Science

Science for Society

Diego Fernandez Prieto

Science for Society Info Day

28/03/2024

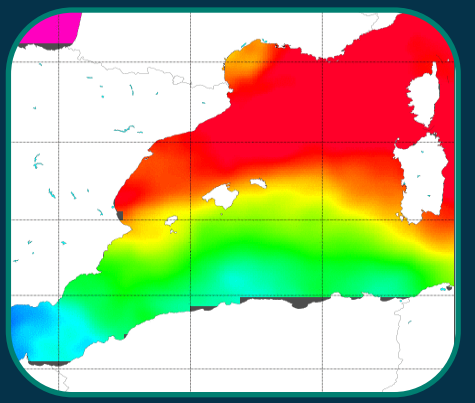
Need for an urgent and collective response…

Need for science as the bedrock for sustainable solutions…

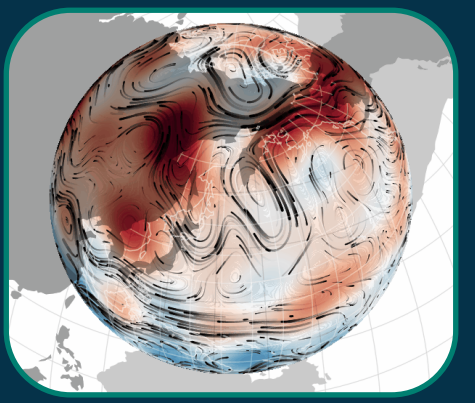
*The unique set of **grand challenges** that humankind is facing require more than ever that scientists advance their understanding of the planet, its processes and its interactions with human activities and translate that knowledge into novel solutions for society.*

Pushing the frontiers of science

Engaging the community



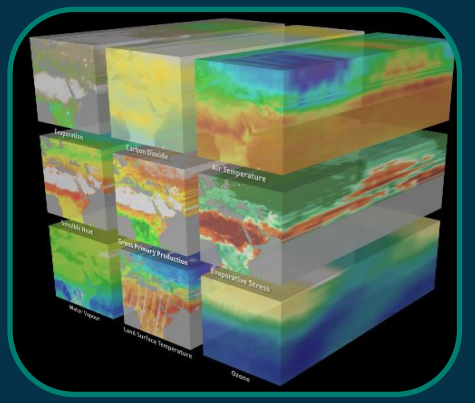
New methods & observation products



Advancing Earth System Science

Advanced simulations & predictability

Training and Education



Open Science Tools/Virtual Labs

Scientific Campaigns

Transfer to future missions

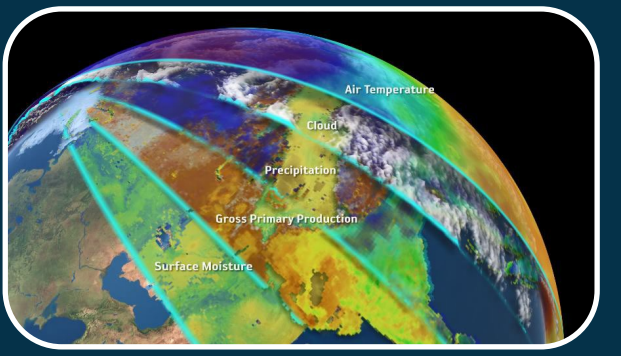
Pushing the frontiers of science

Strategic Activities

Joint ESA-EC Earth System Science initiative strategic partnership with DG-RTD fostering an ambitious European and international scientific collaboration between FutureEO and Horizon Europe

ESA Science Clusters fostering a community open science approach to scientific exploitation bringing together different teams and projects to work together towards common ambitious goals addressing all major scientific domains

ESA Science Hub a new facility in ESA fostering partnerships with academia and collaborative research with centres of excellence in MSs focusing on EO and Earth system science priorities



Advance observations and understanding of the Earth system establishing solid scientific grounds for Digital Twin Earth: advanced digital reconstruction of the Earth system based on the effective integration of novel data sets, numerical simulations and science results

ESA Science Clusters: A community approach

- *Based on a continuous dialogue with the scientific community and joint science agendas;*
- *Promote a community approach to ESA science activities towards common and more ambitious goals;*
- *Promote collaborative research across projects and teams (also non ESA projects: e.g., Horizon Europe), networking and partnerships;*
- *Maximise Open Science for the Science Clusters (EarthCODE Open collaborative environment);*

An strong partnership in Earth Sciences

ESA

FutureEO

ESA new Science and Innovation Earth Observation Programme

EC-R&I

Horizon Europe

New EU Research and Innovation Framework Programme

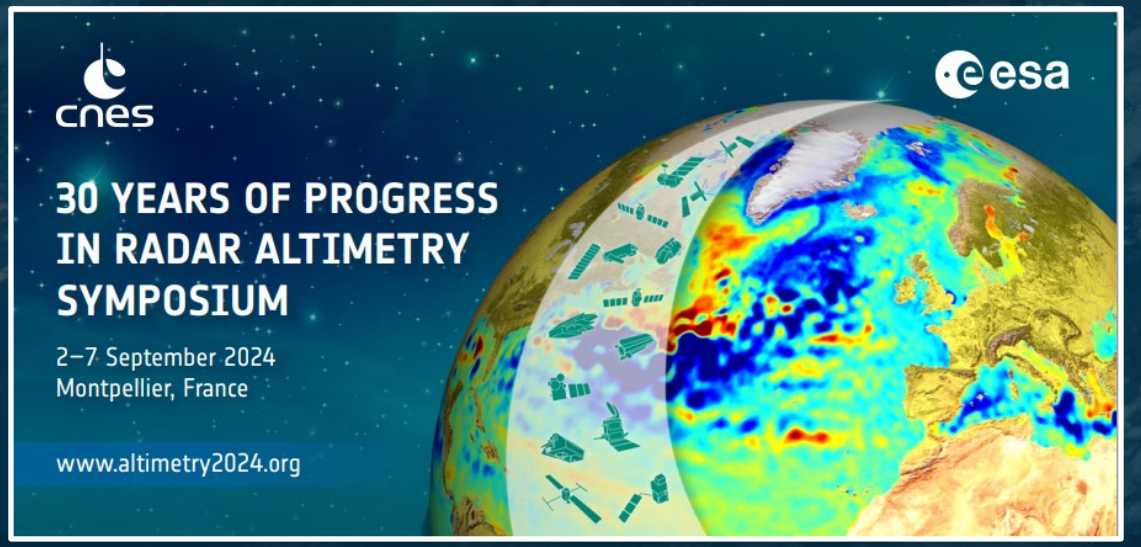
The European Commission's Deputy Director General for Research and Innovation, Patrick Child and ESA's Director General, Josef Aschbacher at the signing ceremony, January 2020.

A common goal "…. 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"

