Operational climate predictions: the Copernicus Climate Change Service (C3S)

Climate Change

Anca Brookshaw

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

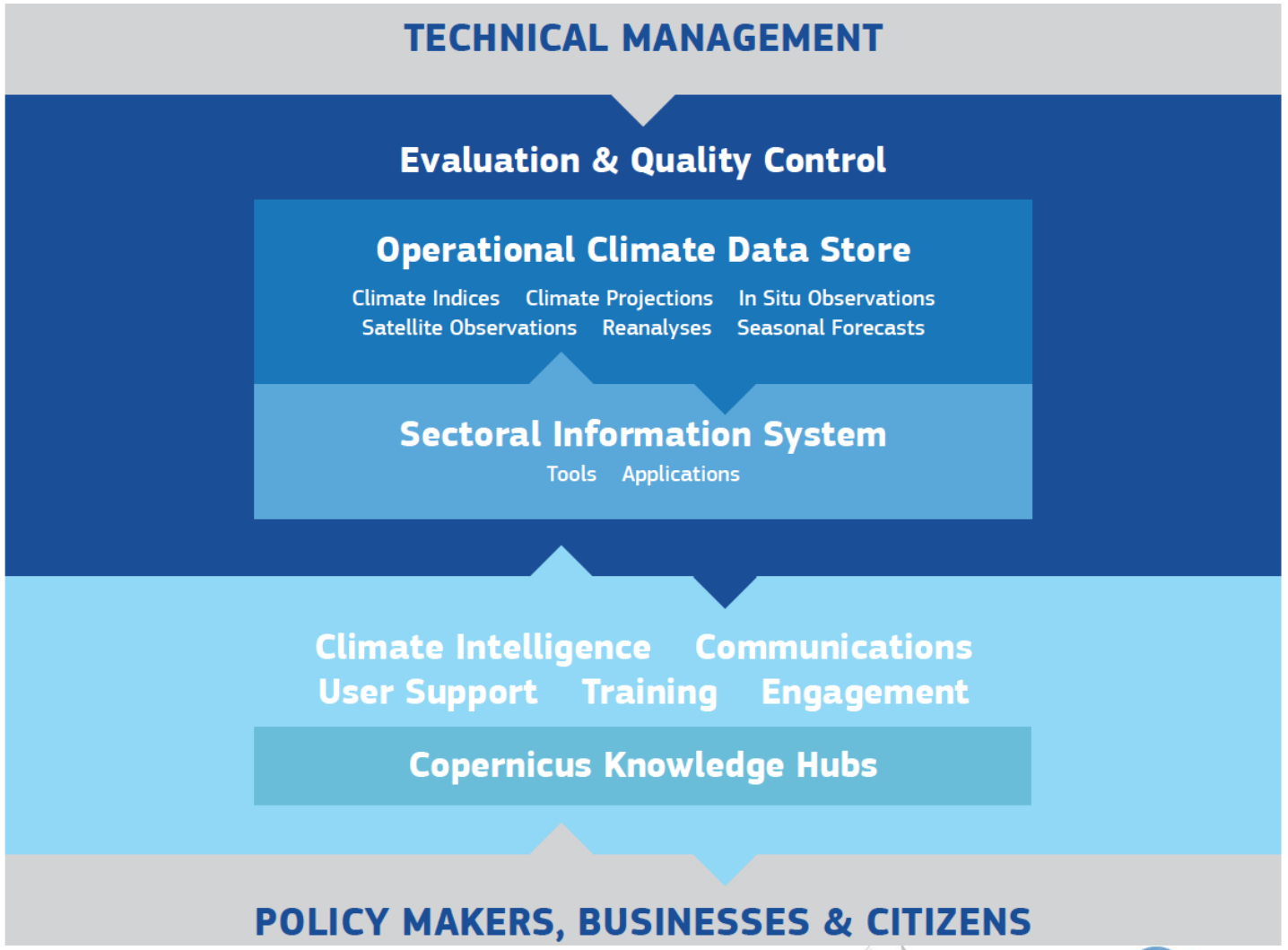
Copernicus Europe's eyes on Earth | European Commission | ECMWF

US CLIVAR Summit - August 2023


Sentinels
In Situ
opernicus
CLIMATE CHANGE
MARINE MONITORING
ATMOSPHERE MONITORING
LAND MONITORING
SECURITY
EMERGENCY MANAGEMENT

Climate Change

C3S in brief



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

C3S seasonal prediction: components

Climate Change

DATA PRODUCTS

cds.climate.copernicus.eu

- Datasets available in the Climate Data Store:

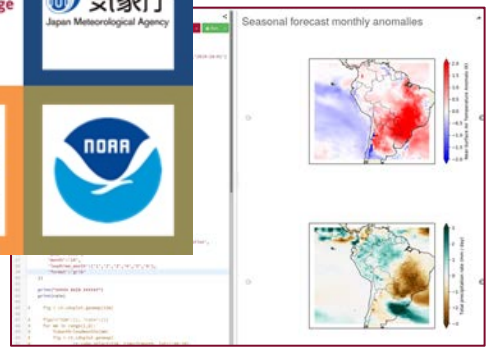
atmosphere

- 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

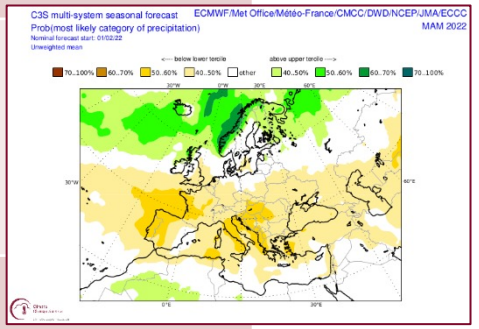


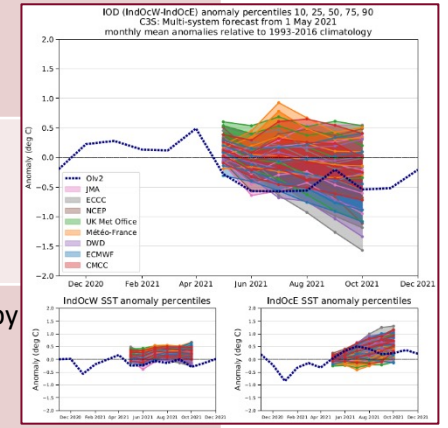
CDS Toolbox

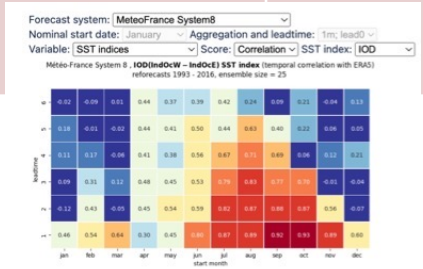
GRAPHICAL PRODUCTS

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
Verification diagnostics	For graphical products published by







C3S seasonal predictions - data products

Climate Change

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 changes in the Earth system over periods of a few weeks or months, as a result of predictable changes in some of the slow-varying components of the system. For example, ocean temperatures typically vary slowly, on timescales of weeks or months; ...

Updated 2023-06-05

Overview | Download data | Quality assessment | Documentation

Clear all

Originating centre

At least one selection must be made

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

System

At least one selection must be made

- 1
- 2
- 3
- 4
- 5
- 6
- 7
- 8
- 12
- 13
- 14
- 15
- 21
- 35
- 600
- 601

Contact

ECMWF Support Portal

Licence

Licence to use Copernicus Products

Additional licence to use non European contributions

Publication date

2018-06-14

Resource updated

2022-05-11

References

DOI: 10.24381/cds.7e37c951

https://cds.climate.copernicus.eu/cdsapp#!/search?type=dataset&keywords=((%20%22Product%20type:%20Seasonal%20forecasts%22%20)%20AND%20(%20%22Variable%20domain:%20Atmosphere%20(surface)%22%20OR%20%22Variable%20domain:%20Ocean%20(physics)%22%20))

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Updated 2023-06-05

Seasonal forecast anomalies on single levels

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

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Updated 2023-06-05

Seasonal forecast monthly averages of ocean variables

Dataset | Global | Seasonal forecasts | Ocean (physics)

This entry covers global ocean data aggregated to a monthly time resolution. The catalogue entry includes temperature and salinity characteris
for the land and atmospheric variables. Seasonal forecasts provide a long-range outlook of changes in the Earth system over periods of a few v

Updated 2023-06-05

Seasonal forecast subdaily data on pressure levels

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

This entry covers pressure-level data at the original time resolution (once every 12 hours). Seasonal forecasts provide a long-range outlook of c
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Seasonal forecast monthly statistics on pressure levels

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Updated 2023-06-05

Seasonal forecast daily and subdaily data on single levels

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

This entry covers single-level data at the original time resolution (once a day, or once every 6 hours, depending on the variable). Seasonal forec
weeks or months, as a result of predictable changes in some of the slow-varying components of the system. For example, ocean temperatures

Updated 2023-06-05

Variable

At least one selection must be made

- [ ] 10m u-component of wind
- [ ] 10m v-component of wind
- [ ] 10m wind gust since previous post-processing
- [ ] 2m dewpoint temperature
- [ ] 2m temperature
- [ ] Eastward turbulent surface stress
- [ ] Evaporation
- [ ] Land-sea mask
- [ ] Maximum 2m temperature in the last 24 hours
- [ ] Mean sea level pressure
- [ ] Minimum 2m temperature in the last 24 hours
- [ ] Northward turbulent surface stress
- [ ] Orography
- [ ] Runoff
- [ ] Sea surface temperature
- [ ] Sea-ice cover
- [ ] Snow density
- [ ] Snow depth
- [ ] Snowfall
- [ ] Soil temperature level 1
- [ ] Sub-surface runoff
- [ ] Surface latent heat flux
- [ ] Surface net solar radiation
- [ ] Surface net thermal radiation
- [ ] Surface runoff
- [ ] Surface sensible heat flux
- [ ] Surface solar radiation downwards
- [ ] Surface thermal radiation downwards
- [ ] TOA incident solar radiation
- [ ] Top net solar radiation
- [ ] Top net thermal radiation
- [ ] Total cloud cover
- [ ] Total column cloud ice water
- [ ] Total column cloud liquid water
- [ ] Total column water vapour
- [ ] Total precipitation

Select all

Year

At least one selection must be made

1981	1982	1983	1984	1985	1986
1987	1988	1989	1990	1991	1992
1993	1994	1995	1996	1997	1998
1999	2000	2001	2002	2003	2004
2005	2006	2007	2008	2009	2010
2011	2012	2013	2014	2015	2016
2017	2018	2019	2020	2021	2022
2023					

Select all

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

C3S seasonal predictions - data products

Climate Change

Seasonal forecast anomalies on pressure levels

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

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Updated 2023-06-05

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Seasonal forecast daily and subdaily data on single levels

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

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The variables available in this data set are listed in the table below. The data includes forecasts created in real-time (since 2017) and retrospective forecasts (hindcasts) initialised at equivalent intervals during the period 1993-2016.

