Seasonal forecasts from Copernicus Climate Change Service (C3S)

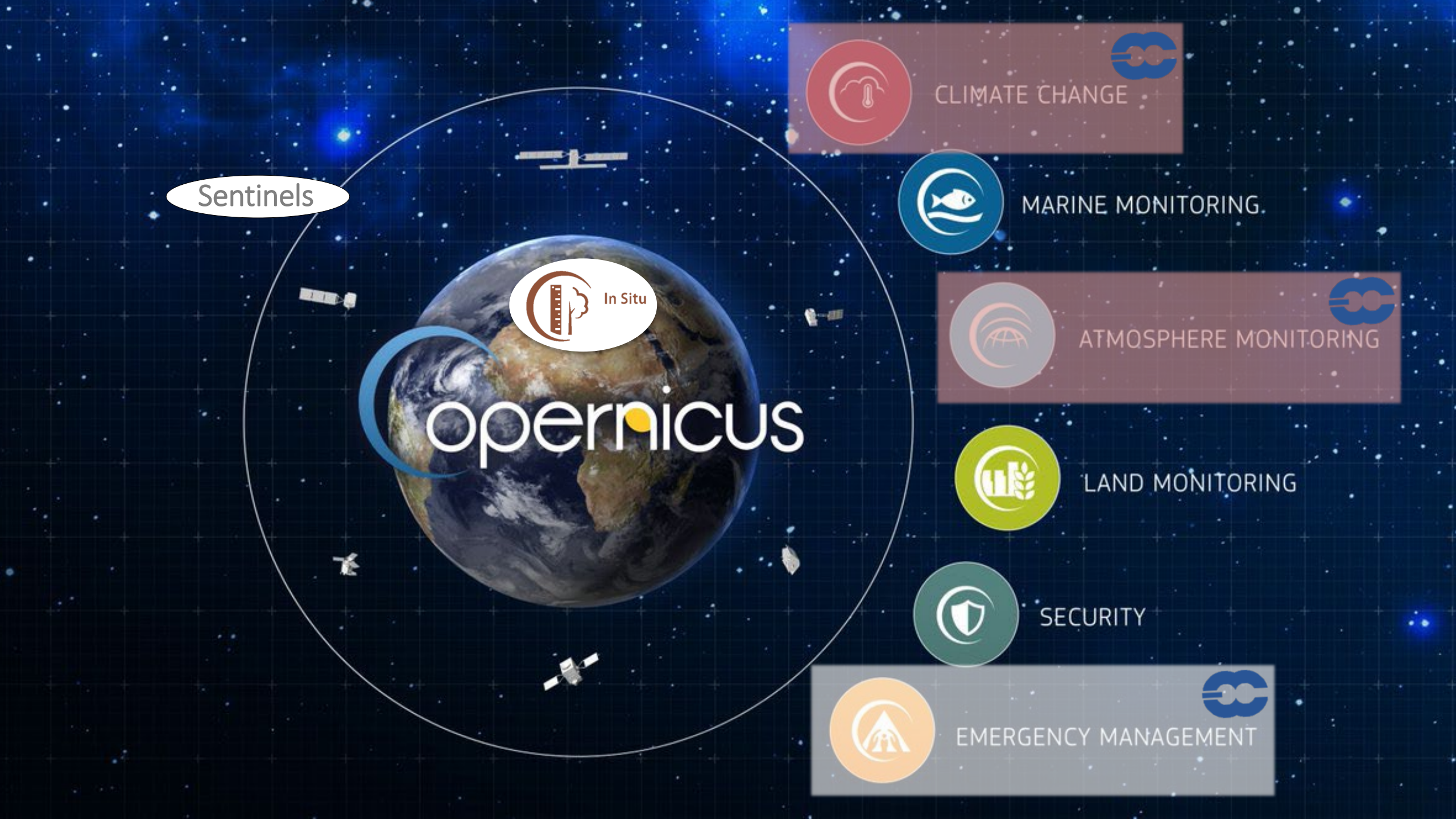
Climate Change

Anca Brookshaw

and colleagues at the Copernicus Climate Change Service (C3S) - ECMWF

Using ECMWF's forecasts (UEF2023) – June 2023

Copernicus Europe's eyes on Earth | European Commission | ECMWF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SECURITY
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C3S in brief

Climate Change

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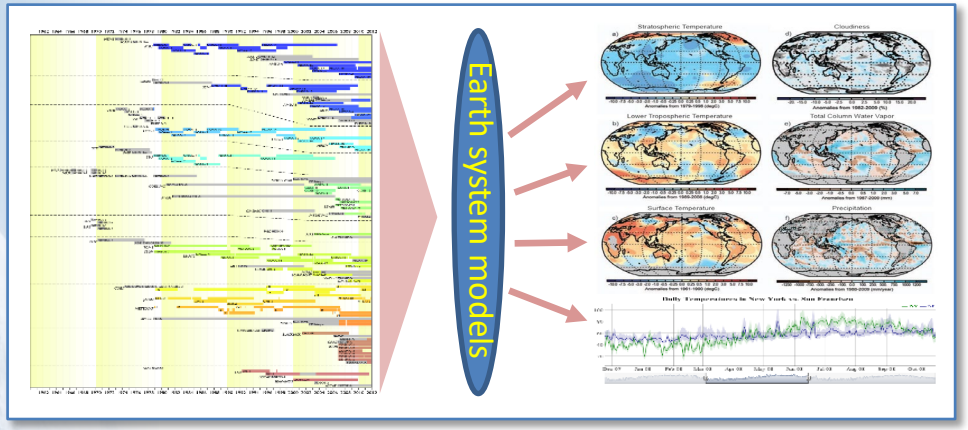
C3S portfolio: Access to past, present and future climate information

Climate Change

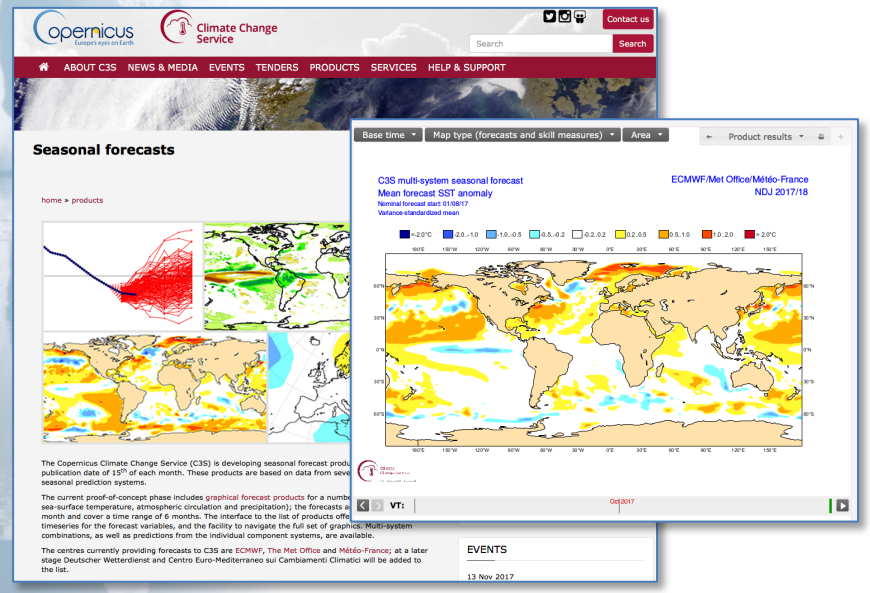


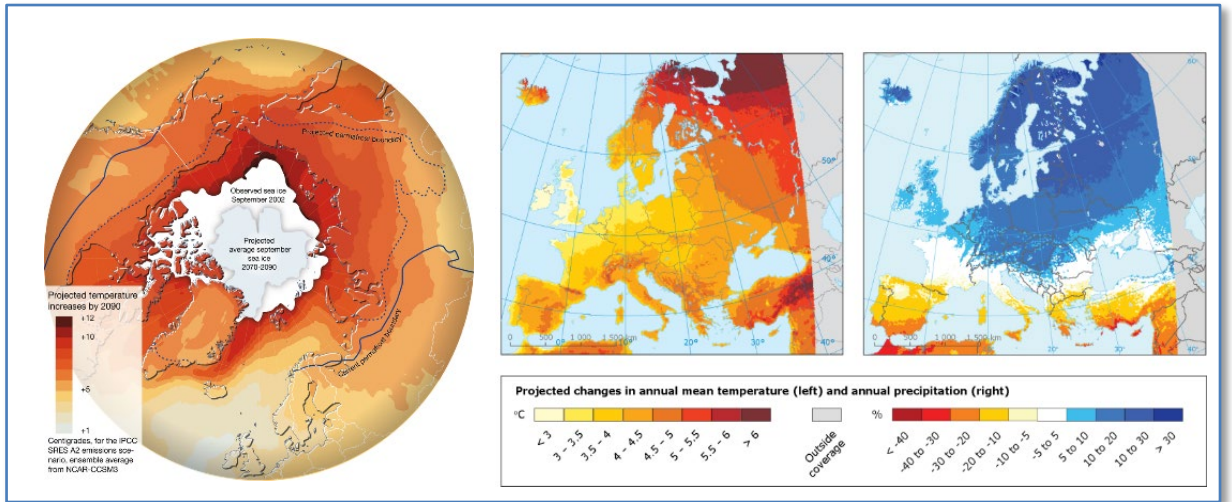
Observations and climate reanalyses

Seasonal forecast data and products

Climate model simulations

Sectoral climate impact indicators





https://cds.climate.copernicus.eu/cdsapp#!/home

C3S portfolio: Applications

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cds.climate.copernicus.eu/cdsapp#!/search?type=application&keywords=((%20"Product%20type:%20Reanalysis"%20))&text=ERA5

Update

Gmail | Maps | Latest weather re... | C3S Seasonal For... | Official Site of the... | Computing Distan... | Warnock's win in... | SystmOnline Login | HORIZON-CL5-20...

ERA5

All | Applications | Datasets | Providers

Sort by

Relevancy

Title

Product type
- Climate projections (2)
- Reanalysis (6)

Variable domain
- Atmosphere (surface) (1)
- Land (biosphere) (2)

Spatial coverage
- Europe (1)
- Global (4)

Temporal coverage
- Future (2)
- Past (6)

Sector
- Agriculture (2)
- Energy (1)

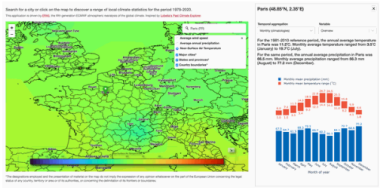
Provider
- Copernicus C3S (4)

Showing 1-6 of 6 results for ERA5 x Reanalysis x

ERA5 explorer

Application | Global | Reanalysis

This application provides visualisations of historical climate statistics for any location around the world. Click anywhere on the interactive map or search for a city to explore the typical monthly climate and discover how the climate has changed over the past forty years. This application is driven by ERA5, the fifth generation ECMWF atmospheric reanalysis of the global climate. ERA5 describes t...

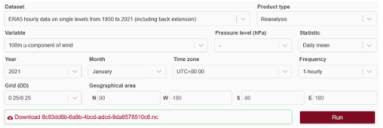


Daily statistics calculated from ERA5 data

Application | Reanalysis

This application allows users to compute and download selected daily statistics of variables from a number of hourly ERA5 datasets. It provides users with a simple tool to obtain ERA5 data aggregated at daily frequency without having to download the original sub-daily resolution data. The ERA5 data is subset to the selected rectangular spatial region of interest and sampled at the selected frequen...

