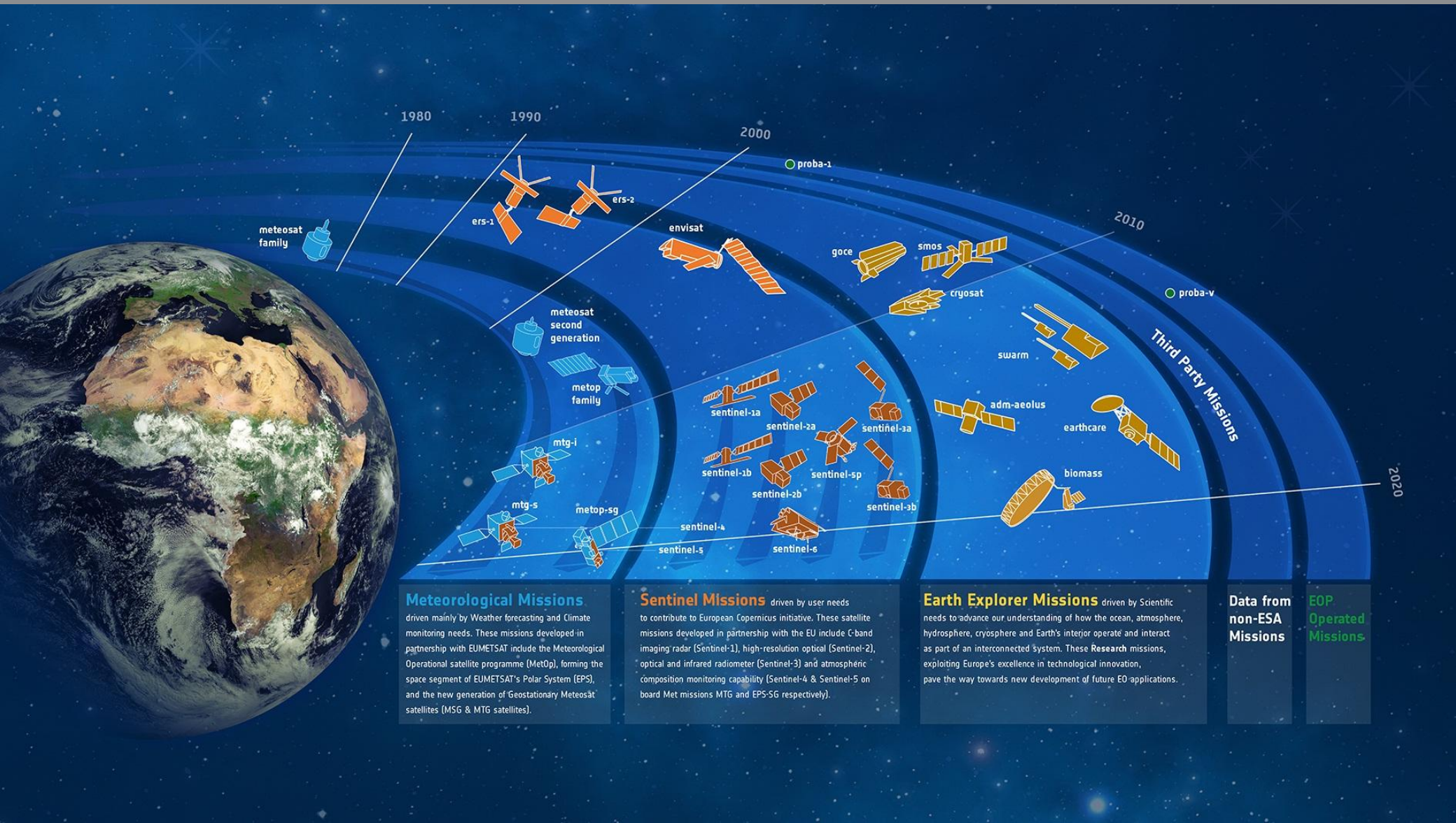
ESA's Earth Observation Programmes

SCERIN-2

Krakow, 9-10 June 2014

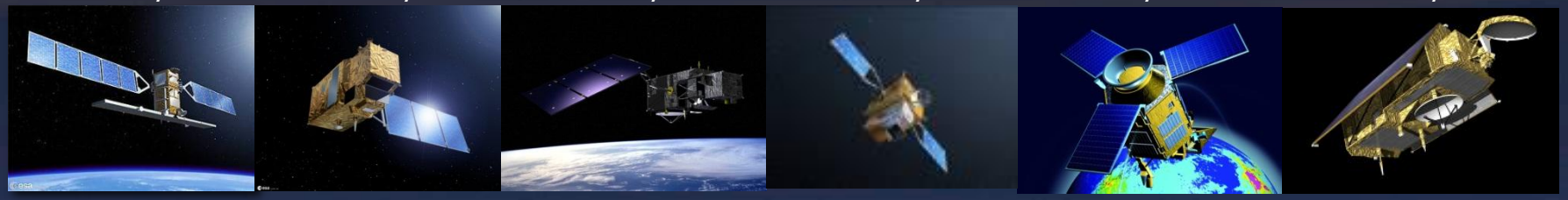
Espen Volden, ESA

ESA Earth Observation Programmes



Copernicus: A New Generation of Data Sources

Sent-1A/B | Sent-2A/B | Sent-3A/B | Sent-4A/B | Sent-5/5P | Sent-6A/B

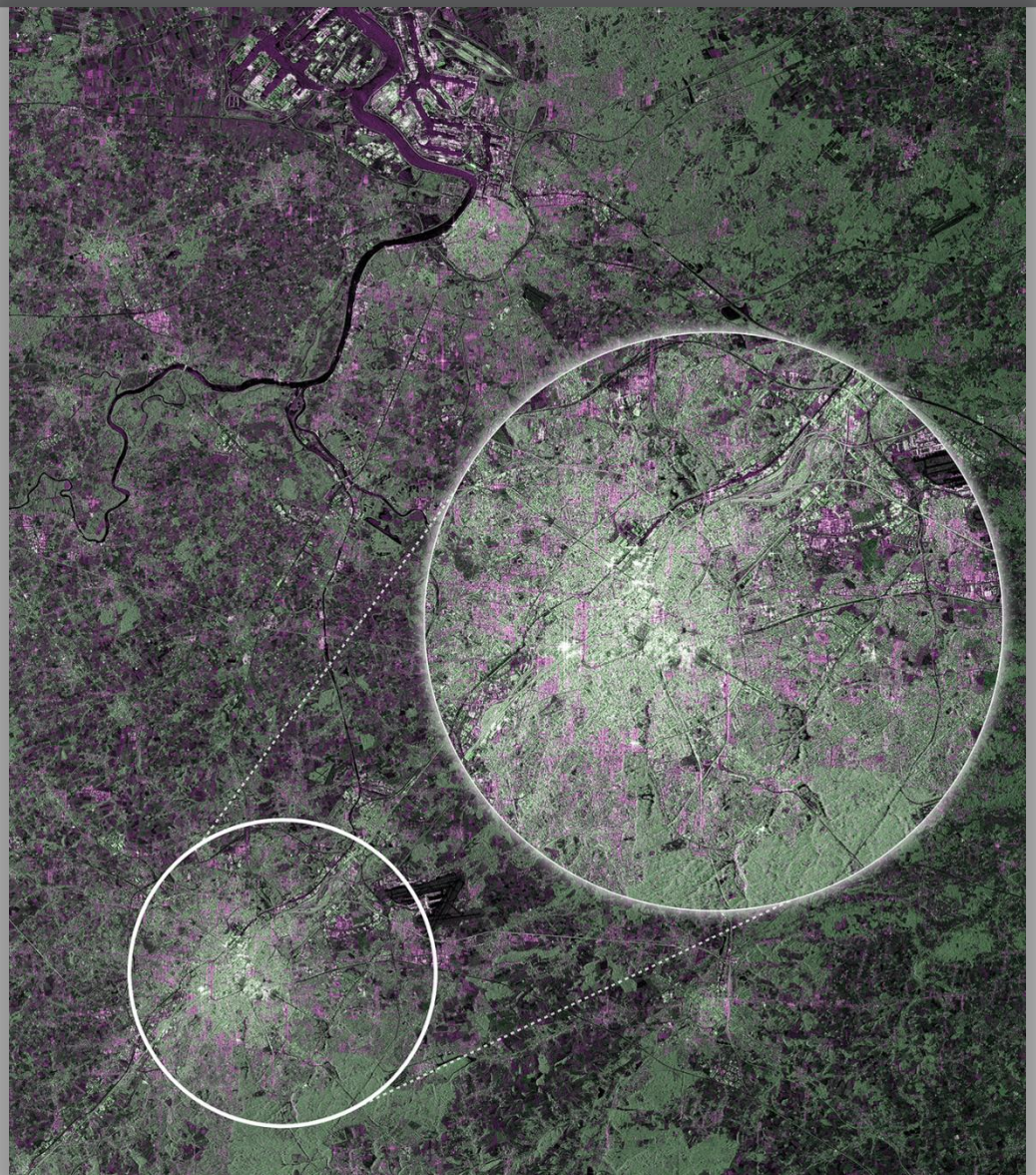


- Copernicus is a European space flagship programme led by the European Union
- ESA coordinates the space component
- Copernicus provides the necessary data for operational monitoring of the environment and for civil security

First Images of Sentinel-1A

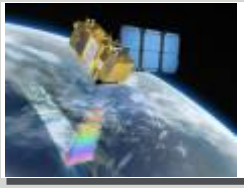
Brussels and Antwerp, Belgium

12 April 2014



Copernicus dedicated missions

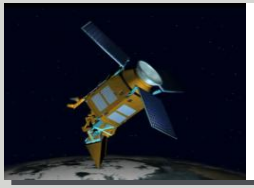
Sentinel-1 (A/B) – SAR imaging
All weather, day/night applications, interferometry



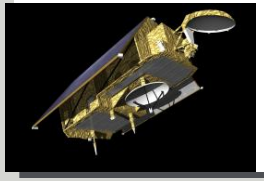
Sentinel-2 (A/B) – Multi-spectral imaging
Land applications: urban, forest, agriculture,…
Continuity of Landsat, SPOT

Sentinel-3 (A/B) – Ocean and global land monitoring
Wide-swath ocean color, vegetation, sea/land surface temperature, altimetry

Sentinel-4 (A/B) – Geostationary atmospheric
Atmospheric composition monitoring, trans-boundary pollution



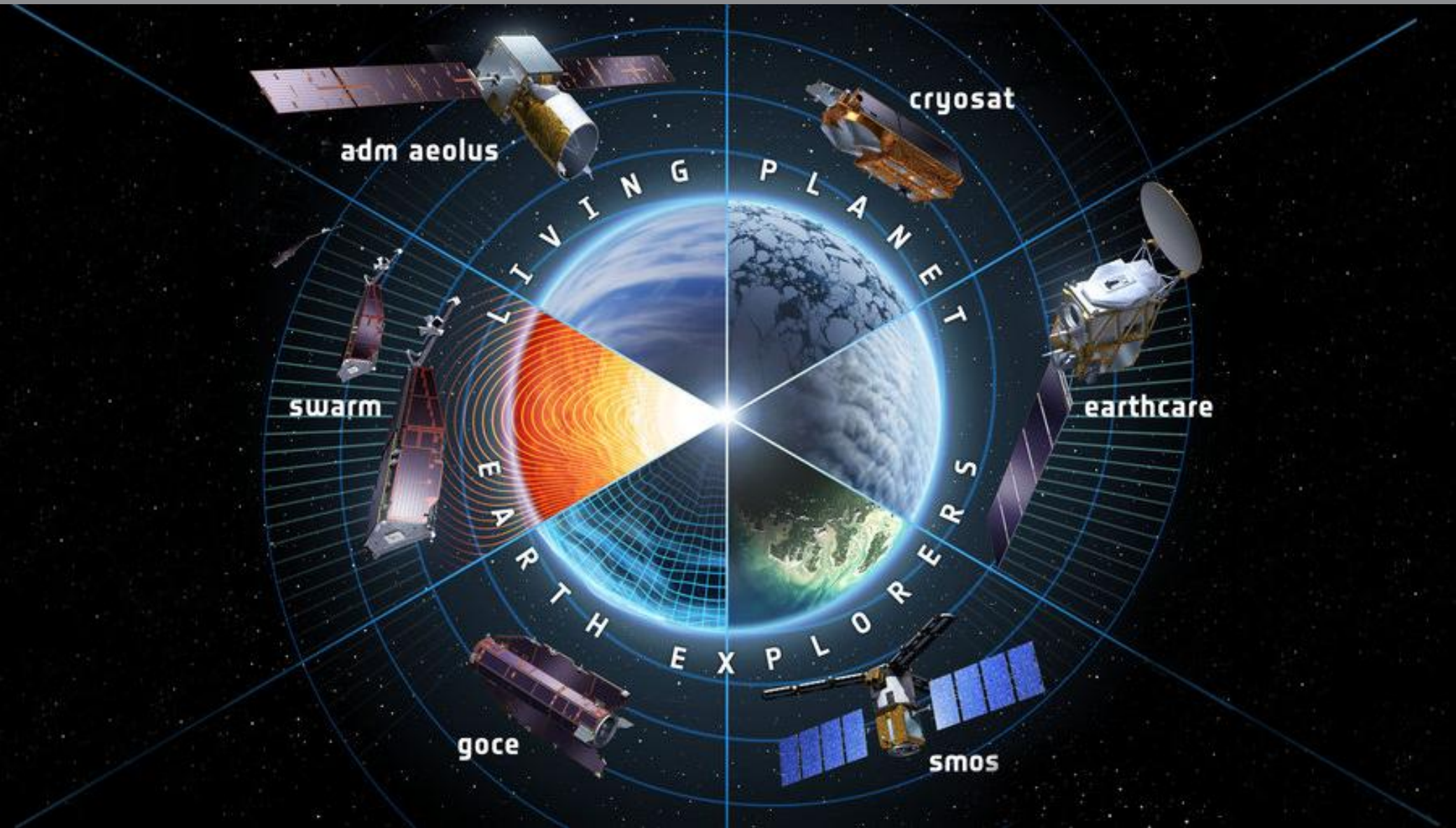
Sentinel-5 precursor/ Sentinel-5 (A/B) – Low-orbit atmospheric
Atmospheric composition monitoring



