



SCIENCE FOR A GREEN AND SUSTAINABLE SOCIETY

EC–ESA Earth System Science Initiative



Jointly prepared by
EC's Directorate General for Research and Innovation
and
ESA's Directorate of Earth Observation Programmes

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By working together, ESA and the EC will be able to shape better how we contribute to the challenges of achieving a sustainable Europe by 2030 and goals set in the 2015 Paris Agreement on climate.

Patrick Child

Deputy Director General, EC's Deputy Director General for Research and Innovation



The European Commission's Deputy Director General for Research and Innovation, Patrick Child, (right) and ESA's Director General, Josef Aschbacher

It is so important that environmental and climatic issues are tackled before it's too late. Here in Europe, we are well-placed to make a real difference. We have the infrastructure and the expertise and we are thrilled to strengthen our cooperation with the EC to further Earth-system science.

Josef Aschbacher

ESA's Director General

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RATIONALE

In the next decades population growth is expected to amplify current pressures on critical resources such as fresh water or food, intensify the stress on land and marine ecosystems and increase environmental pollution and its impacts on health and biodiversity. These problems will be further exacerbated by global warming and the likely impacts of climate change in the Earth system. These, including rising of the sea level, increasing levels of ocean acidification and more frequent and intense extreme events such as floods, heat waves or droughts, are expected not only to have a significant impact on critical resources, but mainly to endanger human lives and property, especially on most vulnerable populations.

Earth system science together with Earth Observations are expected to play a major role in this process. In fact, addressing the unique set of global challenges that society is facing at the onset of the 21st century and progressing towards a sustainable climate transition, requires more than ever that scientists advance their understanding of our planet, its processes and its interactions with human activities and translate that knowledge into solutions for society, policy advice and alternative pathways for development within safe and just planetary boundaries for humanity.

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As a response to these challenges Europe launched the **EU Green Deal** as a new growth strategy that aims to transform the EU into a fair and prosperous society, with a modern, resource-efficient and competitive economy. The Green Deal also aims to protect, conserve and enhance the EU's natural capital, and protect the health and well-being of citizens from environmentrelated risks and impacts.



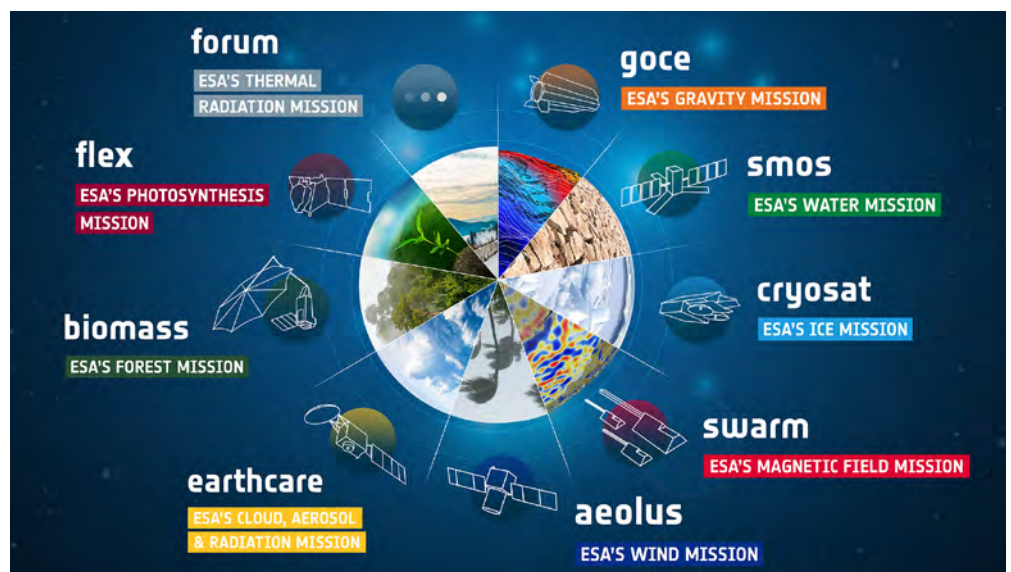
Europe has now an unique opportunity to lead the global scientific efforts to address these challenges. In the next decade Europe will rely on the most comprehensive and sophisticated space-based observation infrastructure in the world, including an extraordinary and complementary suit of sensors on board of the Copernicus Sentinels series, the ESA's Earth Explorers, the coming meteorological missions and different EO observation satellites planned to be launched by national space agencies and private operators in Europe. This comes at the time where the global economy turns into digitalisation in an abrupt way departing from the traditional wealth creation of the 20th and 19th century and making information the fuel of our societies.

Ensure the scientific community takes full advantage from this unique opportunity and maximise its scientific and societal impact is urgent and will require a significant collaborative effort and an integrated approach to science where the synergistic use of EO satellite data, in-situ and citizen observations, advanced modelling capabilities, interdisciplinary research and new technologies will be essential elements.