More details about the products are given in the Documentation section.

DATA DESCRIPTION	
Data type	Gridded
Projection	Regular latitude-longitude grid
Horizontal coverage	Global
Horizontal resolution	1° x 1°
Vertical coverage	From 1000 hPa to 10 hPa
Temporal coverage	1993 to 2016 (hindcasts); 2017 to present (forecasts)
Temporal resolution	12-hourly
File format	GRIB
Update frequency	Real-time forecasts are released once per month on the 6th at 12UTC for ECMWF and on the 10th at 12 UTC for the other originating centres.

MAIN VARIABLES	
Name	Units
Geopotential	$m^2 s^{-2}$
Specific humidity	$kg kg^{-1}$
Temperature	K
U-component of wind	$m s^{-1}$
V-component of wind	$m s^{-1}$

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

C3S seasonal predictions - data products

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Seasonal forecast anomalies on pressure levels

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Updated 2023-06-05

Seasonal forecast subdaily data on pressure levels

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

This entry covers pressure-level data at the original time resolution (once every 12 hours). Seasonal forecasts provide a long-range outlook of changes in th predictable changes in some of the slow-varying components of the system. For example, ocean temperatures typically vary slowly, on timescales of weeks

Updated 2023-06-05

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Updated 2023-06-05

Variable

At least one selection must be made

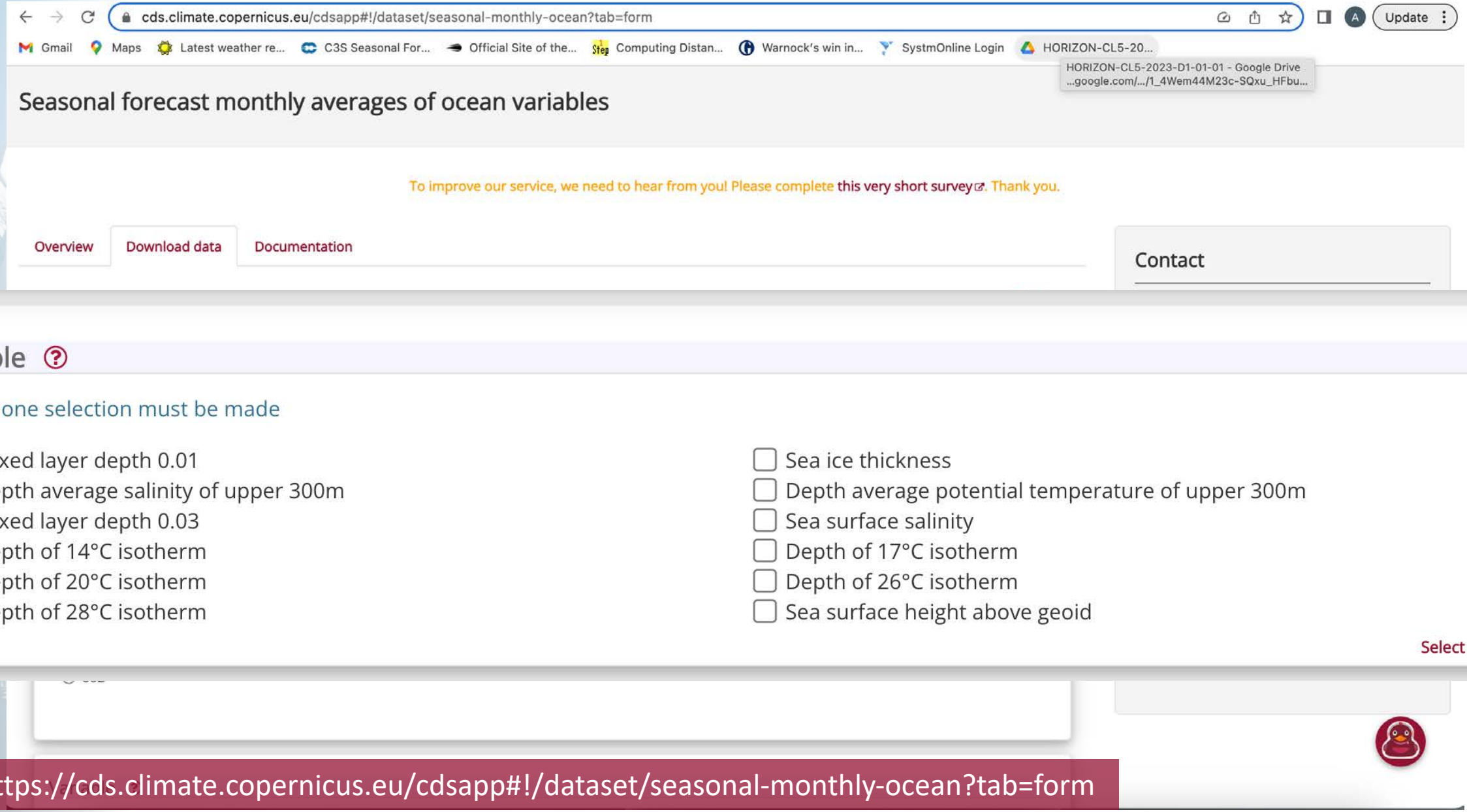
- [ ] 10m u-component of wind anomaly
- [ ] 10m v-component of wind anomaly
- [ ] 10m wind gust anomaly
- [ ] 10m wind speed anomaly
- [ ] 2m dewpoint temperature anomaly
- [ ] 2m temperature anomaly
- [ ] East-west surface stress anomalous rate of accumulation
- [ ] Evaporation anomalous rate of accumulation
- [ ] 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

Climate Change

New seasonal forecast data from ocean model



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

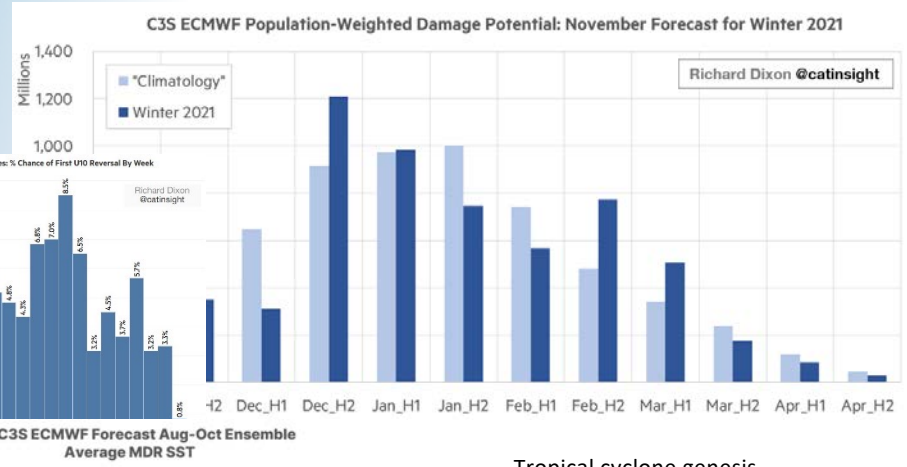
C3S seasonal prediction data - documentation

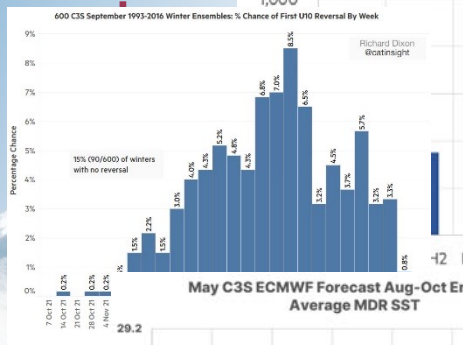
Climate Change

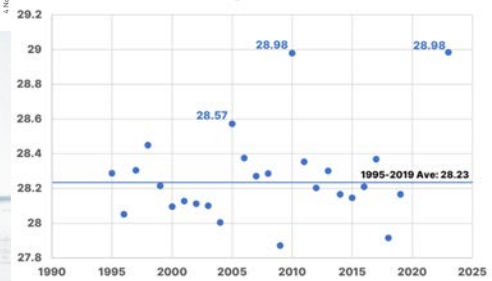
Status on 13 Feb 2022	Time range (forecasts and hindcasts)	Forecast initial conditions	Forecast ensemble size	Hindcast initial conditions	Hindcasts ensemble size	Hindcast period	Hindcast production schedule
ECMWF (ecmf)	215 days	1st of month	51 members	1st of month	25	1981-2016	fixed
UKMO (egrr)	215 days	each day of month	2 members/day[4]	1st, 9th, 17th, 25th of month	7 members/start time	1993-2016	on-the-fly[1]
Météo-France[3] (lfpw)	7 calendar months	last and penultimate Thursday of previous month 1st of month	25 members each 1 member	last and penultimate Thursday of previous month 1st of month	12 members each 1 member	1993-2018	fixed
DWD (edzw)	6 calendar months	1st of month	50 members	1st of month	30 members	1993-2019	fixed
CMCC (cmcc)	6 calendar months	1st of month	50 members	1st of month	40 members	1993-2016	fixed
NCEP (kwbc)	215 days	each day of month members initialised every 6 hours (at 0h, 6h, 12h and 18h UTC)	4 members/day	every 5 days [5] members initialised every 6 hours (at 0h, 6h, 12h and 18h UTC)	4 members/start date	1993-2016	fixed
JMA (rjtd)	215 days	every day of month	5 members/day	2 start dates lagged by 15 days [6]	5 members/start date	1993-2016	fixed
ECCC (cwao) [7] CanCM4i (component of CanSIPSv2.1)	214 days	1st of the month	10 members	1st of the month	10 members	1993-2020	fixed
ECCC (cwao) [7] GEM5-NEMO (component of CanSIPSv2.1)	214 days	1st of the month	10 members	1st of the month	10 members	1993-2020	fixed

