ESA CLIMATE OFFICE

Implementation of CCI+ phase 1 – status

Susanne Mecklenburg,

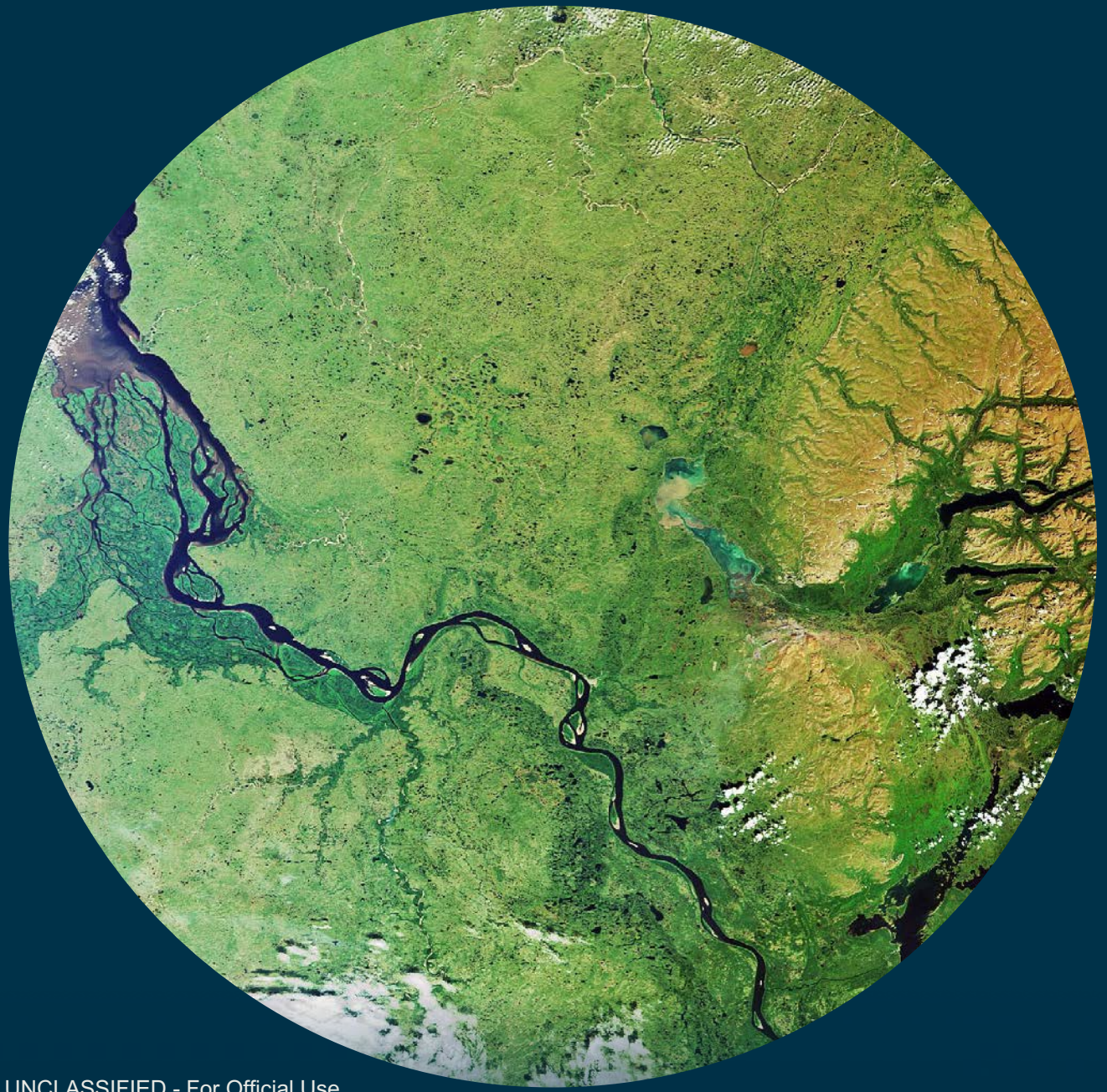
CCI+ mid-term review

26 November 2020

THE ESA CLIMATE OFFICE

Focal point
for climate activities in ESA

- ✓ Implement the **Climate Change Initiative** (CCI) Programme – our flagship programme
- ✓ Working on **international (policy) level** with EU, Copernicus Services, ECMWF, EUMETSAT, UNFCCC, IPCC, GCOS, CEOS, CGMS, WCRP, WMO, Future Earth, SCO etc
- ✓ Observer at **IPCC/UNFCCC**



ESA's CLIMATE CHANGE INITIATIVE

THE MISSION *From ESA/PB-EO(2017)11, rev.2, CCI+ Implementation Plan*

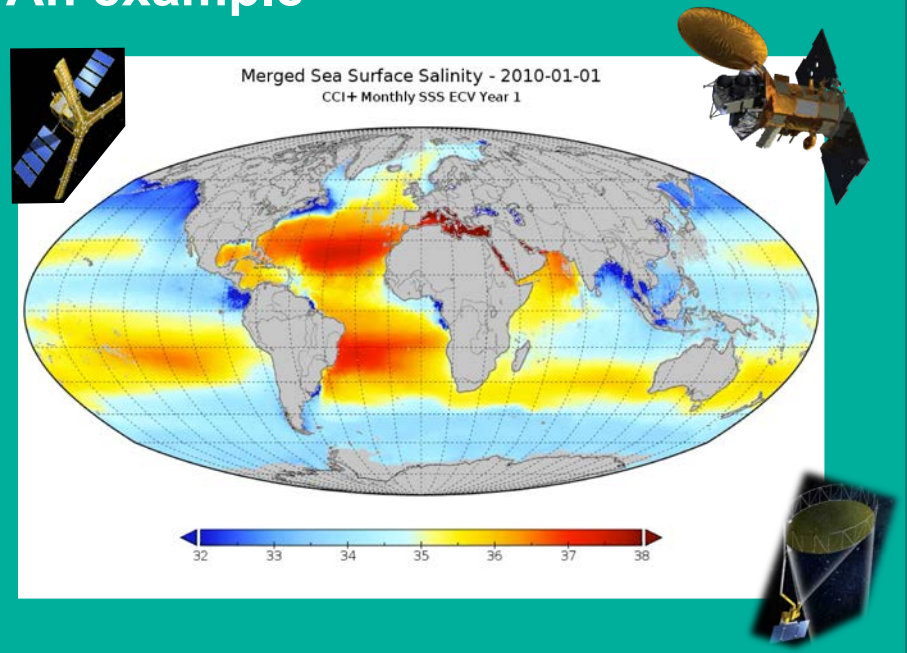
"To realize the full potential of the long-term global Earth Observation archives that ESA together with its Member States have established over the last thirty years, as a significant and timely contribution to the ***Essential Climate Variable (ECV) databases required by the United Nations Framework Convention on Climate Change*** *(UNFCCC).*

It will ensure that ***full capital is derived from on-going and planned ESA missions for climate purposes,*** *including ERS, Envisat, the Earth Explorer missions, relevant ESA-managed archives of Third-Party Mission data and, in due course, the [Copernicus] Space Component.*

Retaining these same objectives, CCI+ aims to continue the successful achievements of CCI to date on the research, development and ***qualification of pre-operational ECV products*** *and processing systems, and promote* ***their transfer to operational production outside ESA****."*

→ FOCUS is on R&D: innovation & pre-operational developments

An example



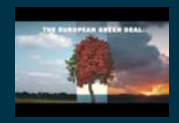
1st merged (SMOS-SMAP-Aquarius) salinity dataset **from space**: 2010-2018

Unprecedented global view of salinity, crucial for modelling ocean circulation + monitoring the marine environment

ESA - NASA collaboration

THE DRIVERS

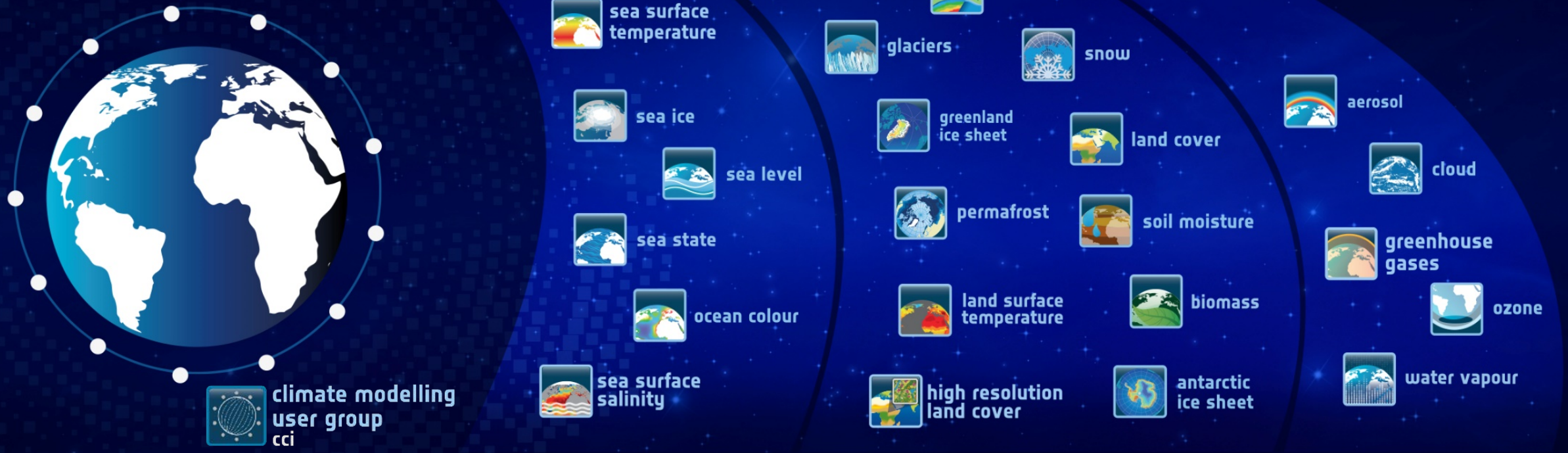
- **GCOS** as the primary source of requirements for ECV and their performance goals
- Climate Science Advisory Board (**CSAB**) providing advice on CCI+ implementation and the link to international climate science programmes
- International coordination with/ contribution to the international response of Space Agencies to GCOS via the Joint **CEOS/CGMS Working Group on Climate**
- Strong link to **operational climate services**, foster uptake of CCI in climate services
- **International collaboration and coordination**
  - International climate research and policy networks
  - EU and national research programmes
  - National space agencies
  - End-user organisations in ESA member states
- Close link to the **international climate modelling community**: Coupled Model Inter-comparison Project (CMIP)



