The Copernicus Climate Change Service (C3S)

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Copernicus Programme - Description

- European Union´s Earth Observation Programme
  - Managed and coordinated by the European Commission
  - Implemented in collaboration with EU member states, ESA, EUMETSAT, Mercator Océan, ECMWF and EU Agencies like EEA
  - ~4300 M€ in the current multiannual financial framework (2014-2020)
- System based on Earth Observation satellite data and “in-situ” (non spatial) observations
- Free, full and open access to data and services for any citizen or organization
  - Improve citizens´ life
  - Offer (to administrations and businesses) tools for decision-making

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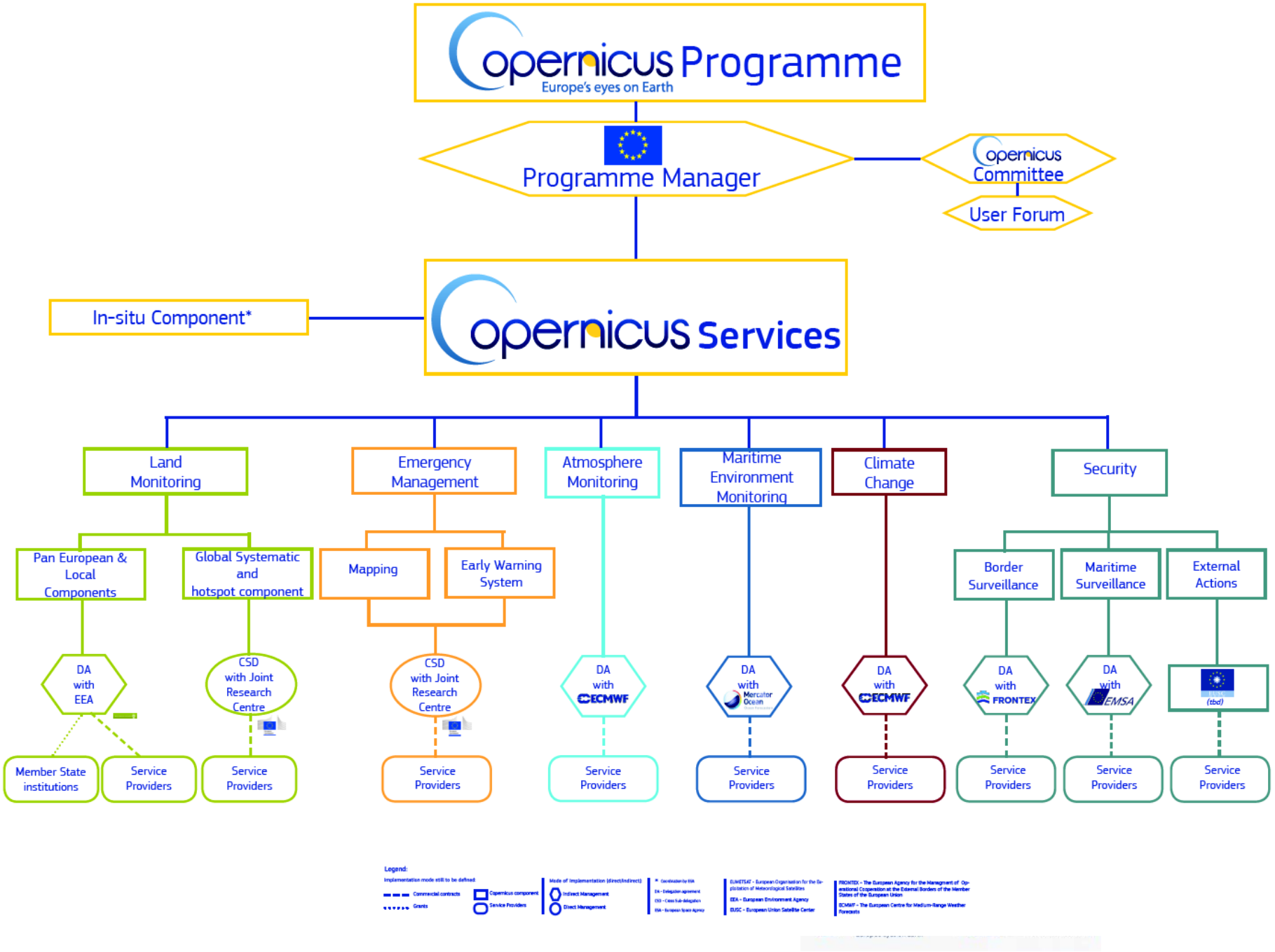
Copernicus Programme
Europe's eyes on Earth
Programme Manager
Copernicus Committee
User Forum
In-situ Component*
Copernicus Services
Land Monitoring
Emergency Management
Atmosphere Monitoring
Maritime Environment Monitoring
Climate Change
Security
Pan European & Local Components
Global Systematic and 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
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Legend:

Copernicus Programme - Components

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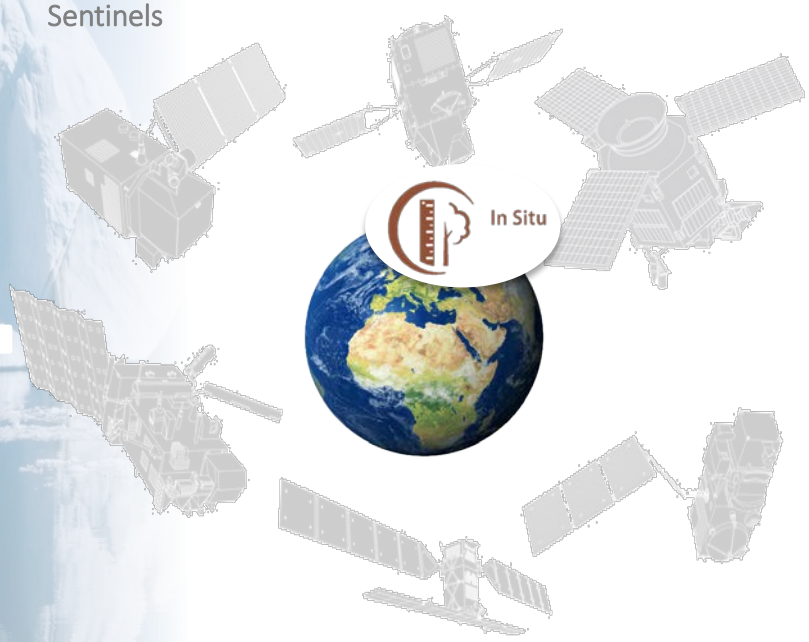
Sentinels



Services

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Copernicus Programme - Components

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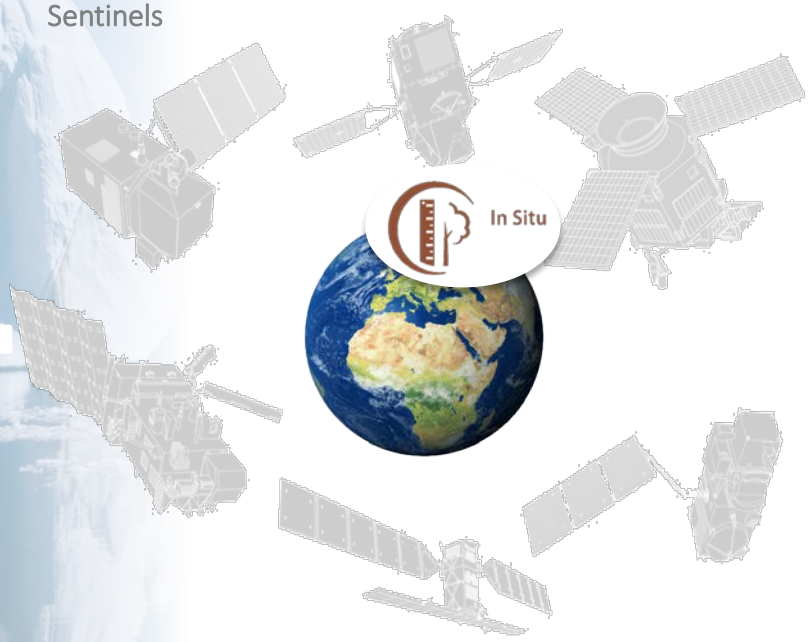

