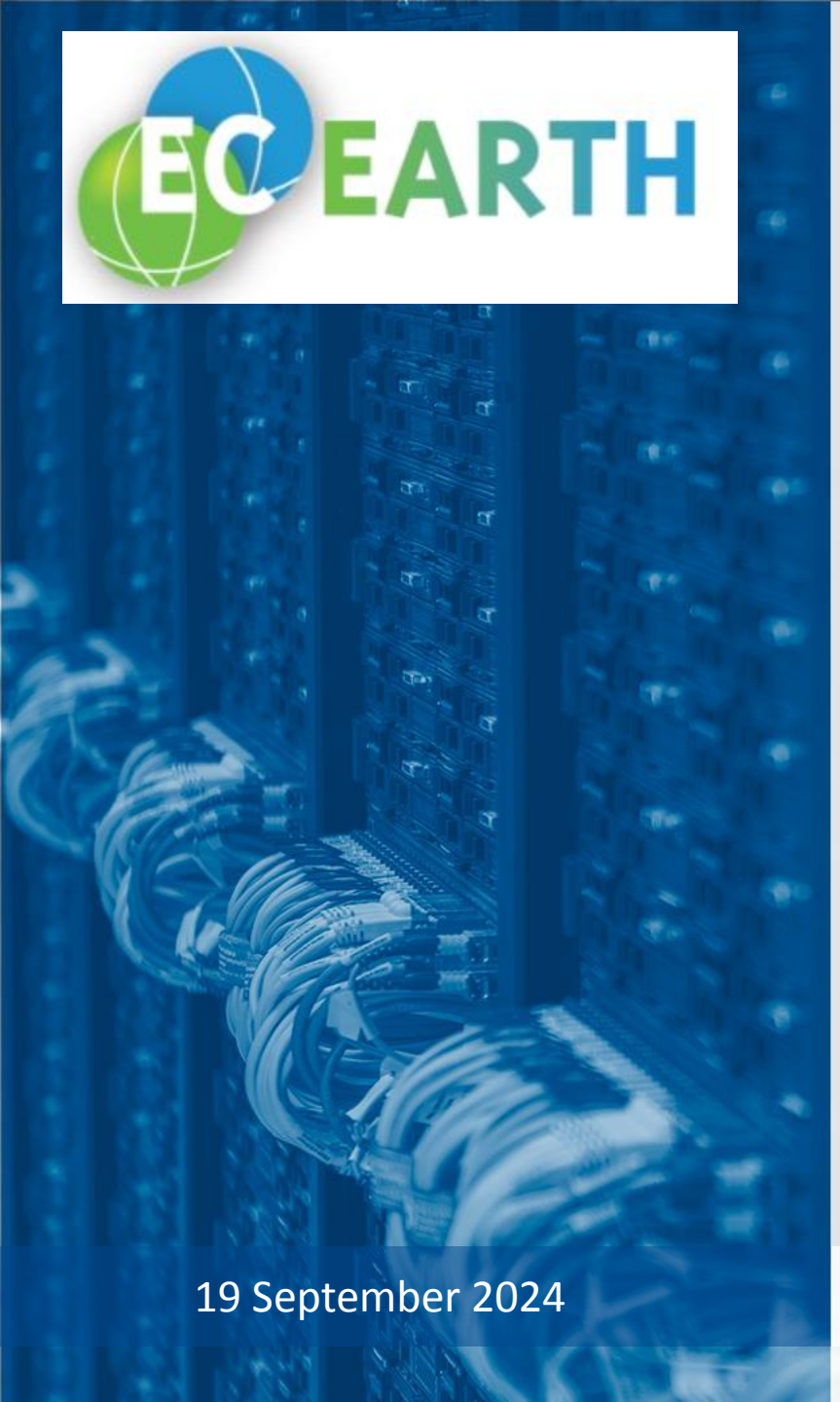


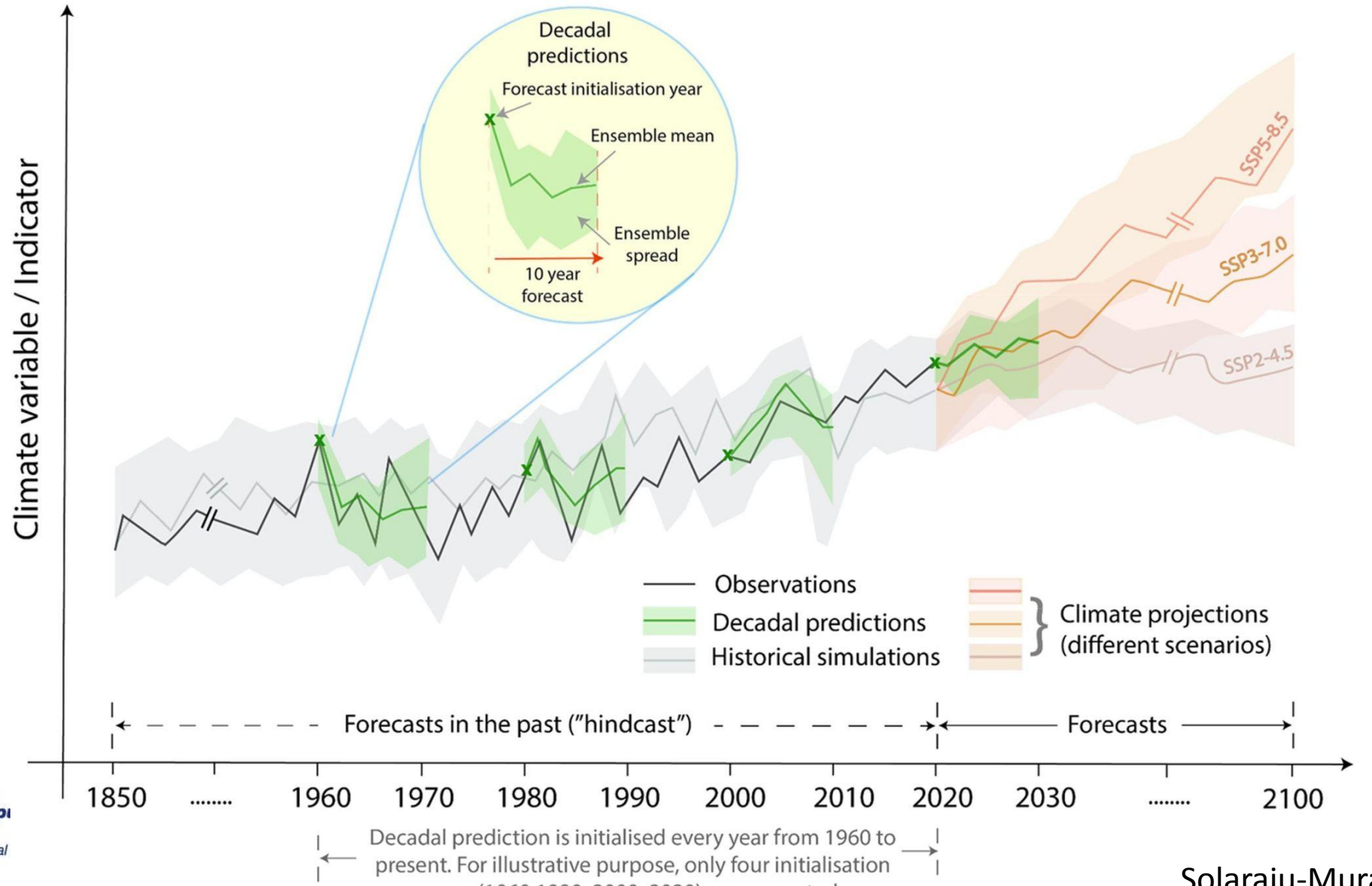
Overview of initialised prediction systems at BSC

Aude Carreric, R. Bilbao, V. Lapin, E. Tourigny, R. Bernardello, V. Sicardi, R. Mahmood, E. Exarchou, J. Acosta, P. Ortega, M. Castrillo, E. Ferrer, P.A. Bretonnière, ... (BSC)

19 September 2024

EC-Earth General Assembly

Climate prediction systems



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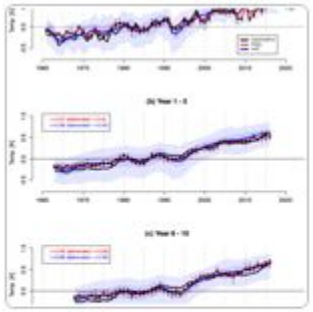
Solaraju-Murali et al., 2022

Decadal prediction system : CMIP6 DCPP-A

Assessment of a full-field initialized decadal climate prediction system with the CMIP6 version of EC-Earth