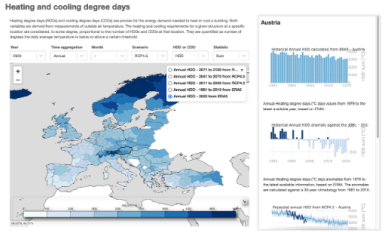
Updated 2021-10-13



Heating and cooling degree days from 1979 to 2100

Application | Global | Atmosphere (surface) | Reanalysis | Climate projections

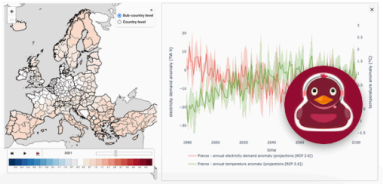
maximum, average and minimum temperatures. **ERA5** reanalysis was used to cover the past and present, while



European energy and climate data explorer

Application | Energy | Reanalysis | Europe

: historical and projections. The historical stream is based on **ERA5** reanalysis data as input, from 1979 to



https://cds.climate.copernicus.eu/cdsapp#!/search?type=application

C3S seasonal prediction: components

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DATA PRODUCTS

cds.climate.copernicus.eu

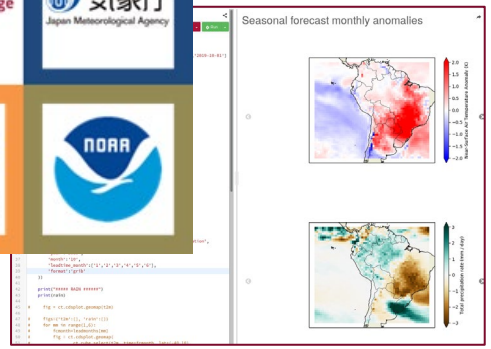
- Datasets available in the Climate Data Store:

atmosphere
  - daily and subdaily data (6h, 12h, 24h)
  - monthly statistics (mean, max, min and standard deviation)
  - bias corrected data (monthly anomalies)

ocean monthly means

- Multi-system retrospective forecasts and real-time forecasts, the latter published on 6th (ECMWF) and 10th day of month (the rest)

CDS API

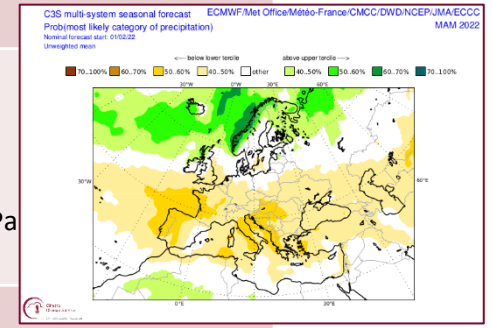


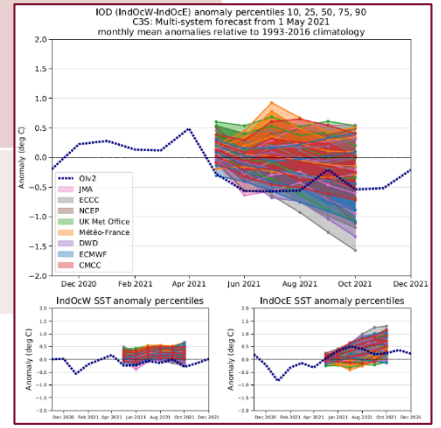
CDS Toolbox

GRAPHICAL PRODUCTS

climate.copernicus.eu/charts/packages/c3s_seasonal/

Source	Individual contributing systems Multi-system combination
Variables	Total precipitation Near-surface temperature Mean sea-level pressure Sea surface temperature Geopotential height at 500 hPa Temperature at 850 hPa
2D Maps - Global - Predefined regions	Ensemble mean anomaly Probabilities exceed quantiles: Median Terciles Quintiles
Time series - SST NINO regions - SST Indian Ocean - Wind at 10hPa	Ensemble members Percentiles Probabilities





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C3S seasonal predictions - data products

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Seasonal forecast anomalies on pressure levels

Dataset | Atmosphere (surface) | Atmosphere (upper air) | Global | Seasonal forecasts

This entry covers pressure-level data post-processed for bias adjustment on a monthly time resolution. Seasonal forecasts provide a long-range outlook of of predictable changes in some of the slow-varying components of the system. For example, ocean temperatures typically vary slowly, on timescales of wee

Updated 2023-06-05

Seasonal forecast anomalies on single

Overview | Download data | Quality assessment | Do

Originating centre

At least one selection must be made

- ECMWF
- UK Met Office
- CMCC
- NCEP

System

At least one selection must be made

- 1
- 2
- 3
- 7
- 8
- 12
- 21
- 35
- 600

Variable

At least one selection must be made

- 10m u-component of wind anomaly
- 10m v-component of wind anomaly
- 10m wind gust anomaly
- 10m wind speed anomaly
- 2m dewpoint temperature anomaly
- 2m temperature anomaly
- East-west surface stress anomalous rate of accumulation
- Evaporation anomalous rate of accumulation
- Maximum 2m temperature in the last 24 hours anomaly
- Mean sea level pressure anomaly
- Mean sub-surface runoff rate anomaly
- Mean surface runoff rate anomaly
- Minimum 2m temperature in the last 24 hours anomaly
- North-south surface stress anomalous rate of accumulation
- Runoff anomalous rate of accumulation
- Sea surface temperature anomaly
- Sea-ice cover anomaly
- Snow density anomaly
- Snow depth anomaly
- Snowfall anomalous rate of accumulation
- Soil temperature anomaly level 1
- Solar insolation anomalous rate of accumulation
- Surface latent heat flux anomalous rate of accumulation
- Surface sensible heat flux anomalous rate of accumulation
- Surface solar radiation anomalous rate of accumulation
- Surface solar radiation downwards anomalous rate of accumulation
- Surface thermal radiation anomalous rate of accumulation
- Surface thermal radiation downwards anomalous rate of accumulation
- Top solar radiation anomalous rate of accumulation
- Top thermal radiation anomalous rate of accumulation
- Total cloud cover anomaly
- Total column cloud ice water anomaly
- Total column cloud liquid water anomaly
- Total column water vapour anomaly
- Total precipitation anomalous rate of accumulation

Select all

https://cds.climate.copernicus.eu/cdsapp#!/dataset/seasonal-postprocessed-single-levels?tab=form

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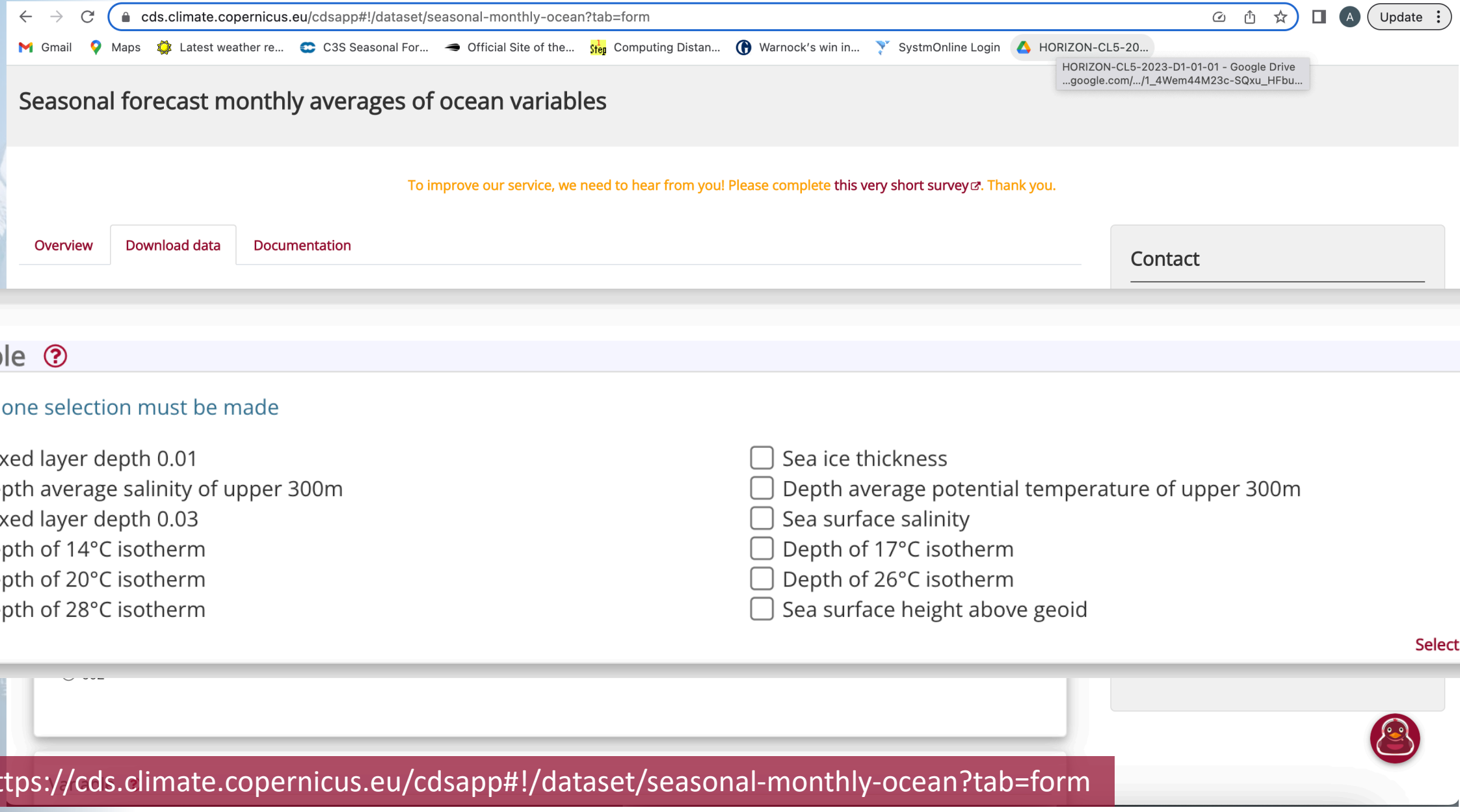
New seasonal forecast data from ocean model



https://cds.climate.copernicus.eu/cdsapp#!/dataset/seasonal-monthly-ocean?tab=form

Overview | Download data | Quality assessment | Documentation

- **Announcements**

  Announcements

- **Seasonal forecasts and the Copernicus Climate Change Service C3S**

  Overall description of seasonal forecasting science, the C3S multi-system approach, the elements of seasonal forecasting systems and production schedules of the individual data streams contributing to C3S seasonal forecasts activity

- **Description of the C3S seasonal multi-system**

  Description of the C3S multi-system components, including details for each one of the individual models contributing to C3S seasonal forecasts activity

- **How to use the CDS interactive forms for seasonal forecast datasets**

  Brief manual to guide users through the seasonal forecast interactive forms in the CDS

- **Summary of available data**

  Description of the C3S seasonal forecasts data available in the CDS in terms of the evolution of the components included in the multi-system for the period covered by the real-time forecasts and available hindcast's start dates

- **Detailed list of parameters**

  Comprehensive list of variables provided by each contributor

- **Recommendations and efficiency tips**

  Compilation of information related to good practice and guidance to avoid inefficient and/or wrong use of C3S seasonal forecast datasets

- **Known issues**

  Information about known issues found within the CDS seasonal forecast datasets

Contact

ECMWF Support Portal

Licence

Licence to use Copernicus Products

Additional licence to use non European contributions

Publication date

2018-06-14

Resource updated

2022-02-11

References

DOI: 10.24381/cds.181d637e

Related data

Seasonal forecast anomalies on pressure levels

Seasonal forecast anomalies on single levels

Seasonal forecast monthly statistics on pres levels

https://cds.climate.copernicus.eu/cdsapp#!/dataset/seasonal-original-single-levels?tab=form