Sentinel-6 [Jason-CS] (A/B) – Low inclination Altimetry
Sea-level, wave height and marine wind speed

Copernicus
European Space Agency

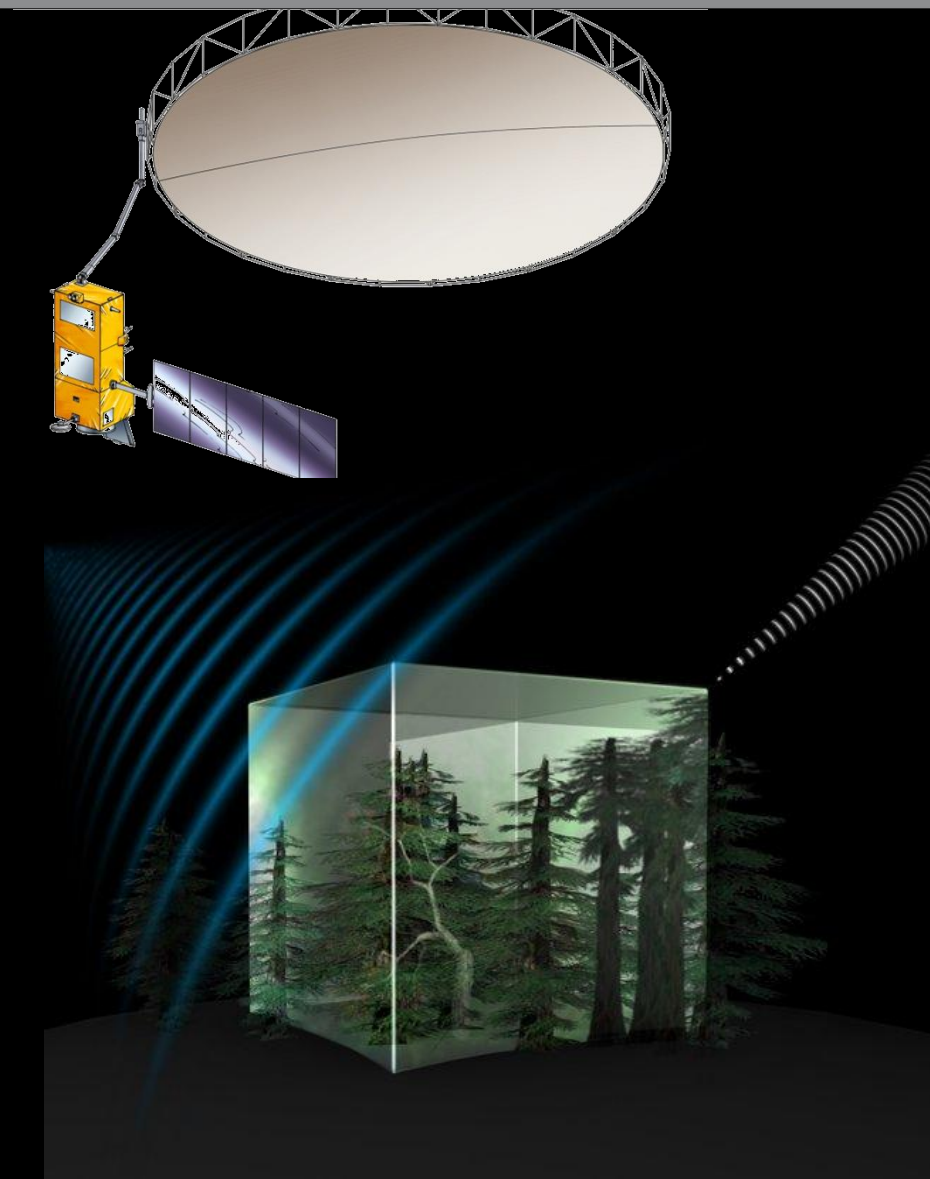
Science – the Earth Explorers



Future Earth Explorer Missions

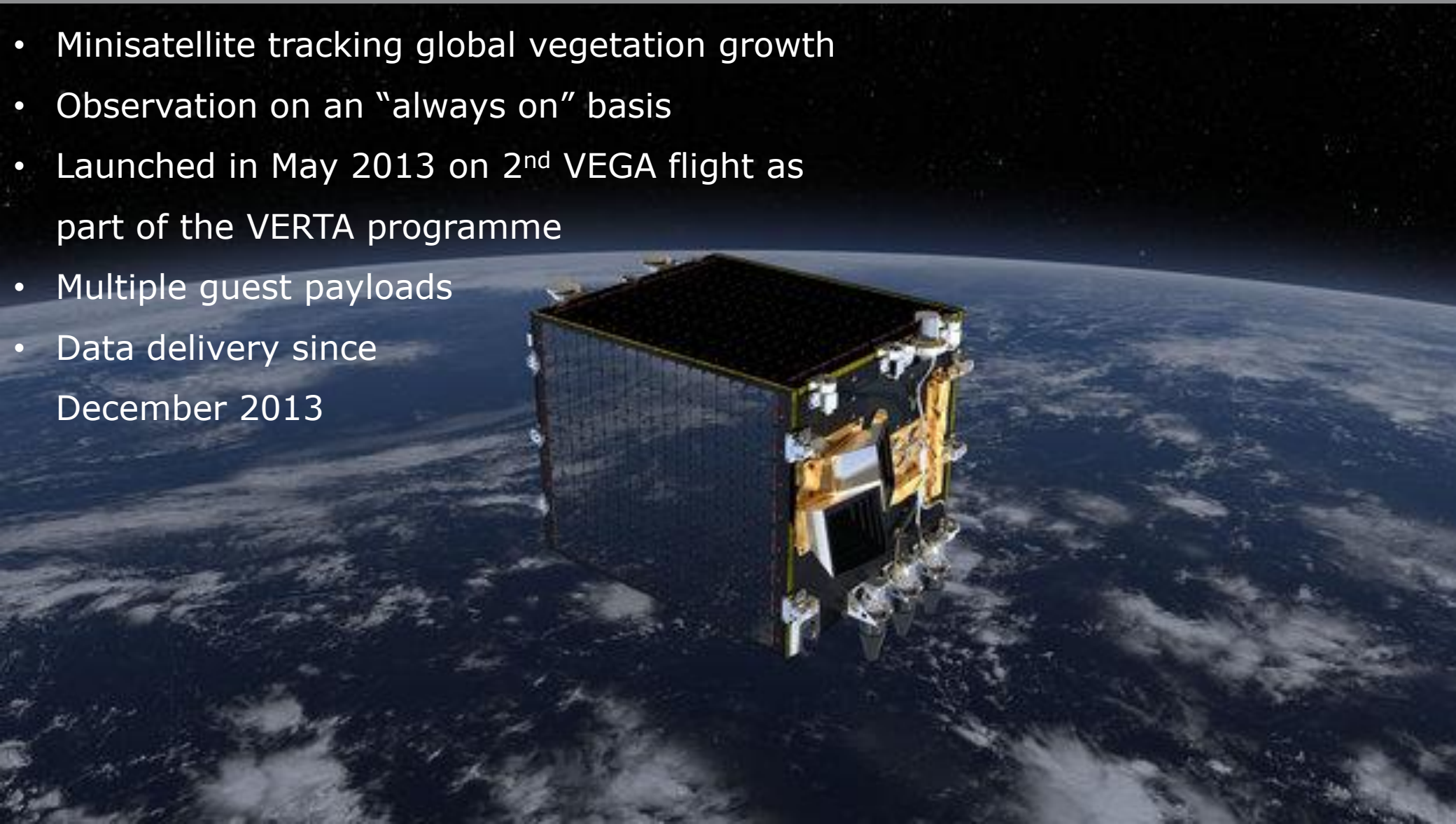
- BIOMASS will be the 7th Earth Explorer
  - Selected by ESA's Earth Observation Programme Board
  - Biomass estimates based on global interferometric and polarimetric P-Band Radar observations
  - Essential to understand the Earth's carbon cycle
  - Offers for phase B received
  - To be launched in 2020

- Candidate missions for 8th Earth Explorer: Flex and CarbonSat

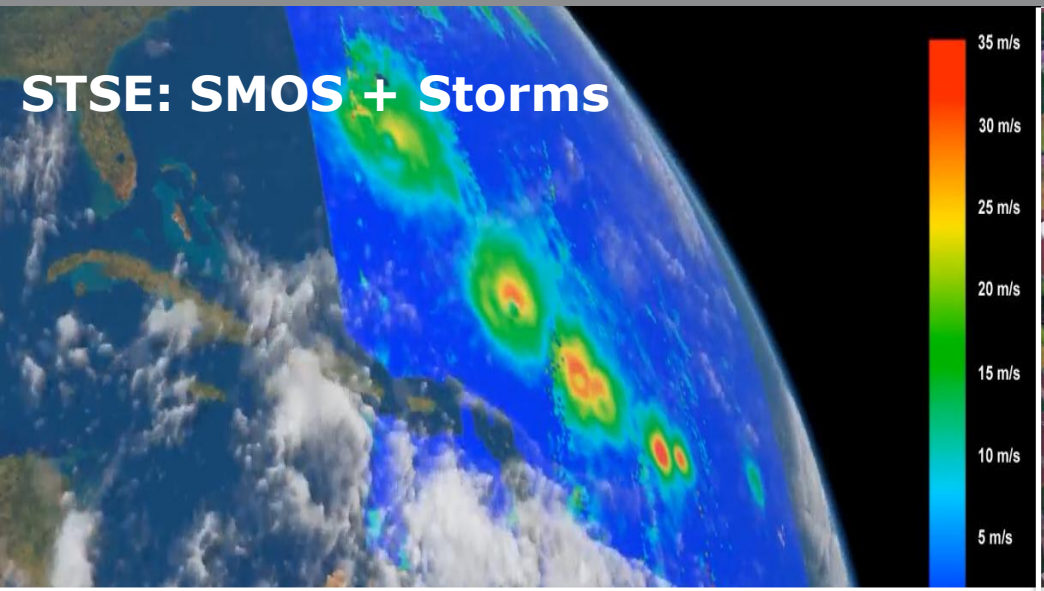


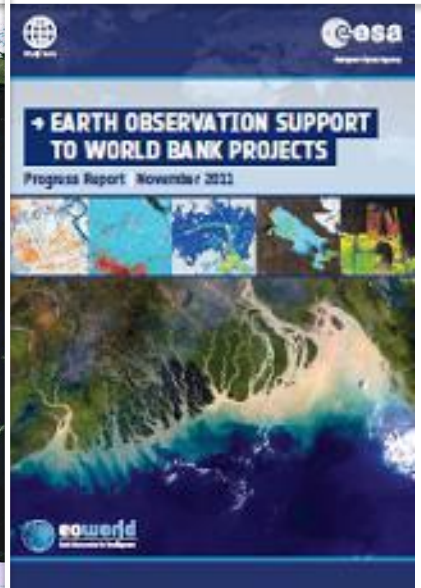
Proba-V

- Minisatellite tracking global vegetation growth
- Observation on an “always on” basis
- Launched in May 2013 on 2nd VEGA flight as part of the VERTA programme
- Multiple guest payloads
- Data delivery since December 2013



ESA Earth Observation Envelope Program (EOEP) Exploitation Activities





Value Adding Element

eoworld
Earth Observation for Development

The Scientific Exploitation of Operational Missions (SEOM)

Program Objectives

- Federate, support and expand the research community
- Strengthen the leadership of European EO research community
- Enable the science community to address new scientific research

Scientific Toolbox Development

- **S-2 Toolbox** (interoperable with S-1, S-3 Toolbox) – 1st Release Sep 2014
  € 550,000, 36 months, Kick Off Feb 2014
  open/source, multi-mission,
  C-S, Brockmann Consult, Telespazio Vega, INRA and UCLouvain

ITTs will be placed for the following R&D activities in 2014:

Research & Development Studies

- **S2-4SCI Land (€ 1,200,000 - Q4 2014):** proposed topics - Vegetation parameters, Classification, Calibrat./Validat., Cloud screening, Atmospheric Correction, Inland Water
- **SY-4SCI Synergy (€ 1,000,000 open call):** S2-3 Synergy Land Product, S1-2 Synergy Land Product, S1-2-3 Ocean Virtual Lab , S3-S5P Phytoplankton

http://seom.esa.int/

The Scientific Exploitation of Operational Missions (SEOM)

Training next Generation of EO Scientists

- **Land Remote Sensing Training**, 8-12 Sep 2014, University of Valencia, Spain
- **EO Summer School**, 4-14 Aug 2014, ESRIN
- The **Living Planet Fellowship**
  Call for Research Proposals 2014

  6 positions for post Docs opened to work on Scientific Exploitation of the Sentinels

  - Development and validation of advanced EO methods and products for ***scientific exploitation of*** the continued observations and **innovative features of the Sentinel missions**.
  - Developing novel scientific methods and tools for enhancing the ***synergetic exploitation of the Sentinel missions***.

