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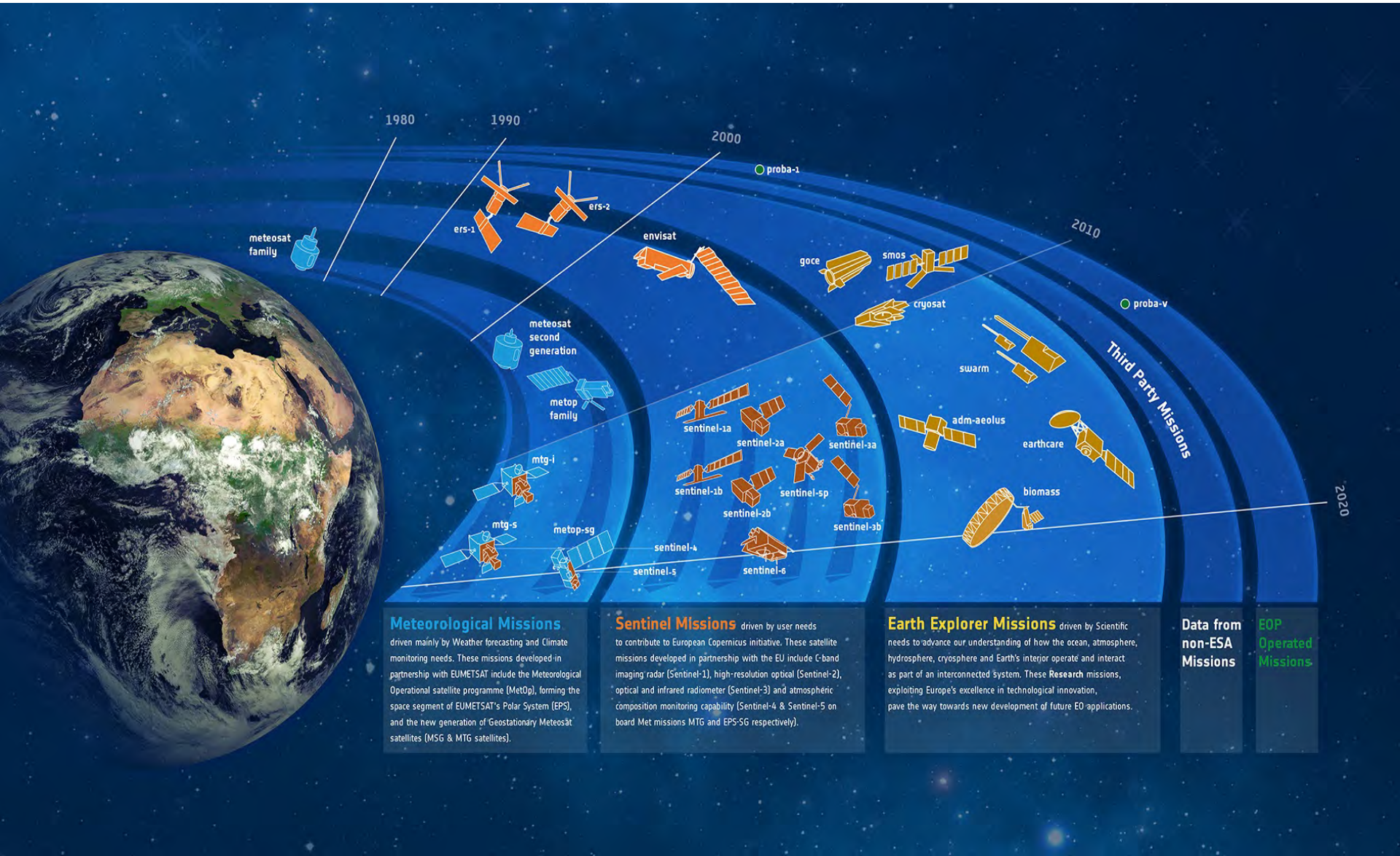
New ESA strategy: what does it mean for EO?

Chris Merchant

Outline

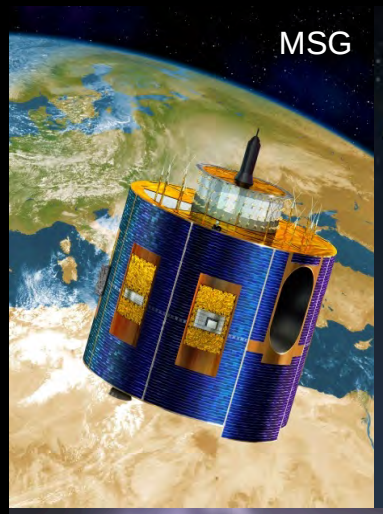
- ESA Earth Observation programmes
- New Earth Observation Science Strategy
- Scientific Readiness Levels

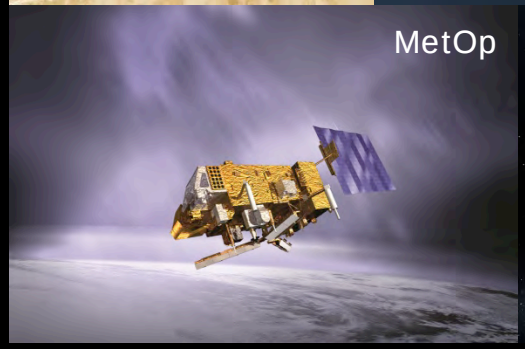
ESA Earth Observation Programmes - Expanding ESA Missions Capability