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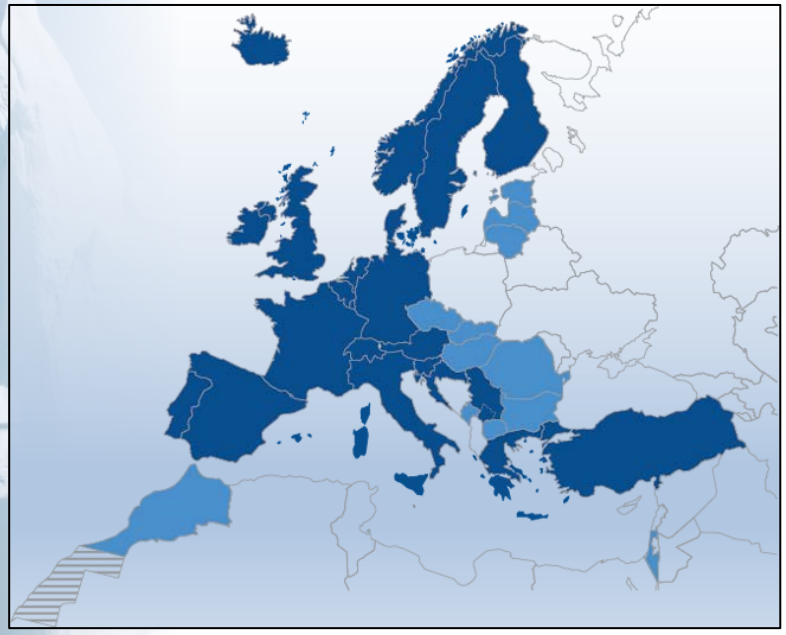
Copernicus Programme - Role of ECMWF

ECMWF



Research institute + 24/7 operational service

Established in 1975, located in Reading, UK

22 member states, 12 co-operating states

350 member of staff, 30 nationalities

Annual Budget ~ 70 M€

MARS: Meteorological data archive (Petabytes)

Commercial catalogue

One of the biggest HPC in Europe

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C3S - Mission

Support the European adaptation and mitigation policies:

- Providing consistent and authoritative information about climate change
- Stimulating the market for climate services in Europe
- Building on existing capabilities and infrastructures

Climate Change Service

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C3S - Components

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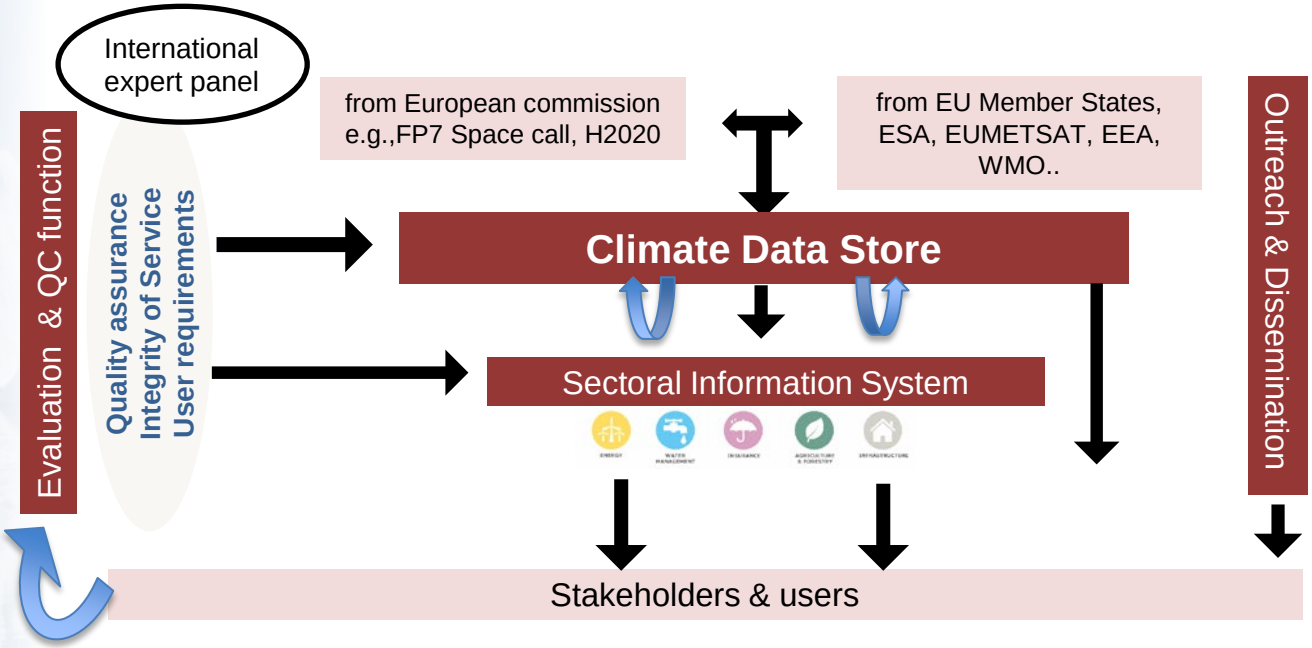

