Seasonal forecasts from the Copernicus Climate Change Service

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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 is based on a multi-system framework.

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

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

- Evaluation and quality control (EQC) function

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Seasonal forecasts- first release 12/2016

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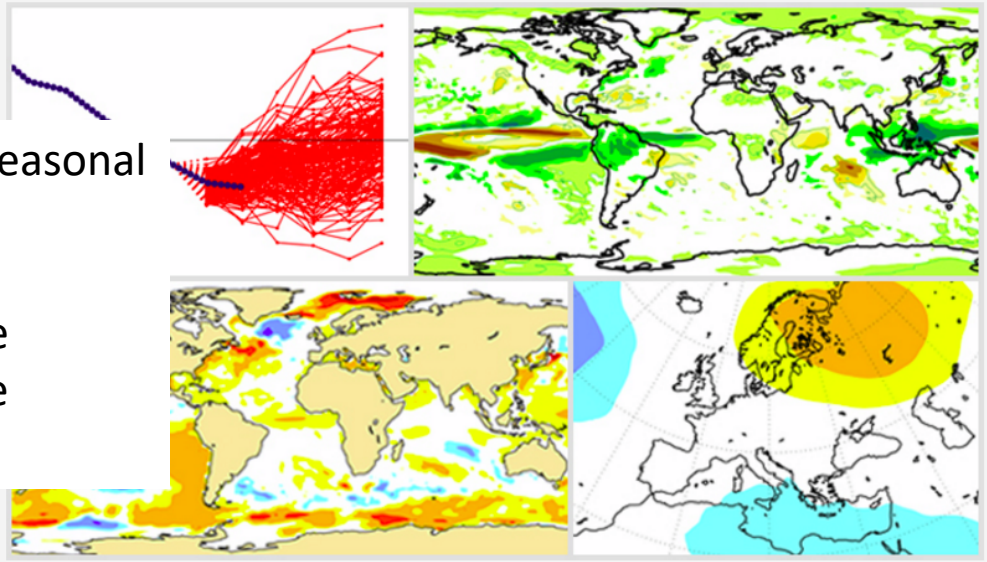
Current C3S seasonal multi-system:

Météo-France
UK Met Office
ECMWF



ABOUT C3S | NEWS & MEDIA | EVENTS | TENDERS | PRODUCTS | SERVICES | HELP & SUPPORT

- MONTHLY SEA-ICE MAPS
- HYDROLOGICAL CLIMATE VARIABLES
- CLIMATE REANALYSIS
- SEASONAL FORECASTS

The Copernicus Climate Change Service (C3S) is developing seasonal forecast products, with a target publication date of 15th of each month. These products are based on data from several state-of-the-art seasonal prediction systems.

The current proof-of-concept phase includes graphical forecast products for a number of variables (air and sea-surface temperature, atmospheric circulation and precipitation); the forecasts are updated every month and cover a time range of 6 months. The interface to the list of products offers links to maps or timeseries for the forecast variables, and the facility to navigate the full set of graphics. Multi-system combinations, as well as predictions from the individual component systems, are available. A number of multi-system data products, derived from the inputs provided by the participants in the C3S seasonal forecast service, are stored in ECMWF's main repository of meteorological data, MARS (Meteorological Archival and Retrieval System). Currently, public access to the data is only possible via the ECMWF WebAPI. From 2018 onwards, C3S seasonal forecast data products will be made available via the C3S Climate Data Store (CDS).

The centres currently providing forecasts to C3S are ECMWF, The Met Office and Météo-France; at a later stage Deutscher Wetterdienst and Centro Euro-Mediterraneo sui Cambiamenti Climatici will be added to the list.

