

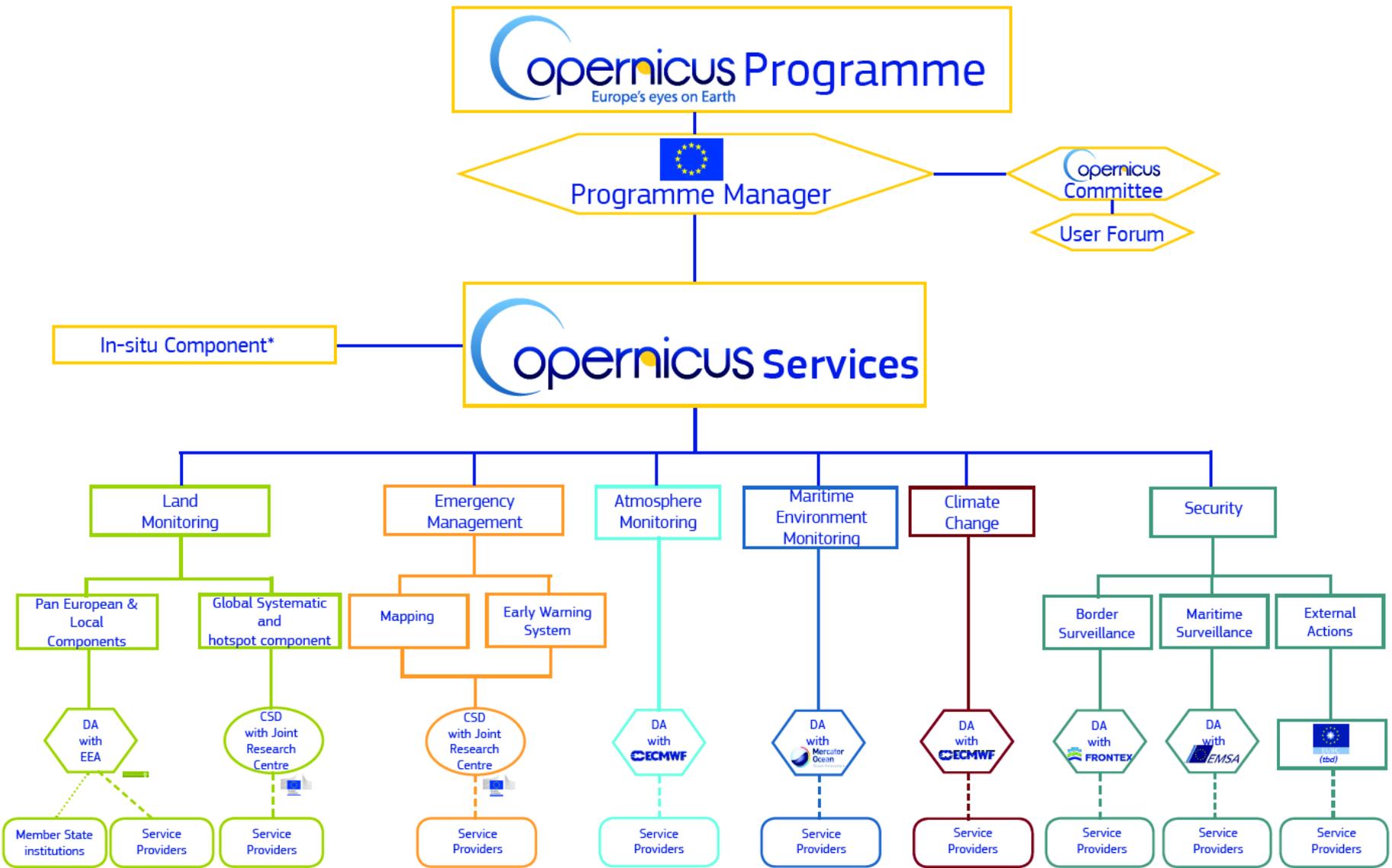


Climate Change

Copernicus Climate Change Service

Anca Brookshaw, ECMWF





Legend:

Implementation mode still to be defined

- Commercial contracts
- Grants

- Copernicus component
- Service Providers

- Indirect Management
- Direct Management

- Mode of Implementation (Indirect/Direct)
- * - Available for ISA
- EA - Eligible agreement
- CO - Cross-border Agreements
- IA - European Union Agency