‘Recent’ products: stratospheric wind

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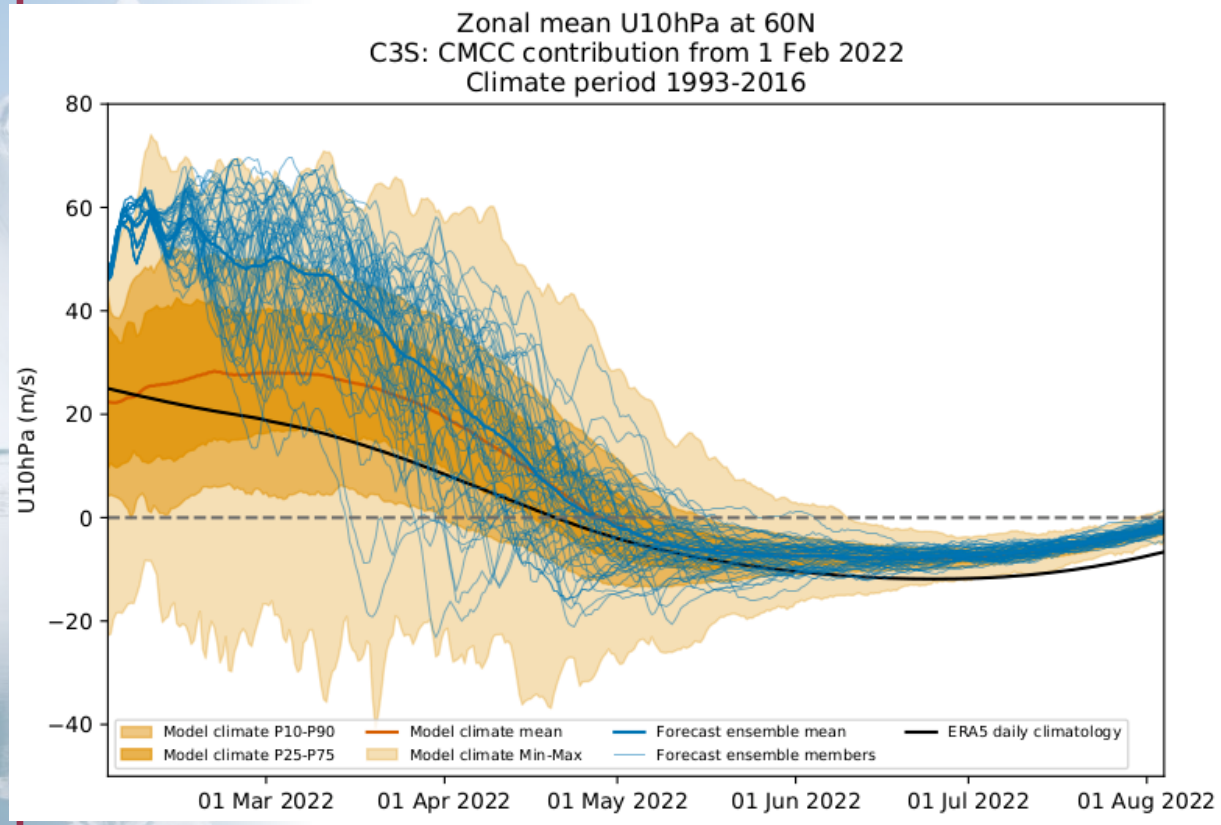

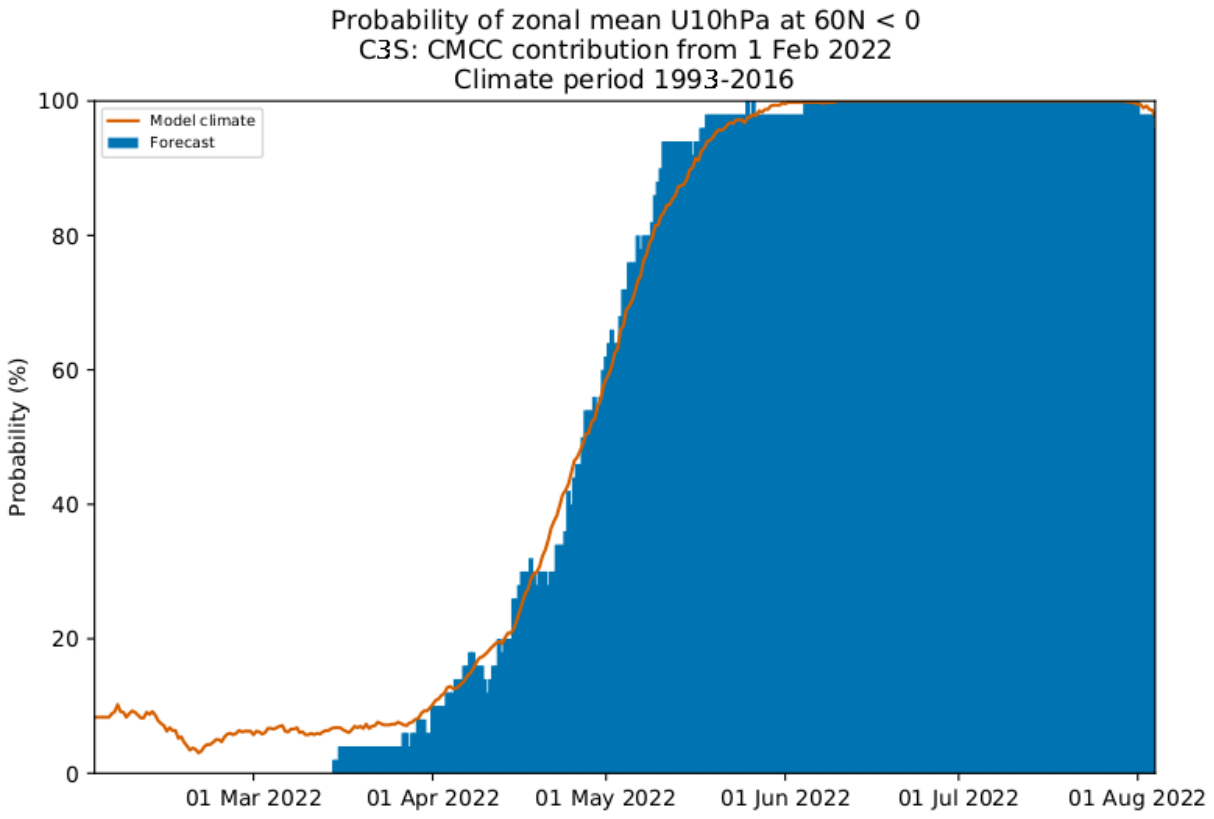

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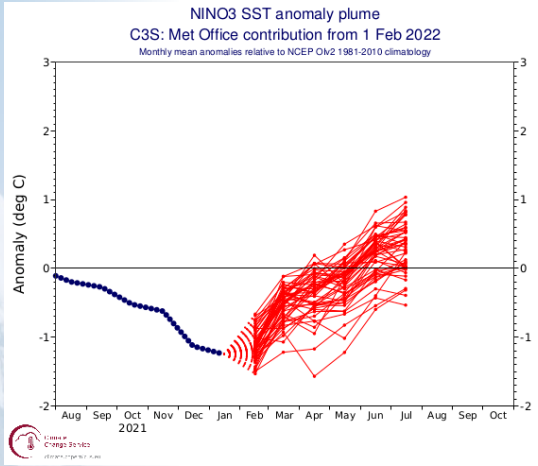
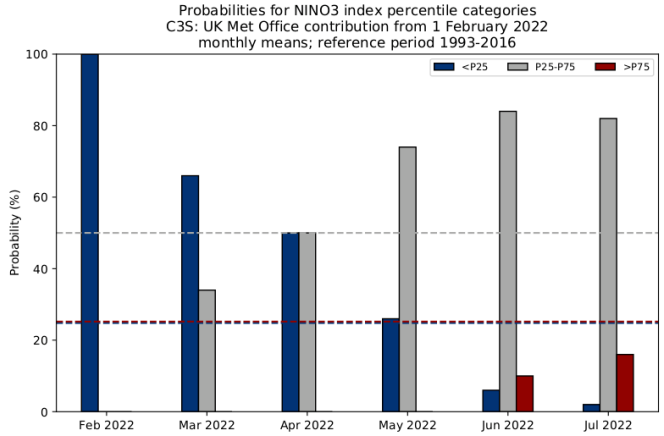
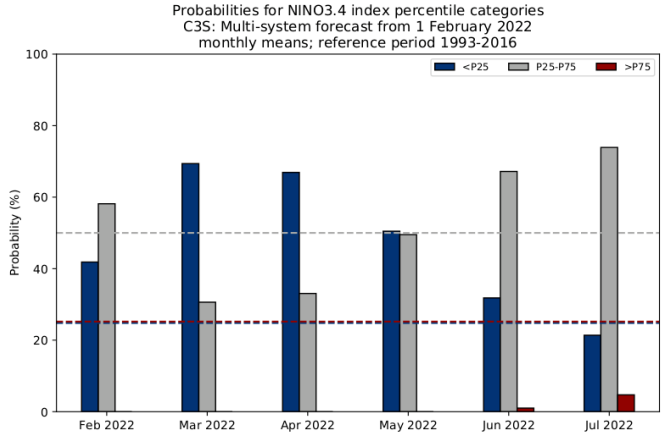
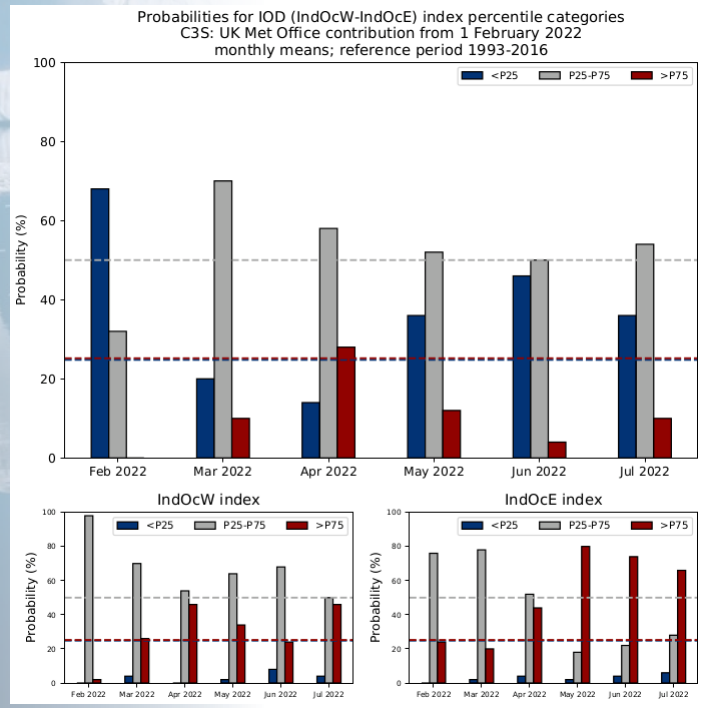
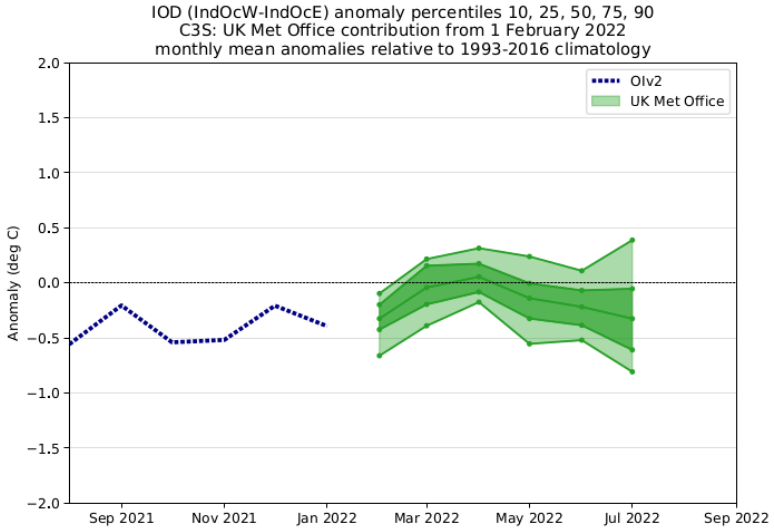
‘Recent’ products: SST indices