Common Priorities

Scientific Consultations

MedCyclones Workshop, ESRIN, 15-18 July

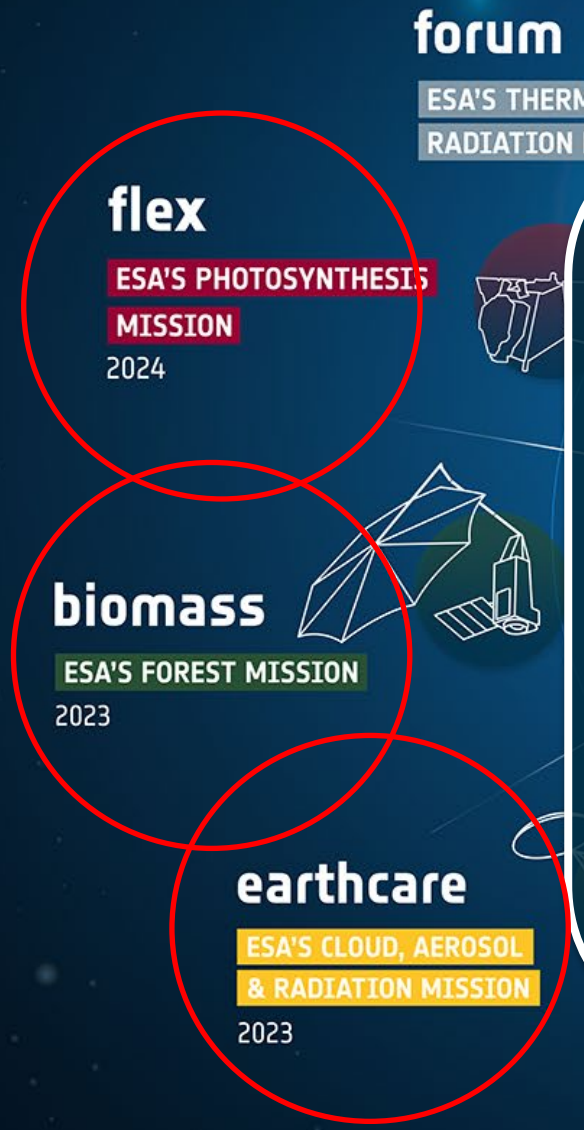


30 years of PRA, Montpellier, 2-7 September

EO Polar Science Week, 3-6 September, Copenhagen

Ocean Salinity Conference, ESTEC, May 13, 2024

Early preparation for Earth Explorers



- BIOMASS Early preparatory studies for novel methods/products. Successful activity may potentially be extended after mission launch;
- Exploring S5P SIF over the ocean and assessment of the potential priority areas for FLEX ocean acquisitions
- Harmony synergistic study for innovative methods/products and potential future applications

Set of ITTs (Parallel studies of 200-350KEuro each)

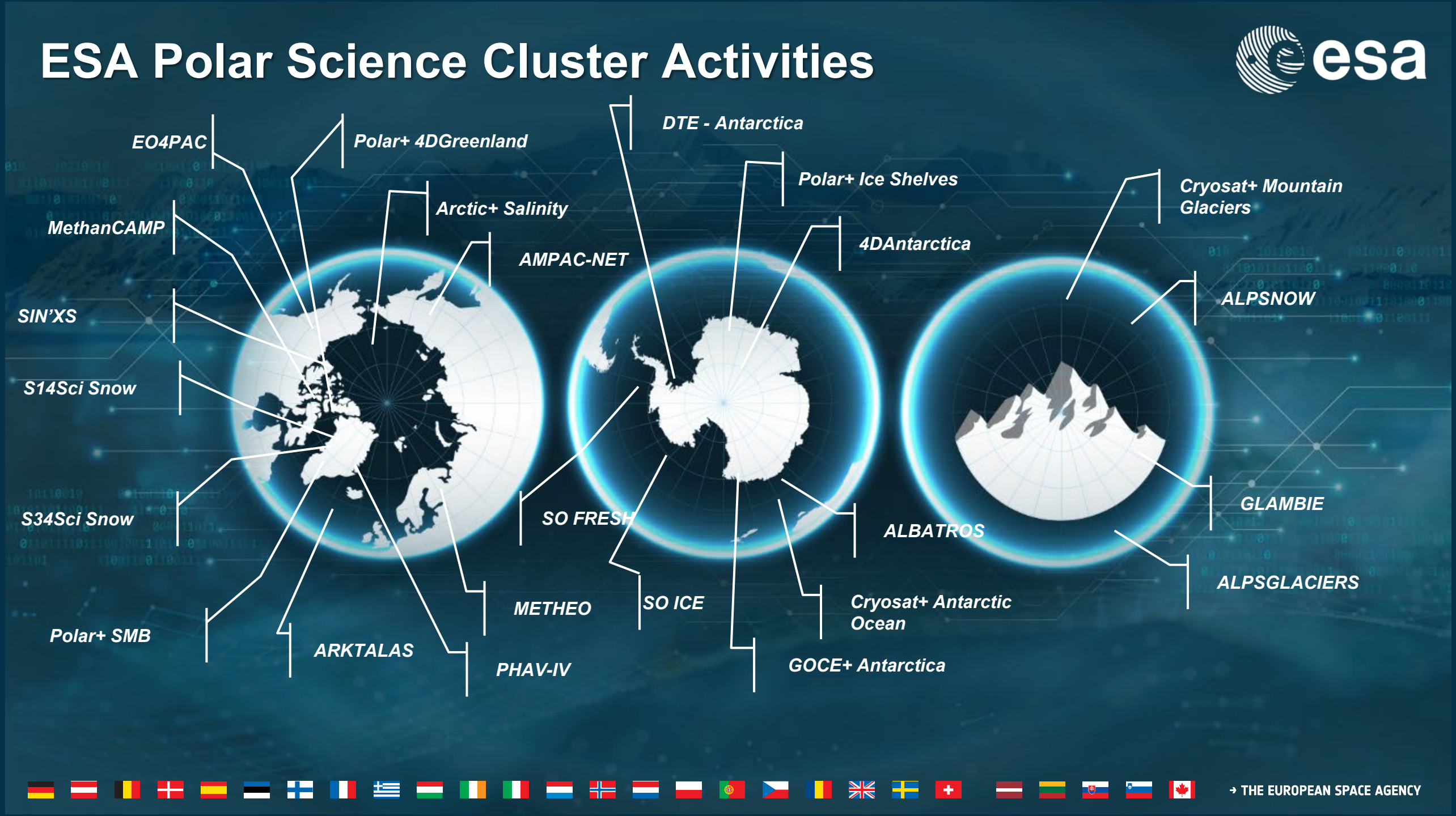
Mission specific developments (e.g., EarthCARE, FLEX, BIOMASS) are also fully integrated in the ITTs planned under the “Thematic” Science cluster activities, promoting a wider uptake of mission results