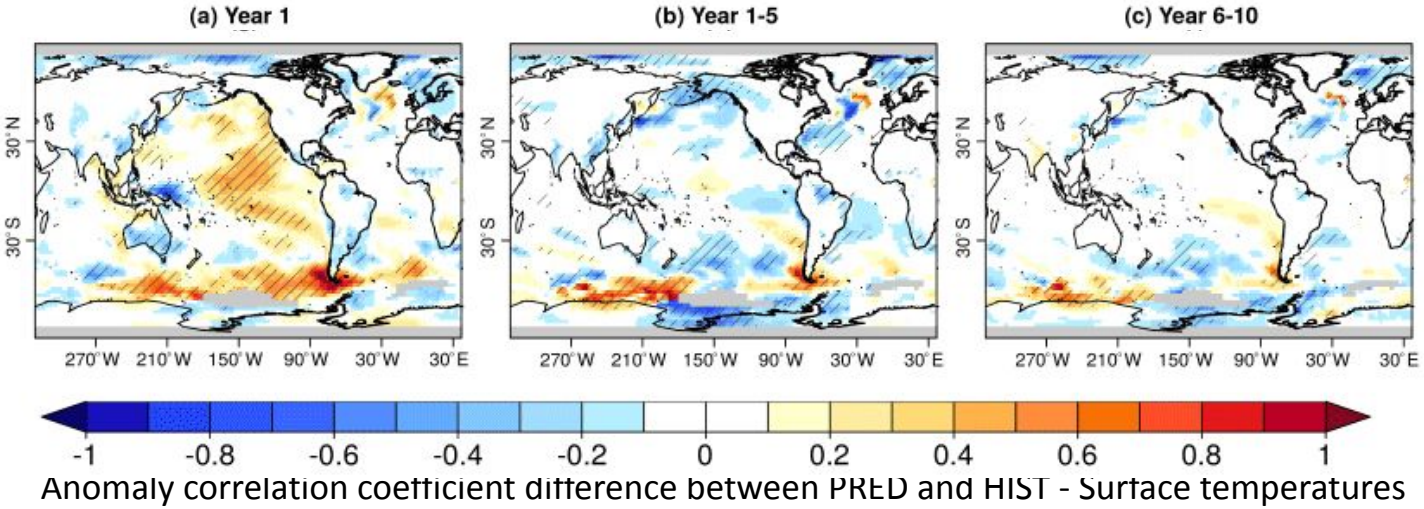
Bilbao et al., Earth Syst. Dynam., 2021



EUCP

European Climate Prediction system

- This prediction system is capable of skilfully simulating past global mean surface temperature variations at interannual and decadal forecast times.
- A **benefit of initialization** is found in some areas of the tropical Pacific and North Atlantic oceans.
- The central subpolar North Atlantic shows a detrimental effect of initialization, explained by an **initialization shock** and the related long-term drift.



Anomaly correlation coefficient difference between PRED and HIST - Surface temperatures

Contact: roberto.bilbao@bsc.es

First DCPP-A Initialisation protocol

ATM:
Interpolated to model grid with IFS using prepIFS at ECMWF (now using openIFS at BSC)

Atmosphere reanalysis (**ERA 40 + Interim**)

Land reanalysis (**ERA-Land**)

Ocean + Sea Ice reconstruction (Assimilating **ORAS4**)

In-house reconstruction produced at BSC

LAND:
Offline land-surface simulation forced by bias-corrected ERA-Interim outputs

Kindly provided by Emanuel Dutra

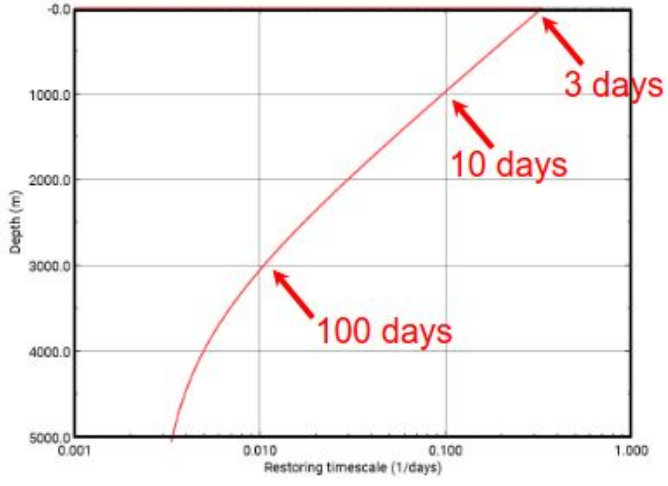
OCE + SI:
Historical reconstruction with NEMO-LIM stand alone, forced with ERA-40/Interim fluxes, and nudged globally towards 3D T and S from ORAS4

Default surface restoring coefficients

γ_T = -40W/m²/K

γ_S = -150 kg/m2/s/psu

Default 3D restoring timescales



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Current initialisation protocol

ATM:
Interpolated to model grid with OpenIFS

Atmospheric reanalysis (**ERA5-HRES**)

Land reanalysis (**ERA5-HRES**)

LAND:
Interpolated to model grid with OpenIFS

Ocean + Sea Ice reconstruction (Assimilating **ORAS5**)

In-house reconstruction produced at BSC

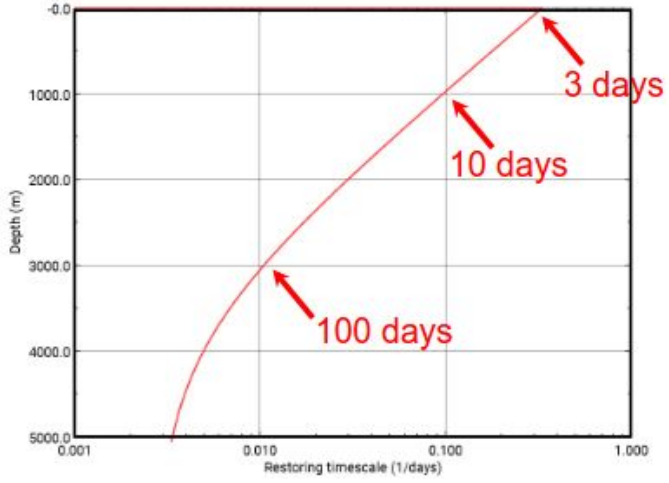
OCE + SI:
Historical reconstruction forced with ERA5-HRES fluxes, restored at the **surface** towards **ORAS5** and nudged at the **subsurface** towards **EN4** and nudged

