

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



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CONTENTS

- 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

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

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

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



Climate change, impacts and vulnerability in Europe 2016

— Key findings



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

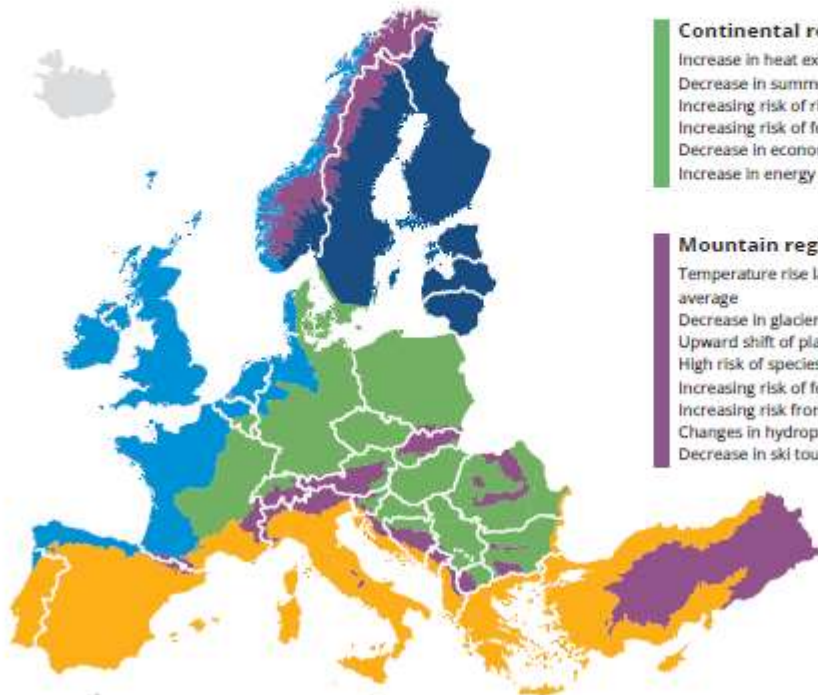
Mediterranean region

- 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

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



Climate change, impacts and vulnerability in Europe 2016

– Key findings



- 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.



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	<p>Surface^[1]: Air temperature, Wind speed and direction, Water vapour, Pressure, Precipitation, Surface radiation budget.</p> <p>Upper-air: Temperature, Wind speed and direction, Water vapour, Cloud properties, Earth radiation budget (including solar irradiance).</p> <p>Composition: Carbon dioxide, Methane, and other long-lived greenhouse gases, Ozone and Aerosol, supported by their precursors^[2]</p>
Oceanic	<p>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,</p> <p>Sub-surface: Temperature, Salinity, Current, Nutrients, Carbon dioxide, partial pressure, Ocean acidity, Oxygentracers, Phytoplankton; Marine biodiversity and habitat properties^[4]</p>
Terrestrial	<p>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 properties⁹</p>

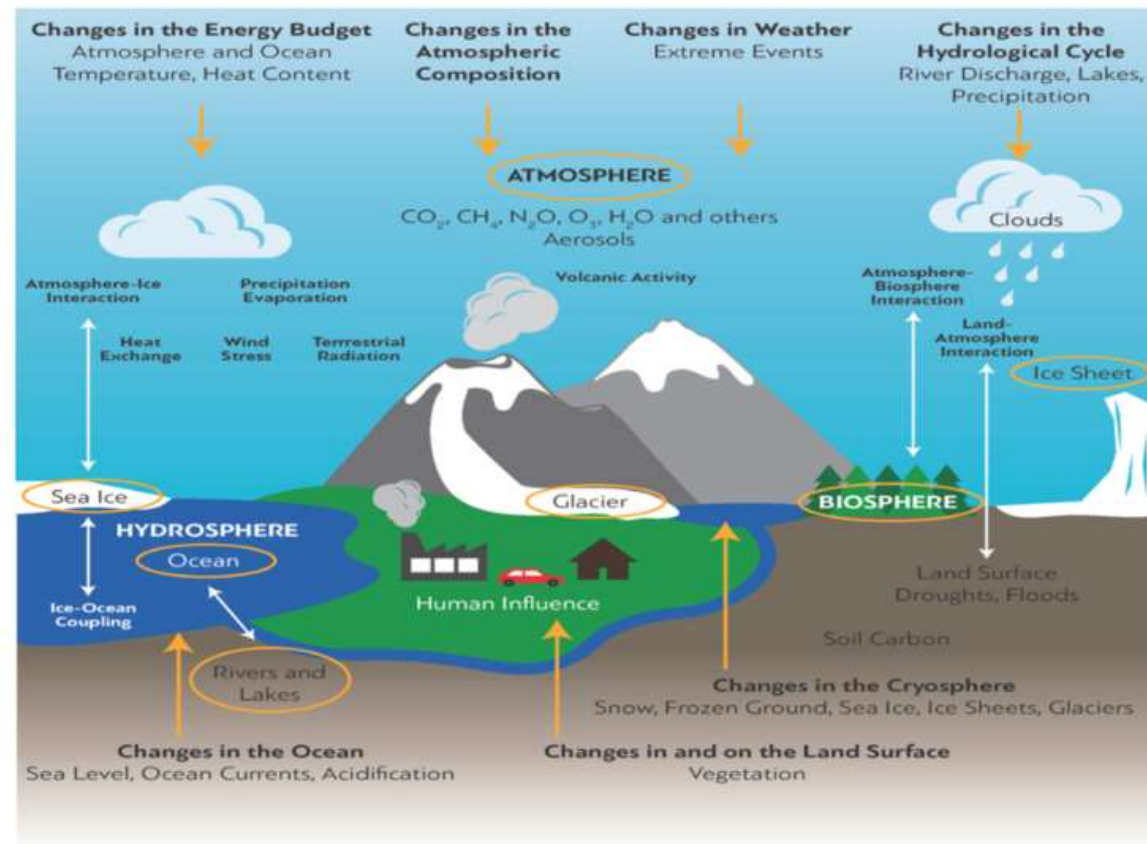


WMO assessment and reporting on Climate Change Indicators



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 INTERNATIONAL PANEL ON CLIMATE CHANGE

WMO assessment and reporting on Climate Change Indicators



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.

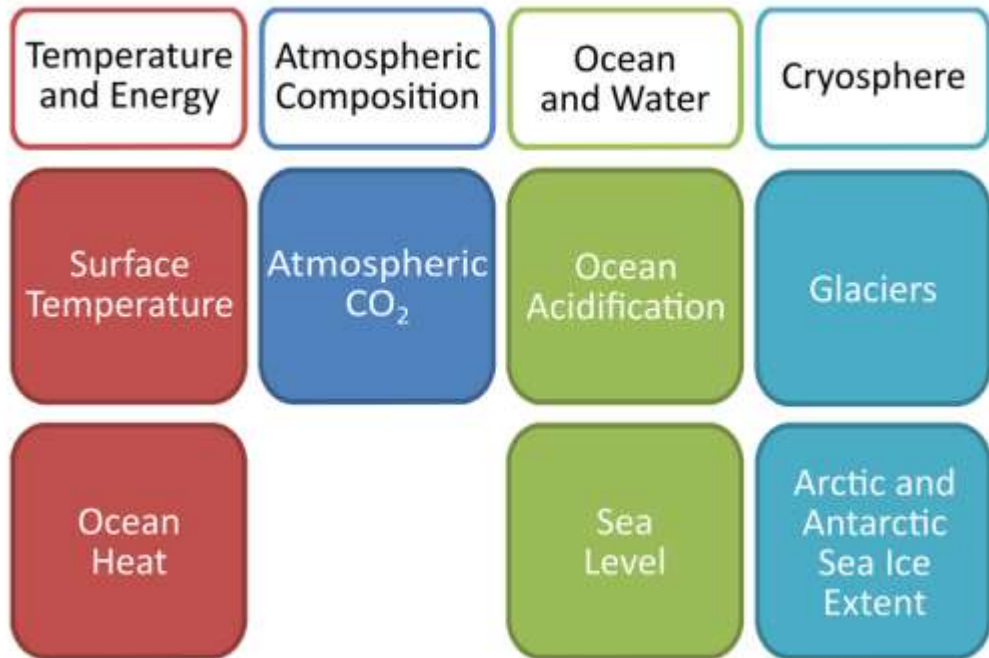
Timeliness: each indicator should be calculated regularly (at least annually), with a short lag between the end of the period and publication of the data.

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.

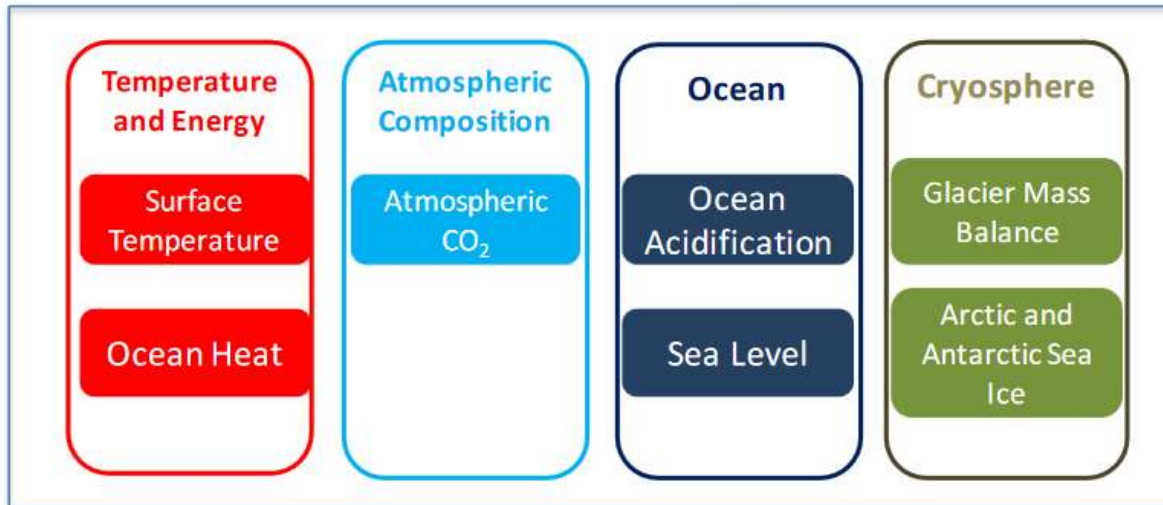
These Global Climate Indicators have been identified by scientists and communication specialists in a discursive process led by GCOS during workshops and scientific panel meetings and have been finally endorsed by WMO. They form the basis of the annual **WMO Statement of the State of the Global Climate**, 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



Extreme Events and Climate Change



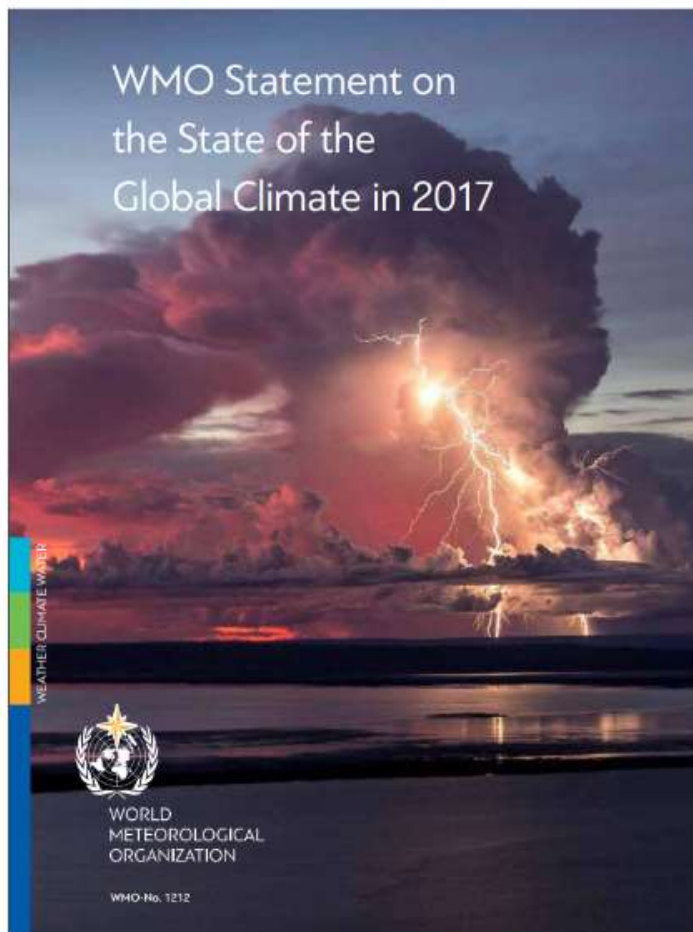
Extreme Events



Attribution to anthropogenic Climate Change ?