C3S predictions in user diagnostics

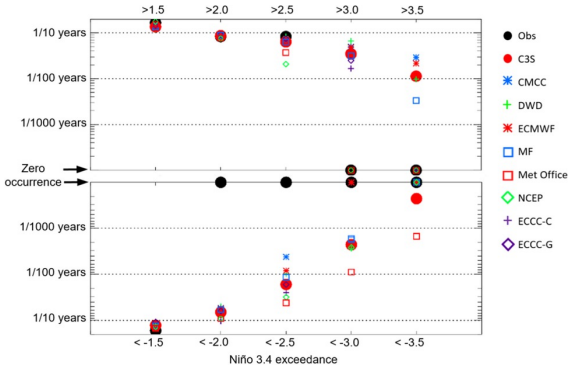
Climate Change





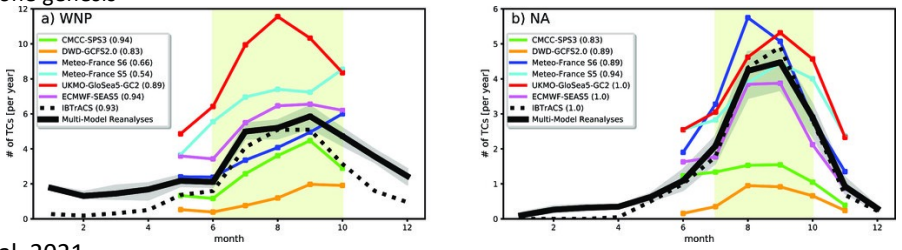


Richard Dixon @catinsight



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

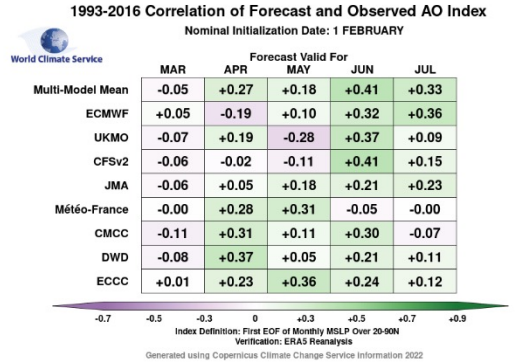
Tropical cyclone genesis



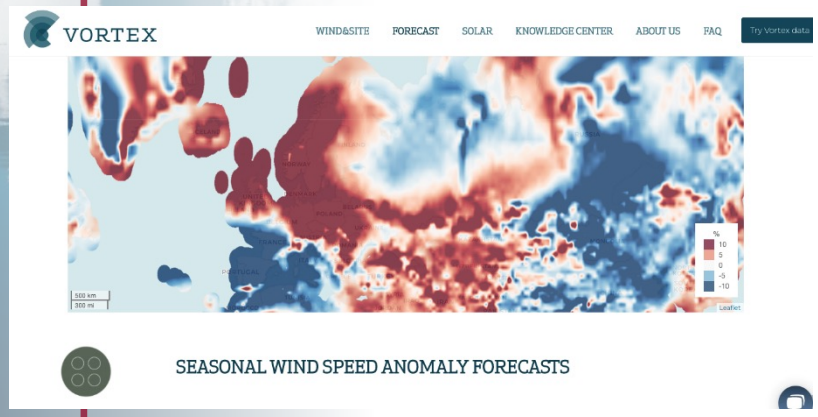
D.Befort et al, 2021

World Climate Service @WorldClimateSvc

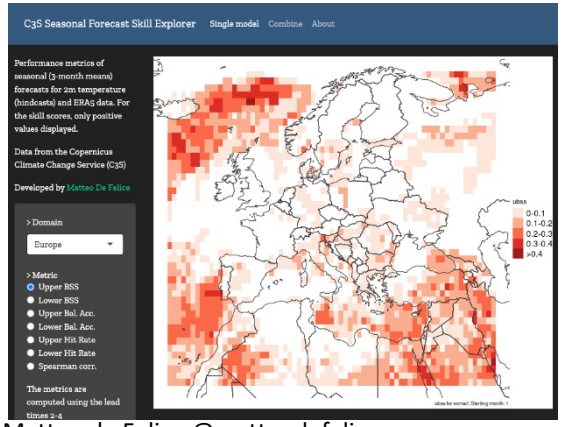
	MAR 2022	APR 2022	MAY 2022	JUN 2022	JUL 2022
Multi-Model Mean	-25.0	-22.8	-15.0	-4.7	+1.7
ECMWF	-22.8	-15.6	-5.7	-1.7	-1.4
UKMO	-30.7	-30.1	-17.3	+0.9	+11.0
CFSv2	NA	NA	NA	NA	NA
JMA	-28.5	-27.7	-17.1	-1.5	+5.1
Météo-France	-26.0	-24.6	-20.0	-8.8	+3.2
CMCC	-21.7				
DWD	-26.4				
ECCC	-18.7				



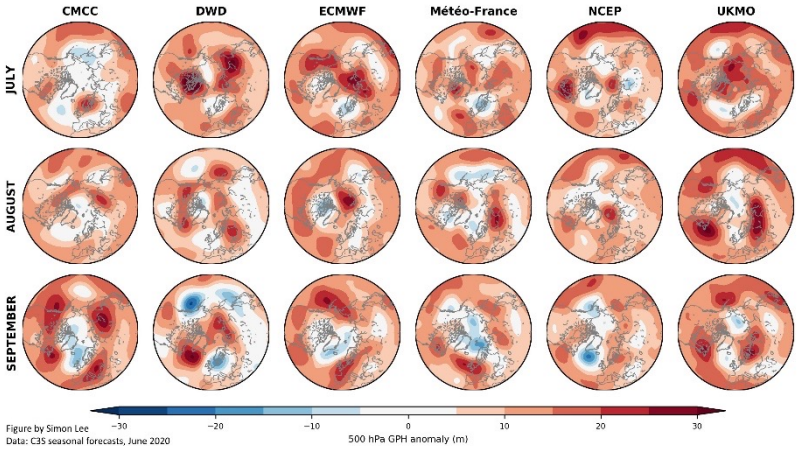
	MAR	APR	MAY	JUN	JUL
Multi-Model Mean	-0.05	+0.27	+0.18	+0.41	+0.33
ECMWF	+0.05	-0.19	+0.10	+0.32	+0.36
UKMO	-0.07	+0.19	-0.28	+0.37	+0.09
CFSv2	-0.06	-0.02	-0.11	+0.41	+0.15
JMA	-0.06	+0.05	+0.18	+0.21	+0.23
Météo-France	-0.00	+0.28	+0.31	-0.05	-0.00
CMCC	-0.11	+0.31	+0.11	+0.30	-0.07
DWD	-0.08	+0.37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



