# CLIMATE CHANGE INITIATIVE
## *Programme status*

CLIMATE CHANGE INITIATIVE MID-TERM REVIEW

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# Today’s agenda

## Present (scientific) achievements addressing requirements from the main drivers and user community for CCI, leading to actionable climate information

- Theme (I) The Excellence Base
- Theme (II) Science highlights
- Theme (III) Linking climate observations and modelling
- Theme (IV) Knowledge Exchange
- CCI’s role in the international climate network

# What this presentation covers

- Organisational change
- CCI and Climate-Space programme implementation
- Working with partners
- Take home messages

# New organisation: we are now a division

## (ECSAT) Section on Actionable Climate Information

**www.climate.esa.int**

Focal point for climate activities in ESA | International climate network | Climate Change Initiative | Observer at IPCC and UNFCCC | Future Earth secondment | Host to WCRP's CMIP-IPO | Space for Green Future

## (ESRIN) Section on Long-Term Action

**www.gda.esa.int**

International Development Assistance: GDA, IFI | Work with DG-INTPA, FAO | COP LAC & COP Phil | Working with African Space Agency | Space for Green Future

**WCRP's CMIP Project Office**

# CCI & Climate-Space Programme Implementation

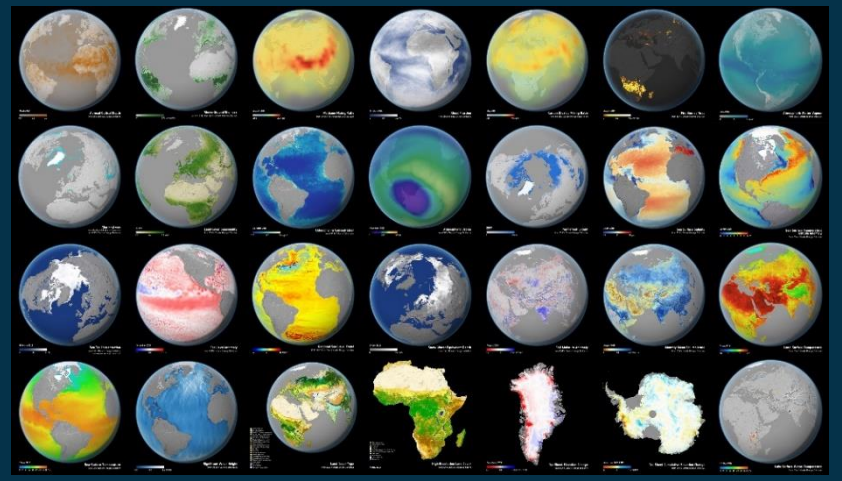
→ *Evolving user requirements leading to larger programme portfolio (GCOS, WCRP, IPCC etc)*

→ *Added focus on addressing global climate policy (UNFCCC)*

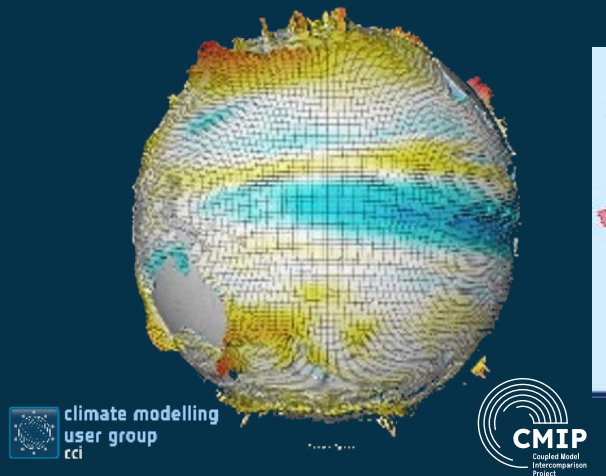
→ *Doubled annual financial envelop*

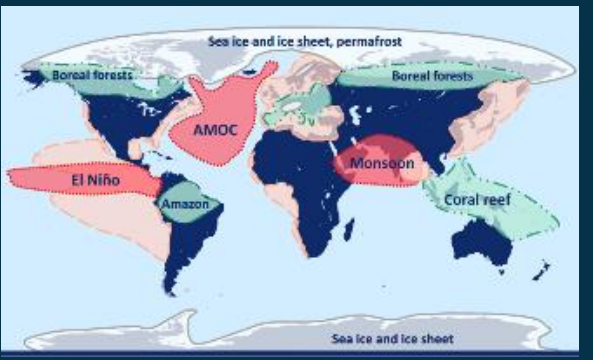
# EXPANDING ESA's CLIMATE CHANGE INITIATIVE

Duration: 2023-2029 | **Funding: phase ~87 Meuro ; phase 2 – part of FutureEO programme proposal at CM25**



COP21·CMP11
PARIS2015
UN CLIMATE CHANGE CONFERENCE




- Providing **physical evidence** for a changing climate, R&D for **operational climate services**
- Earth observation data support and verify the **UNFCCC Paris Agreement** pledges
- **Linking observations with modelling** provides trustworthy climate predictions and projections
- **Cross-ECVs and Tipping Points**

+ **Knowledge Exchange** (data management and curation, comms, outreach, education)

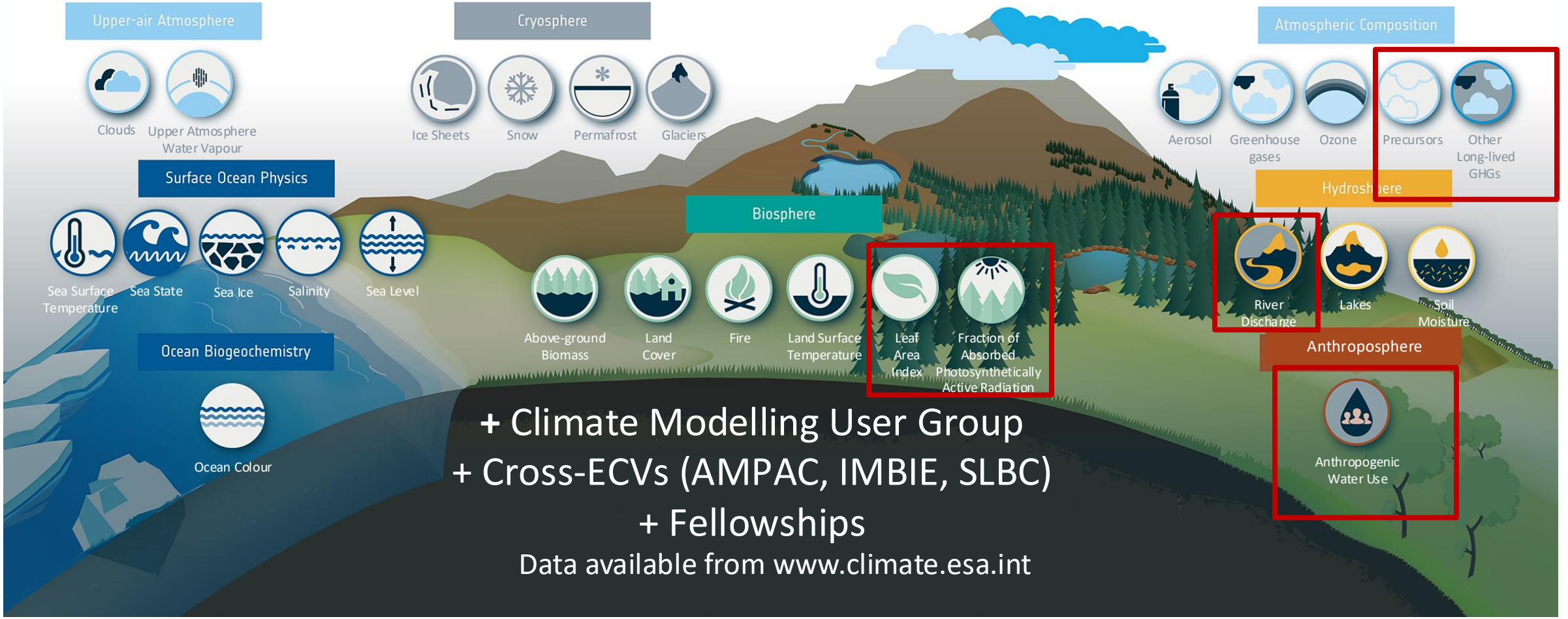
## Policy drivers for CLIMATE-SPACE

- GCOS & WCRP requirements
- UNFCCC Paris Agreement
- IPCC Assessment Reports
- New users: tipping points, biodiversity & ecosystems, health