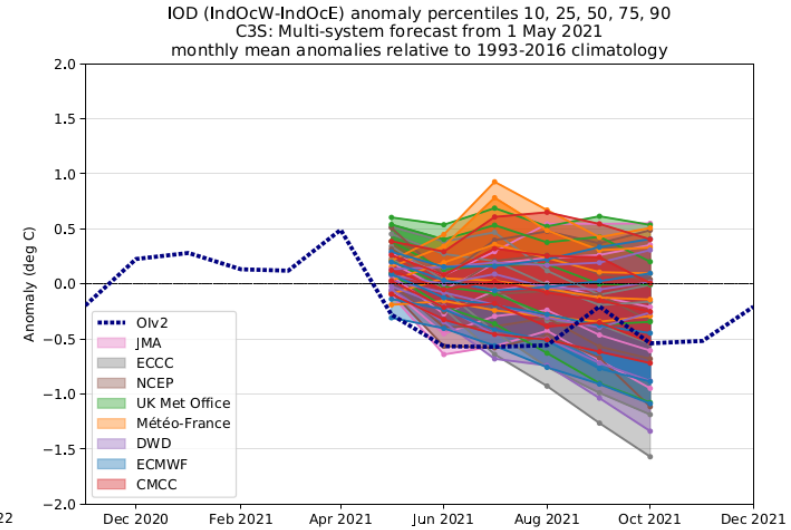


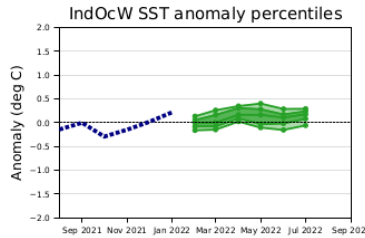


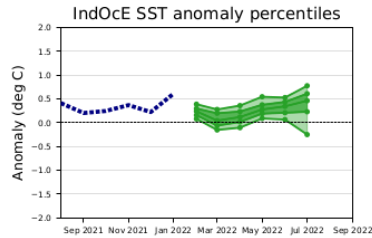


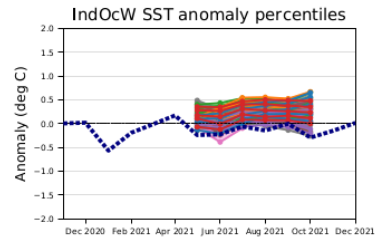


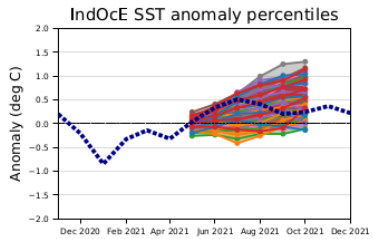












‘Operational’ verification scores

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- Copernicus European Regiona
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    - Seasonal forecasts and th
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    - How to use the CDS intera
    - Summary of available data
    - Detailed list of parameters
    - Recommendations and eff
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    - **C3S seasonal forecasts**
  - C3S Climate projections
  - Essential Climate Variables (EC
  - Global MULti-model hYdrologi
  - In situ gridded observations
  - Mass-consistent atmospheric
  - Near surface meteorological v
  - Sectorial Information System (
- CDS application documentation
- C3S precursor dataset documen
- EQC documentation
- ECMWF model and products

Space tools

/... / C3S Seasonal Forecasts: datasets documentation

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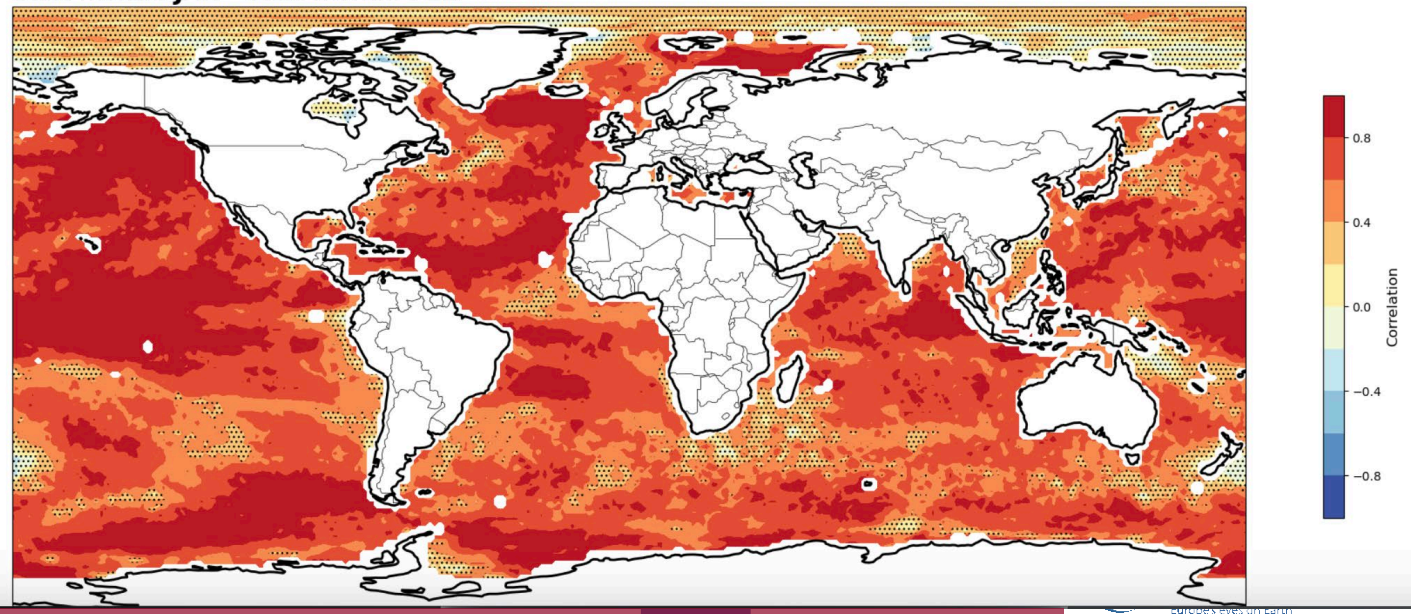
C3S seasonal forecasts verification plots

› Introduction (click to expand)

Forecast system: C3S multi-system (2023)
Nominal start date: January Aggregation and leadtime: 1m; lead1
Variable: Sea-surface temperature Score: Correlation

C3S multi-model (2023) **sea-surface temperature** (stippling where significance below 95%)
Start month: **JAN** - Valid month: **FEB**



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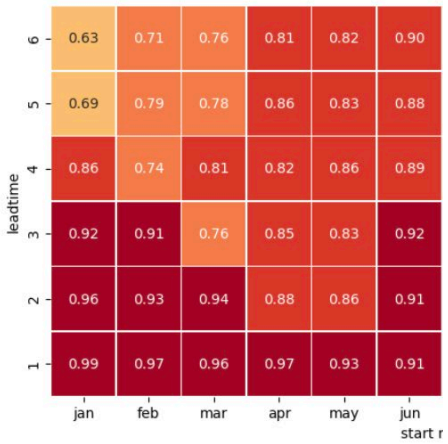
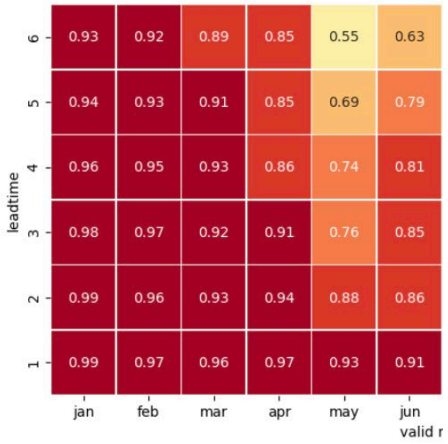
‘Operational’ verification scores

Forecast system: MeteoFrance System8
Nominal start date: January Aggr
Variable: SST indices Sc

Météo-France System 8 , **NINO3.4 SST**
reforecasts 1993 - 201

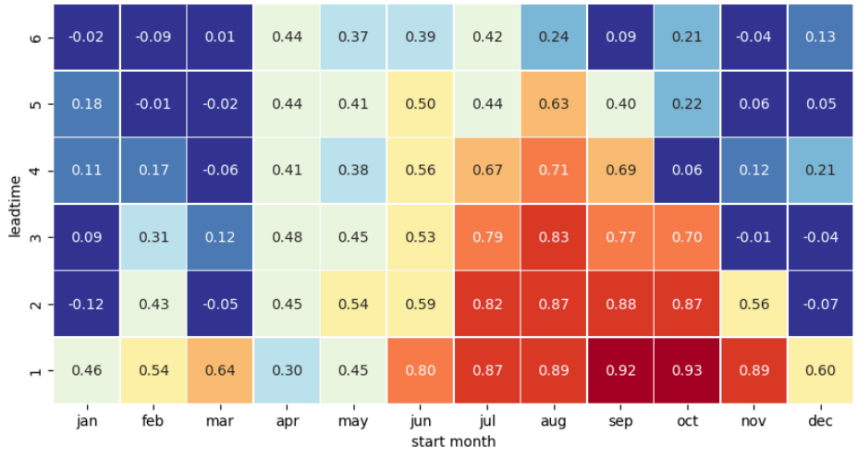


Météo-France System 8 , **NINO3.4 SST**
reforecasts 1993 - 201



Forecast system: MeteoFrance System8
Nominal start date: January Aggregation and leadtime: 1m; lead0
Variable: SST indices Score: Correlation SST index: IOD

Météo-France System 8 , **IOD(IndOcW – IndOcE) SST index** (temporal correlation with ERA5)
reforecasts 1993 - 2016, ensemble size = 25