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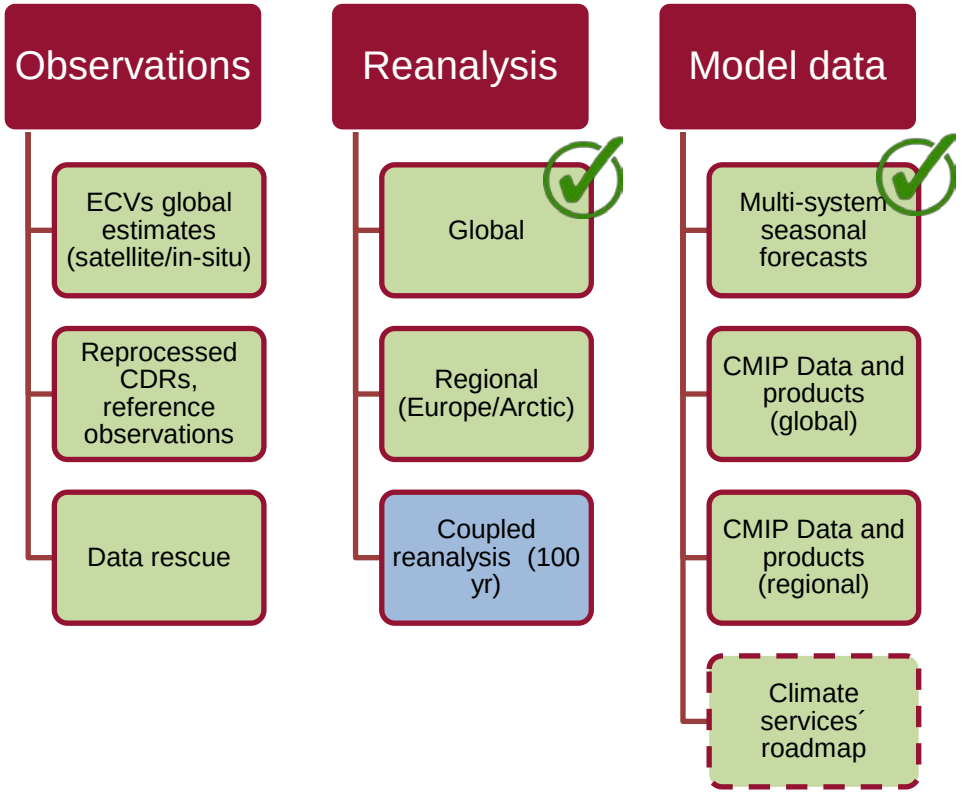
C3S – Available Products



