Climate Change

C3S climate predictions for seasonal to decadal timescales

Anca Brookshaw on behalf of
C3S seasonal and Copernicus production teams

UEF June 2021

Seasonal timescales

- Data – from world-leading producers
  - large set of variables
  - data service:
    - download from forms and API
    - detailed documentation
    - guidance and user support
    - monthly, daily, sub-daily frequency
- Graphical illustrations

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

- Operational schedule
- Tools and computational environment

C3S seasonal prediction multi-system

Free and open access to all these resources

IMPLEMENTED BY ECMWF Copernicus European Commission

C3S seasonal predictions - data products

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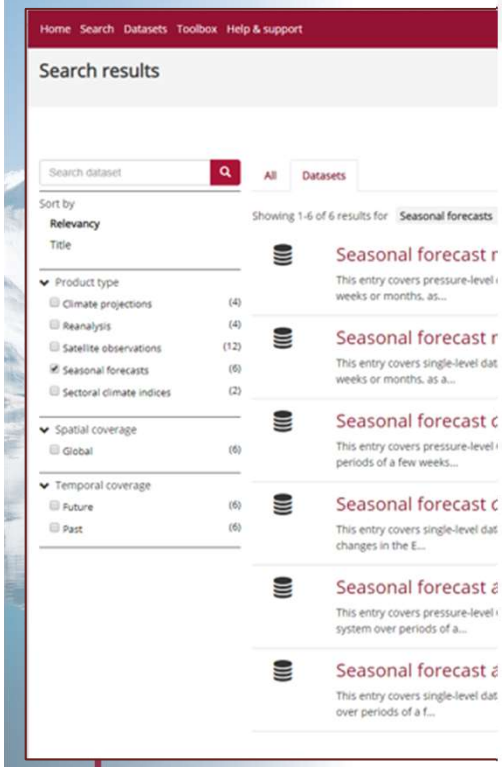

Seasonal forecast daily and subdaily data on single levels

Overview | Download data | Documentation

Clear all

Originating centre

At least one selection must be made

- ECMWF
- CMCC
- UK Met Office
- NCEP
- Météo France
- JMA
- DWD
- ECCC

Select all

System

At least one selection must be made

- 1
- 7
- 35
- 2
- 12
- 600
- 3
- 13
- 4
- 14
- 5
- 15
- 6
- 21

Select all

Variable

At least one selection must be made

- 10m u-component of wind
- 10m wind gust since previous post-processing
- 10m v-component of wind
- 2m dewpoint temperature

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

C3S seasonal forecasts - documentation

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Overview | Download data | 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

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

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C3S seasonal predictions– graphical products

