Copernicus Programme: Opportunities on Monitoring and Assessing Impacts of Climate Change

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FINNISH METEOROLOGICAL INSTITUTE

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- Short Introduction on BalticSatApps
- Climate Change, Impact and Indicators
- Copernicus Programme
- Copernicus Monitoring Services
- Access to Copernicus Data & Services
- Closer Look to Copernicus Climate Change Service

BalticSatApps

Home | Project & Partners | BalticSatApps Copernicus Interface | Contact | Posts | Events

Boosting your business with open satellite data

The BalticSatApps project is where users of Earth Observation (EO) data and the developers of services utilizing EO data can meet. Our goal is to help multiple sides get better results from the open European Copernicus Programme data.

Copernicus Programme

http://balticsatapps.eu/

Universities & User competency

Information and training sessions // User surveys // University-level short course

Developers & Utilizers

Development challenges for hackathons // Hackathons

Start-ups & Business

Iterative development // Acceleration programmes

BalticSatApps — Speeding up Copernicus-based innovation in the Baltic Sea Region

Partnership

Estonia: Tartu Observatory, Tartu Science Park Foundation

Finland: Finnish Meteorological Institute, Turku Science Park Ltd, University of Turku (Lead partner)

Poland: Cracow University of Technology – Technology Transfer Centre, Institute of Geodesy and Cartography, Krakow Technology Park
Polska strona internetowa projektu BalticSatApps: http://balticsatapps.pl/

Russia: Non-commercial Partnership – European-Russian InnoPartnership, St. Petersburg State Unitary Enterprise – St. Petersburg Information and Analytical Centre

Sweden: Swedish National Space Board

Climate change, impacts and vulnerability in Europe 2016
— Key findings

European Environment Agency

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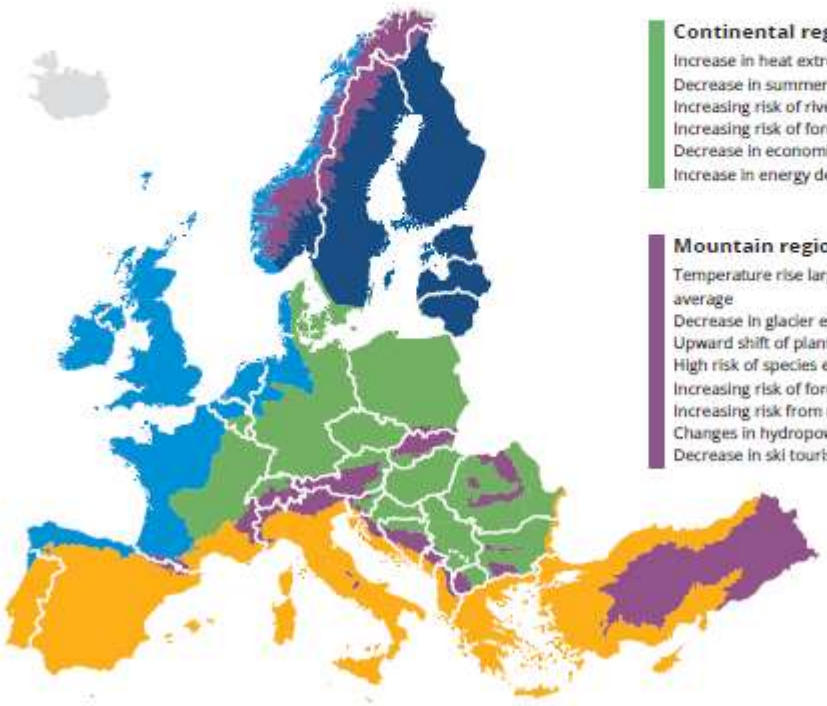
Key observed and projected climate change and impacts for the main biogeographical regions in Europe:

Atlantic region
- Increase in heavy precipitation events
- Increase in river flow
- Increasing risk of river and coastal flooding
- Increasing damage risk from winter storms
- Decrease in energy demand for heating
- Increase in multiple climatic hazards

Arctic region
- Temperature rise much larger than global average
- Decrease in Arctic sea ice coverage
- Decrease in Greenland ice sheet
- Decrease in permafrost areas
- Increasing risk of biodiversity loss
- Some new opportunities for the exploitation of natural resources and for sea transportation
- Risks to the livelihoods of indigenous peoples

Boreal region
- Increase in heavy precipitation events
- Decrease in snow, lake and river ice cover
- Increase in precipitation and river flows
- Increasing potential for forest growth and increasing risk of forest pests
- Increasing damage risk from winter storms
- Increase in crop yields
- Decrease in energy demand for heating
- Increase in hydropower potential
- Increase in summer tourism

Coastal zones and regional seas
- Sea level rise
- Increase in sea surface temperatures
- Increase in ocean acidity
- Northward migration of marine species
- Risks and some opportunities for fisheries
- Changes in phytoplankton communities
- Increasing number of marine dead zones
- Increasing risk of water-borne diseases



Continental region
- Increase in heat extremes
- Decrease in summer precipitation
- Increasing risk of river floods
- Increasing risk of forest fires
- Decrease in economic value of forests
- Increase in energy demand for cooling

Mountain regions
- Temperature rise larger than European average
- Decrease in glacier extent and volume
- Upward shift of plant and animal species
- High risk of species extinctions
- Increasing risk of forest pests
- Increasing risk from rock falls and landslides
- Changes in hydropower potential
- Decrease in ski tourism

Mediterranean region
- Large increase in heat extremes
- Decrease in precipitation and river flow
- Increasing risk of droughts
- Increasing risk of biodiversity loss
- Increasing risk of forest fires
- Increased competition between different water users
- Increasing water demand for agriculture
- Decrease in crop yields
- Increasing risks for livestock production

- Increase in mortality from heat waves
- Expansion of habitats for southern disease vectors
- Decreasing potential for energy production
- Increase in energy demand for cooling
- Decrease in summer tourism and potential increase in other seasons
- Increase in multiple climatic hazards
- Most economic sectors negatively affected
- High vulnerability to spillover effects of climate change from outside Europe

Copernicus

European Commission

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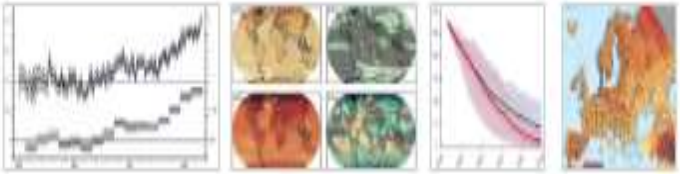
Climate change, impacts and vulnerability in Europe 2016 – Key findings



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- Humans have significantly changed the climate and increased the magnitude of many extreme weather events
- Climate change has wide-ranging impacts on ecosystems, economic sectors and human health
- Different regions and sectors in Europe are affected differently by climate change
- Climate change impacts interact with other developments inside and outside Europe
- Mitigation of climate change is required to limit the long-term risks from climate change
- Adaptation to climate change is necessary to reduce short- and long-term risks from climate change
- Better monitoring, research and information exchange can improve the knowledge base for adaptation

About the report

'Climate change, impacts and vulnerability in Europe 2016' presents a primarily indicator-based assessment of past and projected climate change and its impacts in Europe, consisting of six main parts: (1) Policy context; (2) Changes in the climate system; (3) Climate change impacts on environmental systems; (4) Climate change impacts on society; (5) Multi-sectoral vulnerability and risks; and (6) Strengthening the knowledge base.

The report has been developed by the European Environment Agency in collaboration with the Joint Research Centre, European Centre for Disease Prevention and Control, World Health Organisation Regional Office for Europe and three European Topic Centres (ETC-CCA, ETC-BD, ETC-ICM). The work has been guided by an external advisory group and the content of the report has been reviewed by independent experts.

Climate change, impacts and vulnerability in Europe 2016

eea.europa.eu/publications/climate-change-impacts-and-vulnerability-2016

Climate-ADAPT: The European Climate Adaptation platform

climate-adapt.eea.europa.eu

Interreg Baltic Sea Region

EUROPEAN UNION

EUROPEAN REGIONAL DEVELOPMENT FUND

Copernicus

European Commission

WMO assessment and reporting on Climate Change Indicators

Characterizing the Climate System

GCOS *Essential Climate Variables Climate System Monitoring (ECVs)*

Atmospheric: 15 surface, upper air, and composition ECVs

Oceanic: 19 surface and sub-surface ECVs

Terrestrial: 16 water and snow related, land cover, biomass ECVs

Domain	Essential Climate Variables
Atmospheric	Surface[1]:Air temperature, Wind speed and direction, Water vapour, Pressure, Precipitation, Surface radiation budget. Upper-air: Temperature, Wind speed and direction, Water vapour, Cloud properties, Earth radiation budget (including solar irradiance). Composition: Carbon dioxide, Methane, and other long-lived greenhouse gases, Ozone and Aerosol, supported by their precursors[2]
Oceanic	Surface[3]: Sea-surface temperature, Sea-surface salinity, Sea level, Sea state, Sea ice, Surface current, Ocean colour (for biological activity), Carbon dioxide partial pressure, Ocean acidity, Sub-surface: Temperature, Salinity, Current, Nutrients, Carbon dioxide, partial pressure, Ocean acidity, Oxygentracers, Phytoplankton; Marine biodiversity and habitat properties[4]
Terrestrial	River discharge, Water use, Ground water, Lake Levels, Snow cover, Glaciers and ice caps, Ice sheets, Permafrost, Albedo, Land cover (including vegetation type), Fraction of absorbed photosynthetically active radiation (fAPAR), Leaf area index (LAI), Above-ground biomass, Soil carbon, Fire disturbance, Soil moisture, Terrestrial biodiversity and habitat properties[9]

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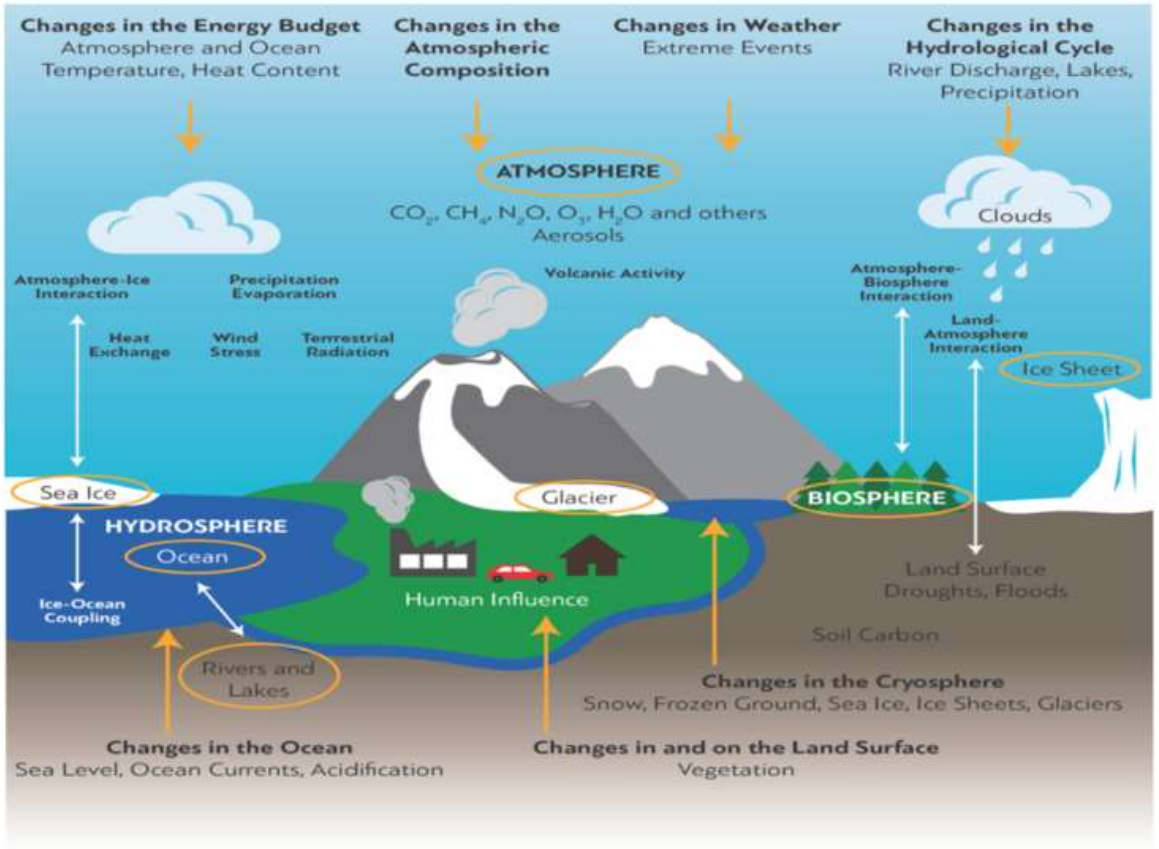
WMO assessment and reporting on Climate Change Indicators

BALTIC SAT APPS

Climate Change Indicators: *WMO Perspective*

- **A set of a limited number of parameters** that describe the changing climate without reducing climate change to only temperature.
- **They comprise key information for the most relevant domains** of climate change: temperature and energy, atmospheric composition, ocean and water as well as the cryosphere.
- A work is ongoing for publishing **a WMO reference** on the indicators. We currently refer to Headline Climate Indicators



WORLD METEOROLOGICAL ORGANIZATION · GCOS GLOBAL CLIMATE OBSERVING SYSTEM · WCRP World Climate Research Programme · ipcc

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WMO assessment and reporting on Climate Change Indicators

BALTIC SAT APPS

Criteria for selection of Climate Indicators

***Relevance**:* each headline indicator should be a clear, understandable indicator of global climate change, with broad relevance for a range of audiences. Some such global indicators may also have value at the national and regional levels.

Representativeness: the indicators as a package should provide a representative picture of changes to the Earth system related to climate change.

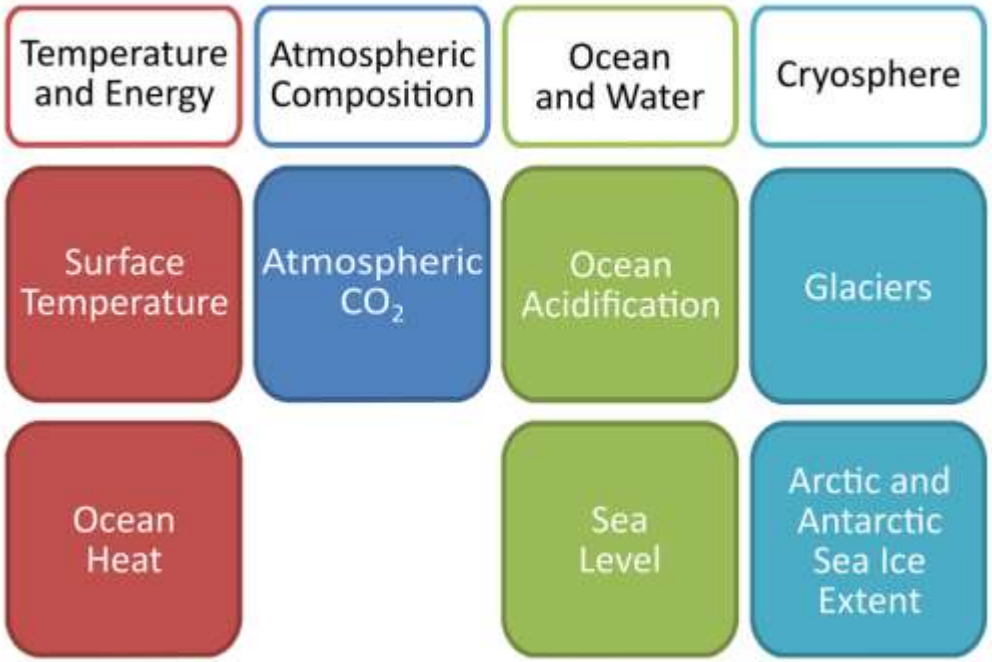
Traceability: each indicator should be calculated using an internationally agreed (and published) method and accessible and verifiable data.

Timeliness: each indicator should be calculated regularly (at least annually), with a short lag between the end of the period and publication of the data.

***Data adequacy*:** the available data needed for the indicator must be sufficiently robust, reliable and valid.

WMO assessment and reporting on Climate Change Indicators

Global Climate Indicators



The Global Climate Indicators are a set of parameters that describe the changing climate without reducing climate change to only temperature. They comprise key information for the most relevant domains of climate change: temperature and energy, atmospheric composition, ocean and water as well as the cryosphere.

These Global Climate Indicators have been identified by scientists and communication specialists in a discursive process led by GCOS during workshops and scientific panel meetings and have been finally endorsed by WMO. They form the basis of the annual **WMO Statement of the State of the Global Climate**, which is submitted to the Conference of Parties of the **United Nations Framework Convention on Climate Change (UNFCCC)**. In addition, the Copernicus Climate Change Service (C3S) of the European Commission uses the Indicators implemented the Global Climate Indicators for their annual "**European State of the Climate**".

These seven headline indicators are complemented by a set of subsidiary indicators that provide additional information and allow a more detailed picture of the changes in the respective domain. It is important to note, that the Global Climate Indicators are not limited to specific datasets or certain storylines.

WMO assessment and reporting on Climate Change Indicators

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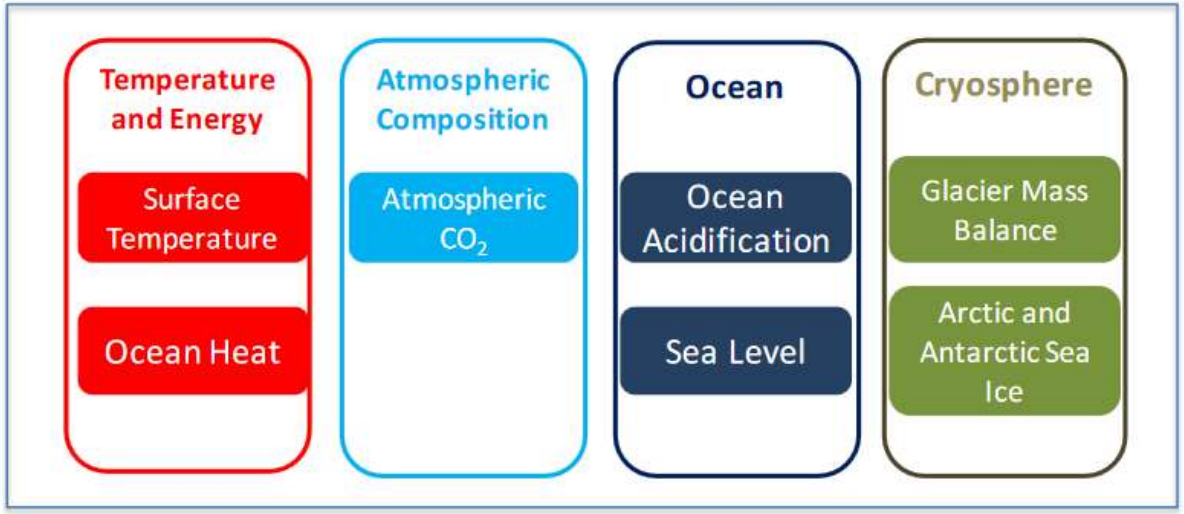
Extreme Events and Climate Change



Extreme Events

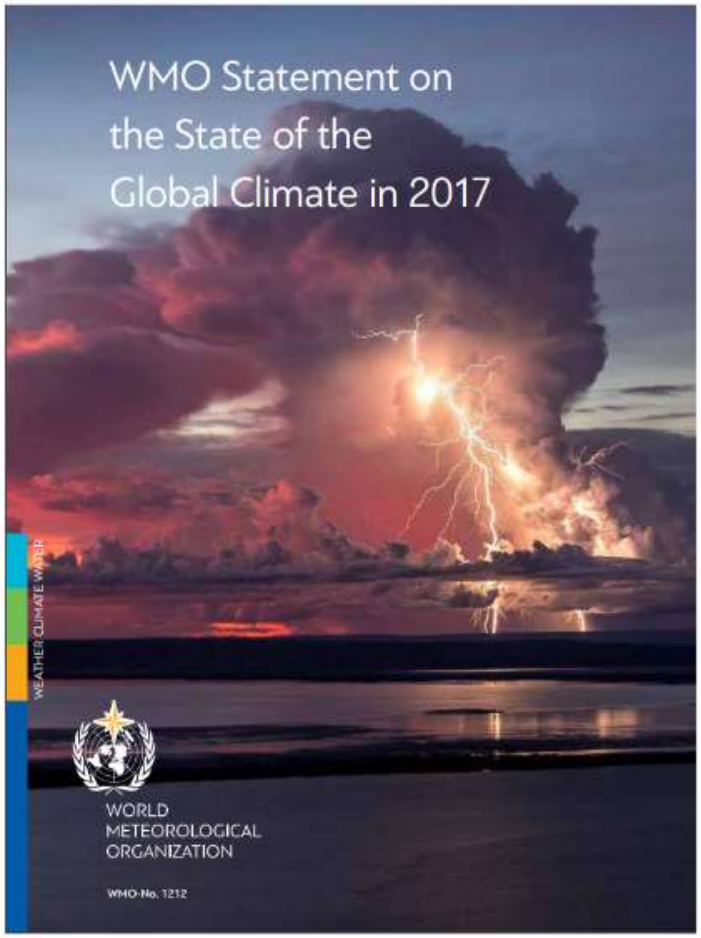
Heat Waves | Cold Waves | Droughts | Storms | Heavy Precipitation | Floods | .....