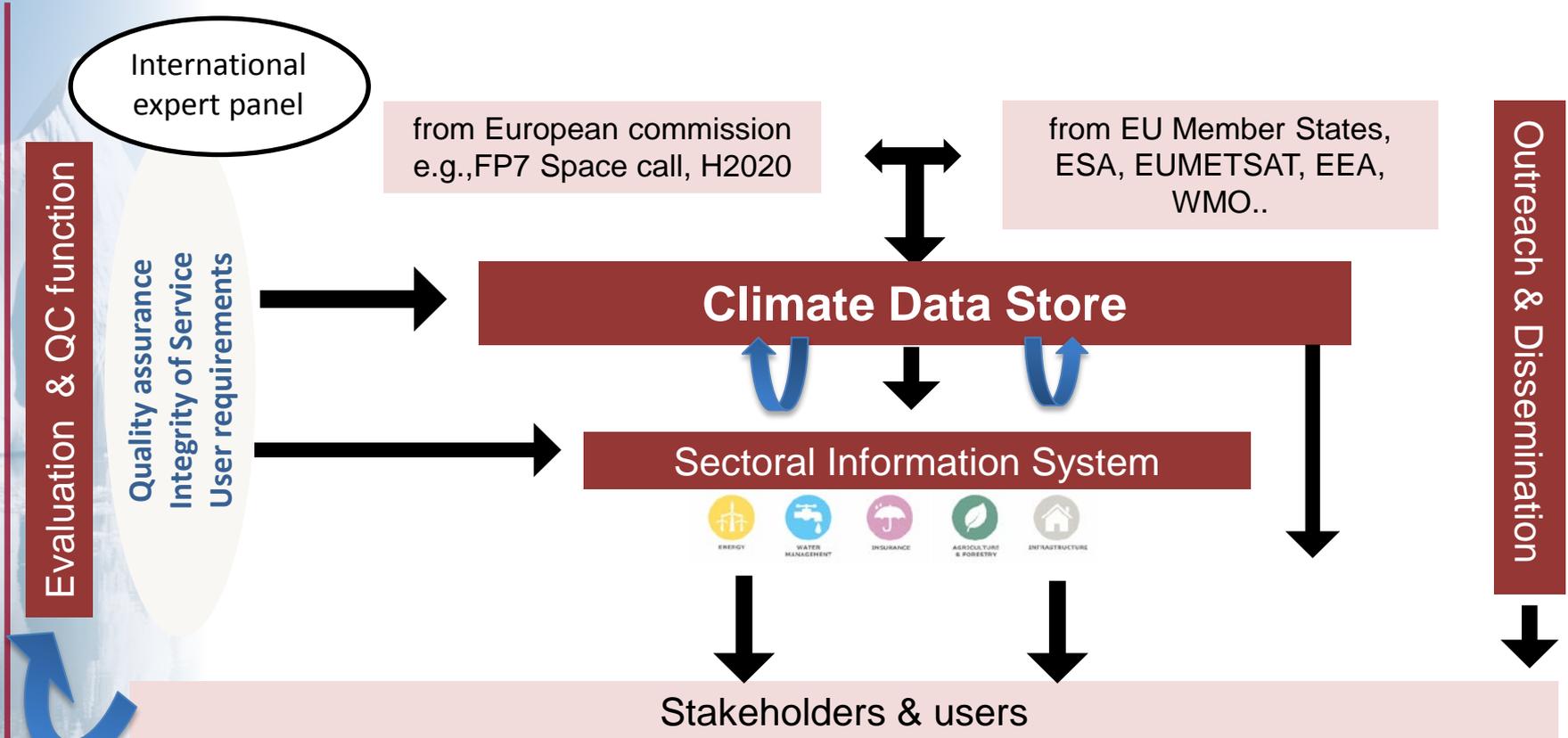
- EUMETSAT - European Organisation for the Exploitation of Meteorological Satellites
- EEA - European Environment Agency
- EUSC - European Union Satellite Center

- FRONTEX - The European Agency for the Management of Operational Cooperation at the External Borders of the Member States of the European Union
- EUMSAP - The European Centre for Medium-Range Weather Forecasts



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C3S in a nutshell





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C3S components

Climate Data Store

- ECVs past, present and future
- Observed, reanalysed and simulated
- Derived climate indicators
- Tools to support adaptation and mitigation at global and European level

Sectoral Information System



Evaluation and Quality Control

- Monitors quality of C3S products and services
- Ensures C3S delivers state-of-the-art climate information to end-users
- Identifies gaps in service provision
- Bridges Copernicus with the research agenda in Europe (e.g. H2020, national research projects)