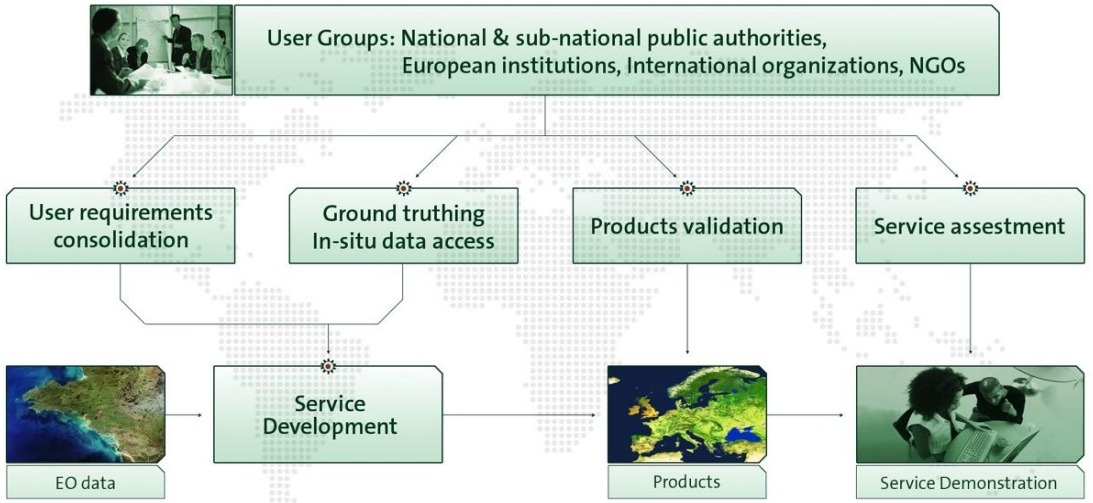
http://livingplanetfellowship.esa.int

Closing date 30 June 2014

The Data User Element (DUE)

Program Objectives

- Create an environment for the development of **user communities**.
- Develop and demonstrate information **products**.
- Support industry in establishing useful and cost effective **services**.



DUE Workplan 2013-2016

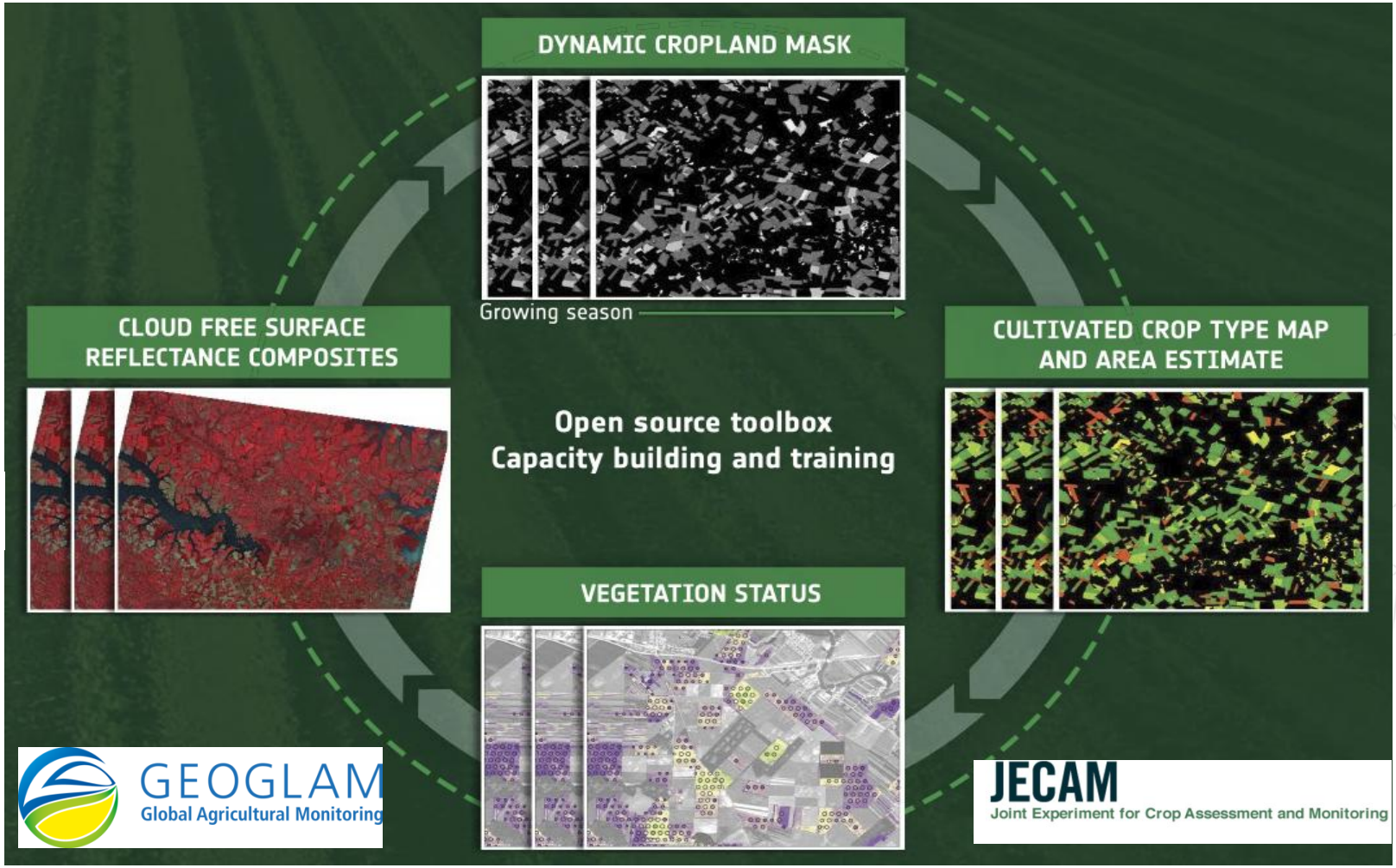
- 2 major axes of activities in EOEP-4 DUE workplan (2013-2016):
  - **Preparing** for the **large-scale production of global data sets**.
  - **Reinforcing** the ESA contribution to the implementation of the **International Environmental Conventions** (UNFCCC, UNCCD, CBD, Ramsar).
- with an **INNOVATION** element, **allowing** innovative EO-based information services to be developed

http://due.esrin.esa.int/

Sentinel-2 for Agriculture

esa

Towards exploitation of Sentinel-2 for local to global agricultural monitoring - contribution to GEOGLAM



Project

UCL Université catholique de Louvain

CESBIO

CS

CS ROMÂNIA

Key Users

FAO FIAT PANIS

WFP

IFAD
Enabling poor rural people to overcome poverty

JRC EUROPEAN COMMISSION

cirad
AGRICULTURAL RESEARCH FOR DEVELOPMENT

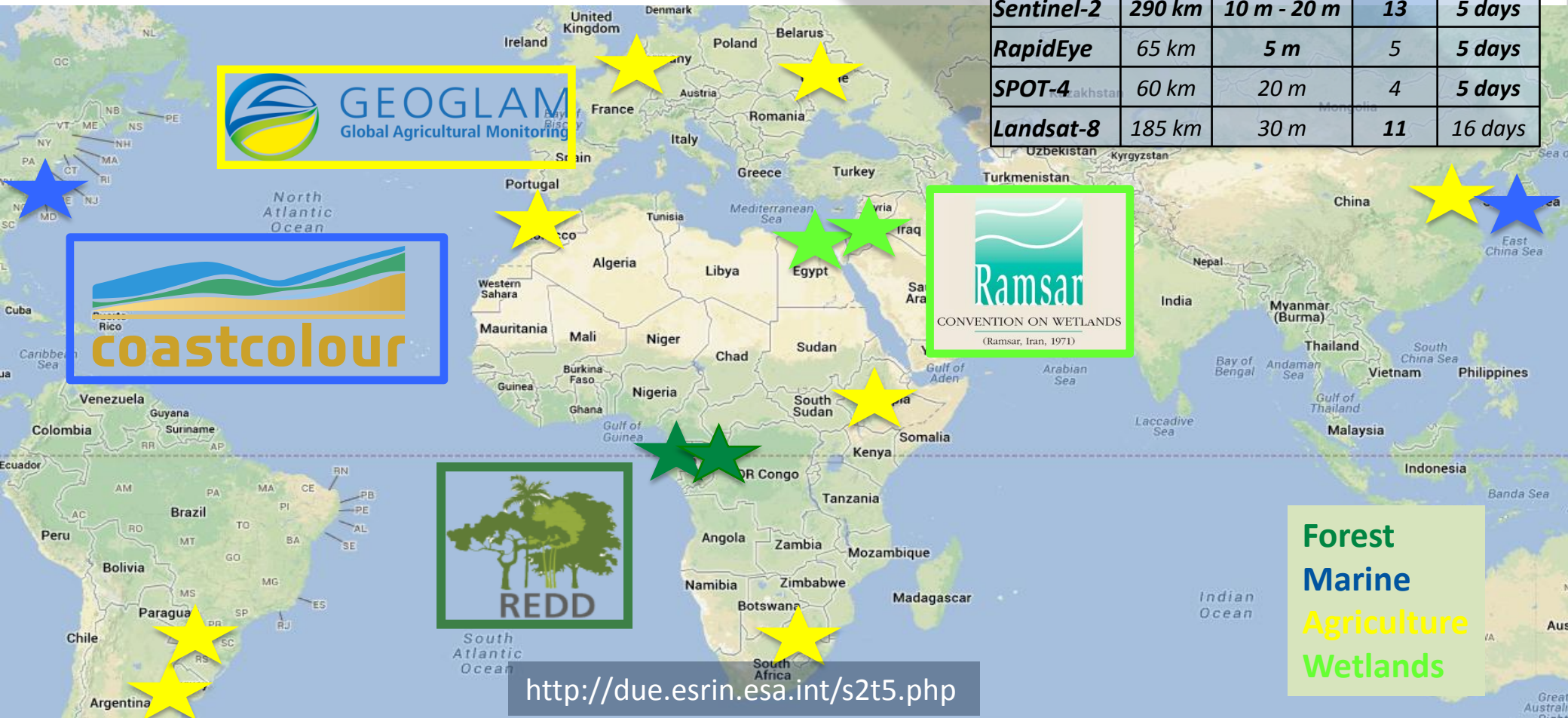
FEWS NET
FAMINE EARLY WARNING SYSTEMS NETWORK

RCMRD

Simulated Sentinel-2 Time Series
(in partnership with Take 5 initiative of CNES/CESBIO)

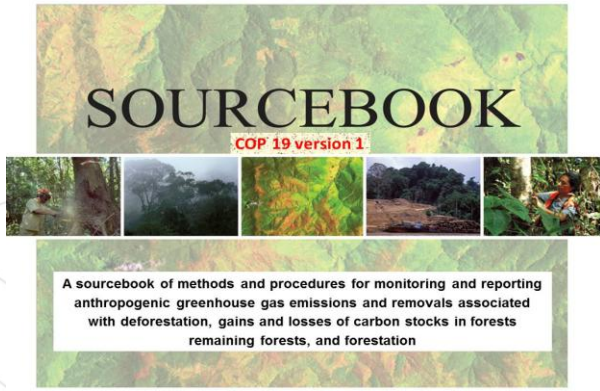
- 14 ESA sites, **globally distributed with international partners**
- Multi-sensor & multi-temporal data set (February-June 2013)

	Swath	Resolution	Bands	Revisit
Sentinel-2	***290 km***	***10 m - 20 m***	***13***	***5 days***
RapidEye	*65 km*	***5 m***	*5*	***5 days***
SPOT-4	*60 km*	*20 m*	*4*	***5 days***
Landsat-8	*185 km*	*30 m*	***11***	*16 days*



GOFC-GOLD land cover project office

- Progress the monitoring of land cover as **Essential Climate Variable**
- Contribute to the **REDD+** process in particular trough updating the GOFC-GOLD REDD Sourcebook
- Developing of the GOFC/CEOS **best practice** document on accuracy assessment of land change
- Implementing an online land cover **accuracy assessment** database and a related user information service
- Contribute to international best practices and standards for harmonization and **validation of LC**
- Organization of GOFC-GOLD LC-IT meetings, workshops and symposia



GOFC-GOLD
Global Observation of Forest Cover and Land Dynamics
Land Cover Project Office

WAGENINGEN UNIVERSITY
WAGENINGEN UR

http://www.gofcgold.wur.nl/

→ CALL FOR INNOVATORS III

Pioneering innovative Earth Observation products and services for long-term exploitation

deadline for submission of proposals: 29 August 2014

Open to ALL domains of EO applications and ALL fields of the Earth's atmosphere, ocean, cryosphere and land surfaces.