Attribution to anthropogenic Climate Change ?

WMO assessment and reporting on Climate Change Indicators

BALTIC SAT APPS

WMO Reporting on Climate Change Indicators



Values of key climate indicators

Indicator	*Time period*	*Value*	*Ranking*
Global mean surface-temperature anomaly (1981–2010 baseline)	2017, annual mean	+0.46°C	Second-highest on record
Global ocean heat content change, 0–700 metre layer	2017, annual mean	1.581 x 1023 J	Highest on record
Global mean CO_2 surface mole fraction	2016, annual mean	403.3 parts per million	Highest on record
Global mean sea-level change since 1993	2017, December	8.0 cm	Highest on record
Arctic sea-ice extent summer minimum	2017, September	4.64 million km^2	Eighth-lowest on record

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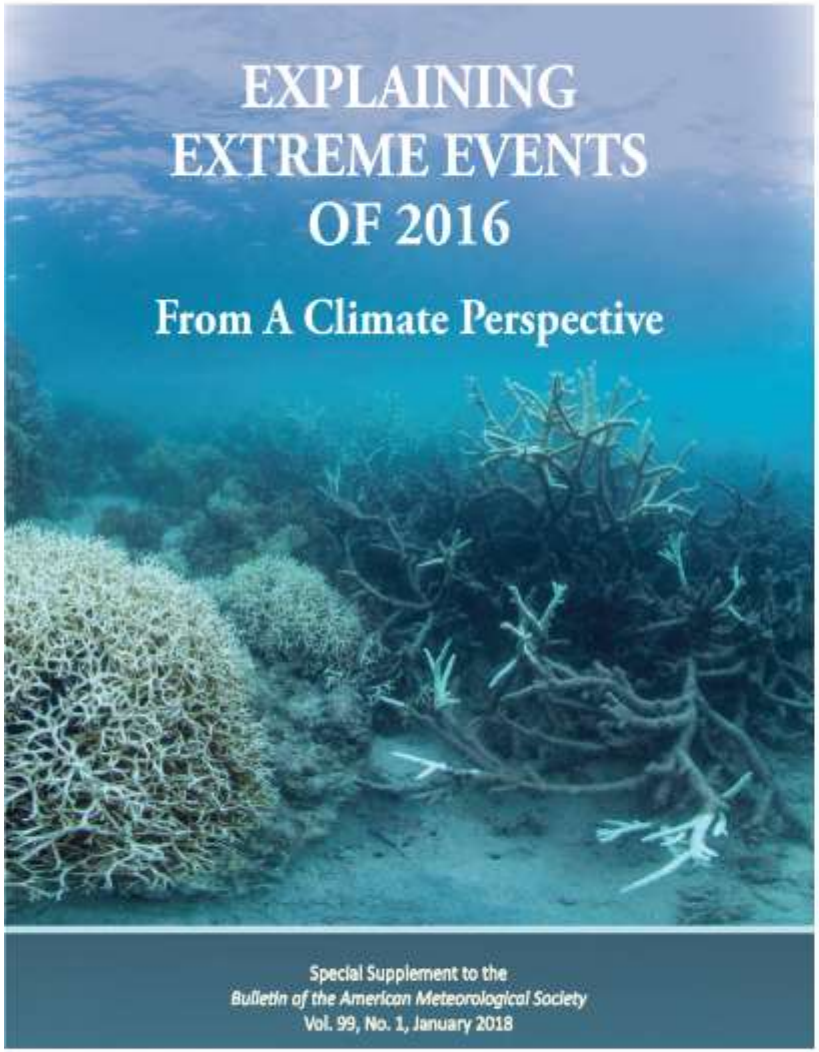
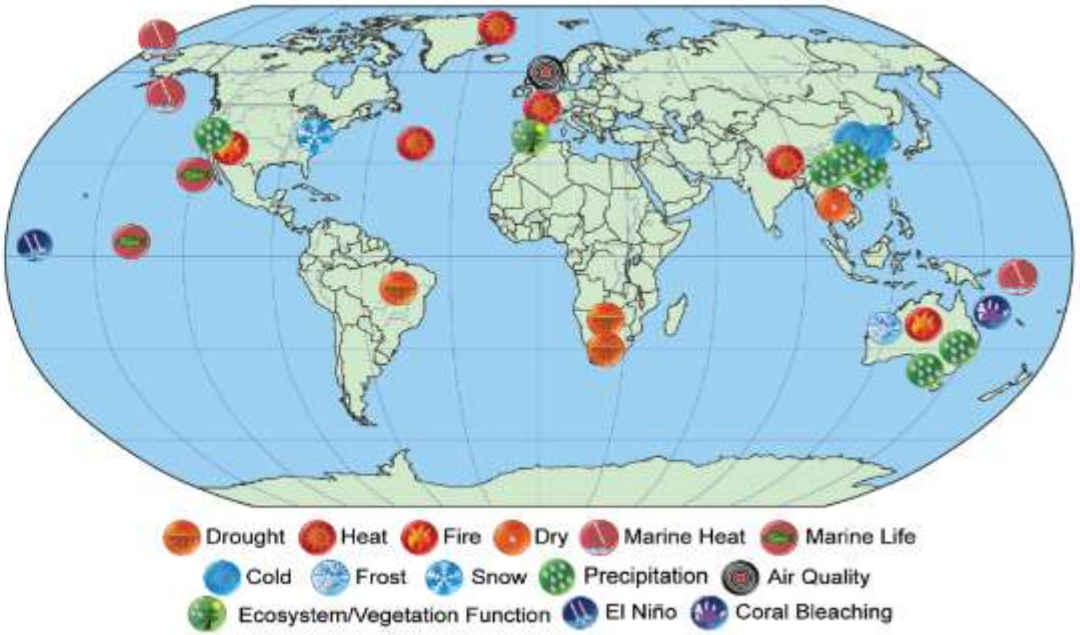
Attribution of extreme events



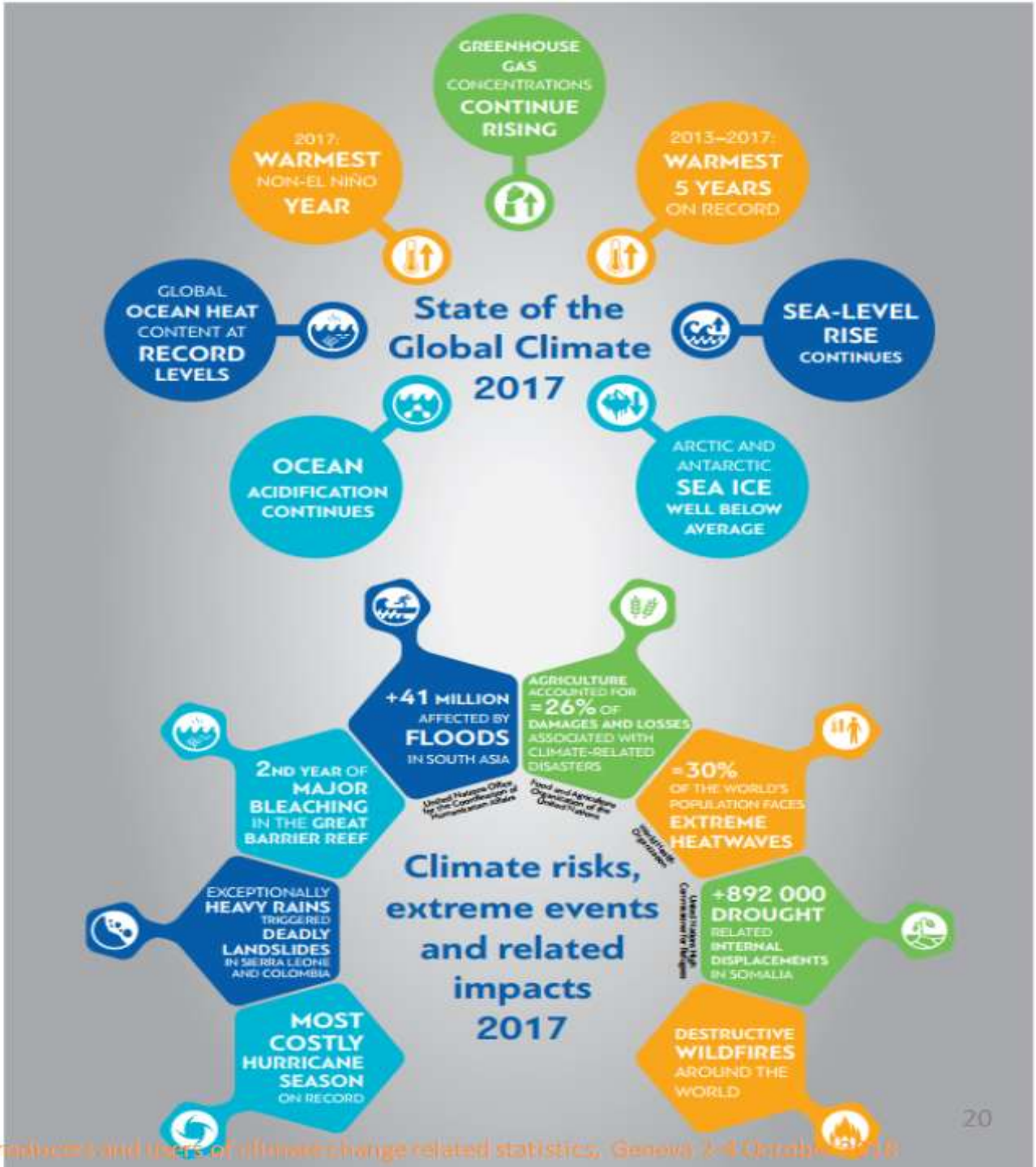
Of the 131 papers now examined in this report over the last six years, approximately 65% have identified a role for climate change, while about 35% have not found an appreciable effect.



Reporting on high impact events

Collaboration with UN Agencies on impacts

- FAO
- IMF
- IMO
- IOC/UNESCO
- UNEP
- UNHCR
- UNISDR
- WHO
- WFP

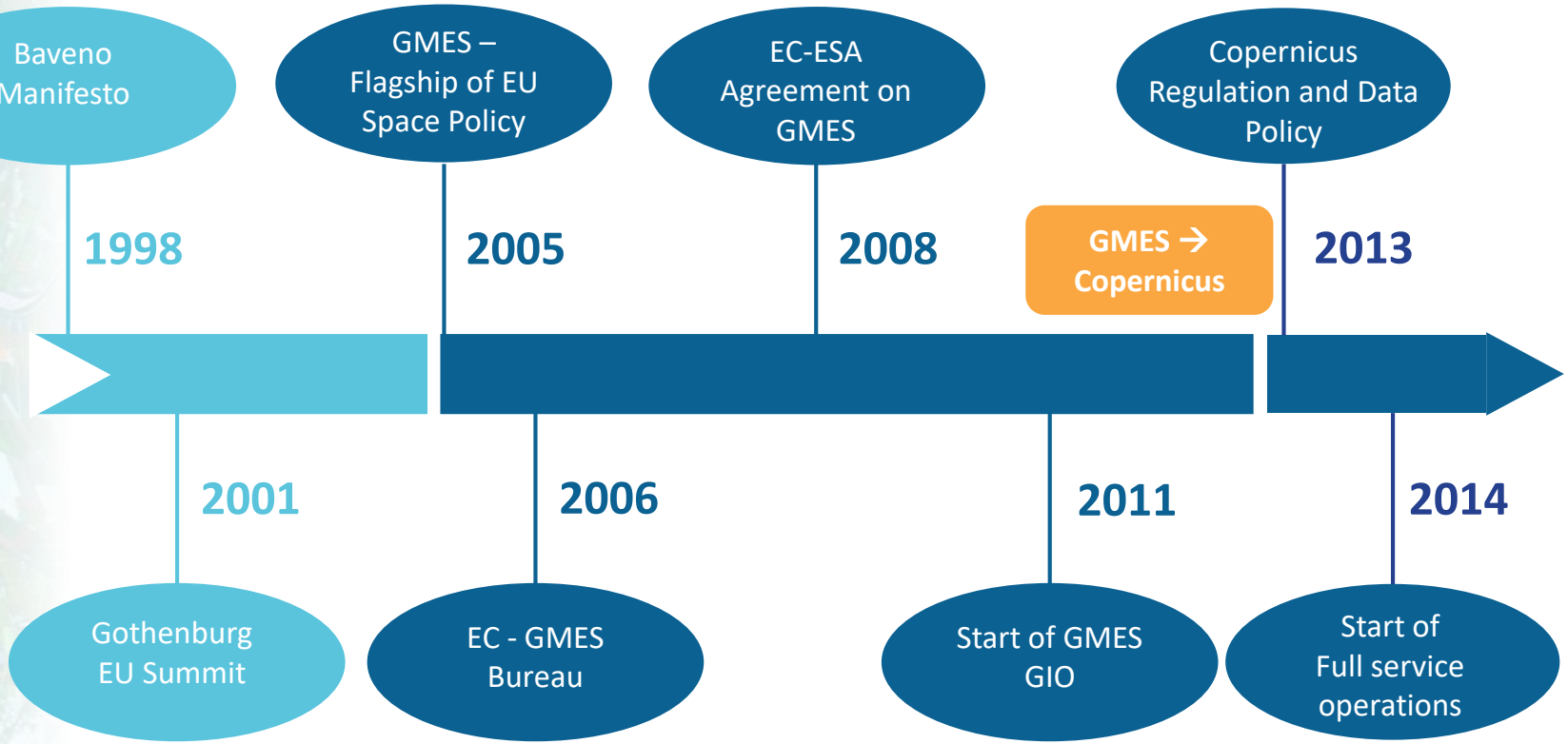


WMO OMM

COPERNICUS IN BRIEF

- **Copernicus, a flagship programme** of the European Union:
  - Monitors **the Earth,** its environment and ecosystems
  - Prepares for **crises, security risks** and **natural or man-made disasters**
  - Contributes to the **EU's role as a global soft power**
- Adopts a **full, free and open data policy**
- Is a tool for **economic development** and a driver for the **digital economy**

COPERNICUS HISTORY



GIO = GMES Initial Operation

THE COPERNICUS PROGRAMME OBJECTIVES

Copernicus

The Union Earth Observation and monitoring programme

Protect people and assets

Increase general knowledge on the state of the Planet

Improve environmental policy effectiveness

Facilitate adaptation to climate change

Monitor the environment

Foster downstream applications in a number of fields

Help managing emergency and security related situations

Copernicus Relays

Copernicus – the European EO programme

European Earth Observation System, led by the EU

European response to global needs:

- to manage the environment
- to mitigate the effects of climate change
- to ensure civil security

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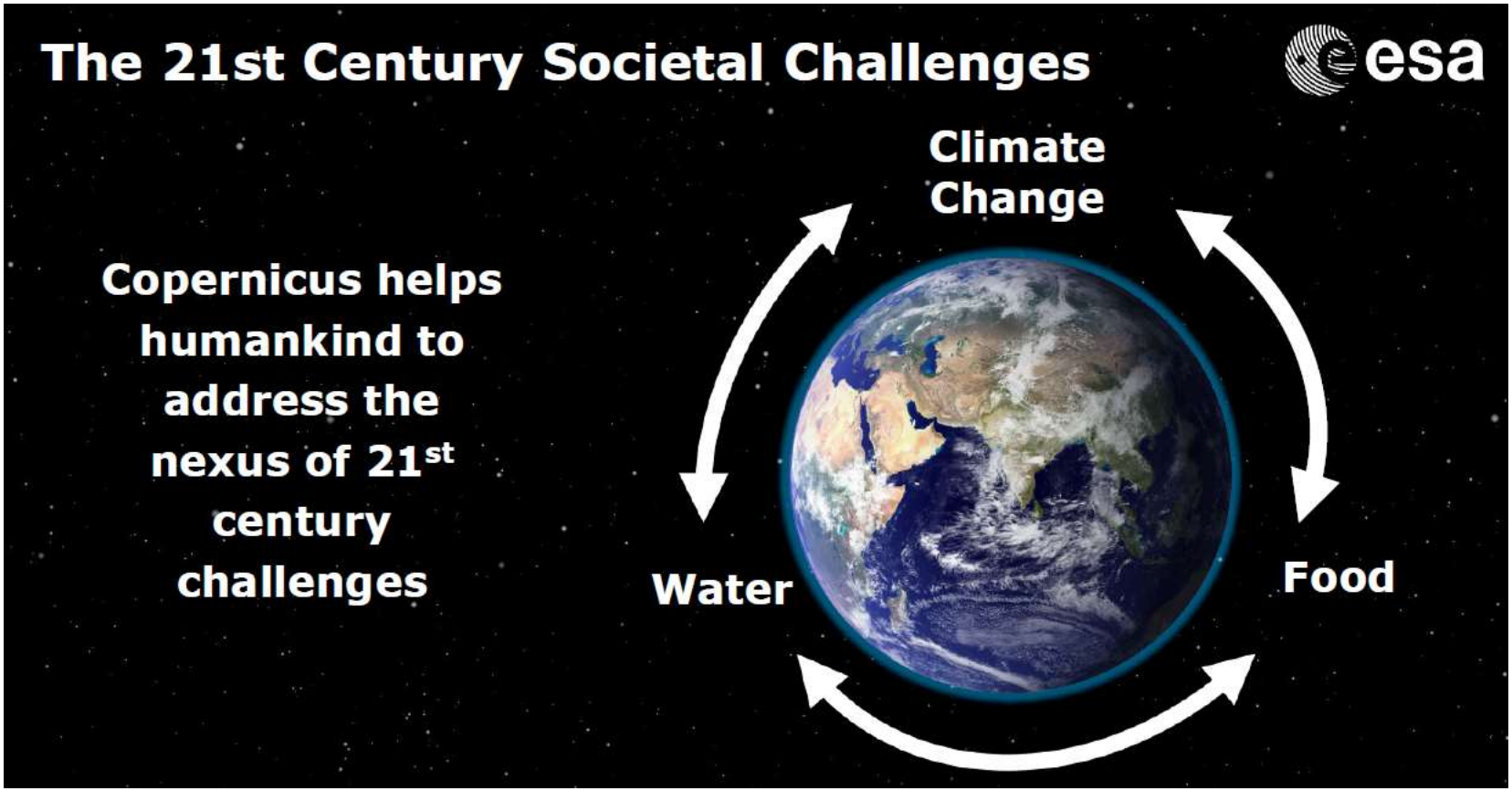