Vortex @VortexFdC



Matteo de Felice @matteodefelice

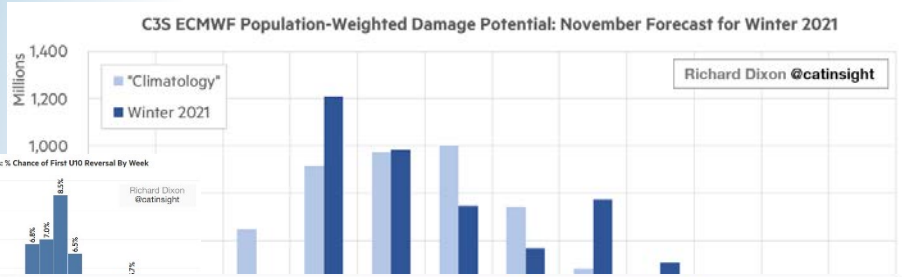


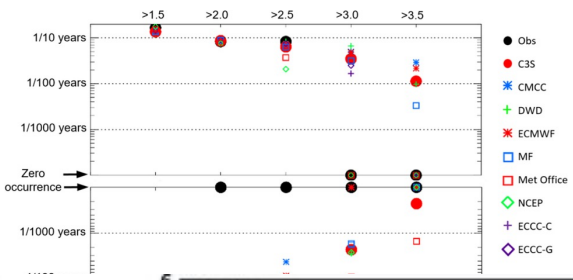
Simon Lee @SimonLeeWx

assembled by E Penabad

C3S predictions in user diagnostics

Climate Change

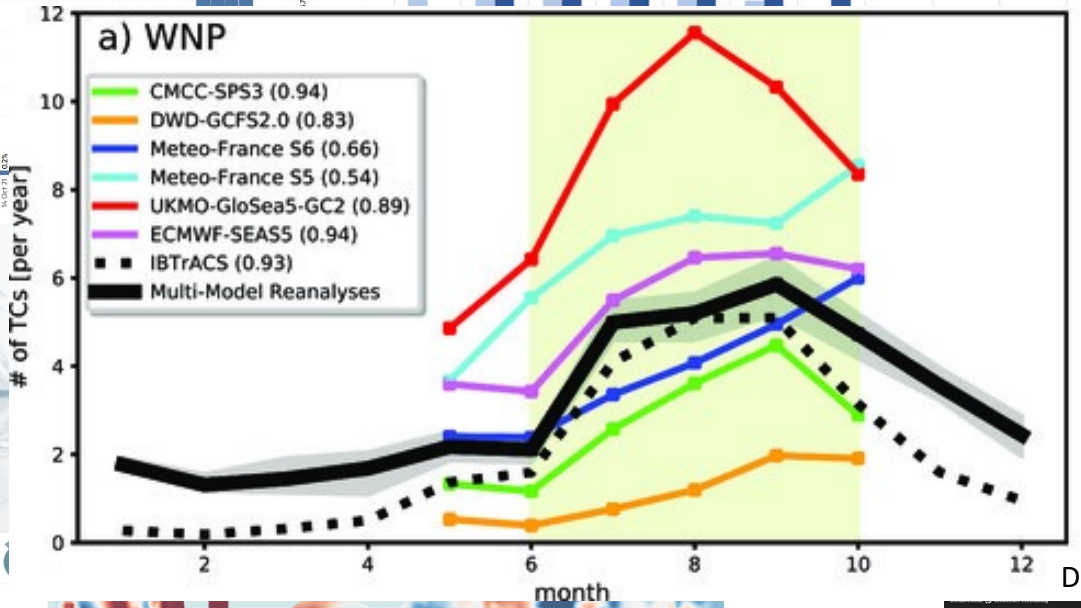


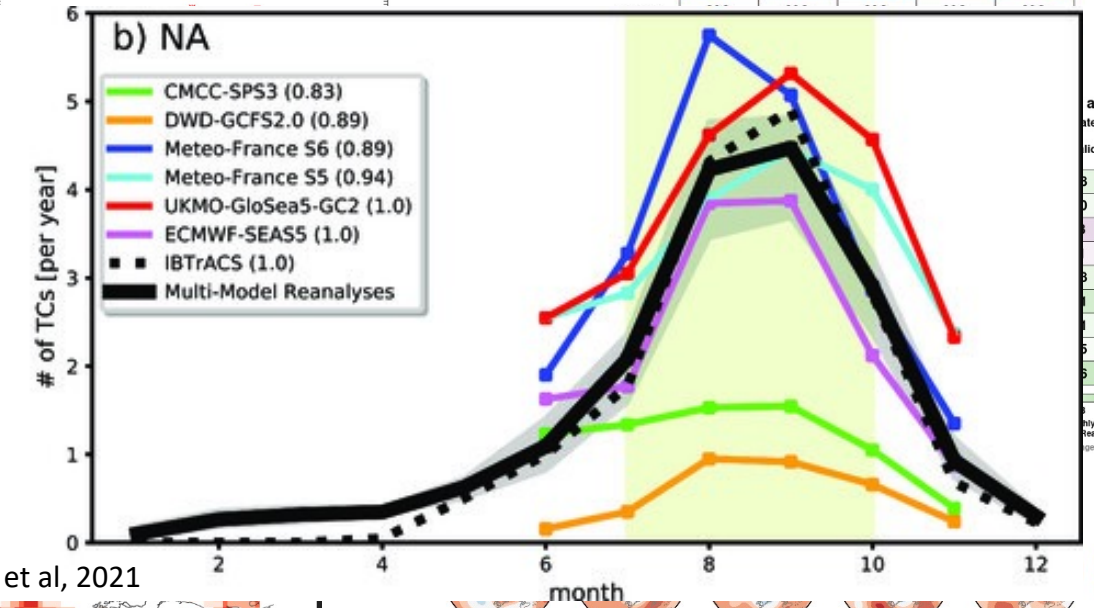


World Climate Service @WorldClimateSvc

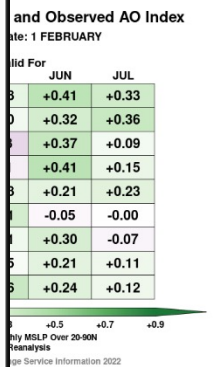
Ensemble Mean Forecast QBO Index
Nominal Initialization Date: 1 FEB 2022

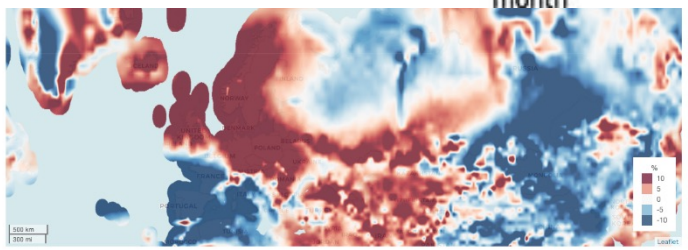
	MAR 2022	APR 2022	MAY 2022	JUN 2022	JUL 2022
Multi-Model Mean	-25.0	-22.8	-15.0	-4.7	+1.7
ECMWF	-22.8	-15.6	-5.7	-1.7	-1.4
UKMO	-30.7	-30.1	-17.3	+0.9	+11.0