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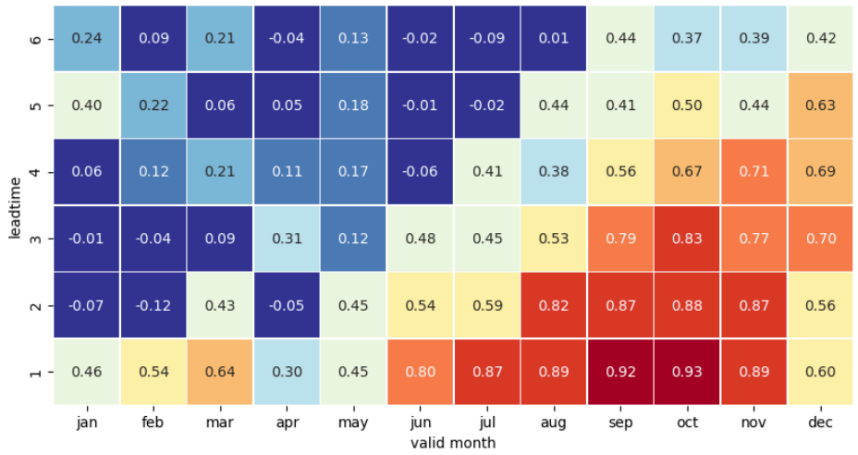
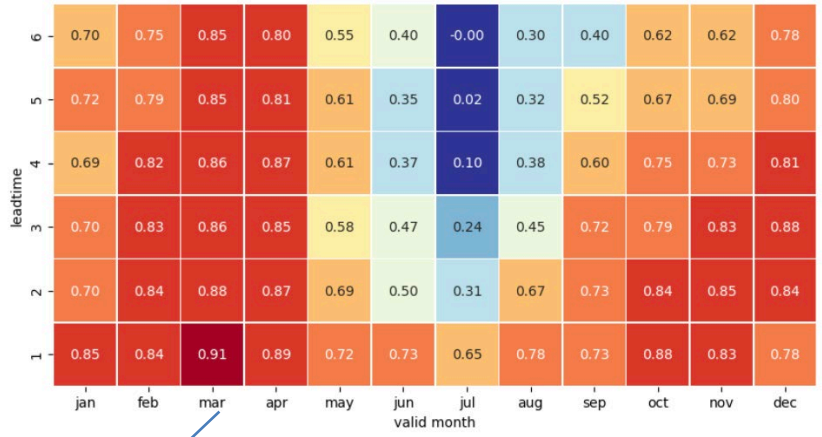
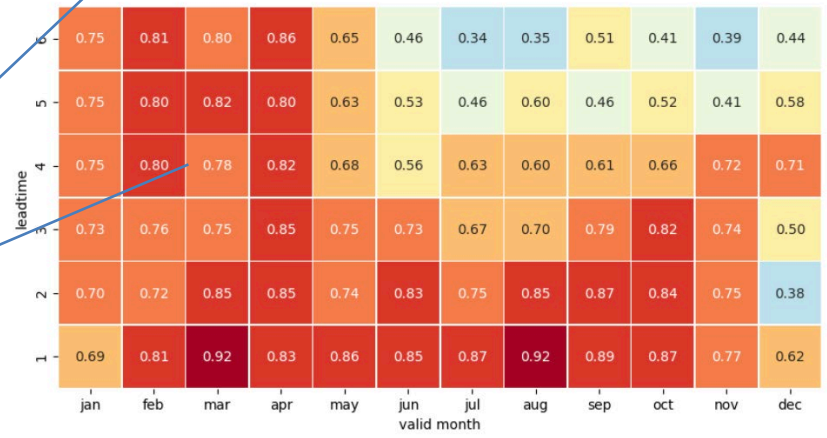


Météo-France System 8 , **IndOcW SST index** (temporal correlation with ERA5)
reforecasts 1993 - 2016, ensemble size = 25



Météo-France System 8 , **IndOcE SST index** (temporal correlation with ERA5)
reforecasts 1993 - 2016, ensemble size = 25



Verification: NINO indices in multi-system

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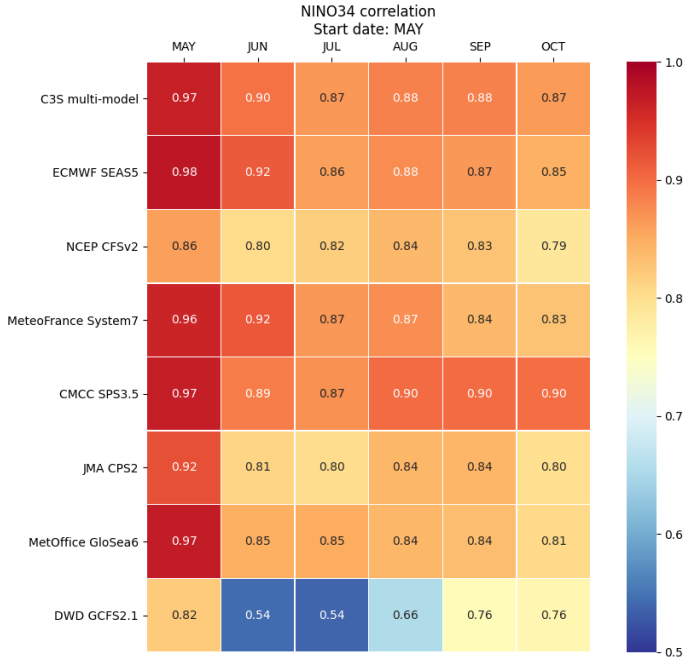

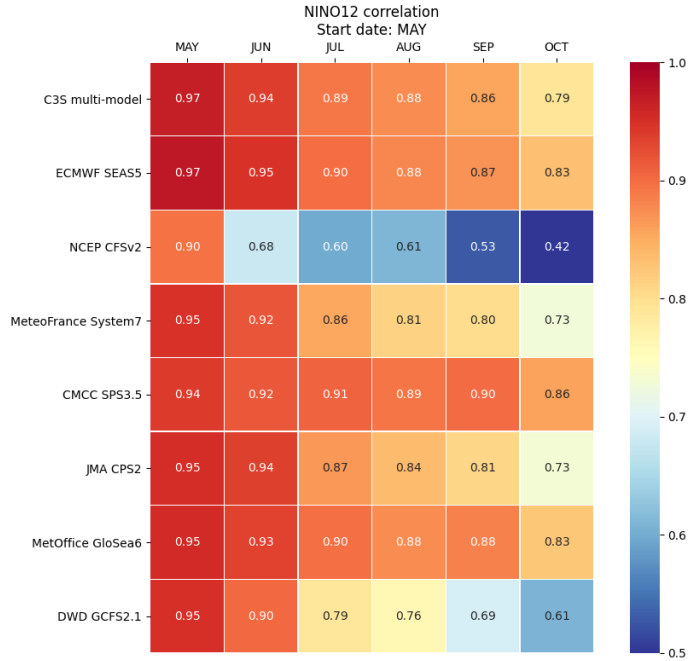

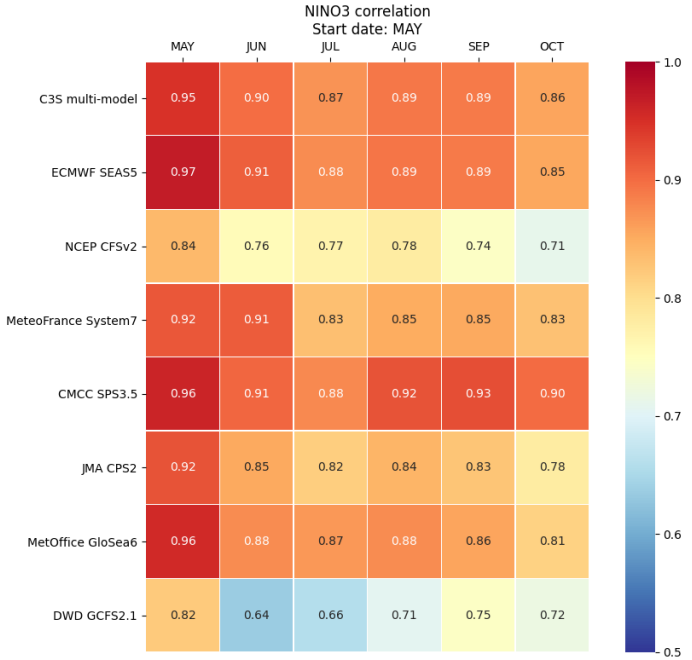

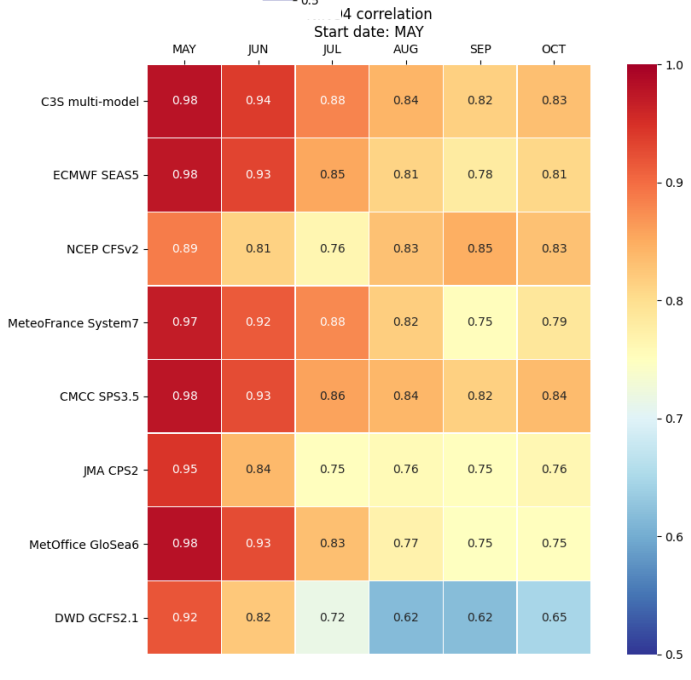

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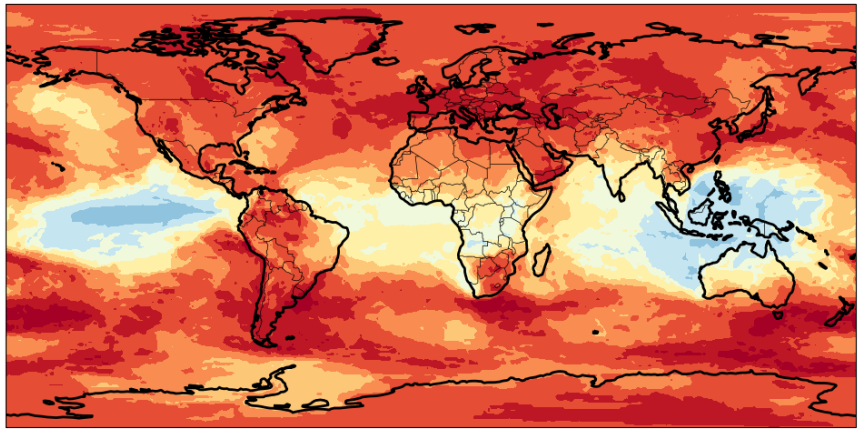
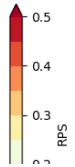
RPS November to December-February

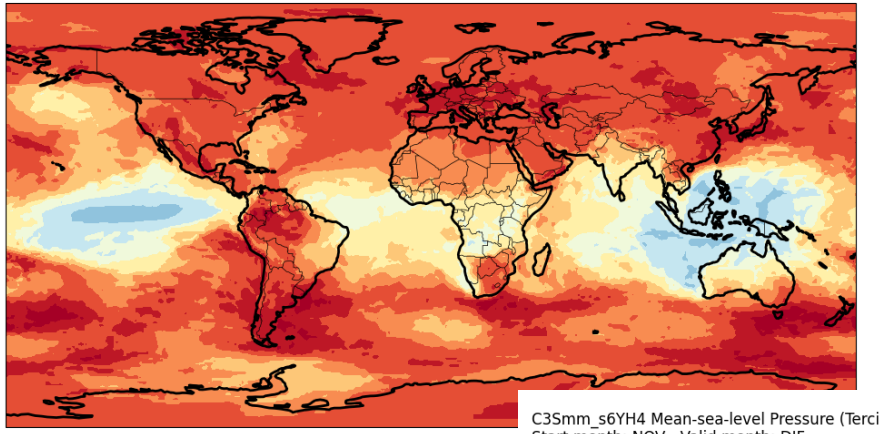
C3Smm_s6BK8 Mean-sea-level Pressure (Tercile Categories)
Start month: NOV - Valid month: DJF