# ESA's CLIMATE CHANGE INITIATIVE

GCOS defined **55** Essential Climate Variables | **36** benefit from space observations | **27** generated by ESA Climate Change Initiative

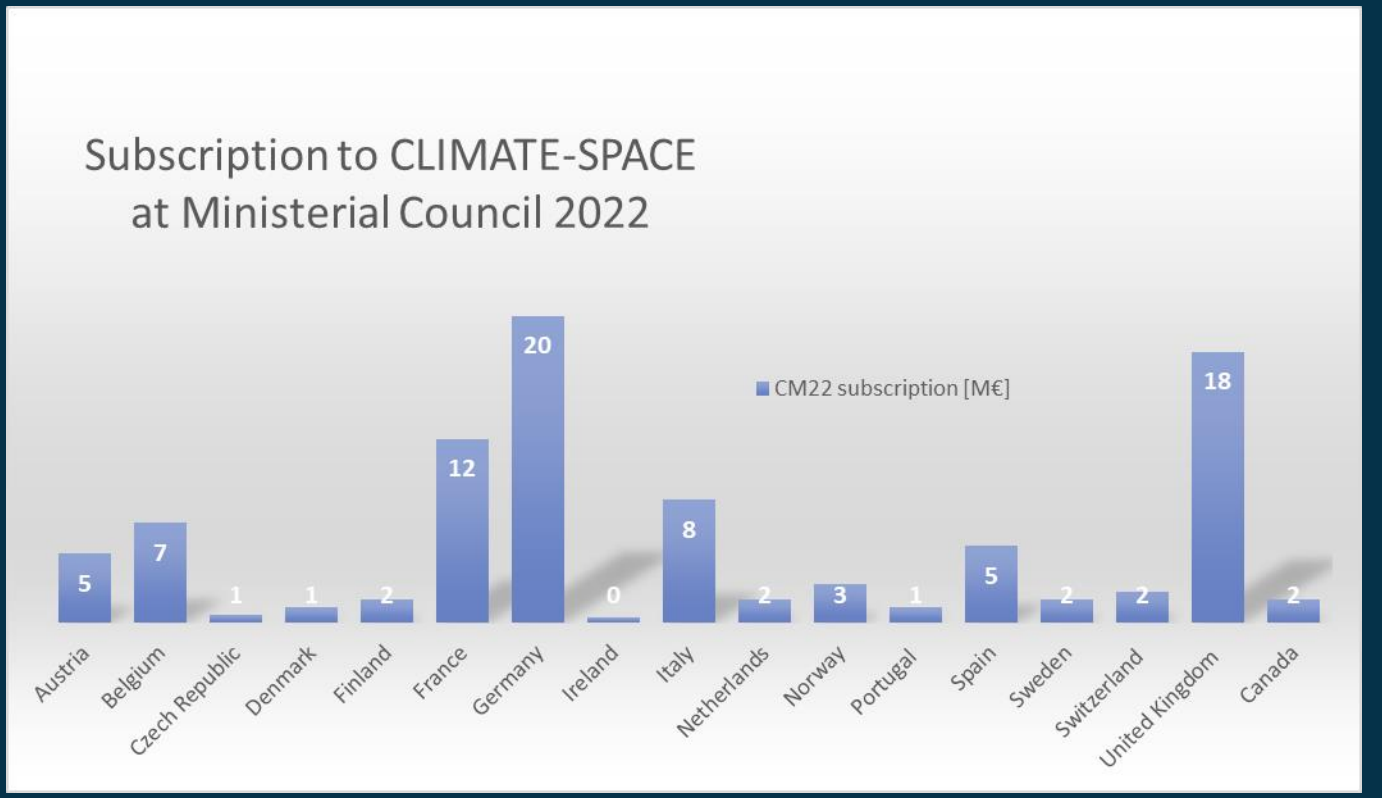
**Newly added ECVs based on requirements from operational climate services, GCOS IP, focus on UNFCCC Paris Agreement**



# CLIMATE-SPACE – extended and expanded support

## A few observations

- Over-subscription additional ~ 6 M€ (total ~87 M€)
- Larger financial envelop
  - CCI+ ~8 M€ /y
  - CLIMATE-SPACE 14 M€ /y
- National funding distribution largely maintained
- New participating states: CZ and IE



# Status of procurements

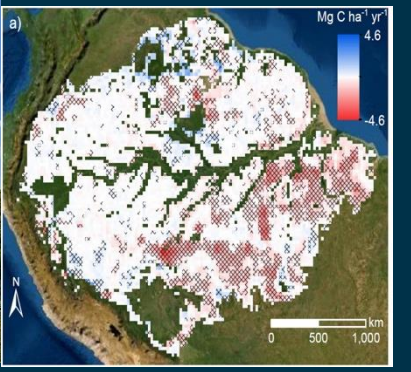
| Activity<br>Ongoing with contracts<br>In selection/ about to be announced<br>Upcoming procurements | Type of procurement | Schedule (ITT release) | Status | Value per contract [M€], multiple contracts |
|---|---|---|---|---|
| GHG emissions | Open competitive tender | Q3 2023 | KO Q2 2024 | ~3 |
| Cross-ECV | Open competitive tender | Q1 2024 | KO Q4 2024 | ~ 0.5-2 |
| Knowledge Exchange | Open competitive tender | Q1 2024 | KO Q3 2024 | ~ 5 |
| Global land carbon budget and its attribution to regional drivers | Open competitive tender | Q4 2023 | KO Q2 2024 | ~ 3 |
| Extension of existing ECV contracts | Direct negotiation | Q1 2024 to 2025 | On-g | |
| Tipping Points | Open competitive tender | Q1 2024 | K | |
| Linking Observations and Models | Open competitive tender | Q2 2024 | I | |
| New ECVs | Open competitive tender | Q2-Q3 2024 | In | |
| Regional climate process study, field campaign over the Amazon | Direct negotiation | Q3-Q4 2024 | O | |
| Climate Change & Health | Open competitive tender | Q4 2024 | ITT | |
| Climate Change & Cities | Open competitive tender | Q1 2025 | ITT prep | |
| Monitoring Climate Adaptation | Open competitive tender | Q1 2025 | ITT prepared | |
| Biodiversity-Climate Study | Open competitive tender | Q1 2025 | ITT prepared | ~ 0.6 |

**Majority of procurements as open competitive tender - Large number of procurements in 2024/25 - High quality proposals received**

# RESPONDING TO GLOBAL CLIMATE POLICY

## *UNFCCC Paris Agreement*

- Based on results from RECCAP-2 and working with operational climate services
- New contracts on
  - Global land carbon budget and its attribution to regional drivers
  - GHG Emission (MEDUSA) Methane hotspots
  - Support to CEOS AFOLU
  - Amazone campaign




Bastos, A., Ciais, P., Sitch, S. et al. On the use of Earth Observation to support estimates of national greenhouse gas emissions and sinks for the Global stocktake process: lessons learned from ESA-CCI RECCAP2. Carbon Balance Manage 17, 15 (2022). https://doi.org/10.1186/s13021-022-00214-w

# X - ESSENTIAL CLIMATE VARIABLES

## *Addressing GCOS & WCRP requirements*

**Xfires** Modelling multidimensional causes and impacts of extreme fires in the climate system through X-ECV analysis; Prime: U of Exeter; U de Alcala, UVSQ, U of Wageningen, U Catholique de Louvain, U of Leicester, TU Wien, CNR, TUD, BIRA