Outreach and Dissemination

- Web content
- Public outreach
- Coordination with national outreach
- Liaison with public authorities
- Conferences, seminars
- Training and education



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C3S Climate Data Store content



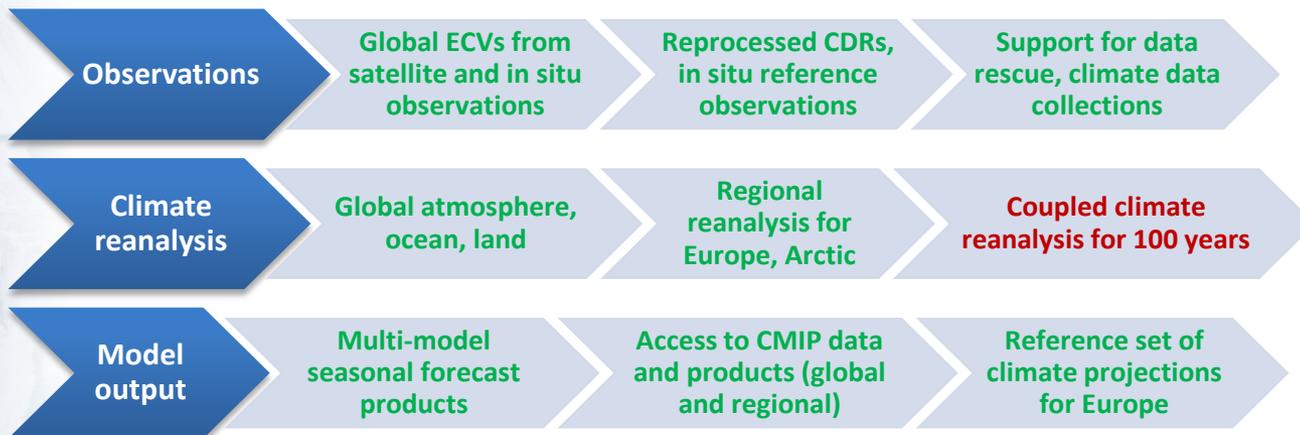
Scientific basis:

- Essential Climate Variables as defined by GCOS
- GCOS Status Report and Implementation Plan
- IPCC, CMIP

In progress

In preparation

Not started





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Climate Data Store: Reanalyses

ERA5 global reanalysis:

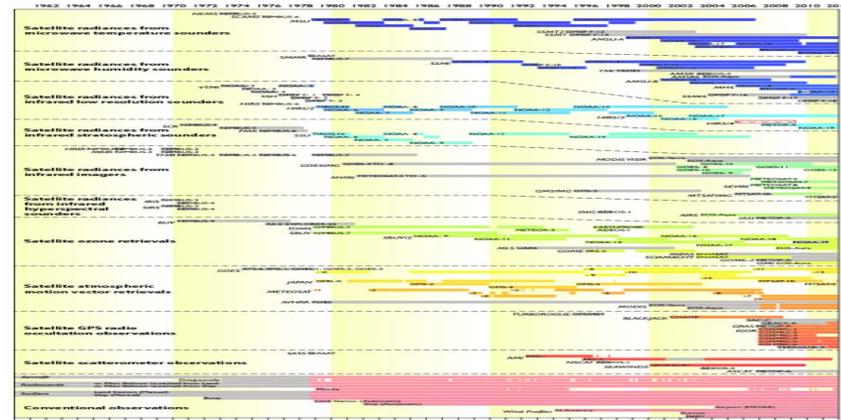
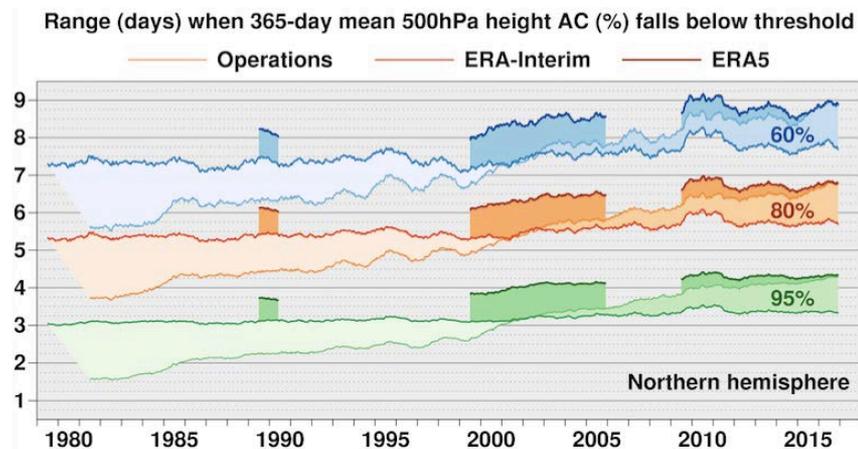
- Atmosphere/land/wave parameters
- 31 km global resolution, 137 levels
- Hourly output from 1979 onward
- Will be extended back to 1950s
- Based on IFS Cy41r2 (March 2016)
- Using improved input observations
- Ensemble data assimilation
- Providing uncertainty estimates
- First segment 2010-2016 released