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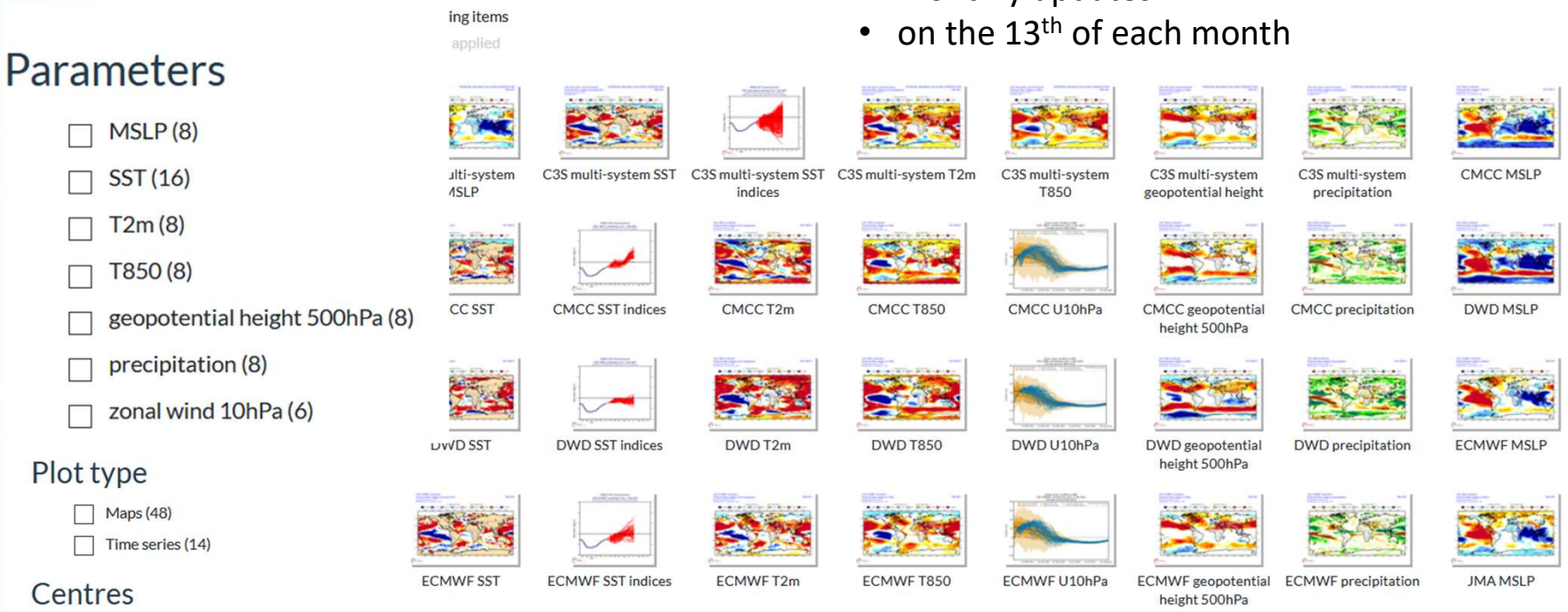
Publication schedule:

- monthly updates
- on the 13th of each month



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

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C3S seasonal predictions– graphical products

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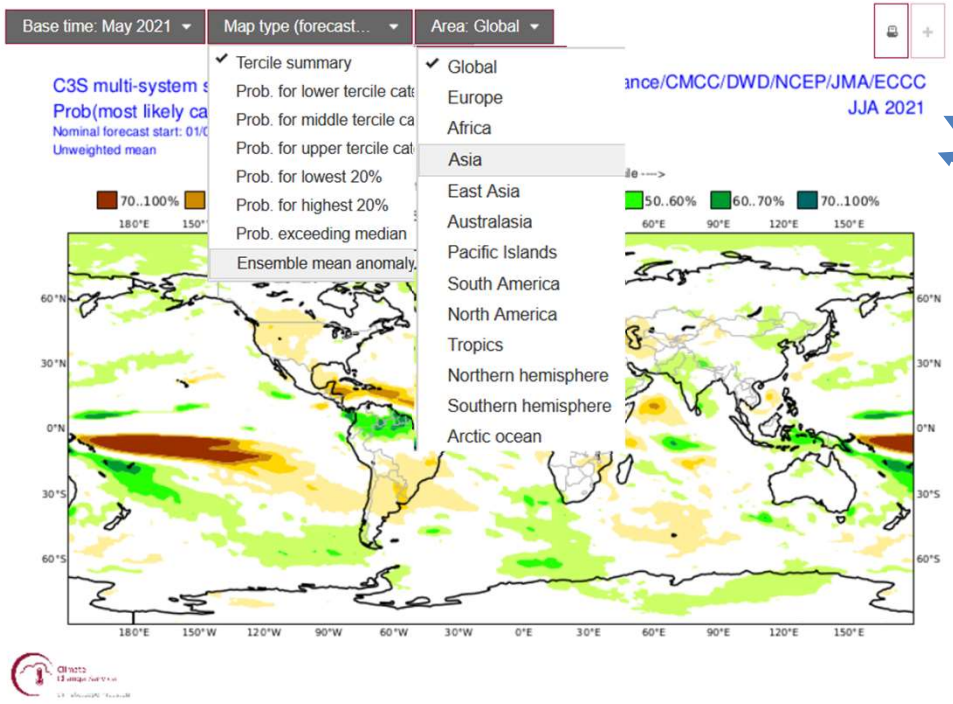
← C3S seasonal charts