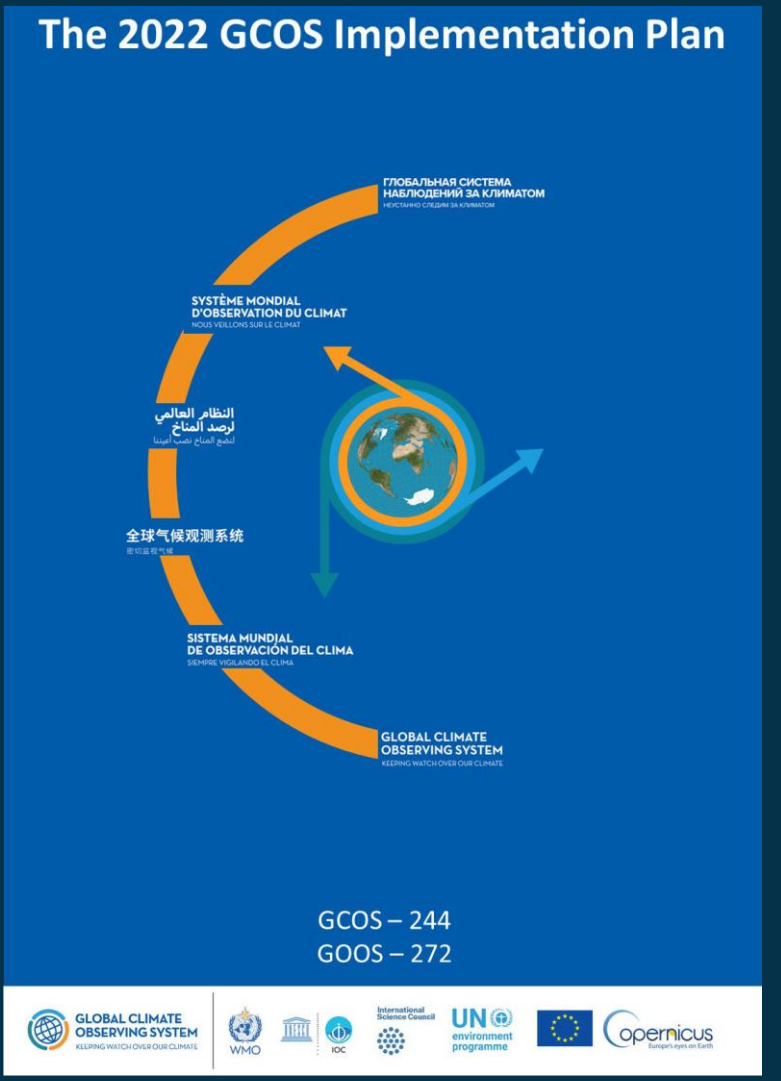
**GLANCE** - The AGricultural Land AbandoNment and ClimatE change impacts on the water, energy and vegetation carbon cycles in the Mediterranean region; Prime: Politecnico di Milano; CNR, TU WIEN, Ghent U, CSIC

**SATACI** - SATellite observations to improve our understanding of Aerosol-Cloud Interactions: Prime: Rayference; DLR, DWD, UKRI, Met-Norway

**ARCFRESH** Improve current estimates of lateral freshwater fluxes between land, sea ice, and ocean in the Arctic. Rime: DTU; ICCC, Enveo, Met-No, NERSC, NPL, SMHI, S&T, Uni Bretagne, EOLA

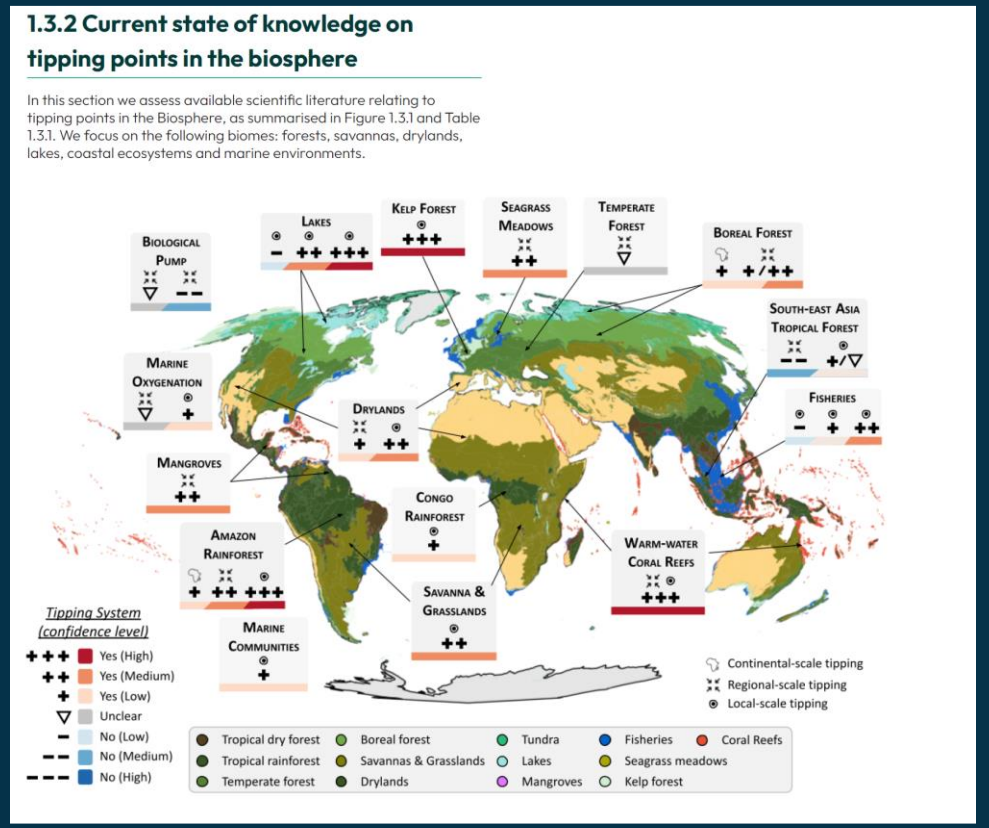
**Karakoram** Anomaly investigates why glaciers in the Karakoram region behave differently from nearly all other regions in the world. Prime: U of Zurich; Uni Oslo, ETH Zurich, Enveo, Gamma Remote Sensing, Uni Bristol, DWD, CLS

**MOTECUSOMA** - Monitoring The Energy Cycle for a better unterstanding of climate change; Prime: Magellium; CNRS, U Reading, U Leicester, DMI, NOC, Met Office UK, TU Wien, LEGOS



# TIPPING POINTS

## *Focus on early warning signals*
## *Addressing IPCC gap analysis*




Global Tipping Points | 1.2.1 Introduction detailed requirements analysis through ISSI forum 2023/24

**TIME** Tipping Points and Abrupt Changes in Marine Ecosystems
Prime: Plymouth Marine Laboratory (UK), U. Exeter (UK), Institut de Ciències del Mar (ICM-CSIC, Spain).

**TiPSOO** Tipping Points in the Southern Ocean Overturning
Prime: Albavalor S.L.U (Spain), U. Southampton (UK), U. Catholique de Louvain (Belgium).

**CryoTipping** Targets marine ice sheet instability, Thwaites glacier, Antarctica.
Prime: U. Northumbria (UK), German Aerospace Center (Germany), ENVEO Environmental Earth Observation Information Technology GmbH (Austria).

**PREDICT** Predicting Resilience and Early Detection of Impending Climate Transitions. Prime: U. Exeter (UK), U. Leicester (UK), Centre for Ecology & Hydrology (UK)

**SIRENE** Satellite Information for Resilience Monitoring and Early warning of Ecosystem Tipping Points
Prime: Technical U. Munich (TUM), Technical U. Vienna (TUW, Austria), NPL Management Ltd (UK), U. Leipzig (Germany), U. Lisbon (Portugal).

**RESETLakes** Investigate lakes as tipping systems in their catchment area using EO data and process-based models
Prime: Eawag (Switzerland), U. Bangor (UK), Environment & Climate Change (Canada), U. Tuebingen (Germany)

# IPCC SYNTHESIS REPORT

Release date: 20 March 2023


Re-emphasise the call for action in terms of taking measures for adaptation and mitigation and identifies opportunities for both.