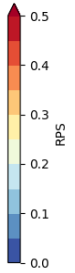




ECs5, MFs8, UKs600 – **MM3**

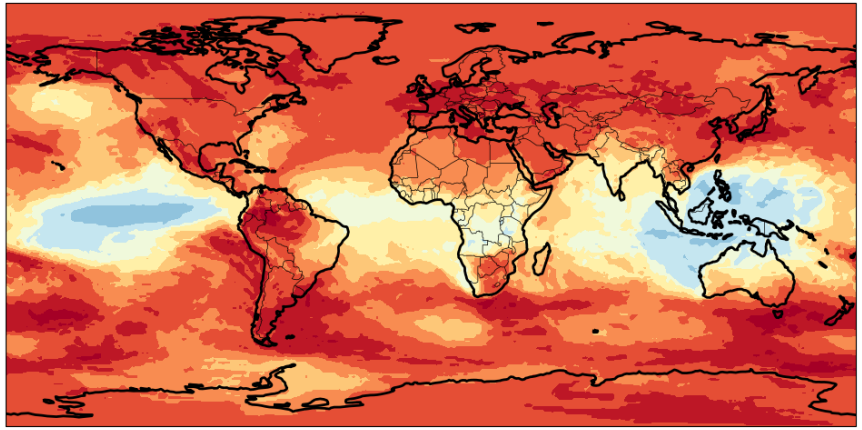
C3Smm_s6RD4 Mean-sea-level Pressure (Tercile Categories)
Start month: NOV - Valid month: DJF

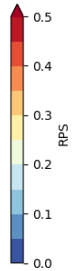




ECs5, MFs8, UKs600, DWDs21, CMCCs35 - **MM5**

C3Smm_s6YH4 Mean-sea-level Pressure (Tercile Categories)
Start month: NOV - Valid month: DJF



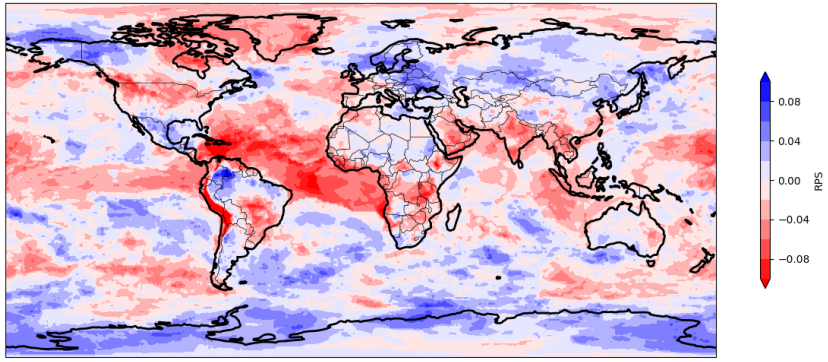


ECs5, MFs8, UKs600, DWDs21, CMCCs35, NCEPs2, JMAs2 – **MM7**

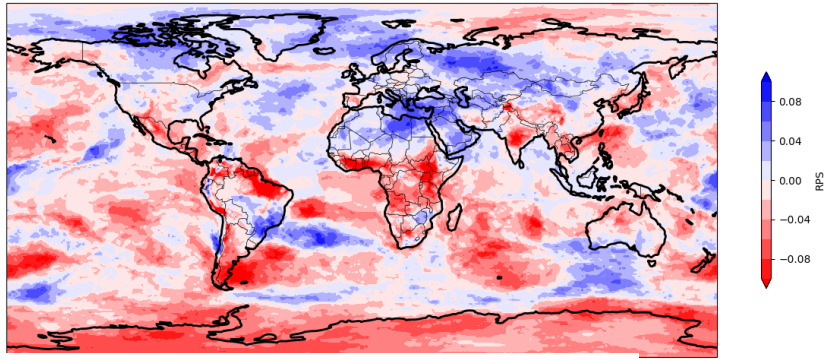
Climate Change

RPS differences: combination-individual

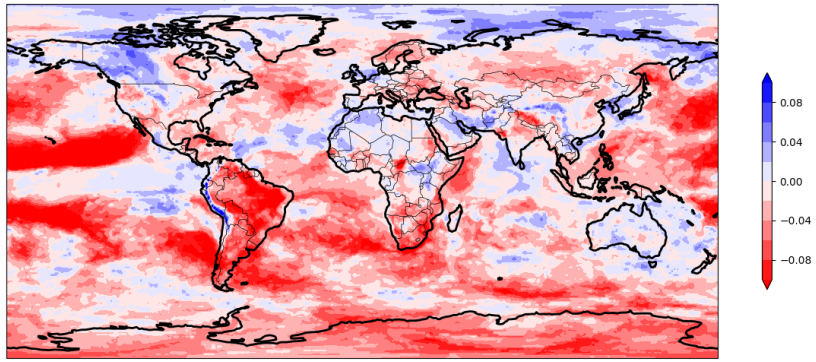
C3Smm_s6YH4 minus ukmo_s600 Mean-sea-level Pressure (Tercile Categories)
Start month: NOV - Valid month: DJF



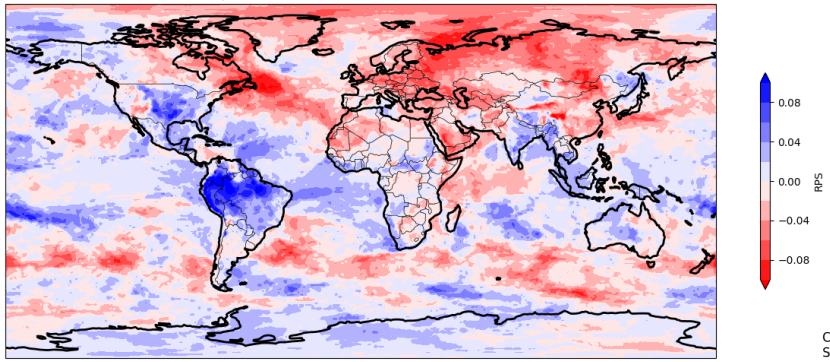
C3Smm_s6YH4 minus dwd_s21 Mean-sea-level Pressure (Tercile Categories)
Start month: NOV - Valid month: DJF



C3Smm_s6YH4 minus meteo_france_s8 Mean-sea-level Pressure (Tercile Categories)
Start month: NOV - Valid month: DJF

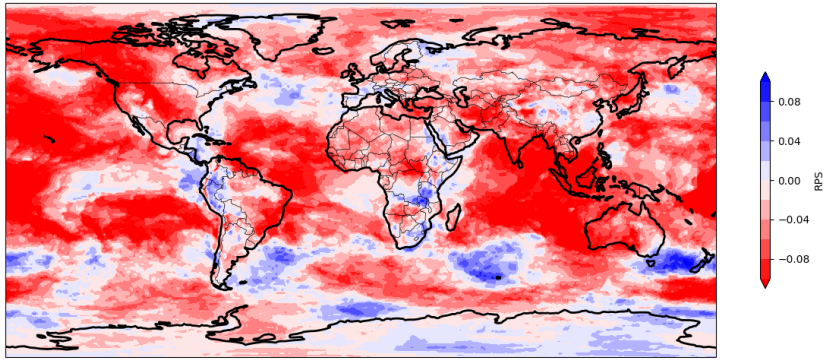


C3Smm_s6YH4 minus ecmwf_s5 Mean-sea-level Pressure (Tercile Categories)
Start month: NOV - Valid month: DJF

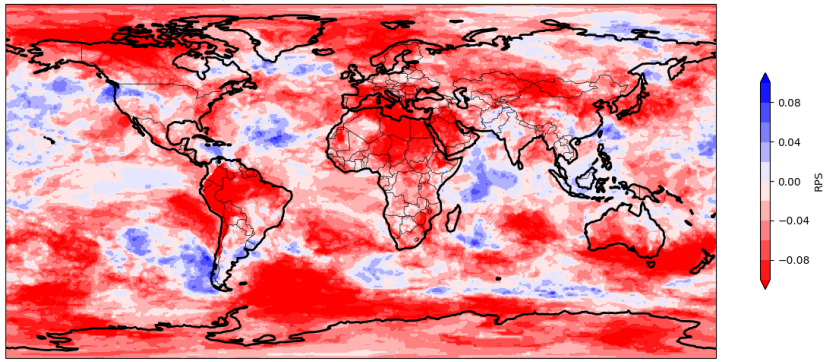


red: combination is 'better'

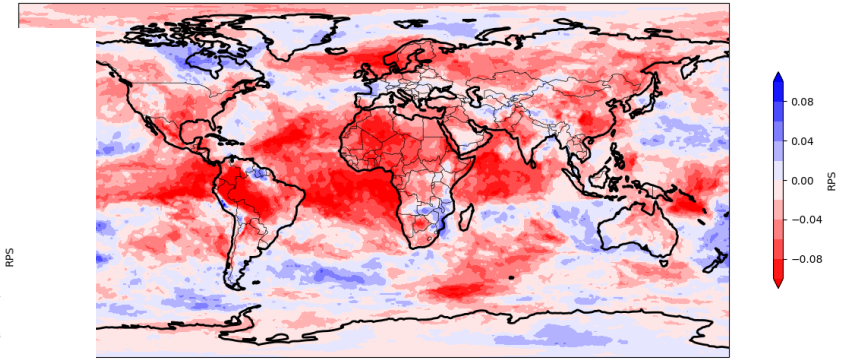
C3Smm_s6YH4 minus ncep_s2 Mean-sea-level Pressure (Tercile Categories)
Start month: NOV - Valid month: DJF



C3Smm_s6YH4 minus jma_s2 Mean-sea-level Pressure (Tercile Categories)
Start month: NOV - Valid month: DJF



C3Smm_s6YH4 minus cmcc_s35 Mean-sea-level Pressure (Tercile Categories)
Start month: NOV - Valid month: DJF



Examples of data processing

Climate Change

ecmwf-projects.github.io/copernicus-training-c3s/intro.html

Gmail | Maps | Latest weather re... | C3S Seasonal For... | Official Site of the... | Computing Distan... | Warnock's win in... | SystmOnline Login | HORIZON-CL5-20...

Update

Climate Change Service
climate.copernicus.eu

C3S Training

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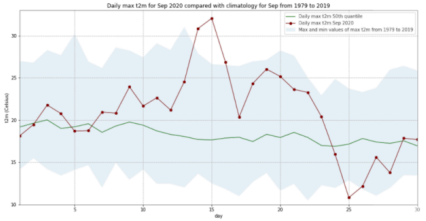
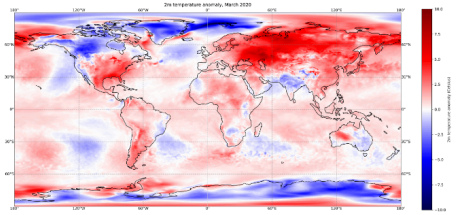
Contents

Copernicus Climate Change Service (C3S) Data Tutorials

Discover how to access and handle data of the past, present and future climate!

This website contains Jupyter notebook based tutorials that demonstrate how to access and process the wide variety of climate data provided by the Climate Data Store (CDS) of the Copernicus Climate Change Service (C3S). Each tutorial provides interactive examples of common workflows to derive information about the past, present and future climate. They include code in Python and content in Markdown to provide clear, engaging and practical instructions on data handling which can be run in various cloud environments without any need for installation. You are invited to experiment with these tutorials and tailor them to your needs to extract results meaningful to you! The tutorials make use of climate data freely available on the CDS and accessed using an Application Programming Interface (API).