ITTs planned in Q4 2024 (depending on launch dates).
Budget range: ~1.5 MEuro

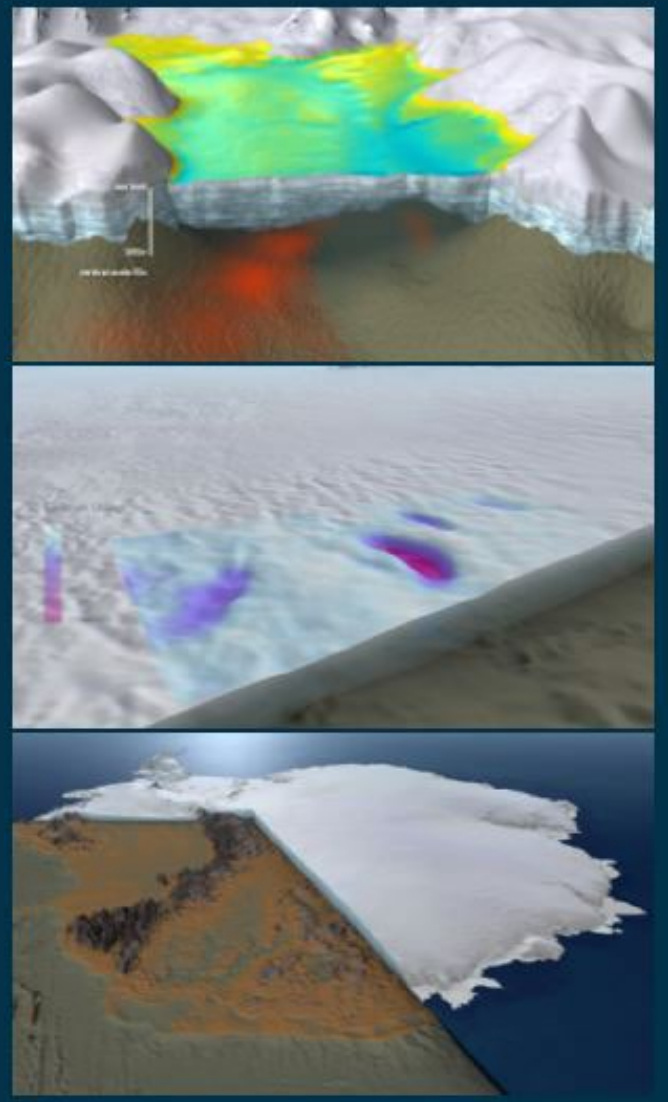
Polar Science Cluster

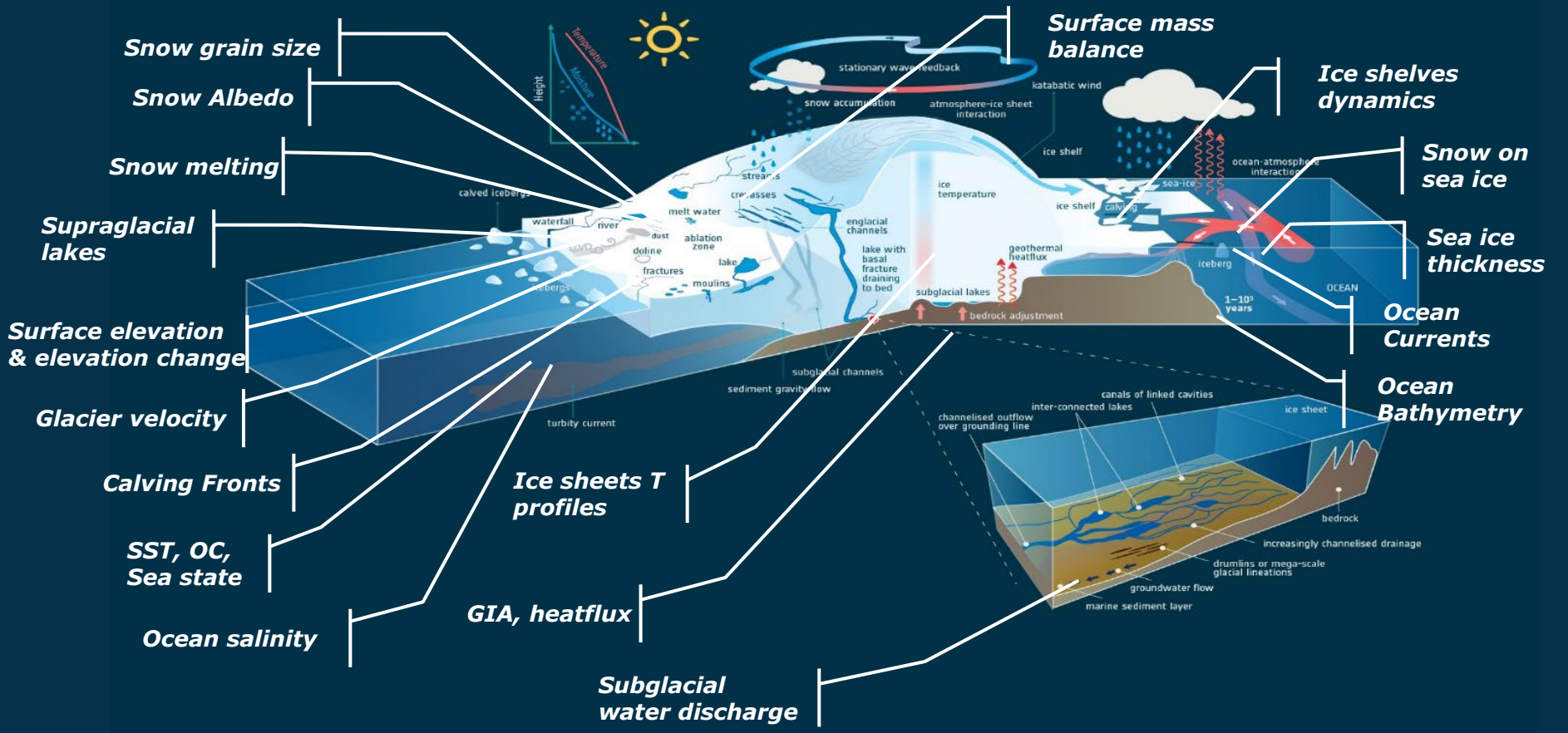
→ THE EUROPEAN SPACE AGENCY

ESA Polar Science Cluster Activities

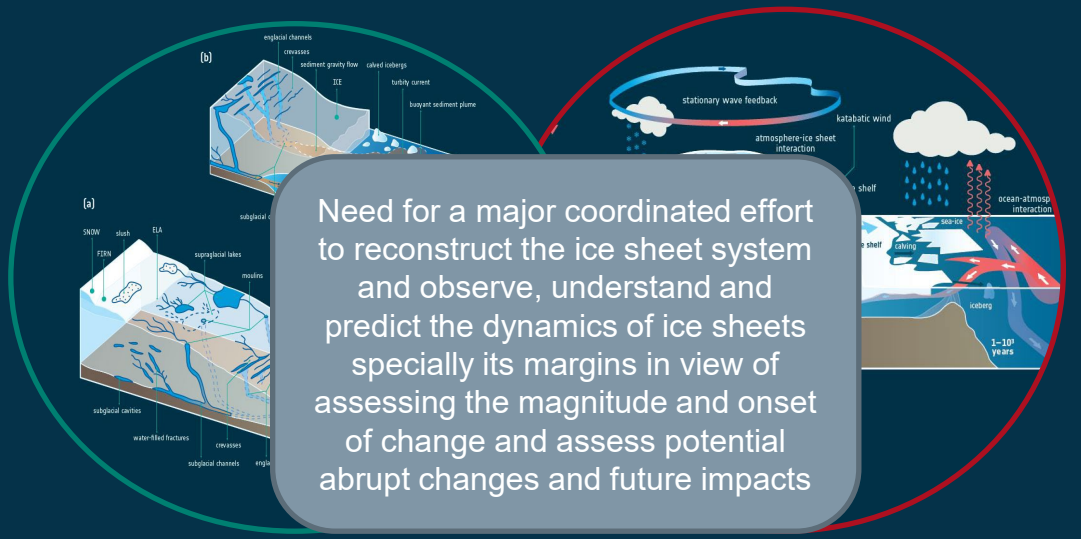


An integrated approach to Polar sciences

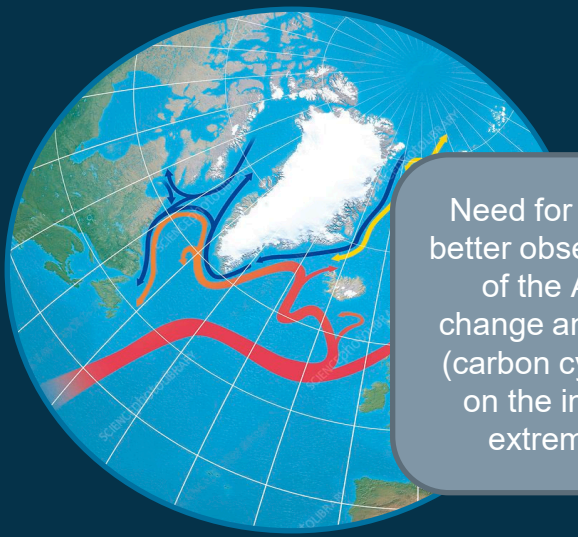




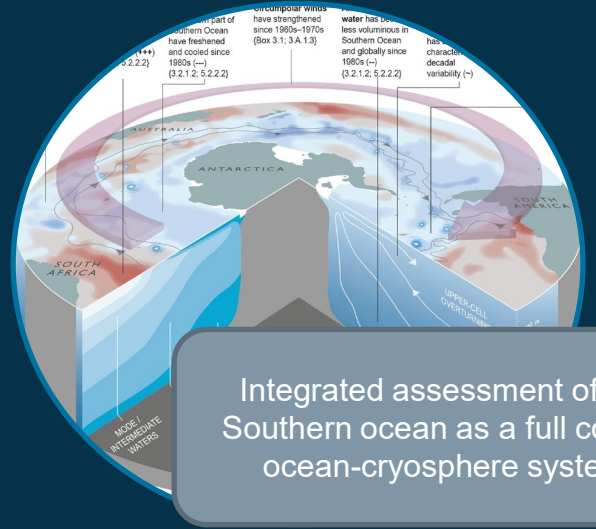
Next challenges for ESA Science Cluster



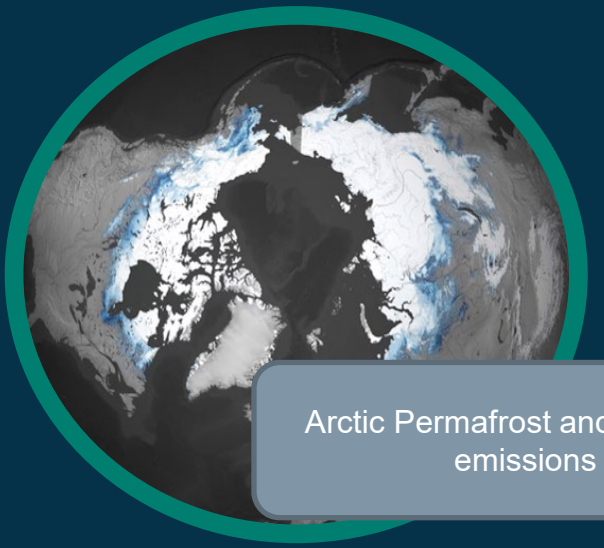
Need for a major coordinated effort to reconstruct the ice sheet system and observe, understand and predict the dynamics of ice sheets specially its margins in view of assessing the magnitude and onset of change and assess potential abrupt changes and future impacts