Sharing this vision, in January 2020, EC and ESA launched a joint Earth System Science Initiative, formalised with the signature of a working arrangement between both institutions. The initiative aims at joining forces to advance Earth System Science to provide a coordinated response to the global challenges that society is facing in the onset of this century.



With this initiative EC and ESA aims at providing a coordinated response to the global challenges that society is facing in the onset of this century



ESA's Earth Explorers missions offer pioneering space technology at the service of cutting-edge Earth system science.

OBJECTIVES

With this initiative, EC and ESA aims at: **establishing an effective alignment of selected scientific activities under Horizon Europe and FutureEO in terms of goals, content, and planning to jointly advance Earth system science and its contribution to respond to the global challenges that society is facing in the onset of this century.**

To this end, RTD and EOP will:

- Maximise the complementary roles, areas of expertise and funding of both institutions for the benefit of the scientific community and citizens, ensuring that the final result is bigger than the sum of the parts;
- Join efforts to ensure the scientific community gets full benefit from the unprecedented, diversified and concurrent space-based EO capacity of the next decade and in particular across Horizon Europe, amplifying its scientific and societal impacts;
- Jointly contribute to unlock the full potential of the unique and unexplored synergistic opportunities offered by the coming European and international space-based EO infrastructure, especially, in conjunction with in-situ and citizen observations and existing operational geoinformation data and services (e.g., from Copernicus services);



- Line up scientific activities to expand the fundamental understanding of our planet, its processes and interactions with human activities, promoting science as an additional resource to meet pressing societal needs;
- Coordinate efforts to accelerate the transition from science results into the digital economy, boosting novel solutions for society and contributing to strengthening and expand the services offered by operational programmes (e.g., Copernicus) and institutions;
- Foster the scientific excellence of Europe in the international scientific arena, providing a coordinated contribution to major international scientific efforts, initiatives and programmes;

This initiative is expected to provide a significant scientific contribution to:

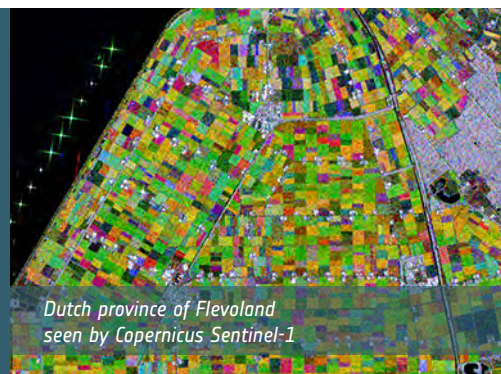
- 1 **Realise the vision of the EU Green Deal.**
- 2 **Achieve the goals of the new Missions of Horizon Europe with special attention to adaptation to climate change, healthy oceans and soil health and food.**
- 3 **Establish a solid scientific basis for the realisation and evolution of the EC DestinE initiative.**
- 4 **The evolution and scientific impact of the Copernicus programme**

SOME BASIC PRINCIPLES

All activities shall focus on major scientific challenges and knowledge gaps in Earth system science that may contribute to respond to the urgent societal needs underpinning the European and global environmental and development agendas.



All activities shall capitalize on the unique and unexplored opportunities offered by the coming space-based observing capacity complemented with in-situ and citizen observations, existing geoinformation data and products (e.g., from Copernicus services), advances in modelling and digital technologies following an holistic and integrated approach to science.



All activities shall ensure a multi-disciplinary and open science approach through collaborative scientific activities involving different scientific domains from Earth science and environmental research to social science, health or economics, where sharing data, results and knowledge is at the core of the scientific value chain.



All activities shall capitalize on novel and emerging technologies as amplifier and accelerator of science, incorporating Big Data technologies, advances in ICT, Data intensive science, Artificial Intelligence, UAVs and other observing platforms as integral parts of the available resources to boost the scientific output.



All activities shall be based on an strong collaborative approach across Europe and beyond, amplifying its impact through collaboration and complementing national, European and international activities and programmes.