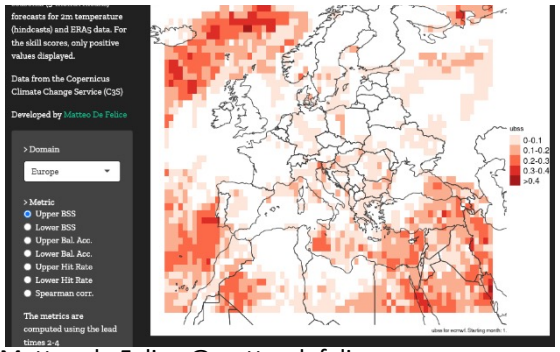


D.Befort et al, 2021

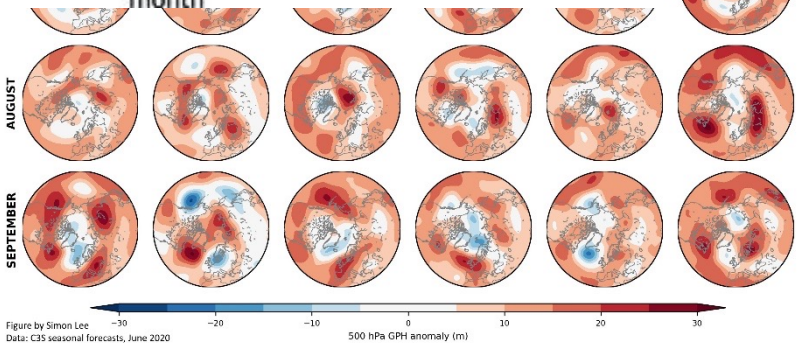




Vortex @VortexFdC



Matteo de Felice @matteodefelice

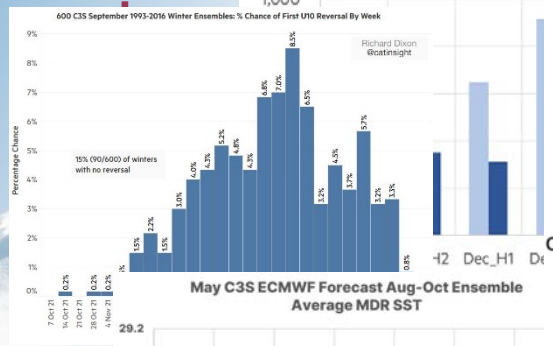


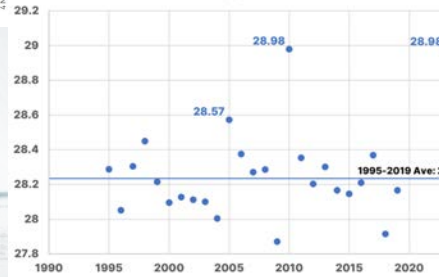
Simon Lee @SimonLeeWx

assembled by E Penabad

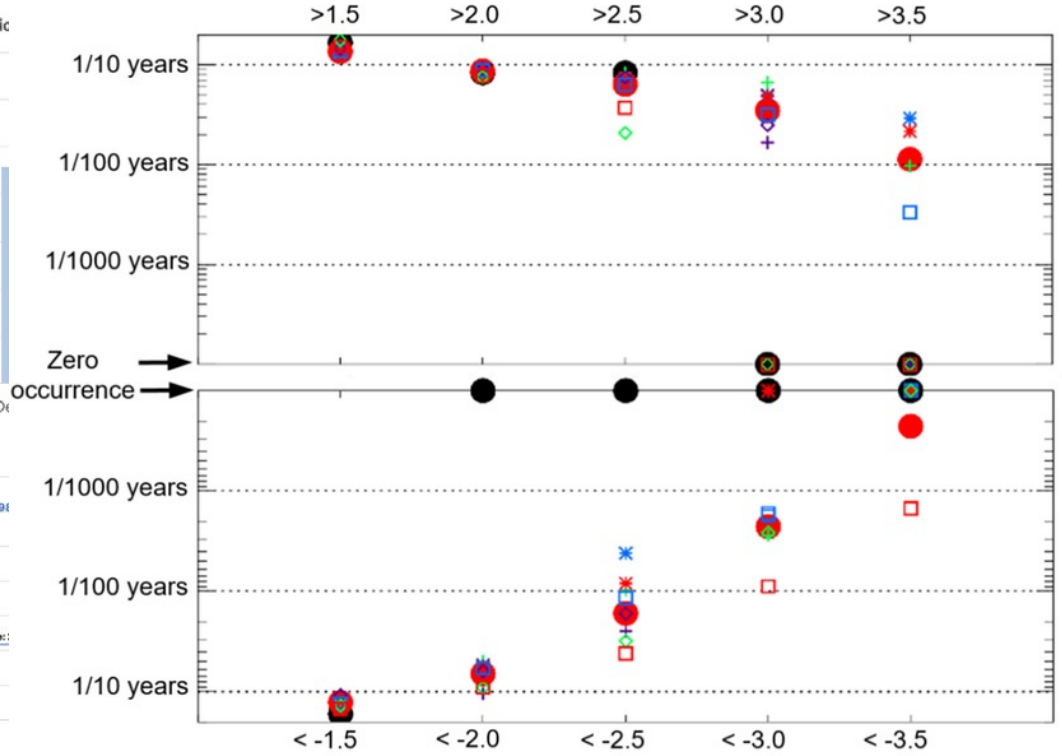
C3S predictions in user diagnostics

Climate Change

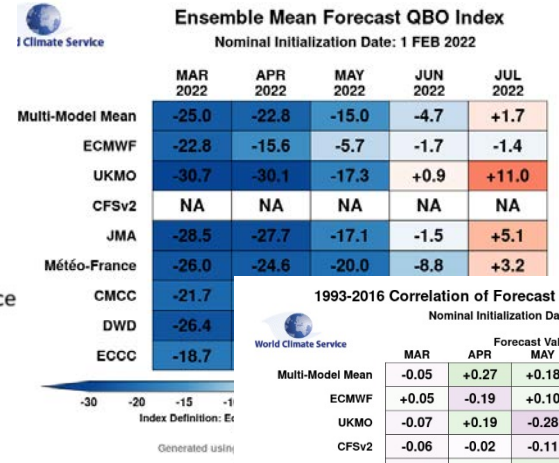


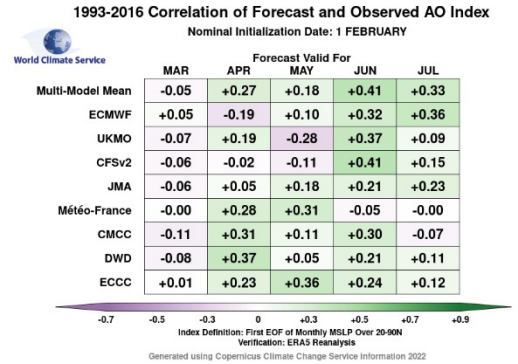


Richard Dixon @catins

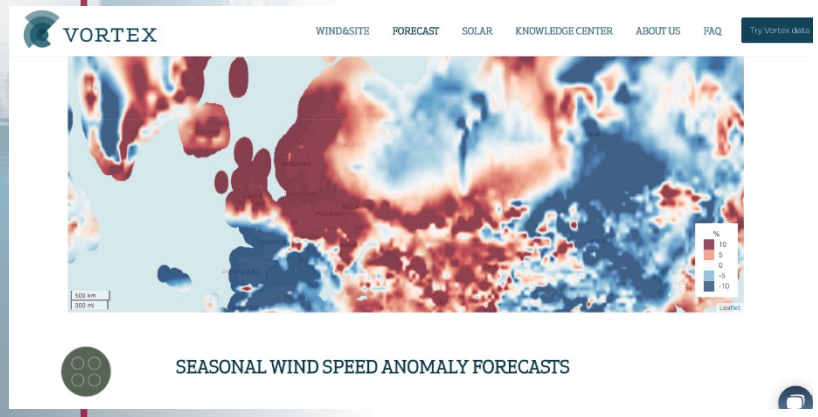


orld Climate Service @WorldClimateSvc

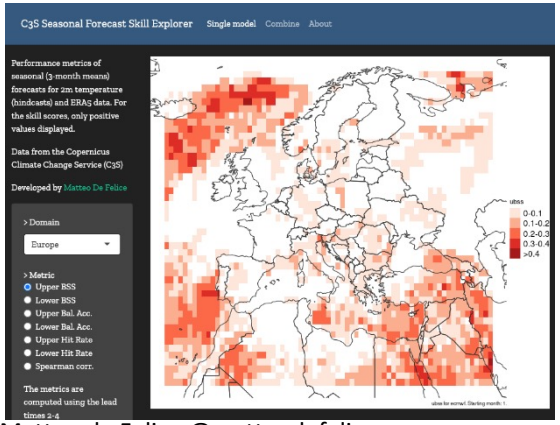




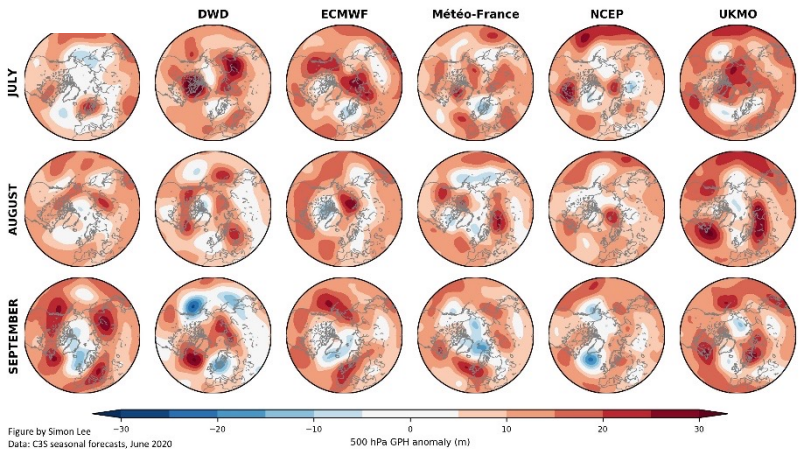
Merryfield and Lee, 2023
Asia-Pac. Journ. Atmos. Sci.