WMO assessment and reporting on Climate Change Indicators

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 10 ²³ 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

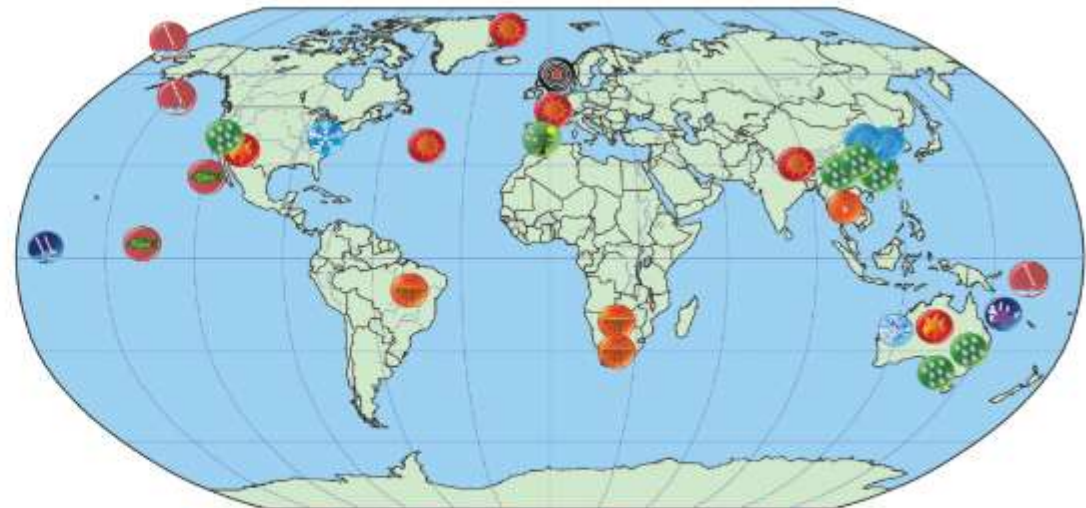
Attribution of extreme events

EXPLAINING EXTREME EVENTS OF 2016

From A Climate Perspective

Special Supplement to the
Bulletin of the American Meteorological Society
Vol. 99, No. 1, January 2018

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

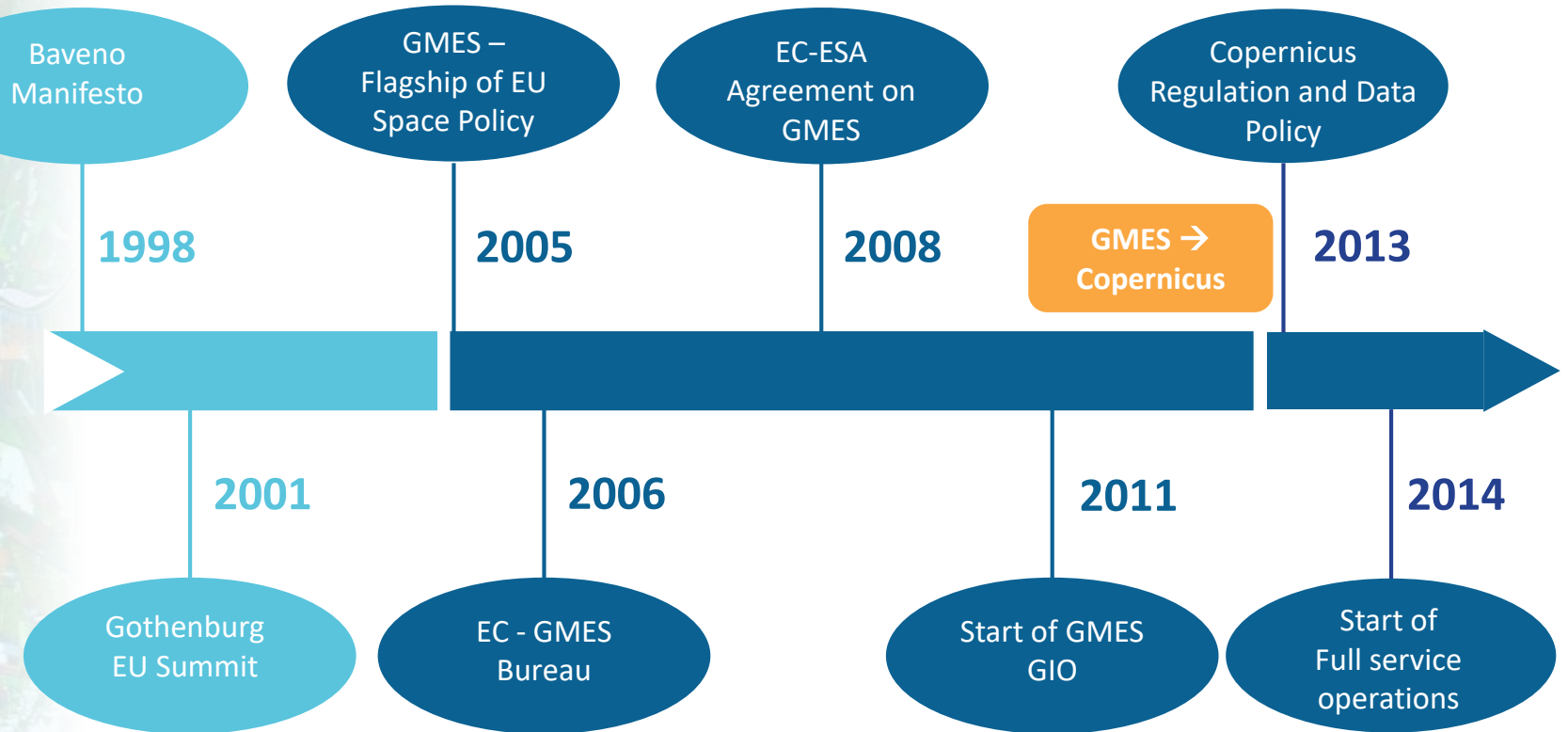
C O P E R N I C U S I N B R I E F

- **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

COPERNICUS HISTORY



GIO = GMES Initial Operation



Copernicus

THE COPERNICUS PROGRAMME OBJECTIVES

The Union **Earth Observation** and monitoring programme

Increase general knowledge on the state of the Planet



Protect people and assets



Improve environmental policy effectiveness



Monitor the environment



Facilitate adaptation to climate change



Foster downstream applications in a number of fields



Help managing emergency and security related situations



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



FULL, FREE AND OPEN ACCESS TO DATA



- ATMOSPHERE MONITORING
- MARINE ENVIRONMENT MONITORING
- LAND MONITORING
- CLIMATE CHANGE
- EMERGENCY MANAGEMENT
- SECURITY

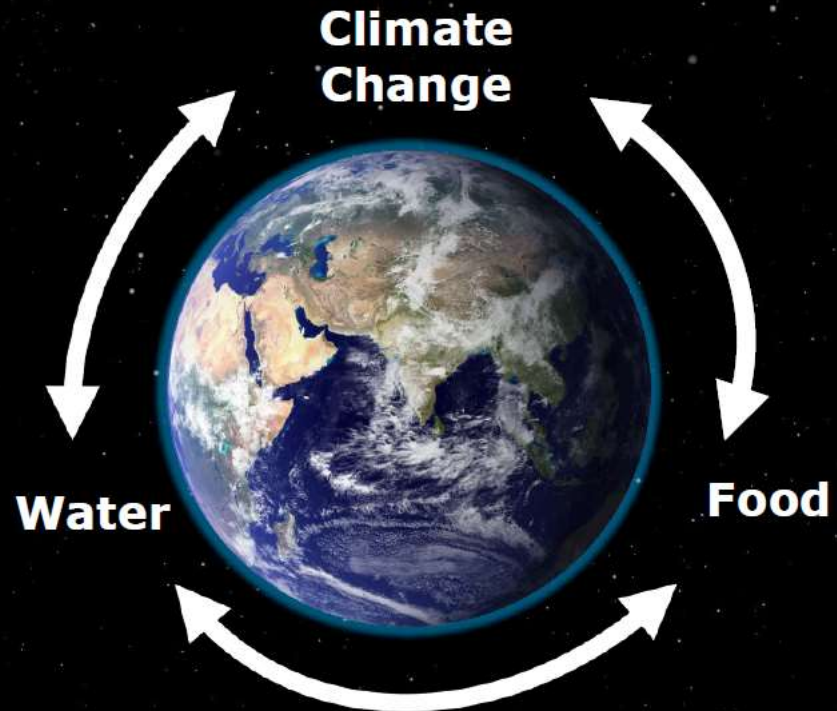


BALTIC SAT APPS

The 21st Century Societal Challenges



**Copernicus helps
humankind to
address the
nexus of 21st
century
challenges**

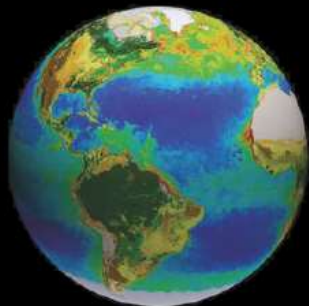


Global & System View by Copernicus

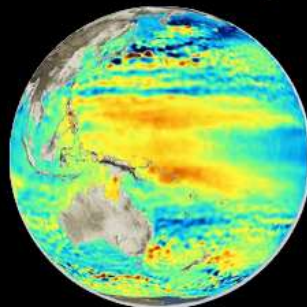


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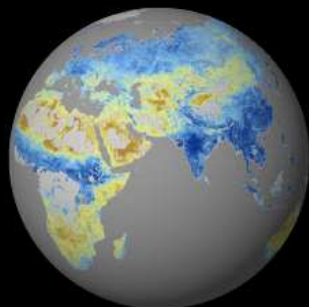
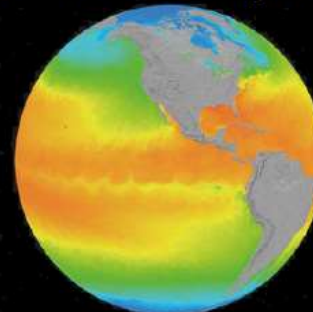
Chlorophyll



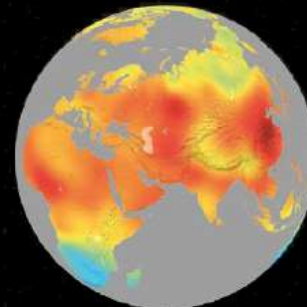
Sea Level Height



Sea Surface Temperature



Soil Moisture



Carbon Dioxide

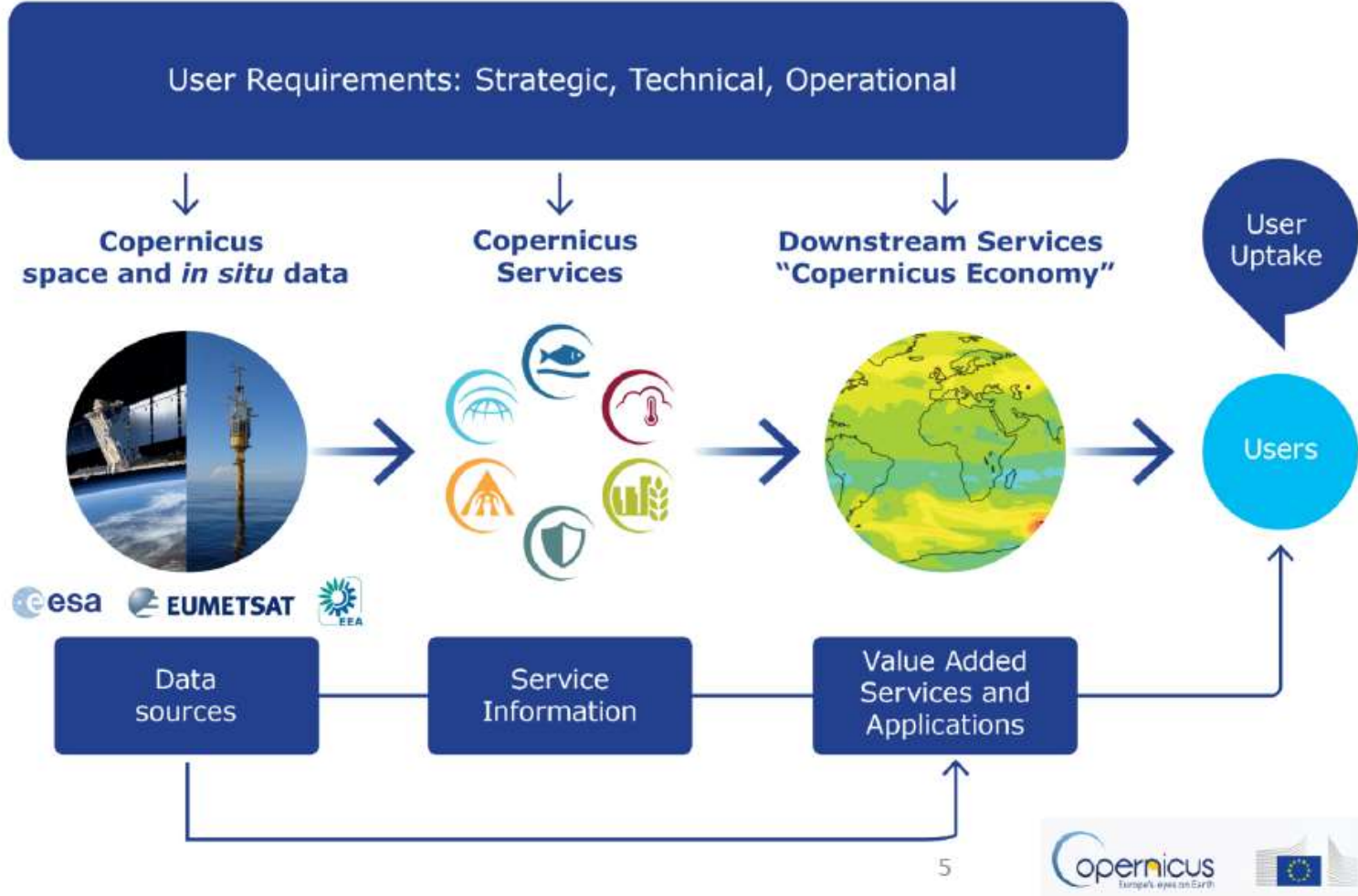


Nitrous Oxide



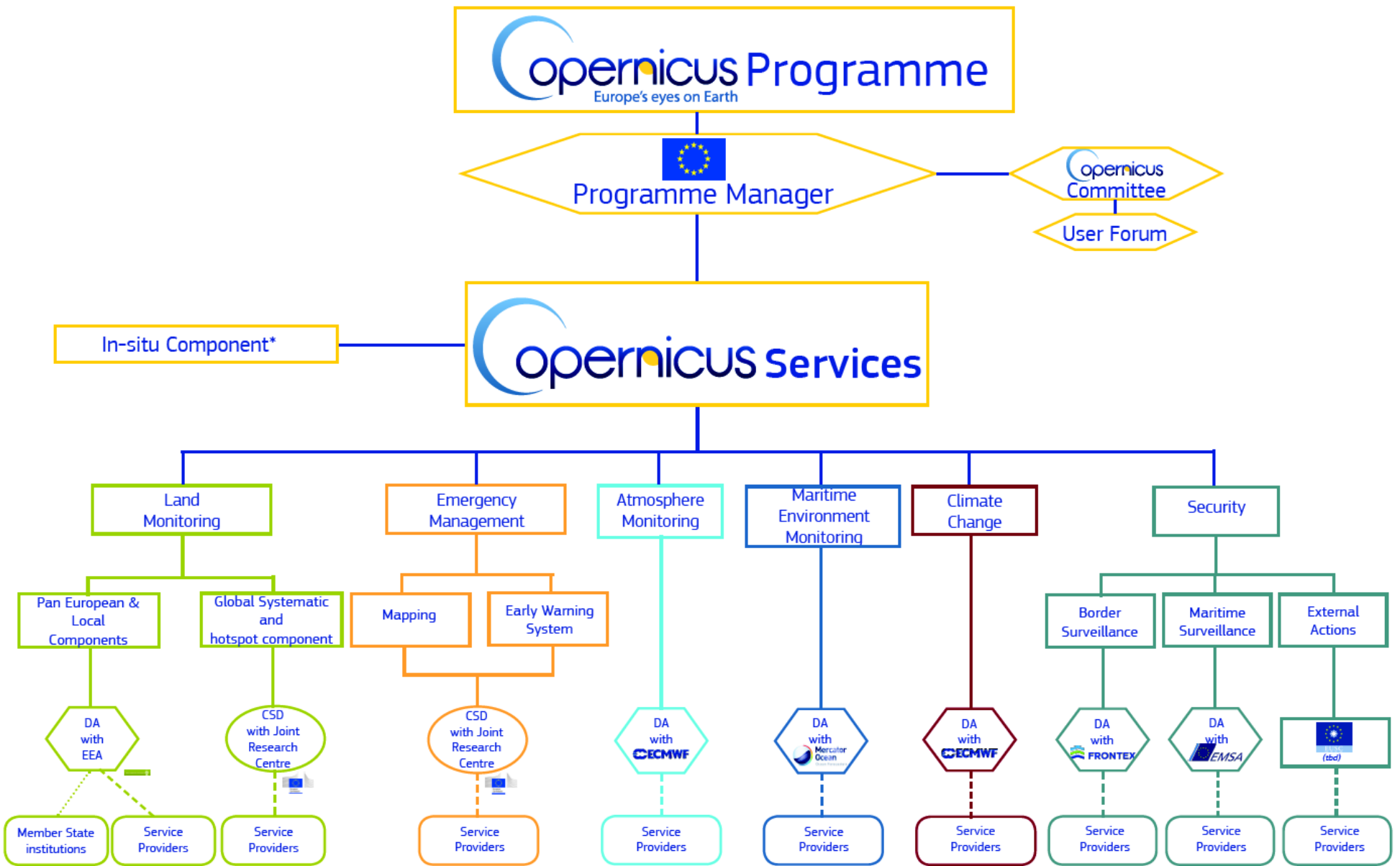
Copernicus

COPERNICUS IS DRIVEN BY THE USERS



5





Legend:

Implementation mode still to be defined

--- Commercial contracts
..... Grants

□ Copernicus component
○ Service Providers

▭ Mode of Implementation (direct/indirect)
○ Indirect Management
○ Direct Management

* Co-financed by EEA
EA - Engagement
CSD - Co-Service-Dispatch
ESA - European Space Agency

EMETSAT - 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
EMSA - The European Centre for Medium-Range Weather Forecasts



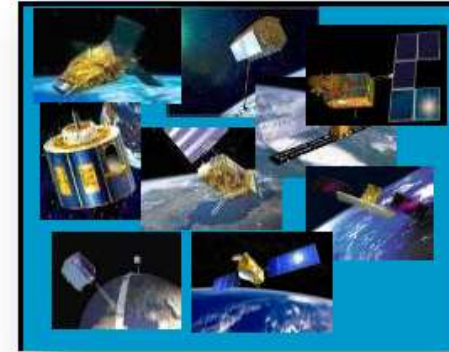
Copernicus

PROGRAMME ELEMENTS

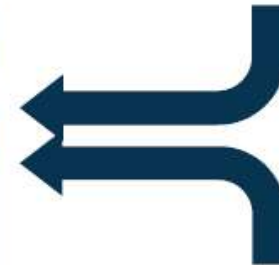


Copernicus Sentinels

6 services use Earth Observation data to deliver ...



Other Satellites



"in-situ"



...added-value products



Copernicus
Europe's eye on Earth



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

COPERNICUS SATELLITES

Sentinel Mission and Status

Key Features

FULL, FREE AND OPEN



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

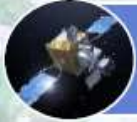
Polar-orbiting, multispectral optical, high-res imaging



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 2ndGen



SENTINEL-6:
10 day revisit time

1st Launch in 2020

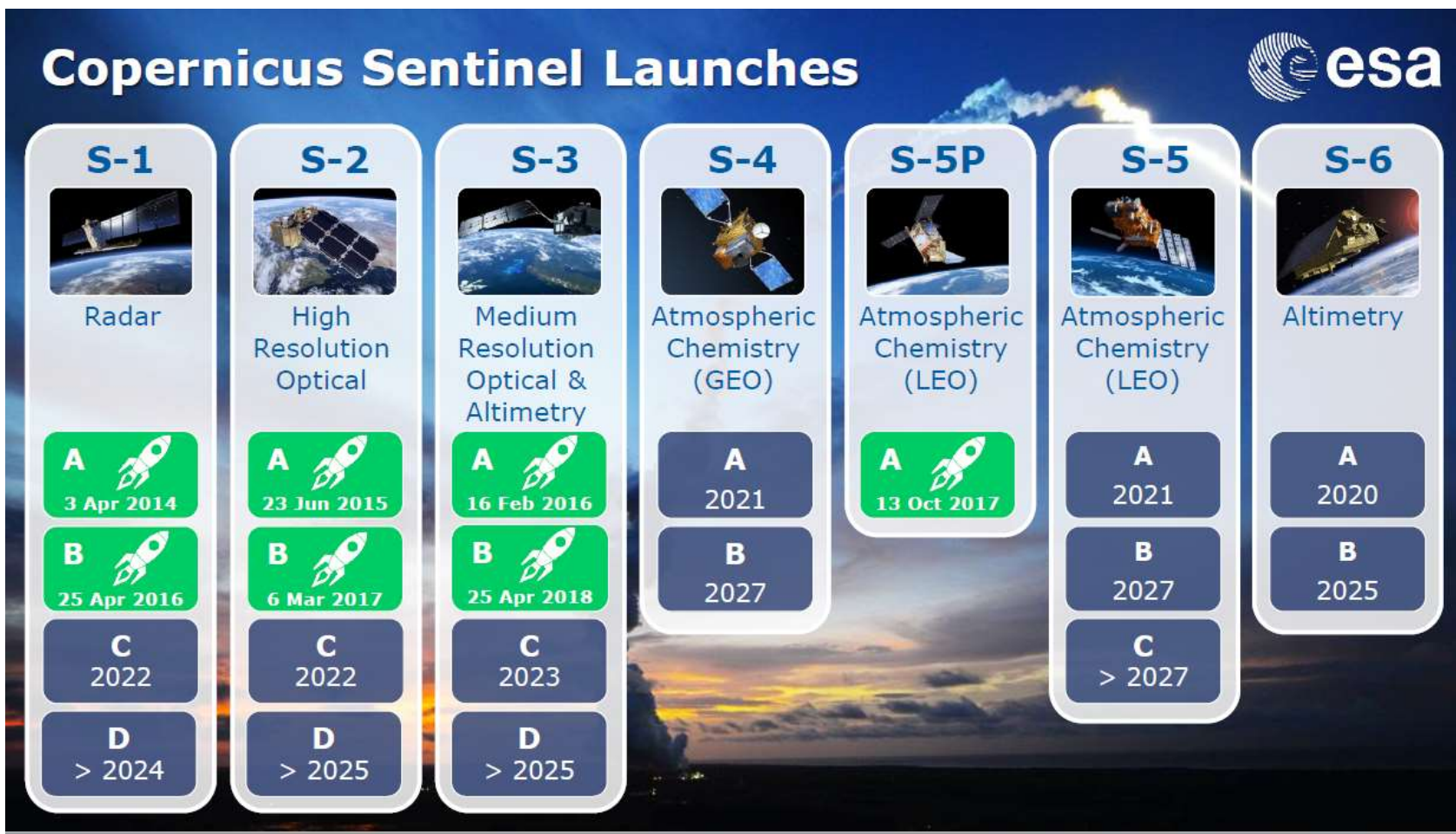
Radar altimeter to measure sea-surface height globally





BALTIC
SAT
APPS

Copernicus Sentinel Launches



Copernicus Contributing Missions



Optical High & Very High Resolution

DMC **Pléiades** **RapidEye**



Deimos-2 **SPOT (HRS)**



Optical Medium & Low Resolution

SPOT **PROBA-V**



and many more ...

Synthetic Aperture Radar

Cosmo SkyMed **Radarsat** **TerraSAR-X Tandem-X**



Altimetry

Cryosat **Jason**



Atmosphere

MetOp **MSG**



Slide 10

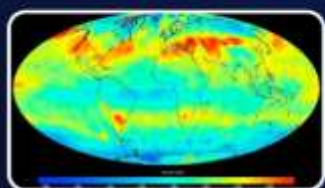


Sentinel Expansion (Phase A/B1 studies)



High Priority Candidate Missions

Applications



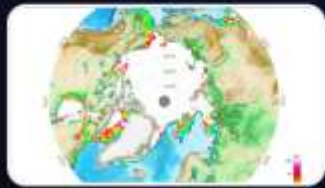
Anthropogenic
CO₂

Climate Change
(Causes)



Polar Ice & Snow
Topography

Climate Change
(Effects)



Passive Microwave
Imaging

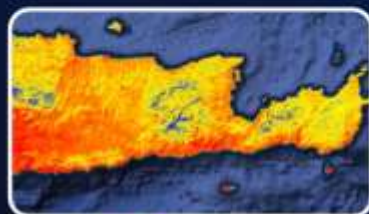
Sea Surface Temperature
& Sea Ice Concentration



Sentinel Expansion (Phase A/B1 studies)



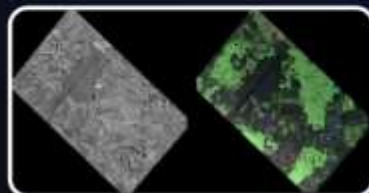
High Priority Candidate Missions



High Resolution
Land Surface
Temperature



HyperSpectral
Imaging



L-band
SAR

Applications

Agriculture & Urban
Management Services

Agricultural Management
& Food Security, Soil &
Mineral Resources

Soil, Vegetation, Food
Security & Ground Motion



Data Access

Sentinels Data Access – Four Access Hubs

The four Copernicus Sentinel data access hubs operated by ESA
→ *the enabler of a wide distribution to users*



58,908,875 Products Downloaded
41.53 PB Volume Downloaded



Copernicus Open Access Hub



32,328,999 Products Downloaded
20.59 PB Volume Downloaded



Copernicus Services Hub

sentinel-1a sentinel-1b sentinel-2a sentinel-2b sentinel-3a sentinel-5p



Collaborative Hub



International Hub



34,223,114 Products Downloaded
26.59 PB Volume Downloaded



10,086,061 Products Downloaded
7.78 PB Volume Downloaded



Statistics at end-October 2018





BALTIC SAT APPS

Data & Information Access Services (DIAS)



Data Access

e.copernicus.eu/DIAS

THE DIAS & WHERE TO REACH THEM



CREODIAS

WWW.CREODIAS.EU



sobloo

WWW.SOBL00.EU



mundi
WEB SERVICES

WWW.MUNDIWEBSERVICES.COM



WWW.WEKEO.EU

ONDA

WWW.ONDA-DIAS.EU

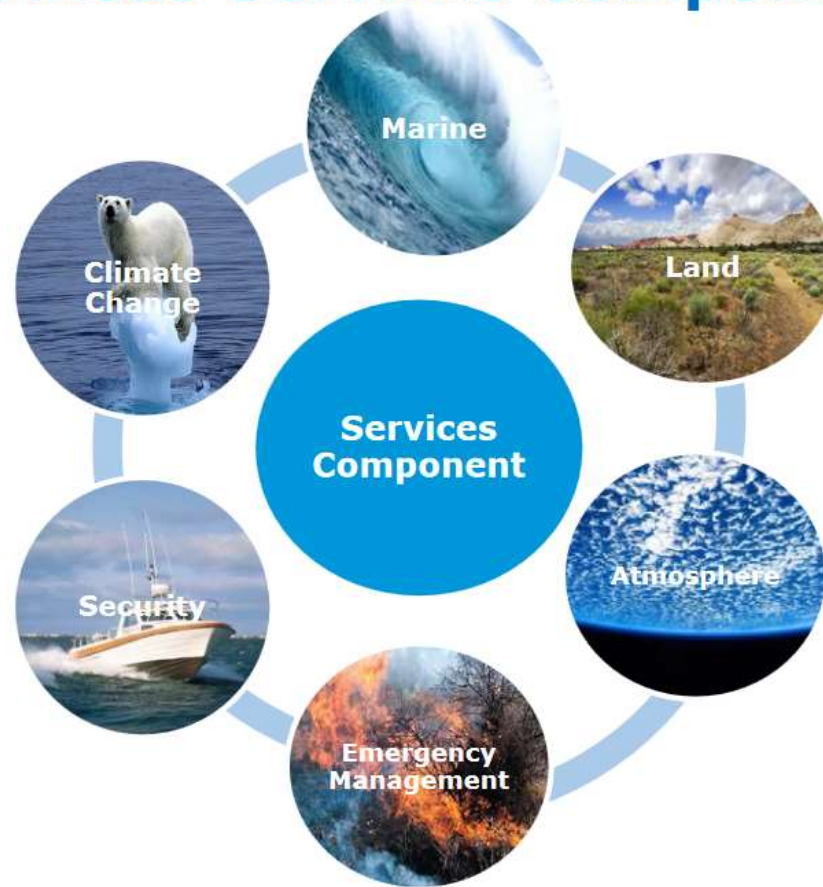


EUMETSAT

Copernicus
Europe's eyes on earth



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


Europe's eyes on Earth

Copernicus Atmosphere Monitoring Service (CAMS)