Graphical forecast products | Digital forecast data and products

NEWS

13 Nov 2017
Reanalysis conference kicks off

10 Nov 2017
The new seasonal prediction system of ECMWF (SEAS5) contributes to C3S seasonal forecast products

03 Nov 2017
Copernicus services help tackle global climate change issues

27 Oct 2017
Meeting the world's science journalists at WCSJ2017

26 Oct 2017
ECMWF Copernicus Services at GEO Week 2017

More News

EVENTS

20 Nov 2017
Discover the C3S ECEM energy data for the European energy sector

13 Nov 2017
5th International Conference on Reanalysis

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

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Seasonal forecasts - graphical products

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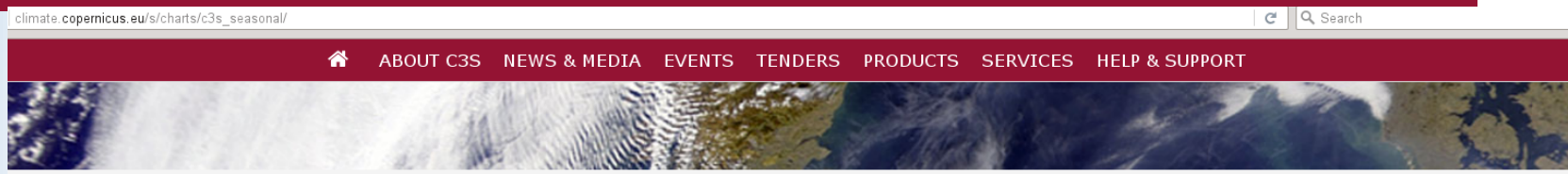
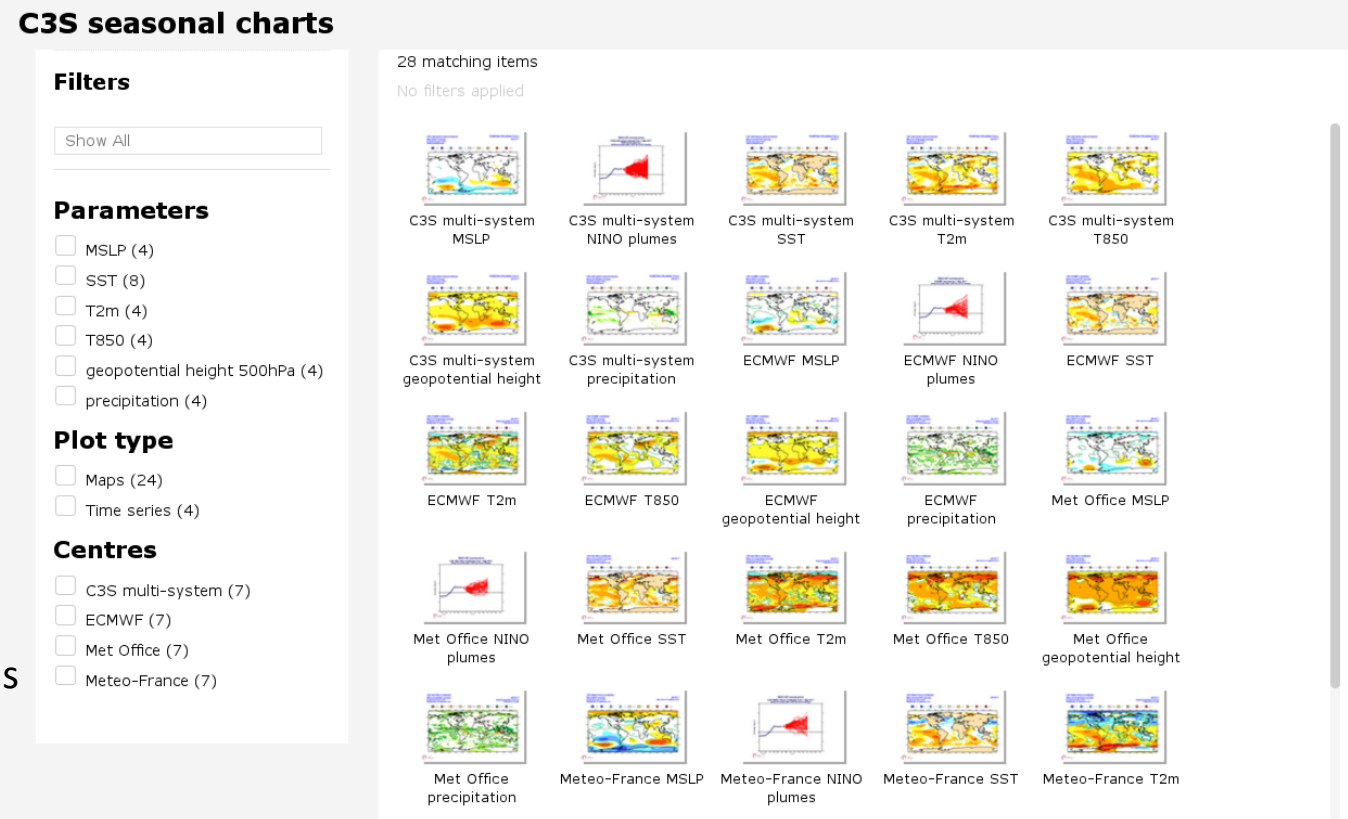