Vortex @VortexFdC



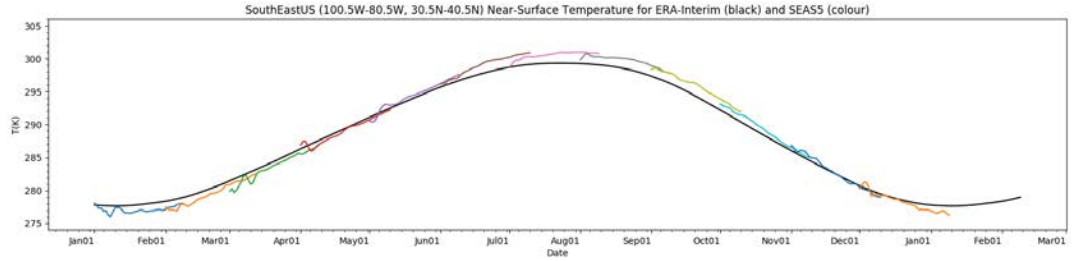
Matteo de Felice @matteodefelice

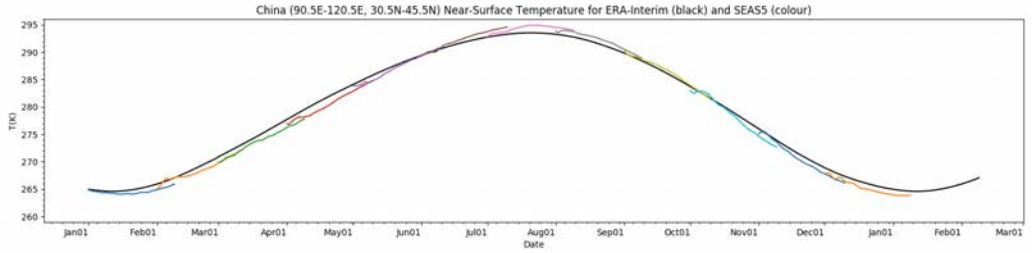


Simon Lee @SimonLeeWx

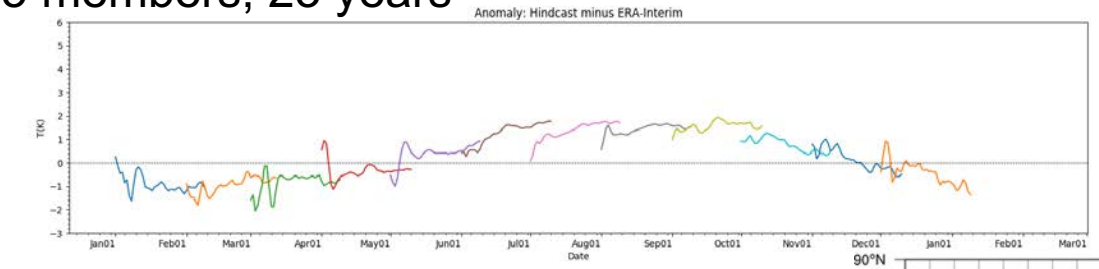
assembled by E Penabad

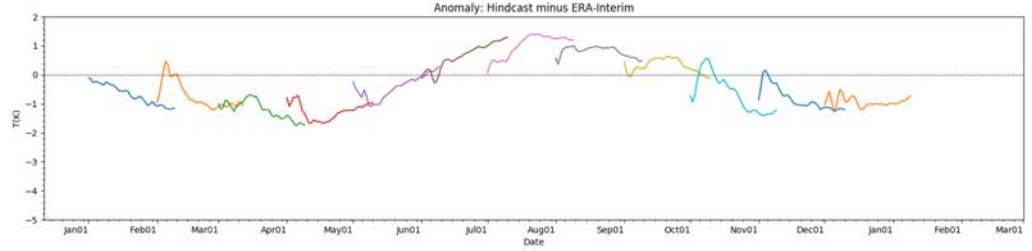
Diagnose systematic forecast errors

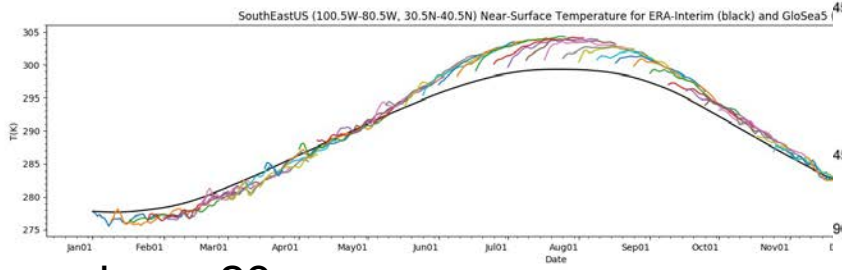


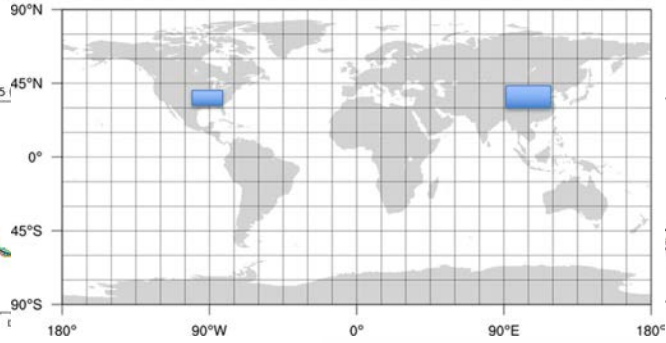


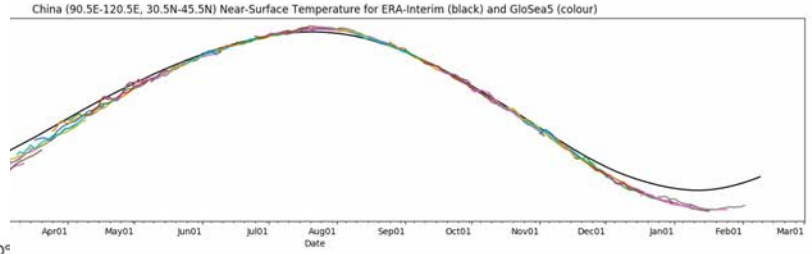
25 members, 23 years



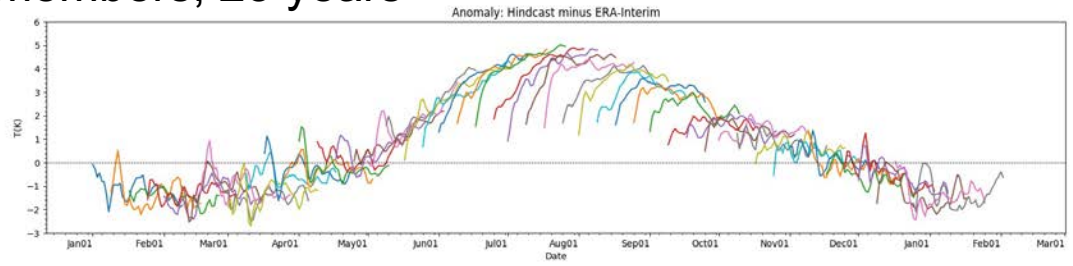


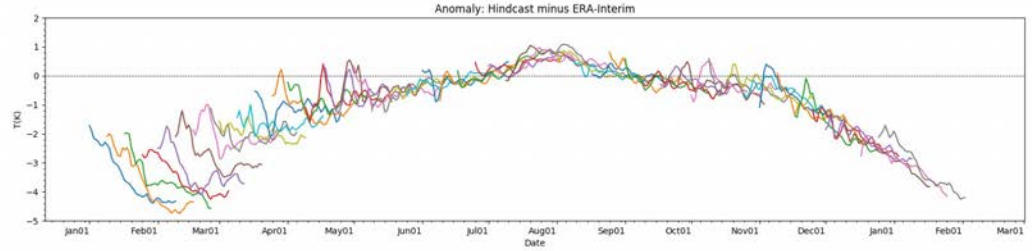




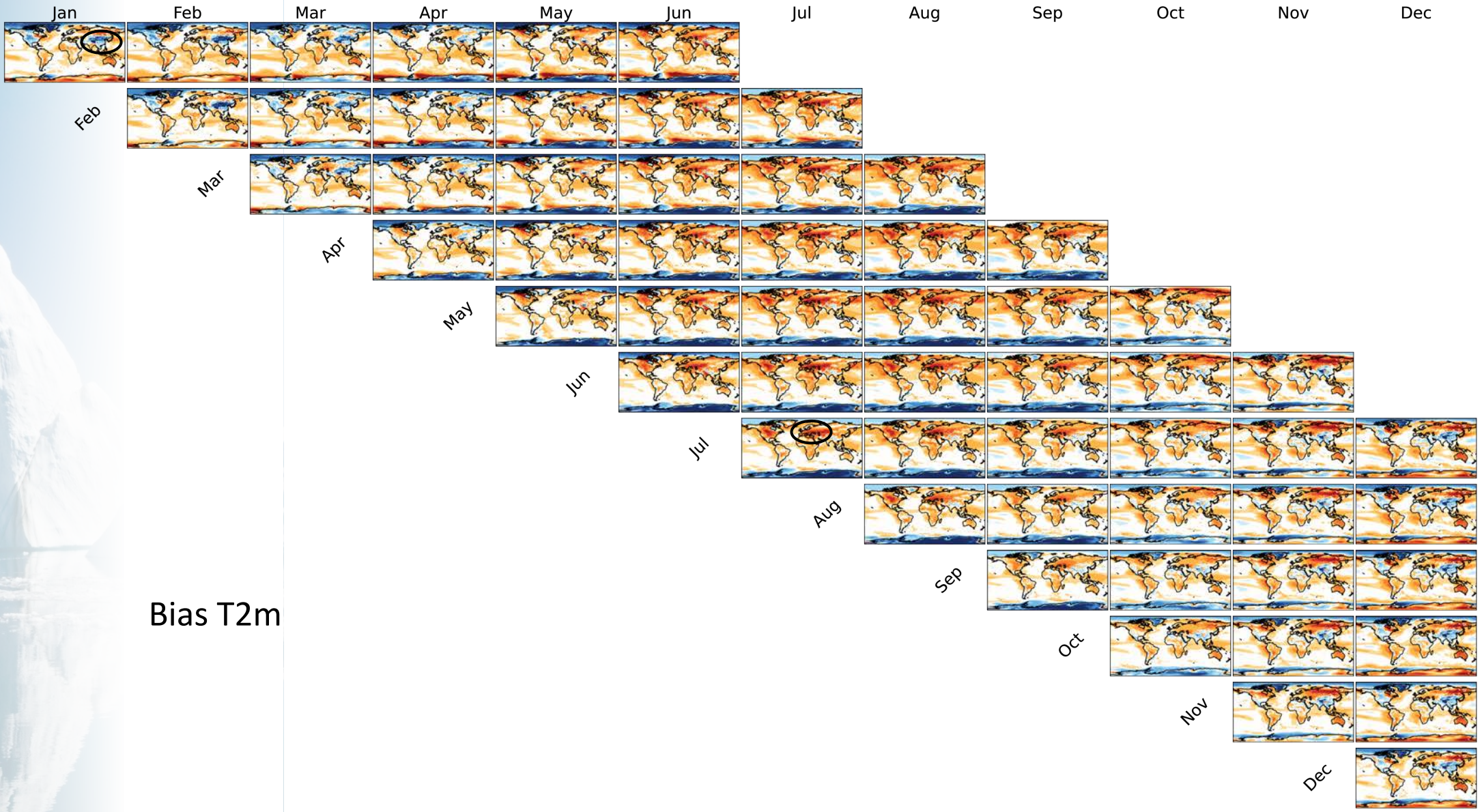