Results

18 matching items

Parameters: T2m, precipitation

- C3S multi-system T2m — Multi-system combination sp...
- C3S multi-system precipitati... — Multi-system combination sp...
- CMCC T2m — Individual system spatial plot...
- CMCC precipitation — Individual system spatial plot...
- DWD T2m — Individual system spatial plot...
- DWD precipitation — Individual system spatial plot...
- ECCC T2m — Individual system spatial plot...
- ECCC precipitation — Individual system spatial plot...
- ECMWF T2m — Individual system spatial plot...
- ECMWF precipitation — Individual system spatial plot...
- JMA T2m — Individual system spatial plot...
- JMA precipitation — Individual system spatial plot...



Multi-system combination spatial plots

Ensemble mean anomalies

The charts display the averages of the standardized ensemble mean anomalies. For each component model, ensemble mean anomalies are computed with respect to the corresponding model climate. These are then re-scaled so that the total variance on the monthly time scale of each model is equal to the mean of the variances of all the models contributing to the combination. The variance standardization is based on the hindcast period common to those models.

C3S seasonal predictions – tools and applications

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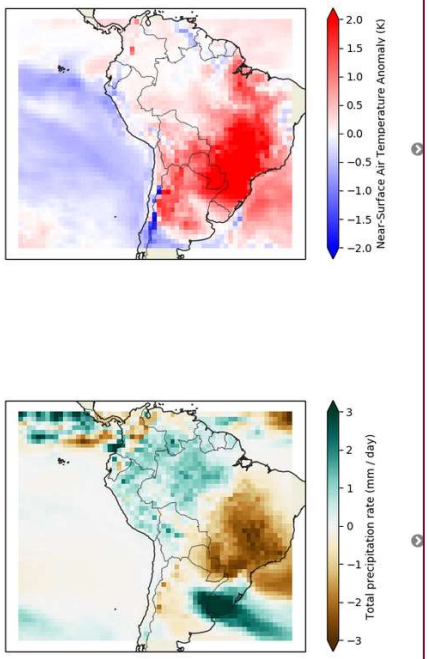
```python
import cdsapi

c = cdsapi.Client()

c.retrieve(
    'seasonal-monthly-single-levels',
    {   'format':'grib',
        'originating_centre':'meteo_france',
        'variable':'total_precipitation',
        'product_type':[
            'ensemble_mean','hindcast_climat
        ],
        'year':'2018',
        'month':'09',
        'leadtime_month':['1','2','3','4','5
    'cds_seasonal_output.grib')
```

example seasonal anomalies ... | Console | History | Your queue

Layout | Copy | Save | Run

```python
import cdstoolbox as ct

leadmonths=
['2019-05-01','2019-06-01','2019-07-01','2019-08-01','2019-09-01','2019-10-01']

@ct.application(title='Seasonal forecast monthly anomalies')
@ct.output.carousel()
@ct.output.carousel()
def application():
    """
    """

    t2m = ct.catalogue.retrieve(
    'seasonal-postprocessed-single-levels',
    {
        'originating_centre':'ecmwf',
        'variable':'2m_temperature_anomaly',
        'product_type':'ensemble_mean',
        'year':'2019',
#         'month':['10','11'],
        'month':['10'],
        'leadtime_month':['1','2','3','4','5','6'],
#         'leadtime_month':'1',
        'format':'grib'
    })

    print("##### T2M ######")
    print(t2m)


    rain = ct.catalogue.retrieve(
    'seasonal-postprocessed-single-levels',
    {
        'originating_centre':'ecmwf',
        'variable':'total_precipitation_anomalous_rate_of_accumulation',
        'product_type':'ensemble_mean',
        'year':'2019',
        'month':'10',
        'leadtime_month':['1','2','3','4','5','6'],
        'format':'grib'
    })

    print("##### RAIN ######")
    print(rain)

#     fig = ct.cdsplot.geomap(t2m)

#     figs={'t2m':[], 'rain':[]}
#     for mm in range(1,6):
#         fcmonth=leadmonths[mm]
#         fig = ct.cdsplot.geomap(
#             ct.cube.select(t2m, time=fcmonth, lat=(-40,10)
```