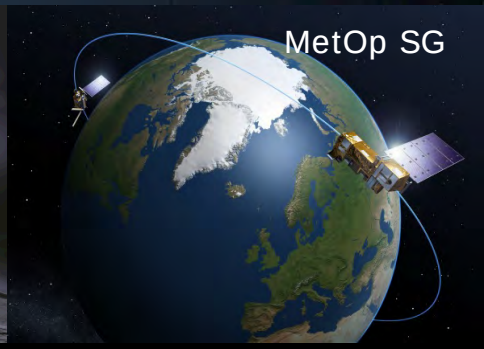


Meteorological missions

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

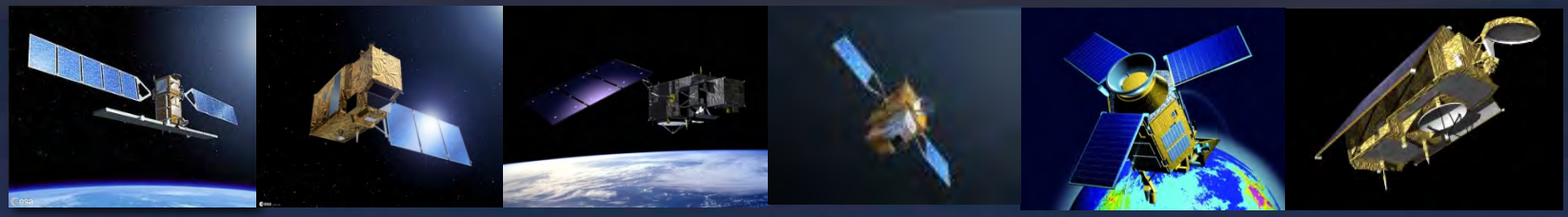






Copernicus: A New Generation of Data Sources

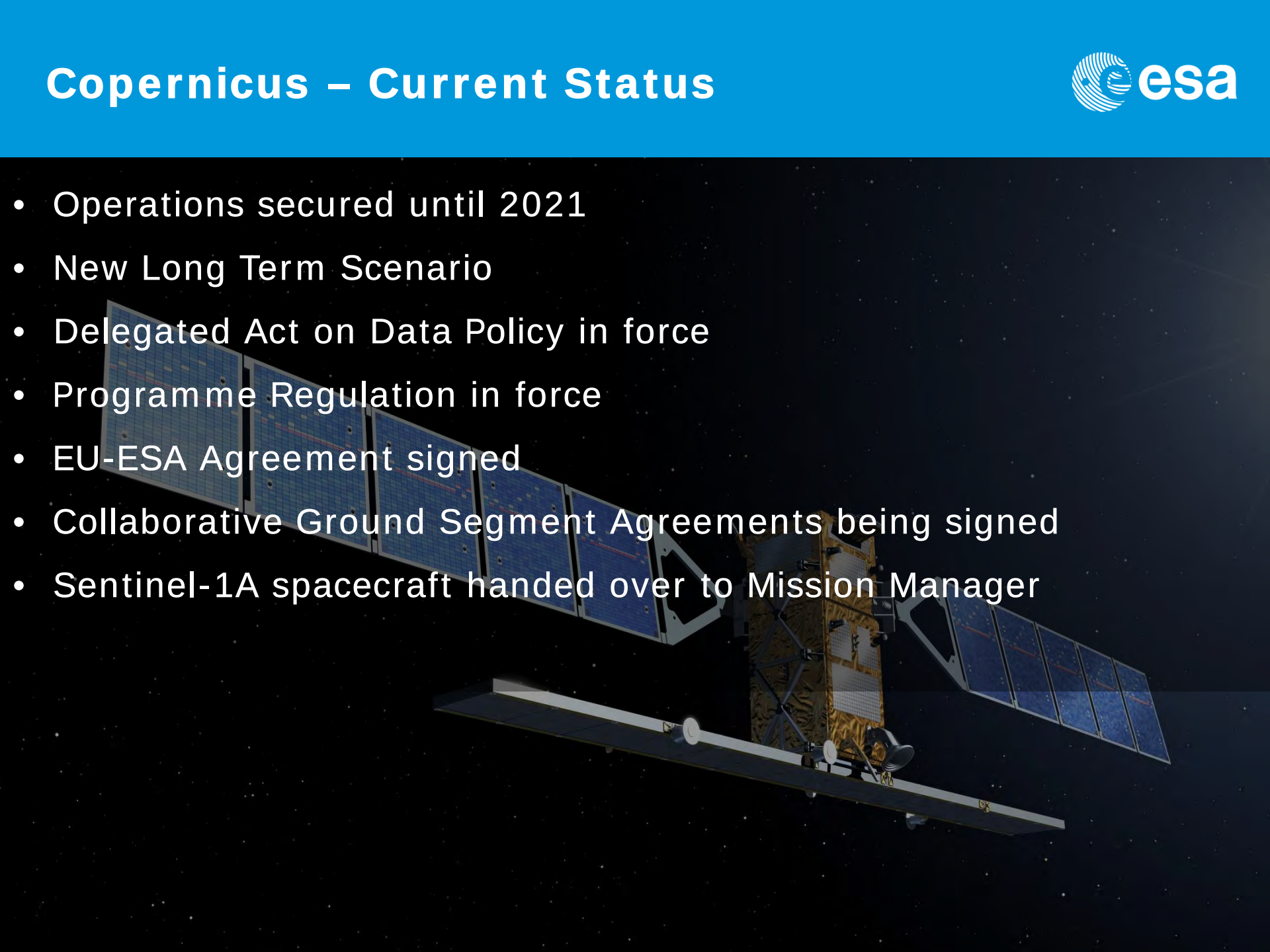
Sent-1A/B | Sent-2A/B | Sent-3A/B | Sent-4A/B | Sent-5/5P | Sent-6A/B



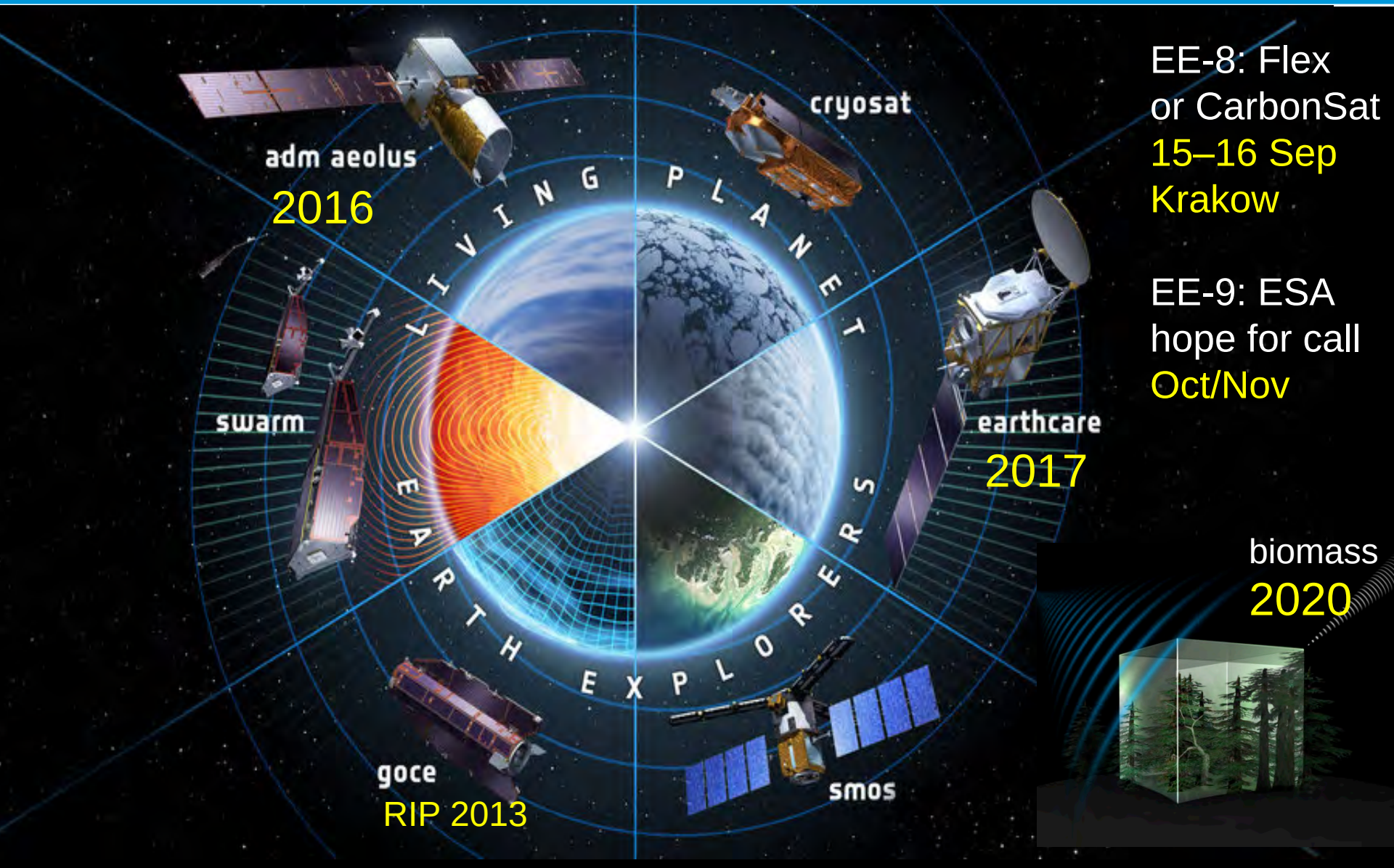
- Copernicus is a European space flagship programme led by the European Union
- ESA coordinates the space component
- Copernicus provides the necessary data for operational monitoring of the environment and for civil security