Variables:
- sea-level pressure
- geopotential height
- precipitation
- air temperature

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

Publication schedule:
- monthly updates
- published on each 15th



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Seasonal forecasts- example

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Copernicus | C3S multi-system NINO plumes | nino3 2016120100,0,2016120100 - Mozilla Firefox

ECMWF | C3s_seas...

seasonal_plume_mm?time=2016120100,0,2016120100&area=nino3

Search

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C3S multi-system NINO plumes

Filters

Show All

Plot type

- Time series (4)

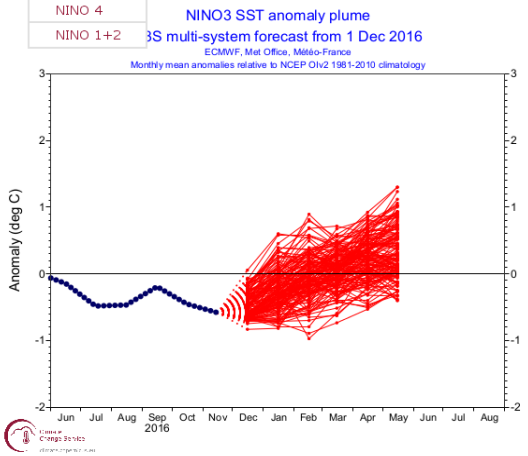
show 1 more

Centres

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

Base time | NINO region | Product results

- NINO 3
- NINO 3.4
- NINO 4
- NINO 1+2



(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.

EVENTS | TENDERS | PRODUCTS | SERVICES | USER SUPPORT

Base time | Map type (forecasts and skill measures) | Area | Product results

- Dec 2016
- Nov 2016
- Oct 2016

ice contribution

Mean 2m temperature anomaly

Nominal forecast start: 01/12/16

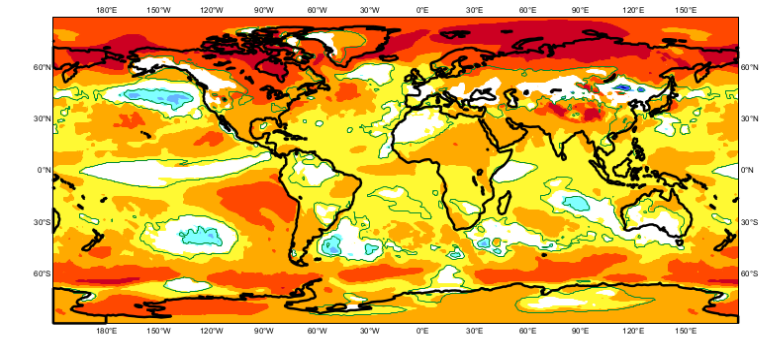
Ensemble size = 50, climate size = 276

JFM 2017

Shaded areas significant at 10% level

Solid contour at 1% level

<-2.0°C | -2.0..-1.0 | -1.0..-0.5 | -0.5..0 | No Signal | 0..0.5 | 0.5..1.0 | 1.0..2.0 | > 2.0°C



VT: Feb 2017

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

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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 (e.g. monthly means, area averages), 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.