Innovators III priority lines:

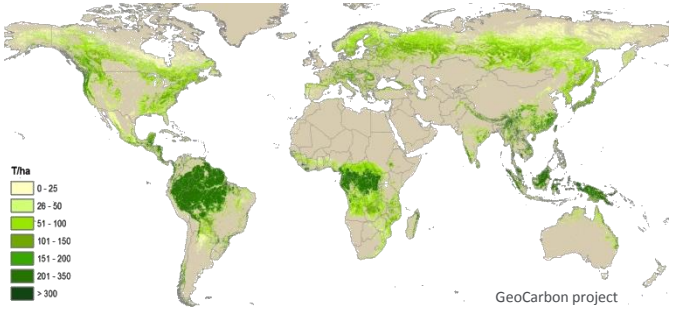
- Respond to the **Research and Development agenda** of major international initiatives e.g. GEO
- perform the necessary R&D preparatory activities of the most innovative aspects of **Sentinel-1** and **Sentinel-2**, for a large scale exploitation by broad user communities.

AO 7829	
ITT issue:	**14 May 2014**
KO:	**Q4 2014**
Contracts:	**12 up to 200 k€**
Overall budget:	**€2,400,000**
Duration:	**max. 2 years**

Innovators III will contribute to the content of ESA EOEP-5 (2017-2021)

DUE Opportunities

GLOBBIOMASS



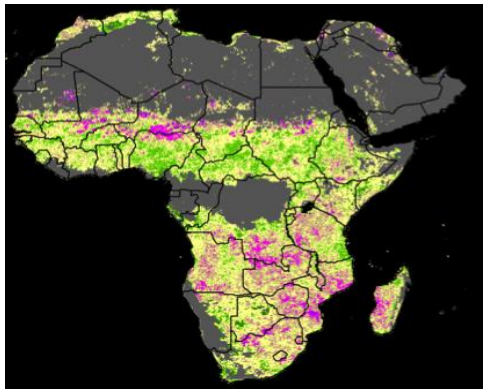
ITT issued: 15 May 2014

KO: Q3 2014

Budget: €1,500,000

Duration: 3 years

GLOBWETLAND AFRICA



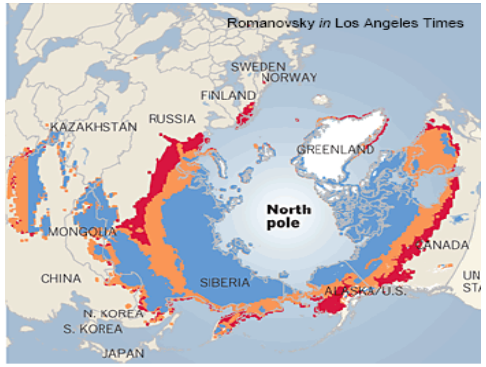
ITT issue: Q3 2014

KO: Q4 2014

Budget: €1,500,000

Duration: 3 years

DUE PERMAFROST



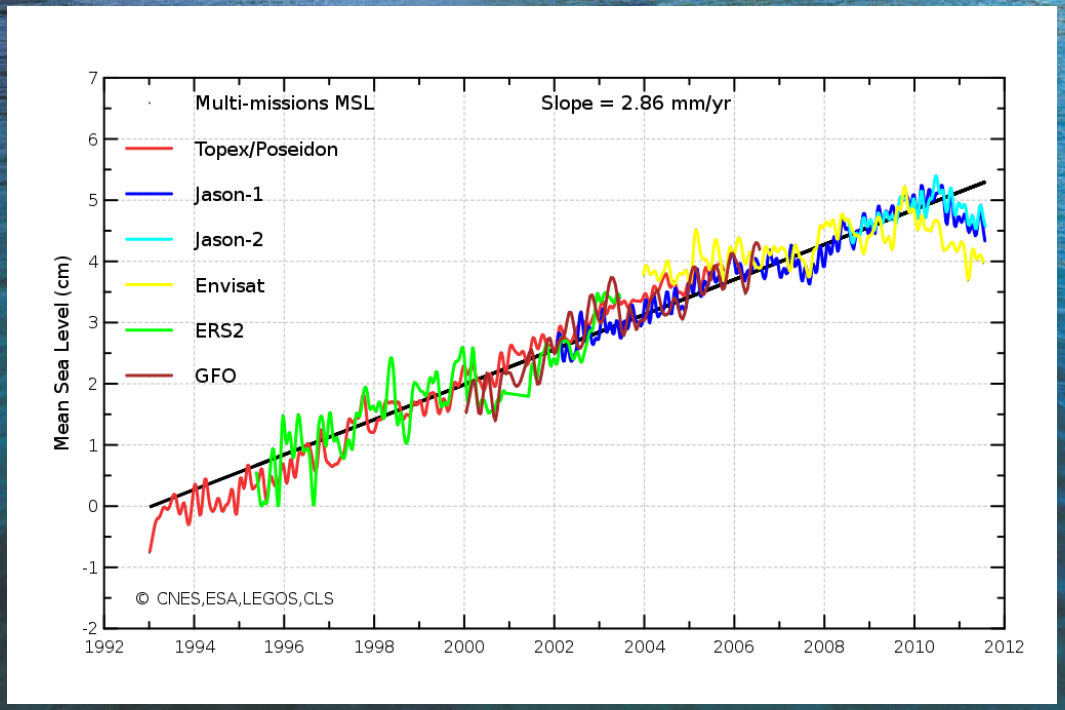
ITT issue: Q4 2014

KO: Q1 2015

Budget: €1,000,000

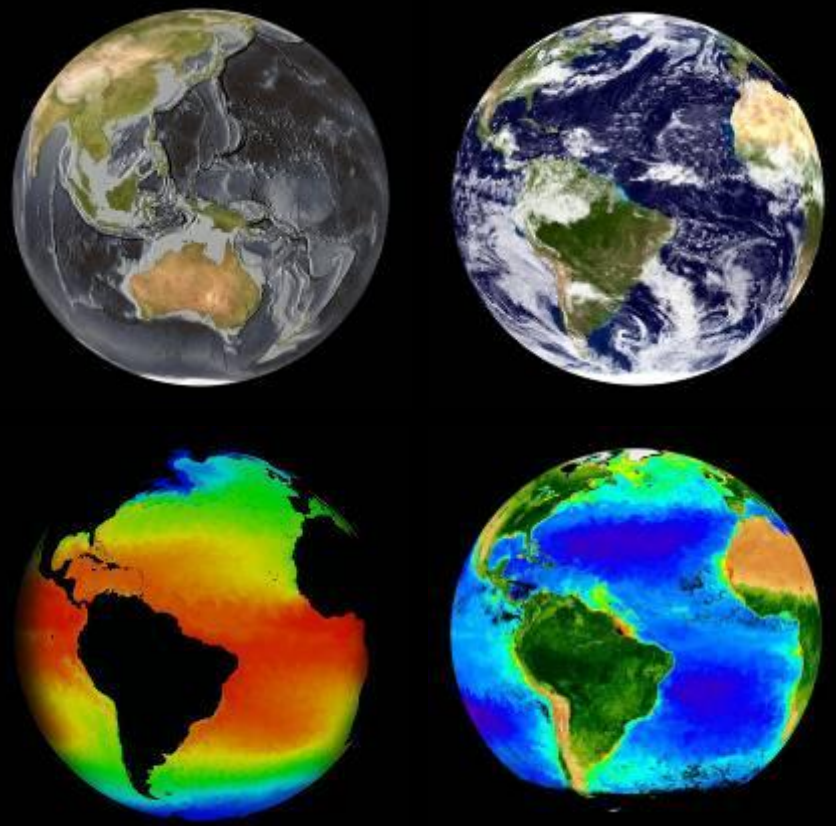
Duration: 3 years

The ESA Climate Change Initiative (CCI)



CCI: Essential Climate Variables

- Cloud Properties
- Carbon Dioxide, Methane & other GHGs
- Ozone
- Aerosol properties
- Sea Surface Temperature
- Sea Level; Sea Ice
- Ocean Colour
- Glaciers and ice caps
- Land cover
- Fire disturbance
- Soil moisture



Plan for European Cooperating States (PECS)

Opportunity to participate more closely in ESA programmes

- **Latvia (2013)**
- **Slovenia (2010)**
- **Estonia (2009)**
- **Poland (2007) -> ESA member (Sept 2012)**
- **Romania (2006) -> ESA member (Dec 2011)**
- **Hungary (2003)**
- **Czech Republic (2003) -> ESA member (Nov 2008)**

- **Other countries are in negotiation with ESA about joining PECS**

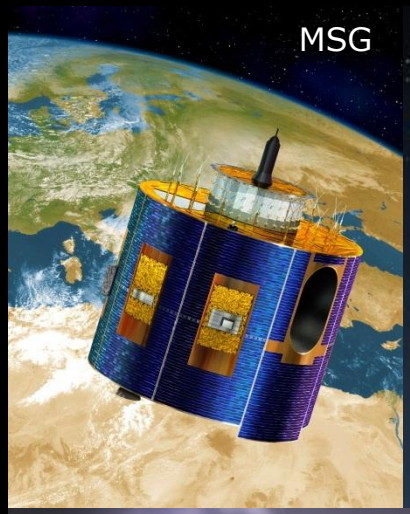
Thank you for your attention

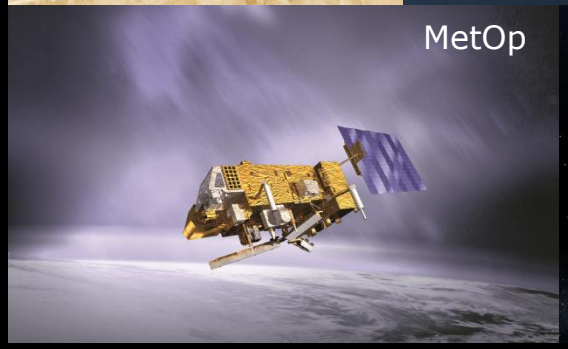
www.esa.int

emits.esa.int

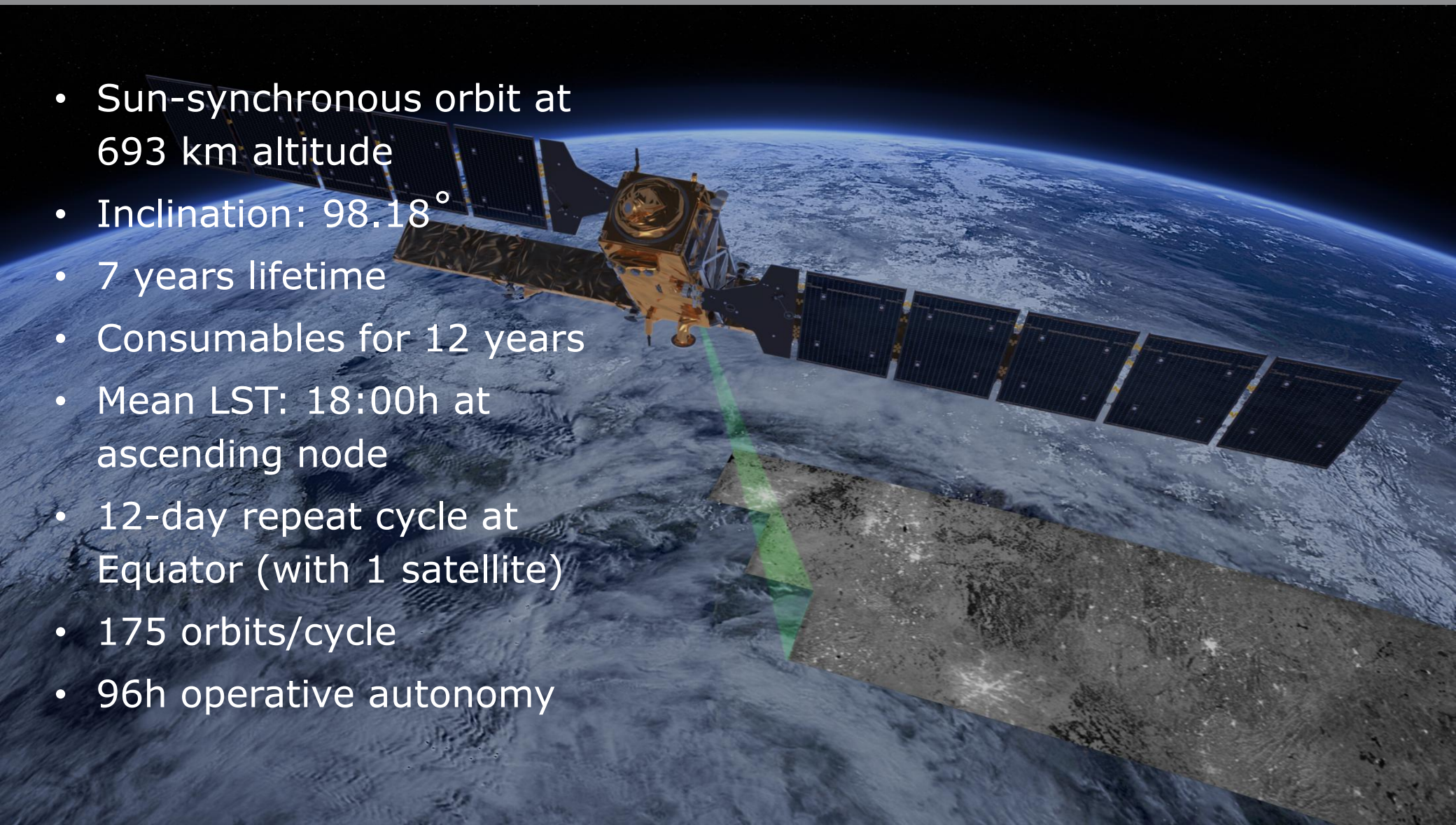
Meteorological missions

- ESA develops prototype satellites and, on behalf of EUMETSAT, procures recurrent satellites
- EUMETSAT procures launchers and LEOP services
- EUMETSAT operates the satellites
- Currently Meteosat Second Generation (MSG) missions in GEO and MetOp missions in LEO
- MeteoSat Third Generation (MTG) and MetOp Second Generation under development