Some representation on panel discussion this afternoon

THE IMPLEMENTATION: current status

WMO defined **54** Essential Climate Variables
36 benefit from space observations
21 generated by ESA Climate Change Initiative



climate change initiative

Oceanic | sea level budget closure cci | Terrestrial | reccap-2 cci | Atmospheric

climate.esa.int

THE IMPLEMENTATION: current contractual structure

THEME 1: New Essential Climate Variables

9 ECVs addressed: Water Vapour, Salinity, Sea State, Snow, Permafrost, HR Land Cover, Lakes, Biomass, Land Surface Temperature

THEME ii) Additional R&D on ECVs included in CCI

13 ECVs addressed: Aerosol, Cloud, Fire, Glaciers, GHG, Ice sheet Antarctica, Ice Sheet Greenland, Land Cover, Ocean Colour, Ozone, Sea Ice, Sea Level, Sea Surface Temperature Soil Moisture

Scientific highlights and overview on activities in …

Agenda #2.1: ocean –cryosphere – land – atmosphere; posters online

THEME iii) Cross-ECVs

Climate Modelling User Group, IMBIE project office, SLBC, RECCAP-2, 1st CCI Fellowship call

Agenda #2.2, posters online

THEME iv) Knowledge Exchange

Open data portal, communication, education, webpage and App, toolbox

Agenda #2.3, video on Climate from Space App

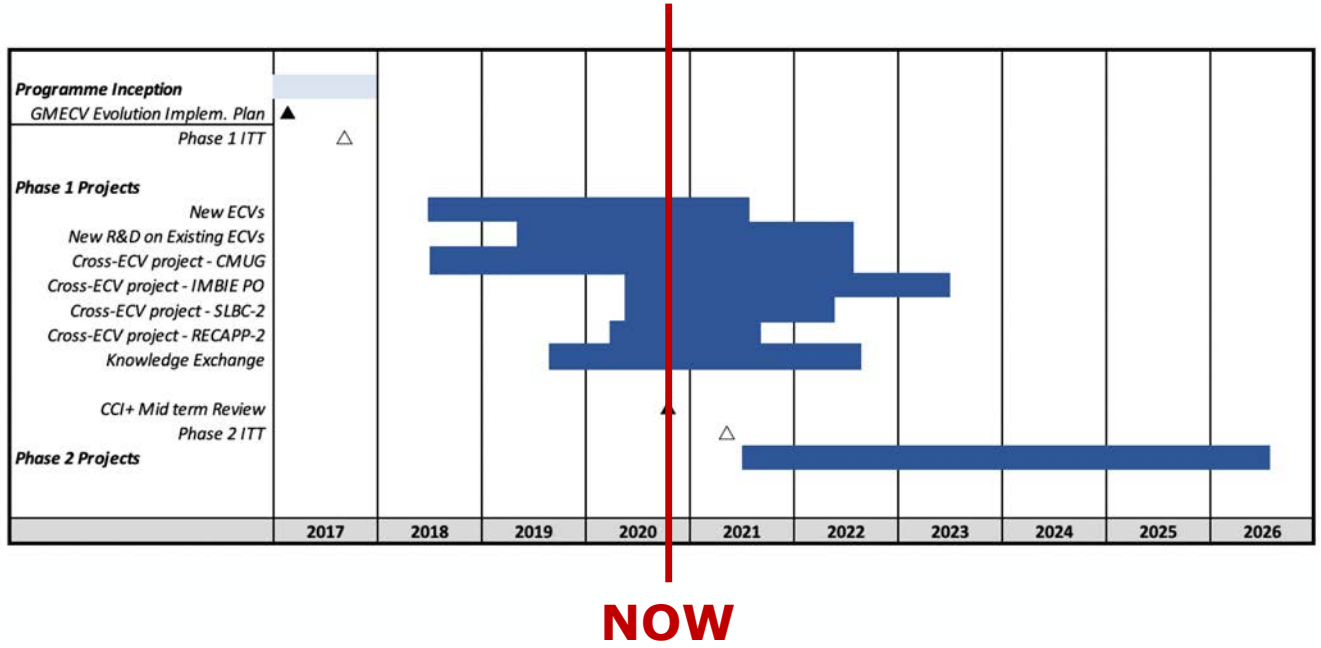
Preparing the new climate programme

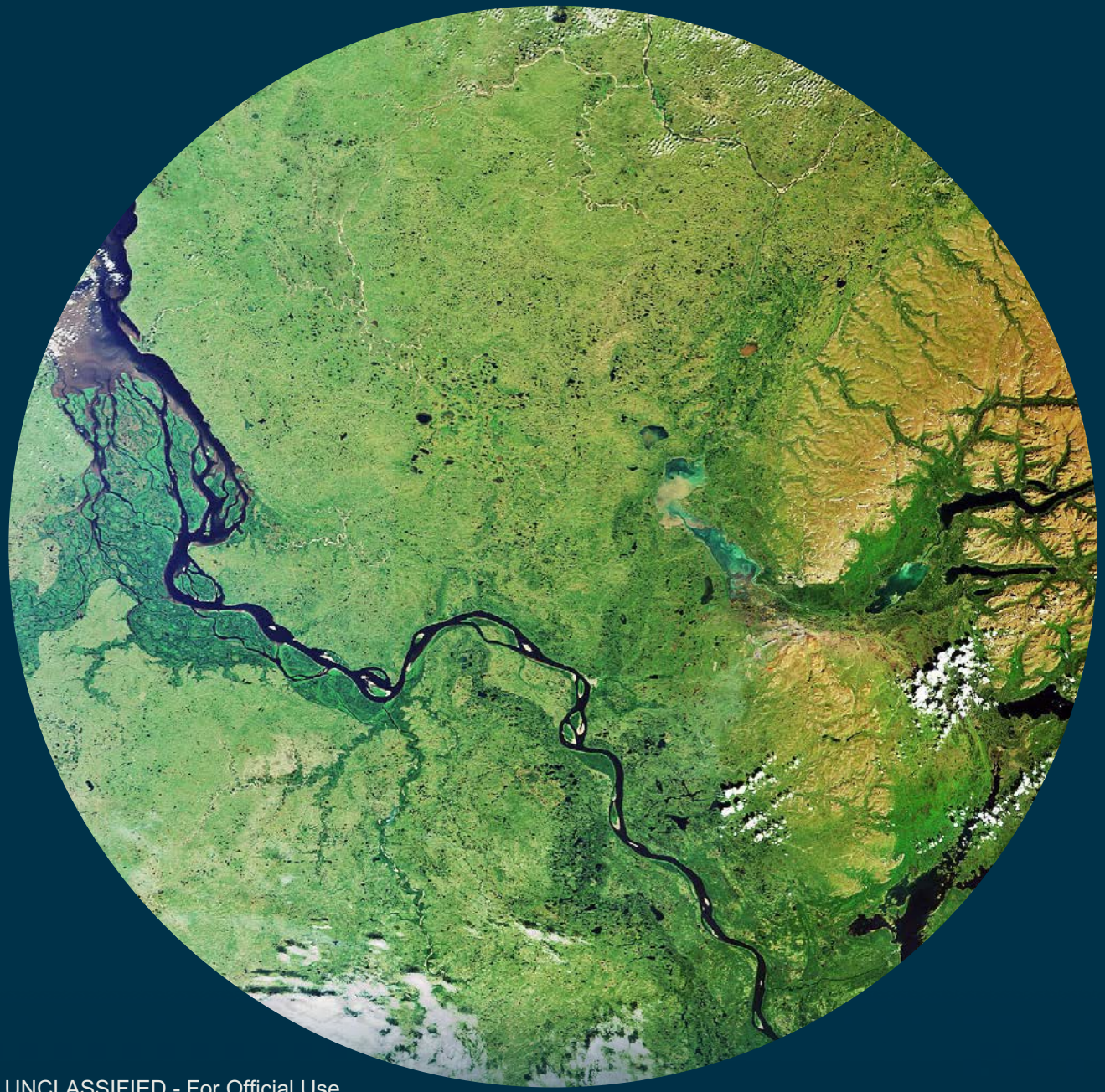
EO support for UNFCCC Paris Agreement

Agenda #3.1

IMPLEMENTATION STATUS OF CCI+ PHASE 1

Contract	CCI+ phase 1 Start	End
Theme i) New ECVs and additional activities	mid 2018	mid-2021
Theme ii) R&D for existing ECVs	Q2/3-2019	mid 2022
Theme iii) Cross-ECV		
CMUG	10-2018	09-2022
IMBIE PO	04-2020	03-2023
SLBC-2	ITT in Q4 2020	+2 years
RECCAP-2	06-2020	12-2021
CCI fellowship		
1st call (May 2020)	Q1 2021	2 years
2nd call (May 2023)	Q1 2024	2 years
Additional activities	TBC	
Theme iv) Knowledge Exchange	09-2019	08-2022
Preparing for new climate programme		