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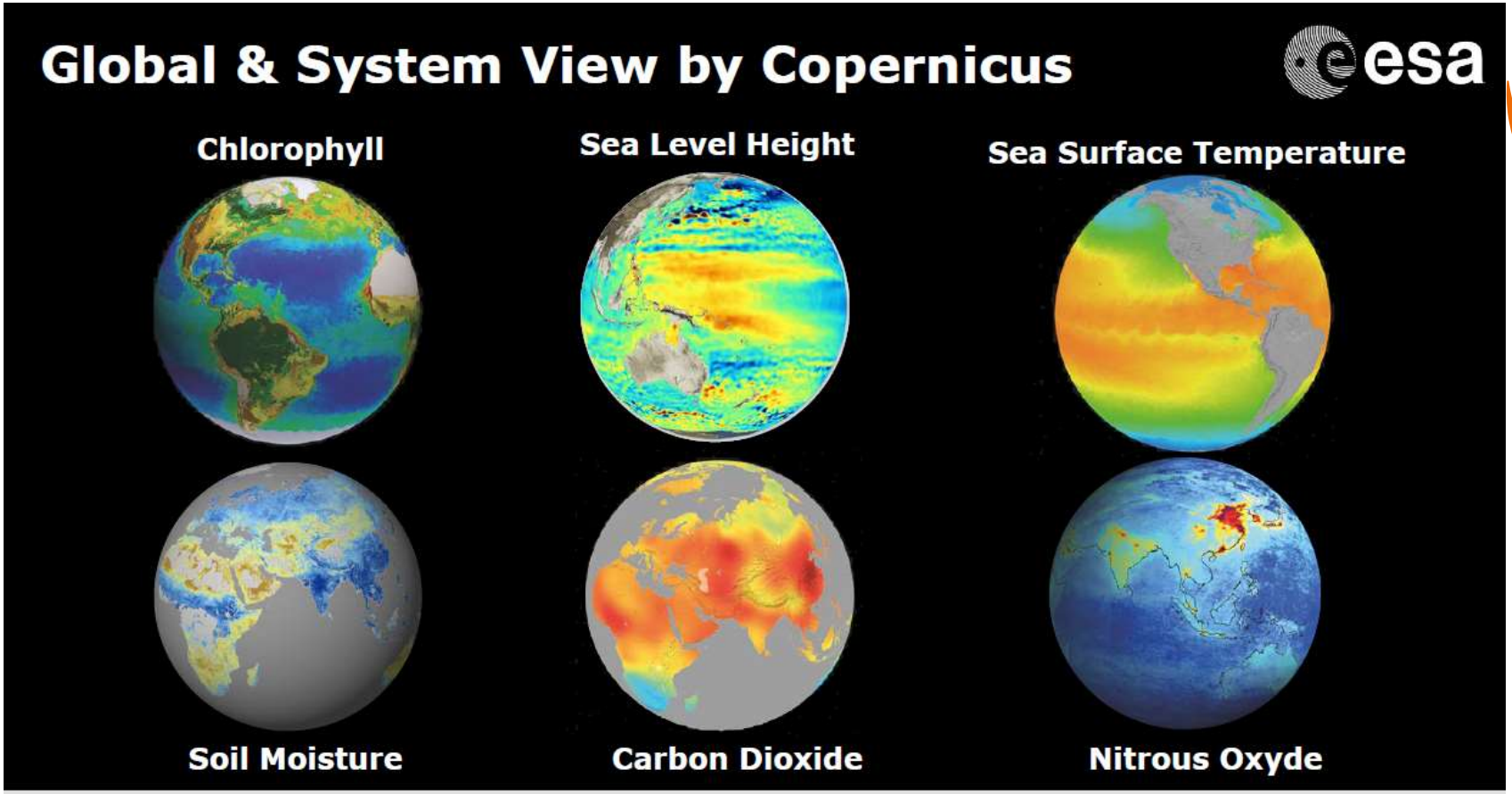
Interreg Baltic Sea Region

EUROPEAN UNION

EUROPEAN REGIONAL DEVELOPMENT FUND



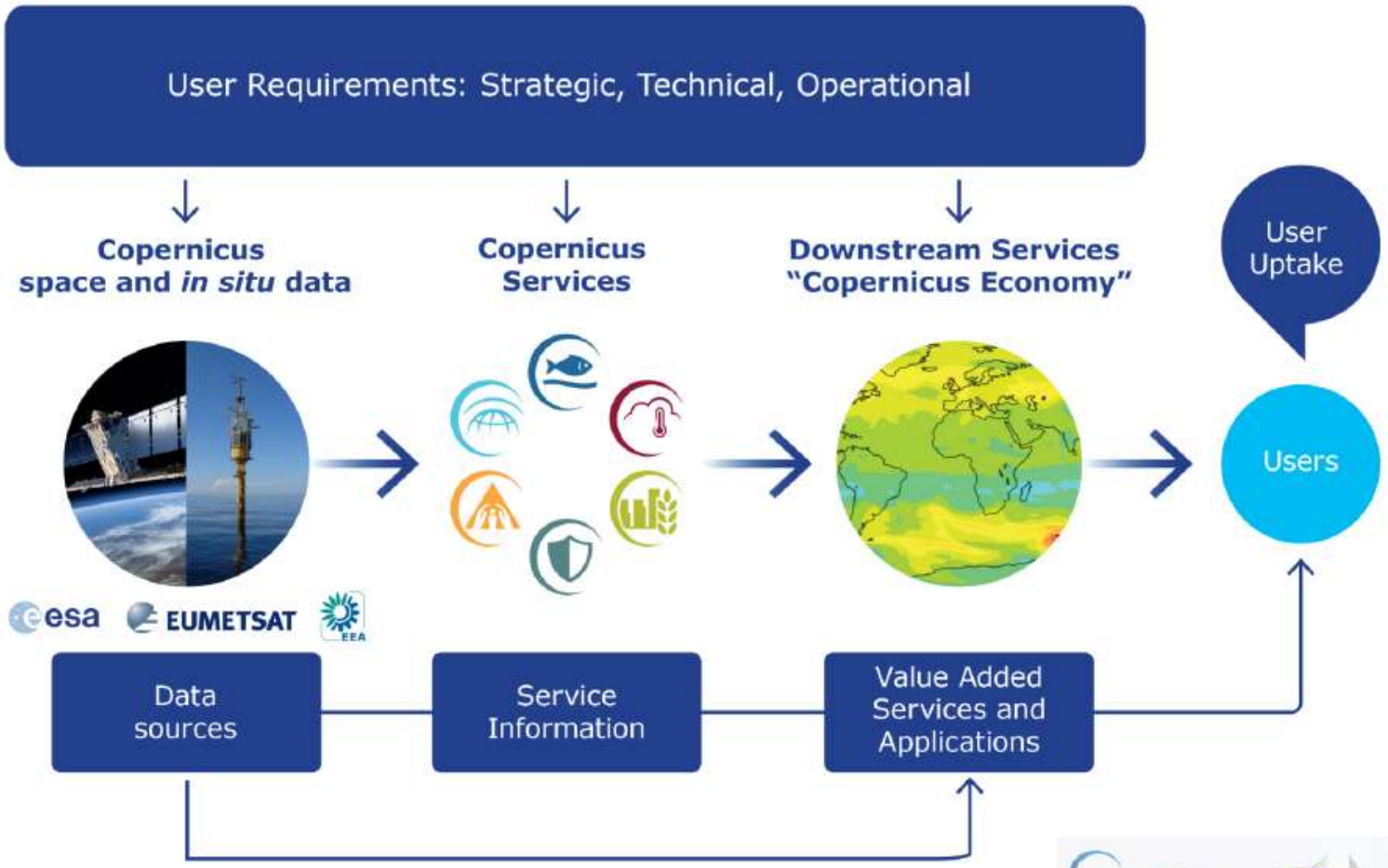
BALTIC SAT APPS

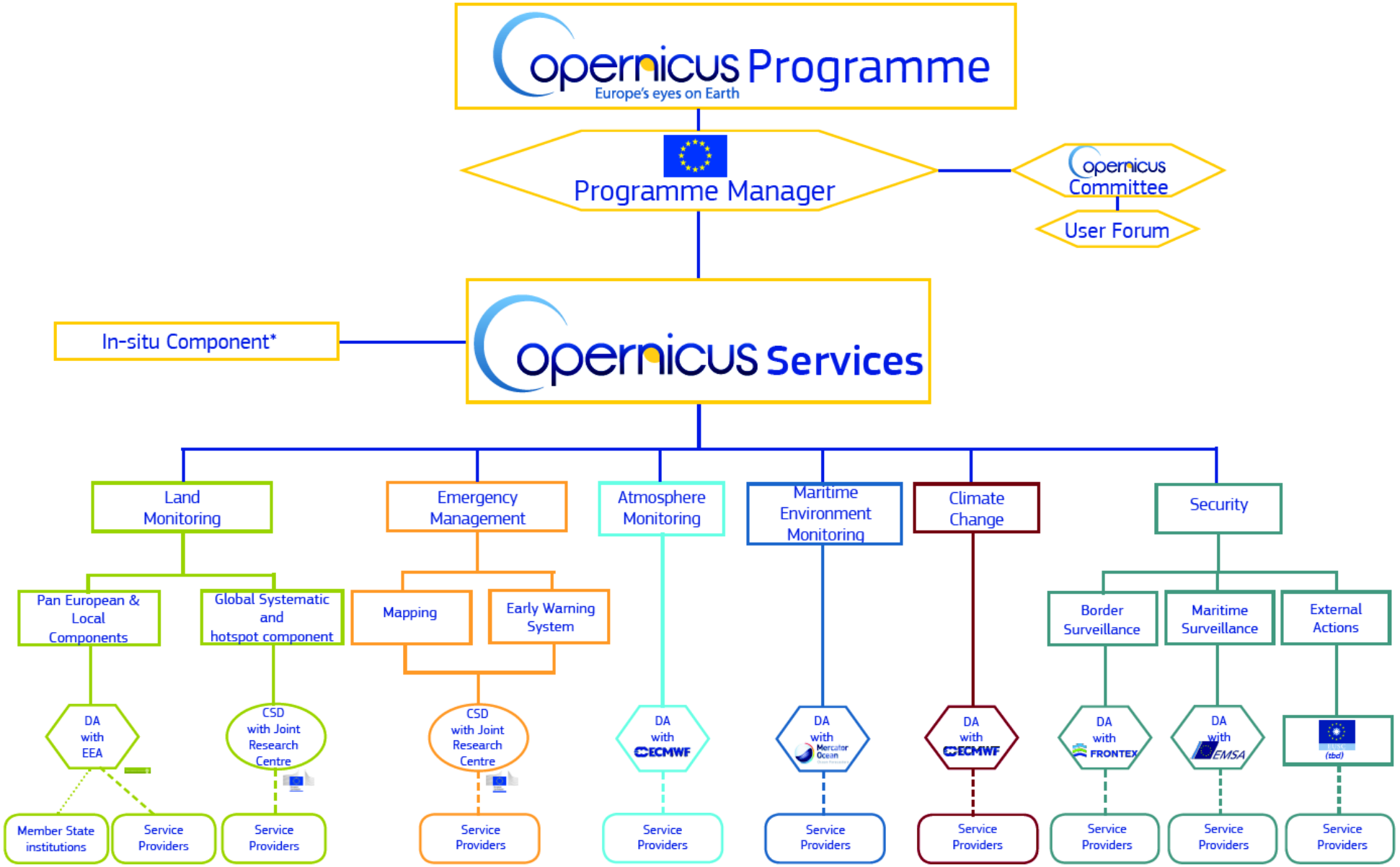
Interreg Baltic Sea Region

EUROPEAN UNION

EUROPEAN REGIONAL DEVELOPMENT FUND

COPERNICUS IS DRIVEN BY THE USERS

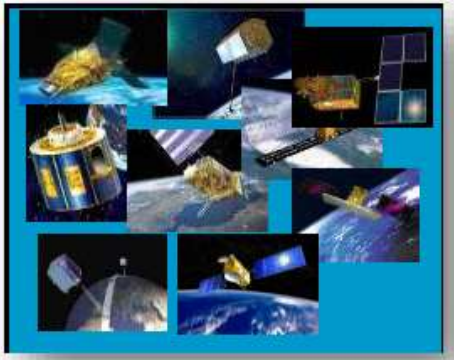



Copernicus Programme
Europe's eyes on Earth
Programme Manager
Copernicus Committee
User Forum
In-situ Component*
Copernicus Services
Land Monitoring
Emergency Management
Atmosphere Monitoring
Maritime Environment Monitoring
Climate Change
Security
Pan European & Local Components
Global Systematic and hotspot component
Mapping
Early Warning System
Border Surveillance
Maritime Surveillance
External Actions
DA with EEA
CSD with Joint Research Centre
CSD with Joint Research Centre
DA with ECMWF
DA with Mercator Ocean
DA with ECMWF
DA with FRONTEX
DA with EMSA
(tbd)
Member State institutions
Service Providers
Service Providers
Service Providers
Service Providers
Service Providers
Service Providers
Service Providers
Service Providers
Service Providers
Legend:
Implementation mode still to be defined
Commercial contracts
Grants
Copernicus component
Service Providers
Mode of implementation (direct/indirect):
Indirect Management
Direct Management
* Coordination by EEA
EA - Delegation agreement
CSD - Cross Sub-delegation
ESA - European Space Agency
EUMETSAT - European Organisation for the Exploitation of Meteorological Satellites
EEA - European Environment Agency
EUSC - European Union Satellite Center
FRONTEX - The European Agency for the Management of Operational Cooperation at the External Borders of the Member States of the European Union
ECMWF - The European Centre for Medium-Range Weather Forecasts

PROGRAMME ELEMENTS

Copernicus Sentinels

6 services use Earth Observation data to deliver …



Other Satellites

"in-situ"

…added-value products

Copernicus – European Leadership in EO

The Copernicus Sentinels Explained

	**Sentinel 1** (A/B/C/D) **SAR Imaging**	All weather, day/night applications, interferometry
	**Sentinel 2** (A/B/C/D) **Multispectral Imaging**	Land applications: urban, forest, agriculture, … Continuity of Landsat, SPOT
	**Sentinel 3** (A/B/C/D) **Ocean & Global Land Monitoring**	Wide-swath ocean colour, vegetation, sea/land surface temperature, altimetry
	**Sentinel 4** (A/B) **Geostationary Atmospheric**	Atmospheric composition monitoring, pollution; instrument on MTG satellites
	**Sentinel 5** (A/B/C) & Precursor **Low-Orbit Atmospheric**	Atmospheric composition monitoring; instrument on MetOp-SG satellites
	**Sentinel 6** **Jason CS (A/B)**	Altimetry reference mission

COPERNICUS SATELLITES

FULL, FREE AND OPEN

	Sentinel Mission and Status		Key Features
	SENTINEL-1: 4-40m resolution, 3 day revisit at equator	*2 Sats in orbit*	Polar-orbiting, all-weather, day-and-night radar imaging
	SENTINEL-2: 10-60m resolution, 5 days revisit time	*2 Sats in Orbit*	Polar-orbiting, multispectral optical, high-res imaging
	SENTINEL-3: 300-1200m resolution, <2 days revisit	*2 Sats in Orbit*	Optical and altimeter mission monitoring sea and land parameters
	SENTINEL-4: 8km resolution, 60 min revisit time	*1st Launch in 2020*	Payload for atmosphere chemistry monitoring on MTG-S
	SENTINEL-5p: 7-68km resolution, 1 day revisit	*1 Sat in Orbit*	Mission to reduce data gaps between Envisat, and S-5
	SENTINEL-5: 7.5-50km resolution, 1 day revisit	*1st Launch in 2021*	Payload for atmosphere chemistry monitoring on MetOp 2nd Gen
	SENTINEL-6: 10 day revisit time	*1st Launch in 2020*	Radar altimeter to measure sea-surface height globally

Copernicus

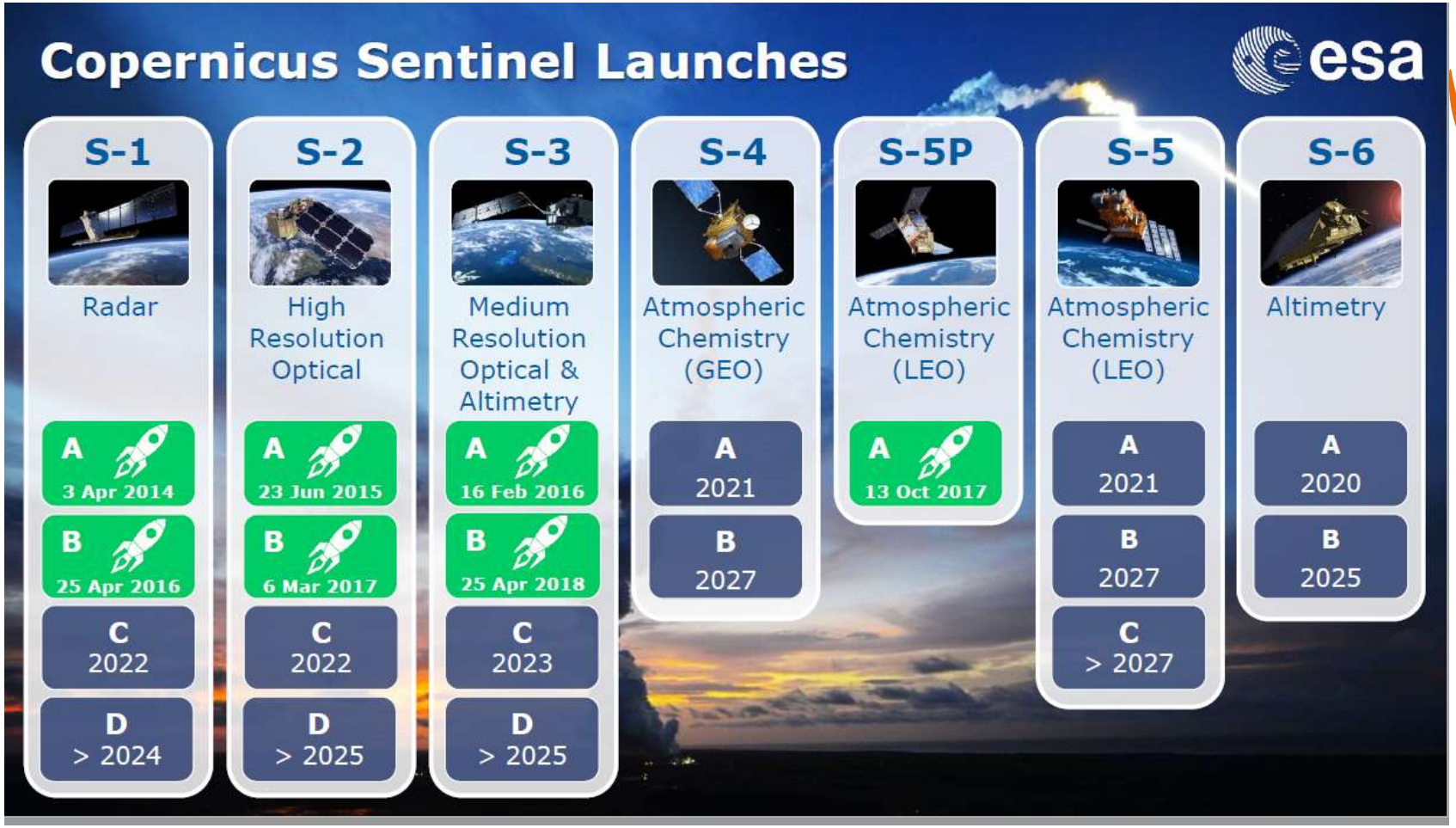
Europe's eyes on Earth

European Commission

Interreg Baltic Sea Region

EUROPEAN REGIONAL DEVELOPMENT FUND

EUROPEAN UNION



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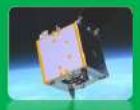
Copernicus Contributing Missions

Optical High & Very High Resolution

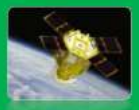
DMC



Pléiades

RapidEye

Deimos-2

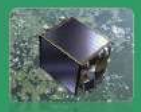


SPOT (HRS)

Optical Medium & Low Resolution

SPOT

PROBA-V



Synthetic Aperture Radar

Cosmo SkyMed

Radarsat

TerraSAR-X Tandem-X

Altimetry

Cryosat

Jason

Atmosphere

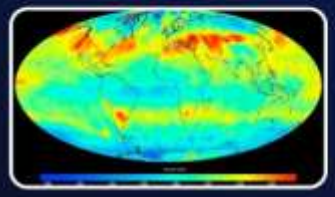
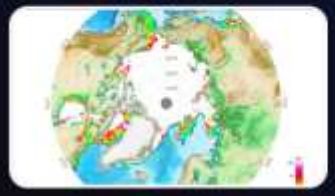
MetOp

MSG

and many more ...