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Seasonal forecasts- variables

From the atmosphere model:

every 6 hours:
- 2 metre temperature
- 2 metre dewpoint temperature
- 10 metre u wind
- 10 metre v wind
- mean sea level pressure
- total cloud cover
- soil temperature level 1
- sea-surface temperature
- sea-ice temperature

every 24 hours:
- sea-ice concentration
- volumetric soil moisture in model (*or* total soil moisture)
- snow depth (water equivalent)
- snow density
- Tmax and Tmin at 2 metres
- Max 10m wind gust

every 24 hours, accumulated:
- large scale precipitation
- convective precipitation
- (*or* total precipitation)
- snow fall
- surface sensible heat flux
- surface latent heat flux
- surface incoming solar radiation
- surface incoming thermal radiation
- surface net solar radiation
- surface net thermal radiation
- top of atmosphere net solar radiation
- top of atmosphere net thermal radiation
- eastward surface stress
- northward surface stress
- evaporation
- surface runoff
- sub-surface runoff
- (*or* total runoff)

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

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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 - consortium led by Barcelona Supercomputing Centre (BCS). Includes:

- assessment of *user needs*
- *inventory* of climate data relevant to seasonal climate variability and prediction
- *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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Seasonal forecasts - uses and users

- Seasonal (probability) forecasts are not universally useful! - It all depends on the decision.
- How to make best use of such information is still an open question; the data made available (for the first time) by C3S would help answer it.

For the benefit of users:

- operational schedule
- forecasts from several models, individually and in combination
- standardised data formats
- tools for post-processing (EQC and toolbox)

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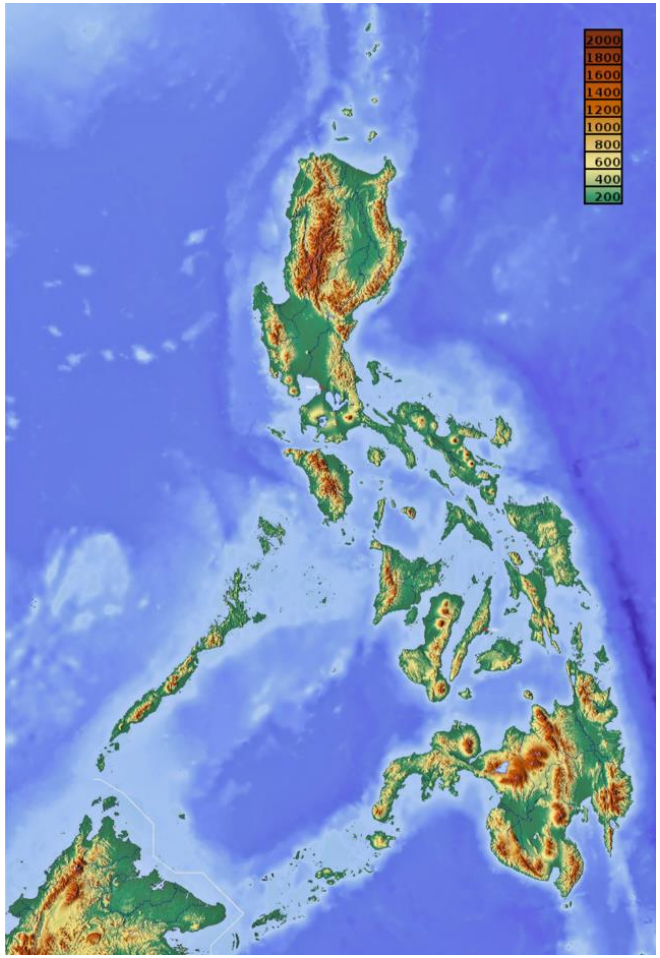
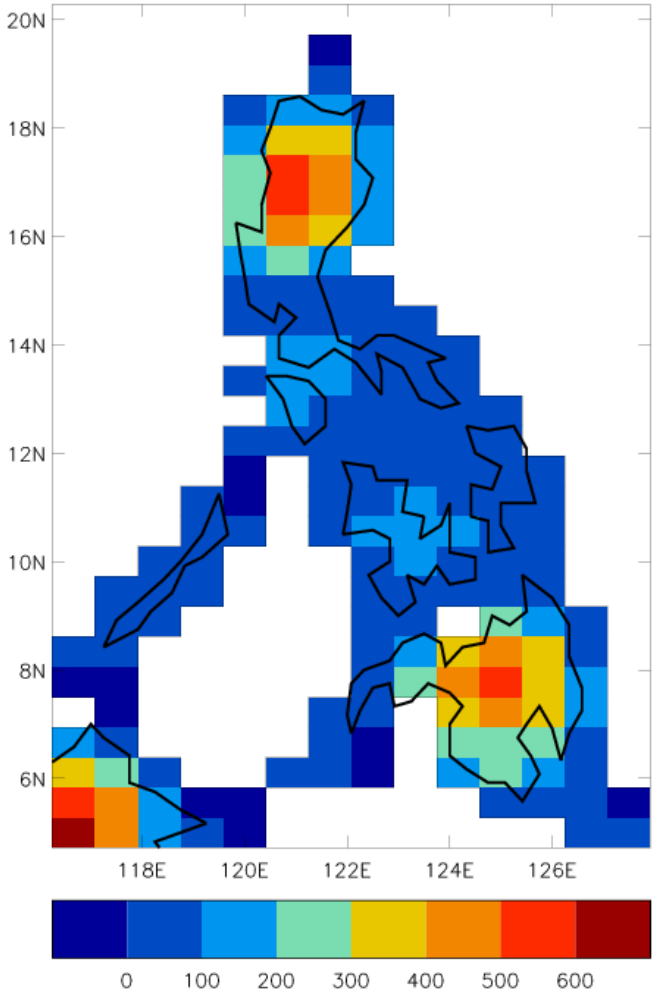
Representation of orography