Copernicus – Current Status

- Operations secured until 2021
- New Long Term Scenario
- Delegated Act on Data Policy in force
- Programme Regulation in force
- EU-ESA Agreement signed
- Collaborative Ground Segment Agreements being signed
- Sentinel-1A spacecraft handed over to Mission Manager



Science – the Earth Explorers



EE-8: Flex
or CarbonSat
15–16 Sep
Krakow

EE-9: ESA
hope for call
Oct/Nov

Ministerials and envelopes

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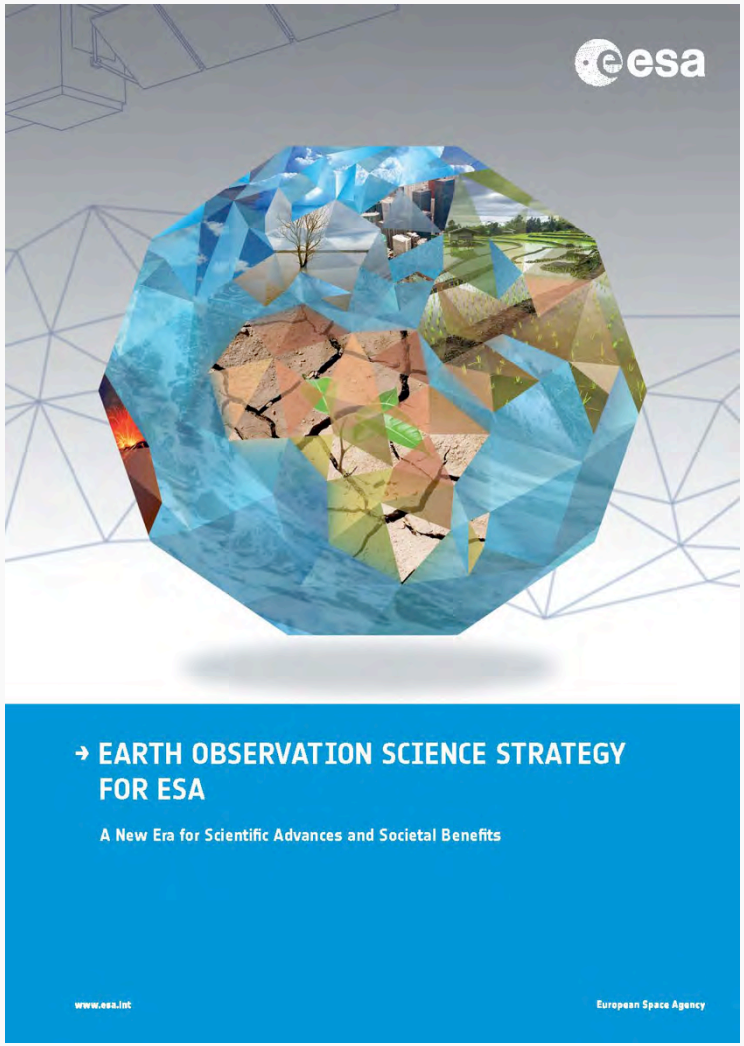
- Last in 2014
  - fully subscribed to Copernicus space programme
  - €32M extra for EO Envelope Programme 4 + €2M more for CCI
  - Left ESA with 32 fully financed satellites to deliver
- Next end 2016
  - set up EOEP 5
  - needs to include feasibility studies for Copernicus second generation
- Earth Explorer 9
  - Phase A is in EOEP 4
  - Two scenarios
    - A mission all within EOEP 5 (launch ~2022)?
    - Or a bigger mission, launch at end of EOEP 6 (~2027)?
      - EOEP 5 would take mission through phase B
  - Call will be framed in the context of new Earth Science Strategy

Earth Observation Science Strategy

- Responsibility of ESAC
  - a strategy for ESA
  - not the EO strategy of ESA
- Publication imminent
  - Strategy: A New Era for Scientific Advances and Societal Benefits
  - LPP: Scientific Context ...
- “Societal Benefits” is a new, *additional* emphasis
  - on top of excellent science and technological innovation



Global trends transforming society in the coming decades

Societal trends posing challenges to the Earth system.
EO from space and revolutionary changes in digital technologies .