The report warns that

- *"Currently insufficient action to limit warming to even 2deg C"*
- *"Global GHG emissions must half by 2030, to stay below 1.5"*
- *"For any given future warming level, many climate-related risks are higher than assessed in AR5 and projected long-term impacts are up to multiple times higher than currently observed (high confidence)"*
- *"Some future changes are unavoidable and/or irreversible but can be limited by deep, rapid and sustained global greenhouse gas emissions reduction."*

**Note: Increased use of satellite data and new methodology in AR6**

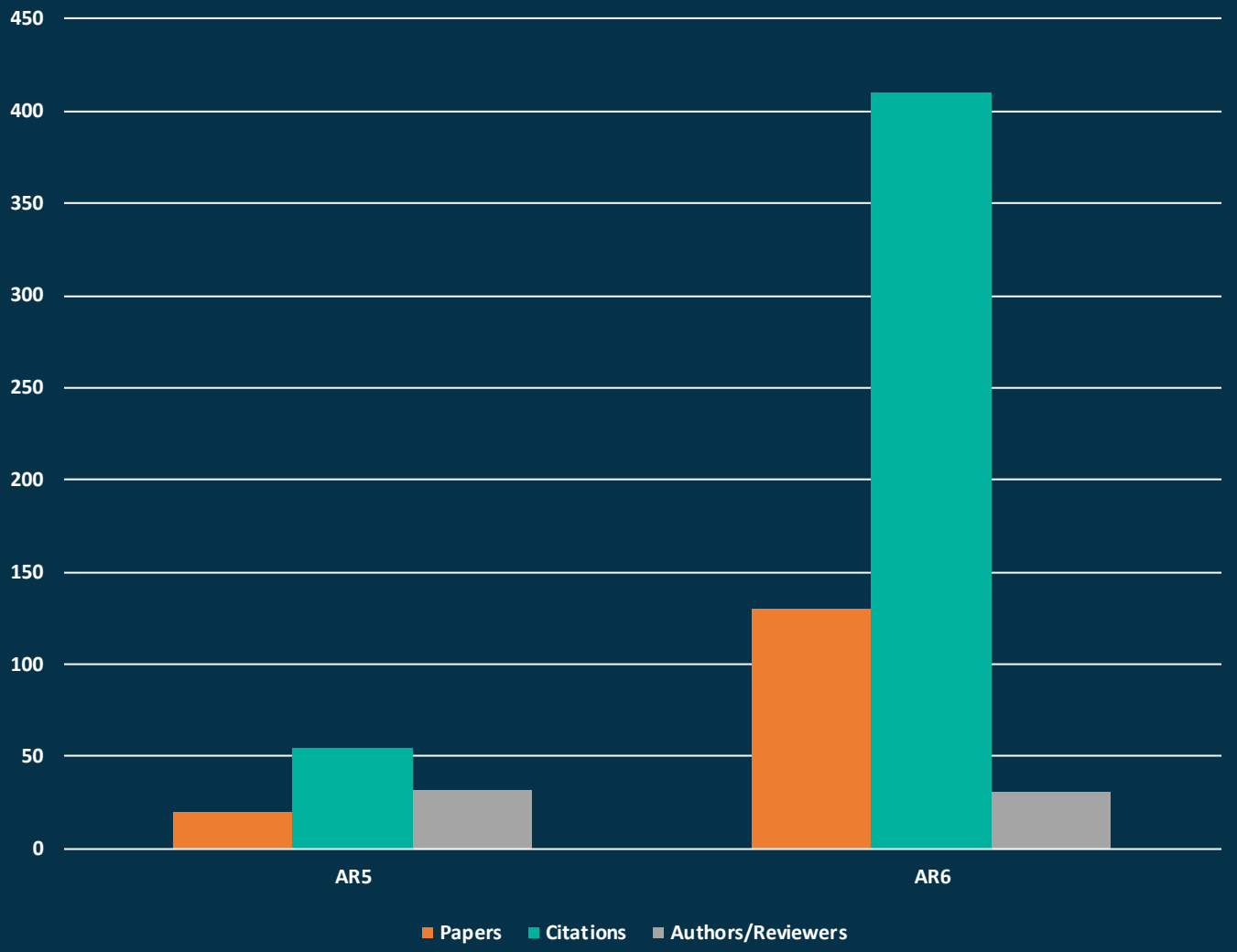
# ESA CCI CONTRIBUTION TO IPCC AR6

**AR6 contribution significant**

- **7** Lead authors
- **15** contributing authors
- **10** expert reviewers
- **130** research papers
- **410** in-text citations

**Major contribution to headline messages**

**Increased impact on WG II and III reporting based on CCI results**

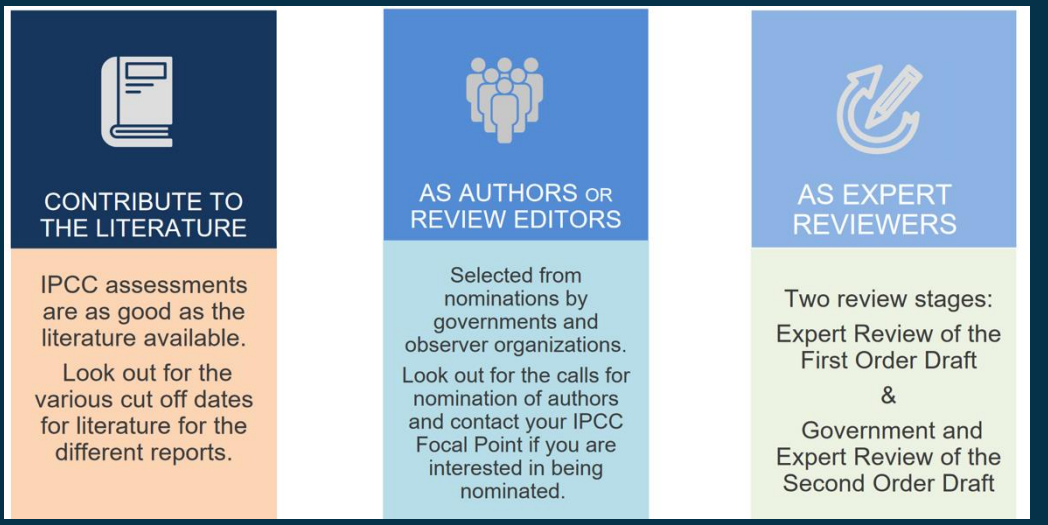


# Engaging with the IPCC 7th Cycle


The **IPCC Seventh Assessment Cycle (AR7) started in 2023**; Not yet decided, expected to be shorter, to have the main WG reports ready for the next GST (by end of 2028). WG outlines will be scoped in December 2024.

**ESA CCI is observer to IPCC** since 2019 – taking pro-active role in aligning to AR7 focus.

- **Special Report on Cities**: Outline approved (to be published in March 2027): ESA CCI & Climate-Space will release dedicated call for supporting special report in Q1 2025.
- **Methodology Report on Calculating emissions for Short-Lived Climate Forces** (SLCFs), to be published Q3-4 2027: CCI to assess supporting action
- **Methodology Report on CDR, CCS and CCU**: Outline scoped but not yet approved (Jan 2025)
- Ongoing discussions how ESA Climate & Long Term action Division can **support data infrastructure in the IPCC** including CCI data, among others.