Air quality, atmospheric composition



Variables of climate forcing



Ozone layer & UV



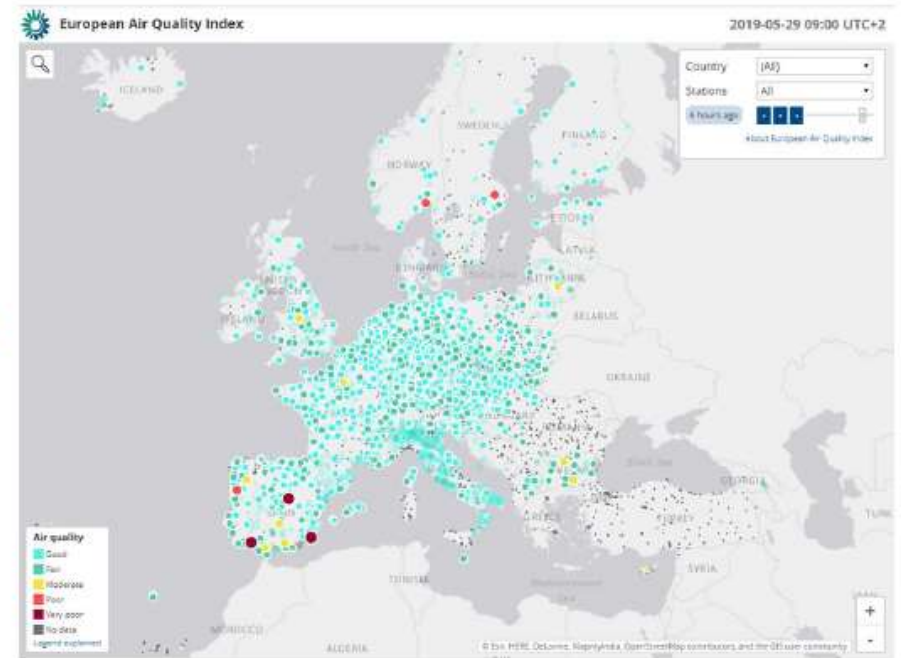
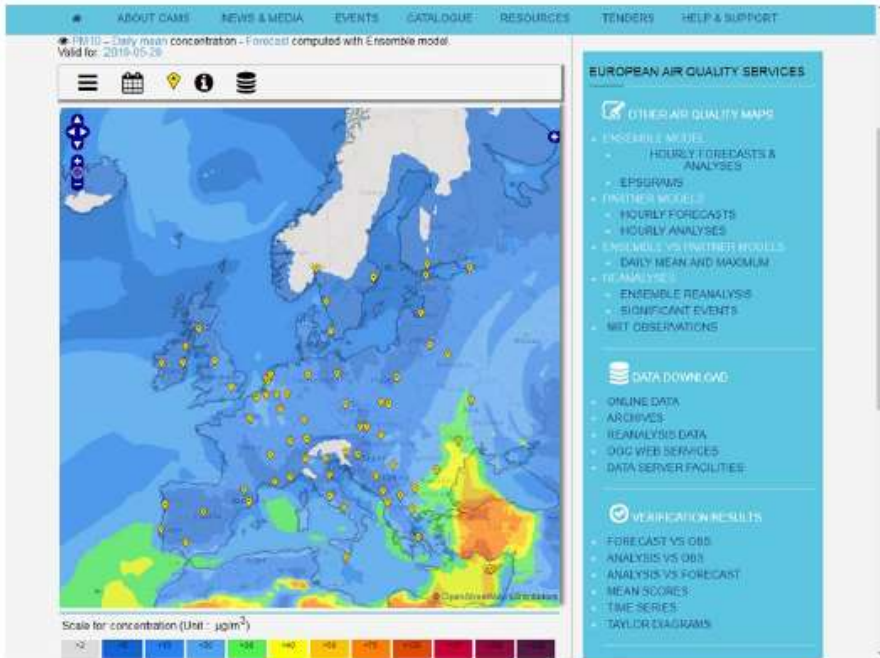
Solar radiation



Emissions and surface fluxes



Use of Copernicus Atmosphere Monitoring Services in air quality monitoring



Copernicus Marine Environment Monitoring Service (CMEMS)



Maritime security



Marine resources



Coastal & marine environment



Meteorology, seasonal predictions and climatology



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	2016 (MIMIST)	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	2018	2021
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’

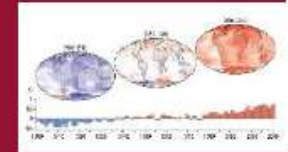
Copernicus Climate Change Service (C3S)



Estimation of essential climate variables (ECVs)



Global and regional re-analyses



Seasonal predictions and climate projections



Support to mitigation and adaptation strategies



EEA climate change impacts indicator

2019

Updates based on C3S information and data

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

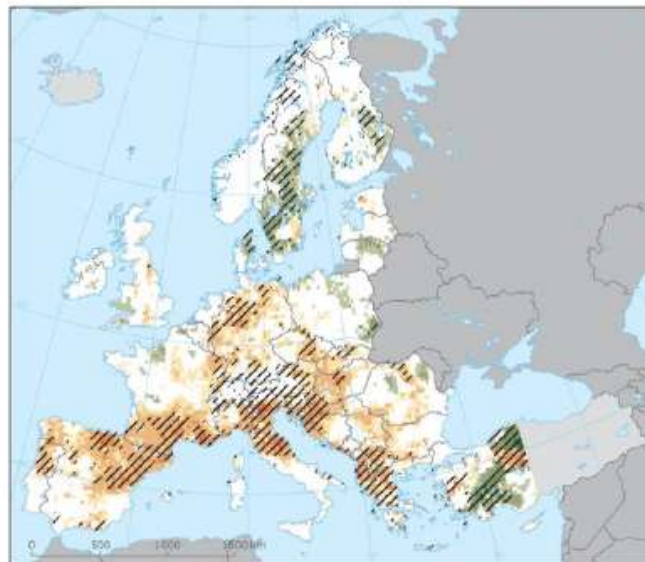
Planned updates partly provided by C3S

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

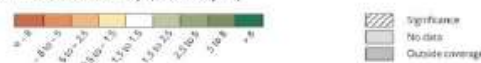
2020

Updates based on C3S information and data

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

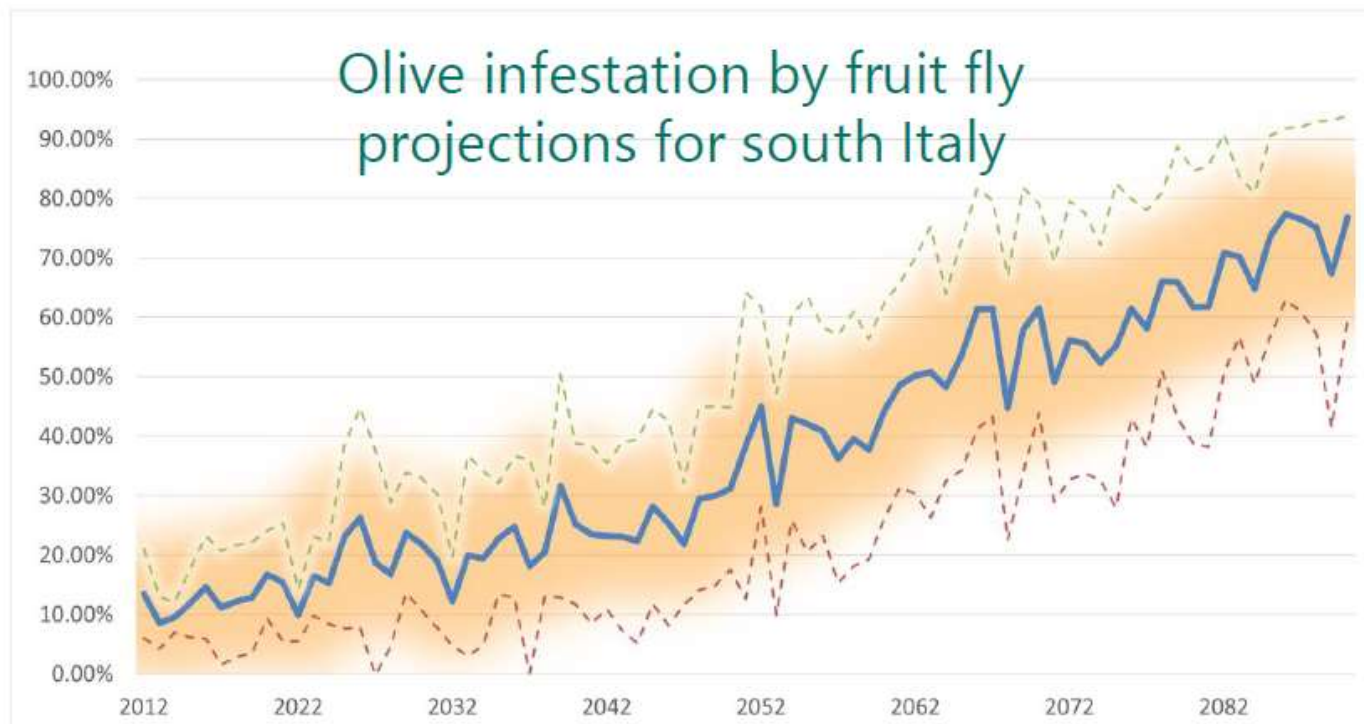
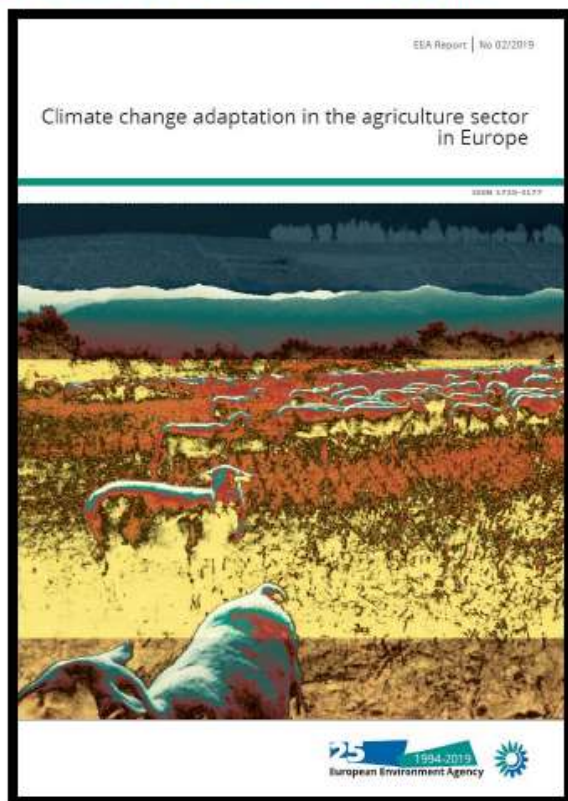


Trends in summer soil moisture in Europe (Stres/m²/10 years)



EEA climate change adaptation assessments

Climate change adaptation in the agriculture sector in Europe



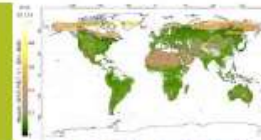
Provided by C3S AgriCLASS project -
<https://climate.copernicus.eu/agriculture-and-forestry>



Copernicus Land Monitoring Service (CLMS)



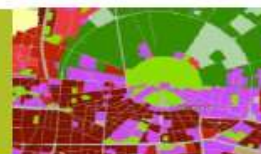
Systematic Biophysical Monitoring



Land Cover & Land Use mapping



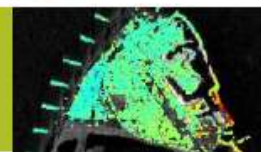
Thematic hotspot mapping



Reference data



Ground Motion service



Land cover and habitat information within Natura 2000



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>

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.

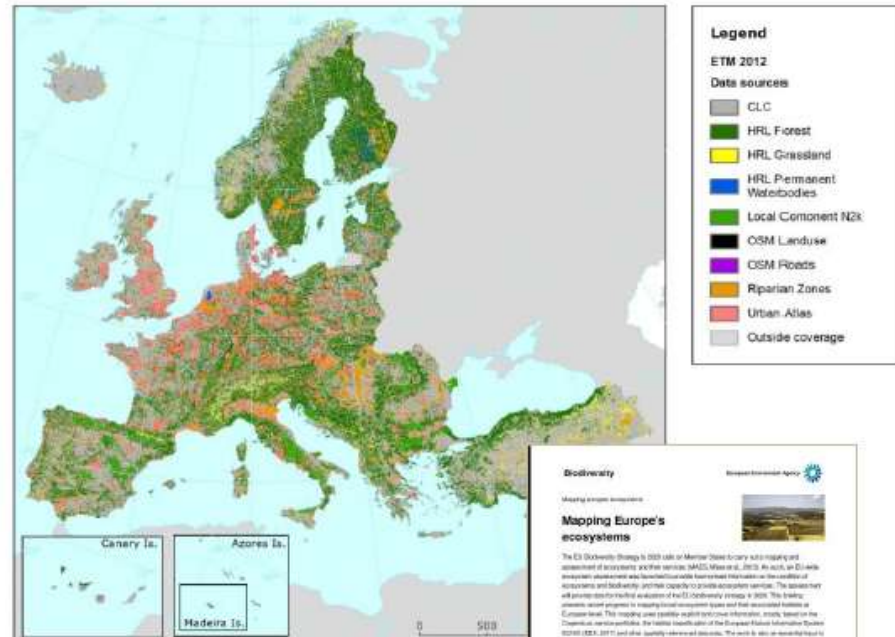
- A change analysis for 2006-2012 reference years,
- Comparison with a 2 km buffer zone for analysis of pressures and threats,
- Checking for decline of certain grassland habitat types is being halted

Ecosystem mapping and habitat delination

Ca. 60 Habitats

- Terrestrial (>50)
- freshwater (3)
- marine (>15)
- Based on habitat distribution maps (selected vegetation plots based on the EUNIS habitat revision criteria).
- Further updates during 2019 following EUNIS revision

<https://www.eea.europa.eu/data-and-maps/data/ecosystem-types-of-europe>
<https://www.eea.europa.eu/highlights/measuring-condition-of-europes-ecosystems>



Biodiversity

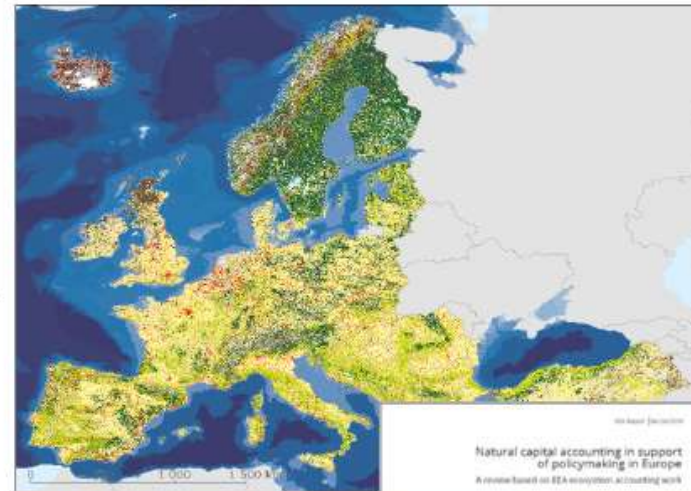
Mapping Europe's ecosystems

The EU Biodiversity Strategy to 2030 calls on Member States to carry out mapping and assessment of ecosystems and their services (EUNIS) in 2019. In 2019, the results of EU-wide ecosystem mapping and assessment have been made available on the website of the European Environment Agency (EEA) in support of the Biodiversity Strategy. The strategy will provide a common framework for the assessment of EU biodiversity strategy in 2030. The strategy allows several progress in mapping ecosystem services and their associated habitats at European level. The mapping uses publicly available information, mostly based on the Copernicus satellite data, the habitat classification of the European Forest Inventory (EFIS) (2017) and other quality-relevant datasets. The work is also in line with the EU Biodiversity Strategy and the assessment of ecosystems and their services (EUNIS) analytical framework (Jain et al., 2019).

