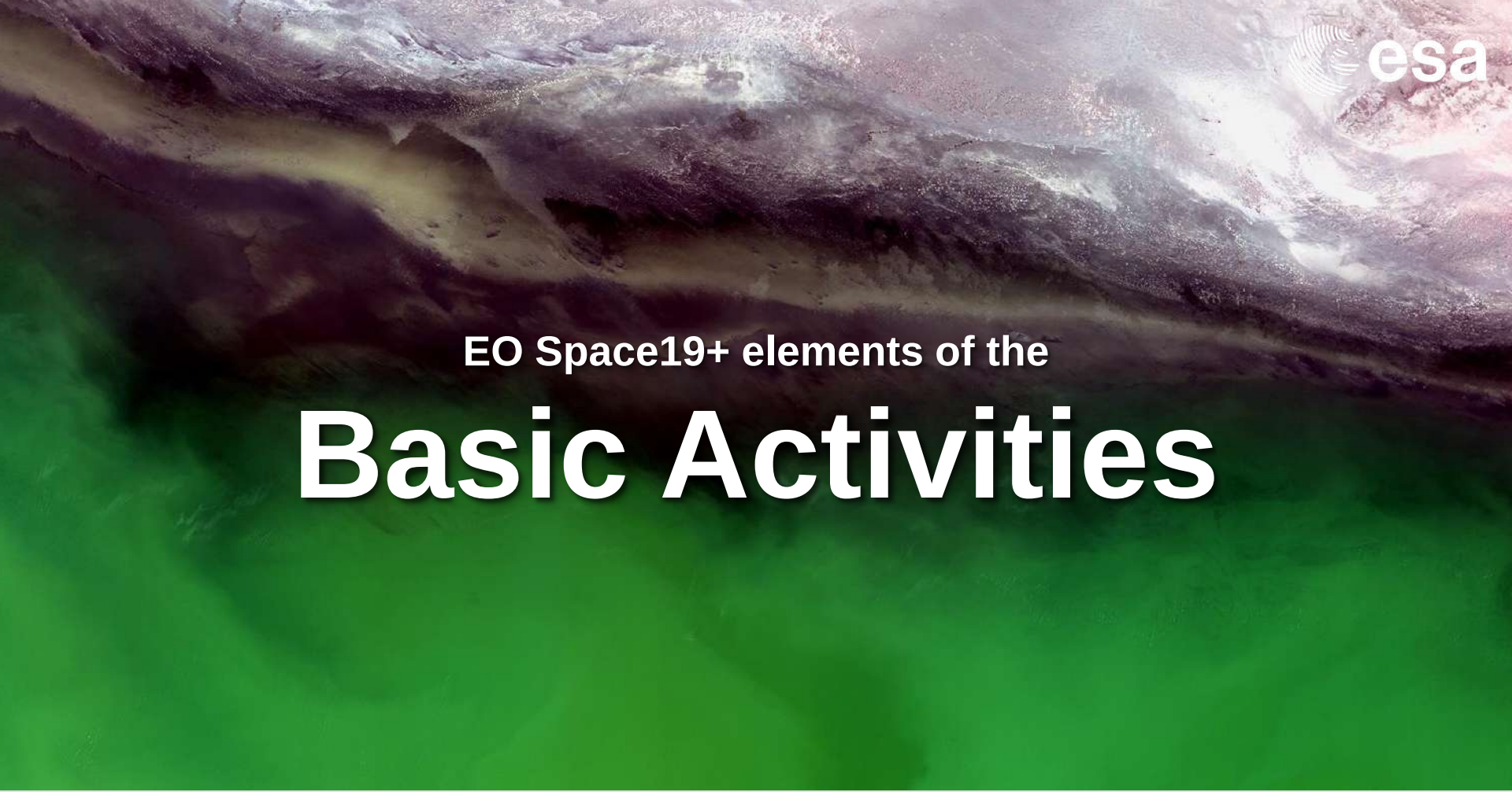
- Currently: VTT (with support from RUAG Space Finland) performing development of Fabry Perot Interferometer for ALTIUS as part of GSTP study, funded by BE.
- Finnish member in ALTIUS Mission Advisory Group
- For next phases: (B2/C/D/E)
  - VTT for delivery of PFM Fabry Perot Interferometer (FPI)
  - Preferably RUAG Space Finland for FPI control and possibly end-responsible for overall PFM FPI, but alternatives under consideration in case of no FI participation.
  - Involvement in Payload Data Processing Segment/algorithm development not yet foreseen but possible in case of FI participation.

=> FI participation of 4-5 M€

TRUTHS

- **Operational mission proposed** by the UK
- Goal: establish space borne **calibration optical observing system** for improved confidence in **climate change** forecasts; “**Copernicus plug-in**”
- Small satellite in processing orbit accurately measuring incoming/reflected solar radiation for 5 years
- Outline provided (evolution of proposals as Earth Explorer of 2001/09/16/17) ➔ forthcoming full proposal to be assessed by ESA in detail





EO Space19+ elements of the

Basic Activities

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, …)

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
17 June 2018

Abstracts
11 November 2018

Registration
April 2019

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