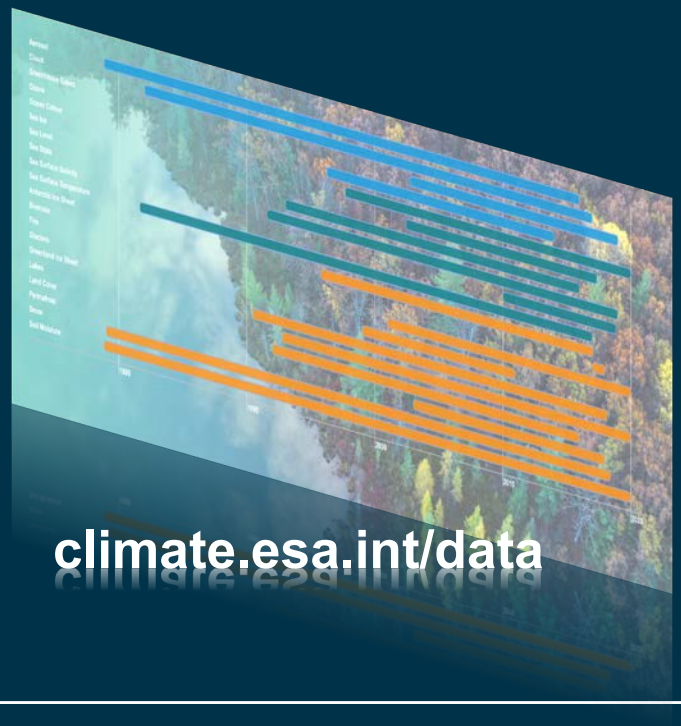
CCI → CCI+

SOME UPDATES

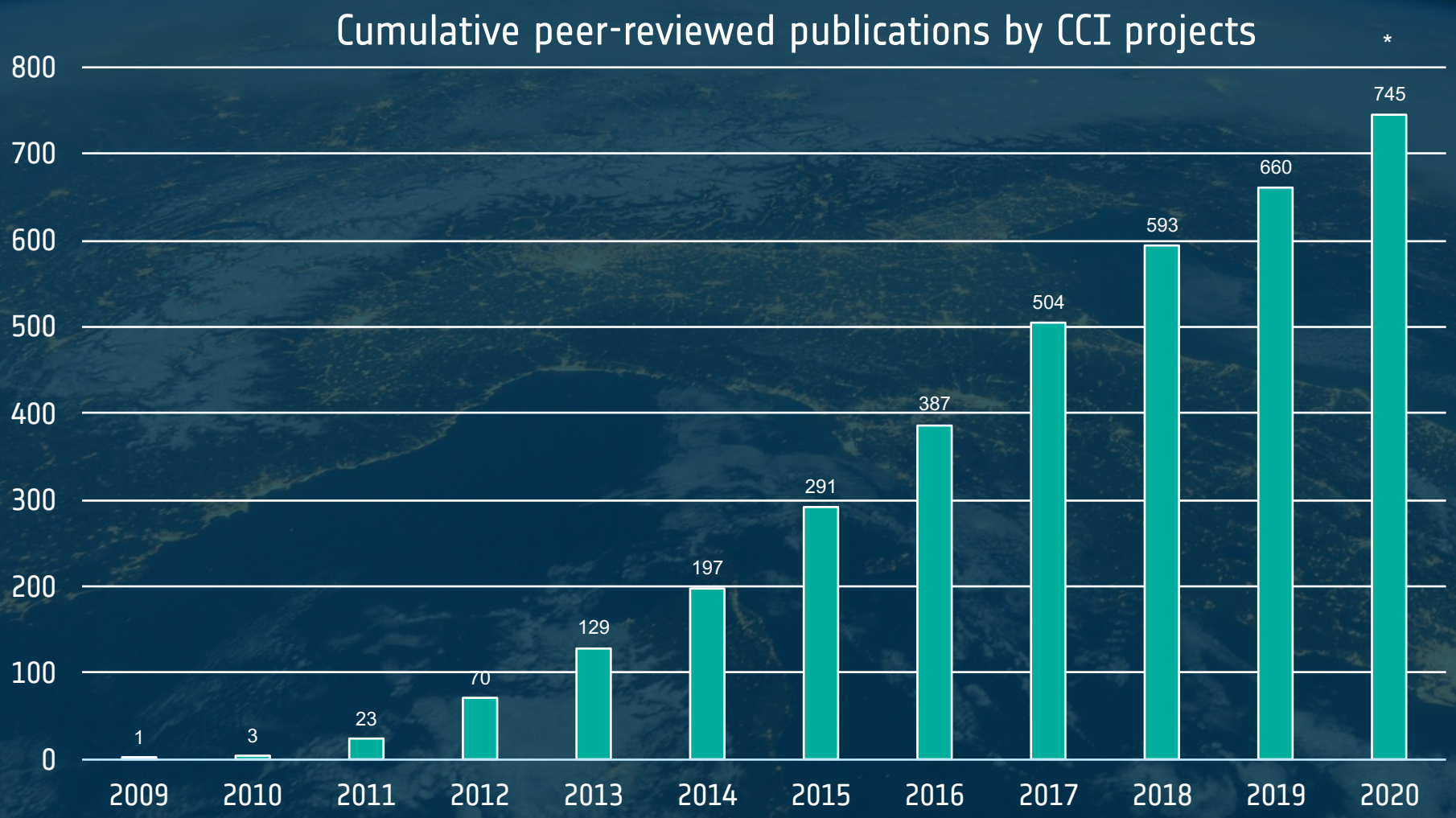
Focus on …
From ESA/PB-EO(2017)11, rev.2, CCI+ Implementation Plan

- **Scientific Excellence** and **cross-ECV research**
- Strengthen link between **modelling** activities (CMUG) and individual ECVs
- CCI+ **best practice**
  - Uncertainty in Climate Data Records from Earth Observation, C. J. Merchant et al., 2017, (10.5194/essd-9-511-2017)
  - Consistency of satellite climate data records for Earth system monitoring, T. Popp et al., BAMS, 2020. https://doi.org/10.1175/BAMS-D-19-0127.1
  - CCI open data portal: free and open access, data standards, ancillary information
- Develop **Knowledge Exchange** strategy to raise awareness for CCI+ achievement
- Foster uptake of CCI+ R&D in **climate services**, maintain synergy with C3S

Agenda #2.1 | 2.2 | 2.3



CCI PEER-REVIEWED PUBLICATIONS



* to end of October

CCI IN NUMBERS

c400
European scientists

126
Institutions

21
ECVs

14 ECVs transferred to Copernicus

Open data

350
terabytes

180+
datasets

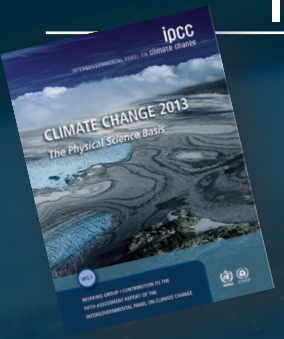
8
million files

640
Peer-reviewed articles

	cci	cci+
Data centres	2	3
Industry	24	37
National weather services	9	10
Universities & Research Institutes	72	76

IPCC CONTRIBUTION

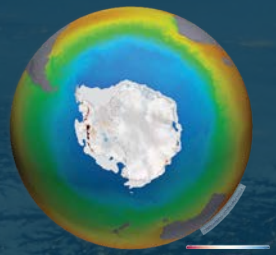
IPCC Fifth Assessment Report

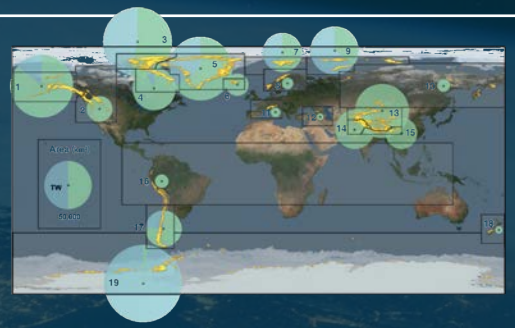


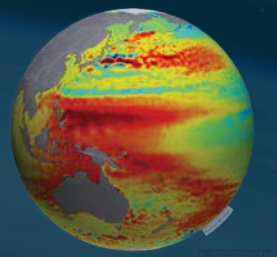
15 papers

60 citations

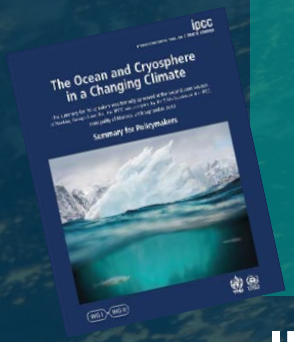
28 contributing authors







Special Report: The Oceans and Cryosphere in a Changing Climate



38 papers

162 citations

authors

von Shuckmann

Käab

Meyssignac

Marzeion

sea level cci

sea level budget closure cci

ocean colour cci

antarctic ice sheet cci

greenland ice sheet cci

sea ice cci

IPCC Sixth Assessment Report

ar6

9 chapters with CCI authors

authors

Sathyendranath (OC), Eyring (CMUG)

Dufresne (CMUG), Doblas-Reyes (CMUG)

Notz (CMUG), Henson (OC), Jones (CMUG)