WG = Working Group
CDR = Carbon Dioxide Removal
CCS = Carbon Capture & Storage
CCU = Carbon Capture & Utilization

# ISSI Forum on Earth Observation for Adaptation

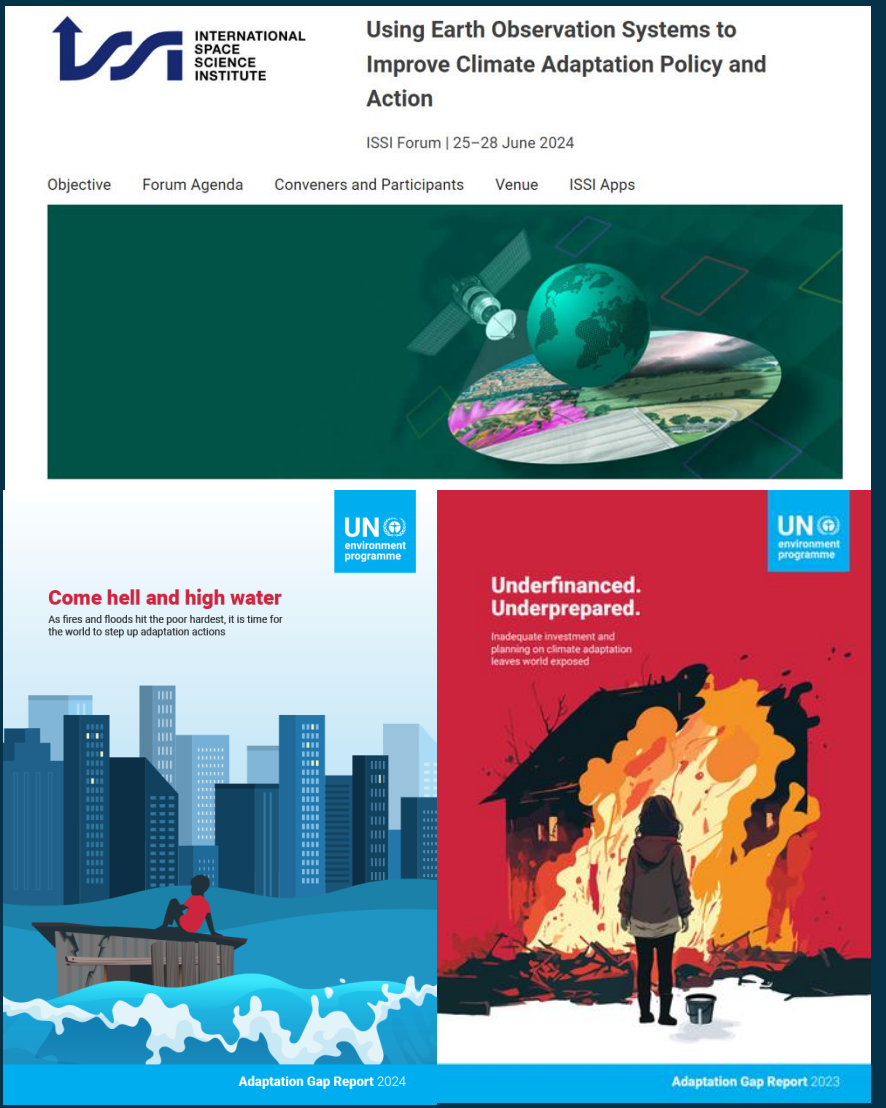
**Organisers** ESA, NASA, World Adaptation Science Programme (WASP), Griffiths University Australia, ISSI.

**Focus** **The Global Goal on Adaptation (GGA)**

> *"By 2030, all Parties have designed, established and* ***operationalized a system for monitoring, evaluation and learning for their national adaptation efforts*** *and have built the required institutional capacity to fully implement the system."*

- The GGA will establish a list of indicators for understanding climate adaptation by Dec 2025.
- The forum discussed
  - what types of adaptation indicators can be best supported by EO
  - knowledge gaps to further enhance EO adaptation R&D

**Output** White paper is now currently being drafted. Aim for release end 2024



# Upcoming open competitive calls 2024-2025

## Climate Change & Health

Q4 2024, 2MEUR available
<500k or 1M per project

Exploit ECV data to assess climate extremes, risk and infectious diseases.

## Climate Change & Cities

Q1 2025, 1.8MEUR available
<600k per project

Exploit ECV data to assess urban climate change to support the IPCC SRCities.

## Monitoring Climate Adaptation

Q1 2025, 2MEUR available
<500k or 1M per project

Case studies using & developing ECV data to measure & monitor adaptation & its impacts

## Biodiversity-Climate Studies

Q1 2025, 1.8MEUR available
<600k per project

Exploit ECV data for studies of biodiversity & ecosystem change & their interactions with climate & the carbon cycle.

# ESA CCI Research Fellowships *(Cohort 2021 and 2023)*


**Topics**

2021:

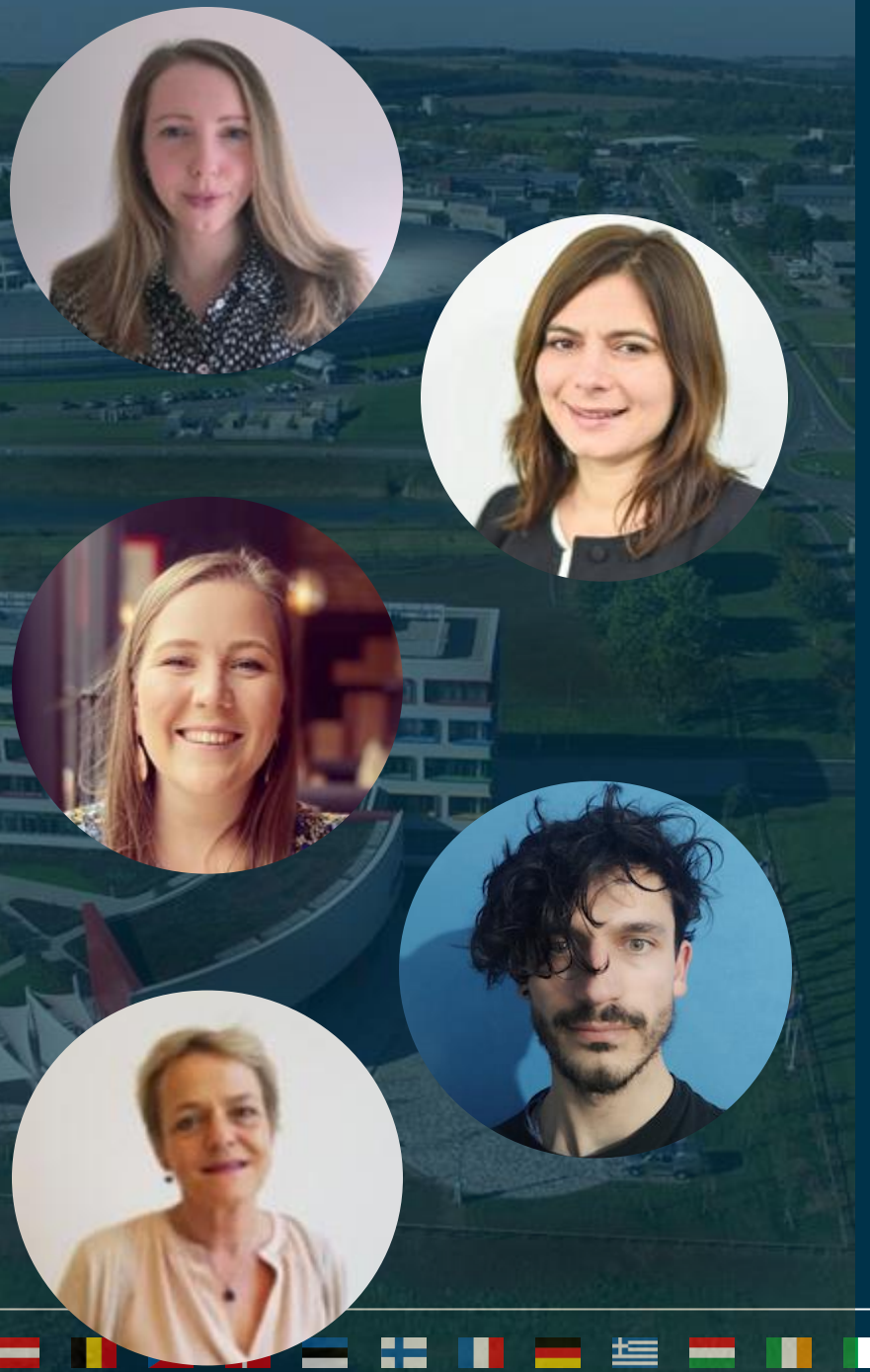
- Fingerprinting approach for regional sea level budgets
- Synoptic controls on surface meltwater across Antarctic ice shelves
- Drydown Evaluation: SSM and LST
- Marine heat wave events
- AridLand
- Permafrost Vulnerability
- Climate change related ecosystem shifts in Lakes
- Global and local atmospheric response to the underlying coupled ocean
- Organic Matter runoff and its fate in a warming Arctic
- Trophospheric Ozone and Climate Interactions
- Carbon emissions and uptake from vegetation change in the tropics