Regional reanalysis:

- European + Arctic domains
- Higher spatial resolution

Development of a Climate Monitoring Facility

- Based on reanalysis
- Pre-computed indices





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C3S seasonal forecasts

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

C3S seasonal service will be based on a multi-system framework.

- Five European forecast systems were selected in 2015:
 - three for immediate use (2016; core providers): ECMWF, Met Office, Météo France
 - two for later use, following further development (late 2017; additional providers): Centro Euro-Mediterraneo sui Cambiamenti Climatici (CMCC), Deutscher Wetterdienst (DWD)

Interest in collaboration expressed by NCEP and JMA; terms and timings to be discussed.

- Evaluation and quality control (EQC) function



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Seasonal forecasts - first release 12/2016

The screenshot shows the Copernicus Climate Change Service website. The header includes the Copernicus logo and the Climate Change Service logo. A navigation menu lists: ABOUT C3S, NEWS & MEDIA, EVENTS, TENDERS, PRODUCTS, SERVICES, USER SUPPORT. The main content area is titled "Seasonal forecasts" and includes a breadcrumb "home » products". There are four weather maps: a time-series plot of a variable, a global map with green and red areas, a global map with yellow and blue areas, and a regional map of Europe with a yellow sun. A text block explains that the Copernicus Climate Change Service (C3S) is developing seasonal forecast products, with a target publication date of 15th of each month. It mentions that the current proof-of-concept phase includes graphical forecast products for variables like air and sea-surface temperature, atmospheric circulation, and precipitation. A list of products is available, including "AVERAGE SURFACE AIR TEMPERATURE MONTHLY MAPS", "CLIMATE REANALYSIS", and "SEASONAL FORECASTS". A "NEWS" section lists recent updates: 13 Dec 2016 (#OpenData16), 06 Dec 2016 (Report Reassesses Variations in Global Warming), 28 Nov 2016 (Copernicus at Wissenswerte), 17 Nov 2016 (C3S and CAMS at COP22), and 01 Nov 2016 (ODI Summit and Awards 2016). An "EVENTS" section lists: 13 Nov 2017 (5th International Conference on Reanalysis), 06 Mar 2017 (C3S General Assembly), and 22 Feb 2017 (Copernicus Symposium on Climate Services for...).

<http://climate.copernicus.eu/seasonal-forecasts>





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Seasonal forecasts - graphical products

C3S seasonal charts

Filters

Show All

Parameters

- MSLP (4)
- SST (8)
- T2m (4)
- T850 (4)
- geopotential height 500hPa (4)
- precipitation (4)

Plot type

- Maps (24)
- Time series (4)

Centres

- C3S multi-system (7)
- ECMWF (7)
- Met Office (7)
- Meteo-France (7)

28 matching items
No filters applied

C3S multi-system MSLP, C3S multi-system NINO plumes, C3S multi-system SST, C3S multi-system T2m, C3S multi-system T850, C3S multi-system geopotential, C3S multi-system precipitation, ECMWF MSLP, ECMWF NINO plumes, ECMWF SST, ECMWF T2m, ECMWF T850, ECMWF geopotential, ECMWF precipitation, Met Office MSLP, Met Office NINO plumes, Met Office SST, Met Office T2m, Met Office T850, Met Office geopotential, Met Office precipitation, Meteo-France MSLP, Meteo-France NINO plumes, Meteo-France SST, Meteo-France T2m

Variables:

- sea-level pressure
- geopotential height
- precipitation
- air temperature

Type of plots:

- maps:
 - global
 - pre-defined regions
- time series

Publication schedule:

- monthly updates
- published on each 15th



C3S multi-system NINO plumes

Filters

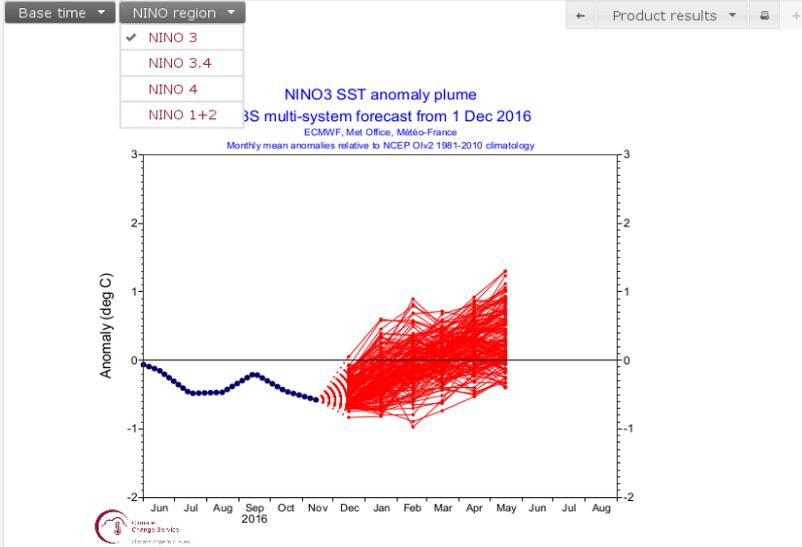
Show All

Plot type

- Time series (4)
- show 1 more

Centres

- C3S multi-system (1)
- ECMWF (1)
- Met Office (1)
- Meteo-France (1)

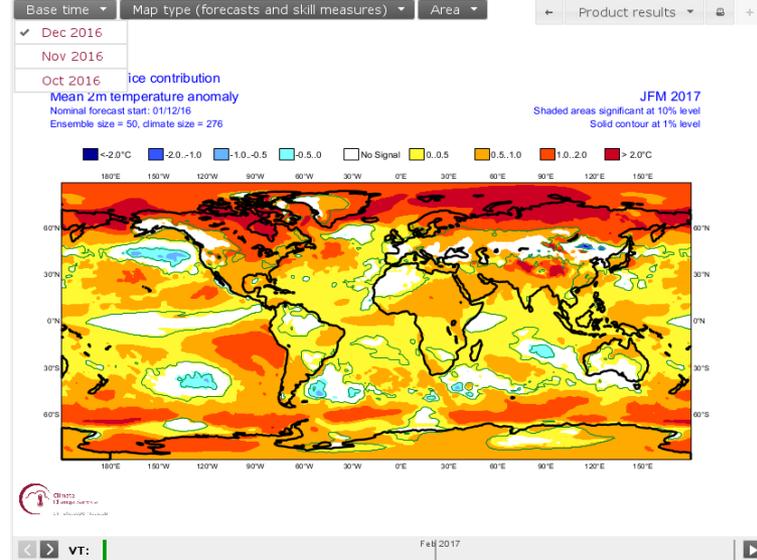


(Produced by the Copernicus Climate Change Service, using Copernicus data.)

⚠ These products are under development, in a proof of concept phase. The quality control of input data and outputs is not guaranteed.

NINO-index timeseries

These plots show the evolution of area-averaged monthly-mean sea-surface temperature anomaly computed over specified regions of the tropical Pacific (the NINO 1+2, 3, 3.4, and 4 areas); the anomaly is shown with respect to the 1981-2010 climate. The red lines show the forecast anomalies from all the individual forecasts; the blue line shows the respective recent observations. For each component model, anomalies are re-scaled so that the total variance on the monthly time scale of each model is equal to the mean of the variances of the three models. The variance standardization is based on the common hindcast period of the three models (1993-2014). In the case of each provider, data is from the current version of the operational seasonal forecast system.



(Produced by the Copernicus Climate Change Service, using Copernicus data.)

⚠ These products are under development, in a proof of concept phase. The quality control of input data and outputs is not guaranteed.

Ensemble mean anomalies

The charts display the ensemble mean anomalies, relative to the model's climate over the reference period. The hindcast period is 1993-2015 for ECMWF and Met Office and 1993-2014 for Météo-France. In the case of each provider, data is from the current version of the operational seasonal forecast system.