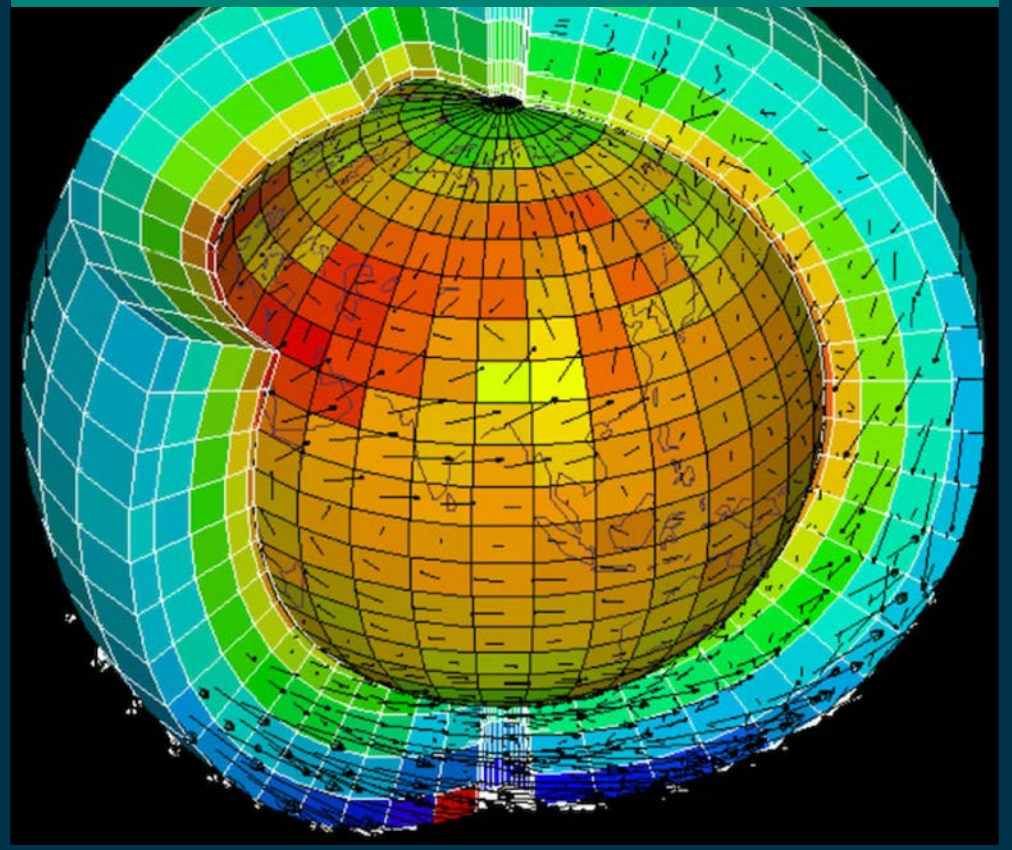
Seneviratne (Soil), von Shuckmann (SLBC), Racaultis (OC)

CLIMATE MODELLING USER GROUP

- Dedicated forum for collaboration between the Earth Observation Data and Climate Modelling Communities
- **Improved interaction through**
  - New cross-project Climate Science Working Group (CSWG)
  - Providing tailored satellite based ECV products for CMIP model evaluation activities
  - 50% of ECVs implemented into ESMValTool (Earth System model Evaluation Tool)
  - Support to WCRP's Obs4MIPs (Observations for Model Inter-comparison Project)

Note: Close interaction with WCRP data advisory council through ESA representation and ESA currently co-chair for Obs4MIPs

Project team: Met Office, ECMWF, Météo France, MPI-M, SMHI, DLR, IPSL, BSC



See dedicated presentation on CMUG, agenda #2.2

WORKING WITH OPERATIONAL SERVICES

CCI-C3S cooperation agreement

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

CCI & C3S COLLABORATION

GCOS-195		CCI	CCI+	uptake	C3S	
Atmospheric surface						
4.3.1	Air temperature					
4.3.2	Wind speed and direction					
4.3.5	Precipitation					■
4.3.6	Surface radiation budget					■
Atmospheric upper air						
4.5.1	Air temperature					
4.5.2	Wind speed and direction					
4.5.3	Water vapour		■	→		■
4.5.4	Cloud properties	■	■	→		■
4.5.5	Earth radiation budget					■
Atmospheric composition						
4.7.1	Carbon dioxide	■	■	→	■	■
4.7.2	Methane	■	■	→	■	■
4.7.3	Other long-lived greenhouse gases					
4.7.4	Ozone	■	■	→	■	■
4.7.5	Aerosol	■	■	→	■	■
Ocean surface						
5.3.1	Sea-surface temperature	■	■	→	■	■
5.3.2	Sea-surface salinity		■			
5.3.3	Sea level	■	■	→	■	■
5.3.4	Sea state		■			
5.3.5	Sea ice	■	■	→	■	■
Ocean biogeochemistry						
5.3.7	Ocean colour	■	■	→		■
5.3.8	Carbon dioxide partial pressure					
5.3.9	Ocean surface acidity					
Ocean sub-surface						
5.4.1	Temperature					
5.4.2	Salinity					
5.4.3	Current					
Land hydrology & cryosphere						
6.3.4	Lakes		■	→		■
6.3.5	Snow cover		■			
6.3.6	Glaciers and ice caps	■	■	→	■	■
6.3.7	Ice sheets	■	■	→		■
6.3.8	Permafrost		■			
6.3.16	Soil moisture	■	■	→	■	■
Land biosphere						
6.3.9	Albedo				■	■
6.3.10	Land cover (including vegetation type)		■	→		■
6.3.11	Fraction of absorbed photosynthetically active radiation				■	■
6.3.12	Leaf area index				■	■
6.3.13	Above-ground biomass		■			
6.3.15	Fire	■	■	→		■
6.3.17.1	Land-surface temperature					

- **Complementarity and synergy**
- Collaborate on **common R&D**
- Provide **pre-operational development** for operational climate services**: 16 ECVs transferred** to operational climate services including C3S (and EUMETSAT)
- **Further collaboration** on
  - Interoperability
  - Quality Assurance
  - Data provenance
  - User Information

Representation on panel discussion this afternoon

CCI & C3S COLLABORATION

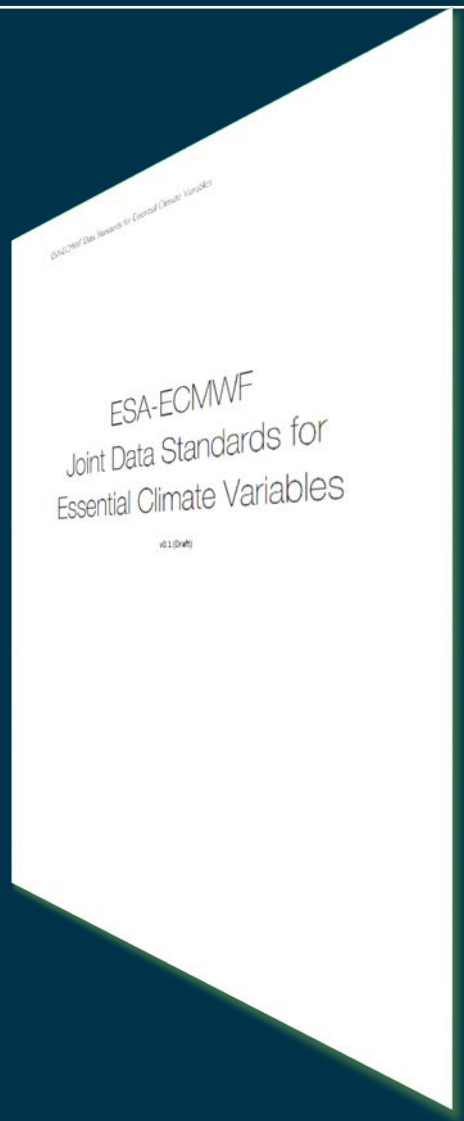
Dedicated workshops on

- R&D Gap Analysis and common interests
- Joint ESA-ECMWF Data Standards for Satellite-Based ECVs
- Dataset Mapping Between C3S & CCI
- Harmonising C3S & CCI Toolboxes Workflows

Main points of discussion for common R&D focus on

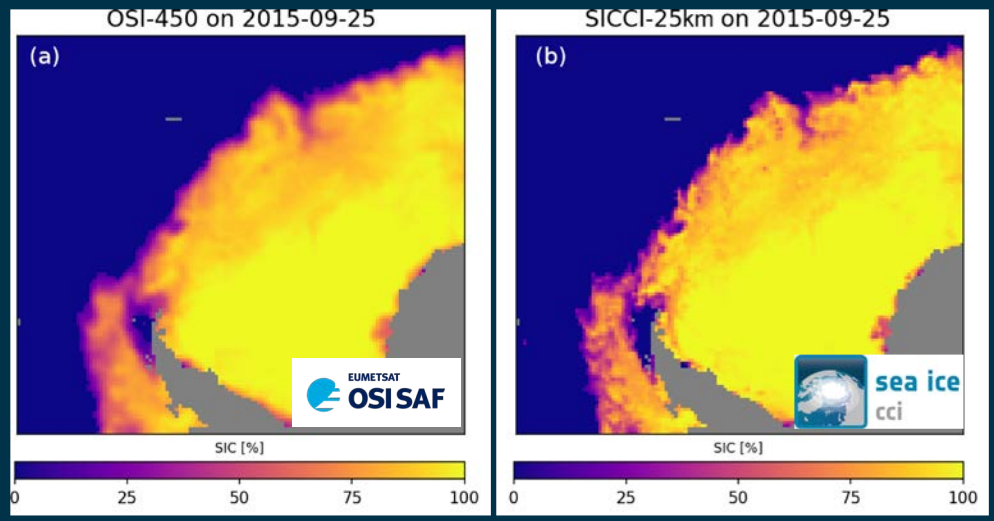
- Including experience from “new” ECVs: biomass, permafrost and LST
- Link to modelling: root-zone soil moisture, vegetation
- New topics: vegetation, biodiversity, terrestrial hydrology/river discharge
- Detailed summary note available, base for new C3S and CCI activities

→ Update on CCI-C3S co-operations agreement planned



CCI & EUMETSAT COLLABORATION

- **Coordination** between CCI and EUMETSAT's Continuous Development and Operations Phase (CDOP) activities on-going as part of current CDOP review
- **Complementary and synergy**
- **Collaboration** on common ECV data sets, e.g. sea ice, soil moisture etc
- Working closely on the **ECV inventory hosted by EUMETSAT** through CEOS/CGMS WGClimate, https://climatemonitoring.info/ecvinventory/
- Regular coordination meetings, through ESA-EUMETSAT bilaterals and on working level



Close collaboration on algorithm development and extension of data records: OSI SAF (left) and CCI (right) sea ice concentration maps (Weddell Sea). Next versions of both data will be run by OSI SAF.