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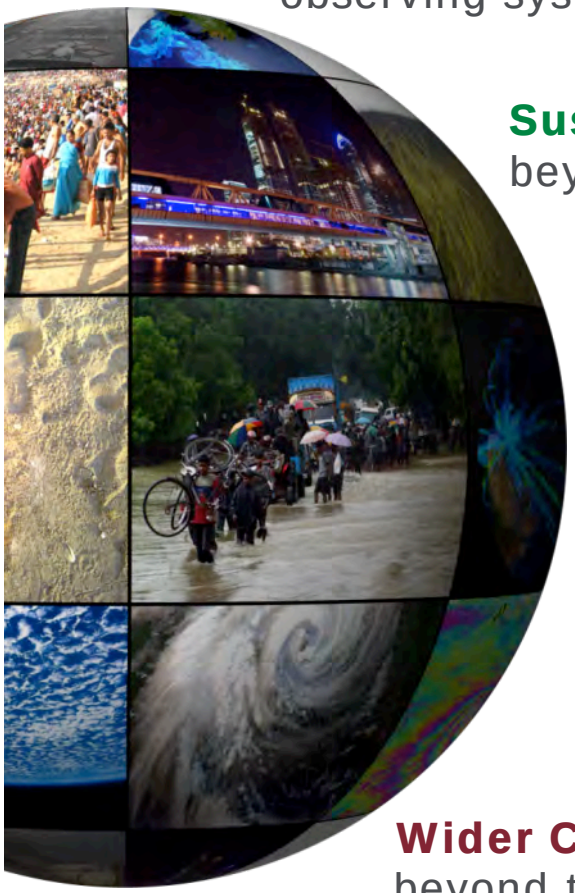
The Strategic Response

ESA's EO Science Strategy at a glance

Ground-breaking exploratory missions integrated into flexible observing systems for Earth system science



Sustained observations to understand and attribute trends beyond the expected variability

International co-operation to provide an integrated, optimised Earth observing system, which can grow in capability in a cost-effective manner

Translational science to synthesize and adapt the data streams from individual instruments and satellites into knowledge

Wider Communication and dialogue with people beyond the scientific sector to help explain the value, opportunities and inspiration provided by EO from space

Key element:

Ground-breaking exploratory missions integrated into flexible observing systems for Earth System science

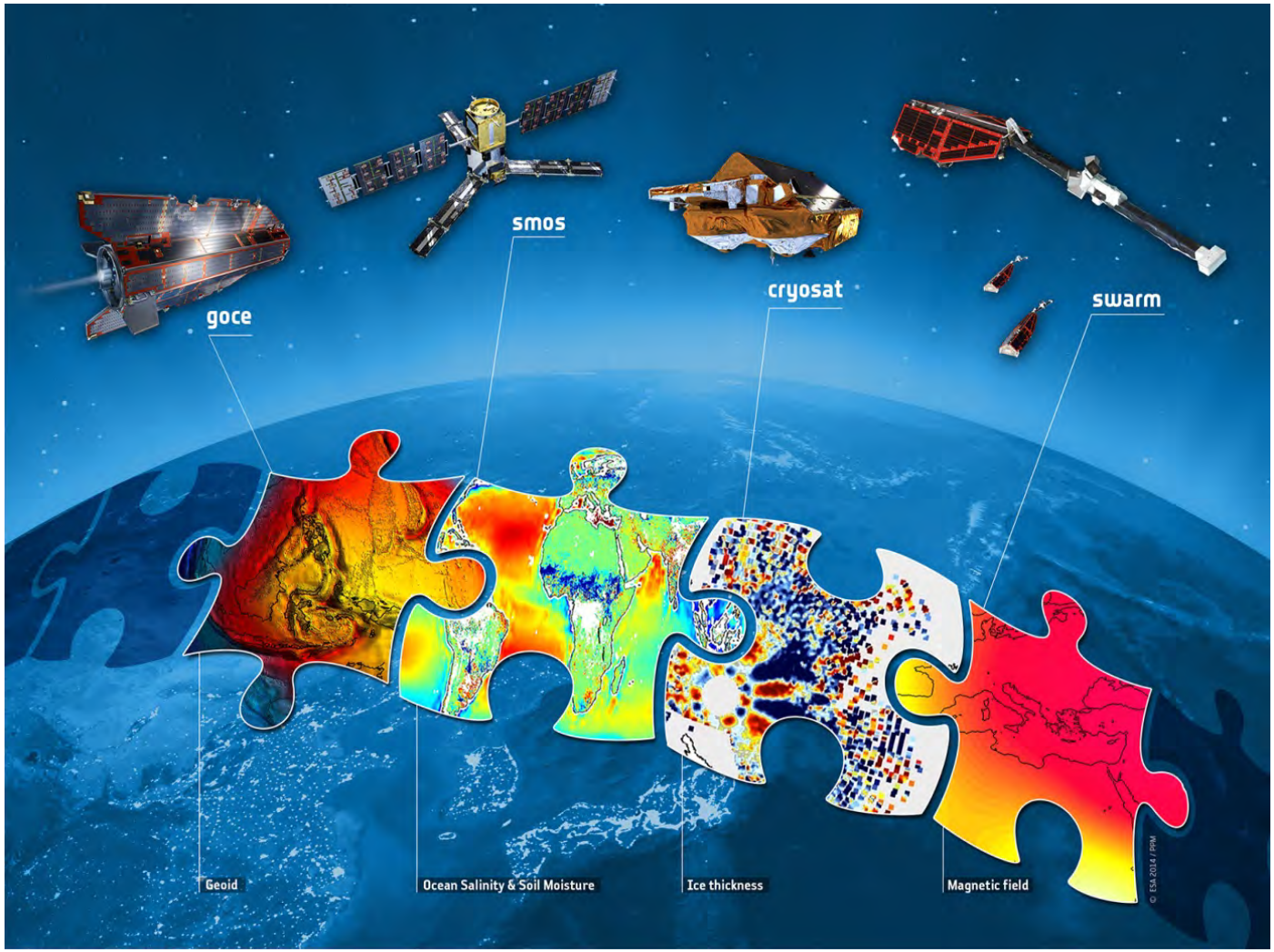
Integration of data across sensors and scientific disciplines

Integrated Earth system science approach

Optimal design of observing system

Science and technology innovation through exploratory missions

Flexibility in satellite mission concepts



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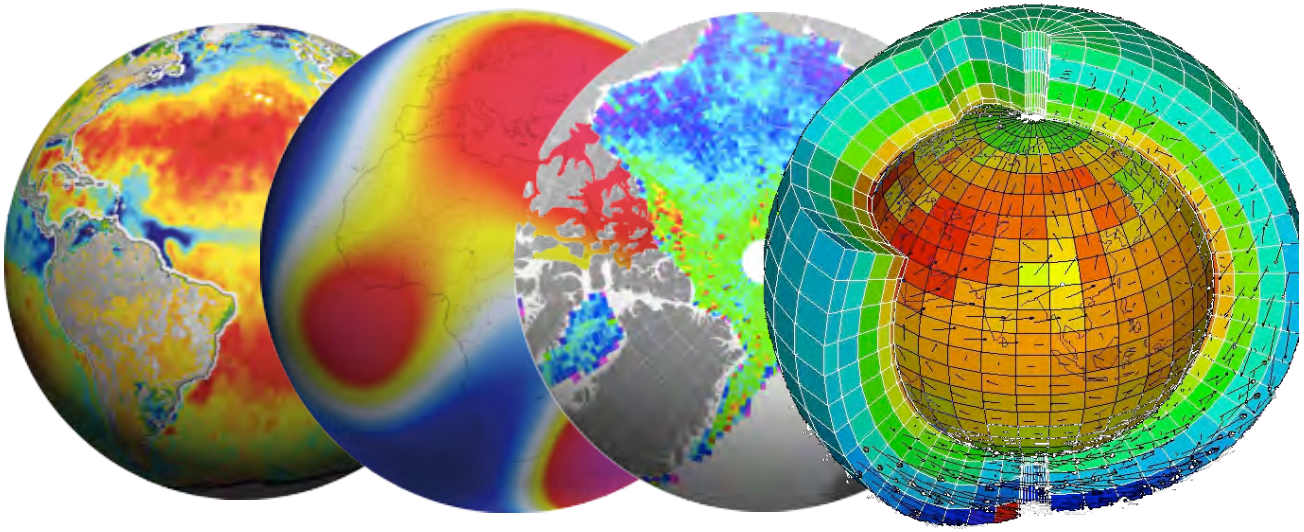
Integrated view from models and data