Default surface restoring coefficients

γ_T = **-200 W/m²/K**

γ_S = **-750 kg/m2/s/psu**

Default 3D restoring timescales

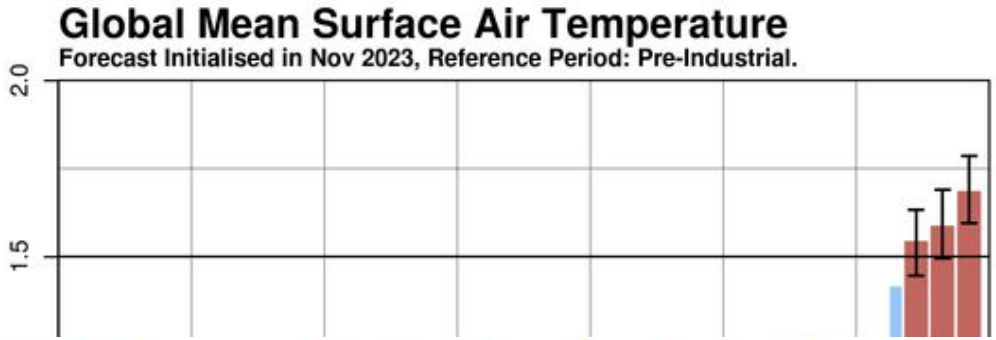


vladimir.lapin@bsc.es

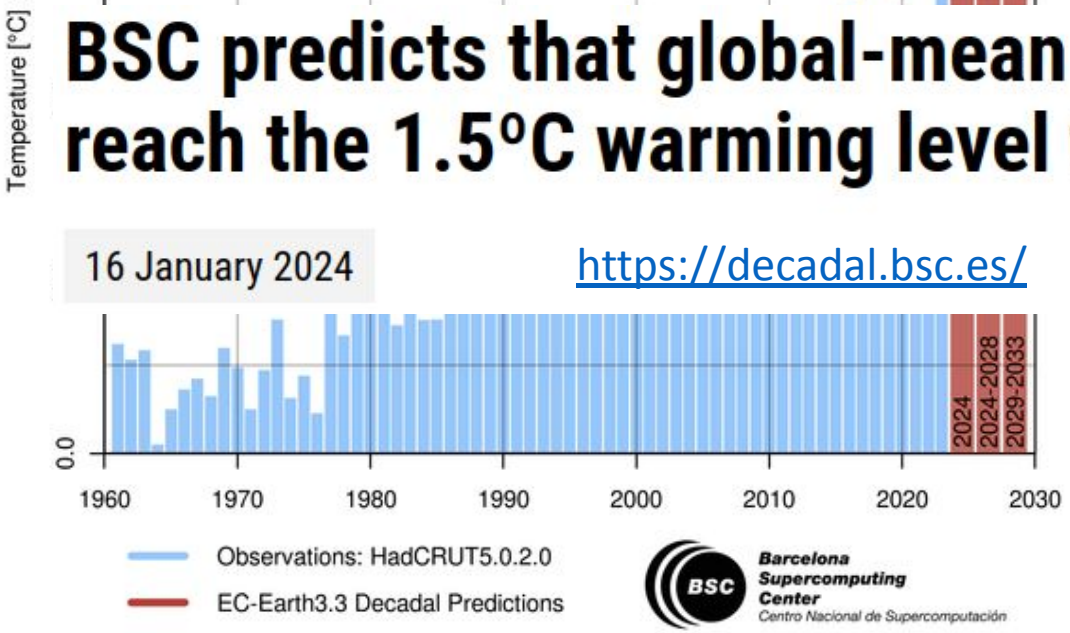
Operational decadal prediction system

- Annual updates
- 50 members for the forecast (10 members for the hindcast)

WMO Lead Centre for
Annual-to-Decadal Climate Prediction



BSC predicts that global-mean temperature could reach the 1.5°C warming level threshold in 2024