Sentinel Expansion (Phase A/B1 studies)

esa

High Priority Candidate Missions	Applications
 Anthropogenic CO_2	Climate Change (Causes)
 Polar Ice & Snow Topography	Climate Change (Effects)
 Passive Microwave Imaging	Sea Surface Temperature & Sea Ice Concentration

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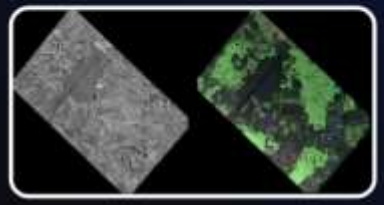
Sentinel Expansion (Phase A/B1 studies)

esa

High Priority Candidate Missions	Applications
 High Resolution Land Surface Temperature	Agriculture & Urban Management Services
 HyperSpectral Imaging	Agricultural Management & Food Security, Soil & Mineral Resources
 L-band SAR	Soil, Vegetation, Food Security & Ground Motion

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Interreg Baltic Sea Region

EUROPEAN UNION

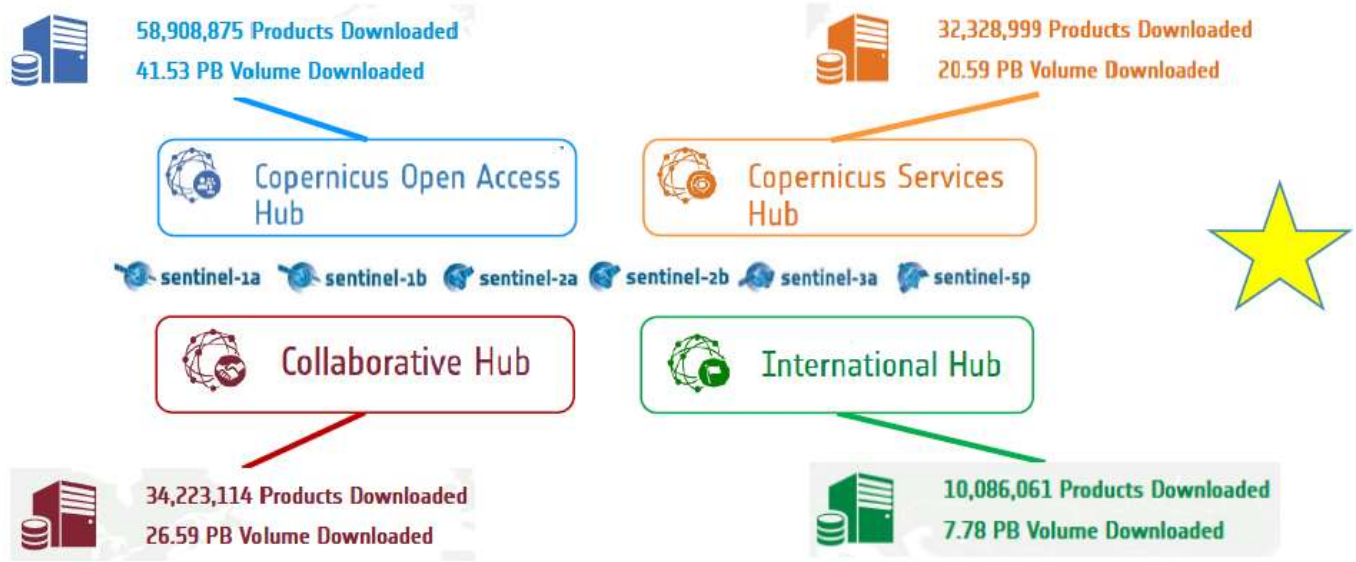
EUROPEAN REGIONAL DEVELOPMENT FUND

Sentinels Data Access – Four Access Hubs

Data Access

The four Copernicus Sentinel data access hubs operated by ESA

→ *the enabler of a wide distribution to users*



Statistics at end-October 2018

BALTIC SAT APPS

Interreg Baltic Sea Region

EUROPEAN REGIONAL DEVELOPMENT FUND

EUROPEAN UNION

Data & Information Access Services (DIAS)

Data Access

e.copernicus.eu/DIAS

THE DIAS & WHERE TO REACH THEM

CREODIAS

WWW.CREODIAS.EU

sobloo

WWW.SOBLOO.EU

mundi WEB SERVICES

WWW.MUNDIWEBSERVICES.COM

ONDA

WWW.ONDA-DIAS.EU

WEKEO

WWW.WEKEO.EU

EUMETSAT

opernicus
Europe's eyes on Earth

European Commission

BALTIC SAT APPS

Copernicus Services Component


Copernicus
Monitoring
Services
FULL, FREE AND OPEN
ACCESS TO DATA
ATMOSPHERE MONITORING
MARINE ENVIRONMENT MONITORING
LAND MONITORING
CLIMATE CHANGE
EMERGENCY MANAGEMENT
SECURITY
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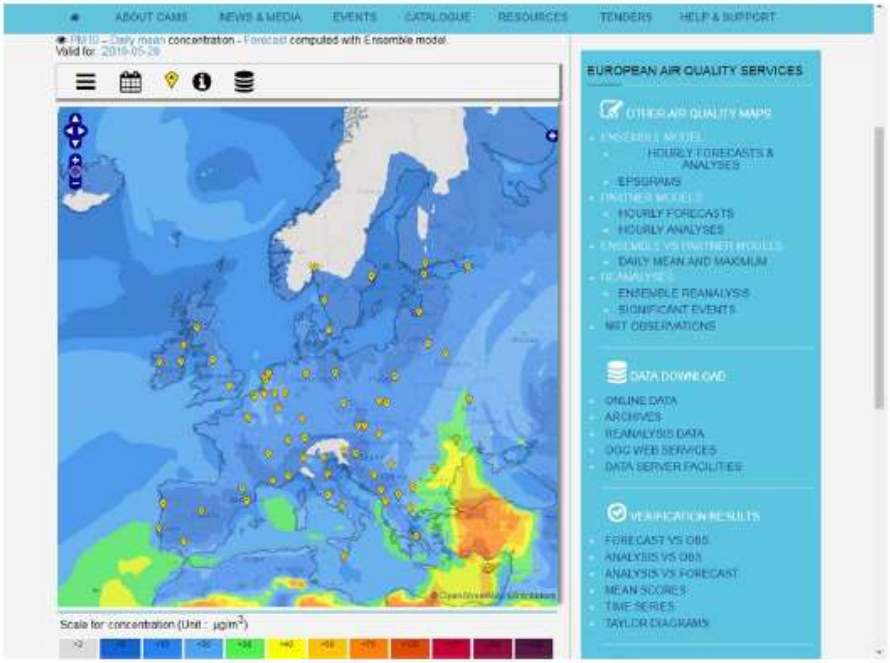
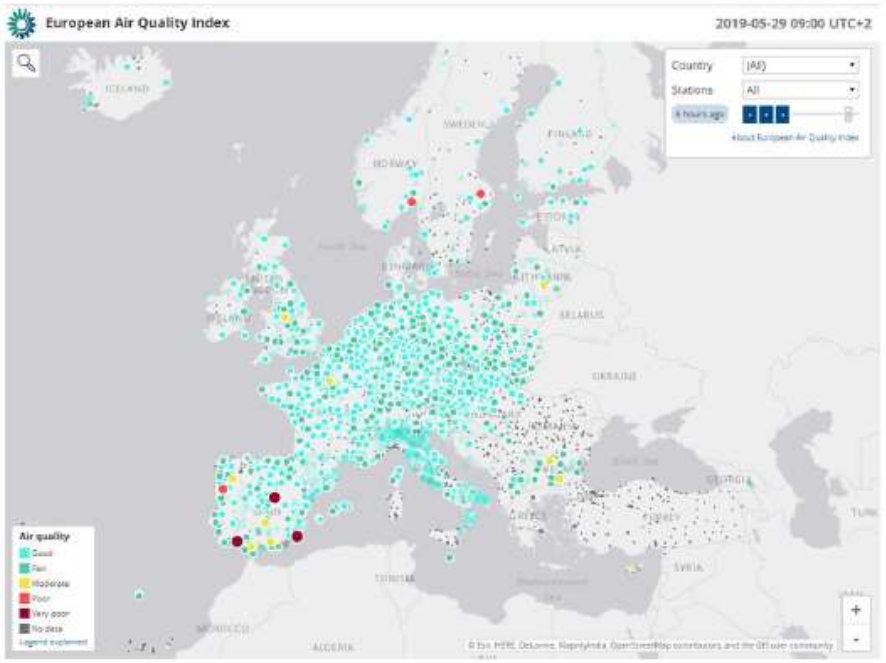
Copernicus Atmosphere Monitoring Service (CAMS)

- Air quality, atmospheric composition 
- Variables of climate forcing 
- Ozone layer & UV 
- Solar radiation 
- Emissions and surface fluxes 

Use of Copernicus Atmosphere Monitoring Services in air quality monitoring





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Copernicus Marine Environment Monitoring Service (CMEMS)

Maritime security

Marine resources

Coastal & marine environment

Meteorology, seasonal predictions and climatology

Copernicus
Europe's eyes on Earth

European Environment Agency

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Baltic Sea Region

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Freshwater and marine work using Copernicus information

Copernicus Land Monitoring Service products that we have been using since 2018:

- Riparian zone layers (used within the 1.5.3 Floodplain ecosystems project)
- Water and Wetness indicator (used within the 1.6.1. Marine indicators project, i.e. NIS in TC waters)

CMEMS products for use in EEA Indicators:

CODE	Indicator name	Data source	Previous update	Next update
MAR 011/CLIM 015	Fish distribution	ICES data	2018	2021
MAR 012/CLIM 054	Reduced oxygen content	ICES, Emodnet, Copernicus –CMEMS references	2018 (WIMS)	2019
CLIM 043	Ocean acidification	Copernicus -CMEMS		
CLIM 044	Ocean heat content	Copernicus -CMEMS		
CSI046/CLIM013	Sea surface temperature	Copernicus -CMEMS		
CSI053/CLIM010	Arctic and Baltic Sea ice	Copernicus -CMEMS		
MAR 010	Offshore wind energy	Emodnet	-	tbd

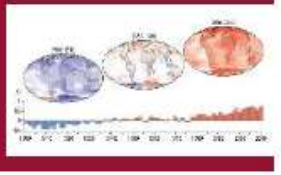
MSFD – Descriptor 5 'Eutrophication is minimised'

MSFD – Descriptor 7 'Permanent alteration of hydrographical conditions does not adversely affect the ecosystem'

Copernicus Climate Change Service (C3S)

Estimation of essential climate variables (ECVs)

Global and regional re-analyses



Seasonal predictions and climate projections

Support to mitigation and adaptation strategies

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EEA climate change impacts indicator

2019

Updates based on C3S information and data

Global temperature (CSI012)
European temperature (CLIM001)
European extreme temperatures (CLIM003)

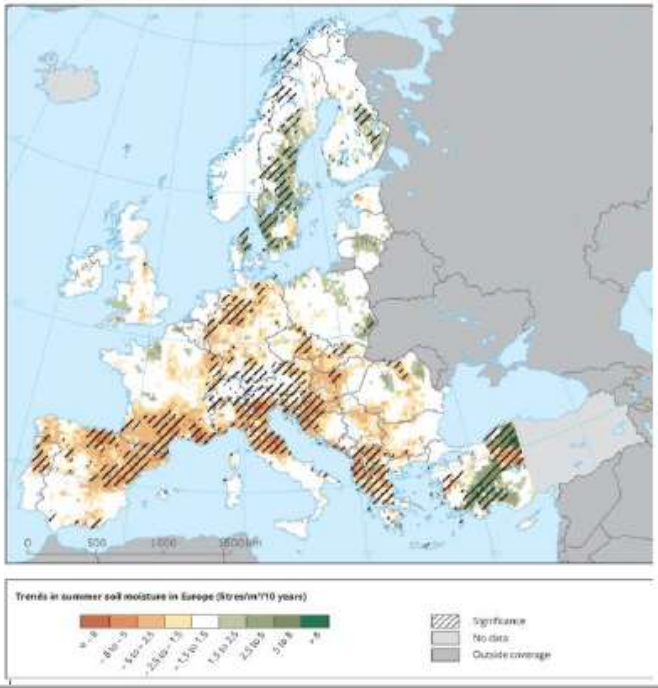
Planned updates partly provided by C3S

Heavy precipitation (CLIM004)
Heating and cooling degree days (CLIM047)

2020

Updates based on C3S information and data

Mean precipitation
Storms
Snow cover
Soil moisture
Extreme temperatures and health
Hail
....



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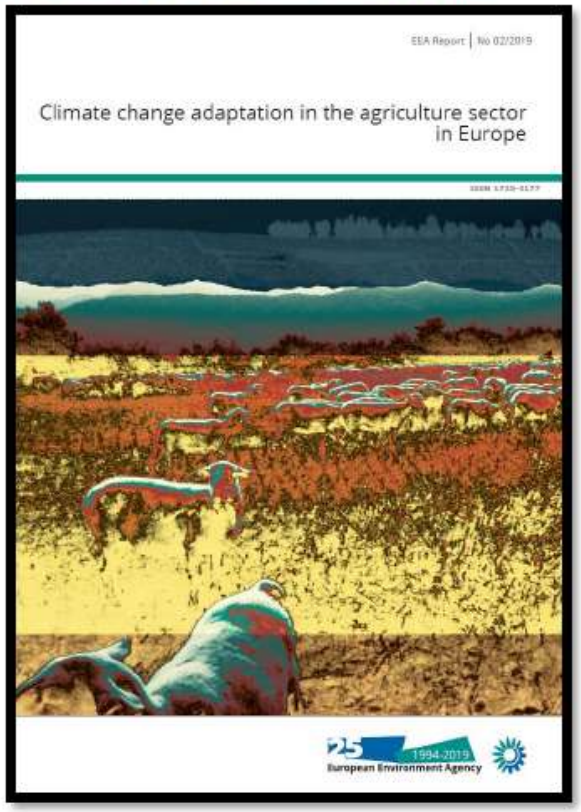
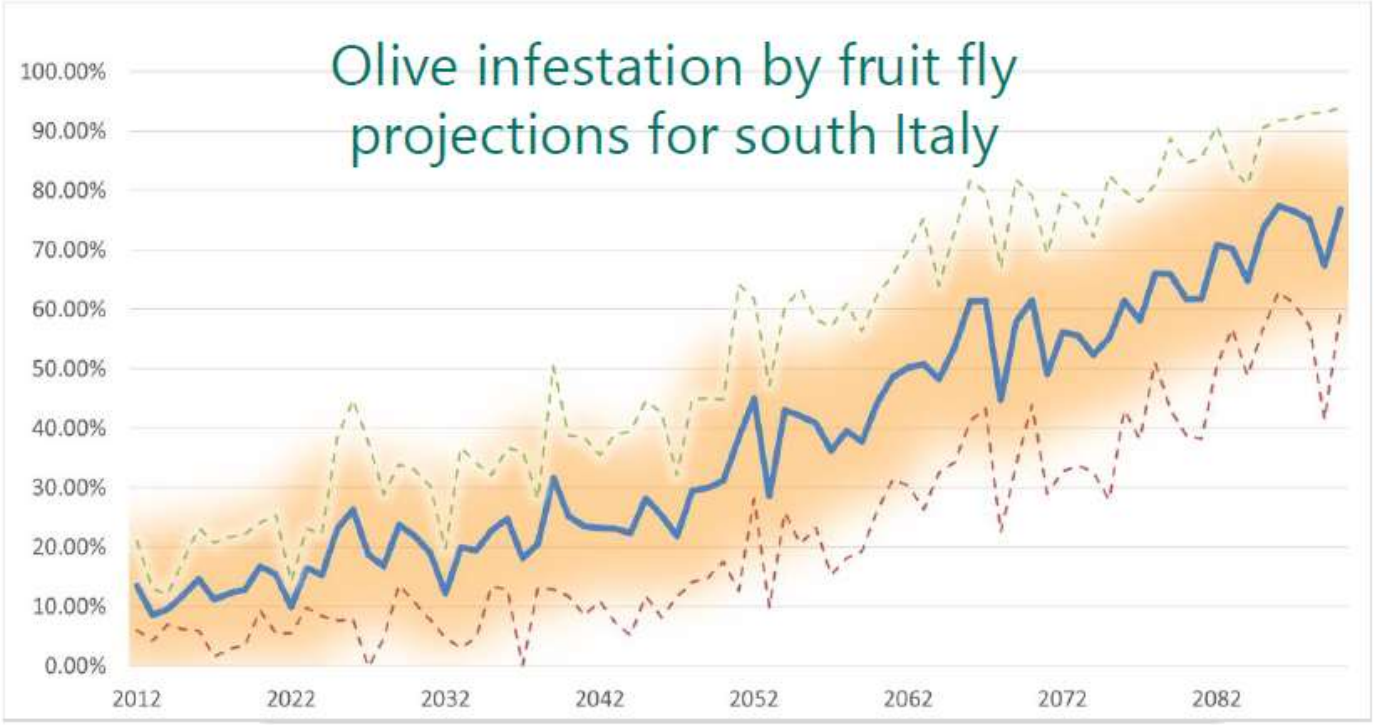
EEA climate change adaptation assessments

Climate change adaptation in the agriculture sector in Europe





Provided by C3S AgriCLASS project - https://climate.copernicus.eu/agriculture-and-forestry

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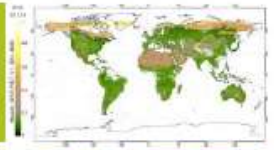
Copernicus Land Monitoring Service (CLMS)

- Systematic Biophysical Monitoring

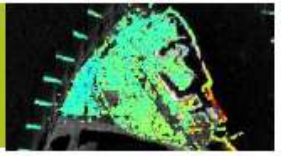


- Land Cover & Land Use mapping

- Thematic hotspot mapping

- Reference data

- Ground Motion service



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Land cover and habitat information within Natura 2000

Copernicus Land Monitoring Service - Natura 2000

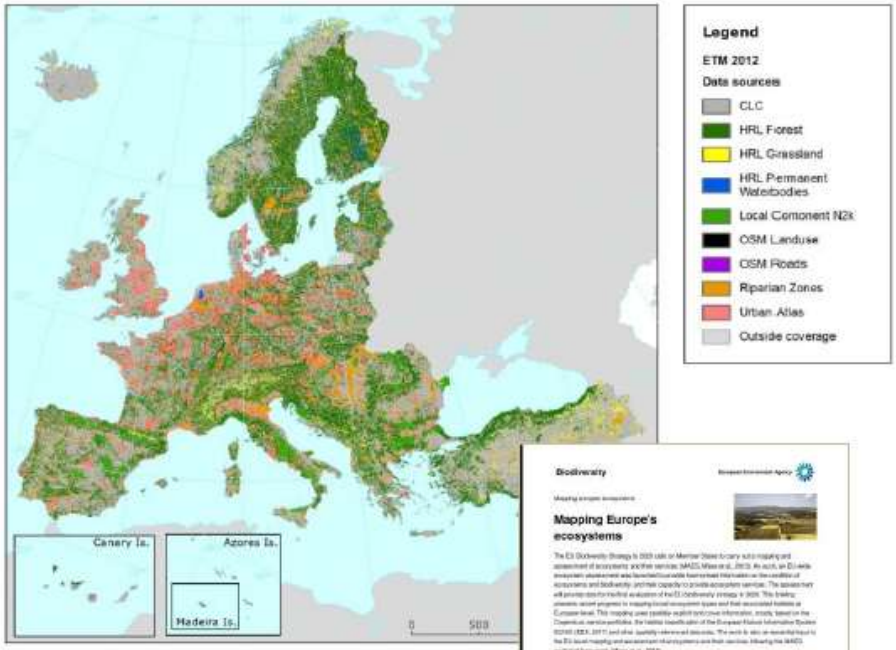
LC/LU in a selection of grassland-rich Natura 2000 sites to assess their actual **area**, **condition** and **development** over time.