Probabilities

Probabilities are estimated by comparing the forecast probability density function (PDF) with the corresponding model climate PDF, estimated from the hindcast set (the hindcast period is 1993-2015 for ECMWF and Met Office and 1993-2014 for Météo-France). Significance testing is not applied. The probabilities are stratified according to: the median, the lower/upper/middle third, and lowest/highest 20% of the model climate distribution. As an overview to the



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Seasonal forecast – data products

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

Preliminary data service expected in Q4 2017.

Useful features:

- operational schedule
- standardised data formats
- tools for post-processing (EQC and toolbox)



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Seasonal forecasts - variables

From the atmosphere model:

every 6 hours: 2 metre temperature (or nearest equivalent)
 2 metre dewpoint temperature
 10 metre u wind
 10 metre v wind
 mean sea level pressure
 total cloud cover
 skin temperature

every 24 hours: sea-ice concentration
 sea surface temperature
 volumetric soil moisture level 1
 volumetric soil moisture level 2
 volumetric soil moisture level 3
 volumetric soil moisture level 4
 (or total soil moisture)
 surface temperature
 snow depth (water equivalent)
 snow density
 Tmax and Tmin at 2 metres
 Max 10m wind gust

From the ocean model:

every 24h: Sea-level (without tides)
 Depth of 28 deg isotherm
 Depth of 26 deg isotherm
 Depth of 20 deg isotherm

every 24 hours, accumulated:

large scale precipitation
convective precipitation
(or total precipitation)
snow fall
surface sensible heat flux
surface latent heat flux
surface solar radiation downwards
surface thermal radiation downwards
surface solar radiation
surface thermal radiation
top solar radiation
top thermal radiation
east-west surface stress
north-south surface stress
evaporation

every 12 hours:

geopotential
temperature
specific humidity
vorticity/divergence
or u/v wind components

at 925, 850, 700, 500, 400, 300, 200, 100, 50, 30, 10 hPa

Mixed layer depth
Surface salinity
Zonal surface current
Meridional surface current



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Technical description

Proof of concept phase (core providers only)

- *spatial resolution of data*: 1 deg or original grid
- *temporal resolution of data*: daily or sub-daily
- *forecasts and reforecasts (1993-2015)*
- *data delivery by 12Z on 10th day of month (product release on 15th day of month)*

Pre-operational (all providers)

- *spatial resolution of data*: 1 deg or original grid
- *temporal resolution of data*: daily or sub-daily
- *ocean data*: on a grid to be agreed
- *forecasts and reforecasts (1993-2015)*
- *data delivery by 12Z on 6th day of month (product release on 10th day of month)*



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Seasonal forecasts - evaluation

Evaluation and quality control (EQC) function for seasonal forecast products contracted with consortium led by Barcelona Supercomputing Centre (BCS). Includes:

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



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Climate projections

Global projection-related service

- **Provision of support to one Earth System Grid Federation (ESGF) node in Europe** – solution for access to and manipulation of global climate projections from the CMIP archive, consistent with the requirements of climate services.
- **Multi-model product generation**
 - **metrics for fidelity** of models in simulating historical climate, to be **translated into quality** for specific applications
 - **interactive tools** for generic products (e.g. maps of intra-ensemble variability for different models and scenarios), and **tailored products** for several economic sectors
- **Roadmap towards a reference set of climate projections for Europe:** studies on how well climate projections address sectoral needs, to guide requirements for the operational phase of C3S. Areas of interest: the benefit of **ensemble size versus resolution** for global models, and the benefit of **initialised decadal predictions**, in relation to the specific needs of different economic sectors.

Regional climate projection service

The goal

- to facilitate access to and manipulation (via the CDS) of output of regional climate projections over Europe and boundary conditions from GCM simulations needed for future regional projections.
- to define, agree and complete a matrix of global/regional model combinations and scenarios, which allows robust assessment of the uncertainties arising from these factors in a multi-model set of regional projections.