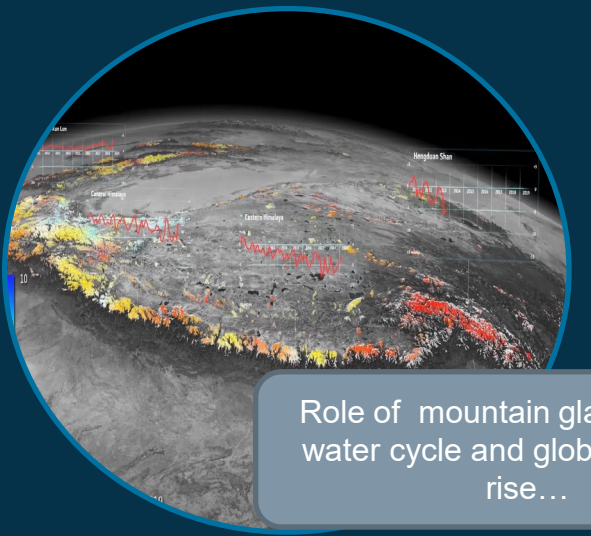
Need for a major coordinated effort to better observe and understand evolution of the Arctic ocean under climate change and its role in the Earth system (carbon cycle, water cycles) with focus on the impacts of Arctic application, extremes, and freshwater fluxes



Integrated assessment of the Southern ocean as a full couple ocean-cryosphere system

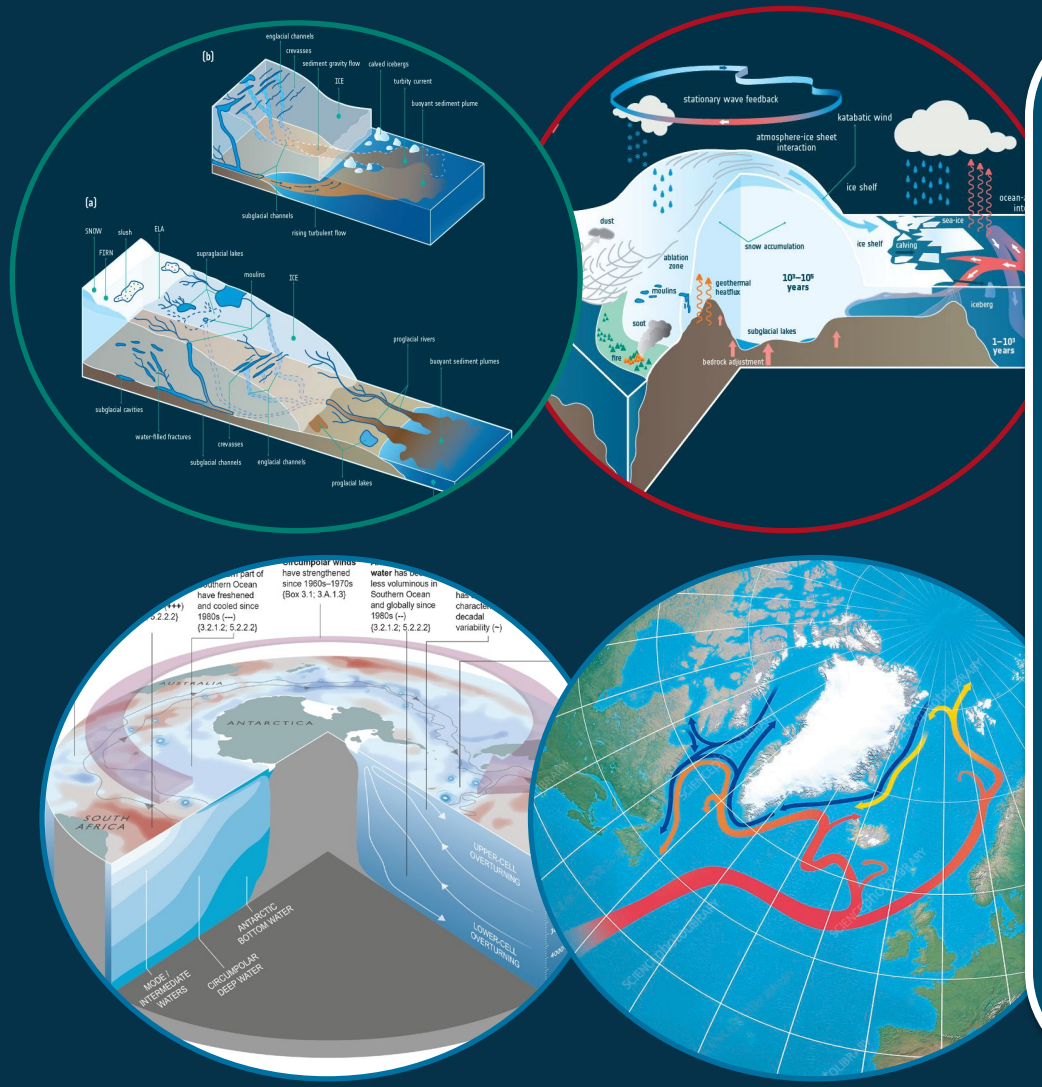


Arctic Permafrost and methane emissions



Role of mountain glaciers in the water cycle and global sea level rise…

Next challenges for ESA Science Cluster



ESA POLAR SCIENCE CLUSTER - RESEARCH OPPORTUNITIES: ANTARCTICA, THE SOUTHERN OCEAN, AND THE ARCTIC - FIXED CALL FOR PROPOSAL
Tender Action Number: 5-50059