7 members, 23 years





Climate Change

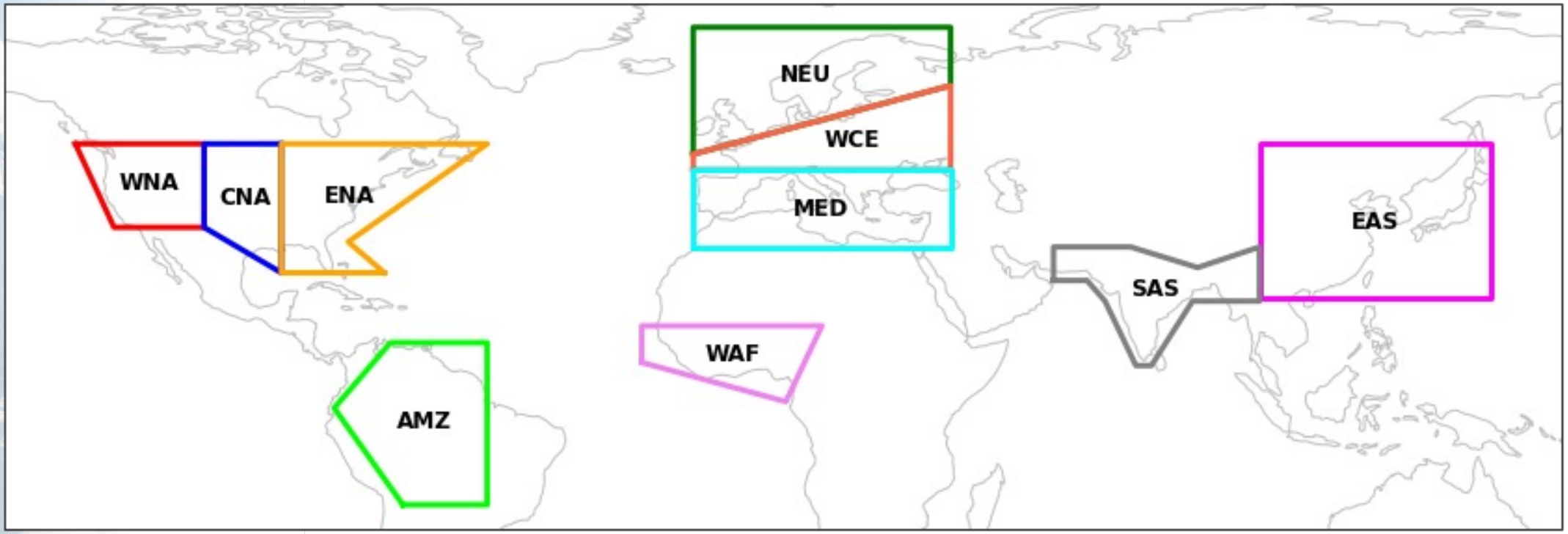


ECMWF Copernicus Europe's eyes on Earth European Commission

Daniel Befort

Diagnose systematic forecast errors

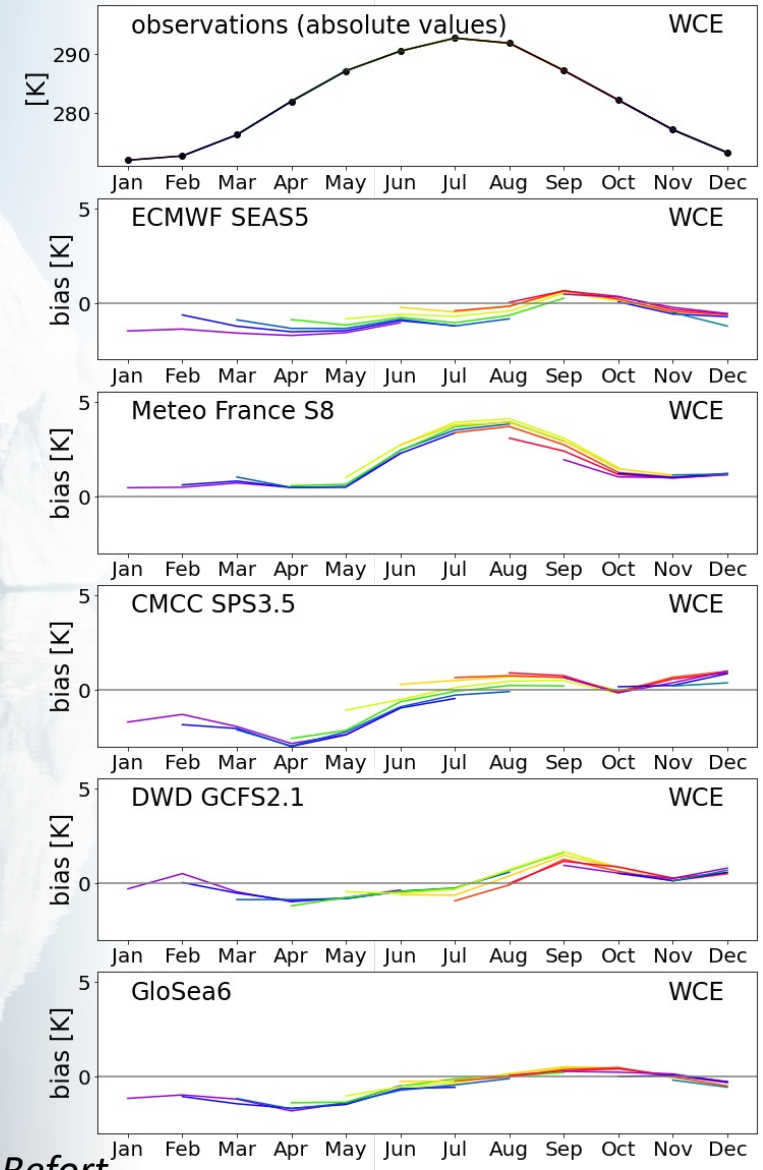
Regional analysis

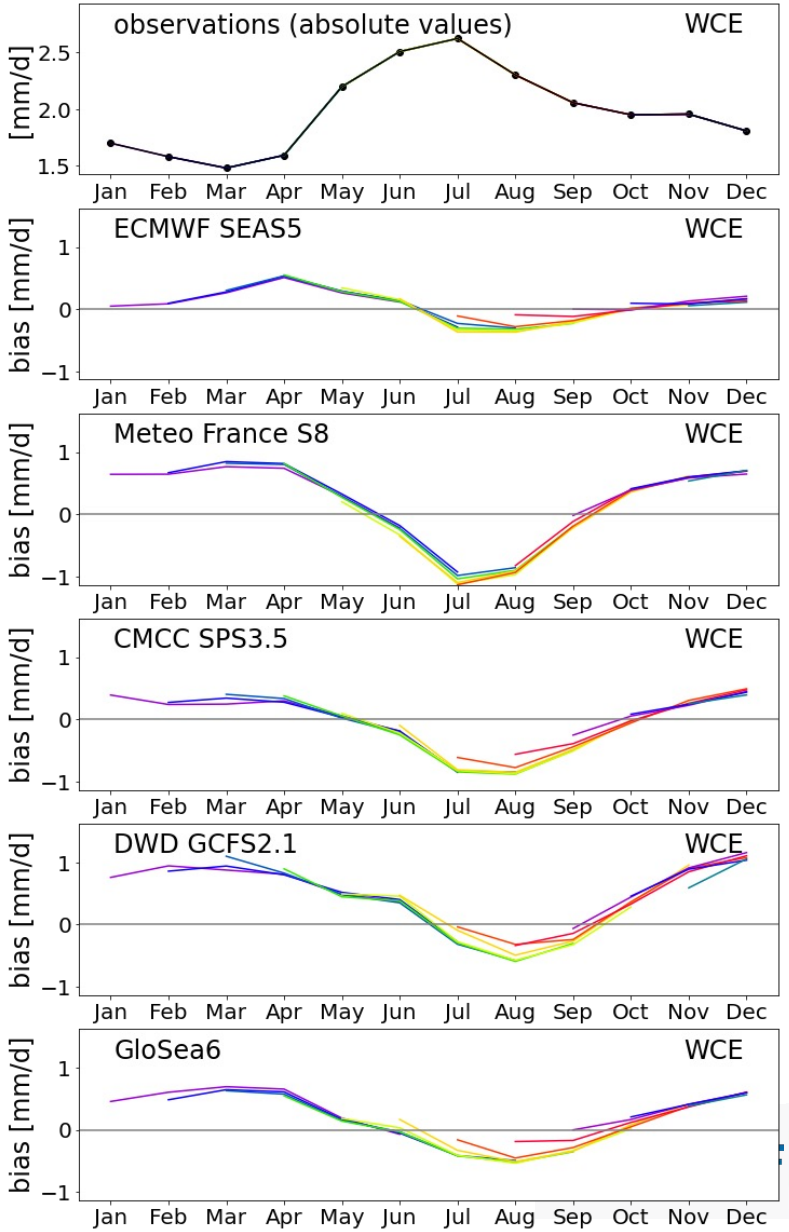


Daniel Befort

Climate Change

Lead- and start-time dependence of bias





WCE

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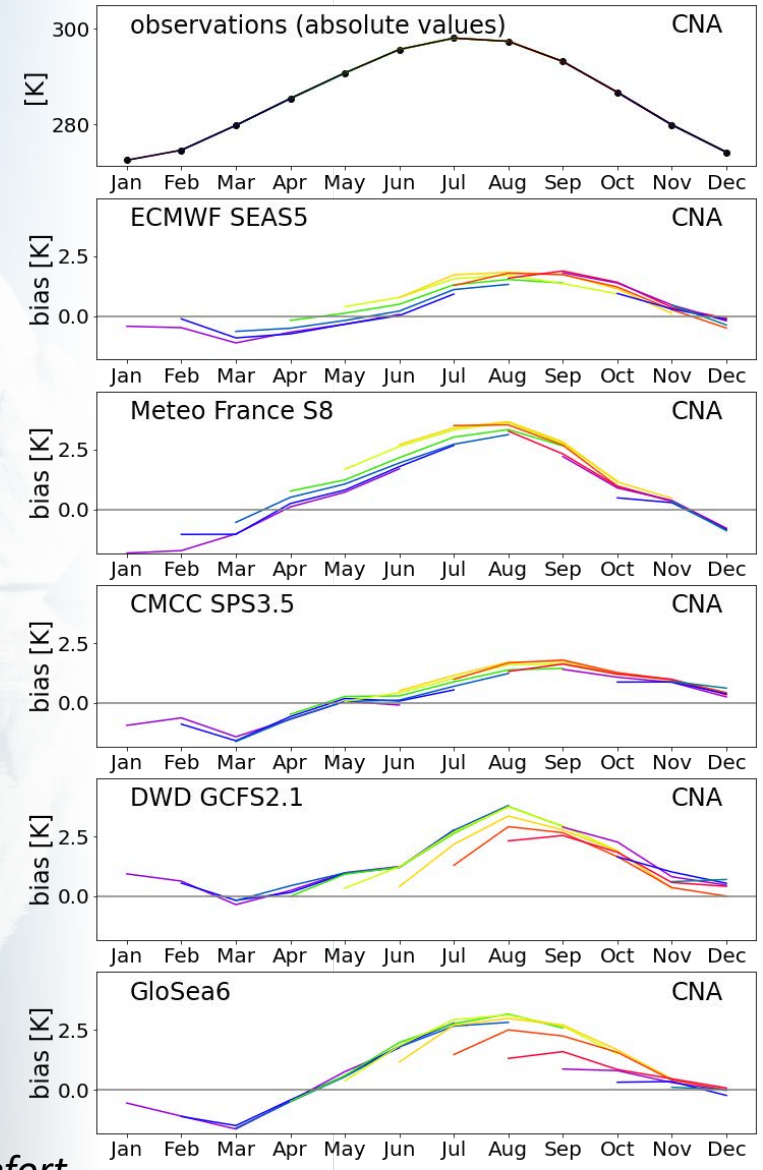
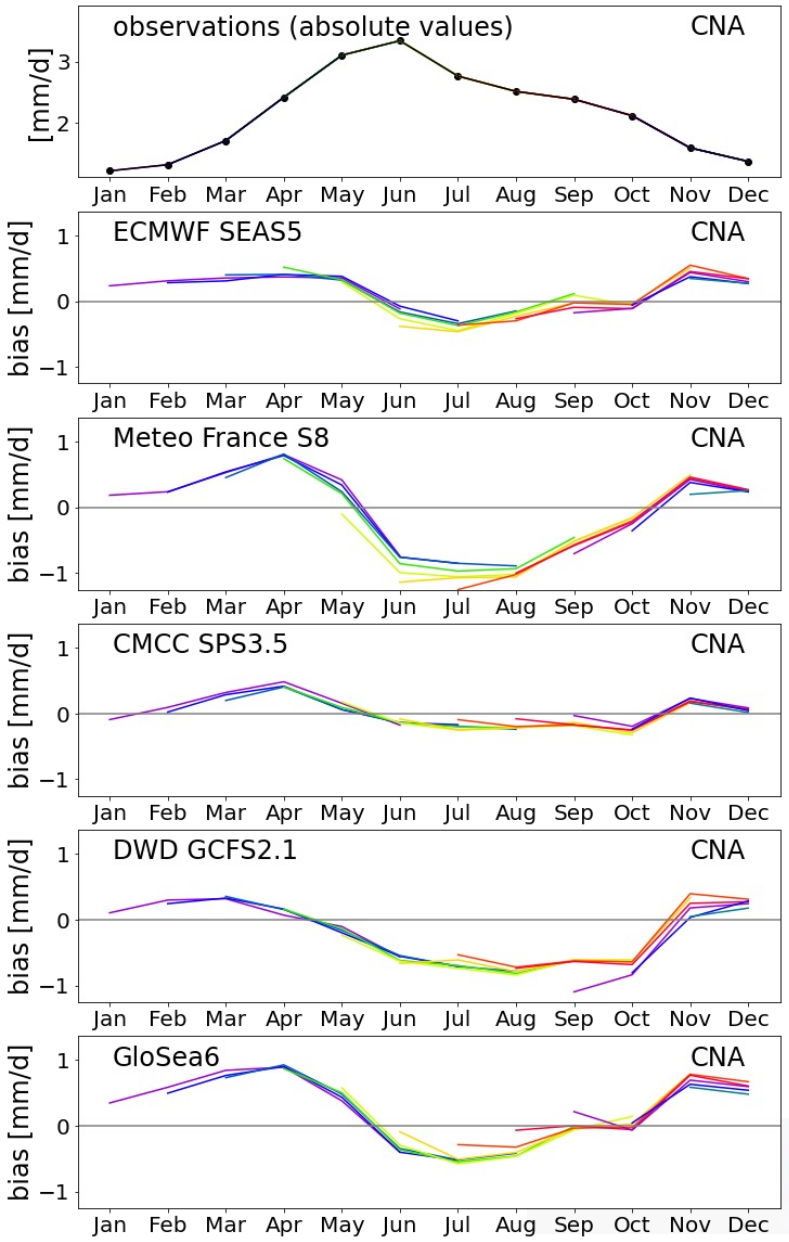
Lead- and start-time dependence of bias