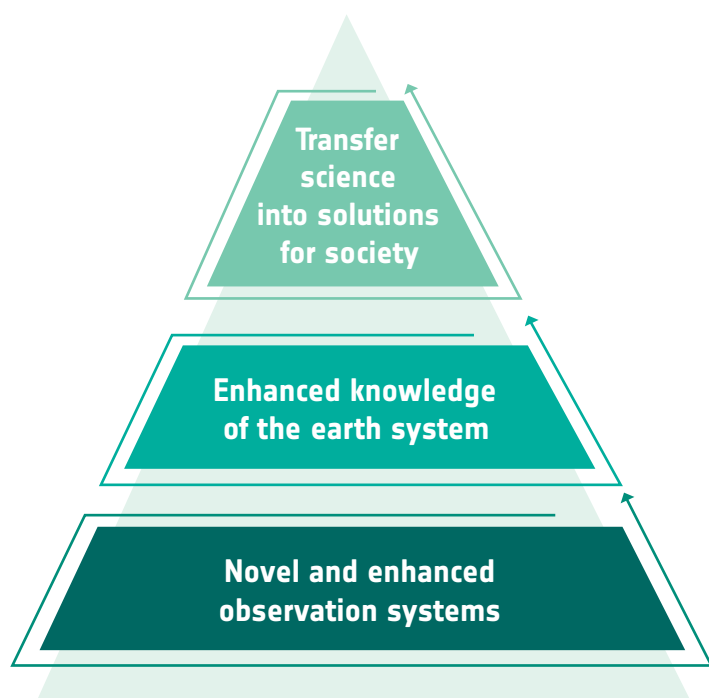


FOSTERING SCIENTIFIC DISCOVERY AS A TOOL FOR SOCIETY

EC and ESA will cooperate on the basis of a common priorities identifying common goals and scientific challenges to be jointly addressed.

Objectives will be pursued through coordinated actions addressing gaps and needs across the value chain of science, from scientific discovery to societal impact.

With this approach, expanding our understanding of the Earth system can play the role of a public service, where basic science is not only driven by curiosity but may also represent a tool to design new solutions for society.



In particular, RTD and EOP will align actions to

Advance our observing capacity and the scientific foundations for the next generation of EO space-based methods, algorithms and data products; Contributing to develop the next generation of fit-for-purpose observing systems that may integrate in an holistic manner advanced space-based observations, in-situ networks, citizen science and latest technologies (e.g., UASs); Supporting large scale multidisciplinary field campaigns and experiments; Facilitate wide access to Earth observations (in the broadest sense) for science, capitalising on the latest developments in ICTs (e.g., European Open Science Cloud, DIAS);

Advance our basic understanding of the Earth system Supporting large-scale scientific endeavours advancing our basic understanding of the complex interactions among the different components of the Earth system and human activities; Bringing together scientists from different sectors to jointly undertake far-reaching interdisciplinary research connecting Earth processes and society; Promoting large-scale scientific assessments of vulnerable ecosystems; Advancing the foundational understanding of the planetary boundaries and their associated knowledge gaps;

Transferring science into new solutions for society Undertake inter-disciplinary research to explore and design alternative development pathways to transit towards a sustainable and climate-neutral society; Involving early adopters (e.g., economic operators, public institutions, local communities) from the initial phases of the science process to accelerate the transition from science into actionable opportunities for society; Ensuring the transfer of scientific results into operational contexts, through the relevant programmes and institutions (e.g., Copernicus services, national programmes, other



Polar Regions and Global Impacts

Establish a strong European coordinated effort to enhance observations, understanding and prediction capabilities the rapid changes being observed at high latitudes to assist citizens, communities and regions in the definition of sustainable and innovative approaches to tackle the resulting risks for society and ecosystems.

Biodiversity and Vulnerable Ecosystems

Develop the next generation of biodiversity observing systems and science based solutions to address better the primary causes and drivers of biodiversity loss, to enhance the conservation and restoration of vulnerable ecosystems and ultimately to contribute to the international scientific efforts of the CBD, IPBES and GEO BON to halt worldwide

Climate Adaptation to Extremes and Natural Disasters

Enhance our observation capacity and fundamental scientific understanding to deal with climate disruptions, multi hazards risk, compound and cascade events, its interactions and feedbacks with the Earth and climate system and its expected impacts on society and ecosystems

Ocean Health

Advance our observing capacity and the scientific understanding of the ocean's role in the Earth system and its responses to management actions to establish a science base Digital Twin of the Ocean as an advance tool to reverse the cycle of decline in ocean health and improve conditions for sustainable development of the Ocean.

Flagship Actions Launched in 2020



Flagship Actions Under preparation for 2023+

Carbon science

Coordinated effort to enhance Earth observing capabilities and basic scientific understanding of the terrestrial components of the carbon cycle, its pools and fluxes and their sensitivity to climate change, with a special attention to land use, agriculture and forestry establishing a solid scientific basis to advance towards a carbon-neutral society.

Agriculture under pressure

Improve our observation capabilities and advance the scientific basis to support resilience of agricultural productivity to climate change, determining the response of food production to many co-occurring stressors (water scarcity, land degradation, hydroclimatic extremes, etc.) and transfer science results into adaptation measurements and alternative management tools for a sustainable climateneutral agriculture.

Climate adaptation and Freshwater

Enhance our observing capacity, basic scientific knowledge and predicting capabilities of the water cycle at global, regional and basin scales and its impacts on and feedbacks with the Earth system and society to propose climate adaptation measurements and alternative management tools for a sustainable use of freshwater resources.

Air quality and health

Improved observations and enhanced understanding of health drivers and risk factors determined by the physical environment including climate and environmental impacts on infectious diseases and cross-border health threats and pollution (e.g., air pollution) and its impacts on population health.



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