Representation on panel discussion this afternoon

CCI KNOWLEDGE EXCHANGE

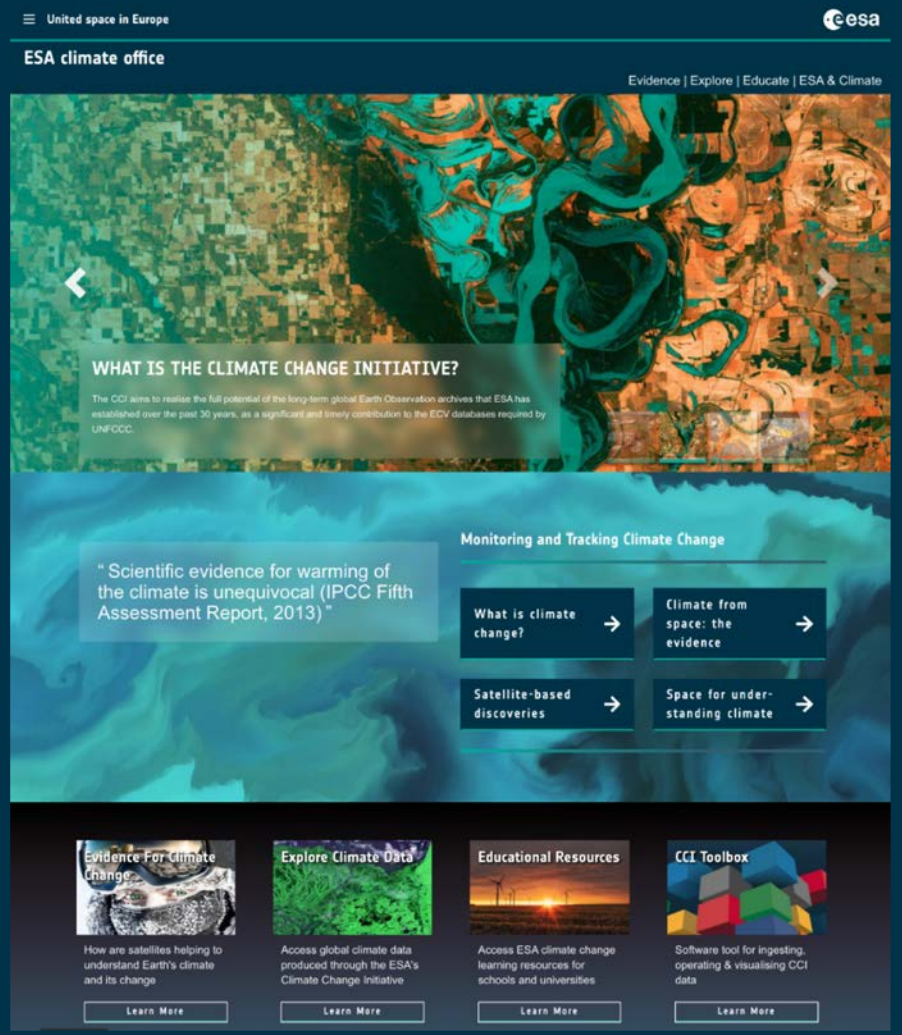
The objective of CCI Knowledge Exchange is to maximise awareness, access, use and understanding **of satellite data for climate research with an emphasis on promoting the CCI Programme.**