- A change analysis for 2006-2012 reference years,
- Comparison with a 2 km buffer zone for analysis of pressures and threats,
- Checking for decline of certain grassland habitat types is being halted

Copernicus Land Monitoring Service - Natura 2000:
https://www.eea.europa.eu/data-and-maps/data/copernicus-land-monitoring-service-natura-2000
And
https://land.copernicus.eu/local/natura/natura-2000-2012?tab=mapview

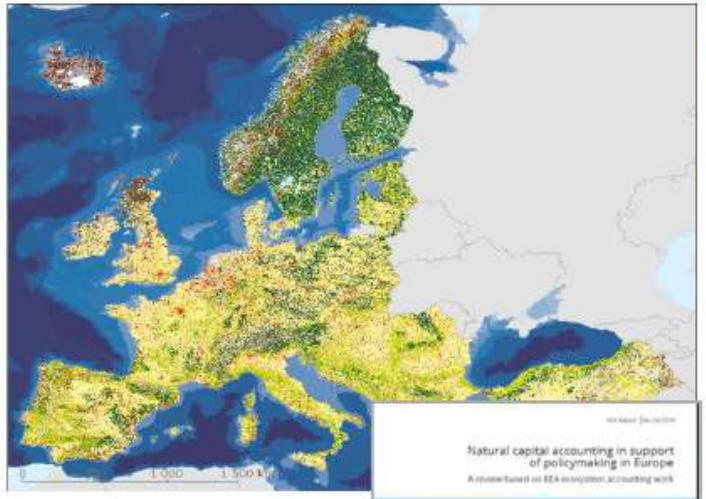
European Environment Agency

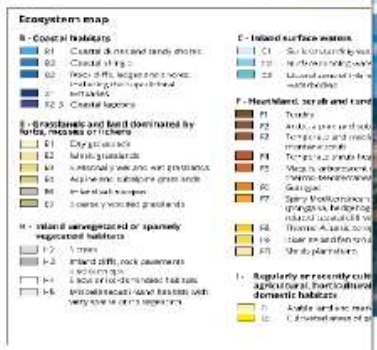
Ecosystem mapping and habitat delination

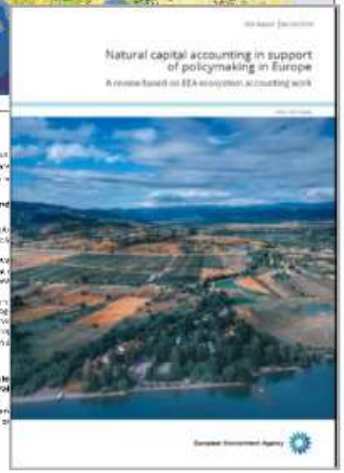


Based on the 7 Copernicus land monitoring services

Ecosystem Map v3.1







Ca. 60 Habitats

- Terrestrial (>50)
- freshwater (3)
- marine (>15

- Based on habitat distribution maps (selected vegetation plots based on the EUNIS habitat revision critieria).
- Further updates during 2019 following EUNIS revision

https://www.eea.europa.eu/data-and-maps/data/ecosystem-types-of-europe-1

https://www.eea.europa.eu/highlights/measuring-condition-of-europes-ecosystems

European Environment Agency

Good potential for future use of Copernicus

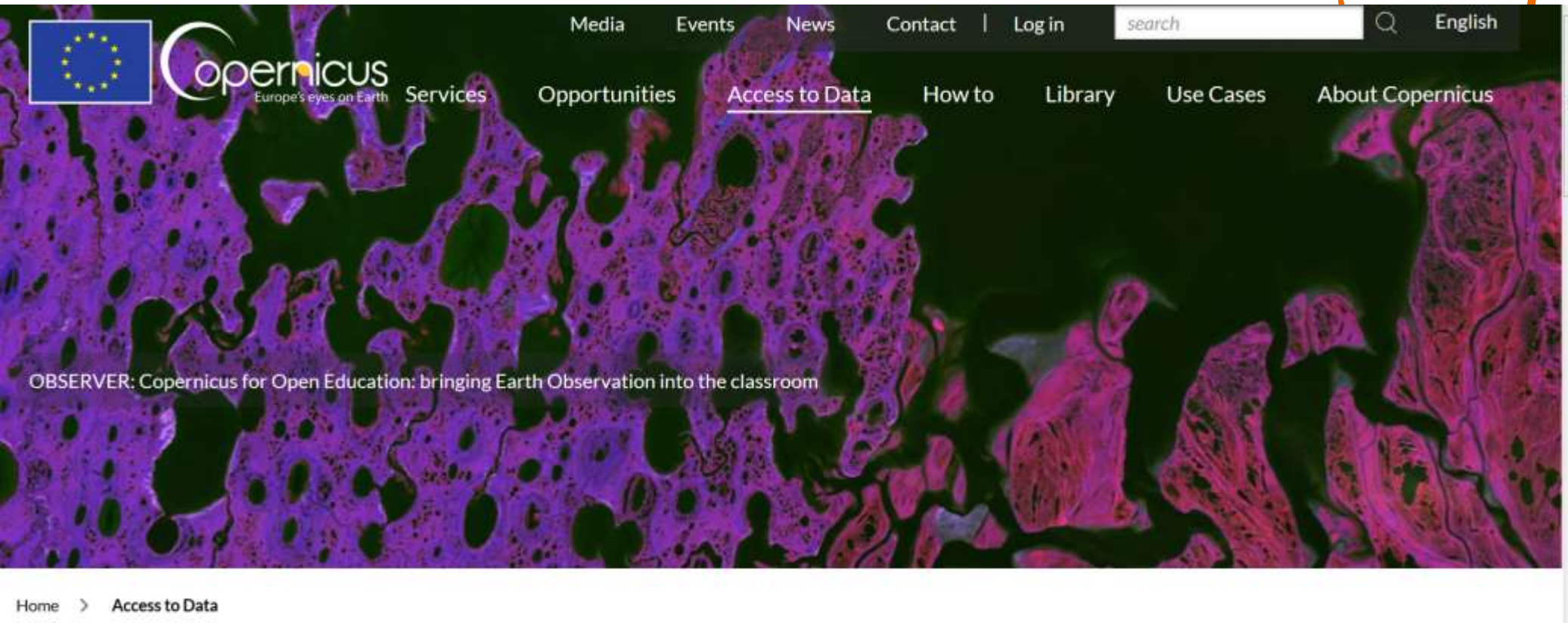
Indicator Code	Indicators	Related Copernicus Service
AIR003/CSI004	Exceedance of air quality standards in urban areas	CAMS
CLIM036	Extreme temperatures and health	C3S / CAMS
CLIM002	Mean precipitation	C3S
CLIM004	Heavy precipitation	C3S / CAMS
CLIM005	Wind Storms	C3S
CLIM007	Glaciers	C3S
CLIM008	Snow cover	C3S
CLIM009	Greenland and Antarctic ice sheets	C3S
CLIM012/CSI047	Global and European sea-level	CMEMS / C3S
CLIM013/CSI04	Sea surface temperature	CMEMS / C3S
CLIM018	Meteorological and hydrological drought	C3S
CLIM032	Water-limited crop yield	C3S / CLMS
CLIM033	Crop water demand	C3S / CLMS
CLIM034	Forest composition and distribution	C3S / CLMS
CLIM035	Forest fires	C3S / CLMS
CLIM044	Ocean heat content	C3S / CMEMS
CLIM046	Floods and health	C3S / CMEMS / CAMS
CLIM049/CSI006	Production/consumption of ozone depleting substances	C3S
CLIM052/CSI013	Atmospheric greenhouse gas concentrations	C3S
CLIM053	Hail	C3S
CLIM054	Ocean oxygen content	C3S / CMEMS
LSI007	Soil moisture	CLMS
MAR005/CSI021	Nutrients in transitional, coastal and marine waters	CMEMS / C3S
MAR006/CSI023	Chlorophyll in transitional, coastal and marine waters	CMEMS / C3S
SEBI007	Nationally designated protected area	CLMS
SEBI017	Forest: growing stock, increment and fellings	CLMS
CLIM050/CSI010	Total greenhouse gas emission trends and projections	C3S
MAR 012	Reduced oxygen content	CMEMS / C3S

Use cases

Many examples of use cases, per application domain and per country, are available from Copernicus Programme official web-site: https://www.copernicus.eu/en/use-cases

European Environment Agency

www.copernicus.eu



Access to Data

Copernicus builds on a constellations of satellites making millions an impressive number of of daily observations, as well as on a global network of thousands of land-, air- and marine-based sensors to create the most detailed pictures of Earth. The technological evolution, especially in terms of availability and accessibility, has made Copernicus the largest space data provider in the world, currently producing 12 terabytes per day.

The vast majority of data and information delivered by the Copernicus Space infrastructure and the Copernicus services are made available and accessible to any citizen and any organisation around the world on a **free, full and open access basis**. You can access Copernicus Data and Information Services through the DIAS or the Conventional Data Hubs.

Go to DIAS

Go to Access Hubs

DIAS

To facilitate and standardise access to data, the European Commission has funded the deployment of five cloud-based platforms providing centralised access to Copernicus data and information, as well as to processing tools. These platforms are known as the DIAS, or Data and Information Access Services.

The five DIAS online platforms allow users to discover, manipulate, process and download Copernicus data and information. All DIAS platforms provide access to Copernicus Sentinel data, as well as to the information products from Copernicus' six operational services, together with cloud-based tools (open source and/or on a pay-per-use basis).

Each of the five competitive platforms also provides access to additional commercial satellite or non-space data sets as well as premium offers in terms of support or priority. Thanks to a single access point for the entire Copernicus data and information, DIAS allows the users to develop and host their own applications in the cloud, while removing the need to download bulky files from several access points and process them locally.

More info

Conventional Data Access Hubs

The vast majority of data and information delivered by the Copernicus space infrastructure and the Copernicus services are made freely available and accessible to any citizen and any organisation around the world.

Copernicus provides knowledge, but it all starts with data.

Satellite data		Services data and information	
ESA	EUMETSAT	Land - CLMS	Marine - CMEMS
SCI Hub	EUMETCast	Atmosphere - CAMS	Climate - C3S
CSCDA	CODA	Emergency - EMS	Security

Land

Discover Land

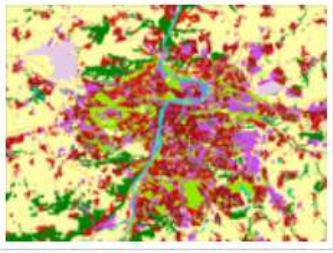
The Copernicus Land Monitoring Service (CLMS) provides geographical information on land cover and its changes, land use, vegetation state, water cycle and earth surface energy variables to a broad range of users in Europe and across the World in the field of environmental terrestrial applications.

It supports applications in a variety of domains such as spatial and urban planning, forest management, water management, agriculture and food security, nature conservation and restoration, rural development, ecosystem accounting and mitigation/adaptation to climate change.

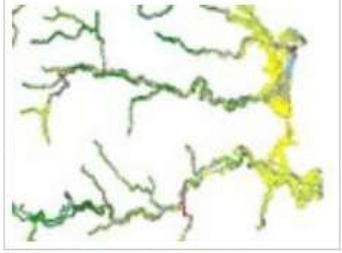
CLMS is jointly implemented by the European Environment Agency and the European Commission DG Joint Research Centre

Local

Print



Urban Atlas



Riparian Zones

Natura 2000 (N2K)

User corner

- How to access our data
- Technical library
- Factsheets
- Use cases

Contract opportunities

EAGLE

Use Cases

Publications

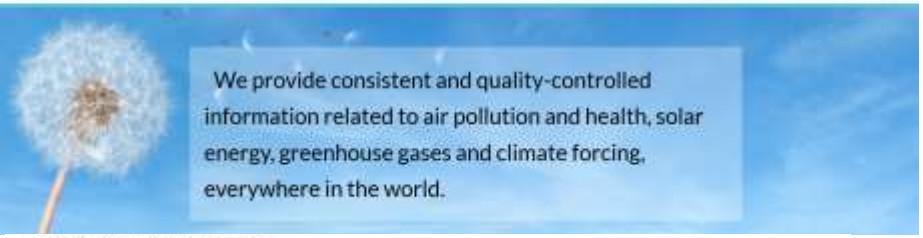
Technical library

Looking for national products?

Atmosphere Monitoring Service

News Events Press Tenders Help & support

DATA ABOUT US WHAT WE DO SEARCH



Today's air quality forecasts

Europe

Worldwide

| Daily CAMS air quality forecast on Euronews

Thematic output areas

Air quality

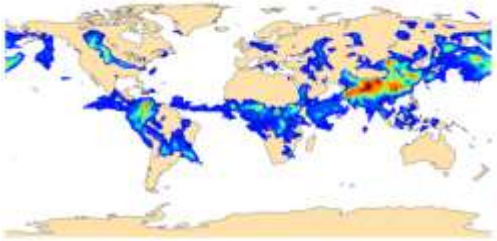
Policy tools

Solar energy

Ozone layer and UV radiation

Emissions and surface Fluxes

Climate forcing



Data catalogue

We provide an extensive catalogue of data visualisations in the form of maps and charts. These data come from a variety of sources but is directly searchable using the catalogue.

Access the catalogue ▶

Service Product Portfolio ▶

Daily analyses and forecasts

Forecast charts:

Reactive gases

Aerosols

European air quality

Ozone layer

CO2

Analyses charts:

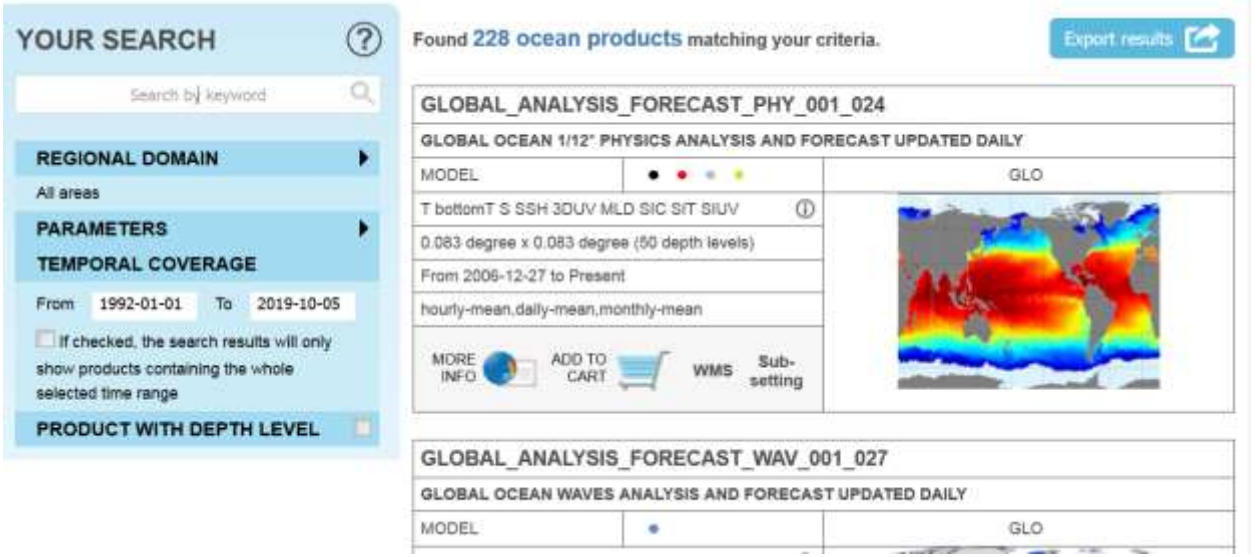
Fire monitoring

Overview on Policy Support

The CAMS policy web pages provide a number of products and results that aim at supporting decision and policy making in the management of air pollution episodes. Policy services are based on the air quality regional services capacities to elaborate added- value products describing the evolution of air quality in Europe and the influence of main anthropogenic sources, helping in designing appropriate and efficient policy responses to episode situations.

Moreover, it is expected that the policy products may be useful tools to support communication action of policy makers towards the general public, and regulatory reporting according to the European air quality Directives (2008/50/EC) and their implementation decisions (2011/850/EU).

1 POLAR ENVIRONMENT MONITORING
2 MARINE CONSERVATION & POLICIES
3 SCIENCE & CLIMATE
4 NATURAL RESOURCES & ENERGY
5 WATER QUALITY
6 COASTAL MONITORING
7 SOCIETY & EDUCATION
8 MARINE FOOD
9 MARINE NAVIGATION
10 SAFETY & DISASTER



USE CASES

See examples of how CMEMS data is used. You can read or download (pdf) **Use Case books** (by member states, by market...) here.

Geographical Area	Market	User type	Country	Mobile application
All	All	All	All	

Climate Change

The C3S mission

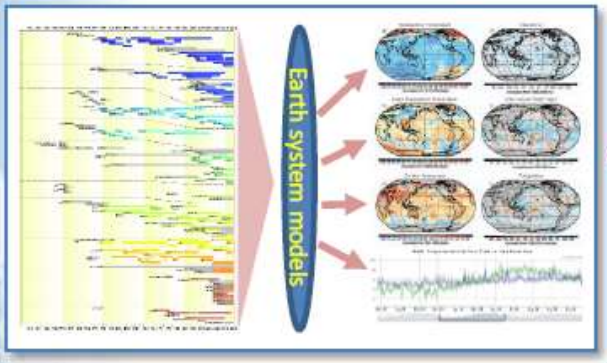
To support European adaptation and mitigation policies by:

- Providing consistent and authoritative information about climate (past, present, future)
- Building on existing capabilities and infrastructures (nationally, in Europe and worldwide)
- Stimulating the market for climate services in Europe

European Commission | Copernicus Europe's eyes on Earth | ECMWF

Climate Change

C3S: ACCESS TO PAST, PRESENT AND FUTURE CLIMATE INFORMATION

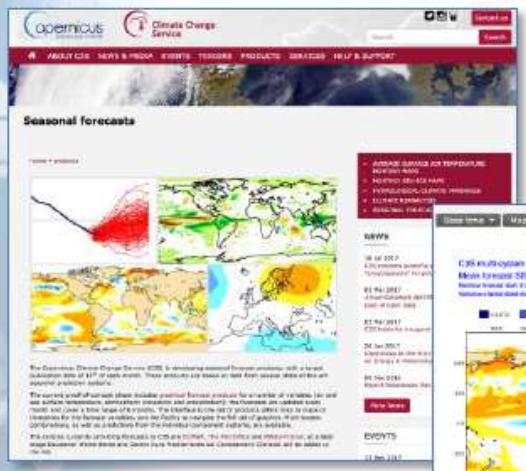


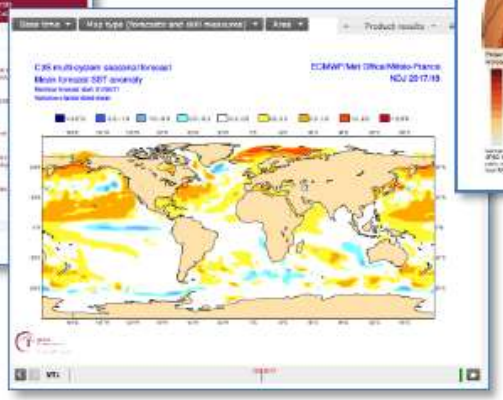
Observations and climate reanalyses

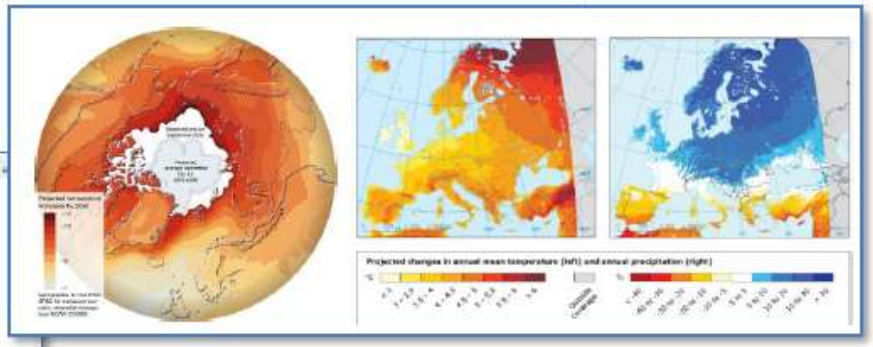
Seasonal forecast data and products

Climate model simulations

Sectoral climate impact indicators







http://climate.copernicus.eu

ECMWF Copernicus Europe's eyes on Earth

European Commission

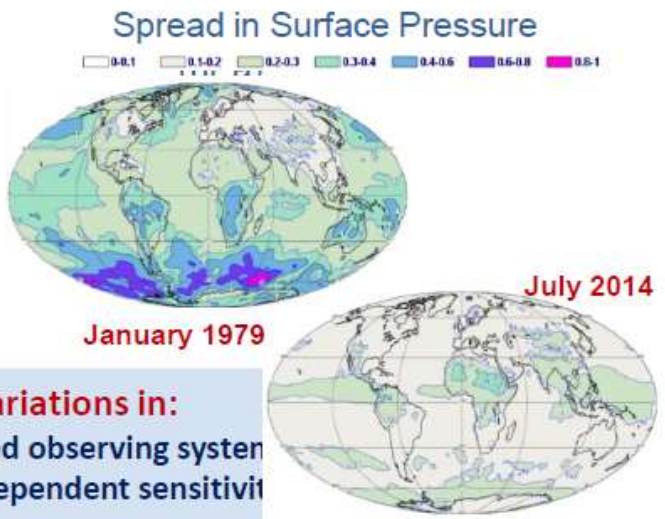
Climate Change

C3S: Reanalysis based Essential Climate Variables (30km global ERA5) Builds upon IFS modelling and Data Assimilation