Key messages

- The first version of the EUNIS habitat classification for the EEA of the EEA includes terrestrial and freshwater ecosystems and covers all of the EU's territory.
- The new version of the EUNIS habitat classification is a significant improvement of the previous version (2017). The first version was based on the Copernicus satellite data and the second version is based on the EUNIS habitat classification.
- The new version of the EUNIS habitat classification is a significant improvement of the previous version (2017). The first version was based on the Copernicus satellite data and the second version is based on the EUNIS habitat classification.
- Further information can be found in the EUNIS habitat classification report, available from the EUNIS website: <https://www.eea.europa.eu/data-and-maps/data/ecosystem-types-of-europe>

Ecosystem Map v3.1



Ecosystem map

A - Coastal habitats

- A1 Coastal dune and sand dunes
- A2 Coastal dune
- A3 Wetland of high nature value
- A4 Coastal salt marsh
- A5 Coastal lagoon

B - Grasslands and forest dominated by herbs, mosses or lichens

- B1 Dry grassland
- B2 Mosaic grassland
- B3 Subalpine and alpine meadows
- B4 Alpine and subalpine grasslands
- B5 Alpine and subalpine grasslands
- B6 Subalpine and alpine meadows
- B7 Alpine and subalpine grasslands

C - Inland surface waters

- C1 Shallow standing water
- C2 Shallow flowing water
- C3 Large rivers and lakes
- C4 Large rivers and lakes
- C5 Large rivers and lakes

D - Mountain, scrub and sand

- D1 Tundra
- D2 Alpine and subalpine meadows
- D3 Alpine and subalpine meadows
- D4 Alpine and subalpine meadows
- D5 Alpine and subalpine meadows
- D6 Alpine and subalpine meadows
- D7 Alpine and subalpine meadows
- D8 Alpine and subalpine meadows
- D9 Alpine and subalpine meadows
- D10 Alpine and subalpine meadows

E - Regularly or recently cultivated agricultural, forested and domestic habitats

- E1 Arable and permanent cropland
- E2 Pasture
- E3 Forest
- E4 Forest
- E5 Forest
- E6 Forest
- E7 Forest
- E8 Forest
- E9 Forest
- E10 Forest

Based on the 7 Copernicus land monitoring services

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
SEBIO07	Nationally designated protected area	CLMS
SEBIO17	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>

www.copernicus.eu



**BALTIC
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FUND
EUROPEAN UNION

7.10.2019

Ali Nadir Arslan

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](#)

THE DIAS & WHERE TO REACH THEM



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

ESA

[SCI Hub](#) 

[CSCDA](#) 


EUMETSAT

[EUMETCast](#) 

[CODA](#) 

Services data and information

[Land - CLMS](#) 

[Atmosphere - CAMS](#) 

[Emergency - EMS](#) 

[Marine - CMEMS](#) 

[Climate - C3S](#) 

[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

Copernicus is a European system for monitoring the Earth. Data is collected by different sources, including Earth observation satellites and in-situ sensors. The data is processed and provides reliable and up-to-date information in six thematic areas: land, marine, atmosphere, climate change, emergency management and security. The land theme is divided into four main components:



Global

provides a series of bio-geophysical products on the status and evolution of the



Pan-European

provides information about the land cover and land use (LC/LU), land cover and land



Local

focuses on different hotspots, i.e. areas that are prone to specific environmental



Imagery and reference data

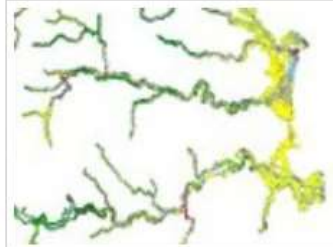
satellite imagery forms the input for the creation of

[Print](#)

Local



[Urban Atlas](#)



[Riparian Zones](#)



[Natura 2000 \(N2K\)](#)

User corner

- [How to access our data](#)
- [Technical library](#)
- [Factsheets](#)
- [Use cases](#)



[Contract opportunities](#)



[EAGLE](#)



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We provide consistent and quality-controlled information related to air pollution and health, solar energy, greenhouse gases and climate forcing, everywhere in the world.

Today's air quality forecasts



Europe



Worldwide



Daily CAMS air quality forecast on EuroNews

Thematic output areas



Air quality



Policy tools



Solar energy



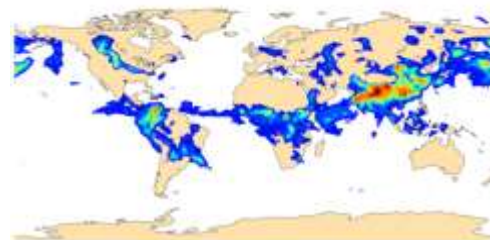
Ozone layer and UV radiation



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).

Overview on Policy Support

Control Scenarios

[Policy Scenarios](#)

[Air Control Toolbox](#)

Source Contribution to EU

Cities

[Daily Forecasts](#)

[Previous Episodes Analysis](#)

CAMS Air Quality Reports

Policy workshops

COPERNICUS MARINE ENVIRONMENT MONITORING SERVICE
Providing PRODUCTS and SERVICES for all marine applications

Search terms

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ACCESS YOUR OCEAN INFORMATION

[GETTING STARTED](#) →

OCEAN PRODUCTS

Ocean product catalogue, to download or visualize data across nearly 15 variables, including hindcast, current and forecast data.

[DATA](#) →

OCEAN MONITORING INDICATORS

Essential variables monitoring the health of the ocean

[TRENDS](#) →

OCEAN STATE REPORT

Extensive annual analysis on the state of the ocean over nearly 20 years and severe/notable annual events.

[EXPERTISE](#) →

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INSITU_GLO_NRT_OBSERVATIC
missing data
ANOMALY

[ALL NEWS FLASH](#)



- 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

YOUR SEARCH

Search by keyword

REGIONAL DOMAIN ▶
All areas

PARAMETERS ▶

TEMPORAL COVERAGE

From 1992-01-01 To 2019-10-05

If checked, the search results will only show products containing the whole selected time range

PRODUCT WITH DEPTH LEVEL

Found 228 ocean products matching your criteria. [Export results](#)

GLOBAL_ANALYSIS_FORECAST_PHY_001_024		
GLOBAL OCEAN 1/12° PHYSICS ANALYSIS AND FORECAST UPDATED DAILY		
MODEL	● ● ● ● ●	GLO
T bottomT S SSH 3DUV MLD SIC SIT SIUV ⓘ		
0.083 degree x 0.083 degree (50 depth levels)		
From 2006-12-27 to Present		
hourly-mean,daily-mean,monthly-mean		
MORE INFO	ADD TO CART	WMS Sub-setting

GLOBAL_ANALYSIS_FORECAST_WAV_001_027		
GLOBAL OCEAN WAVES ANALYSIS AND FORECAST UPDATED DAILY		
MODEL	●	GLO



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:

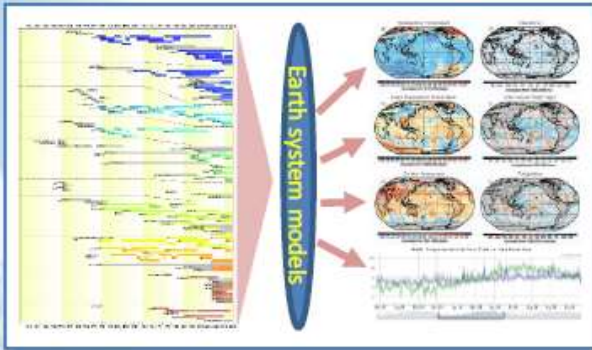
- Providing consistent and authoritative information about climate (past, present, future)
- Building on existing capabilities and infrastructures (nationally, in Europe and worldwide)
- Stimulating the market for climate services in Europe





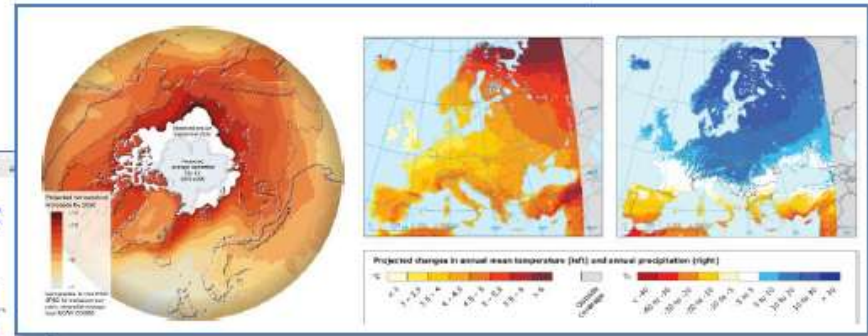
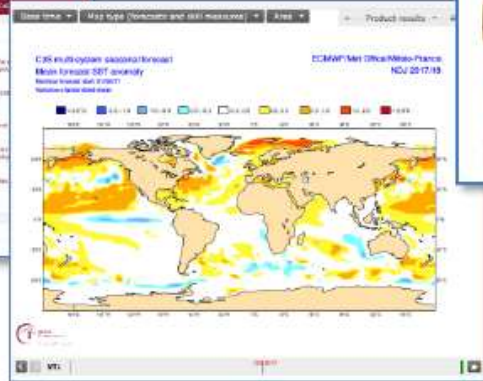
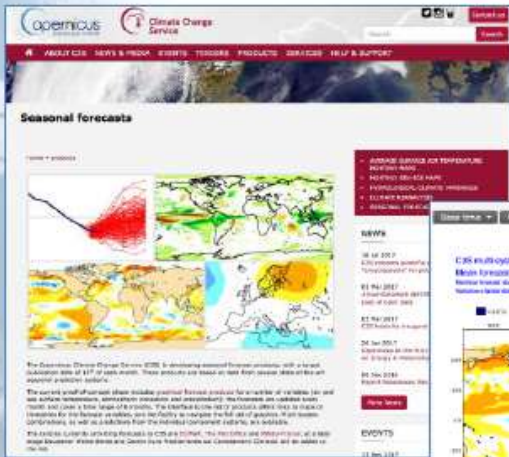
Climate Change

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>



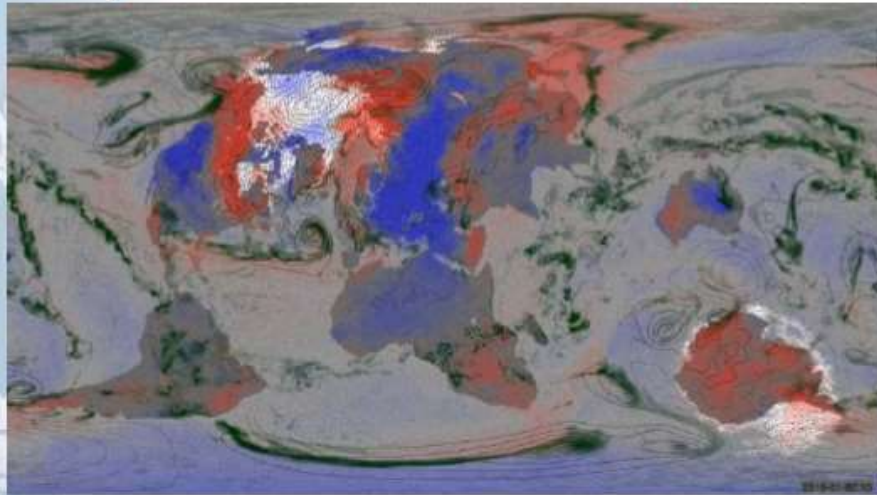


Climate Change

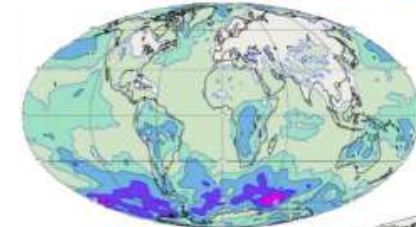
C3S: Reanalysis based Essential Climate Variables (30km global ERA5) Builds upon IFS modelling and Data Assimilation

Hourly data and increased number of parameters

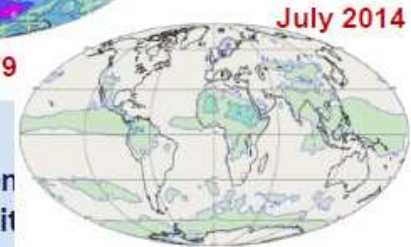
Uncertainty estimate



Spread in Surface Pressure



January 1979



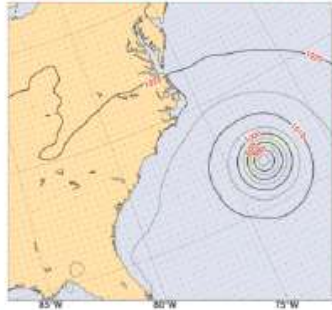
July 2014

Reflects variations in:

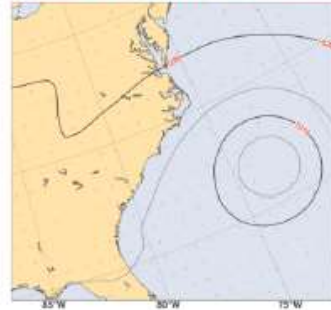
- ingested observing system
- flow-dependent sensitivity

Courtesy: Philip Brohan

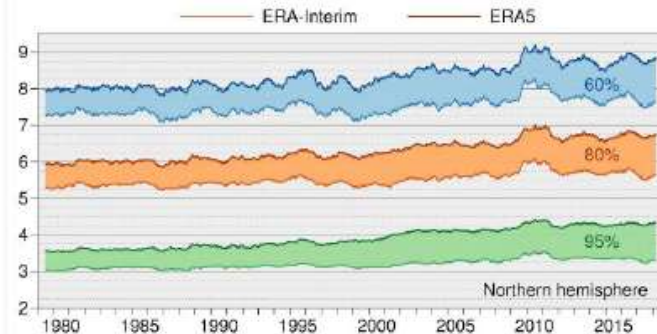
Florence Thu 13 Sep 2018, 01 UTC for ERA5



Florence Thu 13 Sep 2018, 01 UTC for ERA-Interim



Range (days) when 365-day mean 500hPa height AC (%) falls below threshold



Credit: H. Hersbach, ECMWF





Climate Change

C3S: EO based Essential Climate Variables



- 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



GCOS-195	CCI	CCI+	uptake	C3S
Atmospheric surface				
4.3.1				
4.3.2				
4.3.5				
4.3.6				
Atmospheric upper air				
4.5.1				
4.5.2				
4.5.3				
4.5.4				
4.5.5				
Atmospheric composition				
4.7.1				
4.7.2				
4.7.3				
4.7.4				
4.7.5				
Ocean surface				
5.3.1				
5.3.2				
5.3.3				
5.3.4				
5.3.5				
Ocean biogeochemistry				
5.3.7				
5.3.8				
5.3.9				
Ocean sub-surface				
5.4.1				
5.4.2				
5.4.3				
Land hydrology & cryosphere				
6.3.4				
6.3.5				
6.3.6				
6.3.7				
6.3.8				
6.3.16				
Land biosphere				
6.3.9				
6.3.10				
6.3.11				
6.3.12				
6.3.13				
6.3.15				
6.3.17.1				



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





Climate Change

Access to climate datasets before the CDS...