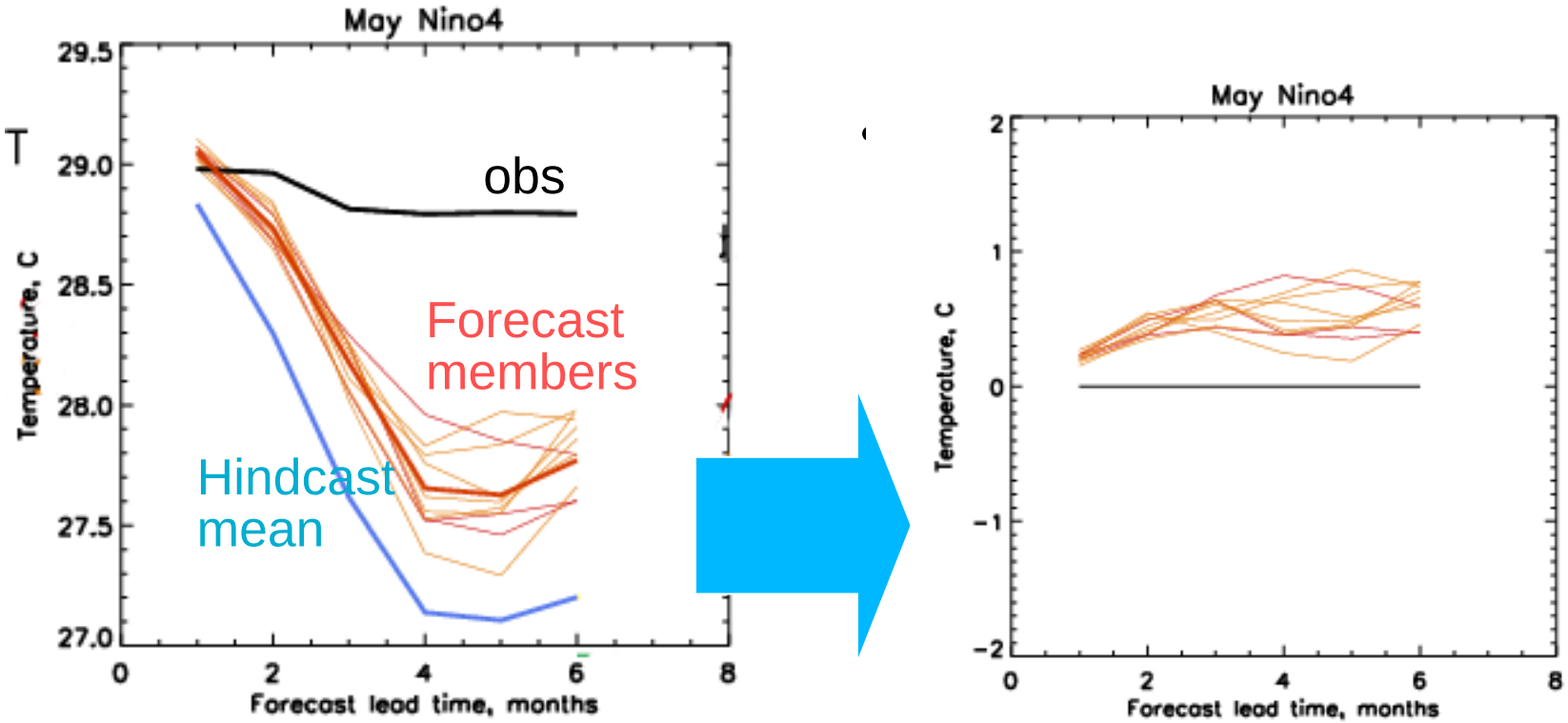
90km (longitude) x 62 km (latitude)