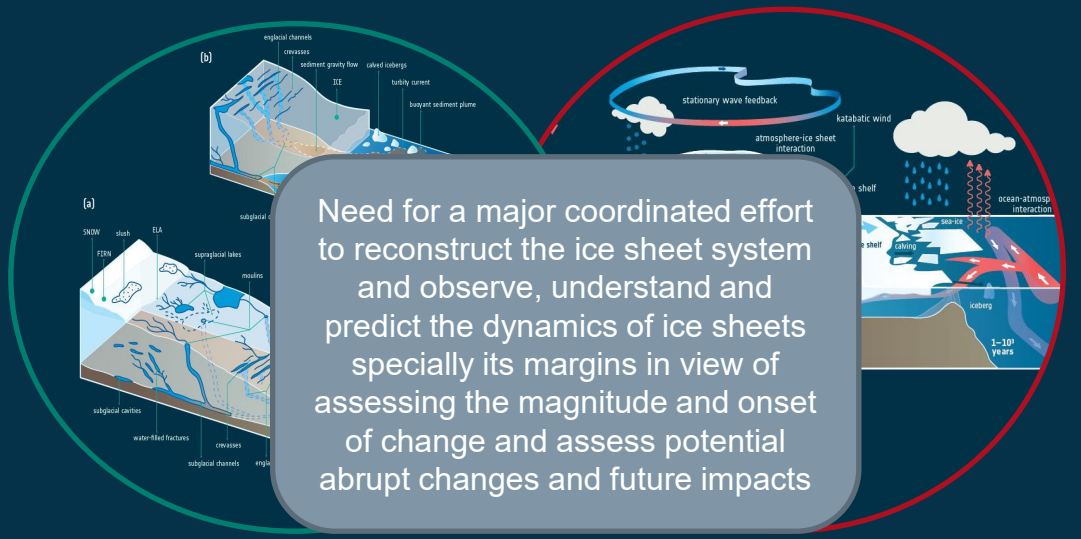
CLOSING DATE - 03/05/2024

Theme 1: Dynamic 4DAntarctica (5DAntarctica): Establishing a state-of-the-art dynamic reconstruction of Antarctica based on a multi-mission EO reference dataset for assessing change and feedbacks in all Antarctic system components: surface, subglacial, englacial and ice-ocean interface. **1.5MEuro**

Theme 2: Sea Ice Southern Ocean Mass Balance: Establishing a state-of-the-art multi-mission reference dataset for assessing the mass balance of Antarctic Sea Ice and feedbacks with the rest of the Polar system. **1MEuro**

Theme 3: Innovative Arctic Integrated Studies: Advances in our capabilities to observe the Arctic are opening new opportunities to better characterise and understand Arctic changes and their role in the Earth and climate system. **500 x 3MEuro**

Next challenges for ESA Science Cluster



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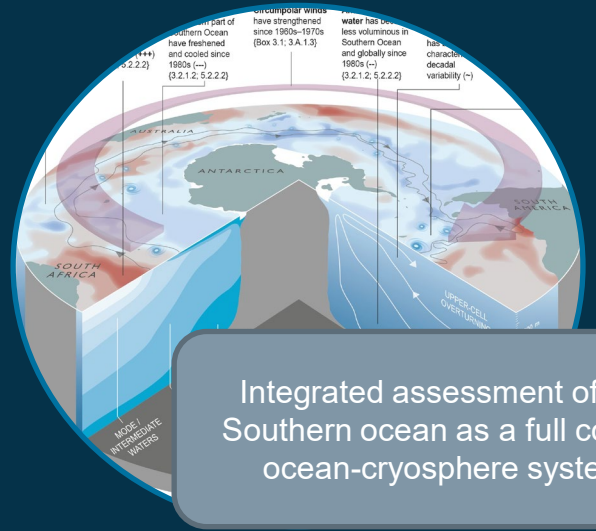
Towards and European Coordinated Action on Greenland Integrated Assessment



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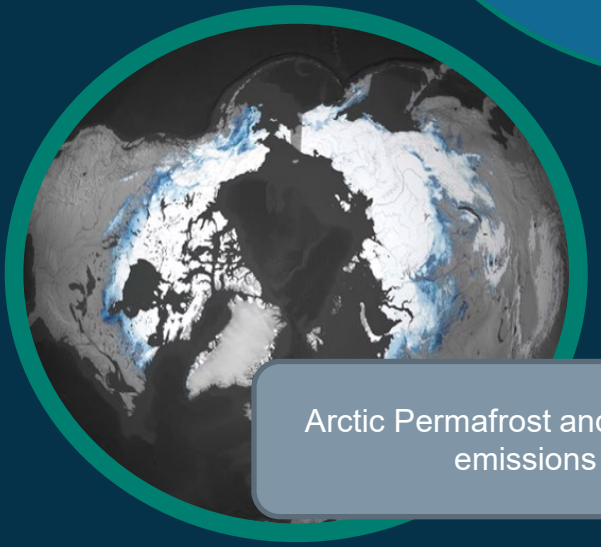

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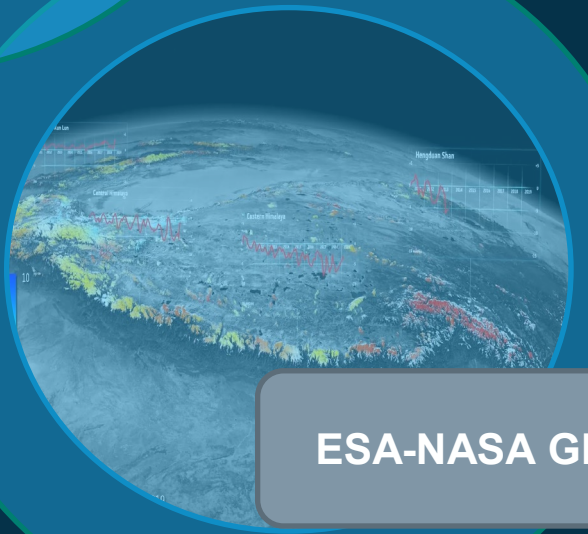


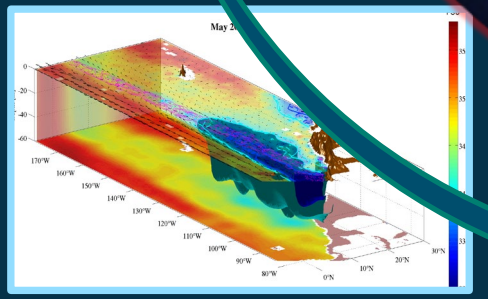
ESA-NASA GLAMBIE

Ocean Science Cluster Projects: Priorities

Ocean Health & Ocean ecosystems

Coastal Ocean incl. Land-Sea interactions

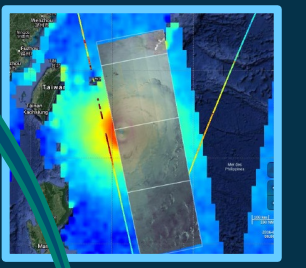
4D dynamics including air-sea interactions



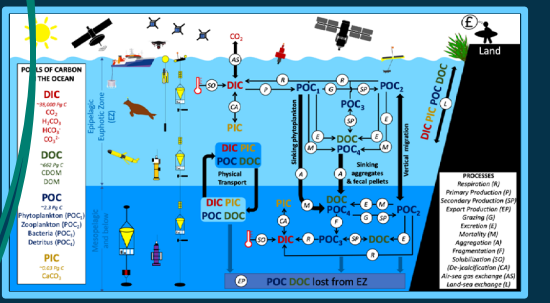
ESA OCEAN SCIENCE CLUSTER

EO SCIENCE FOR SOCIETY

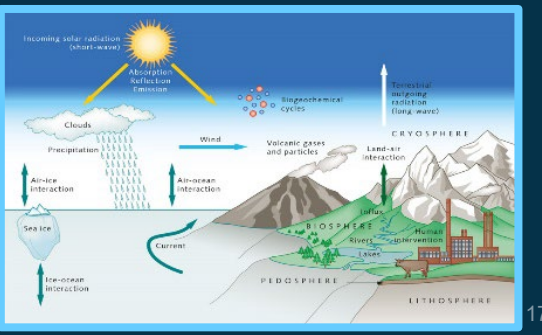
Ocean Extremes



Ocean Carbon



Ocean's role in Earth and Climate System

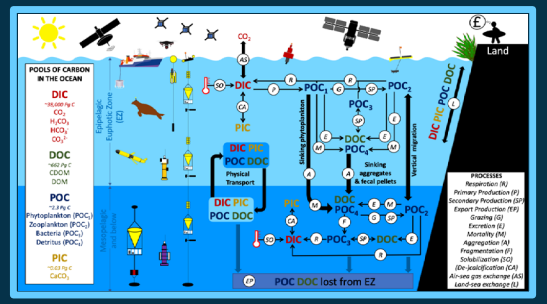


Ocean Sci r Projects
New Gen r Advanced EO-based Ocean Science

Dedicated collaborative opportunities with Horizon Europe

Coastal C
Land-Sea in

Ocean Carbon



Land-Ocean Interactions with priorities on:

- **Coastal Carbon Budget** – Advancing towards a HR integrated assessment of pools and fluxes including the biological pump, inorganic carbon, land-sea transports (river discharge) and sea-air fluxes in coastal areas by exploiting synergies offered by S2, OLCI, PACE, S1, SAR-Altimeters including SWOT.