Thumbnail	File	Version	Status	Searchable input	Level	Frequency	Time-lag	Spatial coverage	Spatial sampling
	Global Sea Ice Concentration (Global)	001-001-1	Operational	INMCM/ISMR	L1	1 per day	0.0	Global	10 km
	Global Sea Ice Edge	001-002-1	Operational	INMCM/ISMR	L1	1 per day	0.0	global	10 km
	Global Sea Ice Type	001-003-1	Operational	INMCM/ISMR, Miroq-ROCAT and CCMA-W/AMIP-2	L1	1 per day	0.0	global	10 km
	Global Sea Ice Freezing	001-004-1	Operational	INMCM/ISMR	L1	1 per day	0.0	global	10 km
	Global Ice Break-up Start Date (GIS)	001-005-1	Operational	INMCM/ISMR, Miroq-ROCAT and CCMA-W/AMIP-2	L1	1 per day	0.0	Global	62.5 km
	Multi-yr Break-up Ice GIS	001-007-1	Operational	Miroq-ROCAT	L2	2 per day	0.0	Northern Hemisphere	20 km



Climate Change

Catalogue of climate datasets

The screenshot shows the 'Catalogue of climate datasets' website. At the top, there are logos for Copernicus, ECMWF, and the Climate Change Service. A search bar is visible with the text 'Search results'. Below the search bar, there is a list of datasets with their titles and brief descriptions:

- Glaciers elevation and mass change data from 1894 to 2014 from the Fluctuation of Glaciers Database**: A glacier is defined as a perennial mass of ice, and piled by firn and snow, originating on the land surface from the recrystallisation of snow or other forms of solid precipitation and showing evidence...
- Glaciers extent data from 1995 to 2015 from the Randolph Glacier Inventory**: A glacier is defined as a perennial mass of ice, and piled by firn and snow, originating on the land surface from the recrystallisation of snow or other forms of solid precipitation and showing evidence...
- Methane data from 2002 to present derived from satellite sensors**: Methane (CH₄) is the second most significant greenhouse gas that has increased its concentration in the atmosphere directly due to human activities, from the widespread use of the solid waste burning of oil...
- Sea surface temperature daily gridded data from 1991 to 2010 produced by ESA-CCI**: This dataset provides daily values for sea surface temperature and sea-ice fraction over a regular grid with missing values in space or in time. The initial satellite data from the Advanced Very High Resolution Radiometer (AVHRR) on the SeaWiFS satellite...
- Water quality indicators for European rivers**: This dataset contains modelled data for phosphorus and nitrogen concentrations and loads. The data comes from the Swedish Meteorological and Hydrological Institute (SMHI) model at catchment level...
- Water quantity indicators for Europe**: This dataset contains modelled data for water runoff and wetness, river flow, river water equivalent, soil water content and other water related quantities for the European region. These variables were...
- CMIP5 daily data on pressure levels**: This catalogue entry provides daily climate projections on pressure levels from a large number of experiments, models, members and time periods computed in the framework of 5th phase of the Coupled Model Intercomparison Project (CMIP5)...
- CMIP5 daily data on single levels**: This catalogue entry provides daily climate projections on single levels from a large number of experiments, models, members and time periods computed in the framework of 5th phase of the Coupled Model Intercomparison Project (CMIP5)...
- CMIP5 monthly data on pressure levels**: This catalogue entry provides monthly climate projections on pressure levels from a large number of experiments, models, members and time periods computed in the framework of 5th phase of the Coupled Model Intercomparison Project (CMIP5)...
- Seasonal forecast monthly statistics on single levels from 2017 to present**: Seasonal forecasts provide a long range outlook of changes in the Earth system over periods of a few weeks or months, as a result of predictable changes in some of the slow-varying components of the Earth system...
- Seasonal forecast monthly statistics on pressure levels from 2017 to present**: Seasonal forecasts provide a long range outlook of changes in the Earth system over periods of a few weeks or months, as a result of predictable changes in some of the slow-varying components of the Earth system...
- Seasonal forecast daily data on pressure levels from 2017 to present**: Seasonal forecasts provide a long range outlook of changes in the Earth system over periods of a few weeks or months, as a result of predictable changes in some of the slow-varying components of the Earth system...
- ERA5 hourly data on pressure levels from 2000 to present**: ERA5 is the fifth generation ECMWF atmospheric reanalysis of the global climate. Reanalysis combines model data with observations from across the world into a globally complete and consistent dataset...
- Seasonal forecast daily data on single levels from 2017 to present**: Seasonal forecasts provide a long range outlook of changes in the Earth system over periods of a few weeks or months, as a result of predictable changes in some of the slow-varying components of the Earth system...





Climate Change

ECV products from Earth observations

Sea ice monthly and daily gridded data from 1978 to present

Overview Download data Documentation

This dataset provides daily values for sea ice concentration, sea ice edge and sea ice type and monthly values for sea thickness. These four variables are important markers for climate change studies since sea ice greatly influences the surface albedo and as exchanges of energy, moisture and carbon. The sea-ice distribution, including polynyas and margins, also has an important infl on marine ecosystems. Changes in the distribution of sea ice affect these ecosystems and a number of activities such as shipping, trade and tourist operations.



Sea ice edge, sea ice concentration and sea ice type were computed from satellite passive microwave brightness temperatures from the series of SMMR, SSM/I and SSM/IS sensors. Sea ice thickness were computed from Ku-Band radar altimeter measurements collected by the Cryosat and Cryosat-2 satellite missions. Ice thicknesses from Envisat satellite (October 2002 to October 2010) have less coverage and higher uncertainty than thicknesses from CryoSat-2 (November 2010 - March 2015), however the combined dataset provides a valuable unique observational record of sea ice variability.

From 1978 up to April 2015 the data records provided by this dataset have sufficient length, consistency and continuity to detect climate variability and change. From April 2015 onwards, satellite data were processed using same algorithms and processing pipeline but consistency and continuity have not been extensively verified. More details about the product are given in the Documentation section.

DATA DESCRIPTION	
Horizontal coverage	Sea ice concentration and edge: global (ocean split) in Northern and Southern hemis (Lambert PASE2/EASE2 projection).
	Sea ice thickness and type: northern hemisphere (Lambert PASE2 projection).

Sea ice monthly and daily gridded data from 1978 to present

Overview Download data Documentation

Variable

At least one selection must be made

- Sea ice concentration
- Sea ice edge
- Sea ice type
- Sea ice thickness

Select all

Year

At least one selection must be made

- 1978
- 1981
- 1984
- 1987
- 1990
- 1993
- 1996
- 1999
- 2002
- 2005
- 2008
- 2011
- 2014
- 2017
- 1979
- 1982
- 1985
- 1988
- 1991
- 1994
- 1997
- 2000
- 2003
- 2006
- 2009
- 2012
- 2015
- 2018
- 1980
- 1983
- 1986
- 1989
- 1992
- 1995
- 1998
- 2001
- 2004
- 2007
- 2010
- 2013
- 2016

Select all

Month

At least one selection must be made

- January
- February
- March
- April
- May
- None

Home Search Datasets Applications Your requests Toolbox Help & support

Search results

Search: glacier

Sort by: Relevancy

Showing 1-11 of 11 results for Satellite observations

- Glaciers elevation and ma from the Fluctuation of GI**
A glacier is defined as a perennial mass of ic from the recrystallization of snow or other f...
- Glaciers extent data from 1995 to 2015 from the Randolph Glacier Inventory**
A glacier is defined as a perennial mass of ice, and possibly firn and snow, originating on the land surface from the recrystallization of snow or other forms of solid precipitation and showing eviden...
- Methane data from 2002 to present derived from satellite sensors**
Methane (CH4) is the second most significant greenhouse gases that has increased in concentration in the atmosphere directly due to human activities, from the viewpoint of the radiative forcing of it...
- Sea surface temperature daily gridded data from 1991 to 2010 produced by ESA-CCI**
This dataset provides daily values for sea surface temperature and sea ice fraction over a regular grid with no missing values in space or in time. The initial satellite data from the Along Track Scan...
- Sea ice monthly and daily gridded data from 1978 to present**





Climate Change

Multi-system seasonal forecasts

Seasonal forecast monthly statistics on single levels from 2017 to present

Overview Download data Documentation

Seasonal forecasts provide a long-range outlook of changes in the Earth system over periods of a few weeks or months, as a result of predictable changes in some of the slow-varying components of the system. For example, ocean temperatures typically vary slowly, on timescales of weeks or months; as the ocean has an impact on the overlying atmosphere, the variability of its properties (e.g. temperature) can modify both local and remote atmospheric conditions. Such modifications of the 'usual' atmospheric conditions are the essence of all long-range (e.g. seasonal) forecasts. This is different from a weather forecast, which gives a lot more precise detail - both in time and space - of the evolution of the state of the atmosphere over a few days into the future. Beyond a weather forecast, the chaotic nature of the atmosphere limits the possibility to predict precise changes at local scales. This is a reason long-range forecasts of atmospheric conditions have large uncertainties. To quantify such uncertain range forecasts use ensembles, and meaningful forecast products reflect a distributions of outcomes.



Given the complex, non-linear interactions between the individual components of the Earth system, the best long-range forecasting are climate models which include as many of the key components of the system and typically, such models include representations of the atmosphere, ocean and land surface. These models are with data describing the state of the system at the starting point of the forecast, and used to predict the evolution of the system in time. While uncertainties coming from imperfect knowledge of the initial conditions of the system, the Earth system can be described with the use of ensembles, uncertainty arising from approximations in the models are very much dependent on the choice of model. A convenient way to quantify the effect of these approximations is to combine outputs from several models, independently developed, initialised and operated.

To this effect, the C3S provides a **multi-system seasonal forecast service**, where data produced by state-of-the-art seasonal forecast systems developed, implemented and operated at forecast centres in several European countries are combined to provide a multi-model ensemble. The combination of the C3S ensembles

Seasonal forecast monthly statistics on single levels from 2017 to present

Overview Download data Documentation

Originating centre

At least one selection must be made

- ECMWF
- UK Met Office
- Météo France

Variable

At least one selection must be made

- 10m u-component of wind
- 10m v-component of wind
- 10m wind speed
- 10m wind gust since previous post-processing
- East-west surface stress rate of accumulation
- 2m dewpoint temperature
- Mean sea level pressure
- Evaporation
- Rainfall
- Minimum 2m temperature in the last 24 hours
- Snow density
- Sea surface temperature
- Soil temperature level 1
- Snow depth
- Surface latent heat flux
- Surface solar radiation
- Surface solar radiation downwards
- Top solar radiation
- Top thermal radiation
- Total precipitation
- 2m temperature
- Maximum 2m temperature in the last 24 hours
- North-south surface stress rate of accumulation
- Sea-ice cover
- Snowfall
- Surface sensible heat flux
- Surface thermal radiation
- Surface thermal radiation downwards
- Total cloud cover