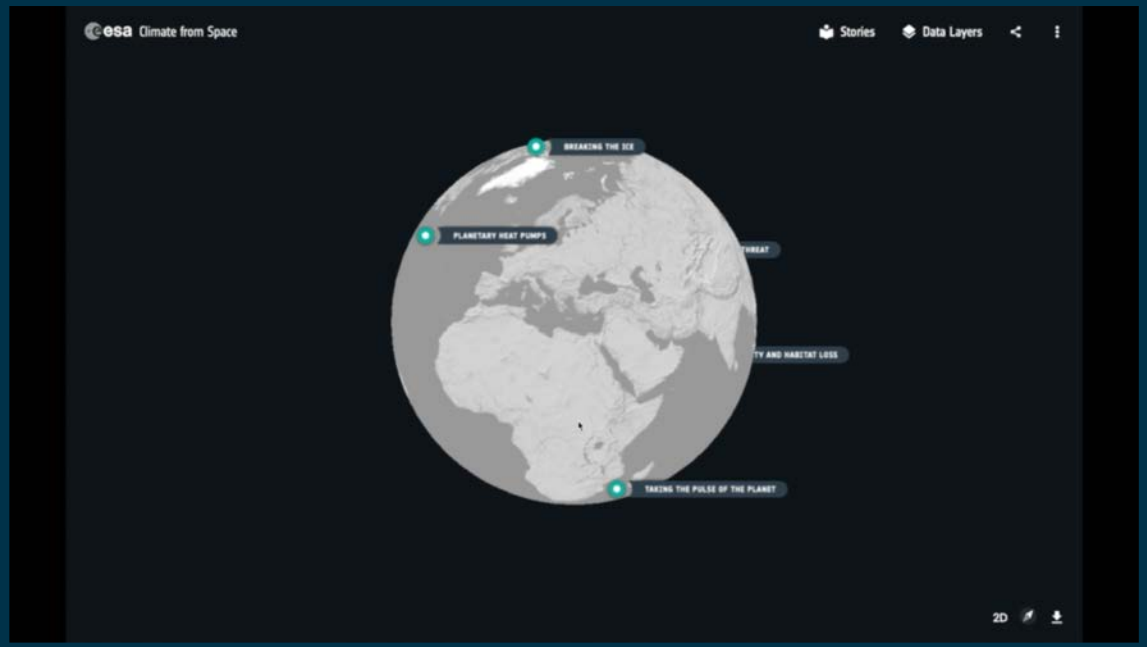
Recent highlights

- New webpage climate.esa.int
- Updated Climate from Space Tool

More details on agenda #2.3

NEW Climate Office Webpage now available: ***climate.esa.int***

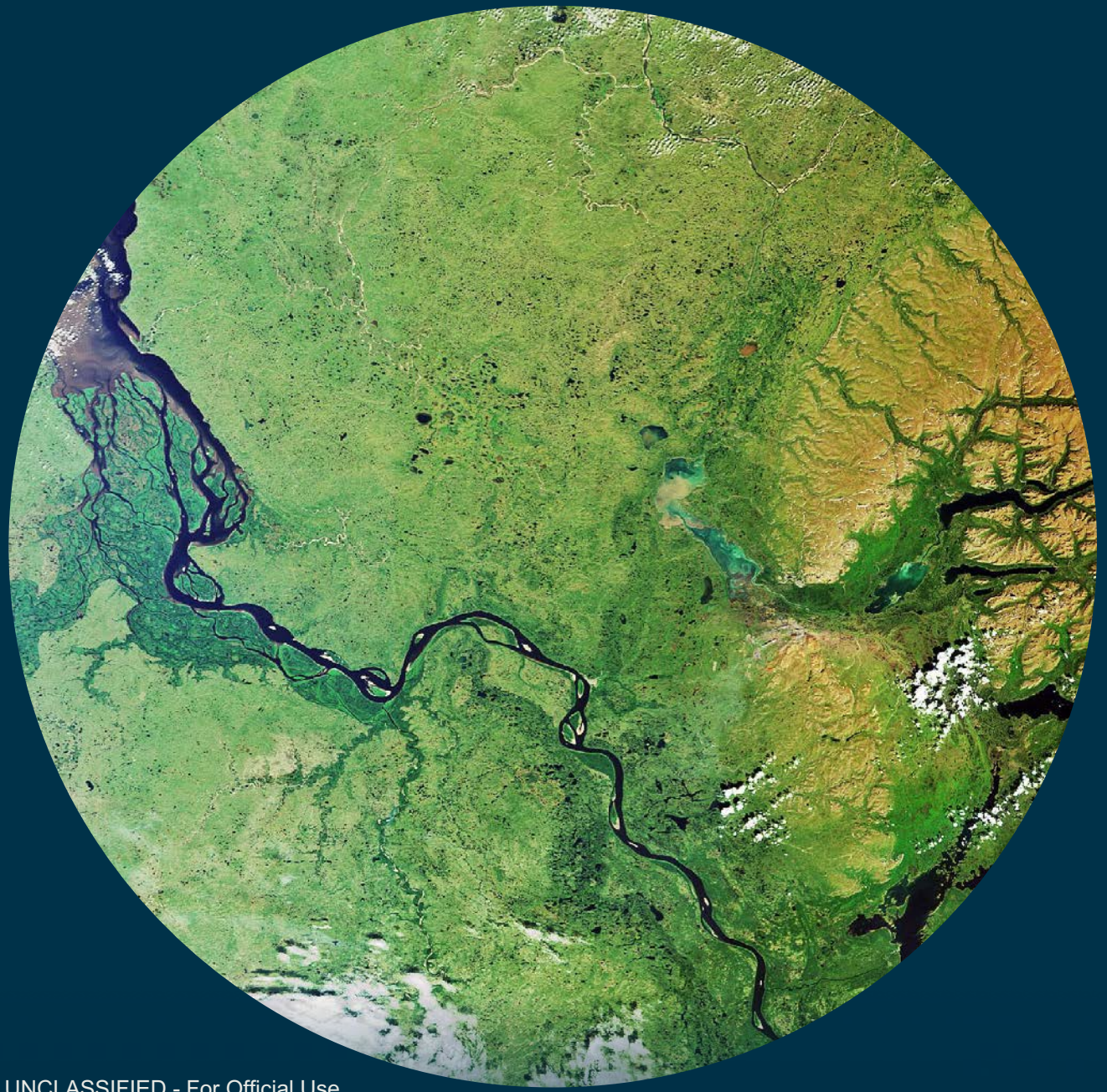




Climate from Space App

cfs.climate.esa.int

- Showcase ESA Climate (ECV) datasets
- Interactive 3D globes & maps
- For teaching & exhibitions
- Mobile | tablet | desktop



INTERNATIONAL COLLABORATION

International climate landscape

ESA's role

STAKEHOLDERS (CCI)

Defining requirements for ECVs & scientific focus

International policy Global Stocktake Mitigation & Adaption

National & regional interests

USERS (CCI)

Climate Science and Modelling

Climate services

New user communities?

Addressing ECV requirements & associated science

Providing scientific evidence as input to policy decision

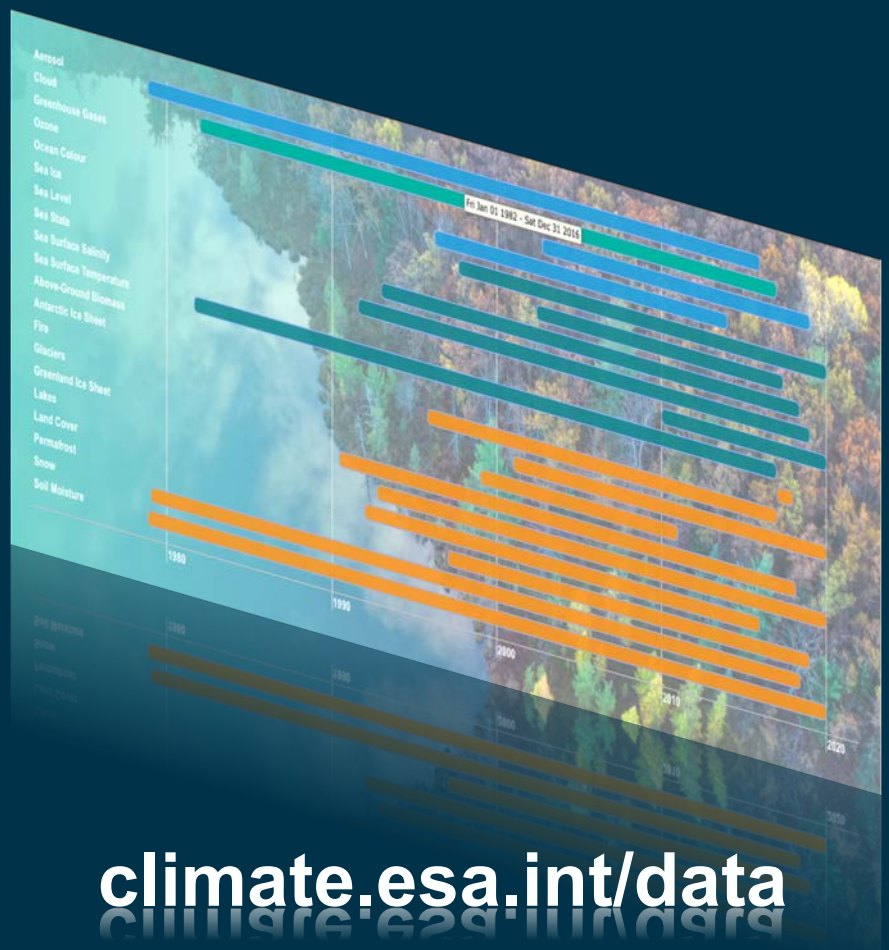
Providing expert input (data and science)

Pre-operational development and R&D

ESA (CCI)

Achievements of CCI+ phase 1

- 21 Essential Climate Variables addressed
- Provision of high-quality, uncertainty characterised, validated climate data records
- Linking individual ECVs in cross-ECV approach: IMBIE, SLBC, RECCAP-2
- Supporting the uptake of climate data records in the climate modelling community: CMUG
- Working closely with the operational climate services, in particular C3S and EUMETSAT
- Contributing to the international climate landscape
- Providing the science base to IPCC assessment reports
- Extended outreach, communication and education



Are you ready to discover more?

www.esa.int

BACKUP SLIDES

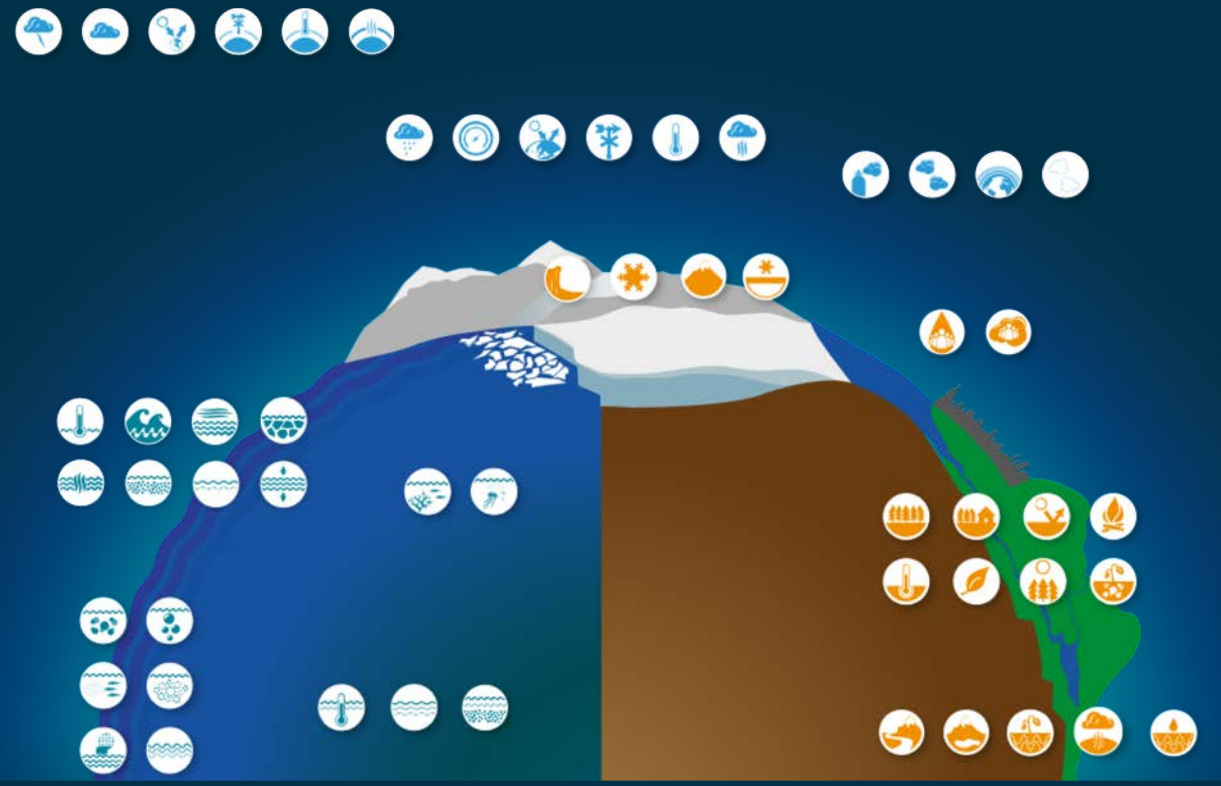
WHAT IS AN ESSENTIAL CLIMATE VARIABLE?

ECV datasets provide the **long-term empirical evidence** needed to understand and predict the key components of the climate.

They are required to support the work of the **UNFCCC and the IPCC** to guide mitigation and adaptation measures, assess risks and enable attribution of climate events to underlying causes, and to underpin climate services.