https://decadal.bsc.es/

EUCP
European Climate Prediction system

ASPECT
FACILITATING SEAMLESS CLIMATE ADAPTATION

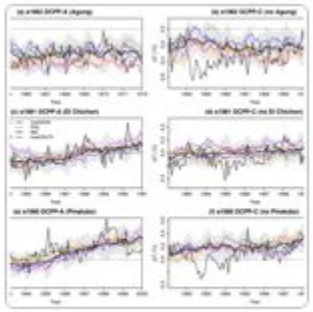
IMPETUS 4CHANGE

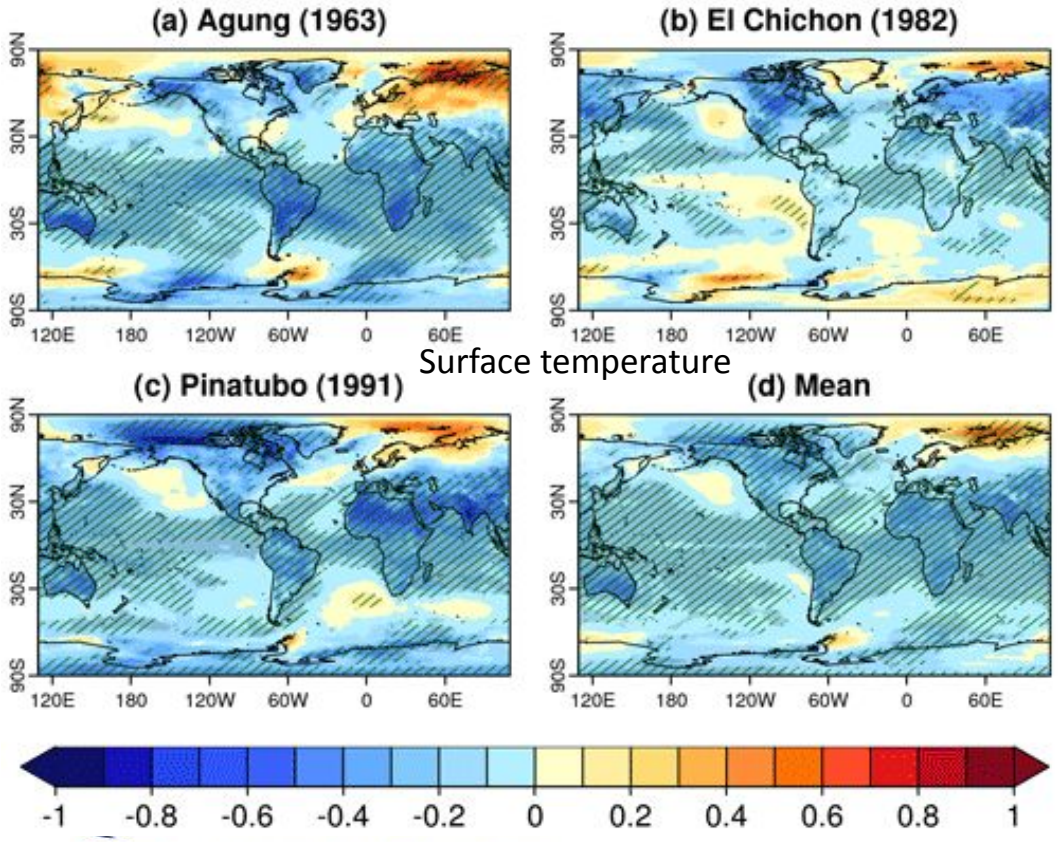
Contact: roberto.bilbao@bsc.es

Decadal prediction system : CMIP6 DCPP-C NoVolc

Impact of volcanic eruptions on CMIP6 decadal predictions: a multi-model analysis

Bilbao et al., Earth Syst. Dynam., 2024





Surface temperature

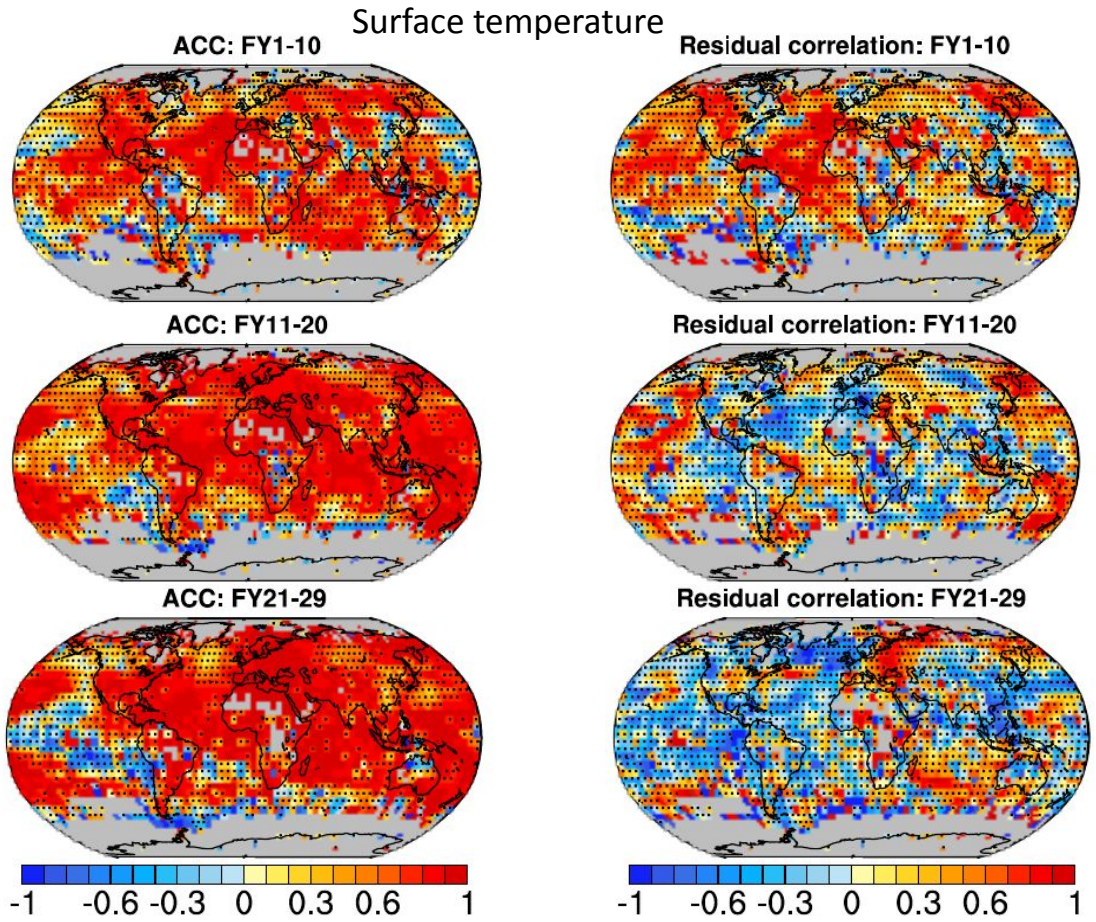
DCPP-A minus DCPP-C during the first year following the volcanic eruptions (June-May)

- Including the forcing of large volcanic eruptions is important to make accurate predictions.
- The six decadal prediction systems show strong agreement in predicting the post-volcanic radiative effects following the eruptions.
- Dynamical responses are both model- and eruption-dependent.