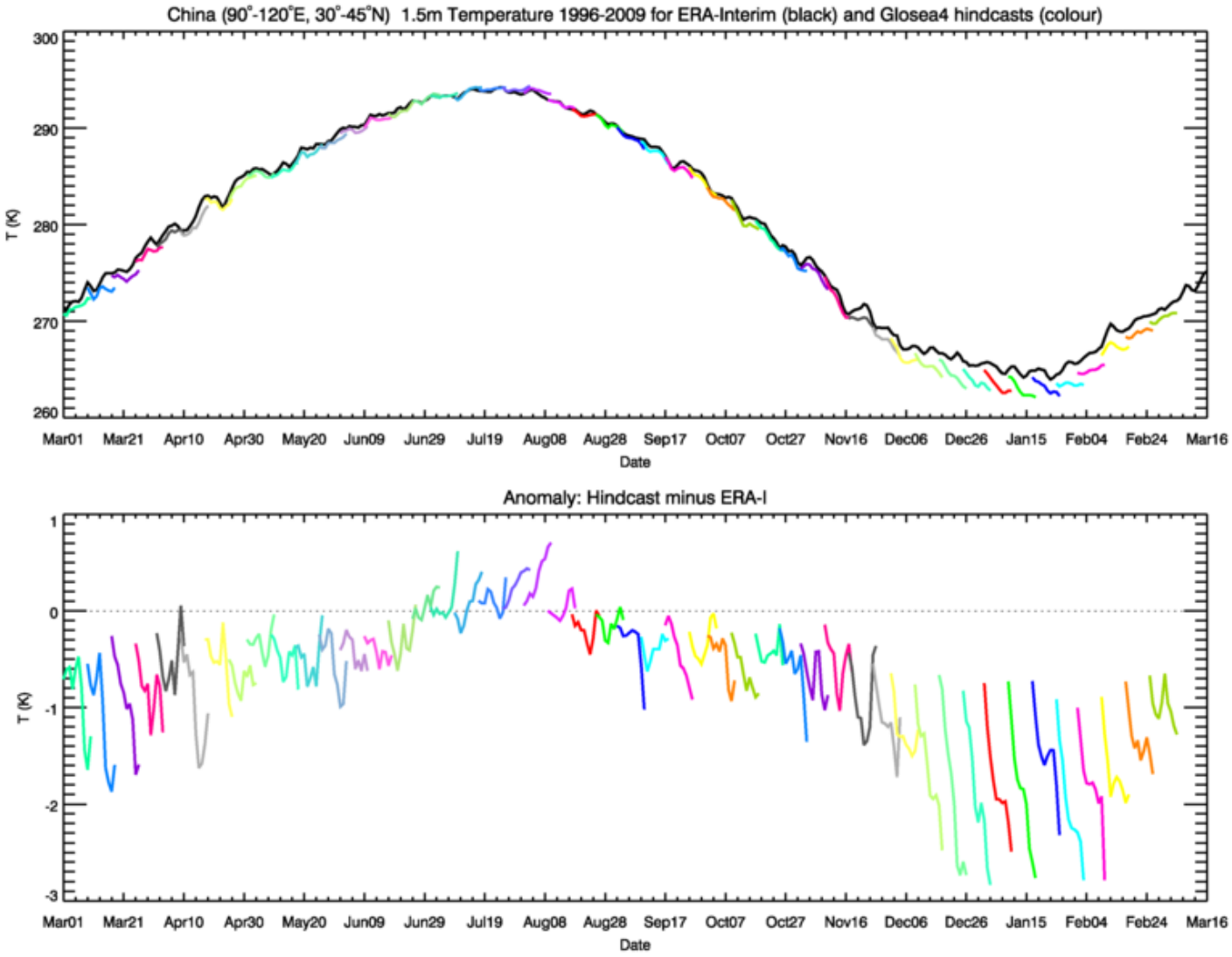
Model bias

Calibrated forecast



At long range, predict anomalies

Model bias



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Seasonal forecast information

- Forecast model output has biases
  - in many cases, these do not affect the skill of the forecast
  - post-processing is necessary to ‘extract‘ information from model output

- Bias adjustment
  - is somewhat dependent on application (e.g. region, season, variable/phenomenon)
  - is very dependent on the design of the forecast system (e.g. burst mode vs lagged start)

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  - post-processing is necessary to ‘extract‘ information from model output
- Bias adjustment
  - is somewhat dependent on application (e.g. region, season, variable/phenomenon)
  - is very dependent on the design of the forecast system (e.g. burst mode vs lagged start)
- For users, uncertainties in estimates of skill (or bias correction factors) should be quantified