54 ECVs, 36 can be monitored from space.

21 ECVs are under development by ESA Climate Change Initiative

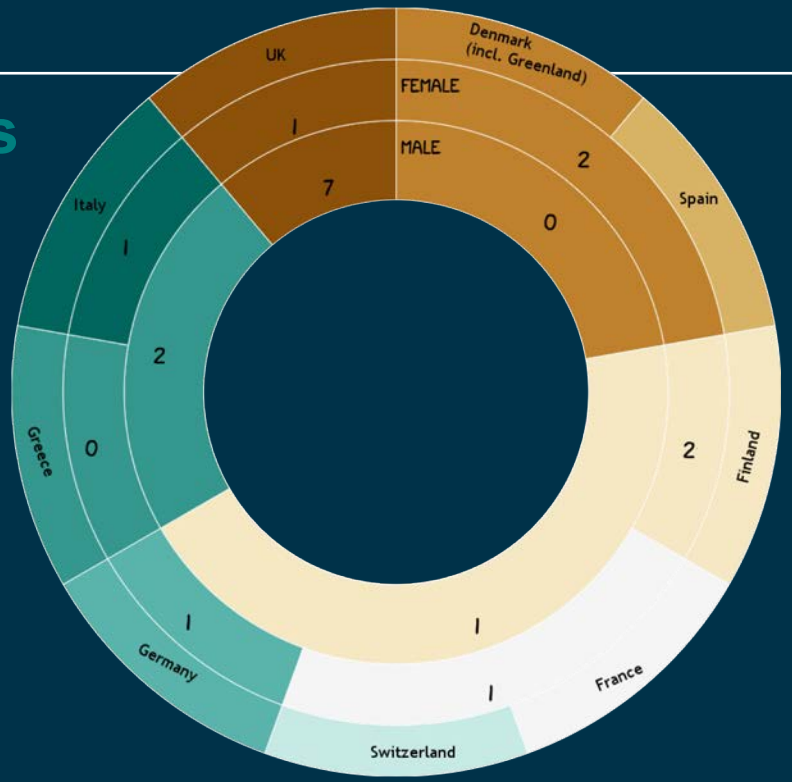


There are 54 ECVs defined by the Global Climate Observing System

CCI FELLOWSHIPS 2020

26 applications received from 9 countries

Terrestrial 12
Ocean 7
Atmosphere 3
Cryosphere 4

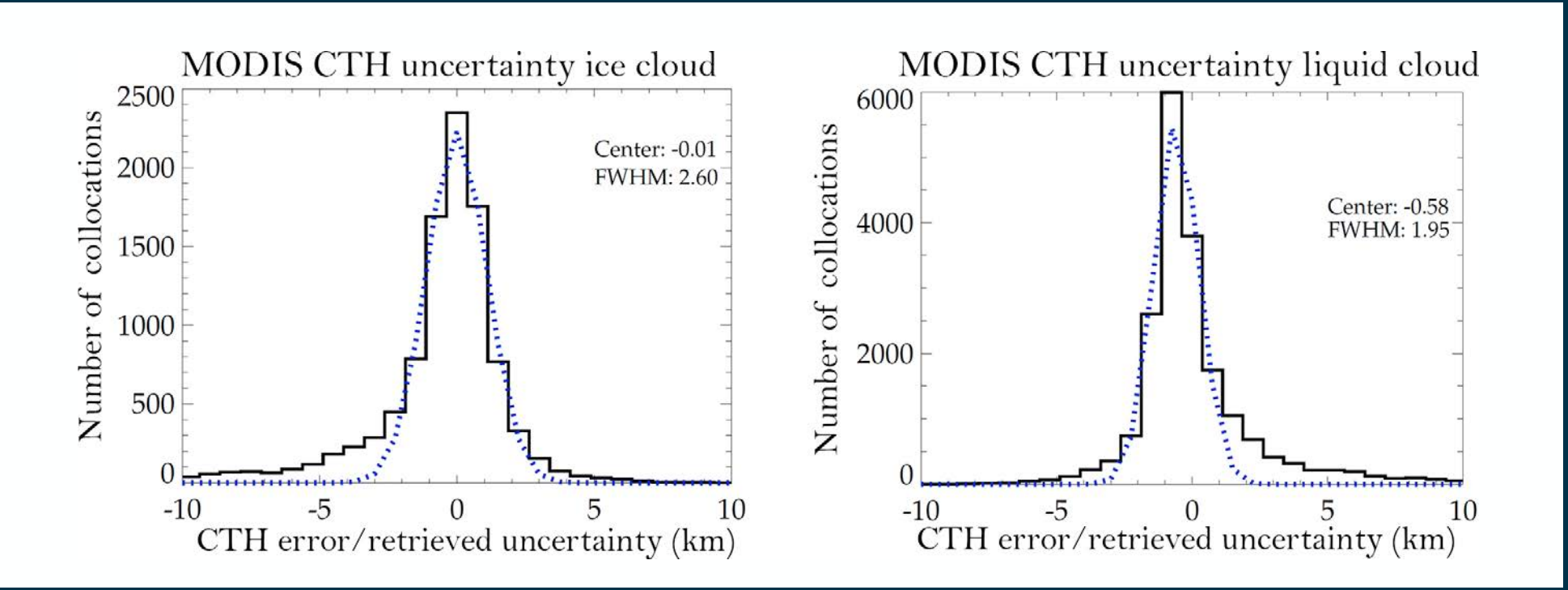


11 proposal selected, to start in Q1/2 2021

Terrestrial 4
Ocean 4
Atmosphere 1
Cryosphere 2

UNCERTAINTY QUANTIFICATION

Uncertainty in Climate Data Records from Earth Observation, C. J. Merchant et al., 2017, (10.5194/essd-9-511-2017) - best practice across 11 CCI ECV projects (18 authors; land, atmos, ocean, cryosphere)



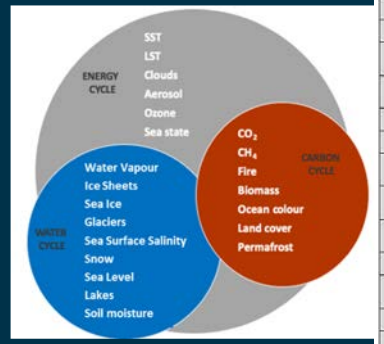
Uncertainty validation using the distribution of differences between matched cloud top heights measured by Cloud_cci and CALIPSO. A correct estimation of the retrieval uncertainty should reproduce the dashed blue curve, with a FWHM of 2.35.

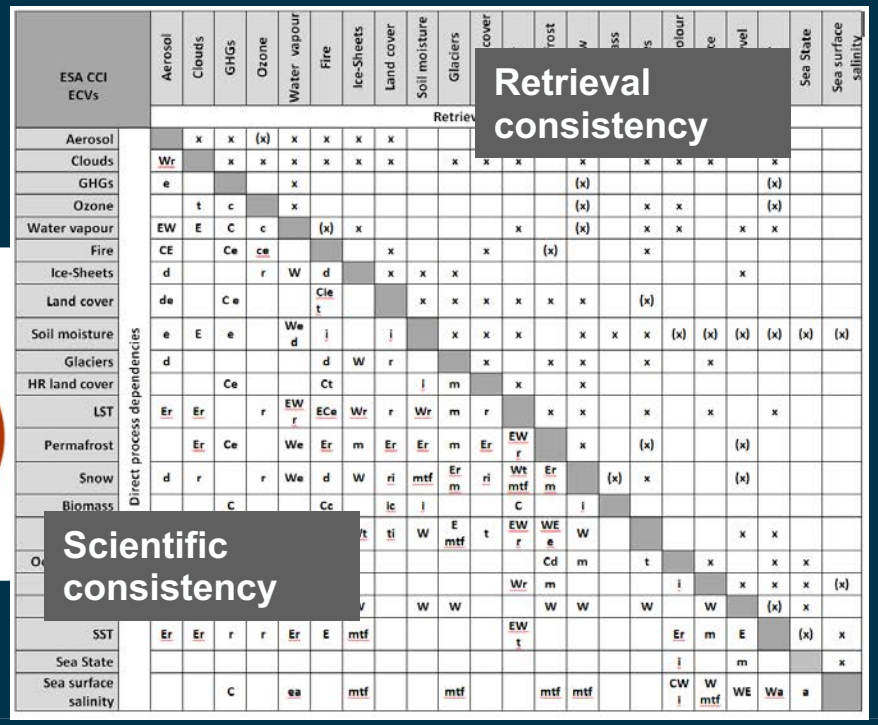
Reference will be made under agenda #2.1 and #2.2

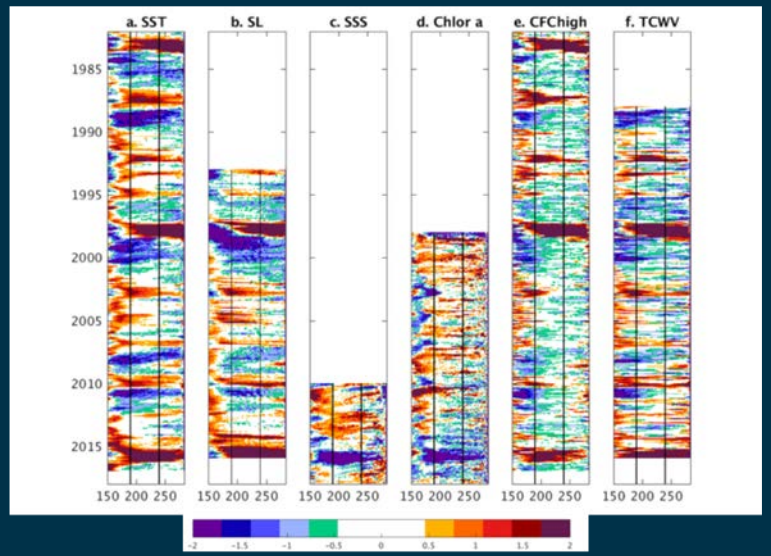
Cross-ECV Consistency

Consistency of satellite climate data records for Earth system monitoring, T. Popp et al., BAMS, 2020.
https://doi.org/10.1175/BAMS-D-19-0127.1

Establish and define the concept of (technical, retrieval, scientific) cross-ECV consistency - 22 CCI co-authors, with 8 detailed examples from across the CCI, identifying also status of research into cross-consistencies