Contact: roberto.bilbao@bsc.es

Multidecadal initialised experiment

- 30 forecast years
- Initialised every 5th year from 1960 to 2020
- Ensemble size 10 members



ASPECT
FACILITATING SEAMLESS CLIMATE ADAPTATION

- Added value from initialization exists only during the first decade while a little or no added afterwards
- Drift of the AMOC with forecast time

Mahmood et al., 2024, in prep

Courtesy of Rashed Mahmood

Multi-year prediction system : 2 init/yr, 2 resolutions

Multi-year prediction systems

Standard res.	High res.
2 init. per year: Nov.: 1960-2021 May: 1980-2021 (every yr)	2 init. per year: Nov.: 1960-2021 May: 1980-2021 (every yr)
20 members	15 members
3 forecast yrs	3 forecast yrs
TOTAL: 6240 yrs	TOTAL: 4680 yrs

ASPECT
FACILITATING SEAMLESS CLIMATE ADAPTATION

EUCP
European Climate Prediction system

APPLICATE.eu
Advanced prediction in polar regions and beyond

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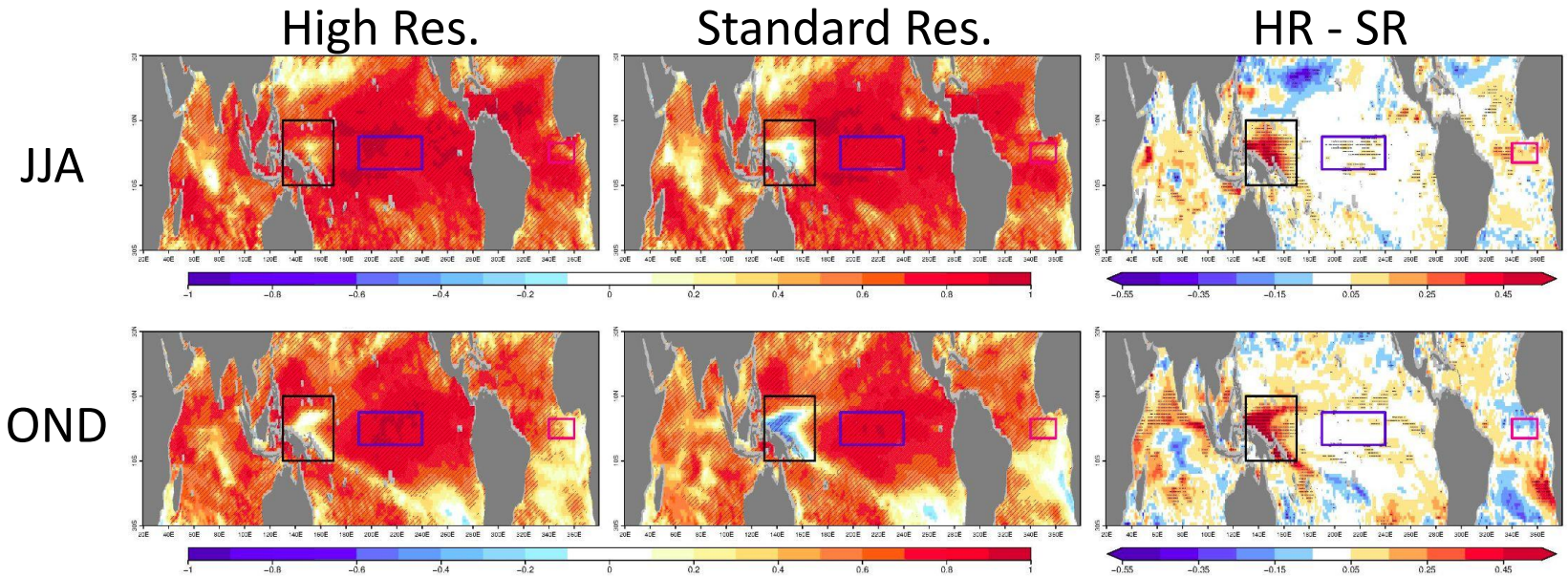
Contact: aude.carreric@bsc.es

Seasonal prediction system: HR versus SR

- 8 forecast months
- Initialised in May
- from 1990 to 2014
- Ensemble size 20 members



Anomaly correlation coefficient - Sea surface temperature

- **Higher predictive skill** in ENSO regions in the HR system
- Due to:
  - smaller ENSO-related errors linked to smaller biases in the mean state
  - smaller initialisation shock in the mixed layer depth
  - better teleconnection with the Atlantic-Nino