2023:

- Subseasonal-to-seasonal drought and heatwave evolution via land-atmosphere interactions
- Unraveling the thermodynamic and dynamic contributions to arctic sea ice thickness change using multiple climate data records and climate models.
- Probabilistic reAnalysis of the Terrestrial Cryosphere by History-matching
- Water Under Snow Cover: multi-frequency microwave
- SnowHotspots2023
- AI4GHEObs

# CCI & Climate-Space Programme Implementation

→ *Working with partners in the international climate network*
→ *Stakeholder feedback from the Climate Science Advisory Board*



# The CMIP International Project Office

- Coupled Model Intercomparison Project (CMIP) has expanded to a point where coordination of its elements requires dedicated secretariat support.
- Focal point for leading national and international entities in climate modelling
  - Emphasises role of EO datasets for model evaluation
  - Brings EO and modelling communities closer
- Main contributor to climate prediction and projection in IPCC
- ESA's Climate Office hosts the CMIP-IPO since March 2022
- IPO team consists of:
  - Director (Eleanor O'Rourke)
  - Programme Manager (Briony Turner)
  - Science & Communications Officer (Beth Dingley)
  - Technical Officer/Software Engineer (Daniel Ellis)
  - Team support (Alice Kolesnikov)

HE SPACE it's all about people

esa

CMIP



Staff from HE Space Operations under contract to ESA

# ESA contribution to forcing data sets

The forcing teams aim to provide:

- Near term (~6 mo): v0 new historical forcing (1850-2022), or updates to the CMIP6 forcing (2014-2022)
- CMIP7 (~2 y): A complete updated forcing dataset incorporating new science, timings coordinated with CMIP7 modelling groups
- Ongoing: “Operational” updates to the historical forcing data, at least annually.

ESA’s contribution:

- Provide research and development support for forcing data that are ESA member state led and have the potential for ESA EO data to make a significant contribution
- Projects will prepare forcing data for CMIP7, to maximise the contribution of EO data in the historical forcings, and prepare for operational provision of
  - Ozone
  - GHG Concentrations
  - Sea surface Temperature
  - Volcanic aerosol concentrations and emissions

In-kind support across the forcing teams to support interoperability, data and documentation standards.

Coordination with other modelling groups to maximise impact (e.g. for volcanic forcing, coordination with ERA6/SEAS6 teams)

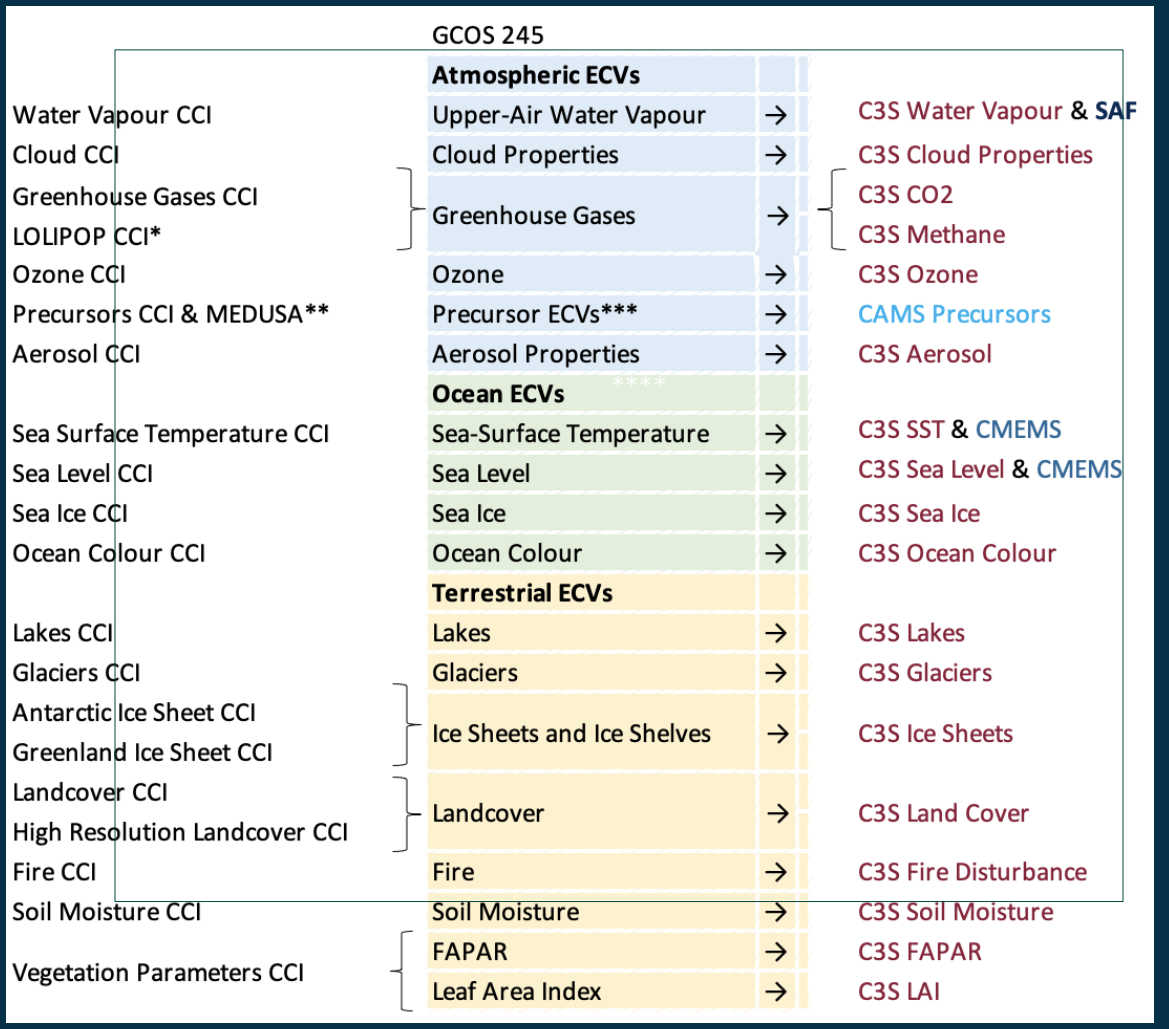
# Working with operational services


- Provision of CDRs
- Coordination of R&D activities
- Collaboration on pre-operational developments

## CCI-C3S cooperation agreement

- Regular interactions with C3S, CAMS, (CMEMS and CGLS) providing R&D and pre-ops support
- ESA presentations at C3S and CAMS general assemblies
- Membership on science advisory boards (CSAB, MEDUSA)
- Coordination as part of 4Es meeting on European Capacity for Climate Observations – report being drafted/ LPS2 agora
- Common topics
  - Supporting DG-CLIMA
  - CMIP: prep for AR7 and forcing data provision
  - Adaptation and health