Sentinel-1: Mission Profile



- Sun-synchronous orbit at 693 km altitude
- Inclination: 98.18°
- 7 years lifetime
- Consumables for 12 years
- Mean LST: 18:00h at ascending node
- 12-day repeat cycle at Equator (with 1 satellite)
- 175 orbits/cycle
- 96h operative autonomy

Sentinel-2

- Wide swath high resolution super-spectral imaging mission
- Land and Security Services
- Data continuity Landsat and SPOT-type missions

Sentinel-3

- Medium resolution imaging and altimetry mission
- Land and ocean applications

Sentinel-4/5/5p

- Atmospheric chemistry missions
- Instruments to be flown on
  - MTG (Sentinel 4)
  - MetOp SG (Sentinel 5)
- Separate precursor mission for Sentinel 5

MTG

MetOp SG

A New Era of Earth Observation

EO: Tool to tackle global challenges

- Reliable assessment of human activity
- Coverage over space and time
- Long observation intervals
- Large scale observations

First EO Revolution:

- WWW, broadband data networks, GIS, desktop processing

Second EO Revolution:

- cloud computing, crowd sourcing, big data, new generation mapping tools

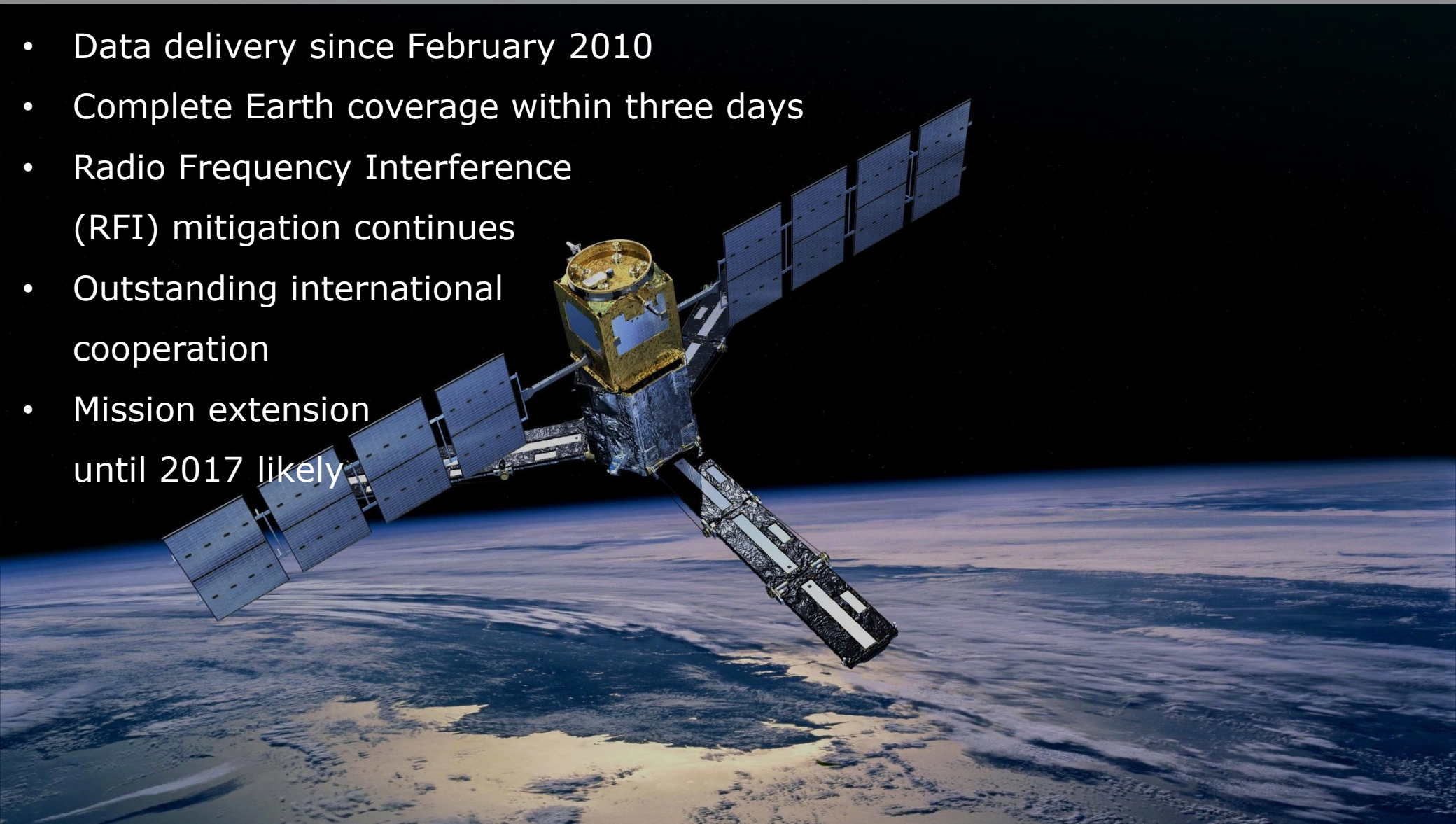
IT Revolution and Earth Observation

Progress in IT creates strong push for EO applications:

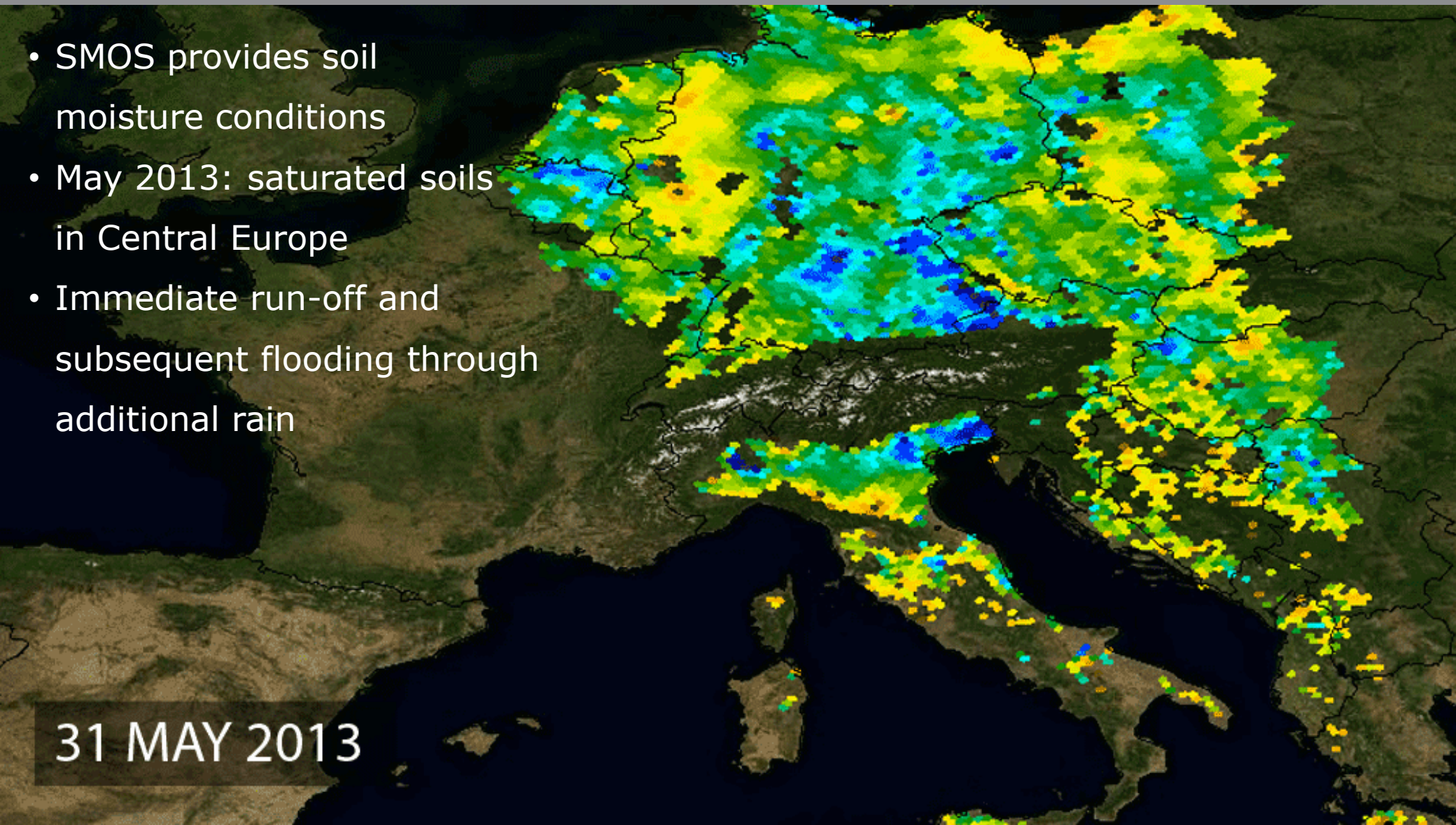
- Crowd Sourcing/Crowd Mapping
- Sensor Web/Internet of Things
- Cloud Computing
- Big Data
- New Generation Mapping Tools
- Social Networks
- Merging of ground- and space-based data on mobile platforms for intelligent services

SMOS – Soil Moisture and Ocean Salinity

- Data delivery since February 2010
- Complete Earth coverage within three days
- Radio Frequency Interference (RFI) mitigation continues
- Outstanding international cooperation
- Mission extension until 2017 likely