Hourly data and increased number of parameters

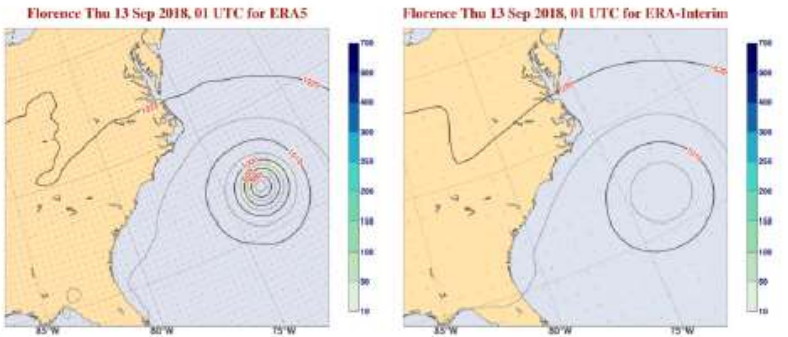
Courtesy: Philip Brohan

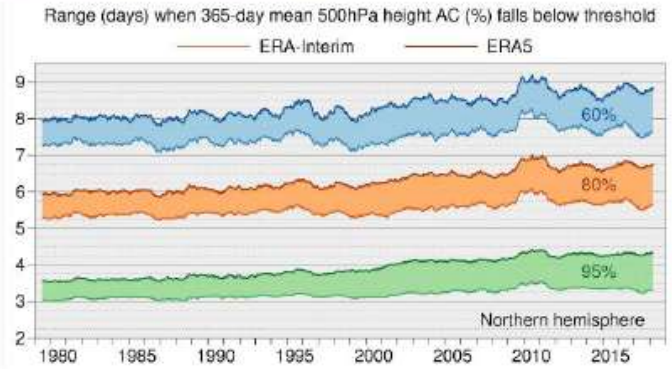
Uncertainty estimate



Reflects variations in:

- ingested observing systen
- flow-dependent sensitivit





Credit: H. Hersbach, ECMWF

Copernicus

European Commission

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C3S: EO based Essential Climate Variables

Climate Change

- Large uptake by Copernicus of Science in Europe (e.g. ESA Climate Change Initiative, EUMETSAT SAFs, etc.)
- Copernicus is a resource to WMO State of Climate, GCOS climate indicators, contributes to CEOS-CGMS Climate data records inventory

		Science → Operations			
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		■		

Climate Change

What C3S offers to its users

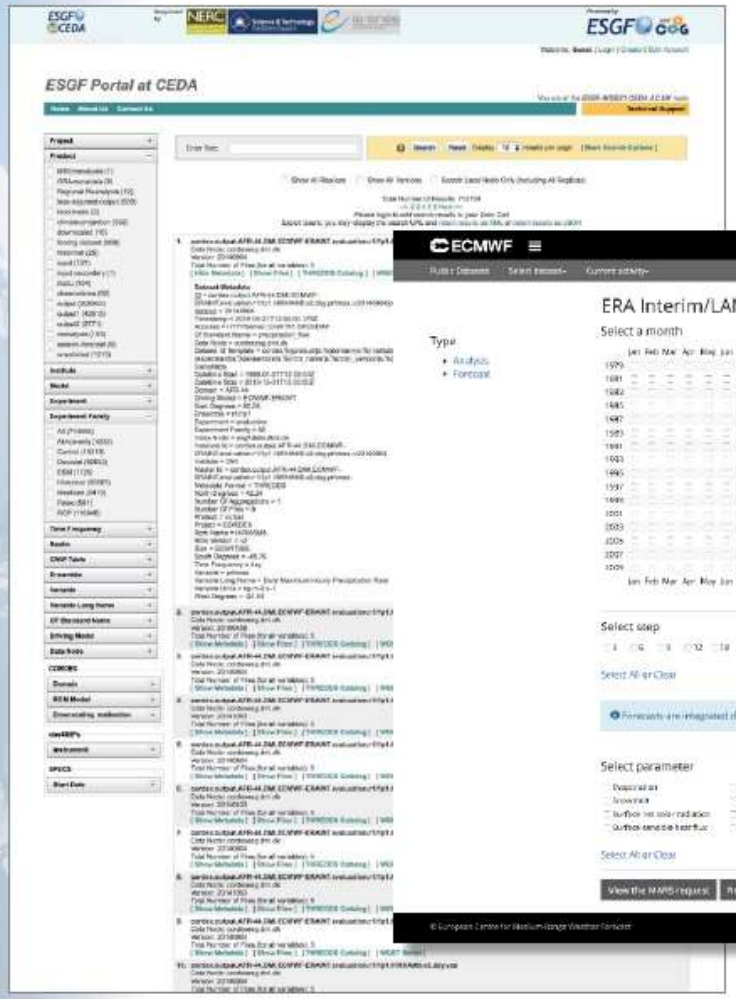
- Access to climate data
- Tools needed to use the data
- Information on sectoral impacts
- Quality assurance
- User support and training
- Climate change assessments
- Outreach and communication

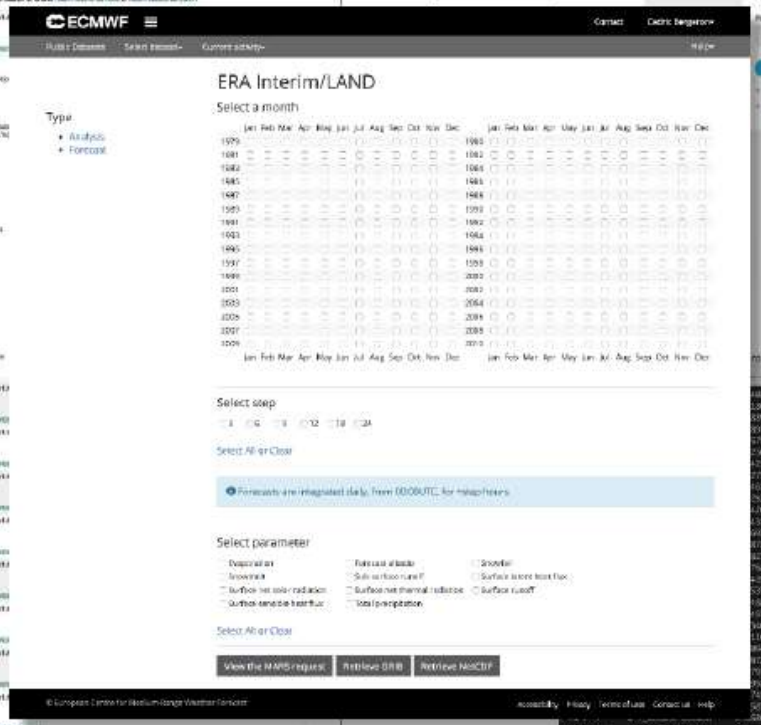
A one-stop Climate Data Store

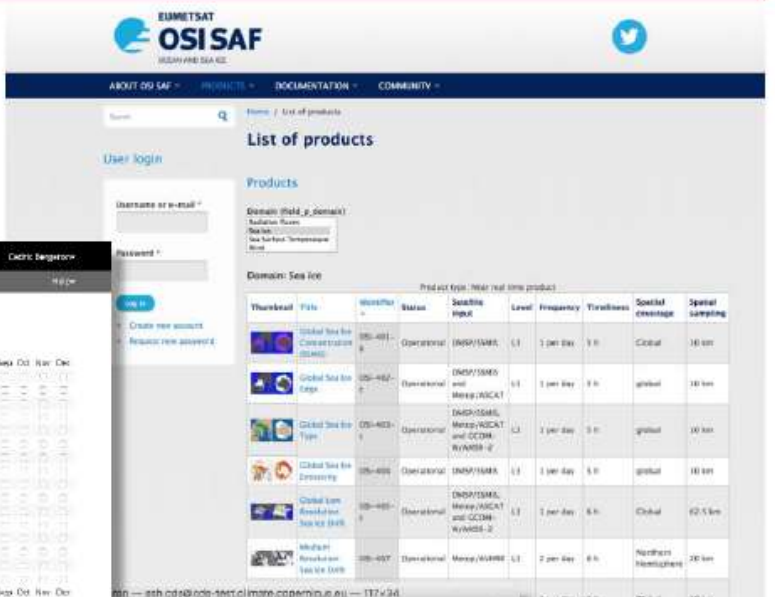
ECMWF Copernicus Europe's eyes on Earth | European Commission

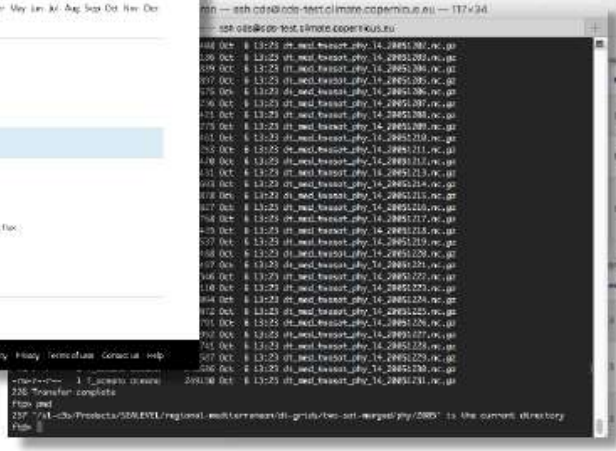
Interreg Baltic Sea Region | EUROPEAN REGIONAL DEVELOPMENT FUND | EUROPEAN UNION

Access to climate datasets before the CDS…



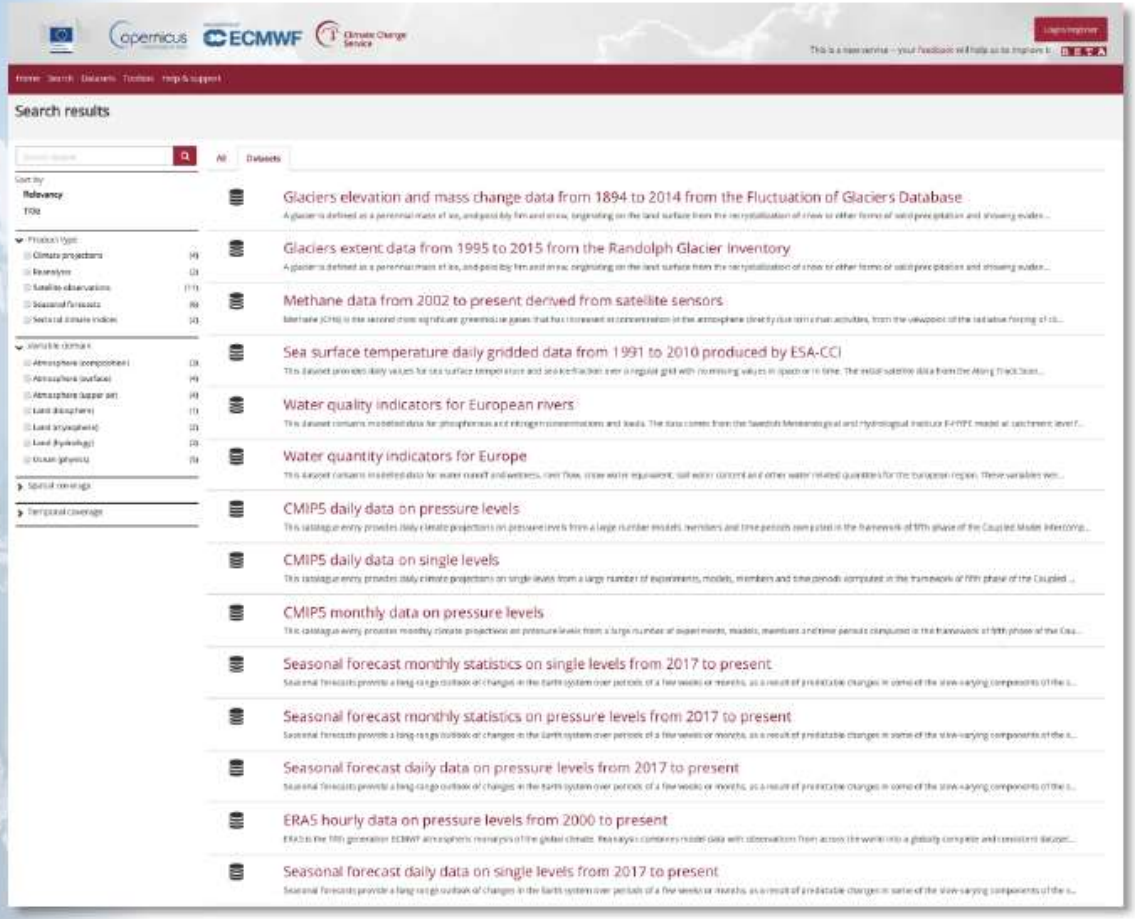






Climate Change

Catalogue of climate datasets



ECMWF Copernicus European Commission

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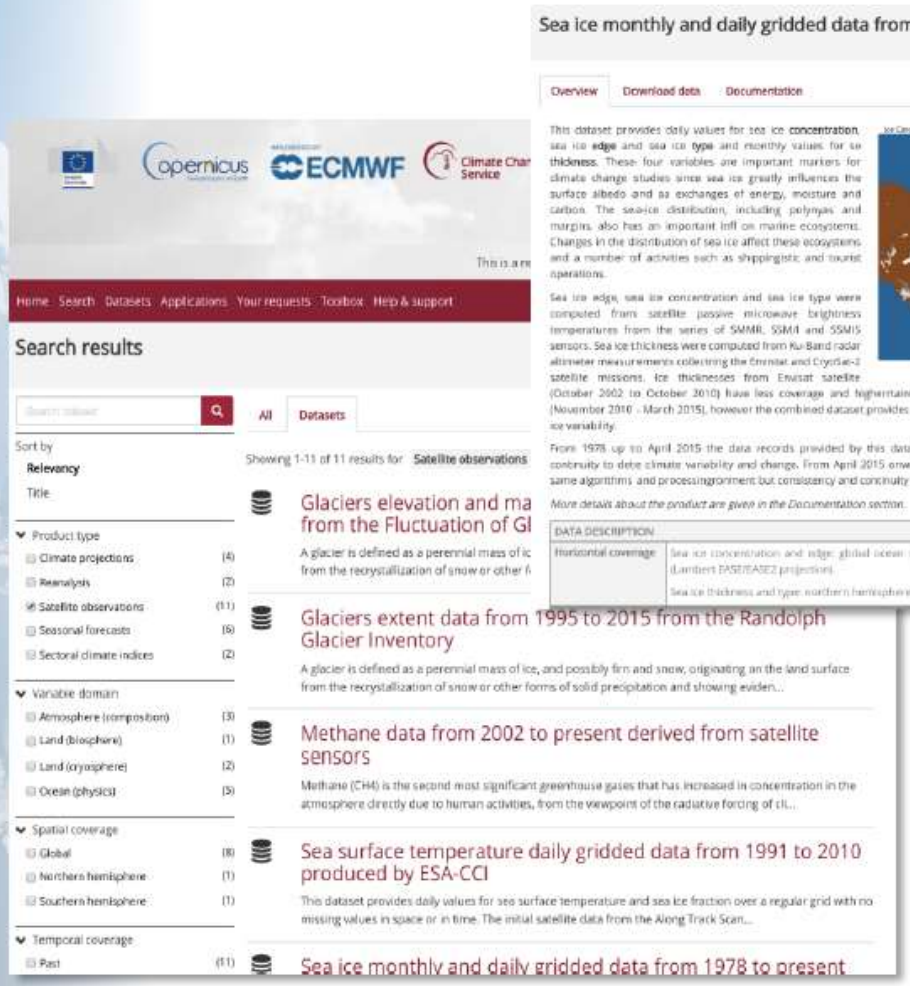
ECV products from Earth observations

Climate Change



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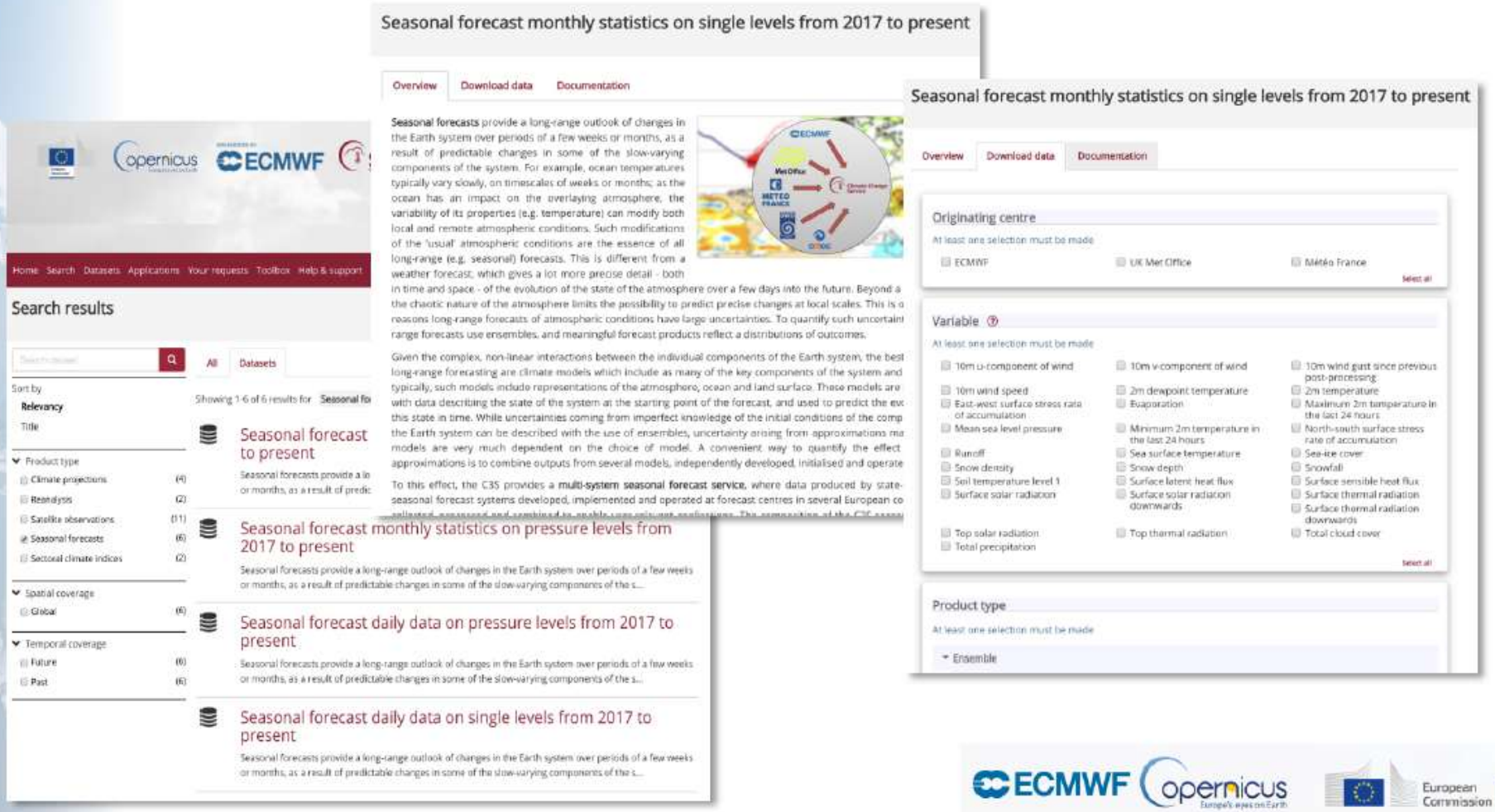
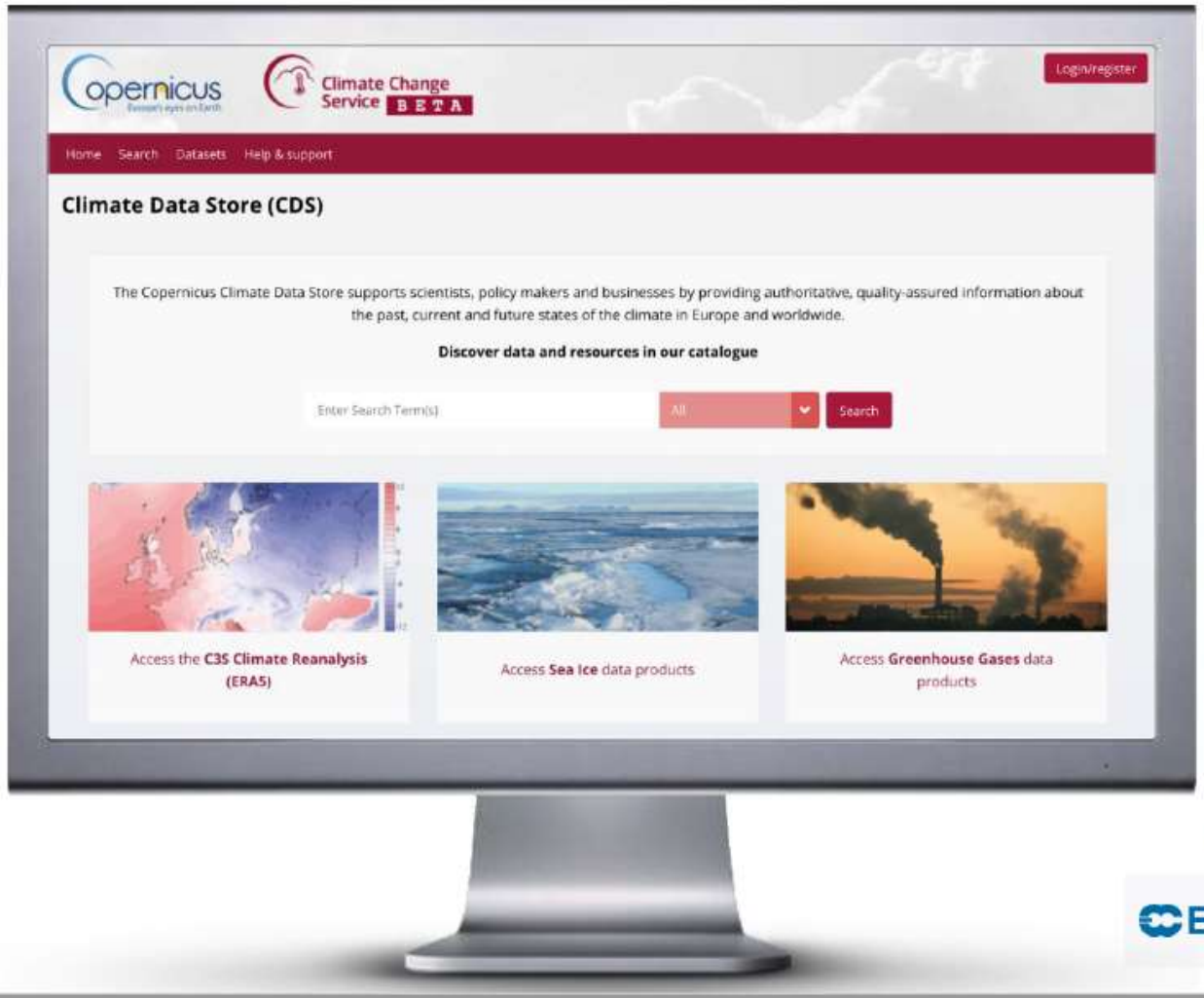
Multi-system seasonal forecasts