- **Coastal Ocean Dynamics** – Novel HR multi-mission (SAR, Optical, SAR-Altimetry, SWOT) coastal products assessing currents, waves, and wave-currents interactions including dedicated OSSE experiments on coastal models (based on recommendations of coastal altimetry workshop);

- **Long-distance Transports and Ocean Biochemistry** – Assessment of the impact of major pyrogenic (fires) aerosols in ocean biochemistry with focus on extreme events and the impact of such events in productivity and carbon cycle.

ITT ~1.5MEuro Q3 2024

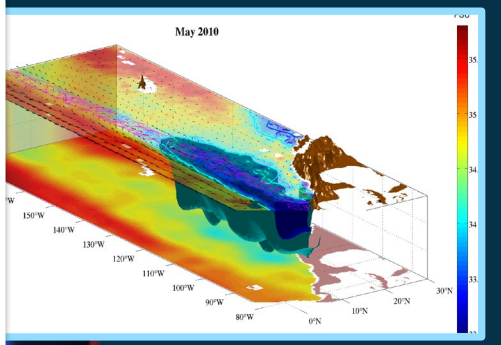
[SC2] Ocean Science Cluster Projects
New Generation of EOVs for Advanced EO-based Ocean Sci

Dedicated collaborative opportunities with Horizon Europe

Ocean Observations and Knowledge Gaps (4DOcean - 4-dimensional view on the world' ocean):

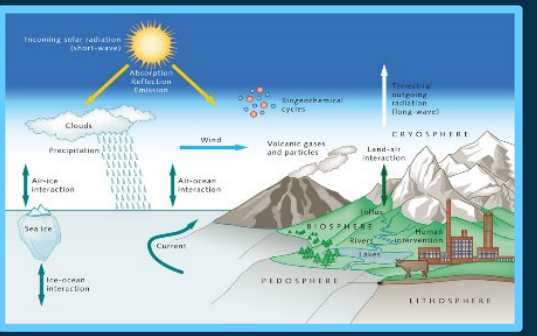
- **Multi-mission ocean dynamics** – Advanced multi-mission ocean-current products (SAR altimetry, Optical, SAR, SWOT) for key knowledge and observational gaps in ocean circulation processes (e.g., tropical currents, non-geostrophic regimes, thermohaline circulation,…) and assessment of impacts on 4D reconstruction of the physical ocean.

ITT ~1 MEuro Q2 2024



4D dynamics including air-sea interactions

Ocean's role in Earth and Climate System



Ocean Science Cluster Projects

New Generation of EOVs for Advanced EO-based Ocean Science

Ocean Health,
biodiversity & ecosystems

Dedicated collaborative Horizon Europe on Ocean Health and Biodiversity

Ocean Health and Biodiversity European Collaborative projects:

Call for collaborative projects aimed at advancing towards novel EO-based ocean biodiversity datasets for enhanced observation and understanding of Open Ocean and Coastal biodiversity and foster collaborative research efforts across complementary projects in Europe (e.g., ESA, EC and nationally funded) to undertake a join interdisciplinary assessment on the health of ocean ecosystems including on-set and drivers of change, vulnerability and responses to natural and anthropogenic pressures, specially under extreme conditions.

ITT (Set of parallel studies. 1.5MEuro Overall budget). Q3 2024

Ocean Science Cluster Projects

New Generation of EOVs for Advanced EO-based Ocean Science

Ocean Data Gaps – Towards a novel Ocean Integrated Dataset
Call for a collaborative project aimed at advancing towards novel integrated dataset of new and emerging products addressing ocean science from a holistic viewpoint. The goal is to bring together the latest advances from Ocean Science Cluster activities and additional science teams to create an advanced integrated co-collocated multi-variate dataset characterising the physical ocean and its biochemistry as a reference and benchmarking datasets for further studies and potential future exaptation at global scales.

The projects will focus on few key pilot areas: e.g., Atlantic and Mediterranean. The ambition is to build the most advanced EO-based data driven description of the ocean and its dynamics from latest EO satellite capabilities.

ITT ~800KEuro Q4 2024

[SC1] ESA Carbon Science Cluster Themes

Interfaces to Ocean and Cryosphere

Permafrost
Land-ocean transport

Analysis Tools

Benchmarking
Data stacks
Open Science Tools

Land use/dynamics impacts on pools and fluxes

Land dynamics, land use, Agriculture

Vegetation State and Processes

Carbon Stocks (Biomass)

Vegetation Processes – water/carbon

Model-data Interfaces

Extremes and Disturbances

Disturbance, Extremes and Vegetation stress

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[SC1] Terrestrial Carbon Constellation – A unique opportunity

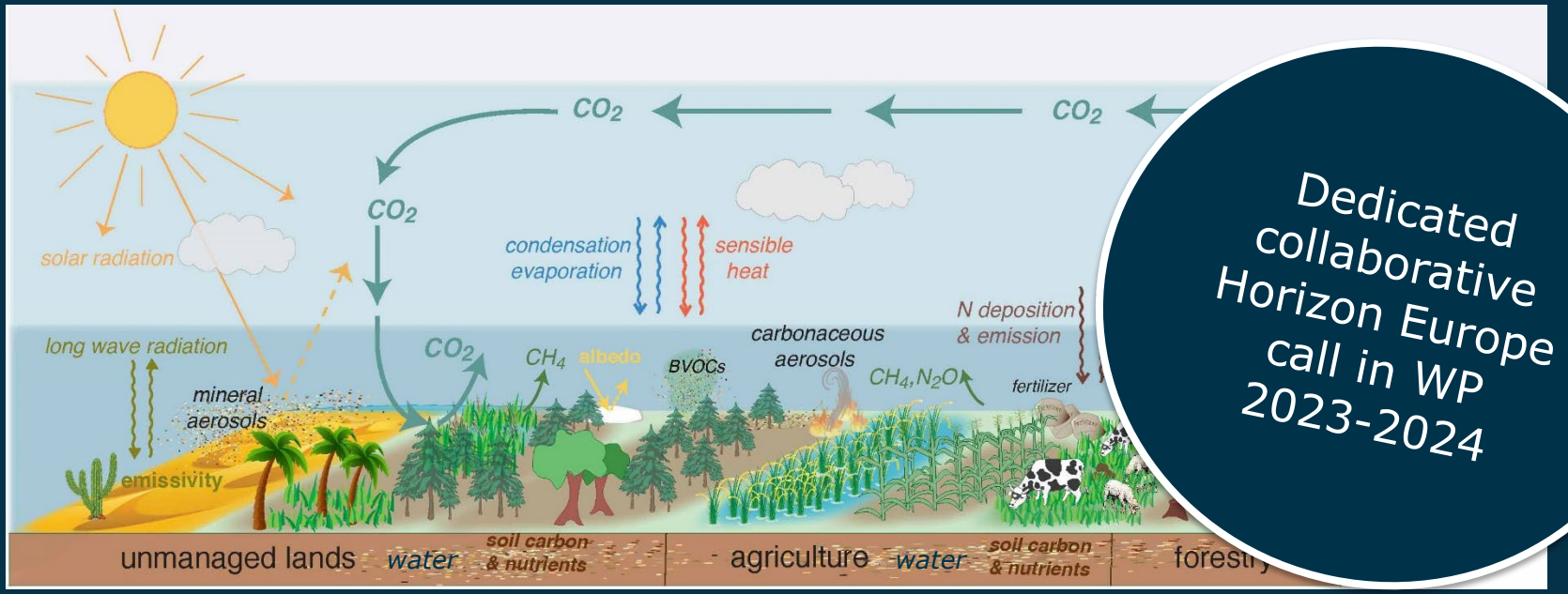






In the next few years, synergistic observations from Sentinels 1, 2, 3, S5P, FLEX, BIOMASS… together with missions from our international partners will open an **unique opportunity** to advanced towards a complete dynamic reconstruction of the terrestrial carbon cycle at high resolution;