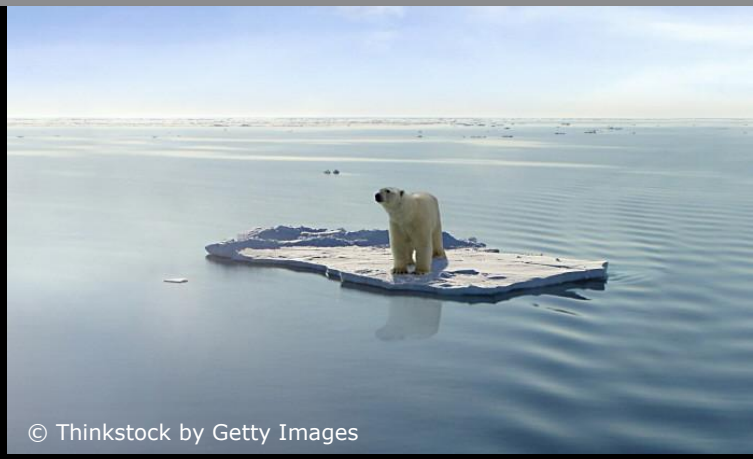


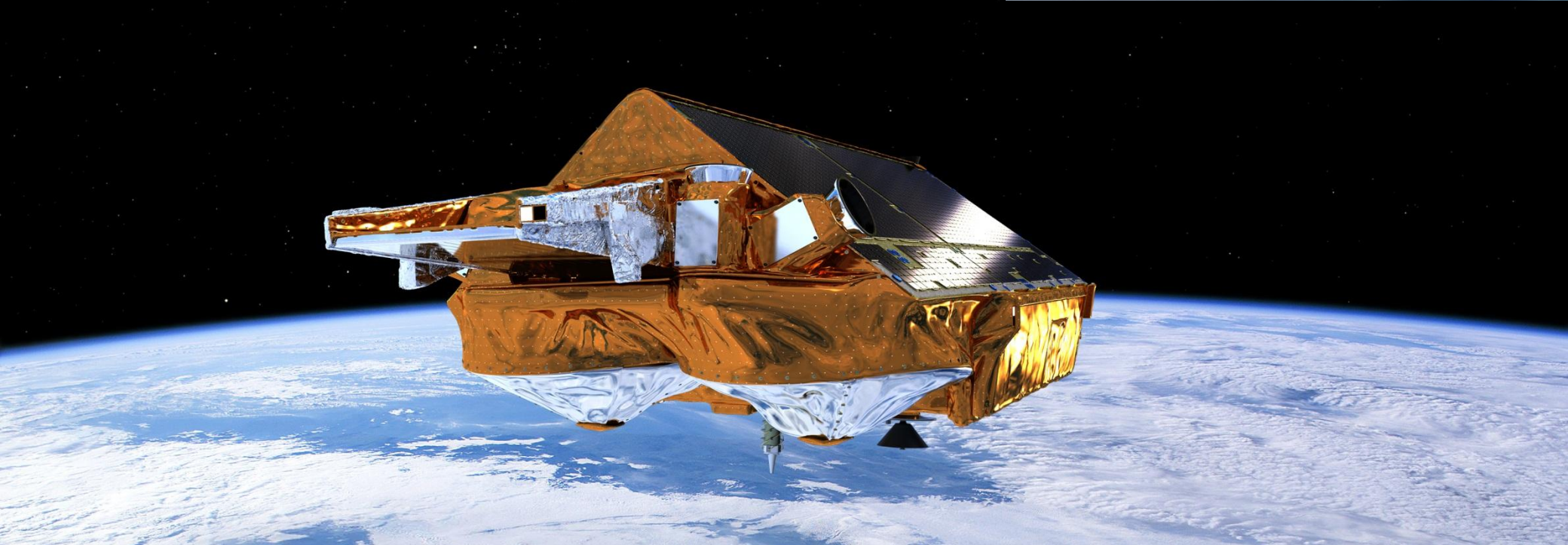
SMOS – Hydrology



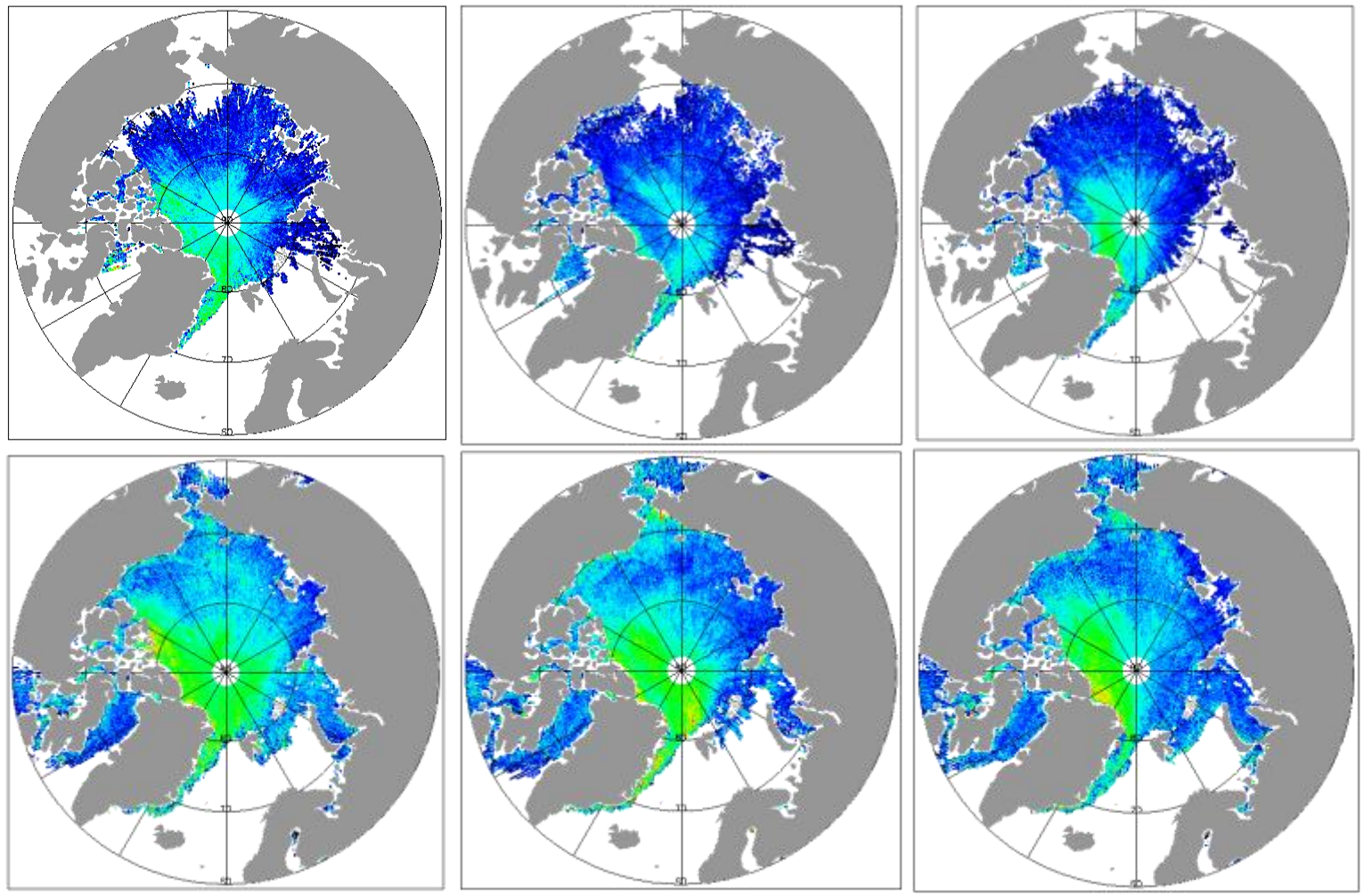
CryoSat: The Ice Mission

- First interferometric altimeter in space
- Global sea ice thickness measurements
- Data used for ice research, but increasingly also for oceanography
- Mission extension until 2017 likely



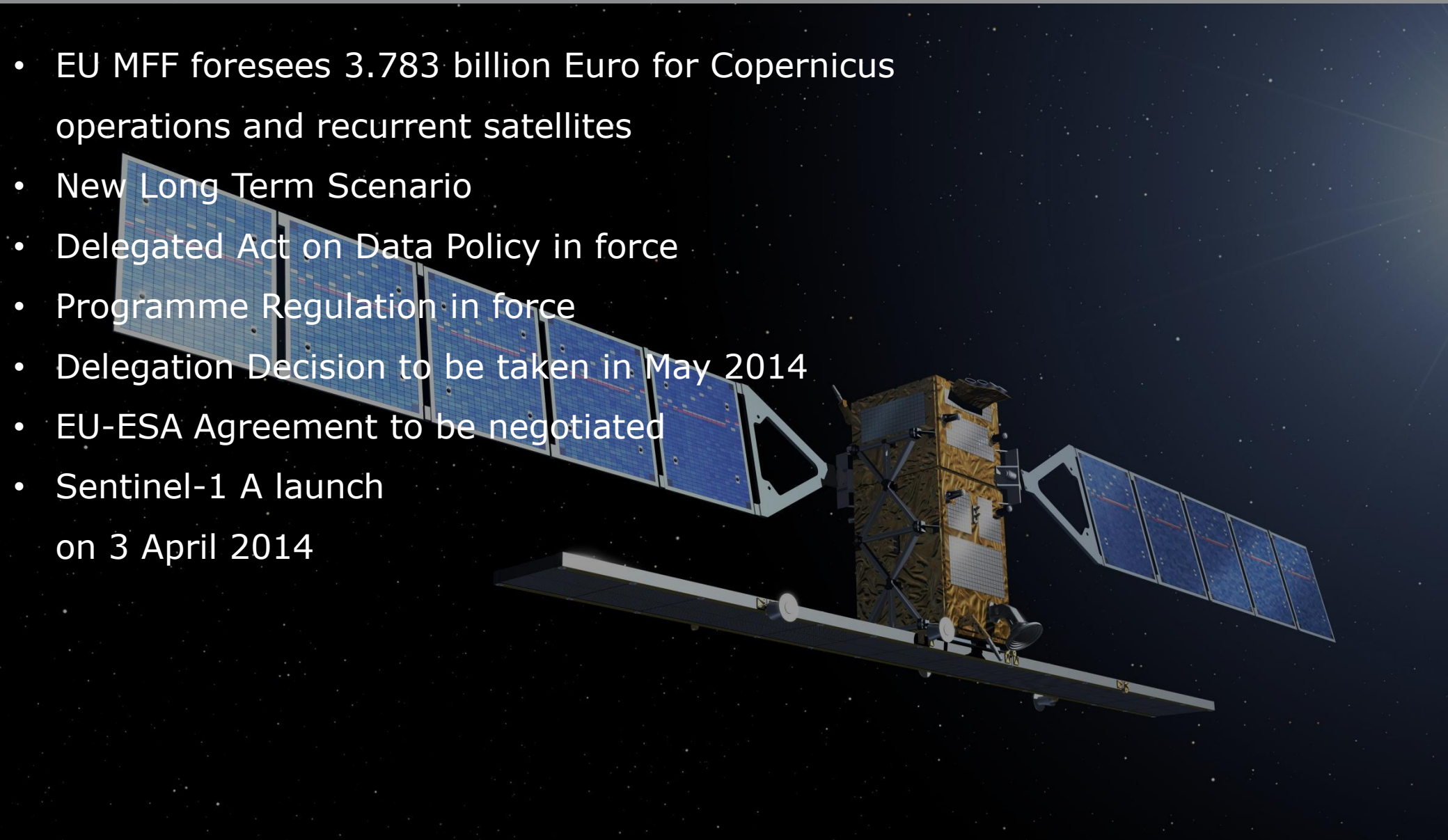


CryoSat Measurements



Copernicus – Current Status

- EU MFF foresees 3.783 billion Euro for Copernicus operations and recurrent satellites
- New Long Term Scenario
- Delegated Act on Data Policy in force
- Programme Regulation in force
- Delegation Decision to be taken in May 2014
- EU-ESA Agreement to be negotiated
- Sentinel-1 A launch on 3 April 2014



Facing the Future

- Third development step under way (GSC-3)
- Phase 2 to be decided in June 2014
- Open for subscription until May 2014
- Sentinels up to D-units (First Generation) covered by current MFF
- Development of Second Generation Sentinels to start in 2016
- Division of tasks
    - ESA: R&D activities
    - EU: funding of operations and of recurrent satellites; integration of Copernicus into sectorial policies

The Sentinel Family

- S1: Radar Mission
- S2: High Resolution Optical Mission
- S3: Medium Resolution Imaging and Altimetry Mission
- S4: GEO Atmospheric Chemistry Mission
- S5P/S5: LEO Atmospheric Chemistry Missions
- S6 [Jason-CS]: Altimetry Mission

Sentinel-1 Quantum Leap

Sentinel-1

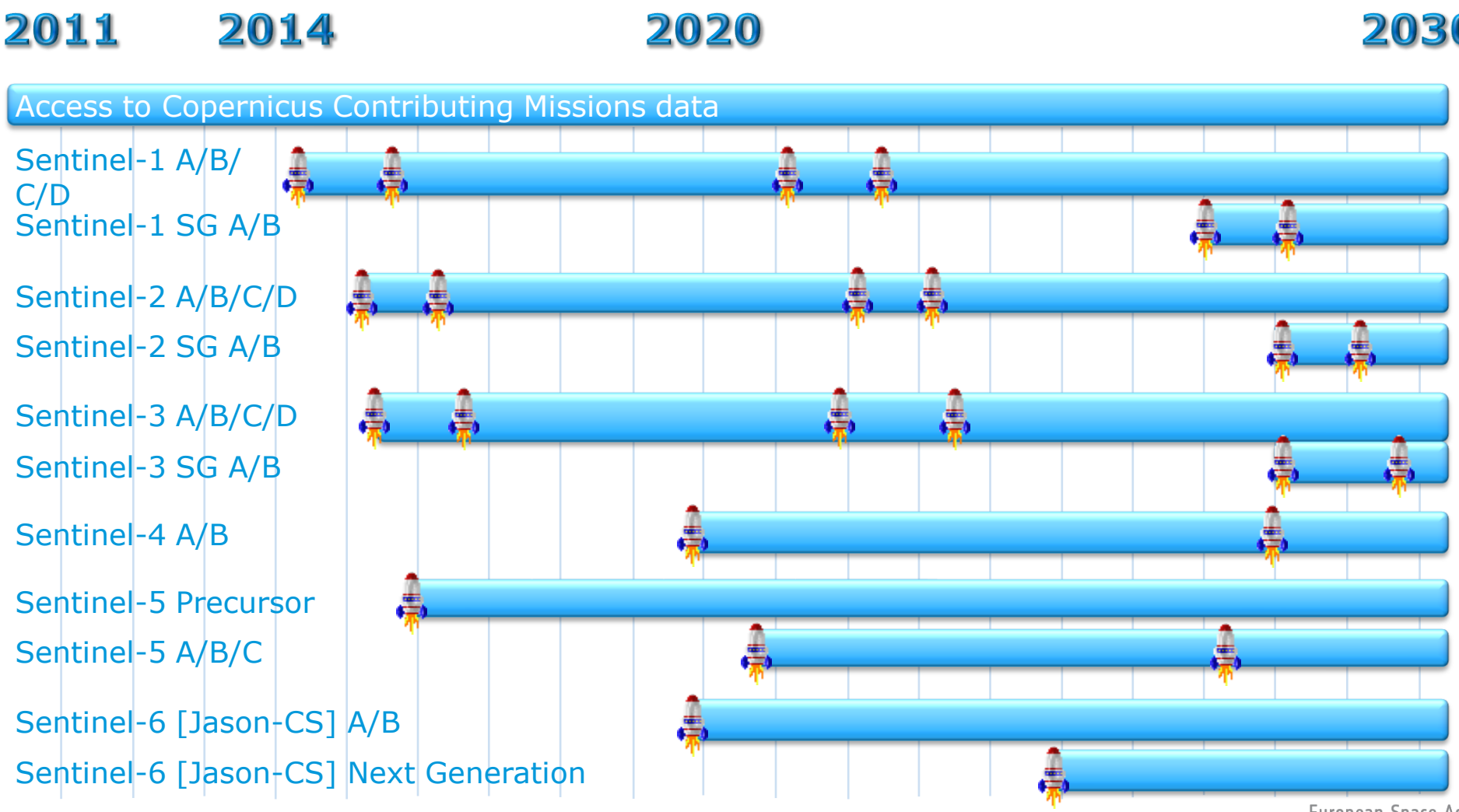
- **10** m ground range resolution (stripmap mode)
- **250** km swath width (Interferometric wide swath mode)
- **6** days repeat cycle (with 2 satellites)
- **2 x 260 Mb/s** downlink data rate
- **7** years design lifetime (consumables for 12 years)
- Optical link to downlink the data to EDRS.