Observations + Models

Modelling processes and interactions

Attributing causes

Predicting trajectories of Earth System and future impact

Key Element:

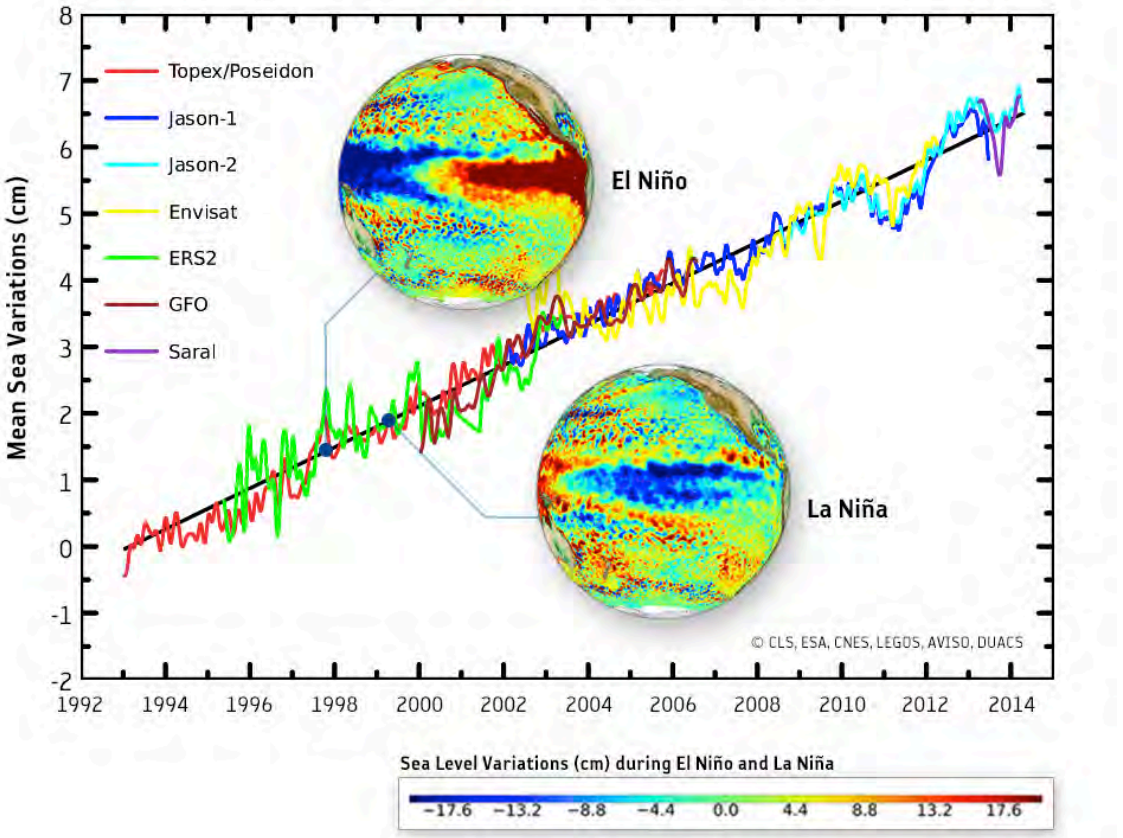
Sustained observations to understand and attribute trends beyond the expected variability