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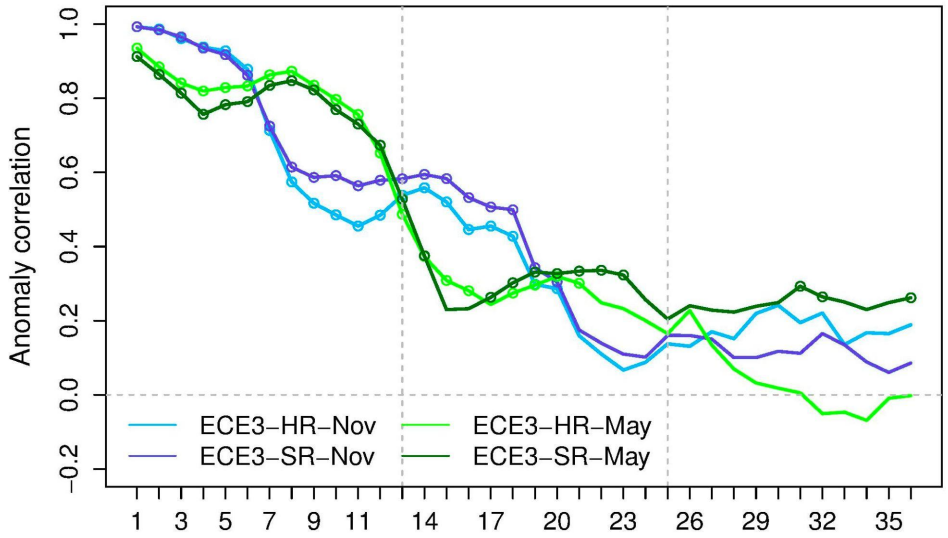
Carreric et al., in prep

Multi-year prediction system: preliminary results

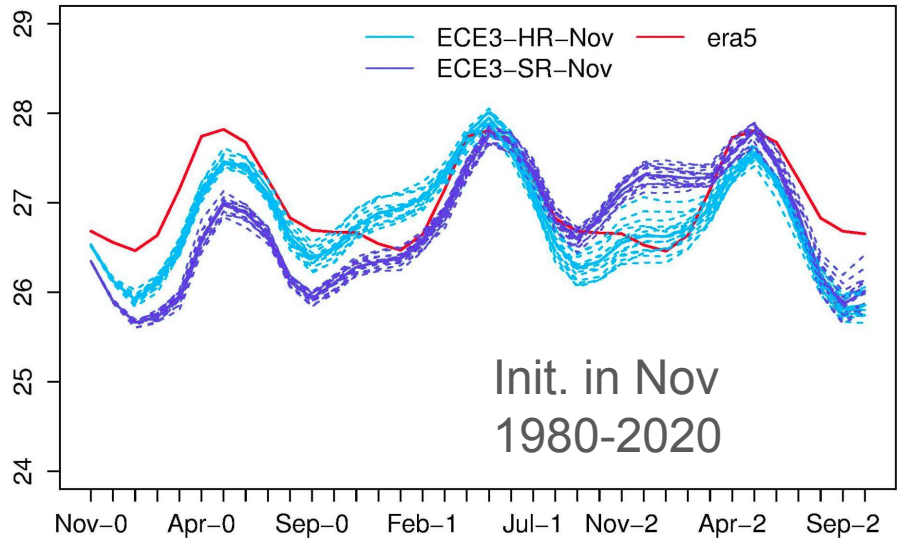
- Initialised in Nov and May
- from 1980 to 2021
- Ensemble size 15 members

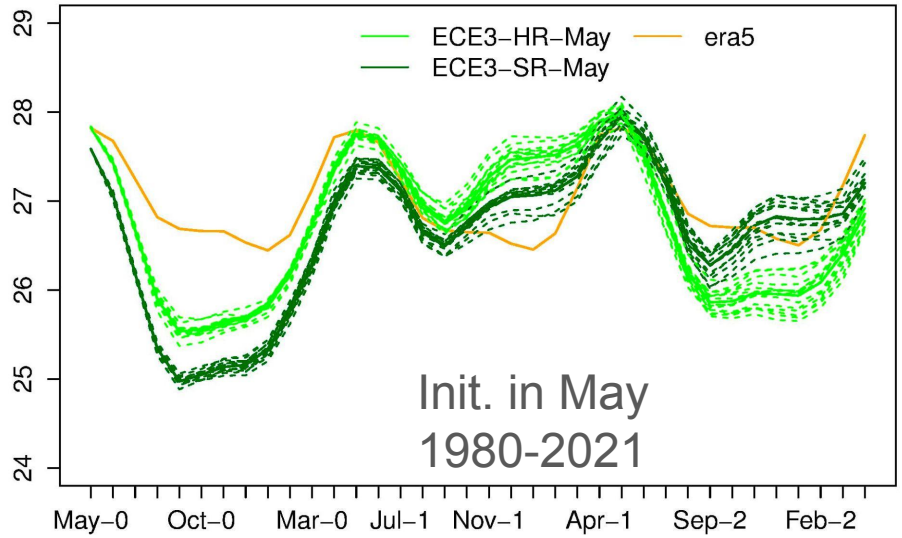
Nino3.4 SST



Anomaly correlation coefficient

raw values





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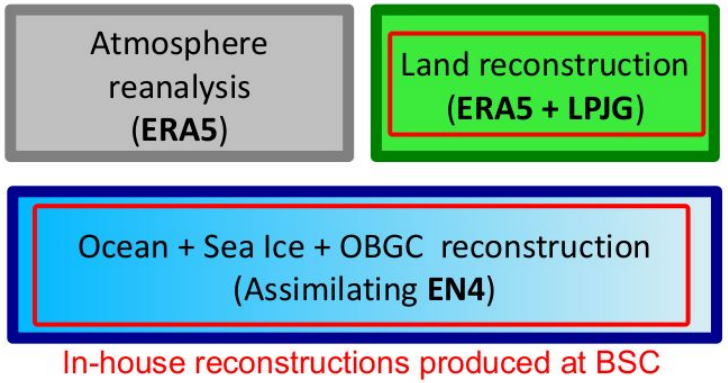
Decadal prediction system with Carbon Cycle