Seasonal forecast monthly anomalies



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Decadal timescales

Prototype aligned to **user requirements** and designed in agreement with producers of predictions

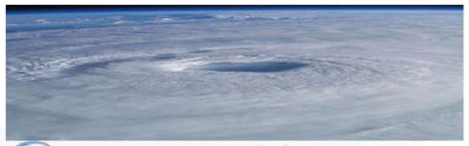
Two topics:

- Identify **best practice** for interpreting decadal prediction model output (bias correction, verification, data encoding)
- Develop **case studies** for user-relevant applications
  - Infrastructure (*DWD*): management of water level and water quality of the upper catchment in North-Rhine-Westphalia

  - Agriculture (*BSC*): planning of crop yields (drought, heat waves), globally – JRC

  - Energy (*CMCC*): Production of hydropower and solar energy – ENEL (Italy and Spain)

  - Insurance (*UKMO*) : Risk associated with tropical and extra-tropical cyclones over the Atlantic basin – Willis Towers Watson



ECMWF Copernicus Europe's eyes on Earth European Commission

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Prototype decadal products

https://climate.copernicus.eu/demonstrator-projects

67%

Search

Home / What we do / Sectoral impacts / Demonstrator projects

Demonstrator projects

We create projects to demonstrate how our data and tools can be used to address key climate challenges in different sectors. Working with industry and experts, the demonstrators are designed to focus on specific themes. These projects make data, tools and indicators available in an accessible format to help users make informed adaptation decisions. Within these projects, case studies are developed that show the demonstrators' tools in action.

Current demonstrator projects

MAY 2021

Sectoral applications of decadal predictions

This prototype service provides sector-specific decadal prediction products to real users from the agriculture, energy, infrastructure and insurance sectors to support decision-making on longer timescales of 1-10 years.

SEPTEMBER 2020

Prototype extreme events and attribution service

Extreme weather events often lead to the question: how much was this event influenced by climate change?

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Prototype decadal products

ABOUT | BACKGROUND | SECTORS | OPERATIONAL SERVICE | PROJECT PARTNERS

About

This demonstrator service aims to provide sector-specific decadal prediction products to specific users from four different sectors: agriculture, energy, infrastructure and insurance. Predictions on the decadal timescale (1-10 years) can be used for long-term planning and potentially facilitate the adaptation of different sectors to climate variability and change.

This service works closely with individual stakeholders from each sector to develop decadal predictions for specific variables in the form of four case studies, which can be used in the decision-making and planning processes of the users.

By engaging users from different sectors, this demonstrator service covers a wide range of user needs and provides a broad range of candidate products.

Background

Decadal climate predictions have been developed relatively recently in an attempt to fill the gap between seasonal predictions and climate change projections, i.e. covering the timescale from 1 to 10 years. These predictions are produced using a number of different global climate models, forming a multi-model ensemble. The initial state of the climate system (atmosphere, ocean, etc.) is set by introducing observation-based data in the model. External factors (both natural and anthropogenic) influencing the Earth system are also introduced in the model, such as volcanic aerosols and the rising greenhouse gas concentrations. The model is then run for a period of 10 years to obtain the decadal forecasts. New decadal predictions for the coming 1-10 years are typically produced at the end of each year.

Each climate model forecast is usually run as an ensemble, which includes several climate simulations performed using slightly different initial conditions, allowing the model to explore different possible outcomes and hence assess the prediction uncertainty. These different simulations produce an ensemble of values that can often be transformed into a probabilistic forecast; for example, the forecast will show that there is 70% chance of above average rainfall next year if 70% of the ensemble simulations produced such an anomaly. To evaluate the quality or skill of the decadal predictions, historical initial conditions are used to make

PREDICTION PRODUCTS

- AGRICULTURE >
- ENERGY >
- INFRASTRUCTURE >
- INSURANCE >

USER GUIDANCE

TECHNICAL APPENDIX
Coming soon...