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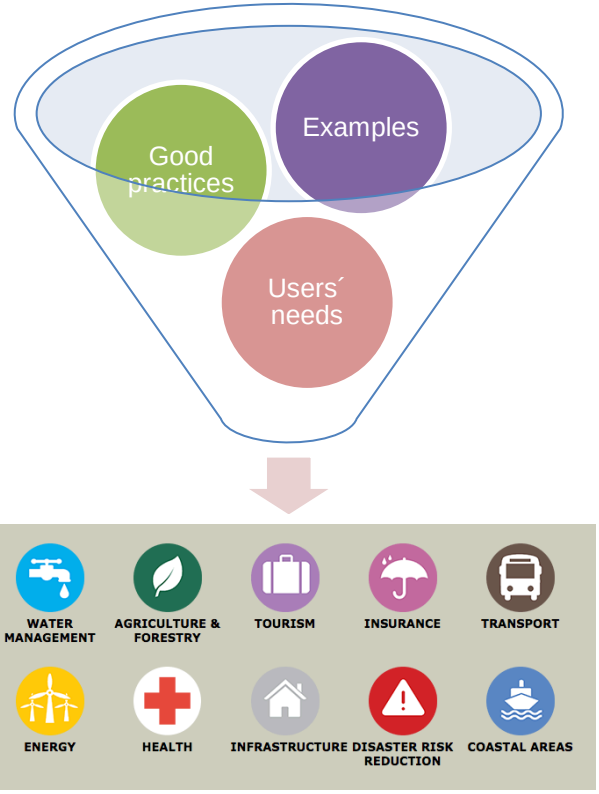
C3S – Sectoral Information System (SIS)



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ECWMF reanalysis
ERA5

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What is new in ERA5?

	ERA-Interim	ERA5
Period	1979 – present	Initially 1979 – present, later addition 1950-1978
Streams	1979-1989, 1989-present	Parallel streams, one/two per decade
Assimilation system	2006, 4D-Var	2016 ECMWF model cycle (41r2), 4D-Var
Model input (radiation and surface)	As in operations, *(inconsistent sea surface temperature)*	***Appropriate for climate***, e.g., evolution greenhouse gases, volcanic eruptions, sea surface temperature and sea ice
Spatial resolution	79 km globally 60 levels to 10 Pa	***31 km globally*** 137 levels to 1 Pa
Uncertainty estimate		Based on a 10-member ***4D-Var ensemble*** at 62 km
Land Component	79km	ERA5L, 9km (separate, forced by ERA5)
Output frequency	6-hourly Analysis fields	***Hourly*** (three-hourly for the ensemble), ***Extended list of parameters*** ***~ 9 Peta Byte (1950 - timely updates)***
Extra Observations	Mostly ERA-40, GTS	Various ***reprocessed CDRs***, ***latest instruments***
Variational Bias correction	Satellite radiances	Also ozone, aircraft, surface pressure

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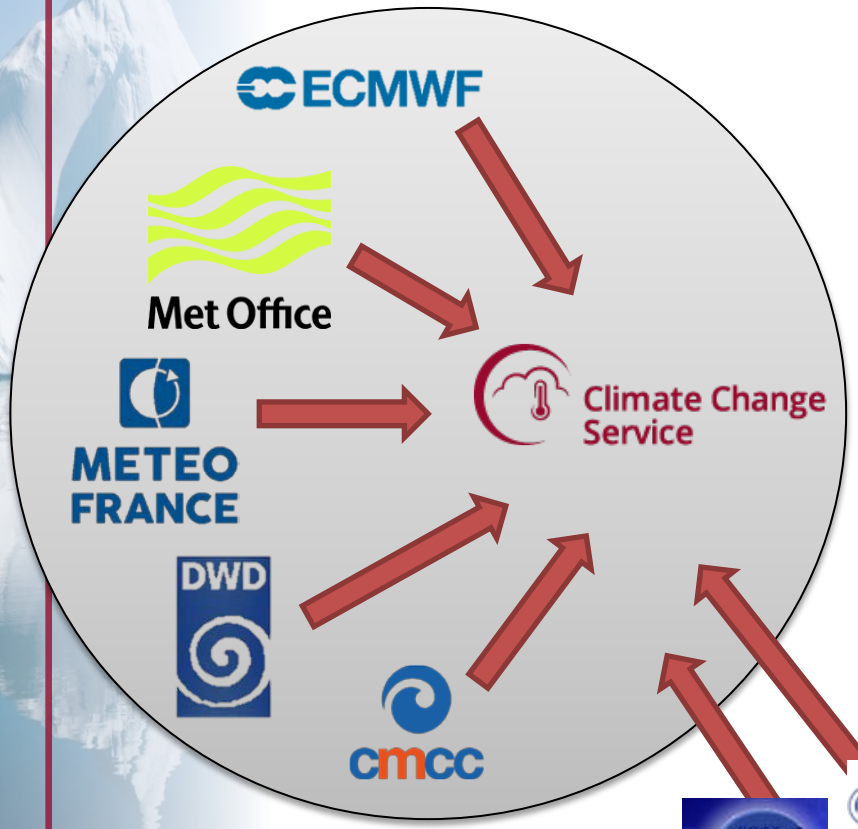
C3S Seasonal Forecasts - Introduction

Aim: to generate seasonal forecast products based on the best information available, to an operational schedule, and make them publicly available.