Initialisation protocol

ATM:
Reanalysis
Interpolated to model grid, 3D T perturbations

CO2:
input4MIPS global surface CO2, scaled to model climatology



LAND:
Offline land-surface reconstruction with LPJ-GUESS stand alone, forced with ERA20C (before 1950) and ERA5 near-surface fields

OCE + SI + OBGC:
Historical reconstruction with NEMO-LIM-PISCES stand alone, forced with ERA5 fluxes, and nudged globally towards 3D T and S from EN4

Climate-Carbon Interactions in the Current Century

- Will participate this year to the [Global Carbon Budget]
- Ocean carbon uptake: very good skill up to 7 years ahead
- Land carbon uptake: predicting skill up to 2 years ahead only due to limitation in predicting land fluxes

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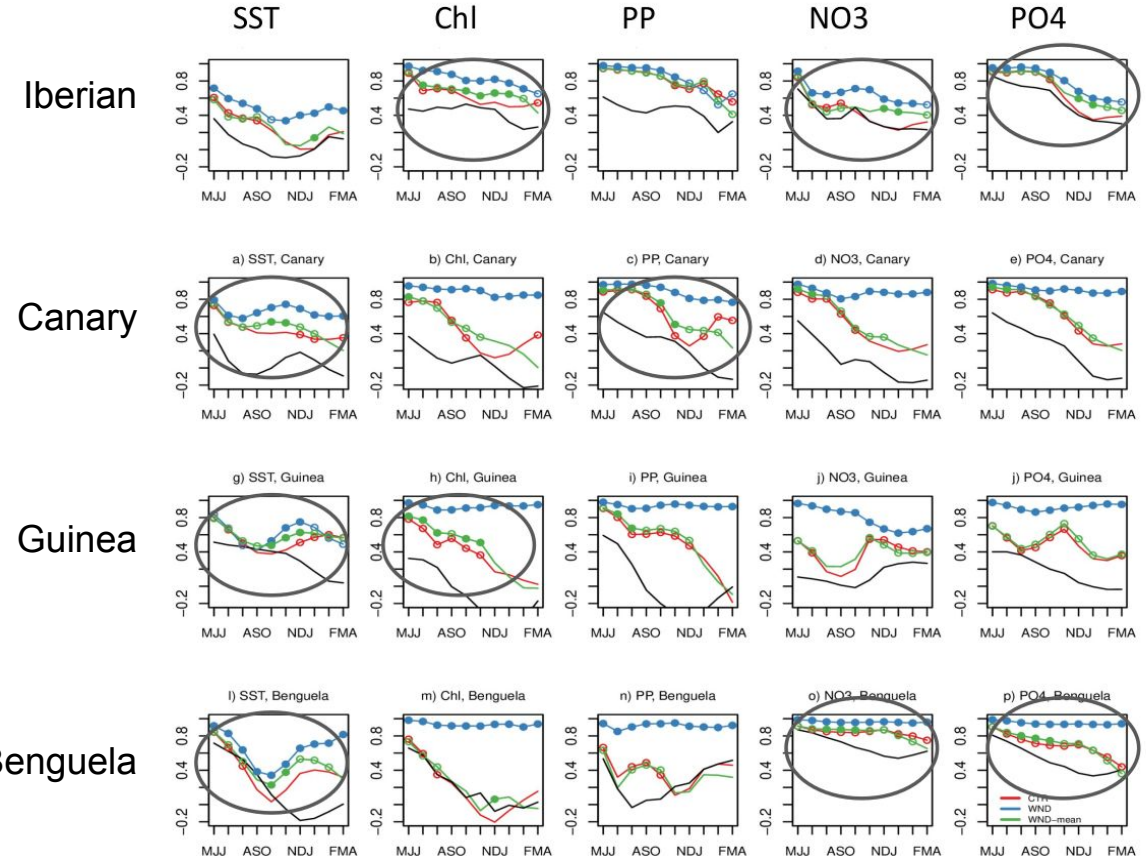
Contact: raffaele.bernardello@bsc.es

Seasonal forecast with Carbon Cycle

- Focus on Large Marine Ecosystems of East Atlantic
- Seasonal forecast experiments correcting wind-stress errors (mean state and mean state + variability)



- Correcting wind stress variability substantially improves the skill, which supports its key driving role
- Correcting the mean-state alone also lead to significant improvements, both for the physical and biogeochemical variables

Exarchou et al., in prep

Contact: valentina.sicardi@bsc.es