Climate Change



Climate Data Store – CDS



The CDS contains **observations**, global and regional **climate reanalyses**, global and regional **climate projections** and **seasonal forecasts.** It also contains generic and **sectoral climate indicators.**

The CDS is designed as a **distributed system**, providing improved access to **existing datasets** through a **unified web interface**

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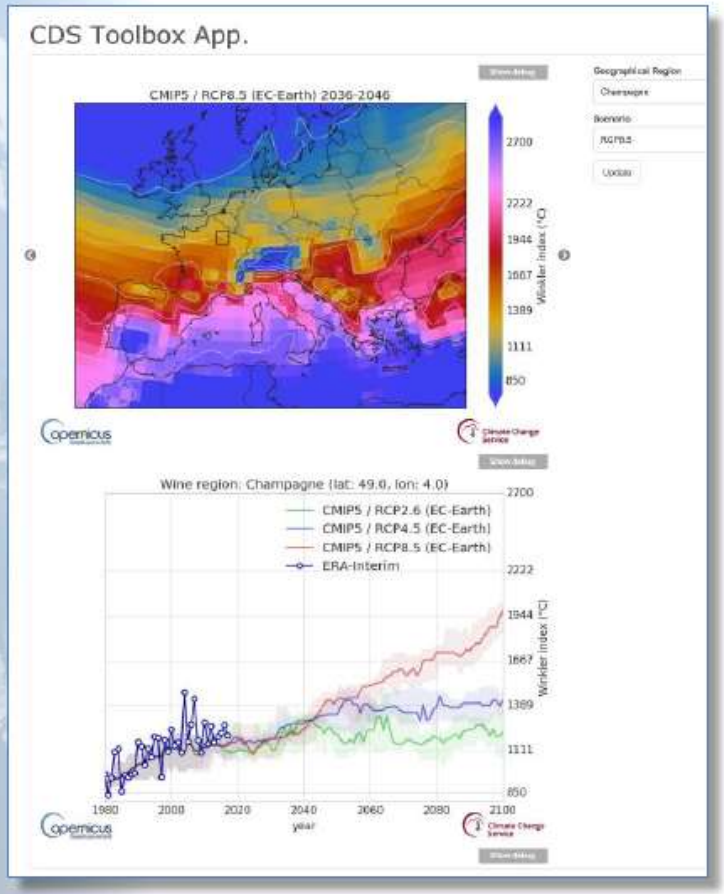
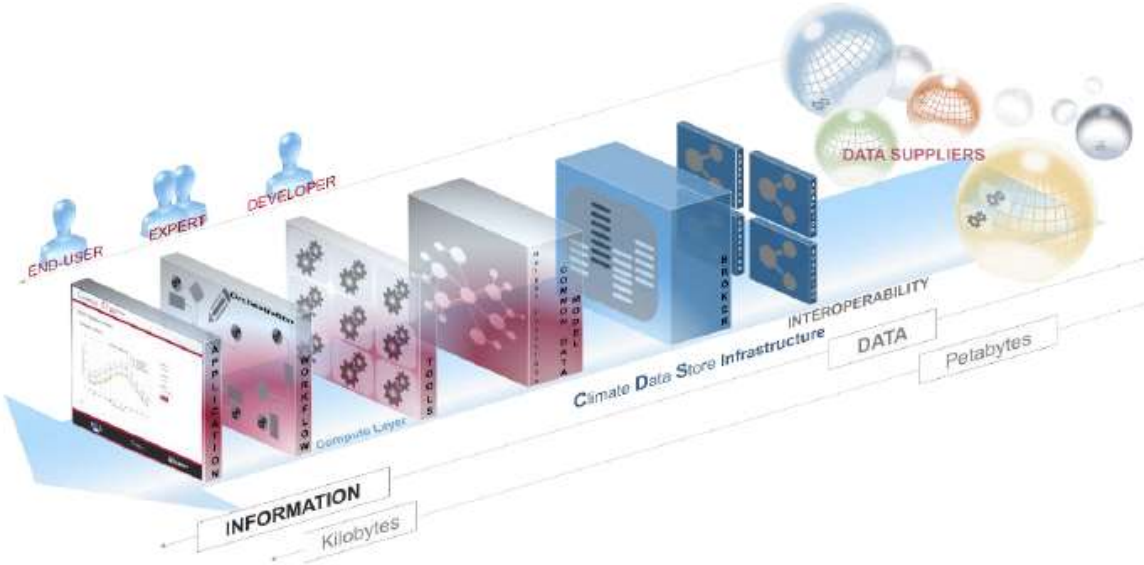
C3S infrastructure
CDS concept: Access to tools, workflows and applications





The CDS and its Tool Box allows managing and handling "climate objects" in a seamless way and within a unified environment.

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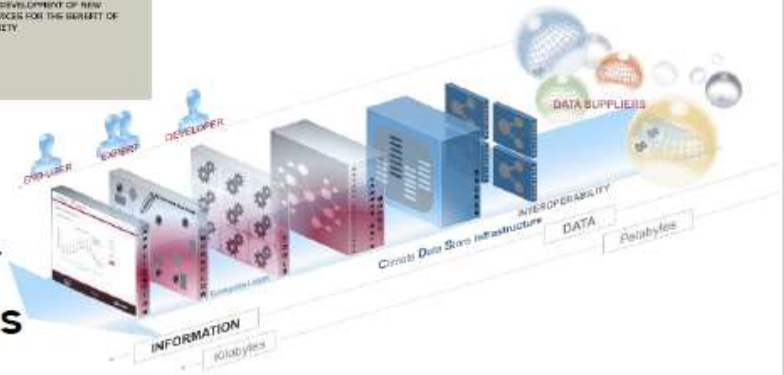
SECTORAL INFORMATION SYSTEM

Proof-of-concepts of climate services:
Demonstration of the **value chain** with several end-to-end **demonstrators**

As an operational Service, **C3S** ambitions to become an **enabler** of **downstream climate services**, by providing or brokering **high quality** and sector relevant climate **data** and **indicators**, **good practices**, **tools** and by supporting compelling **use cases**.



Further down the line, Copernicus **DIAS** will provide free access to **all Copernicus data and information** in the cloud, plus a development environment for users to develop and market their own **cloud-based applications**/front offices (under cloud computing commercial terms). Other EO missions data are also expected to be available.
5 DIASs under development (4 by ESA, 1 by ECMWF/EUM/MO)

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C3S: Enabler for downstream exploitation

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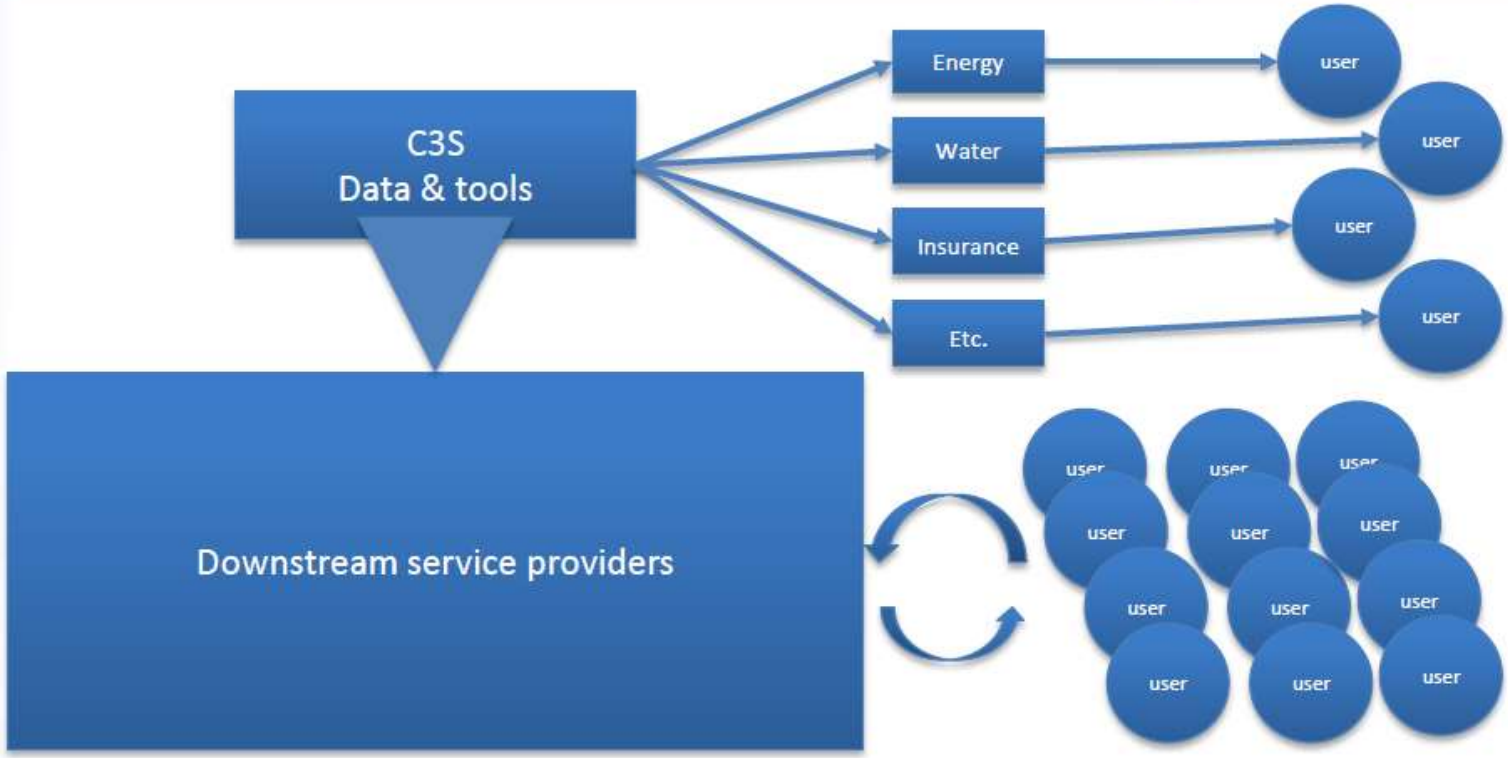

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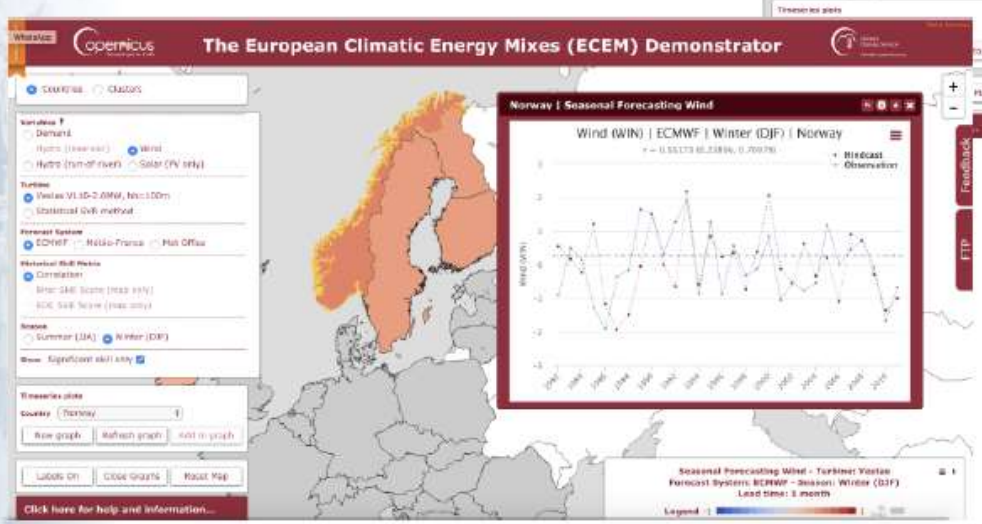
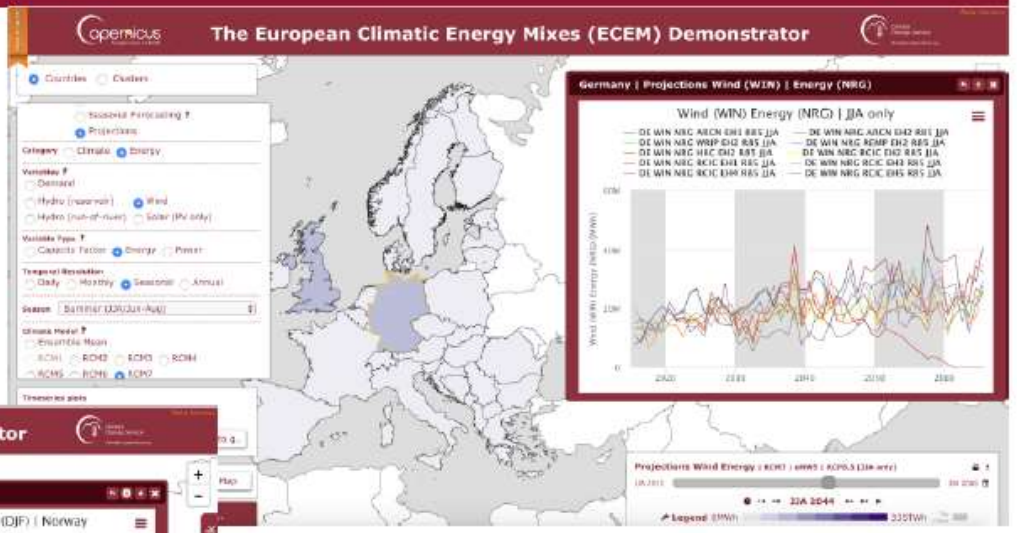
Energy

Integrating climate and energy scenarios to learn how well prepared our infrastructure is to cope with the climate of the future. Will the renewable dominated energy mix of the future able to cope with the expected change in the energy demand profile?





Using a combination of historical data, reanalysis, seasonal predictions and climate projections the SIS contracts have demonstrated how it will be possible to address some of these questions through the CDS.

Contract led by UEA

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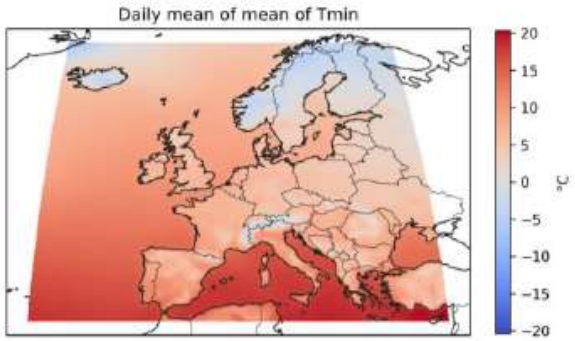
Health exposure demonstrator

Heat_exposure



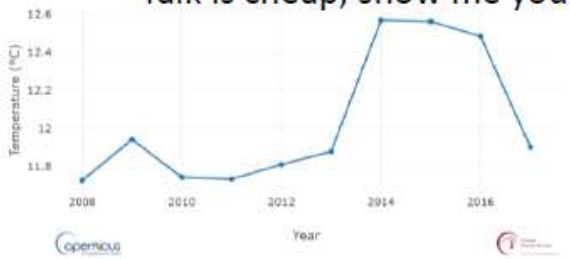
Variable: Tmin

City: Rome

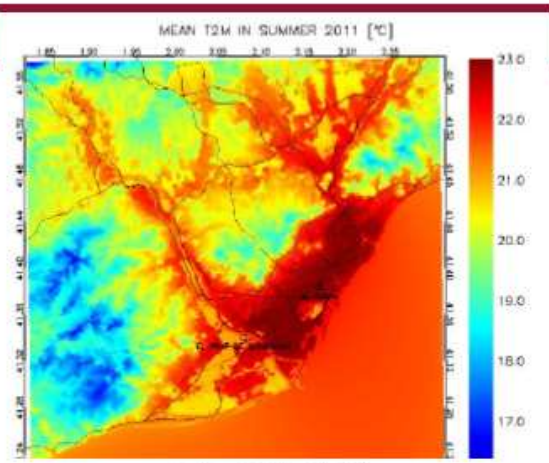
Statistic: Mean

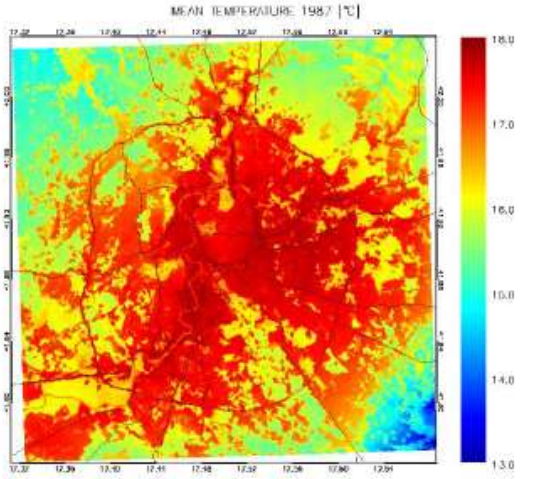
Period: Annual

Timeseries of mean of Tmin for Rome



"Talk is cheap, show me your code" *Linus Torvalds 2000-05-02*





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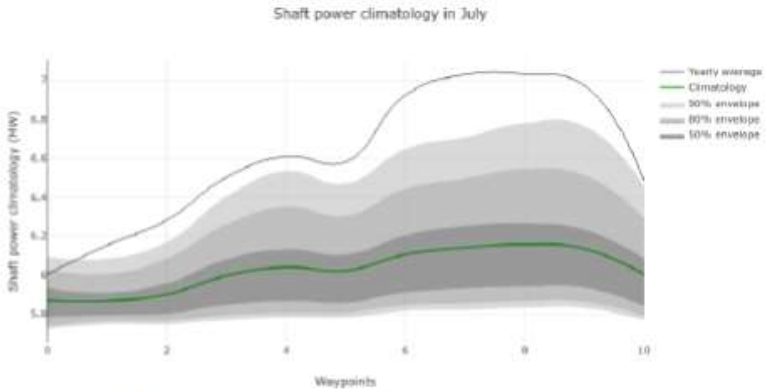
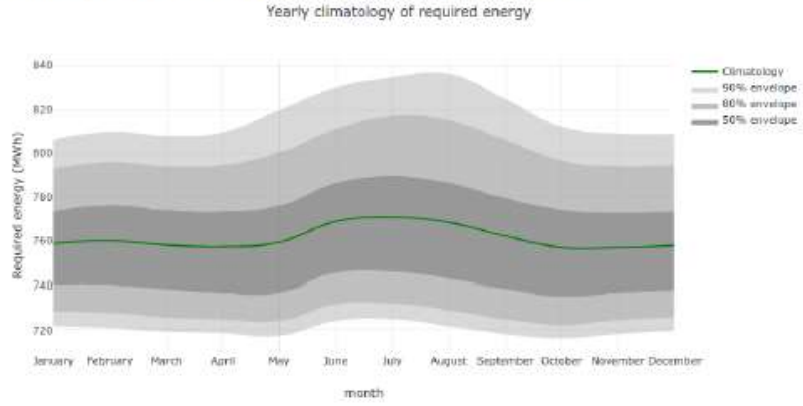
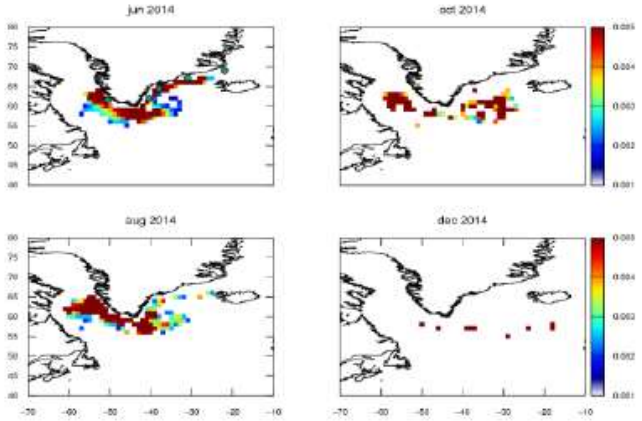
Climate indicators related to Shipping

Which part of the route/season is most likely to lead to overconsumption ?