https://climate.copernicus.eu/sectoral-applications-decadal-predictions

Prototype product – example

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headline results

ACE
(accumulated cyclone energy - meteorological measure of collective intensity of storms)

forecast in the context of past cases (two views)

validation (contingency tables)

insured losses

This document provides forecasts of North Atlantic hurricane activity in the coming five years. Forecasts are for total ACE index from North Atlantic tropical cyclones and total insured loss over the USA and Caribbean. The current headline results are:

For the next 5 years (2015-2019):

- **There is a 95% chance of above-average ACE index.**
- **There is a 75% chance of above-average USA and Caribbean insured losses.**

Background Information

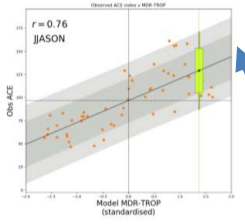
Total ACE index for 2015-2019 (hurricane season)

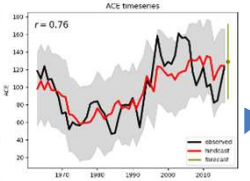
Seven decadal prediction systems, each with 10 ensemble members, have been used to produce this forecast for total ACE index over the next five years (calculated over the June-November North Atlantic hurricane season only). The model index used to predict the hurricane activity is the difference between the air temperature over the sea in the main hurricane development region and the tropics (MDR-TROP). The figure on the right shows the relationship between model hindcast MDR-TROP and observed ACE (HURDAT2) over the period 1963-2016, together with the correlation r and the forecast predicted using that relationship.

Individual years are shown as dots. The solid diagonal line shows the linear regression, with shading showing the 75% and 95% confidence intervals from the fit. The horizontal dotted line shows the climatological mean over this period.

The forecast (in green) is shown as a central estimate (o with vertical line), with uncertainty boxes showing the 75% and 95% confidence limits from the linear regression.

We also show the contingency table (right) for forecasts of above-average ACE index.





Above-average ACE index		Observed: Yes	Observed: No
Predicted	Yes	24 Hits	2 False alarms
	No	3 Misses	25 Correct rejections
Hit Rate:		90%	
False Alarm Rate:		5%	

1 of ??

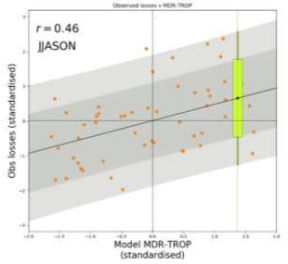
INTERNAL USE ONLY - NOT REAL FORECAST

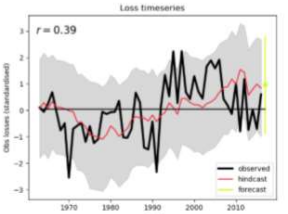
Insured losses for 2015-2019

The figure on the right shows the forecast for total insured losses in the USA and Caribbean for 2015-2019, again using the index MDR-TROP from model ensemble mean as the predictor. The scatter plot shows the relationship between hindcast MDR-TROP and observed insured losses for the period 1963-2016. The horizontal dotted line shows the climatological mean over this period.

The ensemble-mean forecast is again shown in green, with the uncertainty given by the confidence limits on the fit.

The contingency table for forecasts of above-average insured loss is also shown.





...e Copernicus Climate Change Service

Produced 12th May 2020

Above-average 100m wind speed		Observed: Yes	Observed: No
Predicted	Yes	16 Hits	9 False alarms
	No	10 Misses	17 Correct rejections
Hit Rate:		60%	
False Alarm Rate:		35%	

2 of ??