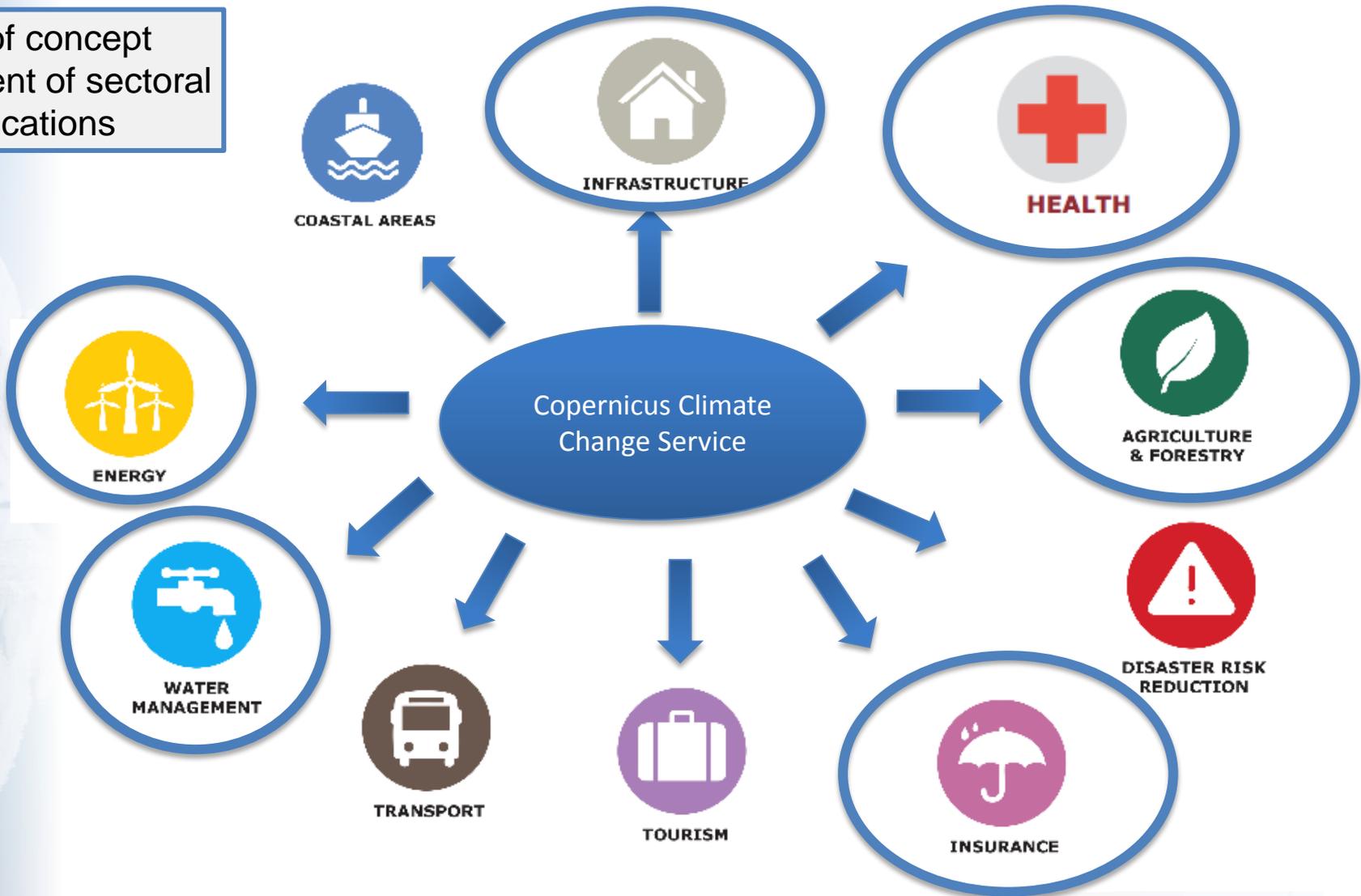
The Invitation to Tender has recently been published

Evaluation and quality control component for climate projection-based services – similar in concept to the equivalent activity for the seasonal forecast service; started in September.



Sectoral Information System

Proof of concept development of sectoral applications





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Seven proof of concept SIS contracts have been awarded:

- SIS water management:
 - SWICCA (Service for Water Indicators in Climate Change adaptation) – **lead SMHI (Sweden)**
 - EDgE (End-to-End demonstrator for improved decision making in the water sector in Europe) – **Lead CEH (UK)**
- SIS energy:
 - CLIM4ENERGY (Climate for Energy) – **Lead CEA (France)**
 - ECEM (European Climatic Energy Mixes) – **Lead UEA (UK)**
- SIS others:
 - AgriCLASS (Agriculture Climate Advisory Services) – **Lead Telespazio – Vega (UK)**
 - WISC (Windstorm Information Service) – **Lead CGI (UK)**
 - URBAN-SIS (touching health, infrastructure,..) – **Lead SMHI (Sweden)**