Product type

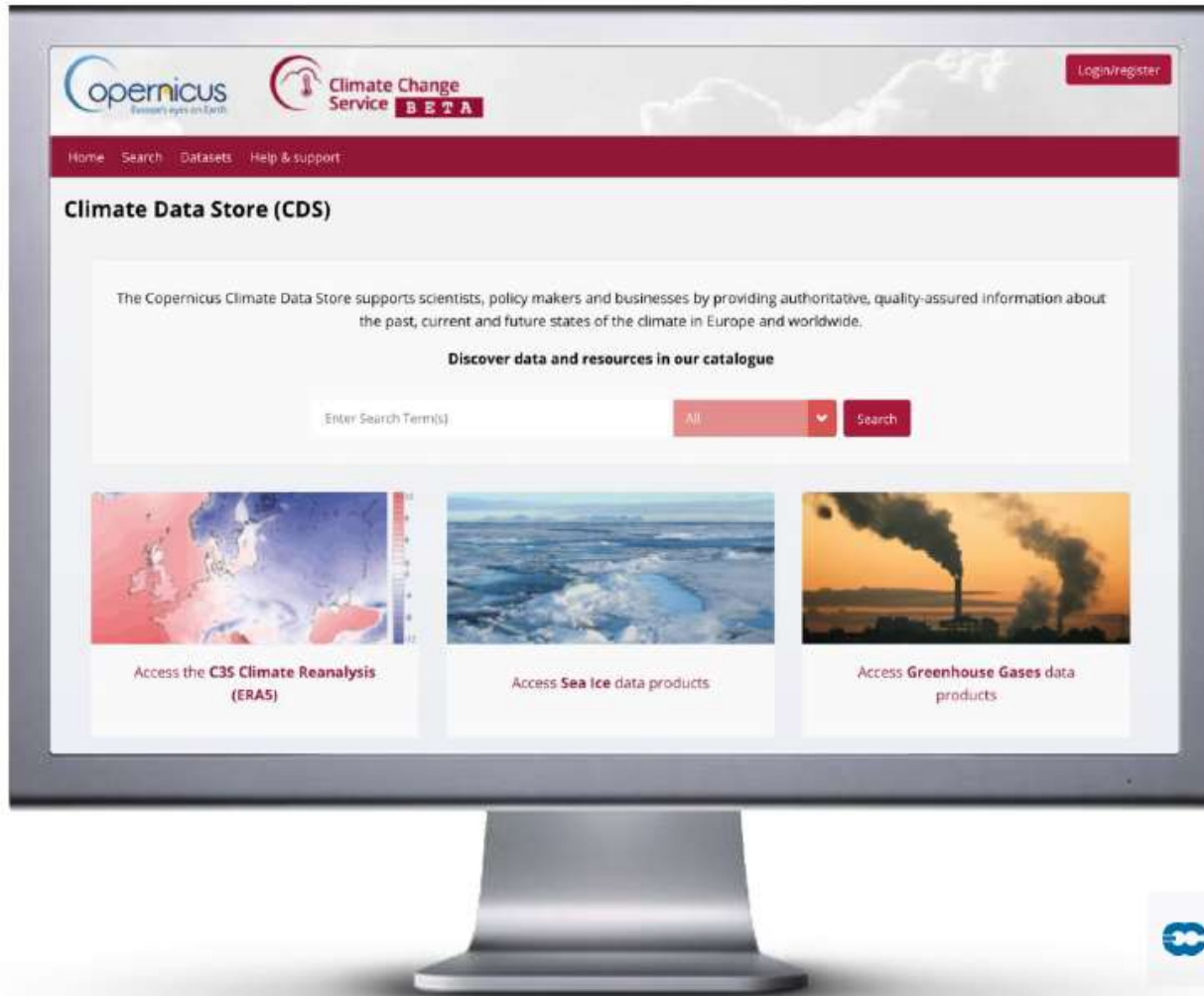
At least one selection must be made

- Ensemble





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**

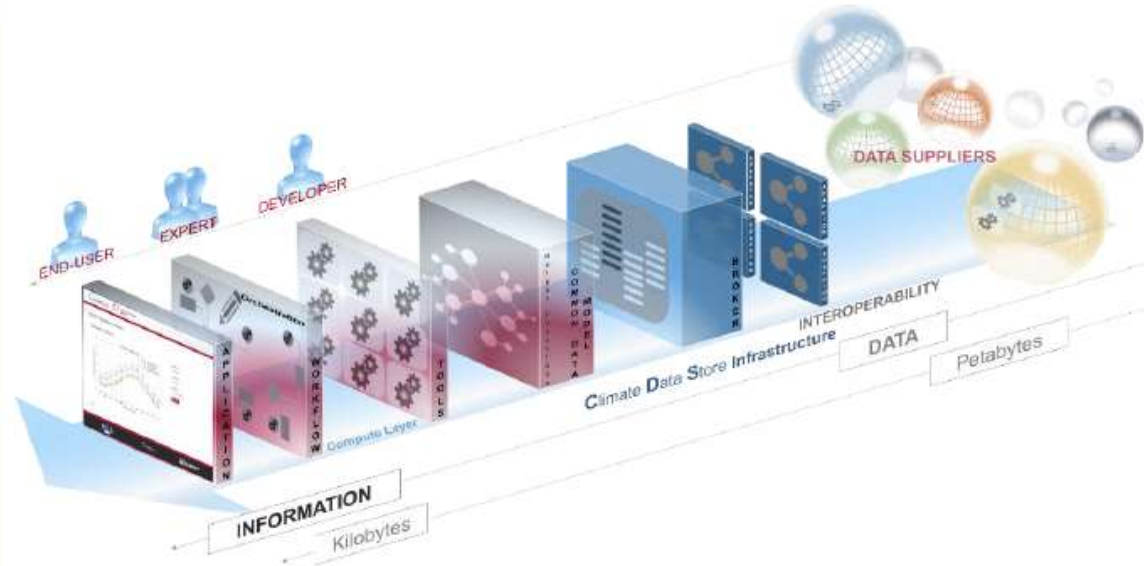
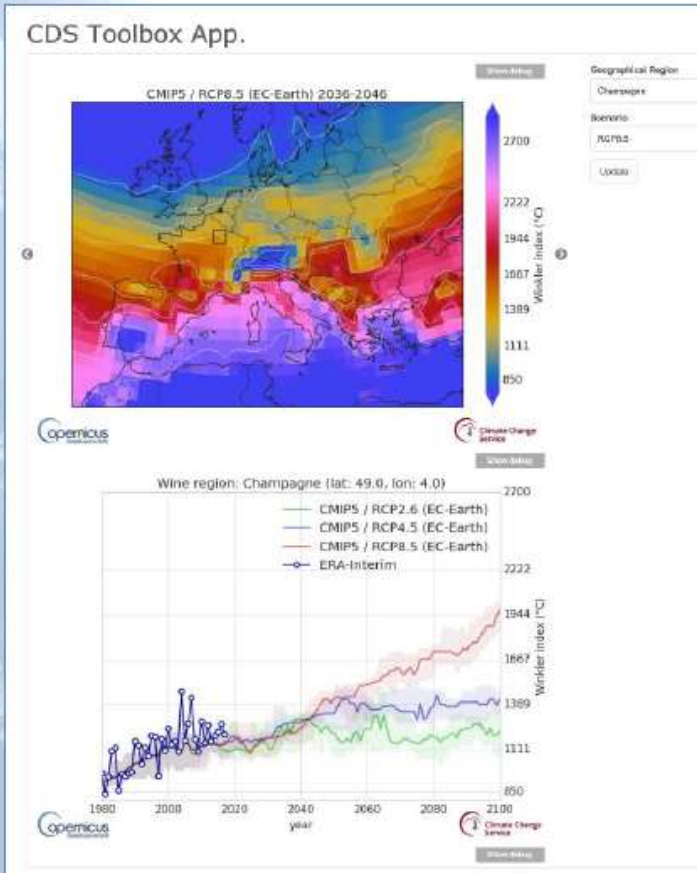




Climate Change

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.



Climate Change

SECTORAL INFORMATION SYSTEM

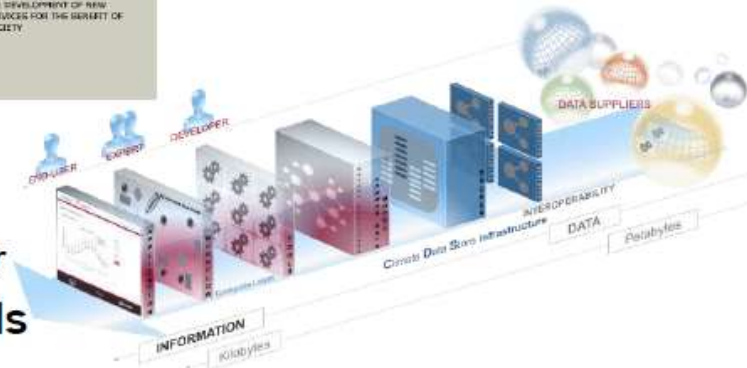
Proof-of-concepts of climate services:
Demonstration of the **value chain** with several end-to-end **demonstrators**



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.

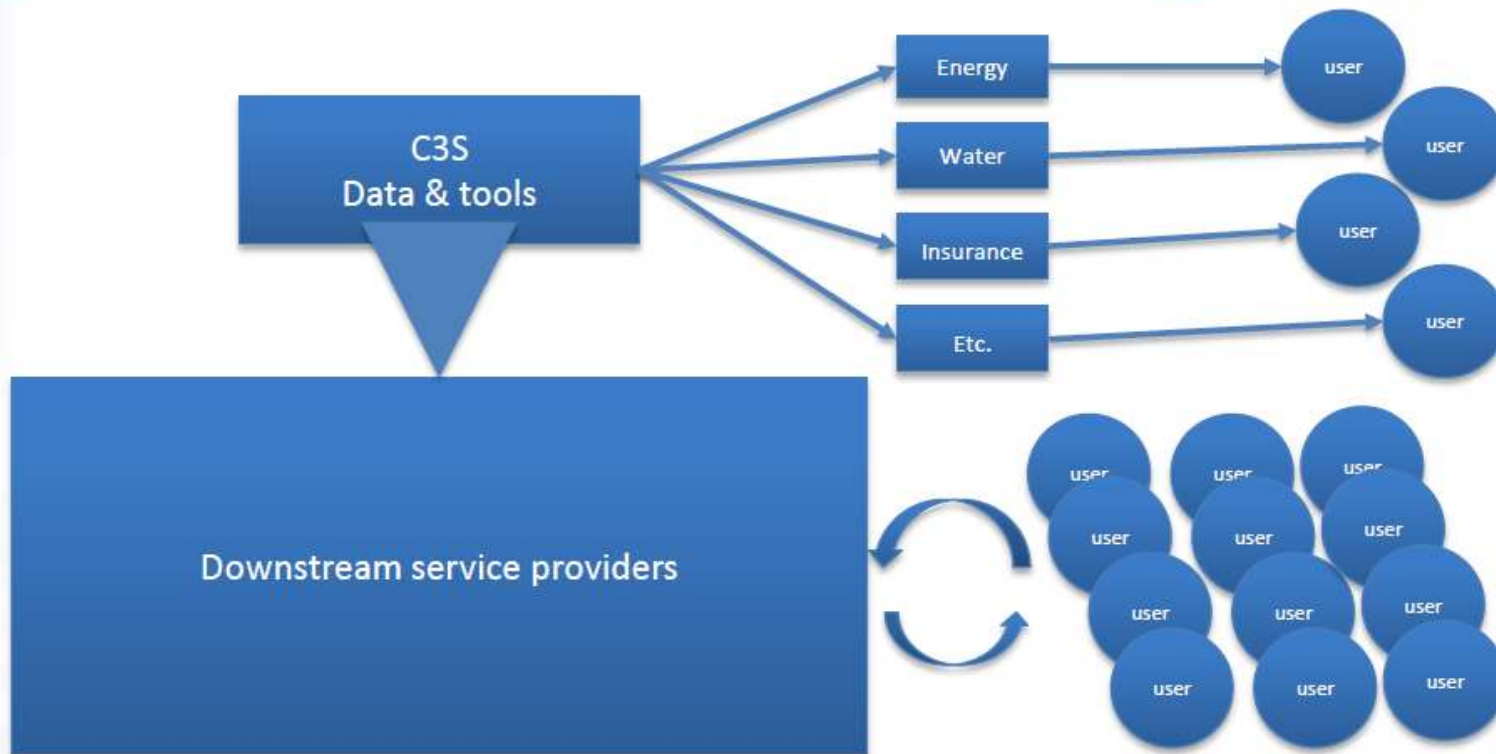
5 DIASs under development (4 by ESA, 1 by ECMWF/EUM/MO)





Climate Change

C3S: Enabler for downstream exploitation

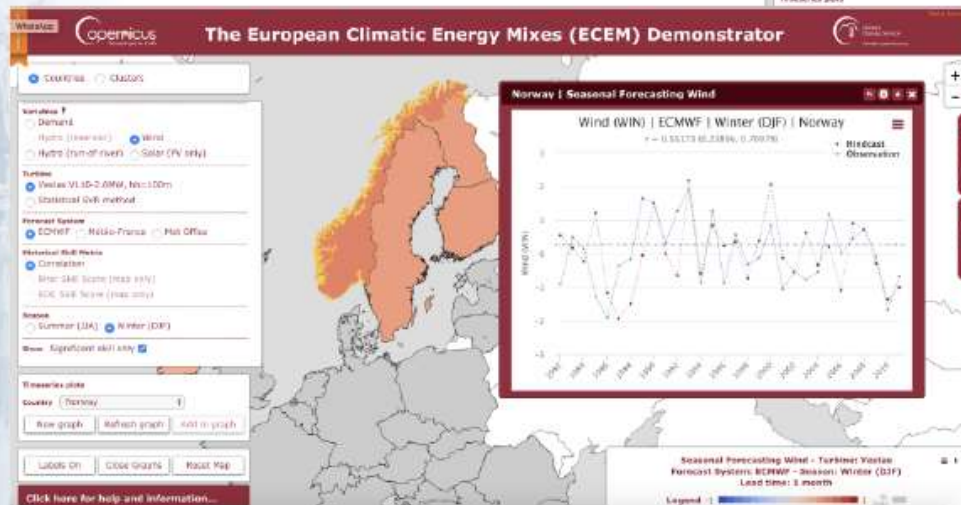
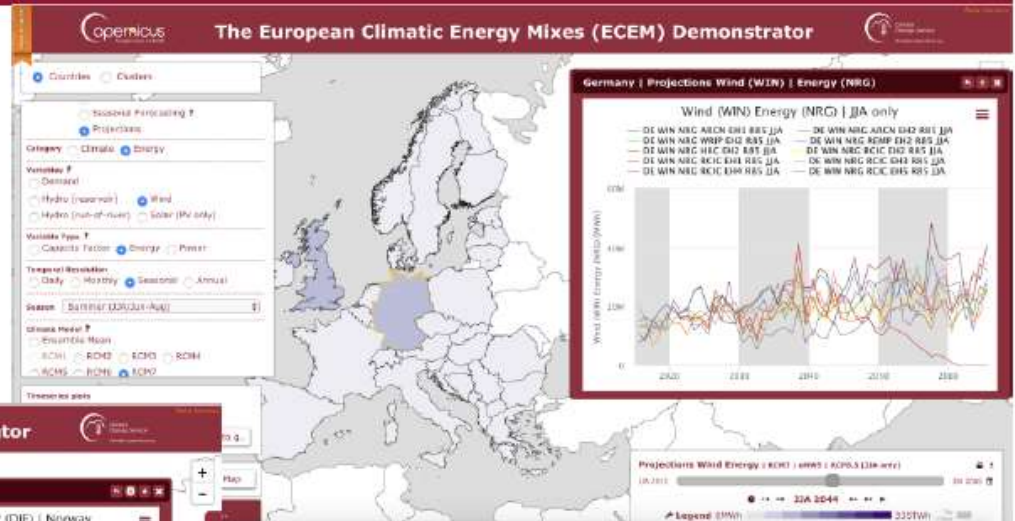




Climate Change

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?



Contract led by UEA

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.



7.10.2019

Ali Nadir Arslan



Climate Change

Health exposure demonstrator

Heat_exposure

Variable: Tmin

City: Rome

Statistic: Mean

Period: Annual

Daily mean of mean of Tmin

Temperature (°C)

Year

Timeseries of mean of Tmin for Rome

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

Logos: Copernicus, Climate Change Service, European Commission

MEAN TSM IN SUMMER 2011 [°C]

MEAN TEMPERATURE 1987 [°C]