Evaluation and quality control

- assessment of ***user needs***
- ***scientific assessment*** and ***gap analysis*** of information available to users
- ***usability*** of service and products (from technical perspective)
- recommendations for ***bridging identified gaps***
- ***software*** for on-demand user evaluation of seasonal forecast products

NOAA

気象庁 Japan Meteorological Agency

Also likely: ECCC and BoM

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C3S Seasonal Forecasts – Graphical Products

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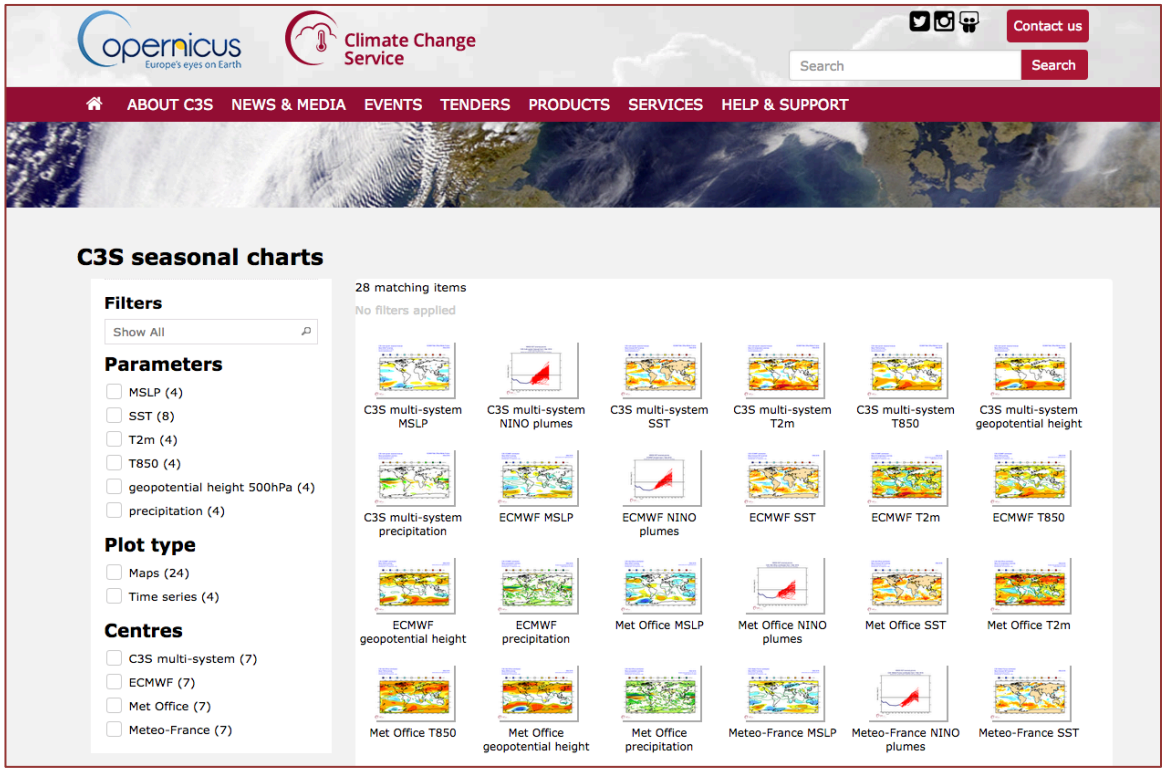
Variables:
- sea-level pressure
- geopotential height
- precipitation
- air temperature
- sea-surface temperature

Type of plots:
- maps:
  - global
  - pre-defined regions
- time series

Publication schedule:
- monthly updates
- on the 15th of each month
  - will be on the 10th



http://climate.copernicus.eu/s/charts/c3s_seasonal/

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C3S Seasonal Forecasts – Graphical Products