In collaboration with NASA and EC



Dedicated collaborative Horizon Europe call in WP 2023-2024

ESA Carbon Science Cluster Upcoming Activities

HR Assessment of the Terrestrial Carbon Cycle – Phase 1
Development of an EO data-driven Assessment of the Carbon Budget taking advantage of the current and planned future launches of carbon-relevant missions to generate a high-resolution assessment of the carbon budget in coordination with EC-RTD Horizon Europe Call HORIZON-CL5-2024-D1-01-07.
Price range 1.5-2MEuro, Q3 2024

Terrestrial Carbon Budget Reconciliation Challenge – Coordination and Networking
Support coordination and networking activities between ESA, EC and NASA teams and projects on EO satellite contributions to RECCAP and GCB internationally by i) providing a satellite 'backbone' for global and regional GHG budget estimates, ii) key satellite-based updates on carbon cycle state and change, with appropriate latency between RECCAP exercises and iii) training for the next generation of carbon cycle scientists
Price range ~0.5MEuro, Q3 2024

Fires in the Carbon Cycle
End to end assessment of the role of fire in the carbon cycle in response to the International FLARE (Fire Science Learning Across the Earth System). In coordination with the Land-ocean transport ITT for the ocean components.
Price range ~0.5MEuro, Q3 2024

[SC4] Atmosphere Science Cluster

Air quality

Atmospheric Chemistry

Atmospheric Dynamics

Precipitation processes

Hydro-climatic extremes

Carbon, Methane, GHGs

Cloud-Aerosols Interactions

Atmosphere Science Cluster

EarthCARE+ (Set of innovation studies for a fast exploitation of the EarthCARE mission).

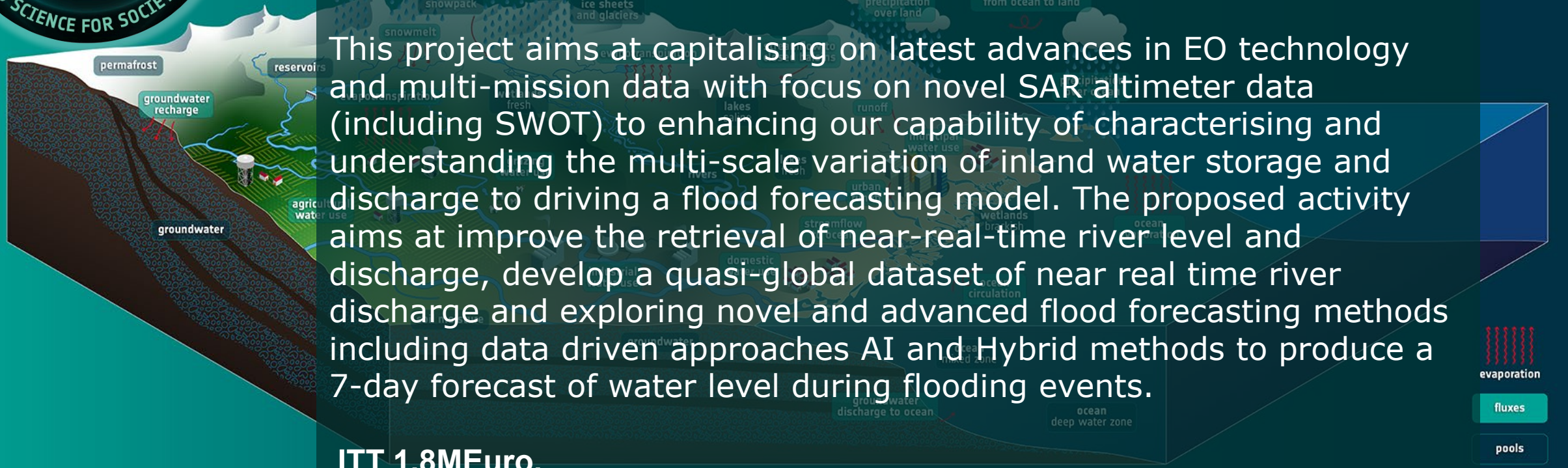
Set of parallel studies to foster a fast community effort to maximise the scientific impact of EarhCARE specially beyond its primary mission objectives. Studies shall ia at developing novel methods/products that may enlarge the product portfolio of EarthCARE as well as novel scientific studies that may maximise it scientific Impacts.

ITT 1.5-2MEuro range, Q3 2024

ESA Water Cycle and Hydrology Science Cluster

WATER CYCLE HYDROLOGY SCIENCE CLUSTER - ADVANCING FLOOD FORECASTING - EXPRO+
Tender Action Number: 1-12101

Closing date: 7/5/2024



This project aims at capitalising on latest advances in EO technology and multi-mission data with focus on novel SAR altimeter data (including SWOT) to enhancing our capability of characterising and understanding the multi-scale variation of inland water storage and discharge to driving a flood forecasting model. The proposed activity aims at improve the retrieval of near-real-time river level and discharge, develop a quasi-global dataset of near real time river discharge and exploring novel and advanced flood forecasting methods including data driven approaches AI and Hybrid methods to produce a 7-day forecast of water level during flooding events.

ITT 1.8MEuro.

ESA Water Cycle and Hydrology Science Cluster

Priorities 2024:

- **How big an impact do humans have on the water cycle?** Community effort to advance in the retrievals, validation and cross-comparison of a new generation of HR hydrological products (e.g., precipitation, soil moisture, snow water equivalent, irrigation, evapotranspiration, ground water…) and develop a quasi-global dataset over key basins around the world as a reference to undertake a scientific assessment of the impacts of human activities in the water cycle at resolutions compatible with decision making.

ITT ~1.5MEuro range, Q3 2024

HYDROSPACE Workshop 2023 Lisbon

Biodiversity

Dedicated collaborative Horizon Europe call in WP 2023-2024

Contribute to EU Biodiversity Strategy for 2030 by fostering a q capacity to observe, understand and predict the complex process loss and develop novel science based solution to enhance the c restoration of vulnerable ecosystems.

Interdisciplinary Assessment of Ecosystems Change, Vulnerability and Response to Natural and Anthropogenic Pressures in Terrestrial and Freshwater Ecosystems. Approx. ~1.5 MEuro Q3 2024.

- Novel set of EO-based products for the characterisation of ecosystems and ecosystem functioning for terrestrial and freshwater ecosystems.
- Better EO-based quantification of the impacts of the main direct drivers of biodiversity changes on terrestrial and freshwater ecosystems (i.e. land use changes, pollutions, climate change, invasive alien species and exploitation of natural resources).
- Enhanced understanding of the adverse impacts of climate change on biodiversity and ecosystem functioning, in particular on species and habitats at risk of climate-related extinctions in sensitive ecosystems.
- Improved understanding of the main changes of biodiversity and better prediction of their trajectories (e.g., elaboration of scientifically-sound scenarios of future changes in biodiversity for key terrestrial and freshwater ecosystems).