Logos: ECMWF, Copernicus, European Commission

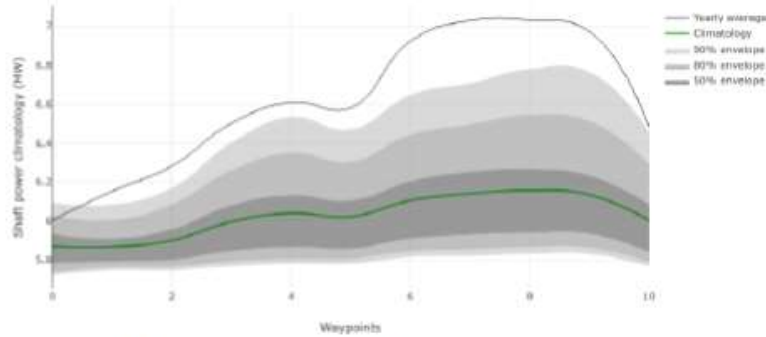


Climate Change

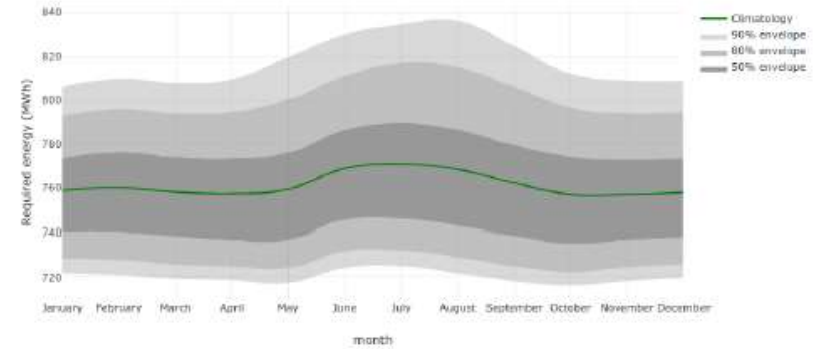
Climate indicators related to Shipping

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

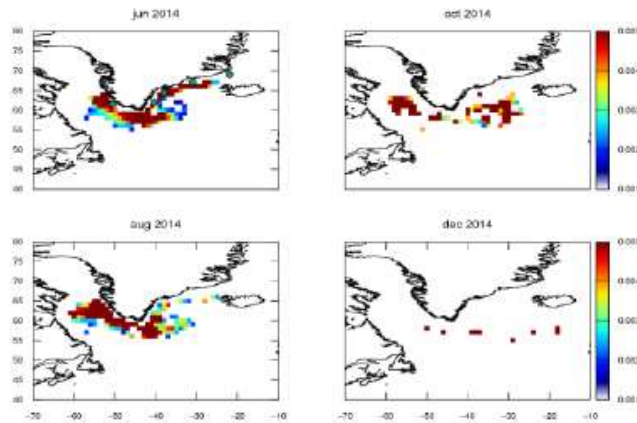
Shaft power climatology in July



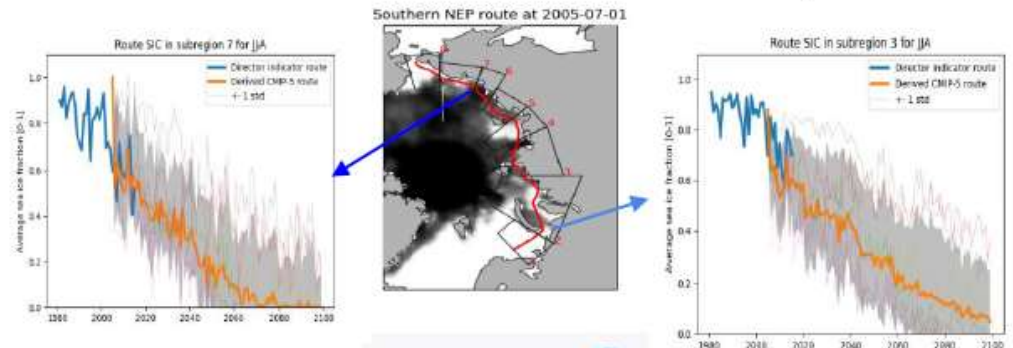
Yearly climatology of required energy



Where/when will I find icebergs ?



When will the Arctic route become commercially viable?





Climate Change

Evaluation and Quality Control (EQC)

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

Key feature: Quality Assurance R

Sea ice monthly and daily gridded data from 1978

Overview Download data Documentatio **Quality**

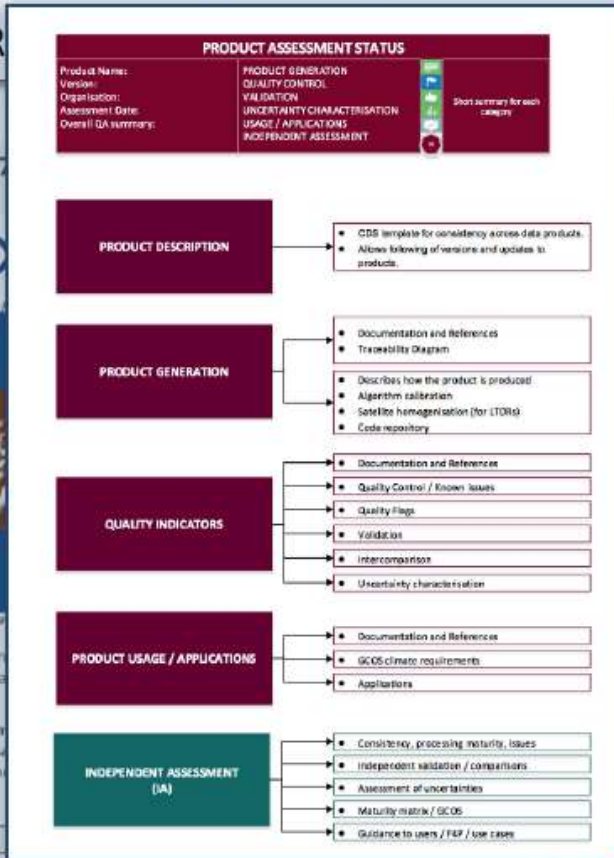
This dataset provides daily values for sea ice concentration, sea ice edge and sea ice type and monthly values for sea ice thickness. These four variables are important markers for climate change studies since sea ice greatly influences the surface albedo and sea exchanges of energy, moisture and carbon. The sea-ice distribution, including polynyas and margins, also has an important infl on marine ecosystems. Changes in the distribution of sea ice affect these ecosystems and a number of activities such as shipping and tourist operations.

Sea ice edge, sea ice concentration and sea ice type were computed from satellite passive microwave brightness temperatures from the series of SMMR, SSM/I and SSMIS sensors. Sea ice thickness were computed from Ku-Band radar altimeter measurements collecting the Envisat and CryoSat-2 satellite missions. Ice thicknesses from Envisat satellite (October 2002 to October 2010) have less coverage and higher uncertainty than CryoSat-2 (November 2010 - March 2015), however the combined dataset provides a valuable record of sea ice variability.

From 1978 up to April 2015 the data records provided by this dataset have continuity to detect climate variability and change. From April 2015 onwards, the data records are produced using the same algorithms and processing environment but consistency and continuity have not been fully maintained.

More details about the product are given in the Documentation section.

DATA DESCRIPTION	
Horizontal coverage:	Sea ice concentration and edge: global ocean split in Northern and Southern hemisphere (Lambert EASE2 projection).
	Sea ice thickness and type: northern hemisphere (Lambert EASE2 projection).



Quality of data:

- assessments
- user guidance
- gaps and limitations

Quality of tools:

- fitness for purpose
- best practices

Quality of service:

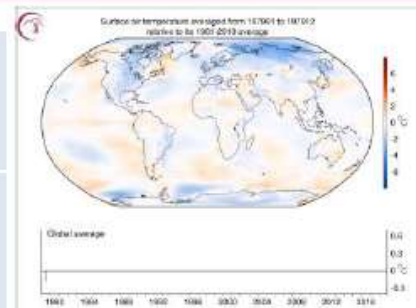
- speed, responsiveness
- system availability, ...



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.



<https://climate.copernicus.eu/CopernicusESC>





C3S and UNFCCC Sustainable Development Goals

Climate

C3S contribution to SDGs

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.

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

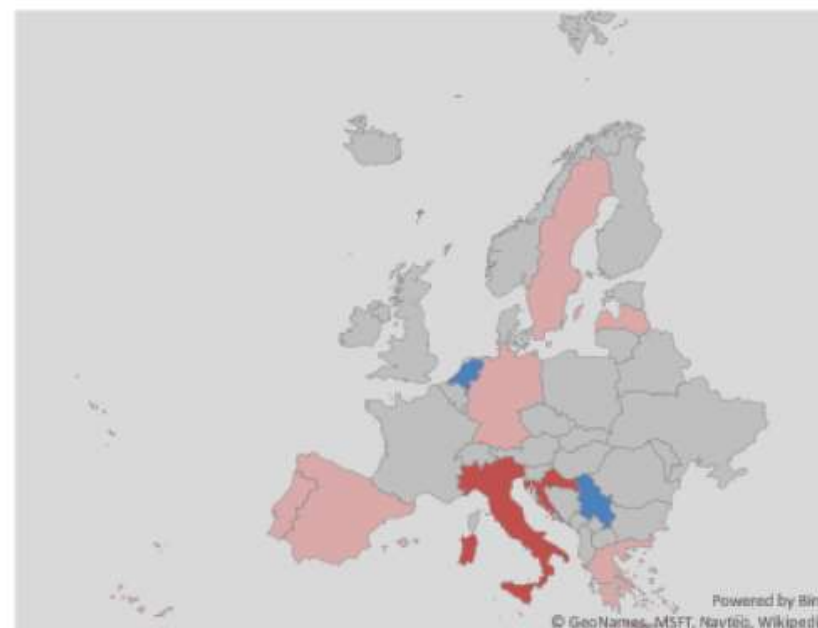
Key elements:

- 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

Train the trainer events

- completed (2018)
- planned (2018)
- tentative (2019)

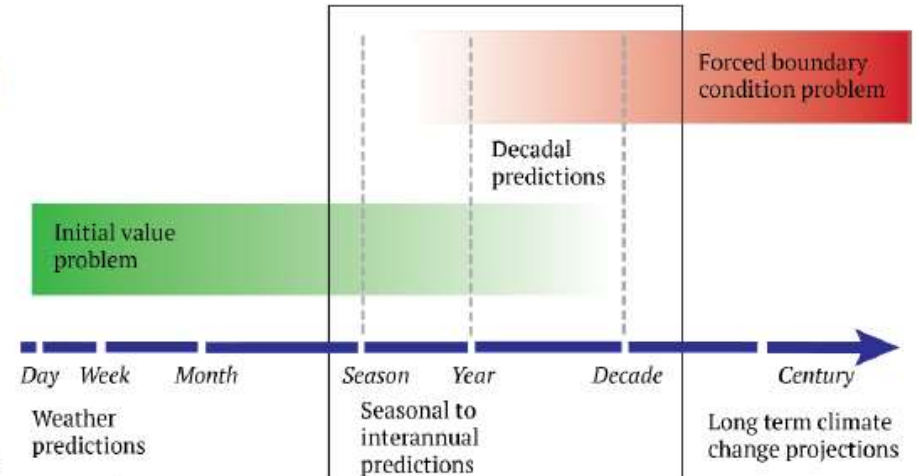




Climate
Change

What's next: Decadal Component

- 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](#)





Climate Change

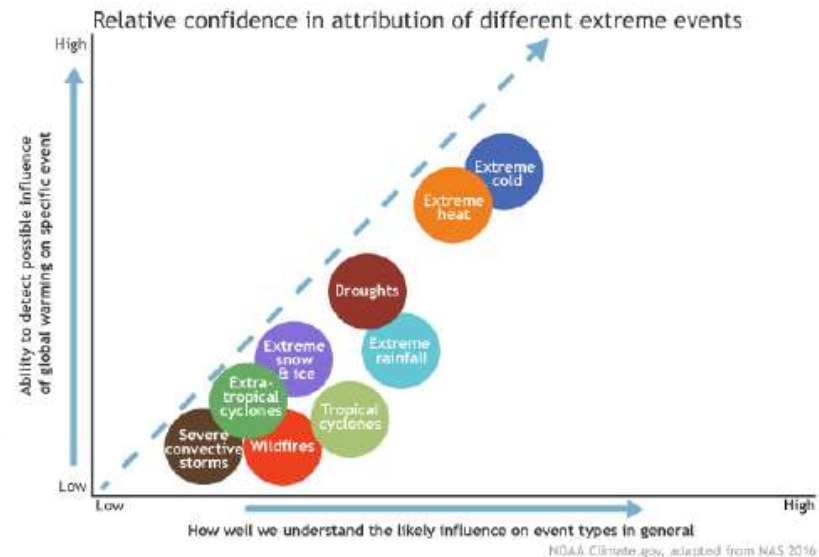
What's next: Attribution component

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>



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



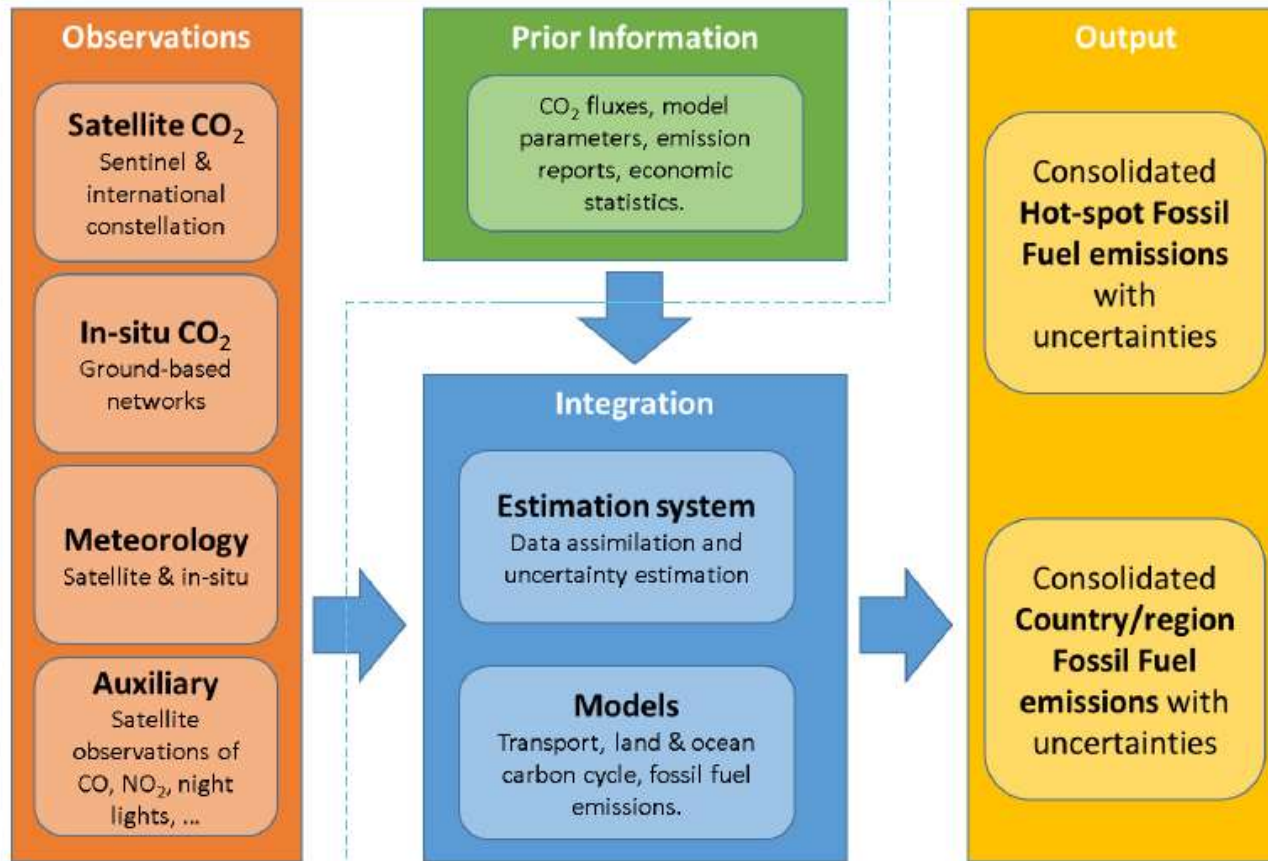
Credit: WMO



European
Commission



CO₂ 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!