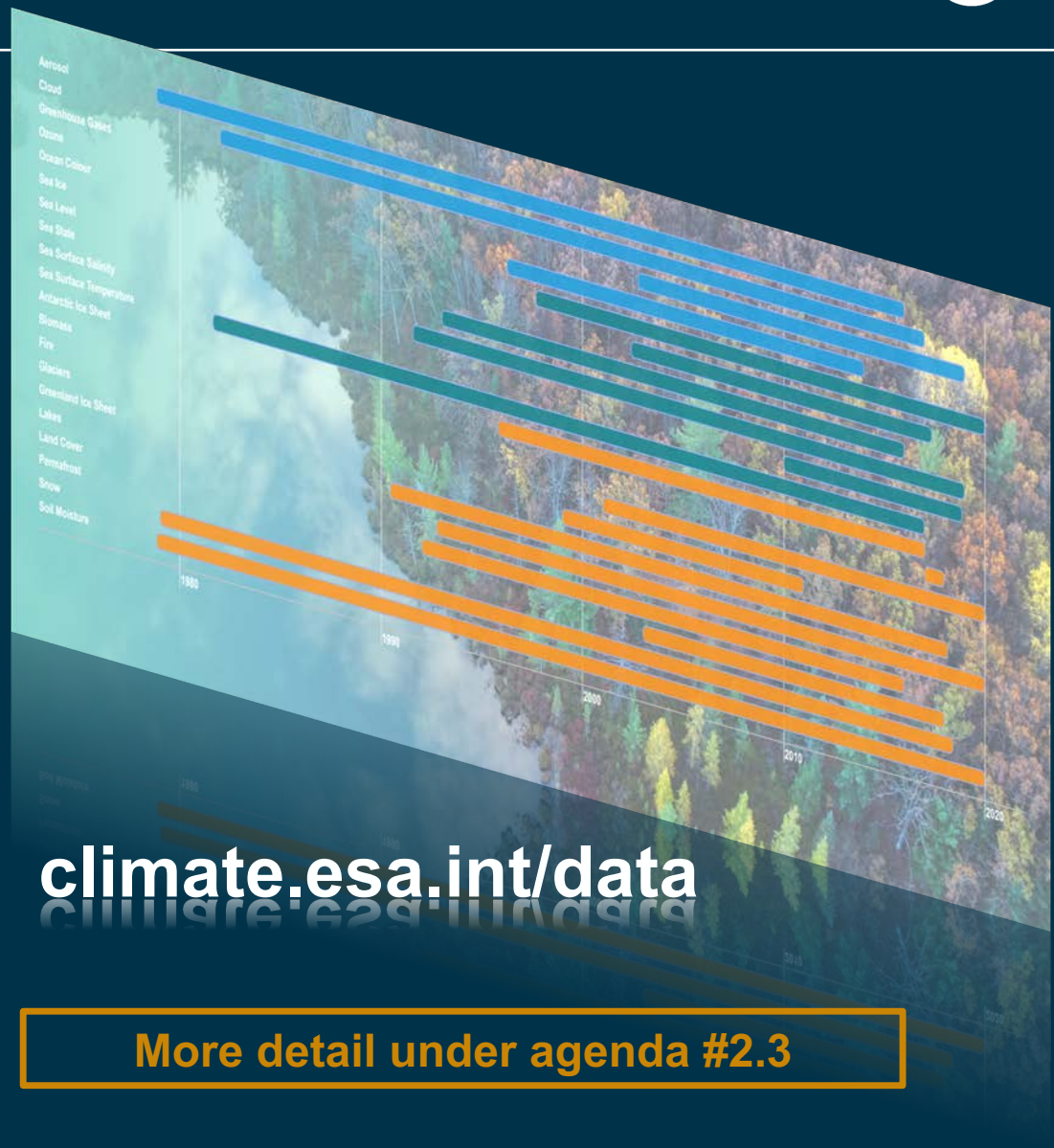


Example above shows co-variation between multiple ECVs: El-Nino region SST, sea level, sea surface salinity, chlorophyll-α, cloud fraction, water vapor, soil moisture, aerosol optical depth (credit: U. Willen, SMHI)

Reference will be made under agenda #2.1 and # 2.2

ECV DATA ACCESS – *CCI OPEN DATA PORTAL*

- ✓ **Free and Open Access**
- ✓ **Global** coverage (where applicable)
- ✓ Long timeseries (20-30 years)
- ✓ **Gridded** (at a usable resolution e.g. ¼ degree)
- ✓ **Validated** (by in situ observations) and tested
- ✓ **Bias corrected** (e.g. between different satellites)
- ✓ **Uncertainty characterisation** (per pixel, correlated…)
- ✓ Useful temporal resolution (**daily, monthly**…)
- ✓ Can be sourced back to algorithm choice
- ✓ Level 1, 2 or 3
- ✓ **Consistency** between CCI_ECV datasets
- ✓ Full documentation & version control
- ✓ Peer reviewed publications
- ✓ Available on CCI Data Portal, and Copernicus Services
- ✓ Supporting information, e.g. cloud masks



More detail under agenda #2.3

LIAISON LINK WITH FUTURE EARTH

FORMAL PARTNERSHIP

- **Strategic link to major international research network** for environmental and sustainability science.
- **Widens use of ESA and CCI data products** within Future Earth's Global Research Projects and **increases ESA involvement**.
- Supports EO **capacity building, awareness and communications** e.g. *10 Climate Insights* report launched at COP-25.
- Identifying **opportunities for collaboration and potential ESA contributions** in the international context – GEO, CEOS, UNFCCC.
- Joint Activity Programme helps **set research priorities**. Recent activities:
  - **Global Mountain Biodiversity Assessment** *ECVs for Mountains* workshop with GEO initiative GEO-GNOME, June 2019.
  - **Future Earth Coasts** *Linking EO data and sustainable development across the Atlantic,* 3-5 Dec 2019.
  - **Research demonstrators for COP-26: To Demonstrate Benefits Of Long-Term Climate Records**

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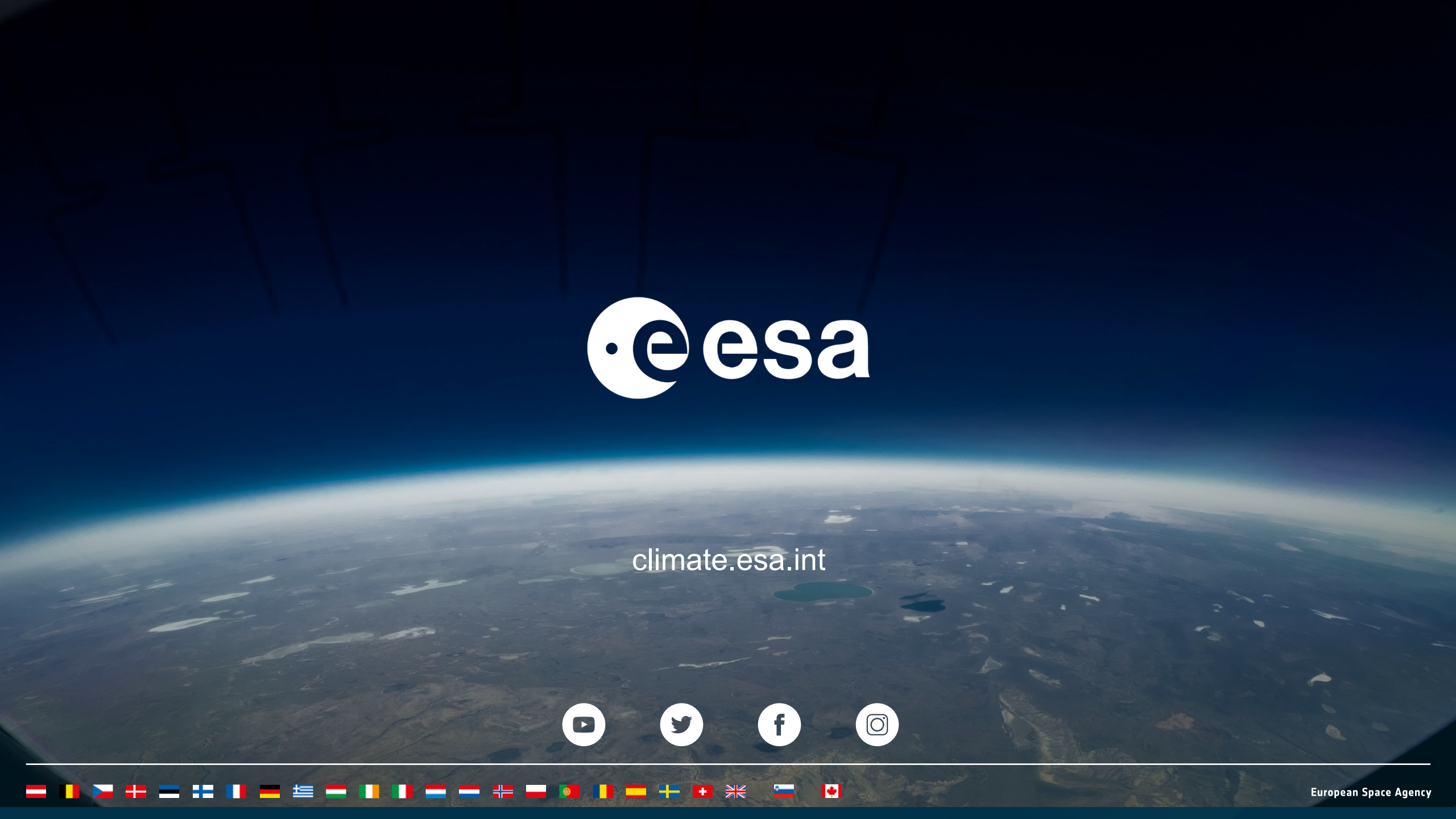
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