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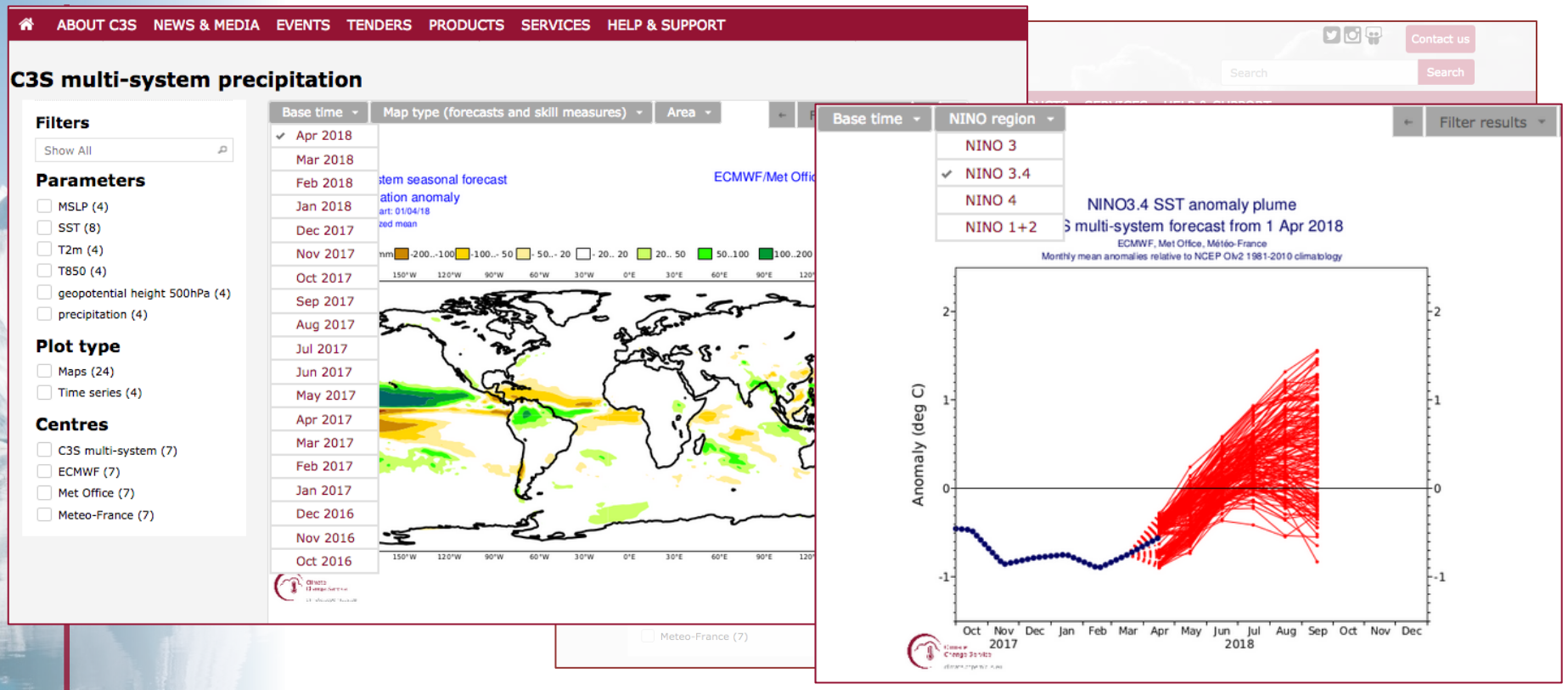