Envisat

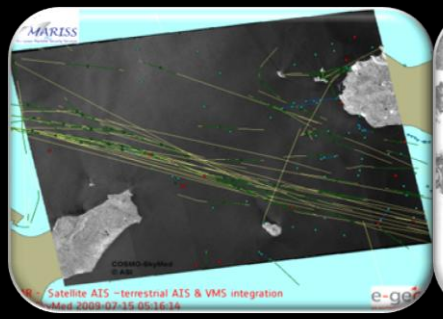
- **20** m ground range resolution
- **100** km swath width (Imaging mode)
- **35** days repeat cycle
- Up to **100 Mb/s** space to ground data rate
- **5** years design lifetime

Sentinel-1: Twice the sensitivity and thrice the accuracy in Radar imaging quality

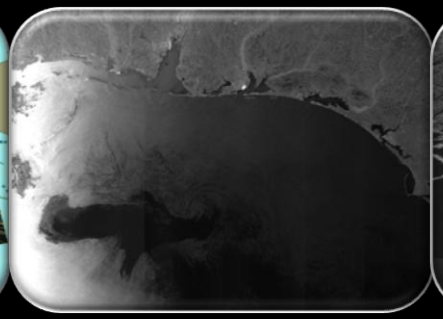
Sentinel Deployment Schedule

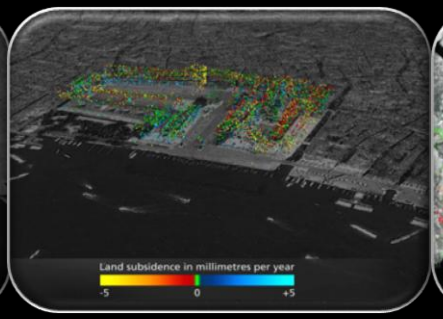


Some Sentinel Application Areas

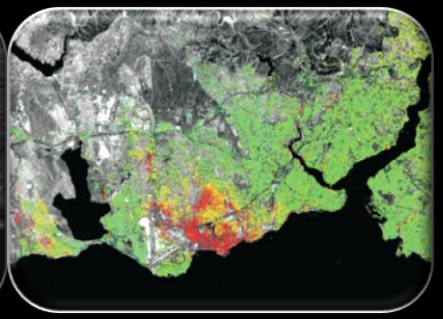


Maritime surveillance

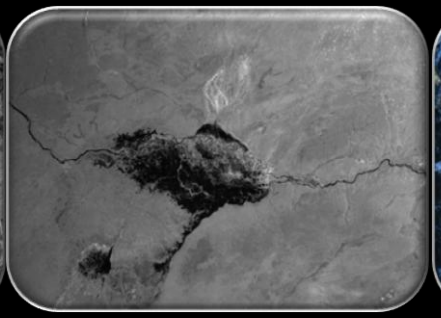

Oil spills



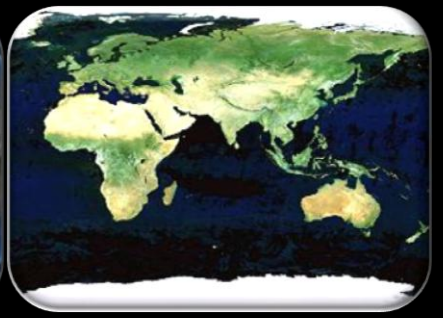
Land subsidence

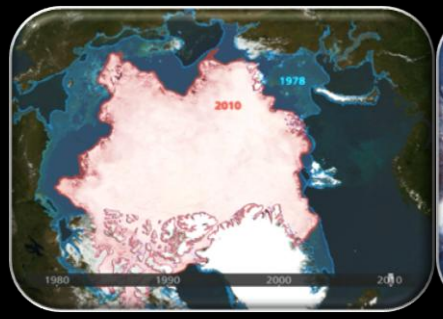

Tectonics


Volcanoes

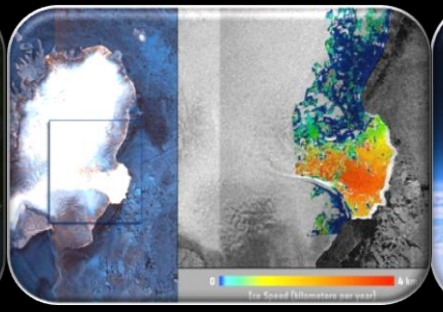

Floods


Deforestation


Vegetation



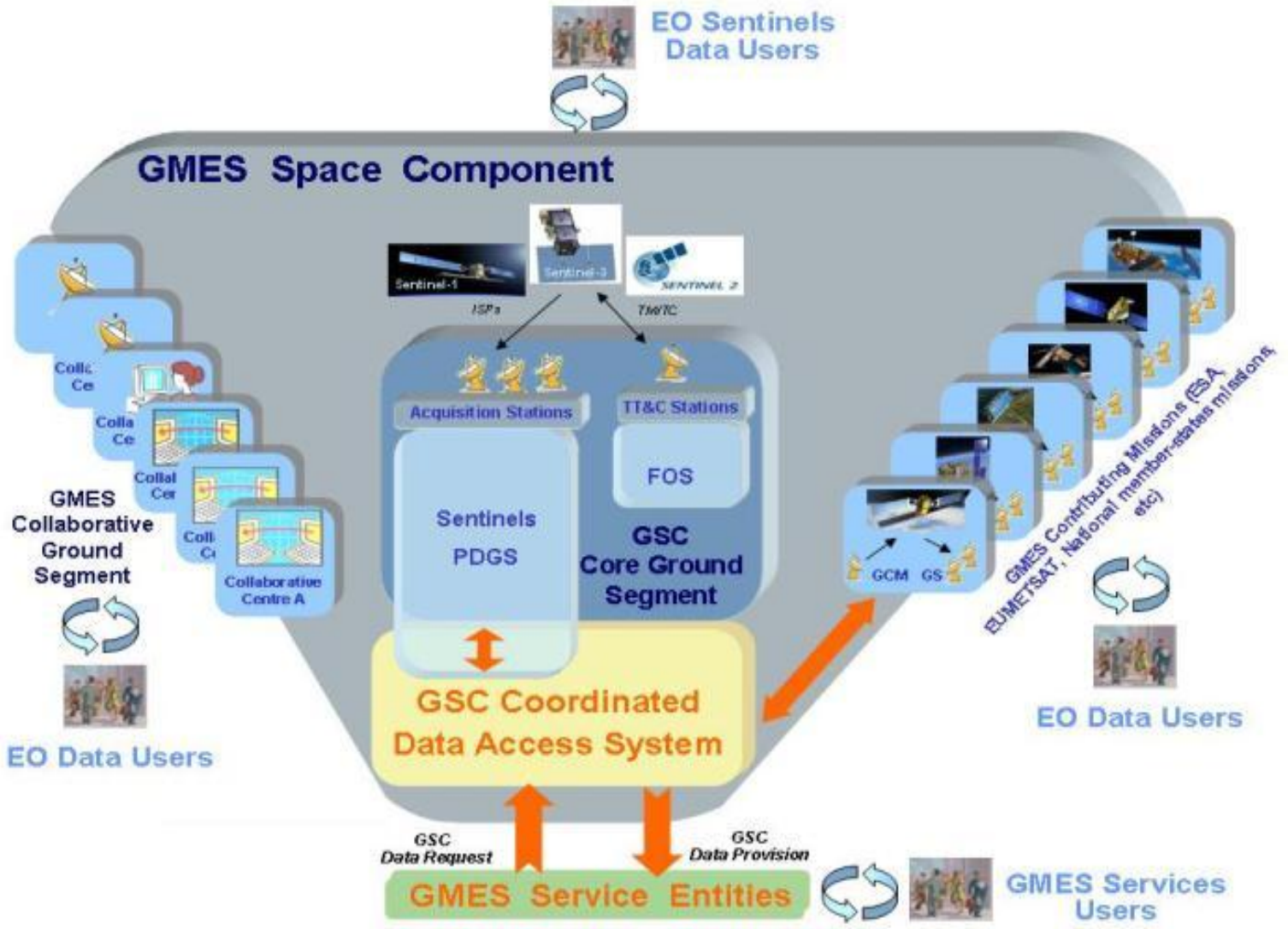
Sea ice extent


Ice speed

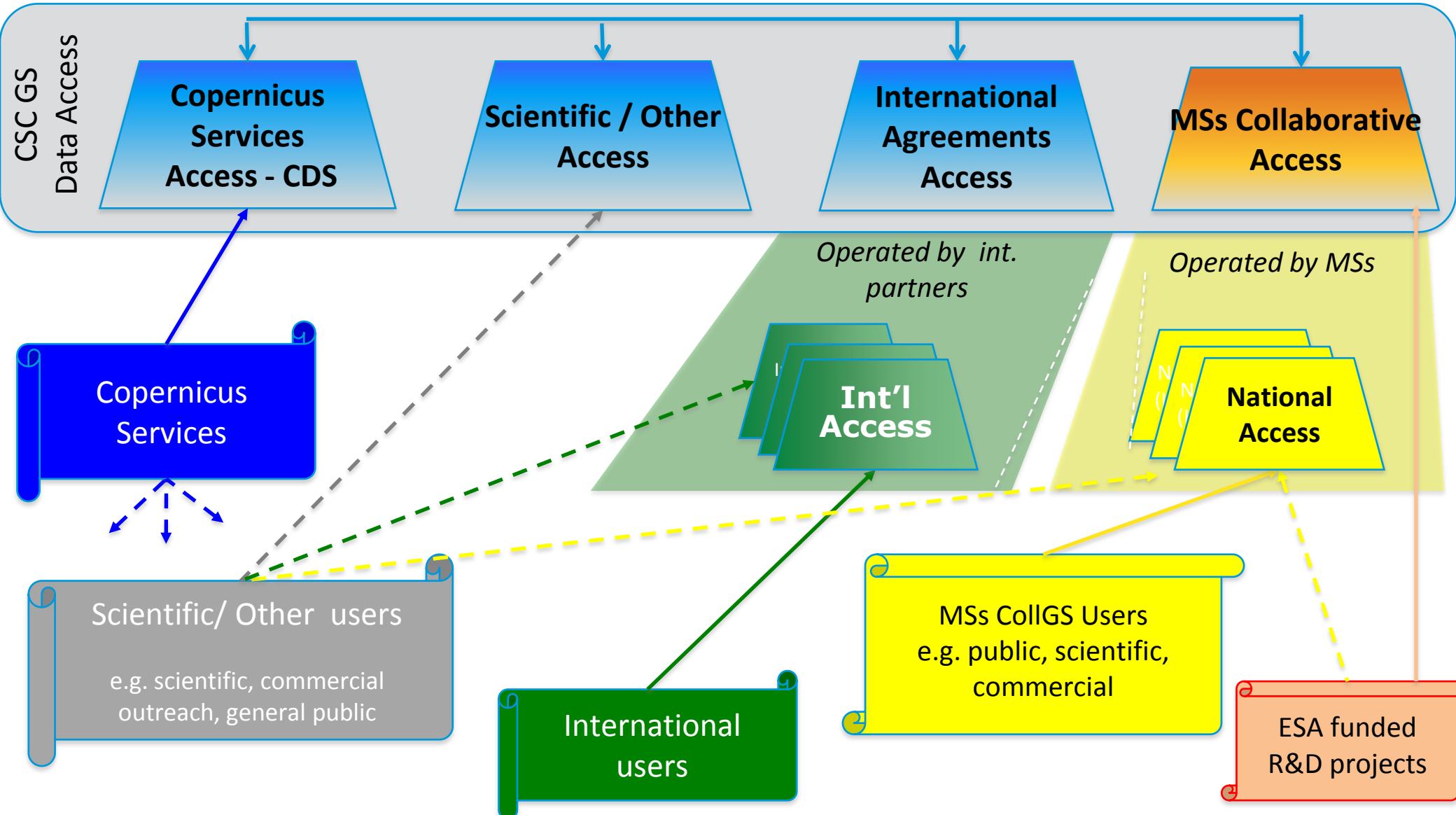

Atmosphere