# CCI R&D in Operational Services



| CCI Project | GCOS ECVs | | Operational Service |
|---|---|---|---|
| | GCOS 245 | | |
| | **Atmospheric ECVs** | | |
| Water Vapour CCI | Upper-Air Water Vapour | → | C3S Water Vapour & SAF |
| Cloud CCI | Cloud Properties | → | C3S Cloud Properties |
| Greenhouse Gases CCI | Greenhouse Gases | → | C3S CO2 |
| LOLIPOP CCI* | | | C3S Methane |
| Ozone CCI | Ozone | → | C3S Ozone |
| Precursors CCI & MEDUSA** | Precursor ECVs*** | → | CAMS Precursors |
| Aerosol CCI | Aerosol Properties | → | C3S Aerosol |
| | **Ocean ECVs** **** | | |
| Sea Surface Temperature CCI | Sea-Surface Temperature | → | C3S SST & CMEMS |
| Sea Level CCI | Sea Level | → | C3S Sea Level & CMEMS |
| Sea Ice CCI | Sea Ice | → | C3S Sea Ice |
| Ocean Colour CCI | Ocean Colour | → | C3S Ocean Colour |
| | **Terrestrial ECVs** | | |
| Lakes CCI | Lakes | → | C3S Lakes |
| Glaciers CCI | Glaciers | → | C3S Glaciers |
| Antarctic Ice Sheet CCI | Ice Sheets and Ice Shelves | → | C3S Ice Sheets |
| Greenland Ice Sheet CCI | | | |
| Landcover CCI | Landcover | → | C3S Land Cover |
| High Resolution Landcover CCI | | | |
| Fire CCI | Fire | → | C3S Fire Disturbance |
| Soil Moisture CCI | Soil Moisture | → | C3S Soil Moisture |
| Vegetation Parameters CCI | FAPAR | → | C3S FAPAR |
| | Leaf Area Index | → | C3S LAI |

Climate Change Service

Copernicus Marine Service

Atmosphere Monitoring Service

SAF
The EUMETSAT Network of Satellite Application Facilities

*LOng-LIved greenhouse gas PrOducts Performances
** Precursors for aerosols and ozone CCI
Methane Emissions Detection Using Satellites Assessment
*** Precursors supporting the aerosol and ozone ECVs
**** In discussion with CMEMS re. Sea State

The R&D of **21** CCI projects has been taken up by operational services.

# CCI-to-C3S Data Traceability – API Live

climate.esa.int/cci-to-c3s

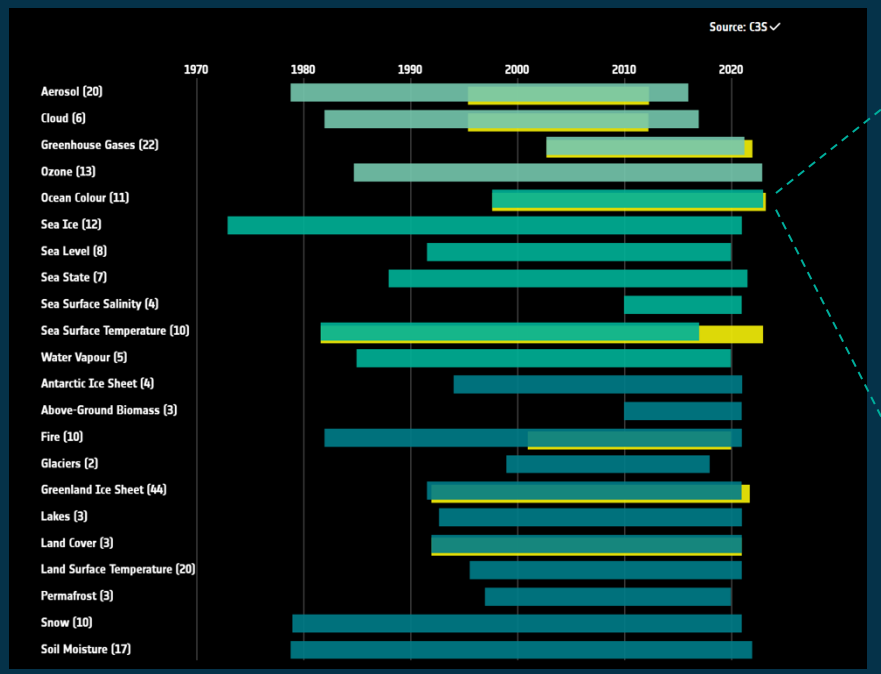
A dataset-level metadata mapping from CCI ECVs to C3S ECVs. Phase 1 live.

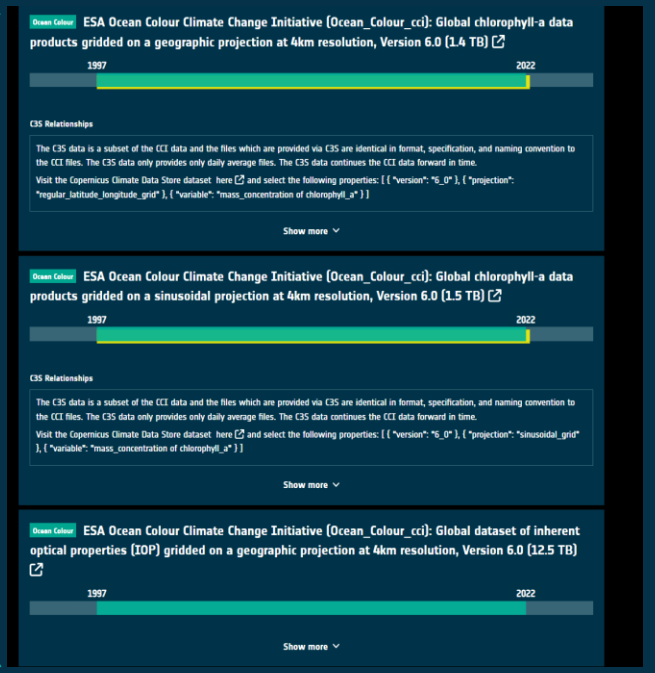
Informs users on the dataset relationship between CCI ECVs & C3S equivalents

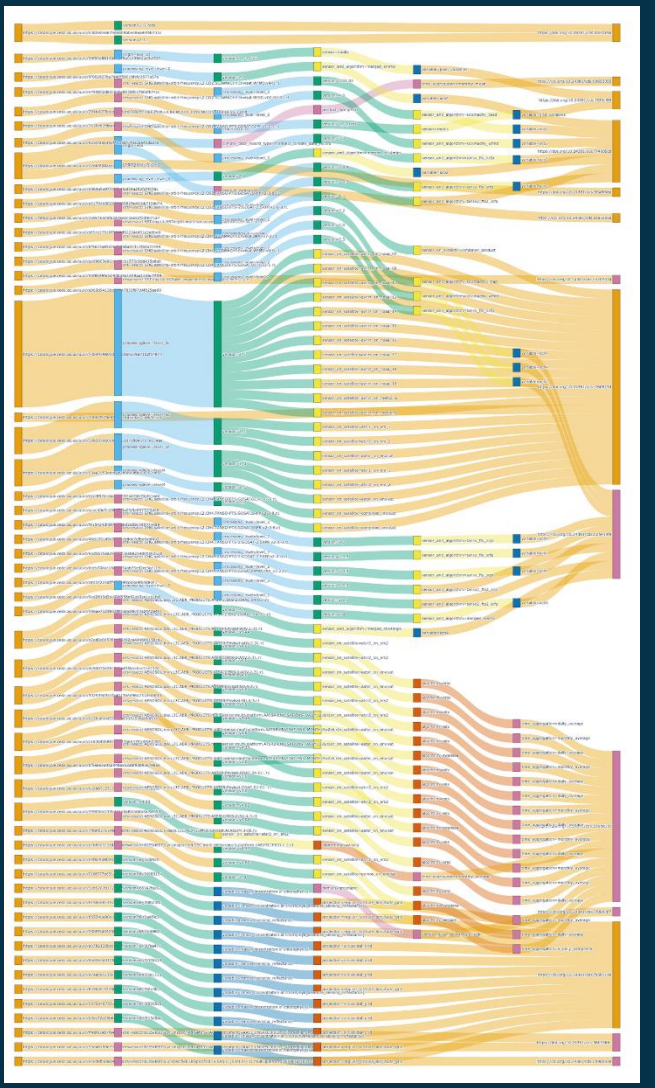
It is a complex mapping. 16 types of ECV dataset-level mapping relationship.

Informs data users via an API, Sankey diagram and soon the CCI Dashboard.

Also soon, similar mapping from CCI ECVs to EUMETSAT equivalents.