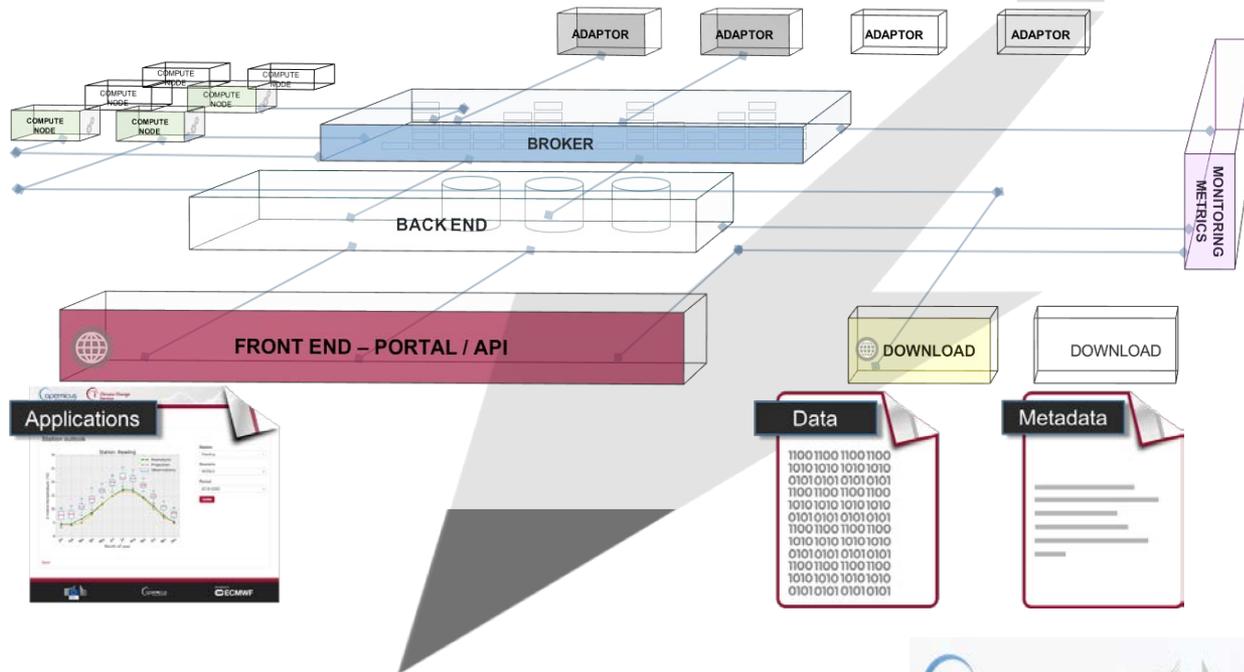
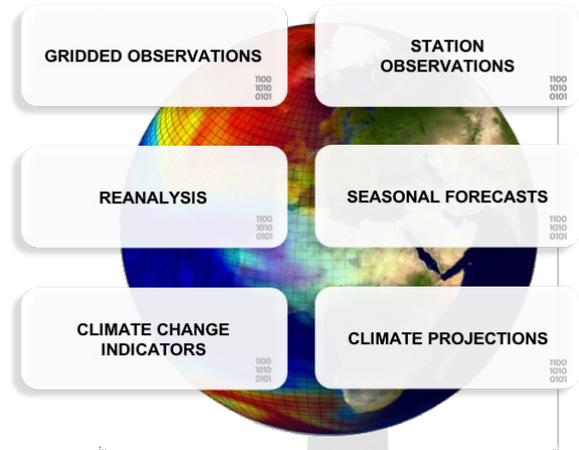
- No noticeable delays in the deliverables (...so far).
- Quality of the output generally high.



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Climate Data Store / Toolbox - Concept

CLIMATE DATA STORE





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Climate Data Store Toolbox

- The **Toolbox** will be composed of:
 - **Tools** that perform basic operations on data, such as the computation of statistics, sub-setting, averaging, value at points, etc.
 - **Workflows** that combine tools by chaining them so that the output of some tools is used as input to others
 - **Applications** that make use of workflows and selected data and products of the CDS, to build interactive web-pages allowing end-users to interact with the CDS
- **A Toolbox Compute layer:**
 - When possible tools will be executed next to the data (at the data suppliers)
 - Otherwise, computations will be performed in a dedicated compute layer
 - Use of cloud technologies will be considered
 - Compute layer will also hold intermediate results



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C3S - Development timeline

Mid-term review



Signature of Delegation Agreement

March: first C3S General Assembly

C3S first operations

2014

2015

2016

2017

2018

2019

2020

2021

Stage 0/I

Stage II

Stage III