Ocean colour

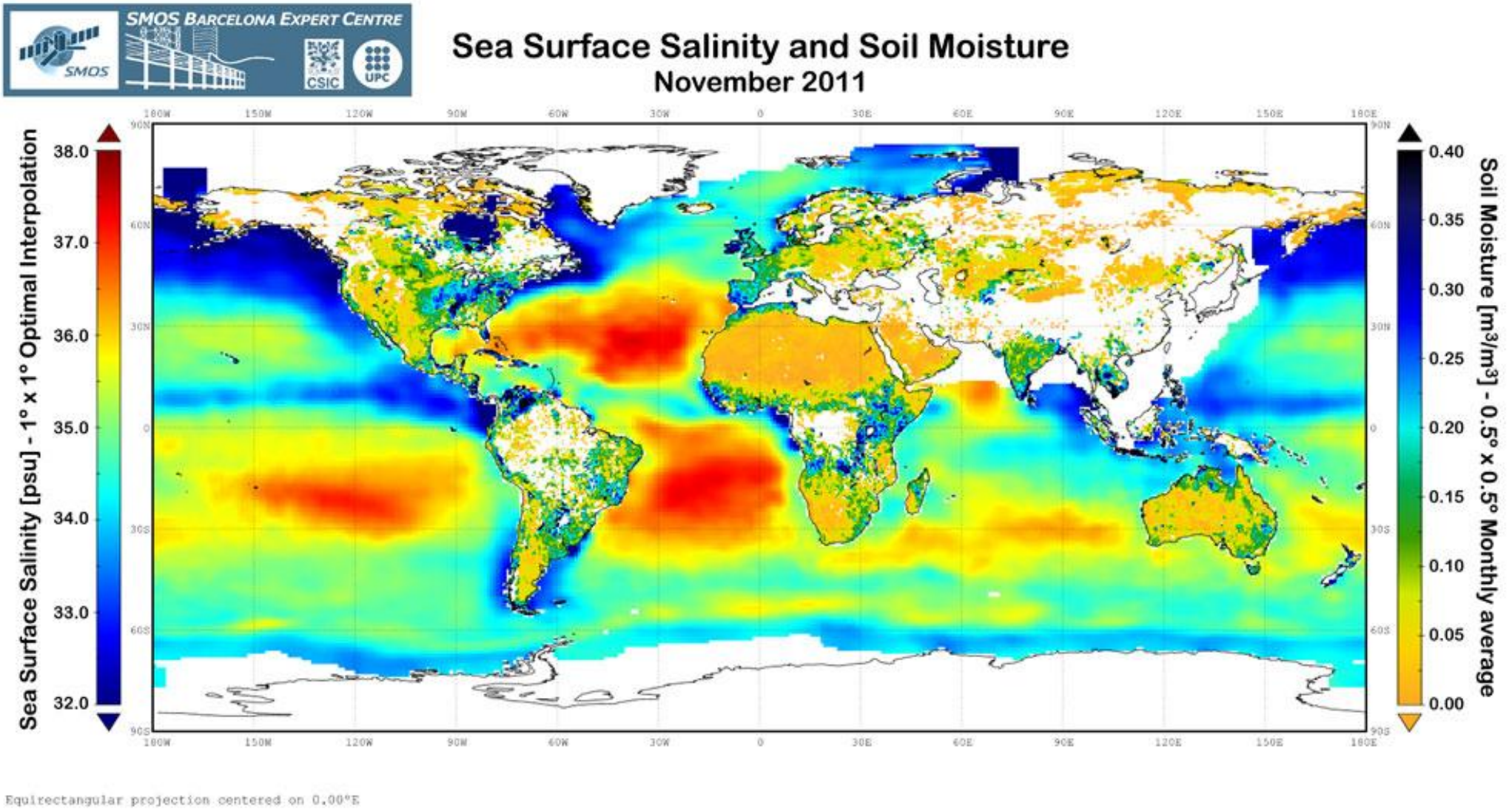
Copernicus Ground Segment



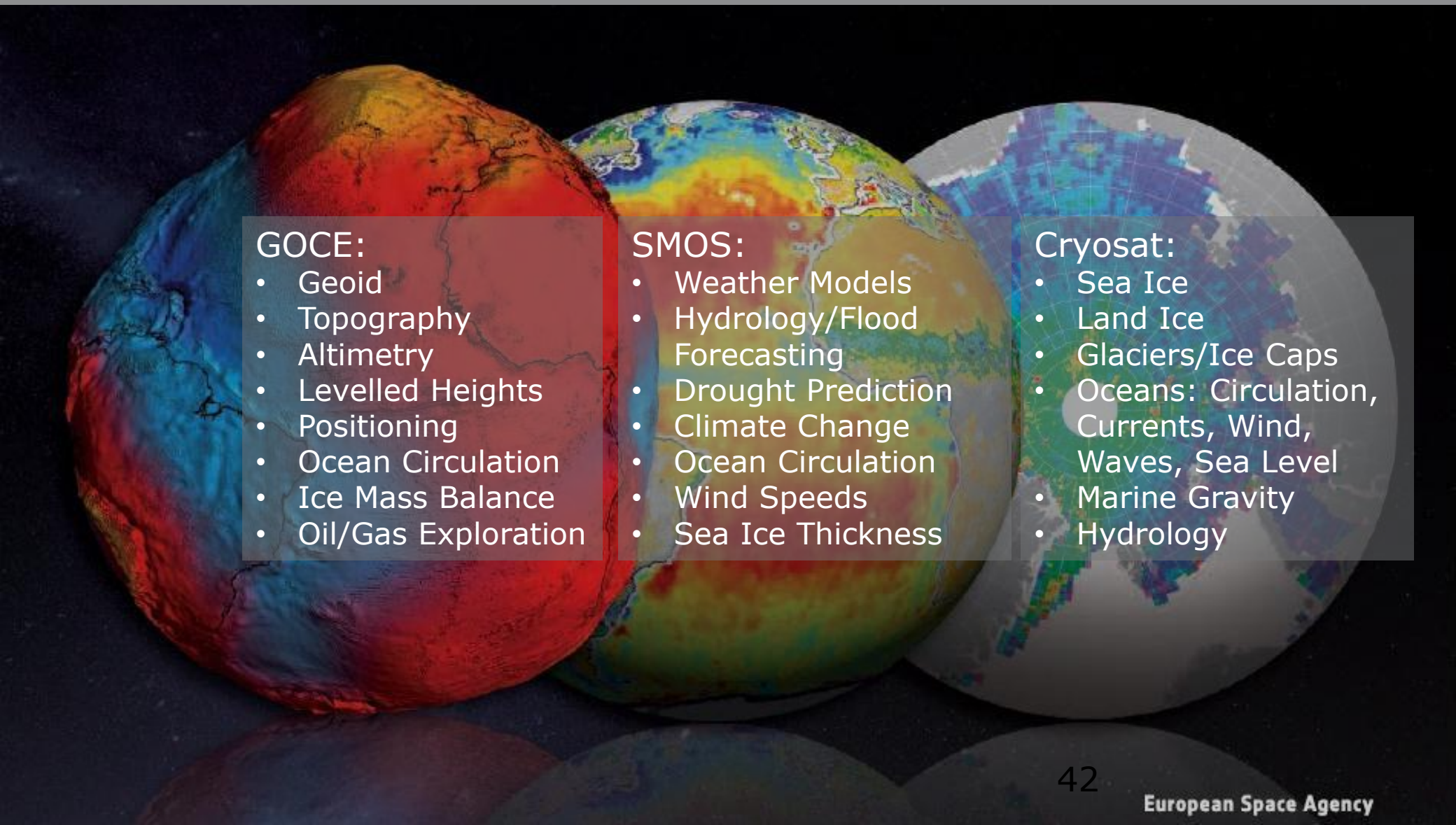
Copernicus Data Access



SMOS Measurements



Earth Explorers: A Wealth of Applications

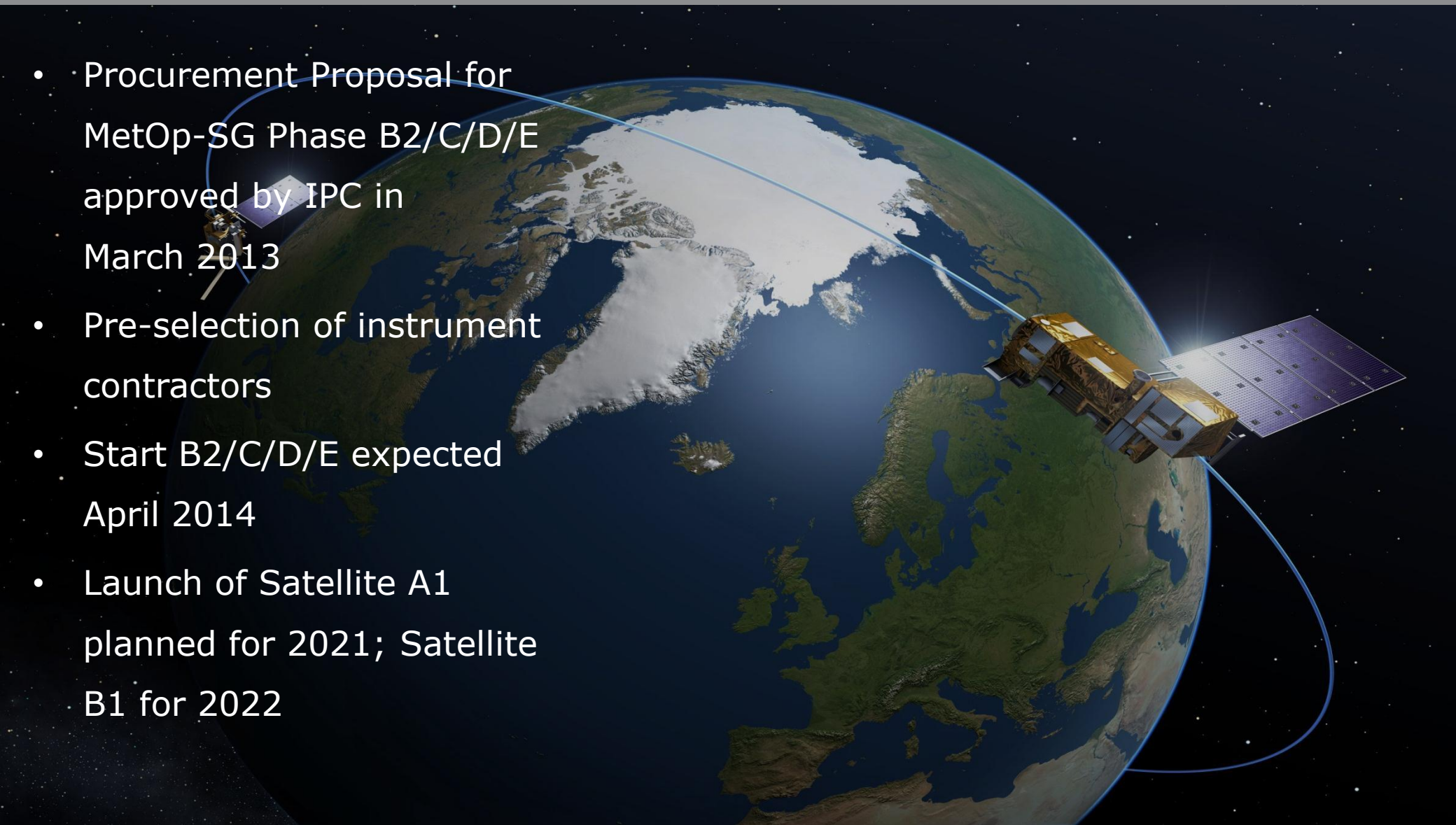


GOCE:
- Geoid
- Topography
- Altimetry
- Levelled Heights
- Positioning
- Ocean Circulation
- Ice Mass Balance
- Oil/Gas Exploration

SMOS:
- Weather Models
- Hydrology/Flood Forecasting
- Drought Prediction
- Climate Change
- Ocean Circulation
- Wind Speeds
- Sea Ice Thickness

Cryosat:
- Sea Ice
- Land Ice
- Glaciers/Ice Caps
- Oceans: Circulation, Currents, Wind, Waves, Sea Level
- Marine Gravity
- Hydrology

MetOp Second Generation



- Procurement Proposal for MetOp-SG Phase B2/C/D/E approved by IPC in March 2013
- Pre-selection of instrument contractors
- Start B2/C/D/E expected April 2014
- Launch of Satellite A1 planned for 2021; Satellite B1 for 2022