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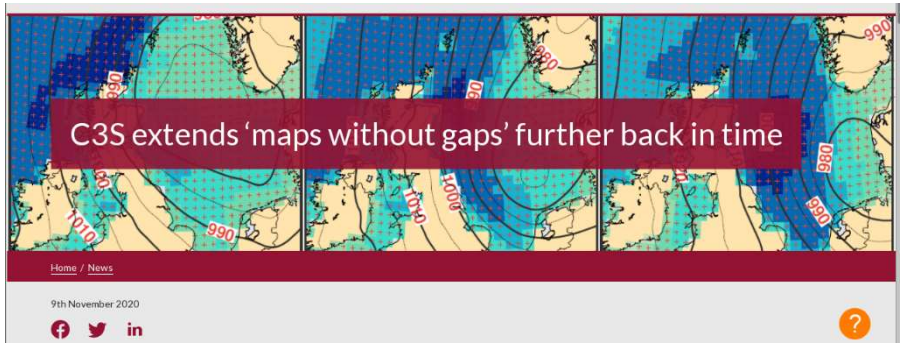
Status C3S Reanalysis: global (ERA5, ERA5-Land) and regional (Europe, Arctic)

ERA5 (global, 31km)

Daily updates 5 days behind real time from 1979 onwards
Preliminary back extension (1950-1978) is available in the CDS
Final back extension is currently in production:

1) 1959-1978: four parallel streams of 5 year each: right now
2) 1950-1958, potentially 1940-1958: after completion of 1)



ERA5-Land (global, dynamical downscaling to 9km)

Available from 1981, updates 2-3 months latency

Back extension from 1950 has completed and is currently being evaluated

European reanalysis (CERRA, 5.5km)

Production is well underway (including a dedicated land component)

Predecessor (UERRA) is available in the CDS

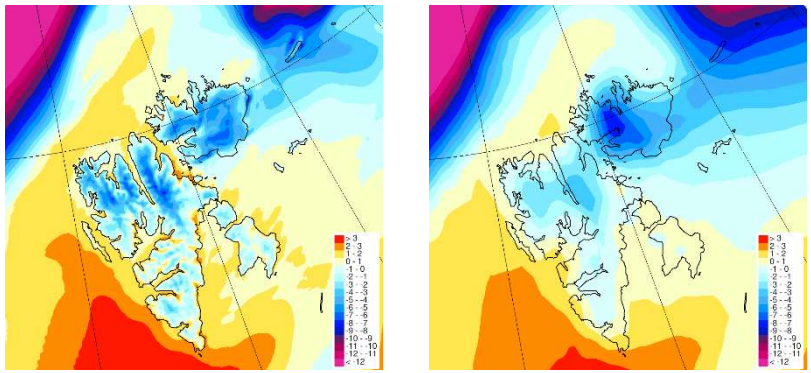
Arctic reanalysis (CARRA, 2 sub-areas, 2.5km)

Period of 1998-2019 (22 years) was recently published in the CDS

A back extension from 1991 should be completed by the end 2021

A pan-Arctic one-year test period has started; a full pan-Arctic is to be produced in COP2.

Near-surface temperature



CARRA ERA5

ECMWF EUROPEAN CENTRE FOR MEDIUM-RANGE WEATHER FORECASTS

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

Reanalysis and climate predictions

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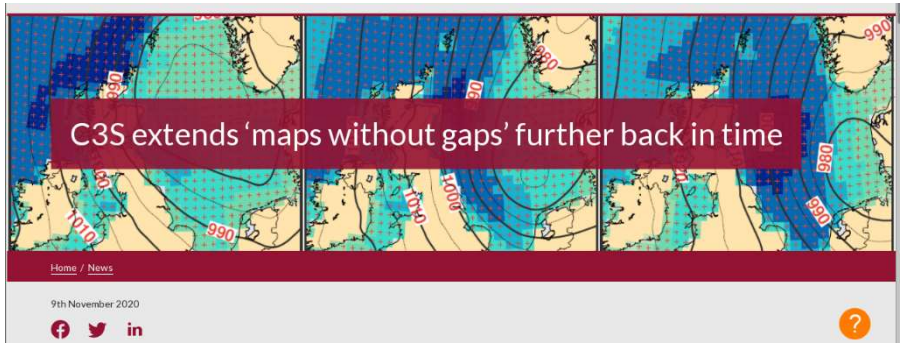

'Value' to climate predictions:

- initialization
- monitoring
- validation
- downscaling, calibration

⇨ **product generation**

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Thank you for your attention