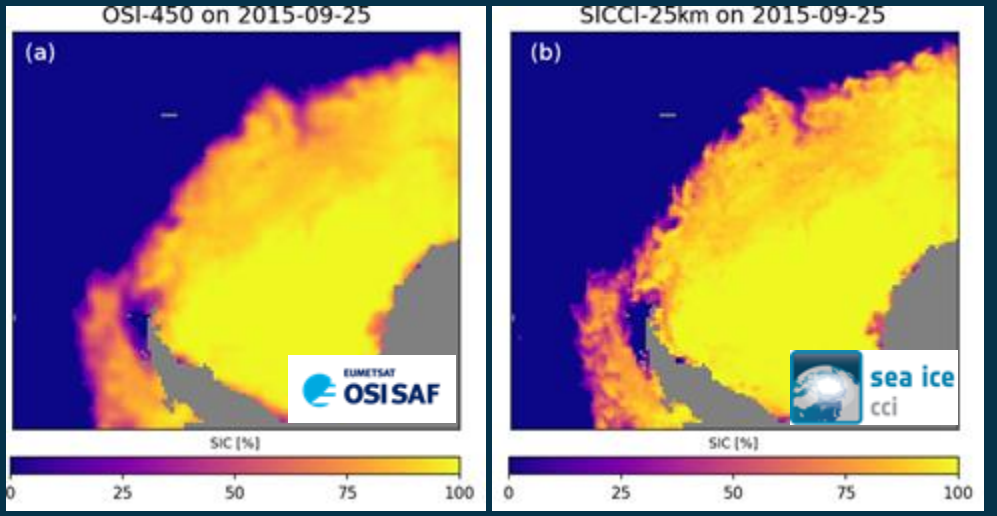


# Working with EUMETSAT

- International collaboration as part of CEOS/CGMS WGClimate, including gap analysis of the ECV Inventory, use case activities, and the GHG task team
- ECV evolution: coordination, complementarity, synergy and collaboration
  - R&D, pre-ops development
  - Interoperability and data standards
- Link to the scientific and climate application community
- Collaborate with the climate modelling and observation communities
- Link to the WCRP's CMIP project office hosted by ESA
- Link to the WCRP's ESMO project
- Collaboration on DestinE
- EUMETSAT (P.Ruti) is a member of Climate Science Advisory Board




Close collaboration on algorithm development and extension of data records: OSI SAF (left) and CCI (right) sea ice concentration maps (Weddell Sea

# Committee for EO Satellites

## WGClimate-22 & GHG Task Team

**Event Dates:** February 11th - 13th, 2025

**Register here**

Week at a glance

| | Tuesday, 11 February | Wednesday, 12 February | Thursday, 13 February |
|---|---|---|---|
| Morning | Opening Session<br>Invited presentations | UNFCCC & the Global Stocktake<br>Partnerships | WGClimate: GCOS Topics<br>GHG-TT: System Development; Stakeholder Engagement<br>Future activities |
| Afternoon | WGClimate: ECV Inventory; Climate Data Records<br>GHG-TT: Best Practices, Sensor Development; Calibration and L1 Products, L2 Products and Validation, Flux Inversion Modelling | National emission estimates | Closing session |
| Evening | Reception at the ECSAT conference center – Celebrating WGClimate at its birthplace | Hosted dinner – in central Oxford | |

Hosting – and active member of - CEOS WGClimate and GHG Task Force in Feb 2025 at ECSAT

Dedicated sessions on

- Global Stocktake and national emission quantification
- GCOS implementation plan 2022 – space agency actions
- Coordination of ECV evolution
- Support to CEOS AFOLU

# Interaction with DG-CLIMA in support of S4GF

- EC and ESA joint initiative on Space for Climate Action signed in autumn 2023
- Workshops focussing on thematic areas
    - Global emission reporting and Solar Radiation Modification
    - Decarbonization, cities and transport
    - Adaptation mission
    - LULUCF, carbon removal and forestry
- Tangible collaborations being discussed
- Secondee started in May 2024


# Future Earth


United Nations Framework Convention on Climate Change

SUSTAINABLE DEVELOPMENT SOLUTIONS NETWORK

ipcc

ipbes Science and Policy for People and Nature

GEO GROUP ON EARTH OBSERVATIONS

esa

CGIAR Climate Change, Agriculture and Food Security CCAFS

Global Sustainability Scholars

BELMONT FORUM

IAI INTER-AMERICAN INSTITUTE FOR GLOBAL CHANGE RESEARCH

MOUNTAIN RESEARCH INITIATIVE

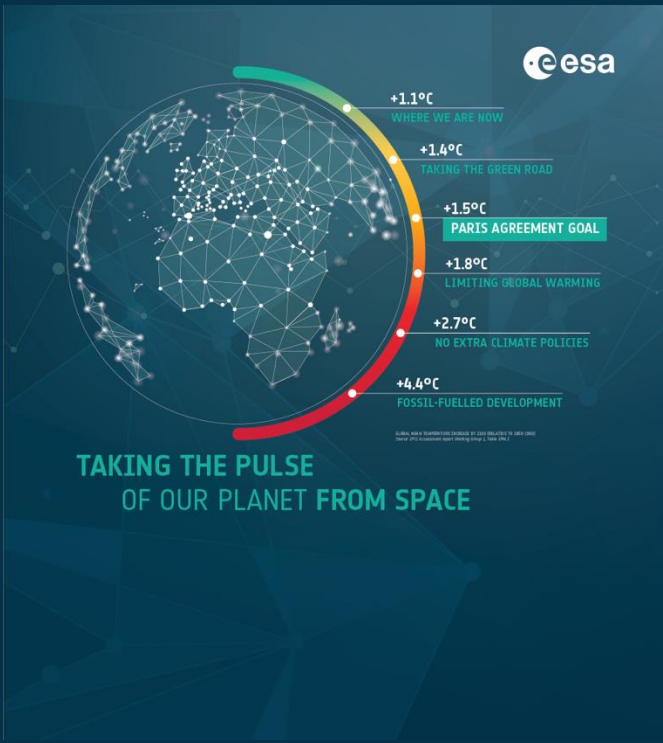
WCRP World Climate Research Programme

WMO

**Future Earth Secondee at ECSAT – renewed collaboration agreement for 2025-2027 in place**

# Take home messages

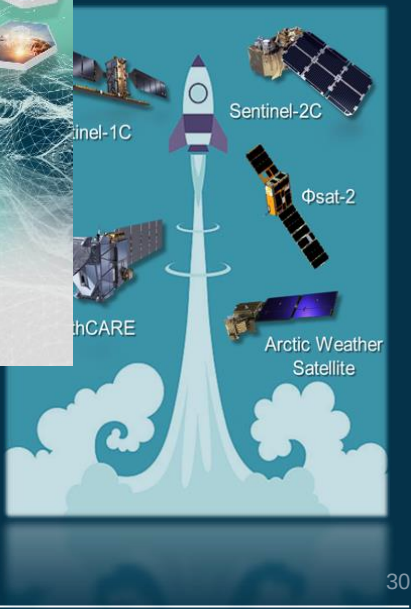
- ESA's CCI programme contributes significantly to our understanding of the Earth's climate through space-based observations in combination with R&D and pre-operational development to develop actionable climate information, including
  - Addresses evolving user requirements (GCOS, WCRP, IPCC etc) leading to a more comprehensive programme portfolio
  - Addresses global climate policy in particular the UNFCCC Paris Agreement
  - Links to new communities (adaptation, health, biodiversity)
  - Intensifies the link between climate observations and modelling
  - Acts as a climate ambassador through knowledge exchange activities
  - Plays an active role and supports efficiently the international climate network
  - Provides the science base to IPCC assessment reports
  - Links to operational services (Copernicus and national etc)
  - Plays a major part in the ESA accelerator S4GF



# Looking towards to CM25

- Addressing evolving requirements and contributing to global climate policies
    - GCOS ECV rationalisation
    - IPCC Assessment Report #7
    - UNFCCC Paris Agreement  Global Stocktake 2028
    - …
- Focusses on new user communities
    - Adaptation, Health, Biodiversity
- Plays a major role in addressing Earth Action
- Is a major source for implementing the new ESA EO science strategy
- Capitalises on new space based information





# Thanks for your attention