From Exploratory to Sustained Observing Systems

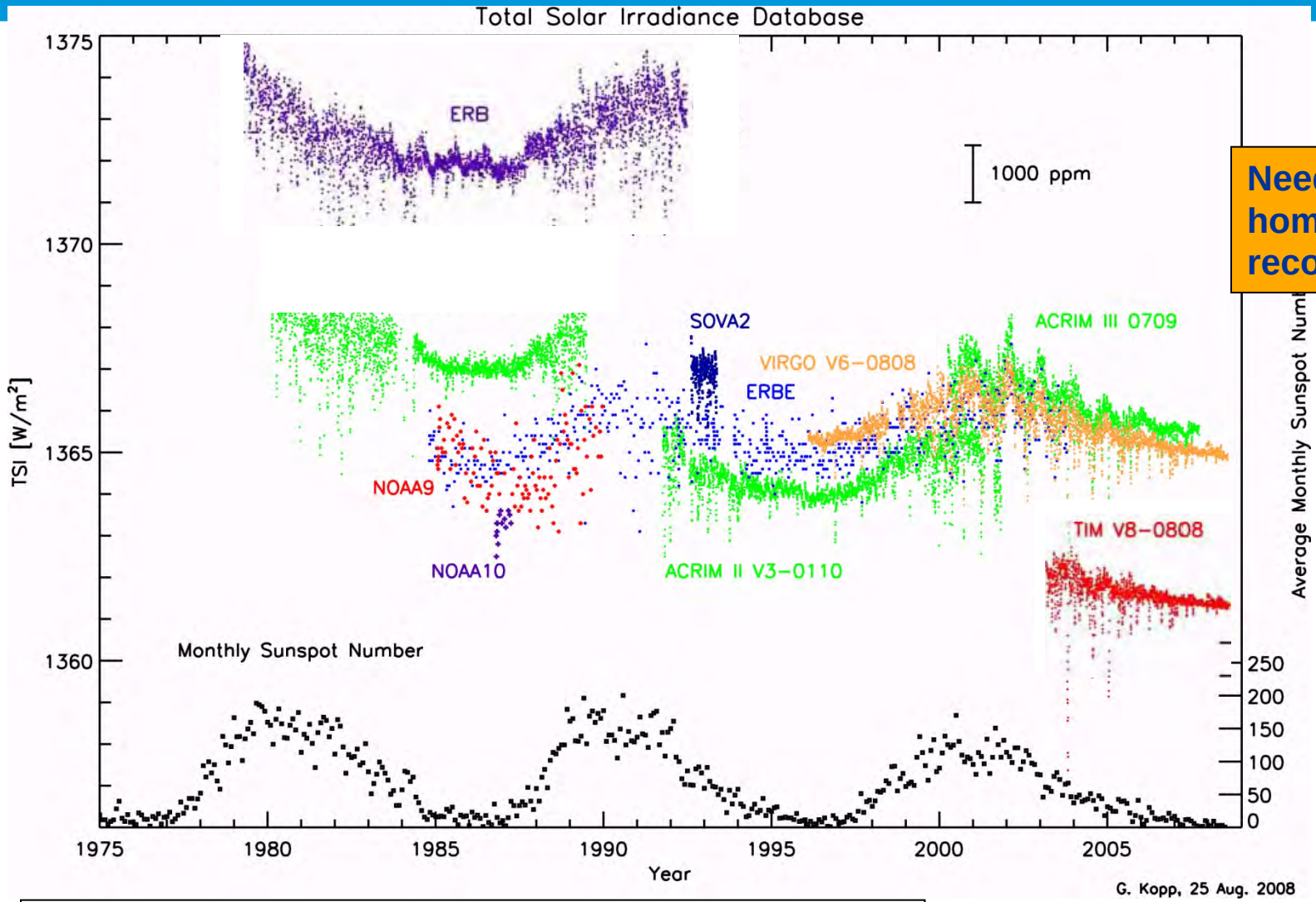
Sustained observations

Discrimination between trends

Transition into practical applications addressing societal issues



Foresee repeated re-processing to release full value of datasets



Need for homogeneous records

Required accuracy: 1 W/m2

Required decadal stability: 0.2 W/m2

(Satellite Supplement, GCOS-107, 2006)

Key Element:

International co-operation to provide and integrated, optimised Earth observing system, which can fill gaps in observational needs and build new capability in a cost-effective way

Integration with international assets and

International collaboration for cost-effective and optimal design

Infrastructure for science: formation flying, constellations or convoys

Sharing of resources for system calibration and data validation

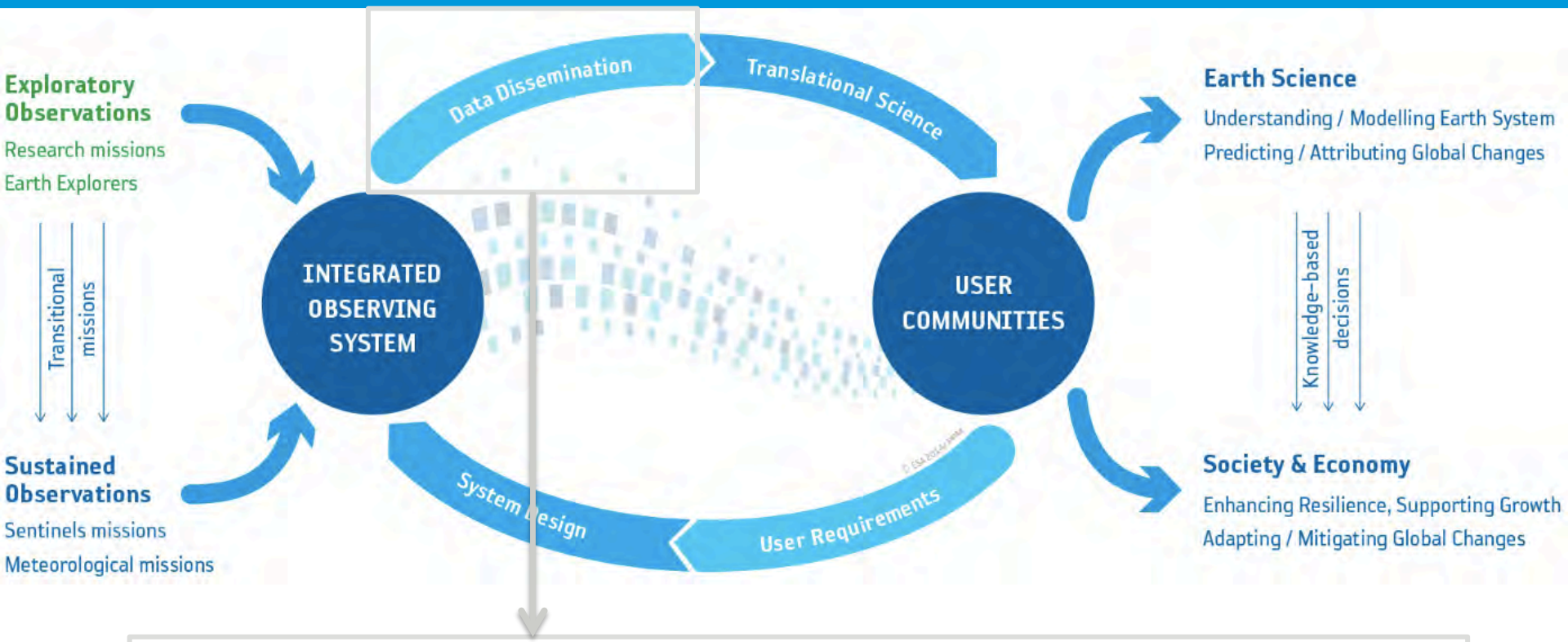
ESAC wants to avoid joint missions being disadvantaged

Key Element:

Translational science to synthesise and adapt the data streams from individual instruments and satellites into knowledge

ESA UNCLASSIFIED – For Official Use

Data distribution activities

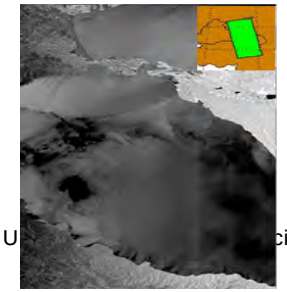


From Data that are
- Unmanaged
- Disconnected
- Invisible
- Single Use

To structured collections that are
- Managed
- Connected
- Discoverable
- Re-useable

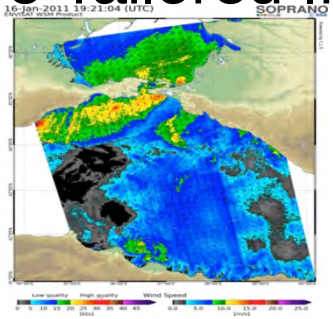
Translational activities with user communities