BIODIVERSITY SCIENCE CLUSTER
EO SCIENCE FOR SOCIETY

→ THE EUROPEAN SPACE AGENCY

[SC7] Soils and agriculture science

Dedicated collaborative Horizon Europe call in WP 2023-2024

Advancing in observations and process understanding in key domains of soils, food systems and agriculture:

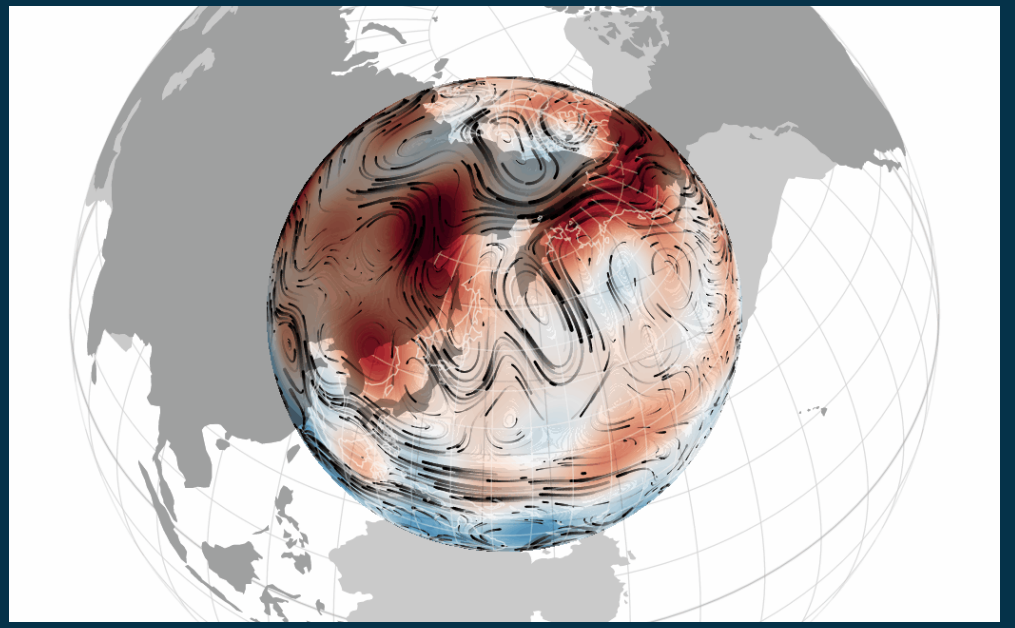
All activities will be based on dedicated experiments at field level combining multi-mission data and novel in-situ sensors

- **Integrated assessment (satellite, in-situ, modelling, AI) of vegetation/crop stress under multiple stressors; disentangle biotic and abiotic stresses, and advance towards early detection of the impact on plants of pests, land degradation and of hydro-climatic stressors and its combined effects (in preparation for FLEX).**

This activity will be coordinated with the SUP ITT on Foundational Synergistic Multi-Mission Integrated Experiment on water/soil & agriculture

ITT Approx. ~1 Million, Q3 2024

4D Earth: State of the Art 4D reconstruction of the solid Earth and its dynamic processes from core to crust



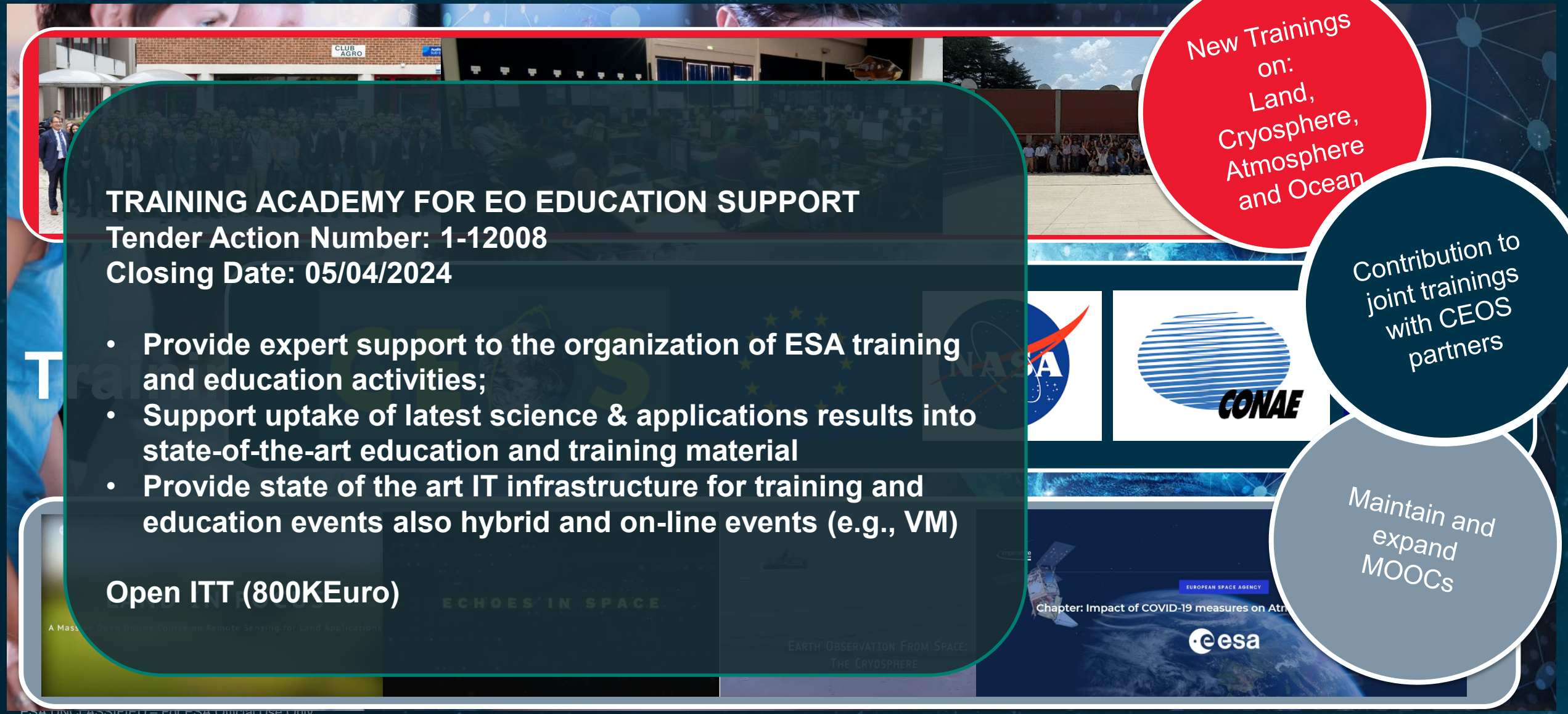
4DEarth DeepEarth team: Core flow from SWARM data and numerical models

Advance the science on Deep Earth dynamics along the scientific roadmap set by the 4D Deep Earth: Core study and focus on enhancing the prediction of the magnetic signal from stochastic and deterministic re-analyses as well as the use of short period dynamics in the core to constrain wide geodynamical issues (e.g., the mantle conductance in the deep mantle, the degree of stratification at the top of the core, the viscosity of the inner core).

Activities will be based on Swarm, the MSS Chinese mission recently launched, and potentially NanoMagSat

ITT ~500KEuro range, Q4 2024

Training the Next Generation of EO and Data Scientists



TRAINING ACADEMY FOR EO EDUCATION SUPPORT
Tender Action Number: 1-12008
Closing Date: 05/04/2024

- **Provide expert support to the organization of ESA training and education activities;**
- **Support uptake of latest science & applications results into state-of-the-art education and training material**
- **Provide state of the art IT infrastructure for training and education events also hybrid and on-line events (e.g., VM)**

Open ITT (800KEuro)

New Trainings on: Land, Cryosphere, Atmosphere and Ocean

Contribution to joint trainings with CEOS partners

Maintain and expand MOOCs

The new ESA Earth System Science Hub

A new science facility in ESRIN to boost the scientific output of ESA and its MSs through networking and partnerships, offering ESA as a hub for scientific cooperation, exchange of ideas and promoting a community response to major science challenges

Opportunities for collaboration in all ITTs