- Ensemble forecasts have many attributes; ‘skill’ is not fully defined by a single measure.

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Climate projection services

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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.

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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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ERA5 Release Plan

Q2 2017: public release 2010 – 2016

Access: initially similar to ERA-Interim (Web-API)

later (2018) via the **C3S Climate Data Store**

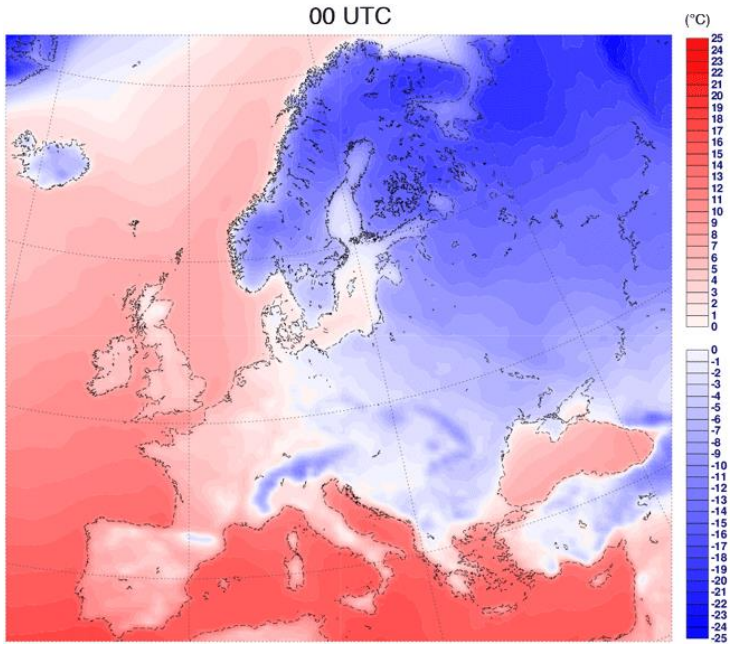
Q4 2017/ Q1 2018: 2017 – timely updates

- ERA5: Updates with about 2-months delay (final product)
- ERA5T: Updates with short delay (<1 week, preliminary product)

Q1-3 2018: Release 1979 – 2009:

- Continue ERA5 timely updates
- Continue ERA-Interim for another 6 months after this release

2018: integration of ERA5 segment from 1950



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