From Raw Data

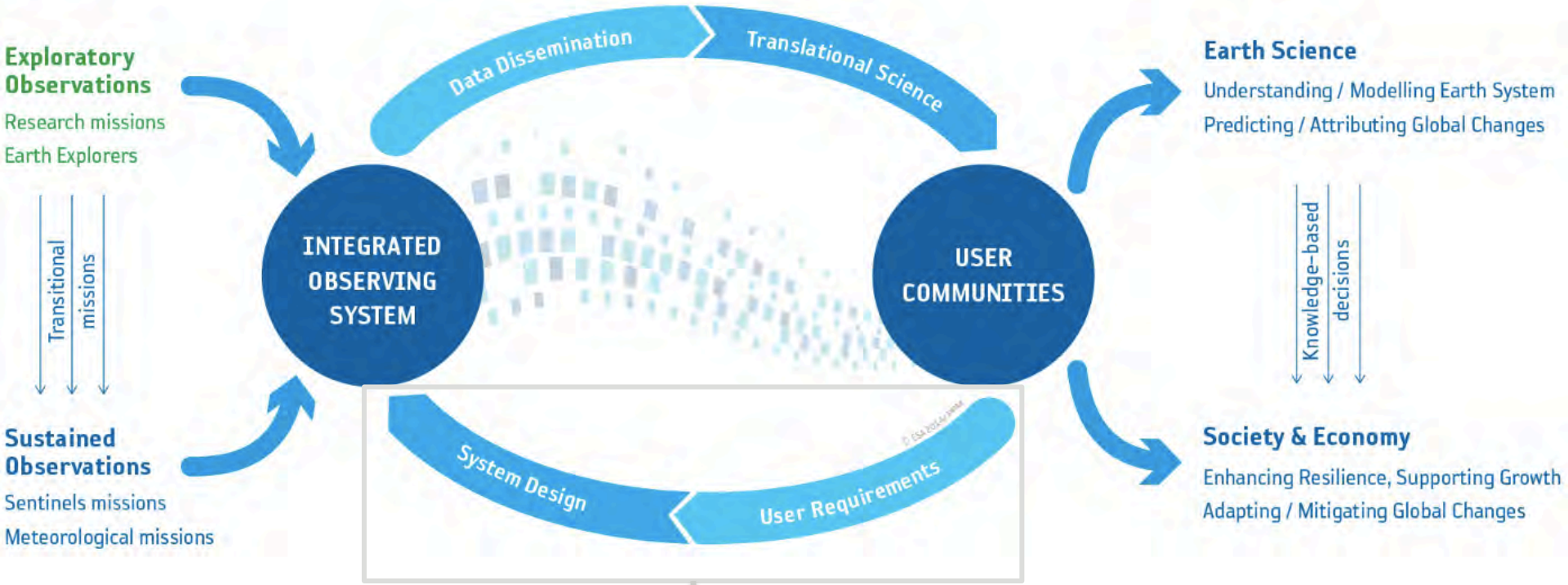


Enabling & nurturing the EO Science Community

To Tailored Information



Feedback loop to ensure data fitness for purpose



Feedback loop to:

- Gather user feedback on data quality, integrity and suitability
- Gather user and missions requirements
- Design systems in an optimised, integrated manner

Key Element:

Wider communication and dialogue with people beyond the scientific sector to help explain the value, opportunities and inspiration provided by EO from space

The need for Wider Communication

Integral part of the science-to-society value chain

Need for well-informed community of decision makers and citizens

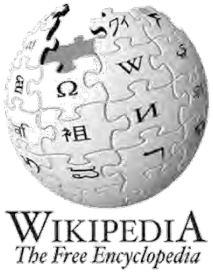
Technological trends

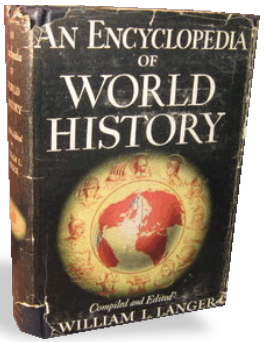
ResearchGate

MENDELEY

github
SOCIAL CODING

ScienceConnect





LinkedIn

TED Ideas worth spreading

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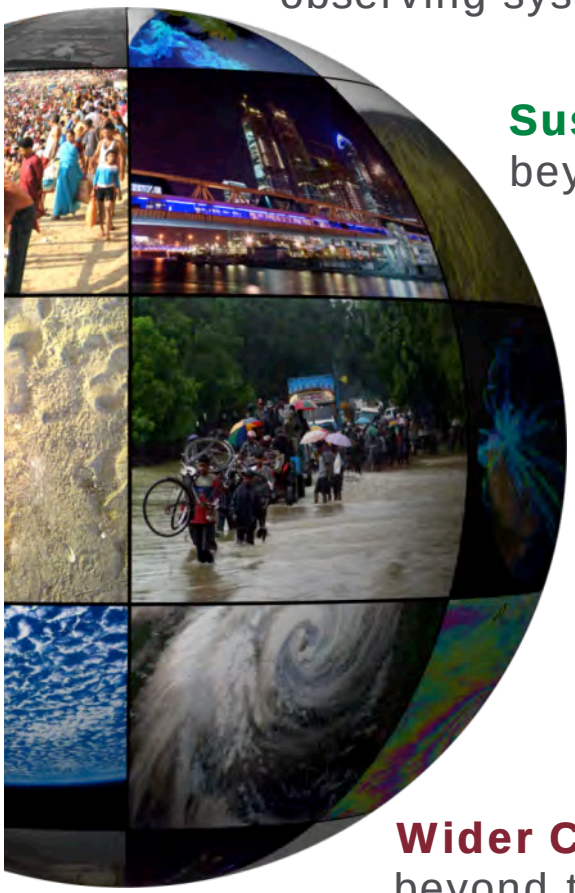

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Implementation goals, not only science goals (my take)

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- Use for Earth system science
- Integration with other data / information systems
- In-mission, planned demonstration of “operations”
- Identify routes for
  - transition to sustained mission (Copernicus)
  - policy support
  - dissemination and services

What does this practically mean?

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- No prioritised science problems
  - In practice, the “challenges” would always be trumped by the most exciting science in any case
- Give thought to societal benefit aspects early
  - Not only innovation in measurement concept or target
  - Not only innovation in instrumentation
  - Not only new science
  - But also innovation in exploitation (including co-benefits)
    - Does this mission integrate into operational environmental monitoring systems?
    - Can it pull through to policy support, public or commercial services?
- Is it a trail-blazer for future Copernicus mission?
  - This needs a clear societal benefit
- “Excellent science through innovation benefiting society”

Scientific Readiness Levels

OBJECTIVE:

Provide an objective metric that enables the assessment of the scientific maturity of an EO (candidate) mission and supports a traceable development from Pre-Phase 0 to Phase F.

BENEFITS:

- Support an earlier scientific preparation of mission proposals (in pre-Phase 0).
- Support the selection of mission proposals through a standardised and common metric across missions.
- Provide a standardised tool for scientific quality analyses, control, and risk assessment during mission development.
- Provide a common metric for end-to-end (E2E) mission performance assessment in all phases.
- Provide flexibility to bring in additional scientific expertise.