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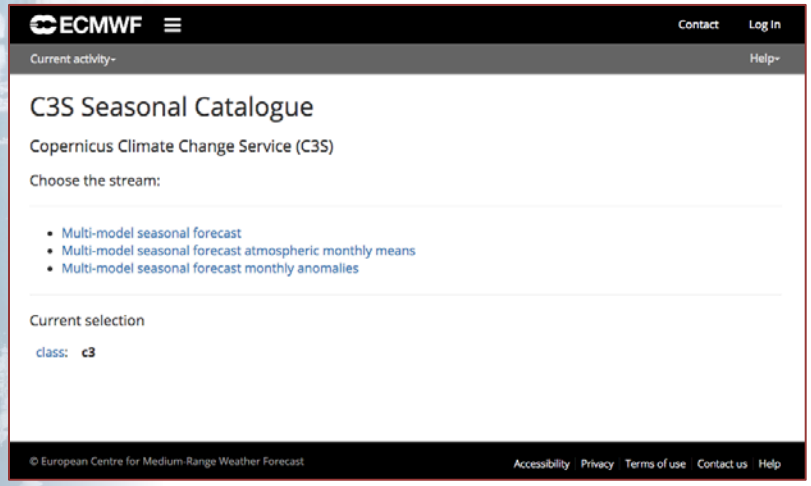
C3S Seasonal Forecasts – Data Products

Scope of the data service

- Original provider data: 1 deg gridded data sets for many variables (atmosphere, ocean; high temporal resolution: 6h - 24h)
- Processed data, including data represented in the graphs
- Forecasts from individual systems and multi-system combinations
- Information on (average) skill will accompany forecast products wherever possible.

Current status – preliminary data service using ECMWF´s MARS WebAPI



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Nominal start dates	ECMWF		Météo-France		Met Office		DWD	CMCC
	System 4	SEAS5	System 5	System 6	GloSea5 - GC2	GloSea5 - GC2 (C3S-0.1 netcdf)	GCFS2	SPSv3
September 2017 - October 2017	✓	✗	✓	✗	✓	✗	✗	✗
November 2017 - January 2018	✗	✓	✓	✗	✓	✗	✗	✗
February 2018 - present	✗	✓	✓	✗	✗	✓	✗	✗

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Products - Technical Description

- Horizontal grid: global 1deg x 1deg
- Ensemble size:
  - Forecasts: ~50 members
  - Hindcasts: ~25 members x 24 years (1993-2016)
- Variables
  - Surface
    - 7 vars every 6h
    - 30+ vars every 24h
  - Pressure (11 levels, from 925 hPa to 10 hPa)
    - 8 vars every 12 h
- Agreed netCDF specification C3S-0.1 (based on CF)
- Publication date: currently 15th of the month; change to an earlier date planned for second half of 2018

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C3S Seasonal Forecasts – Next Steps

- Generate and display **verification scores for products** presented in the graphs
  - Add monthly mean based products to the plots
- Add **new providers to the multi-system**; regularly generate data and graphical products from all contributors
  - CMCC and DWD in Q2 2018
  - By the end of 2018 NCEP, JMA?
  - and possibly BoM and ECCC
- Introduce **new products** in the C3S suite of outputs
  - probability forecasts for ENSO indices
  - indices of atmospheric circulation (NAO, SOI)
  - products based on within-season statistics (frequency/length of spells)
  - …

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Decadal Prediction Service (Prototype)

- Rationale:
  - Current user requirements surveys and discussions with C3S stakeholders clearly indicate **the need for information at decadal timescales**, e.g. **in economic sectors** such as energy, infrastructure, transport, water and urban issues, etc., where there is a need from planners and policy makers to make informed decision about future investment, resource allocation, etc.
  - Decadal forecasts are designed to predict variations of the climate system over the next few years and decades, taking into account natural variability and human influences.
- Process:
  - The proposed approach is to organise **a workshop** (*probably Q1 2019*) involving key stakeholders, **the scientific and user community**, in order to assess **the level of maturity of decadal prediction science** (including verification), and **the level of ambition of a possible operational service**.
- Objective:
  - Prototype service (2019-2020), followed by operational service (2021-..)
- Heritage:
  - EU projects (e.g. SPECS), Copernicus Roadmap for European Climate Projections (C3S_34a lot 3), WCRP international Conferences on Subseasonal to Decadal Prediction (Boulder - October 2018), WMO workshops on Operational Climate Prediction, etc.

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C3S and Climate Predictions

- Products/data from state of the art prediction systems (e.g. seasonal forecasts), for climate services
- Technical infrastructure for data access and processing (CDS and toolbox)
- ‘Quality’ information (operational evaluation and quality control)
- Ingredients for climate prediction producers (reanalyses)

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