How to run these tutorials

The tutorials are in the form of Jupyter notebooks. At the top of each notebook you will find links to a selection of cloud-based services to run, edit, export or create new notebooks. These include the following:

Binder	Kaggle	Colab

https://ecmwf-projects.github.io/copernicus-training-c3s/intro.html

Examples of data processing

Climate Change

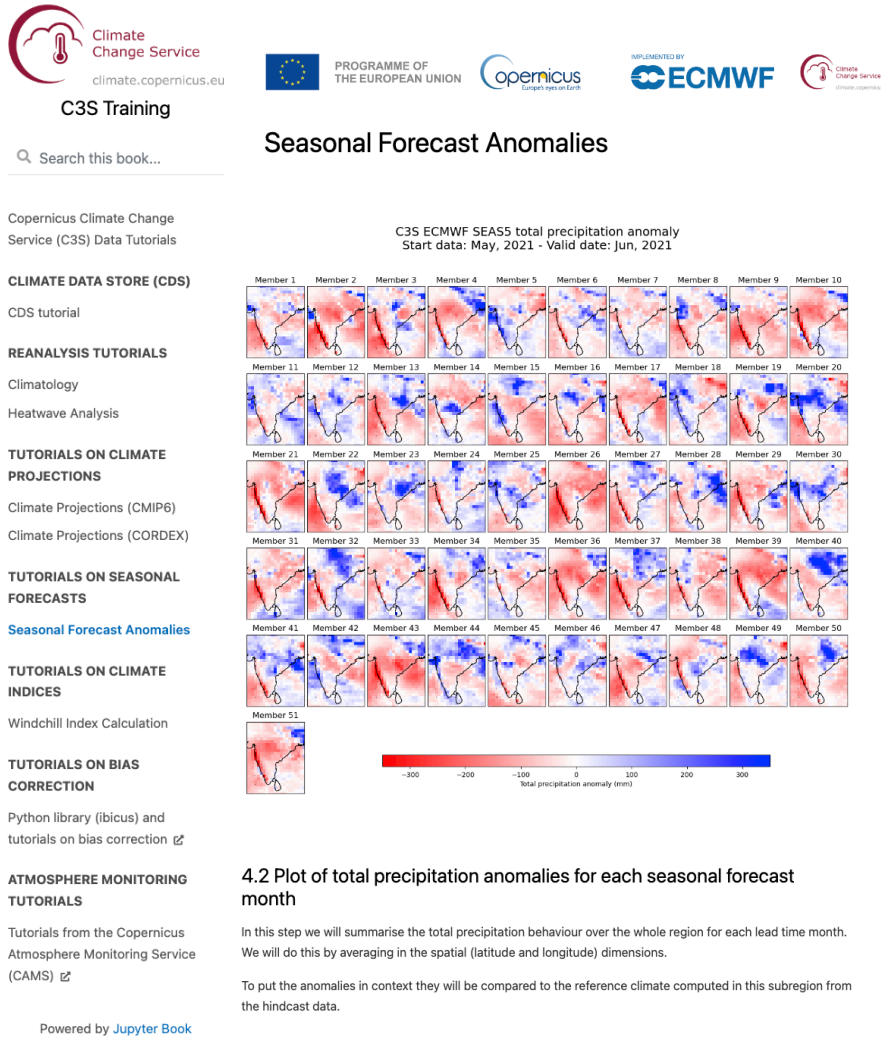
As part of the C3S training offering, a Jupyter notebook is available showing how forecast anomalies can be calculated and visualised: https://ecmwf-projects.github.io/copernicus-training-c3s/sf-anomalies.html

Further examples will be added, including the generation of verification charts (similar to those shown on the verification plots page), and bias correction of SST indices.

These examples may be useful even for those familiar with analysing similar data, as common issues or pitfalls can be highlighted, e.g.

NOTE:
The second of the time dimensions is valid for systems with burst start dates (such as in our example), but for lagged systems, *time* should be replaced with *indexing_time*. Please see here for more details on the difference between burst and lagged systems.

```
ds_hindcast = xr.open_dataset(f'{DATADIR}/ecmwf_seas5_1993-2016_05_hindcast_monthly_tp.grib',
ds_hindcast
```



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

created by by Eduardo Penabad and Chris Goddard

User statistics- data requests

Climate Change

We are exploring the CDS logs for insights into user preference/needs and practices.

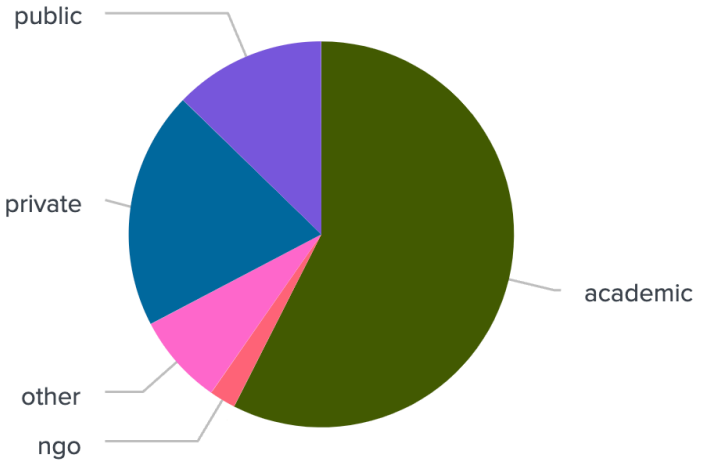
Headlines so far:

- While academic users are the largest group, there is significant representation from other groups
- There were ~1100 unique users of the data during January to May 2023
- There are approximately 500 unique users per month
- ‘Monthly single levels’ data have the largest number of requests

We also provide producing centres with statistics about use of their data.

In the future we plan to investigate which physical variables see the highest useage.

Distribution of users by sector (year to date)



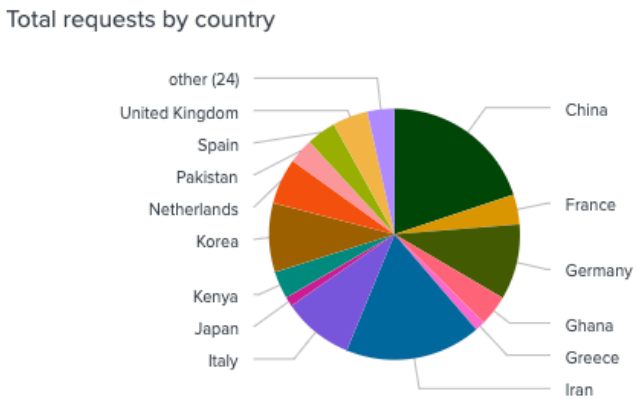
European Commission | Copernicus Europe's eyes on Earth | ECMWF

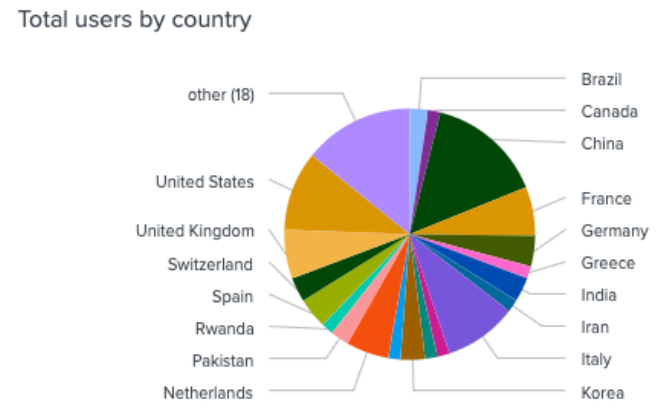
assembled by C Goddard

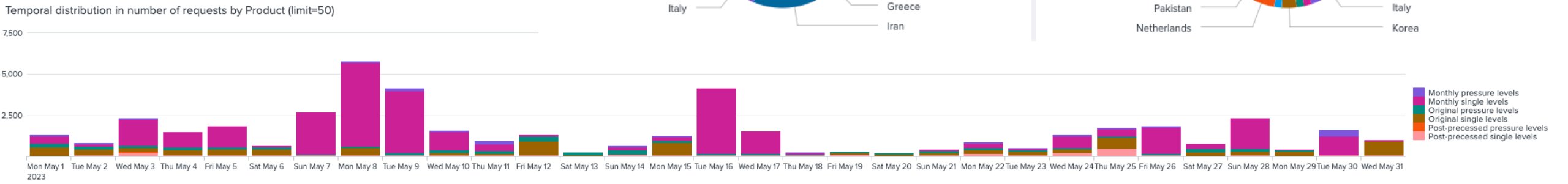
User statistics- data requests

Climate Change

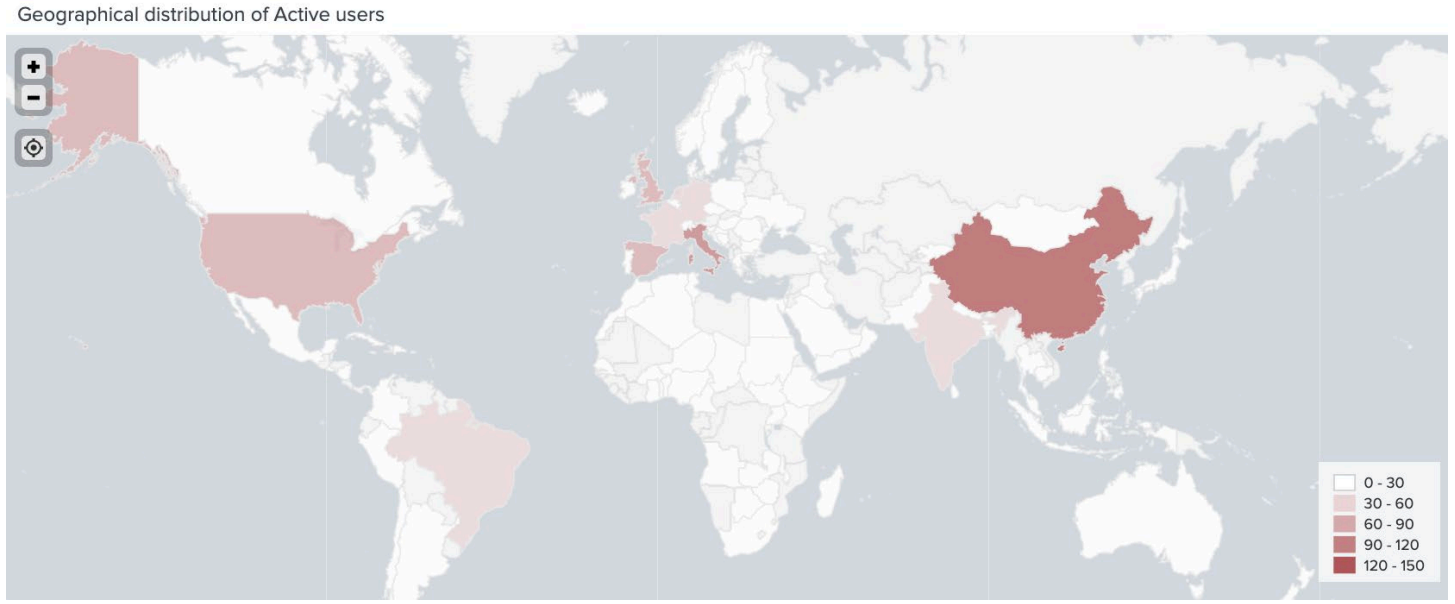
May 2023:







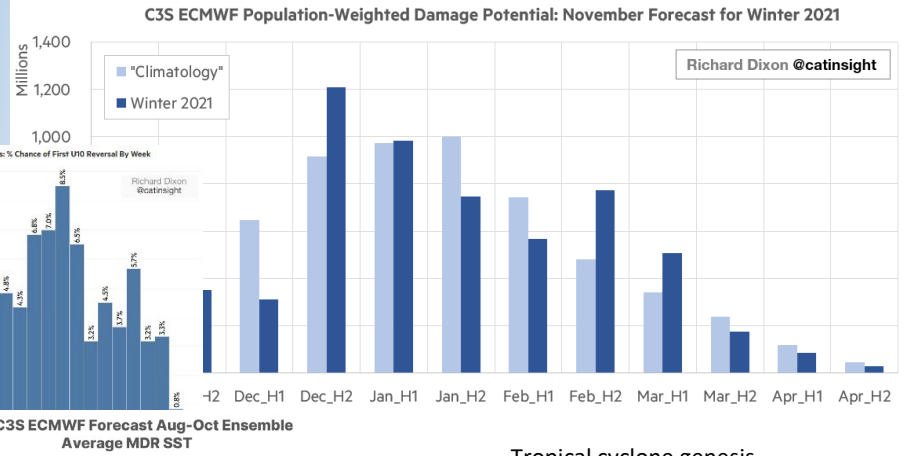
Year to date:

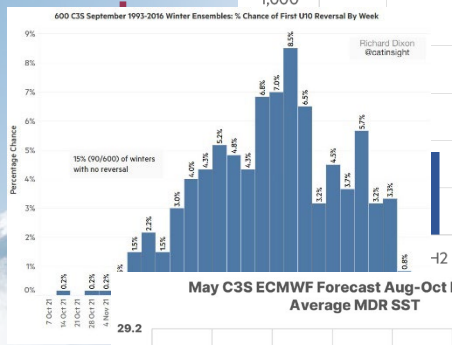


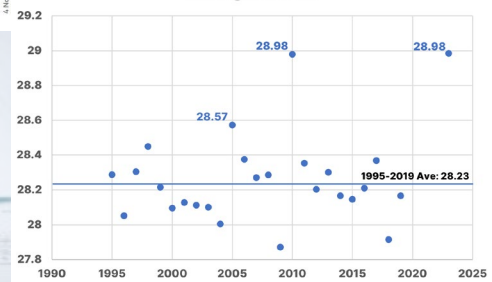
ECMWF

C3S predictions in user diagnostics

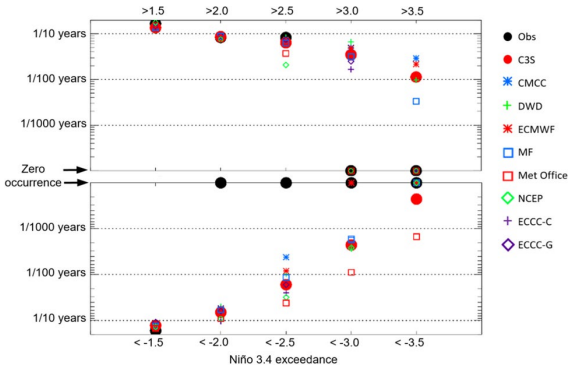
Climate Change





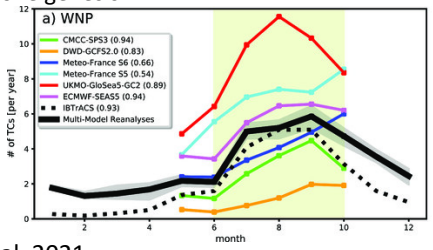


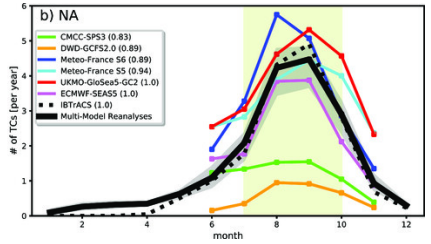
Richard Dixon @catinsight



Merryfield and Lee, 2023
Asia-Pac. Journ. Atmos. Sci.

Tropical cyclone genesis





D.Befort et al, 2021

World Climate Service @WorldClimateSvc

Ensemble Mean Forecast QBO Index
Nominal Initialization Date: 1 FEB 2022

	MAR 2022	APR 2022	MAY 2022	JUN 2022	JUL 2022
Multi-Model Mean	-25.0	-22.8	-15.0	-4.7	+1.7
ECMWF	-22.8	-15.6	-5.7	-1.7	-1.4
UKMO	-30.7	-30.1	-17.3	+0.9	+11.0
CFSv2	NA	NA	NA	NA	NA
JMA	-28.5	-27.7	-17.1	-1.5	+5.1
Météo-France	-26.0	-24.6	-20.0	-8.8	+3.2
CMCC	-21.7				
DWD	-26.4				
ECCC	-18.7				

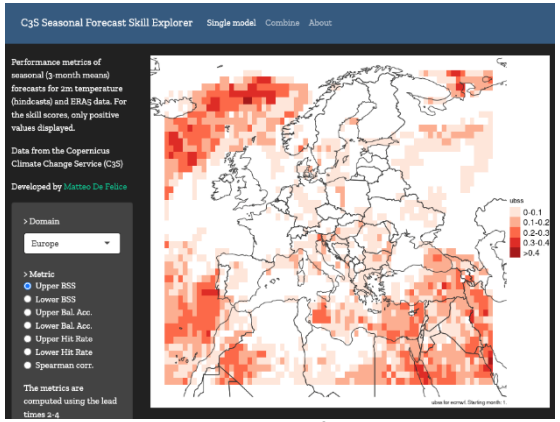
-30 -20 -15 -1
Index Definition: E
Generated usin

1993-2016 Correlation of Forecast and Observed AO Index
Nominal Initialization Date: 1 FEBRUARY

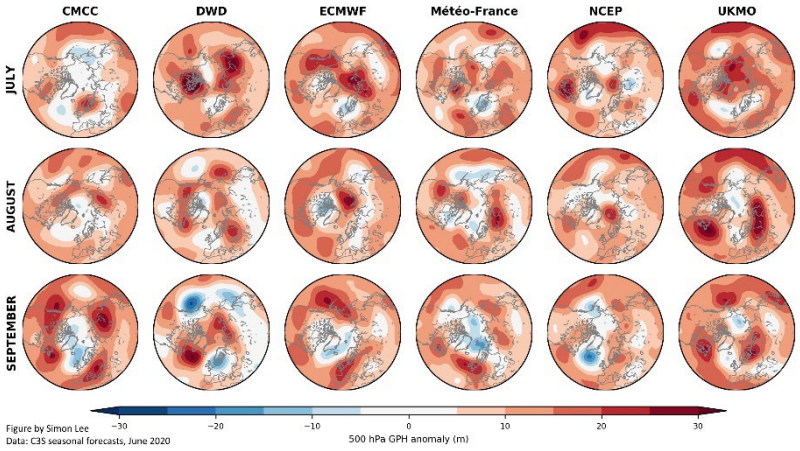
Forecast Valid For	MAR	APR	MAY	JUN	JUL
Multi-Model Mean	-0.05	+0.27	+0.18	+0.41	+0.33
ECMWF	+0.05	-0.19	+0.10	+0.32	+0.36
UKMO	-0.07	+0.19	-0.28	+0.37	+0.09
CFSv2	-0.06	-0.02	-0.11	+0.41	+0.15
JMA	-0.06	+0.05	+0.18	+0.21	+0.23
Météo-France	-0.00	+0.28	+0.31	-0.05	-0.00
CMCC	-0.11	+0.31	+0.11	+0.30	-0.07
DWD	-0.08	+0.37	+0.05	+0.21	+0.11
ECCC	+0.01	+0.23	+0.36	+0.24	+0.12

-0.7 -0.5 -0.3 0 +0.3 +0.5 +0.7 +0.9
Index Definition: First EOF of Monthly MSLP Over 20-90N
Verification: ERA5 Reanalysis
Generated using Copernicus Climate Change Service Information 2022

Vortex @VortexFdC



Matteo de Felice @matteodefelice



Simon Lee @SimonLeeWx

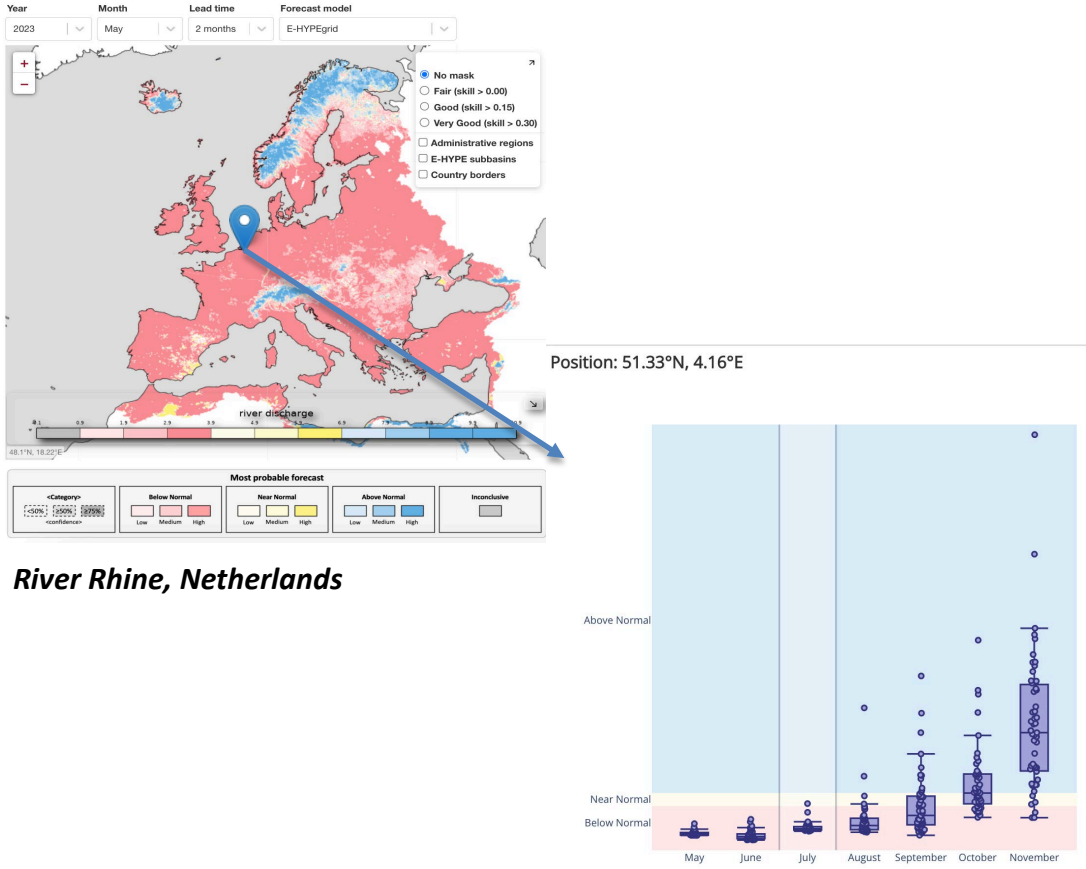
assembled by E Penabad

C3S Multi-model Seasonal Hydrological Prediction Service

Climate Change

- **Climate forecast / reforecast forcing (ECMWF SEAS5, CMCC):**
  - Downscaled and bias corrected (quantile mapping)
  - Reforecasts 1993-2015 (25/40 ensemble members)
  - Forecast (51/50 ensemble members)
- **9 Hydrological models**
  - ***European-scale (5 km):*** E-HYPEcatch, E-HYPEgrid, VIC-WUR, EFAS LISFLOOD
  - ***Global-scale (10 km):*** JULES, mHM, HTESSEL, PCR-GLOB, GloFAS LISFLOOD
- **Variables (daily time-step):** River discharge, runoff, snow water equivalent, soil moisture, precipitation & temperature
- **Quality control, skill assessment & available via the CADS**
- **Due to become operational in April 2024**

CADS toolbox: European hydrology seasonal forecast explorer (May 2023)



River Rhine, Netherlands

courtesy of Shaun Harrigan

Climate Change

What next?

- seasonal predictions
  - new graphical products: wind speed, sea ice, marine ‘heatwaves'
  - new data: soil moisture (July ‘23), water column (June ‘23); diagnostics
  - new products as workflows (Jupyter notebooks): sea-surface height as proxy for coastal El Niño; Tmin/max
  - further upgrades to operational systems, including ECMWF’s SEAS6
  - multi-year predictions? (under discussion)
- decadal prediction product development and real-time updates
- more examples of data use and applications (as workflows)

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