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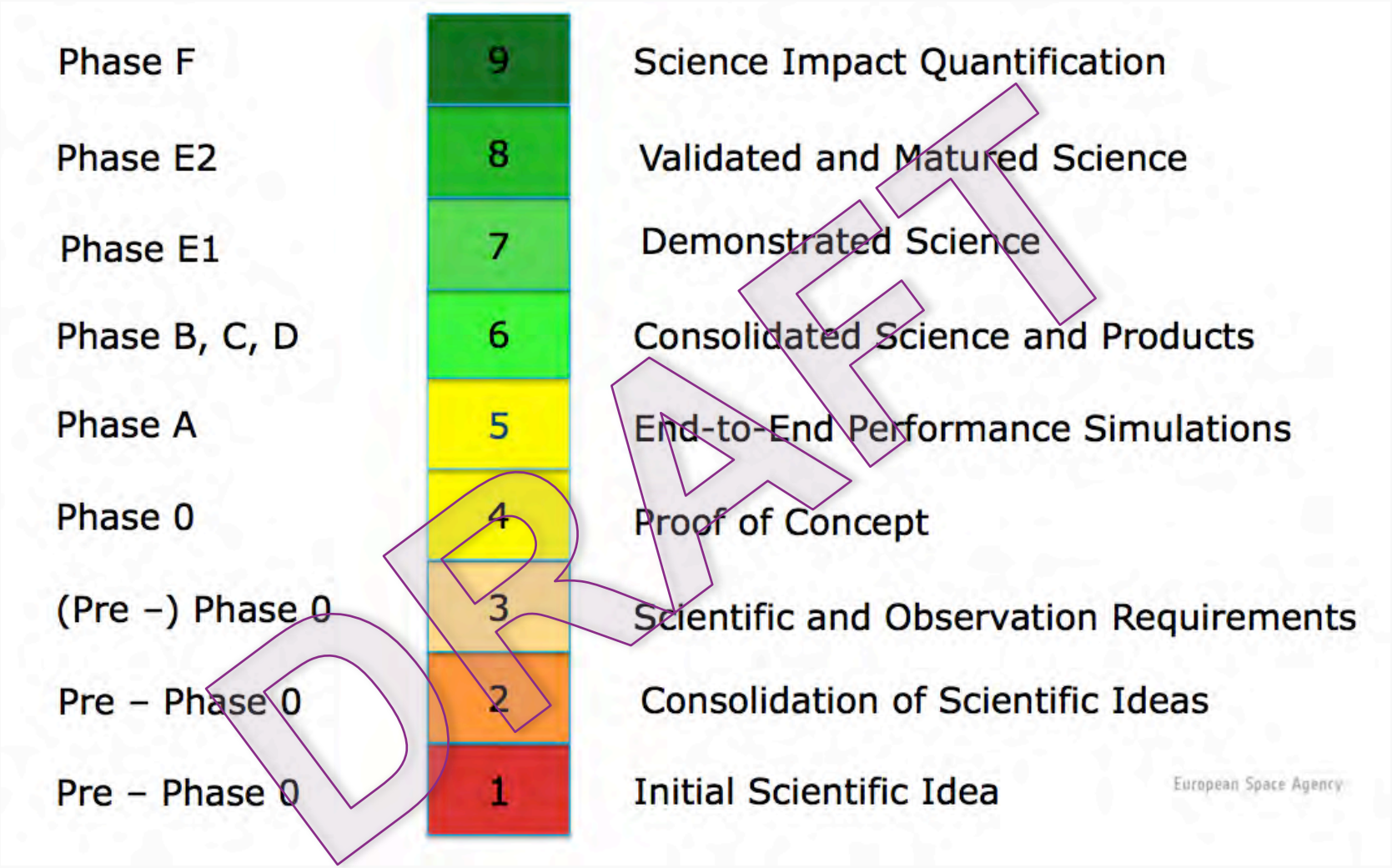
Phase F
9
Science Impact Quantification
Phase E2
8
Validated and Matured Science
Phase E1
7
Demonstrated Science
Phase B, C, D
6
Consolidated Science and Products
Phase A
5
End-to-End Performance Simulations
Phase 0
4
Proof of Concept
(Pre –) Phase 0
3
Scientific and Observation Requirements
Pre – Phase 0
2
Consolidation of Scientific Ideas
Pre – Phase 0
1
Initial Scientific Idea
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SRLs 1, 2, and 3: Proposal Preparation in Pre-Phase 0

esa

SRL	Name (ESA)	Theory	Experiments	Users & Requirement
1	**Scientific Idea**	• A scientific challenge is identified. • The scientific objective is formulated. • A scientific hypothesis is established.	No observational evidence is required.	• The application area is defined. • Interest of the users is identified. • Start defining high-level scientific requirements.
2	**Consolidation of Scientific Idea**	• A scientific theory is formulated. • The physical principle behind the hypothesis is outlined (at least qualitatively).	Experimental evidence supporting the scientific hypothesis.	• Consolidated scientific requirements are established. • A gap analysis with respect to the uniqueness of measurements and observations is performed. • Scientific objective are formulated.
3	**Scientific / Observation Requirements Definition**	• Quantitative theoretical understanding of link between measurement and observation (no software required) is established.	• Initial capability assessment performed.(Information content analysis) • Conceptual measurement technique is established.	• Scientific objective confirmed and approved. • Scientific goal formulated. • Mission objective(s) formulated.

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SRLs 4 and 5: Mission Preparation and Selection (Phase 0 and A)

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SRL	Name (ESA)	Theory	Experiments	Users & Requirement
4	**Proof of concept**	• Simulation of measurements based on geophysical parameters (e.g. numerical forward model). • 1st simulated measurements are available.	• First measurement device approximating the instrument is available in case possible for the measurement principle. • Sensitivity of measurements wrt observation is demonstrated.	• Mission objective confirmed and translated into mission requirements and system requirements
5	**End-to-end performance simulations**	• Consolidated retrieval and draft ATBDs (+ prototype) are available	• Demonstrator (e.g. airborne instruments) provides/simulates representative measurements with error budgets, • Draft calibration strategy available.	• First evaluation of observations and / or measurements in applications, • Higher-level products approached.

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My take for the coming years

- Parameters of upcoming EE-9 are not yet clear
- Will be driven by the new strategy
  - Open with regards to scientific challenge
  - Looks for additional dimensions to innovation from the start
    - Broader exploitation, benefiting society
    - Exploiting new technologies for “translational science”
    - Innovation in public engagement / communication
- I hope call will facilitate
  - Safe to pursue joint missions with other agencies
- Scientific Readiness Levels may be defined