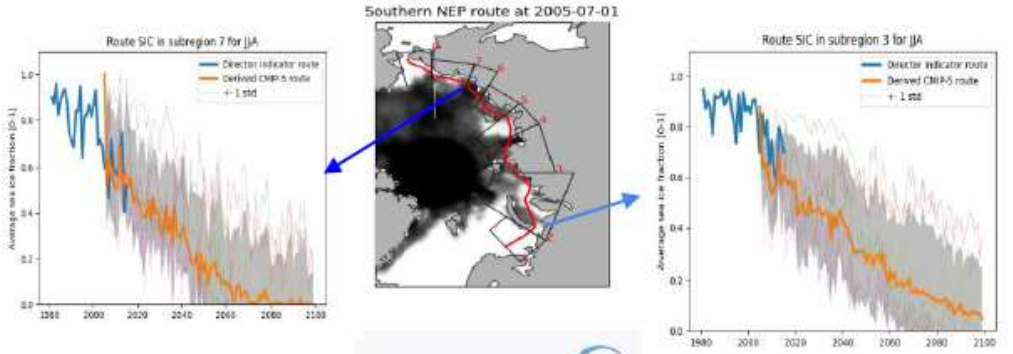




Where/when will I find icebergs ?



When will the Arctic route become commercially viable?



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Evaluation and Quality Control (EQC)

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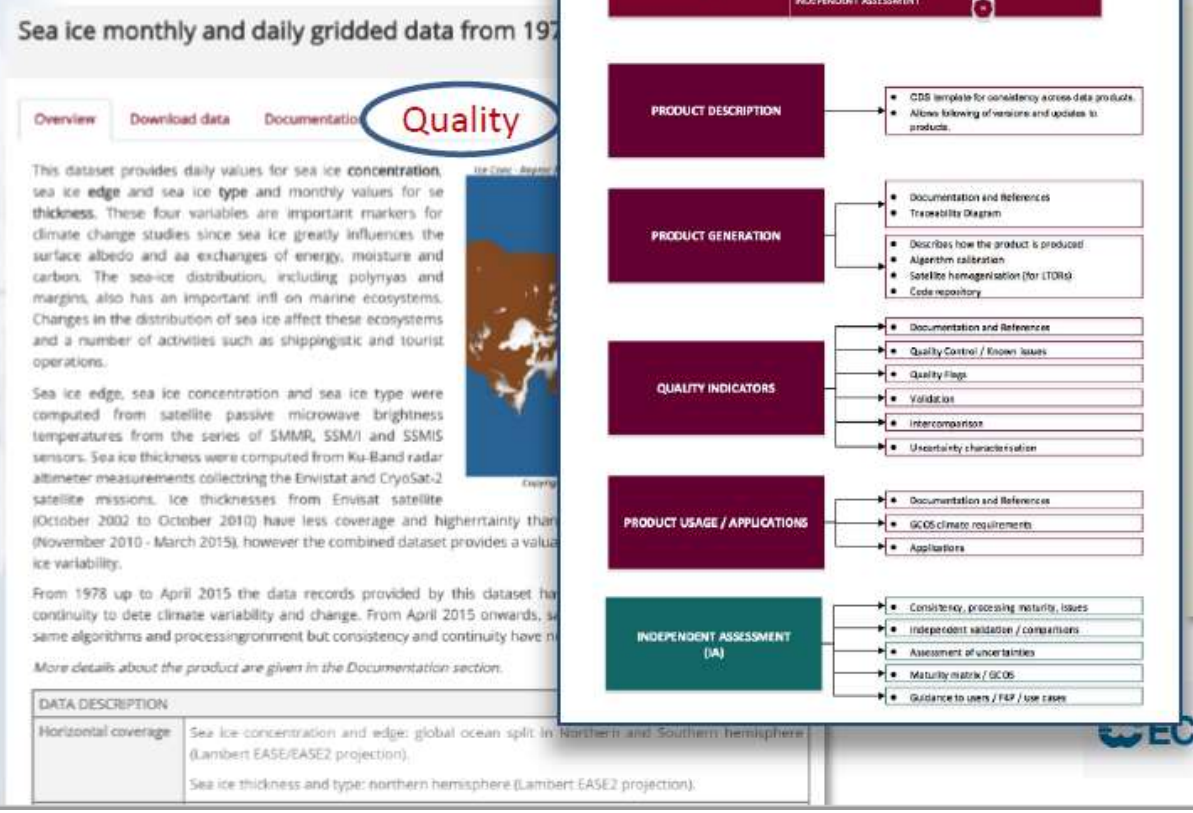
A suitable EQC framework has been developed for quality assurance of CDS datasets

Key feature: Quality Assurance R… S



Quality of data:
- assessments
- user guidance
- gaps and limitations

Quality of tools:
- fitness for purpose
- best practices

Quality of service:
- speed, responsiveness
- system availability, …

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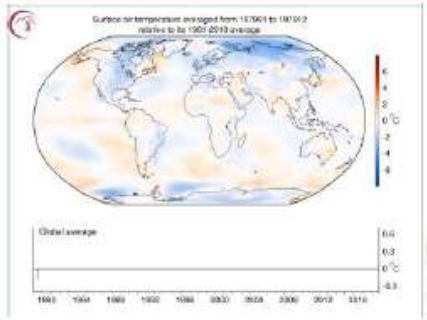
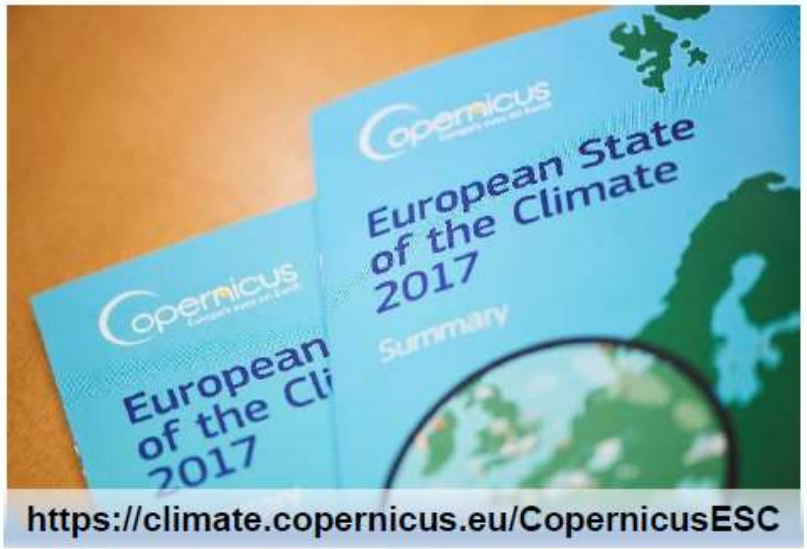
C3S: Operational production of climate indicators

Surface temperature	↑
Greenhouse gases	↑
Rain	–
Sea Ice	↓
Glaciers	↓
Sea Level	↑
Soil Moisture	↓



Credit: Victor & Kennel, Nature Climate Change, 2014.



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C3S and UNFCCC Sustainable Development Goals

Climate

	C3S contribution to SDGs
2 ZERO HUNGER	C3S SIS addresses agriculture, and some of the global services will focus on food security
3 GOOD HEALTH AND WELL-BEING	C3S SIS addresses health, providing relevant climate change indicators
6 CLEAN WATER AND SANITATION	Two Proof-of-concept SIS projects in C3S dedicated to water management. A urban PoC SIS is also addressing this SDG at city level. Operationalisation underway
7 AFFORDABLE AND CLEAN ENERGY	Two proof-of-concept SIS projects in C3S dedicated to the Energy Sector. Reanalyses (produced by C3S) are also highly relevant.
8 DECENT WORK AND ECONOMIC GROWTH	C3S activities contribute indirectly to this SDG insofar that the energy climate impact indicators (see goal 7) are relevant.
9 INDUSTRY, INNOVATION AND INFRASTRUCTURE	C3S is working closely with the standardisation community (via DG-CLIMA) on developing climate change information required for the writing of standards in infrastructure and transport.

	C3S contribution to SDGs
11 SUSTAINABLE CITIES AND COMMUNITIES	C3S SIS related to urban aspects of climate change, as well as health and infrastructure aspects, contribute indirectly to this SDG. Reanalysis products too.
12 RESPONSIBLE CONSUMPTION AND PRODUCTION	C3S SIS products and indicators on water management are directly relevant for this goal.
13 CLIMATE ACTION	ECV products, including from reanalysis, CDRs, seasonal forecasts and climate scenarios, directly relevant for adaptation. The SIS also delivers relevant indicators in support of adaptation. Cooperation: EEA Climate ADAPT
14 LIFE BELOW WATER	Some of the ECV products generated by C3S (including reanalysis ORAS5) are ocean relevant. This is done in coordination with CMEMS.
15 LIFE ON LAND	Biodiversity is a future sectoral application of C3S. Relevant products will contribute to this goal. ECV products on soil moisture, forestry, lakes, also contribute to this goal.

Climate Change

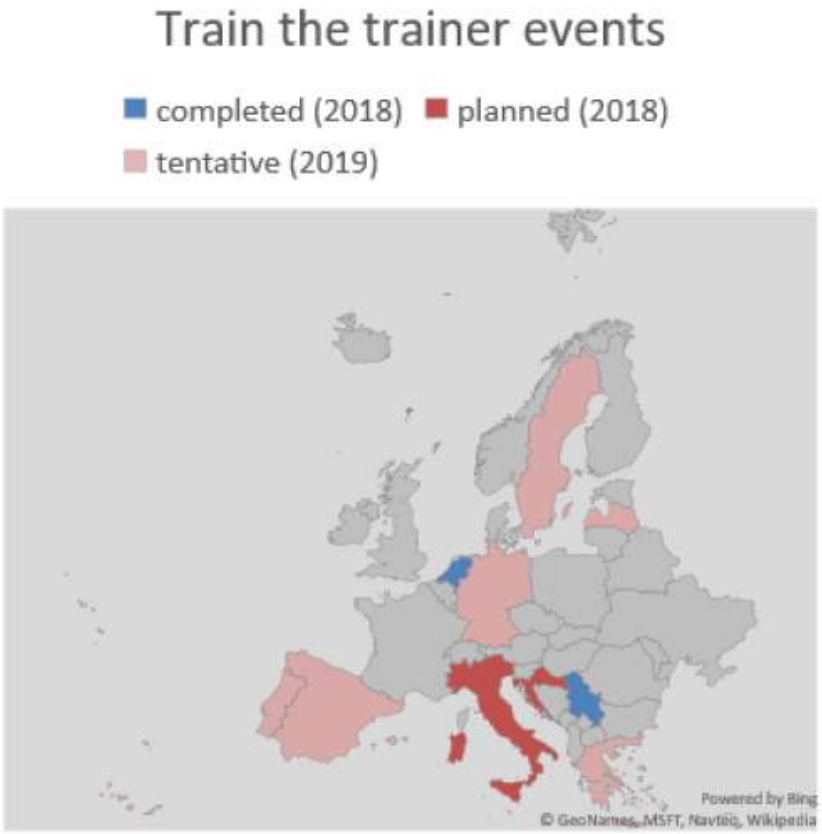
C3S user learning services

Focus on the use of the Climate Data Store to address climate change adaptation challenges

Key elements:

- Blended training
- Online training resources freely available anywhere and anytime
- Personalized learning
- 3 main target audiences
- In-country training events in local language in more than 30 EU countries
- Train the trainers to widen the reach of the training and increase the impact

➢ uls.climate.copernicus.eu



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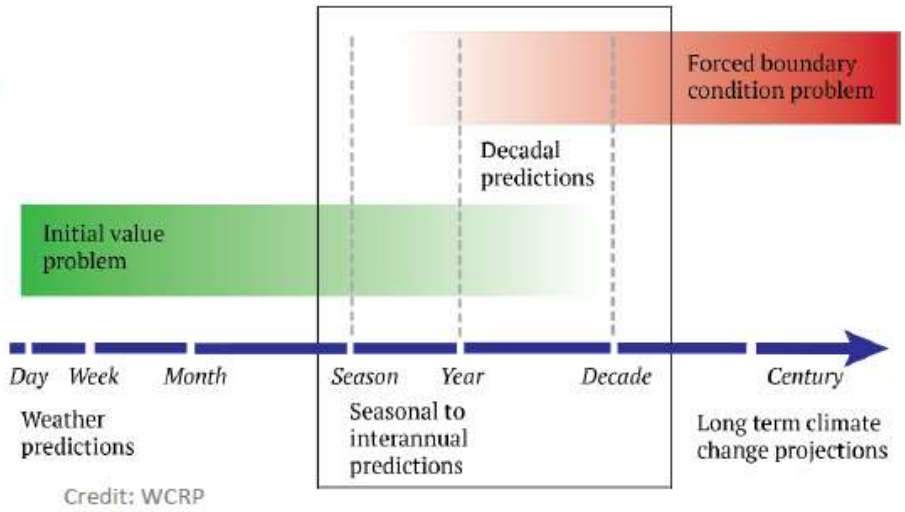
What's next: Decadal Component

Climate Change

- Rationale:
  - Current user requirements surveys and discussions with C3S stakeholders clearly indicate the need for information at decadal timescales.
    - Current gap in the Service
- Process:
  - Workshop (early 2019) involving key stakeholders, the scientific and user community
    - Take stock of the existing state-of-play
      - (WMO operational initiative, C3S climate projections roadmap recommendations, projects e.g. EUCP, etc.)
  - Assess the level of maturity of decadal prediction (including verification) science.
  - Agree and design a prototype decadal component before the end of the current Delegation Agreement



Credit: WCRP

Reference:

- C3S User Requirement study (https://climate.copernicus.eu/secteur)
- https://www.sciencedirect.com/science/article/pii/S2405880717300018
- European Roadmap for Climate Services

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What's next: Attribution component

Climate Change

- Rationale:
  - High interest from the society (media, policy makers, planners)
  - Event attribution studies aim at providing a rigorous scientific approach to determine to what extent weather-related risks have changed due to human influences on climate.
- Process:
  - Brainstorming with key stakeholders to revisit the "attribution science" state of play (Prague workshop, 10-11 October 2017)
  - Ongoing study to define a publishable protocol for operational attribution, together with requirements on data and tools
  - Validation of this protocol by the scientific community
  - commission a "prototype" Attribution service element towards a possible operational Attribution component for C3S next generation.

Reference:

- C3S Technical Annex (page 34)
- C3S precursor project EUCLEIA https://eucleia.eu

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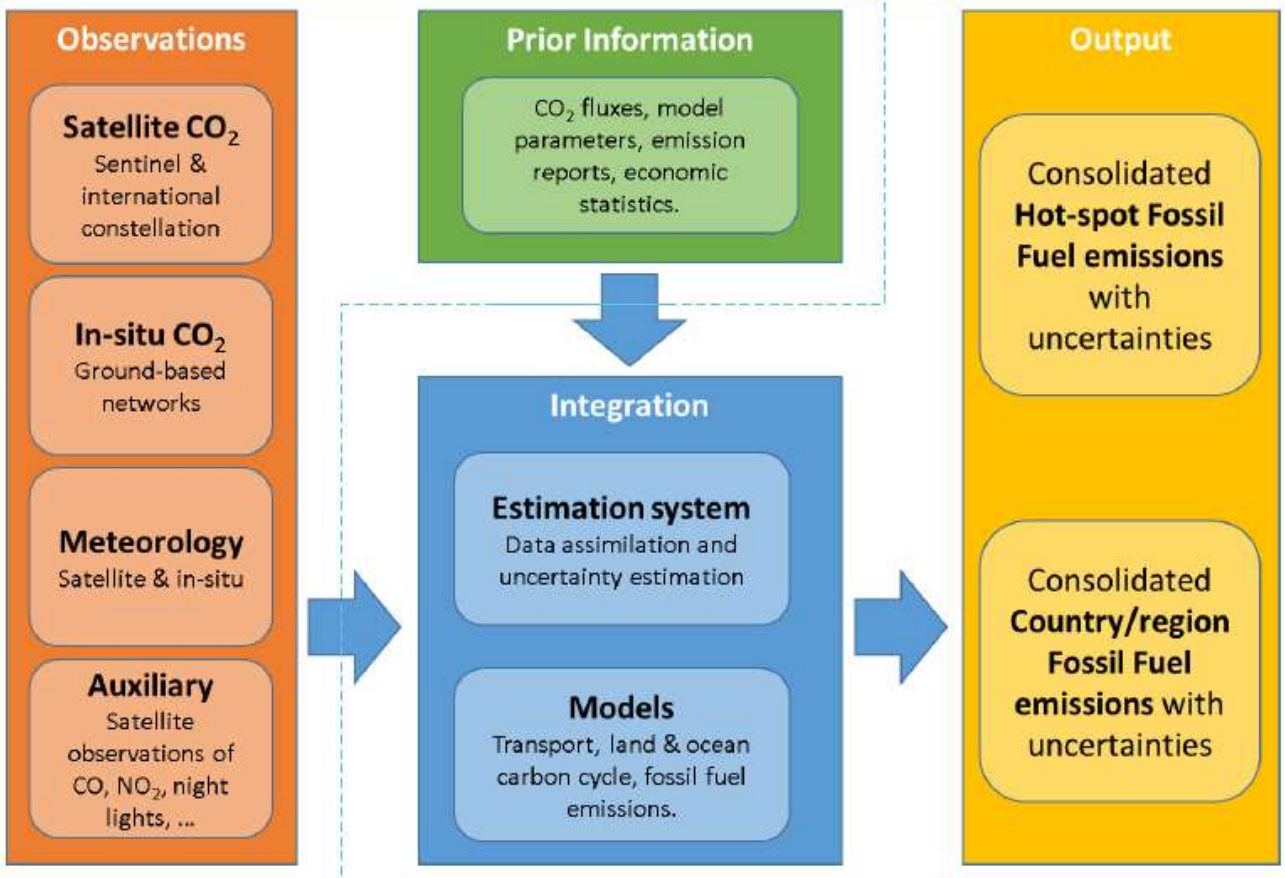
What's next: Broad international agenda

- "Transforming our world: the 2030 Agenda for Sustainable Development" - 17 **Sustainable Development Goals** with 169 associated targets
- Sendai Framework for **Disaster Risk Reduction** 2015–2030 with seven global targets
- **Paris Agreement** adopted by conference of parties to United Nations Framework Convention on Climate Change (COP-21)
- The **New Urban Agenda** adopted at Habitat III

Credit: WMO

CO_2 ANTHROPOGENIC EMISSION MONITORING SYSTEM



Approach based on CAMS and C3S, with 3 complementary components:

- ECMWF/IFS @5-10km, 100+ satellite data streams
- Regional zooms @1-2km
- Hot spots

Kiitos!