Climate Change



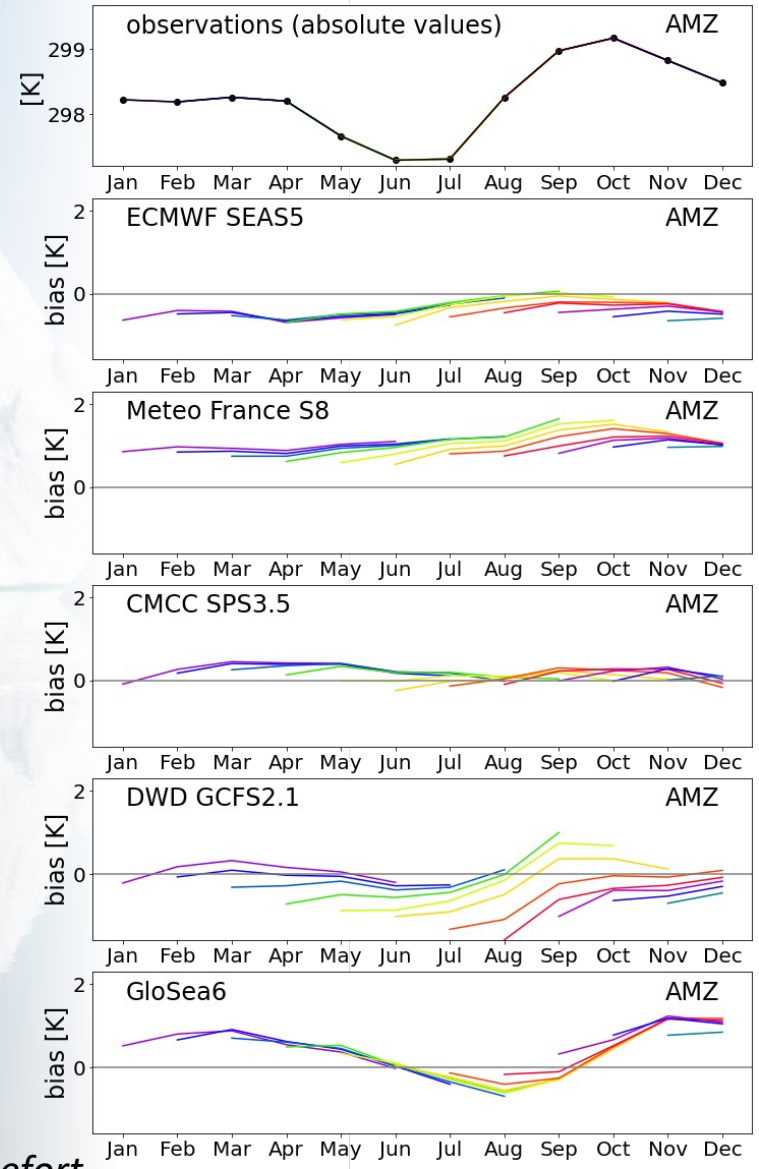


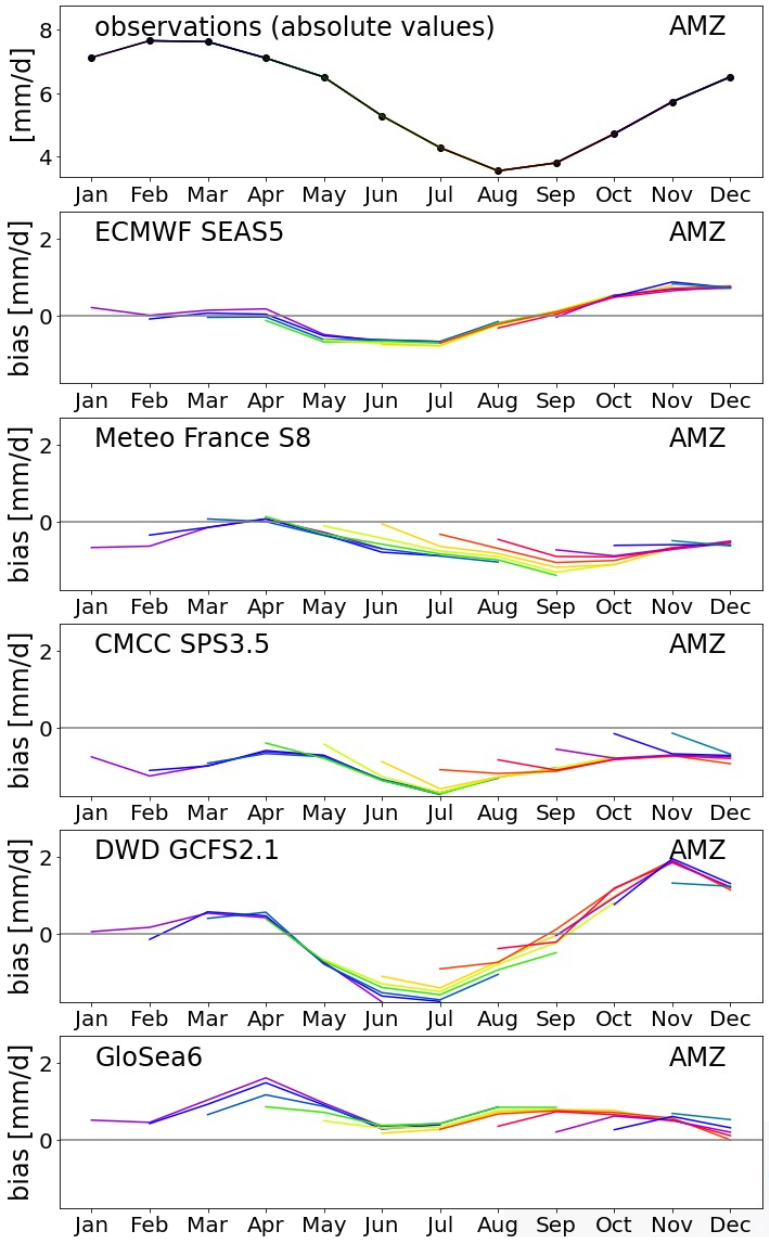
CNA

Daniel Befort

Lead- and start-time dependence of bias

Climate Change





AMZ

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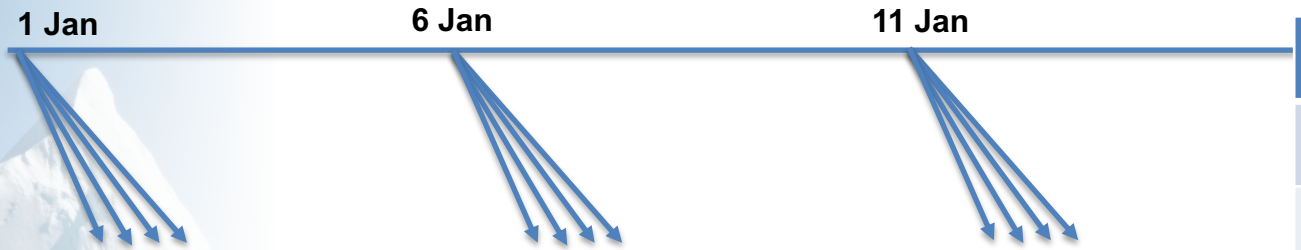
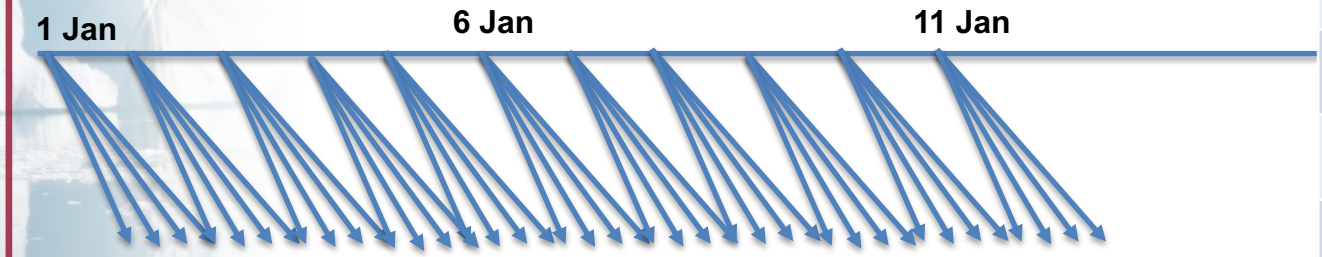
Climate Change

Developing products from lagged-start ensembles; NCEP CFSv2 example



Hindcast: 4 members each time



Real-time forecast: 4 members each day

Dates of hindcast initial conditions	
Jan	1, 6, 11, 16, 21, 26, 31
Feb	5, 10, 15, 20, 25
Mar	2, 7, 12, 17, 22, 27
Apr	1, 6, 11, 16, 21, 26
May	1, 6, 11, 16, 21, 26, 31
Jun	5, 10, 15, 20, 25, 30
Jul	5, 10, 15, 20, 25, 30
Aug	4, 9, 14, 19, 24, 29
Sep	3, 8, 13, 18, 23, 28
Oct	3, 8, 13, 18, 23, 28
Nov	2, 7, 12, 17, 22, 27
Dec	2, 7, 12, 17, 22, 27