Comparing the seasonal predictability of Tropical Pacific variability in EC-Earth3 at two different horizontal resolutions

21 March 2024

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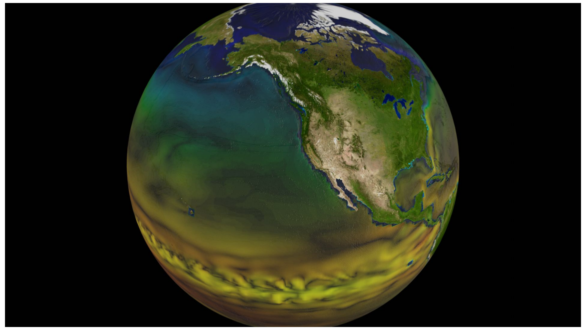
Forecast systems: 2 resolutions

Standard resolution:
- EC-Earth 3.3.3.1
- IFS T255L91 (~80 km)
- ORCA1 (~100 km)

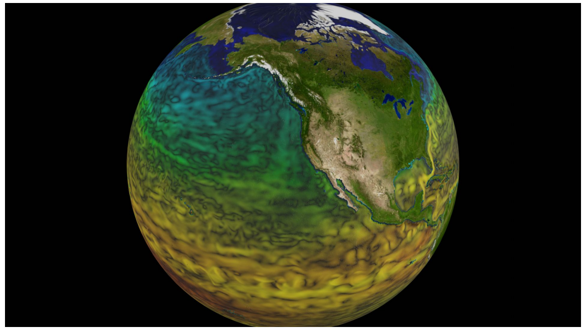
eddy-parameterized ocean



ORCA grid 1°

Courtesy of O. Tinto

High resolution:
- EC-Earth 3.3.4
- IFS T511L91 (~40km)
- ORCA025 (~25km)



ORCA grid 0.25°

eddy-permitted ocean

Hindcast period:

1990-2015

Ensemble:

20 members

Initialisation:

May and November every year

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Same initialization protocol

Atmospheric Reanalysis
ERA5

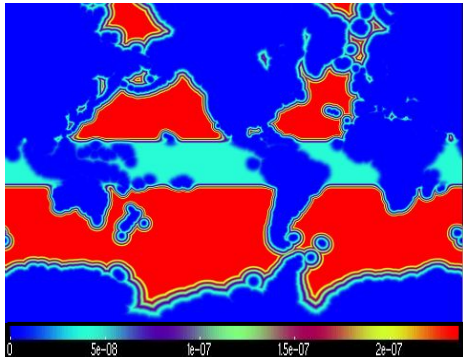
➜ interpolation to the corresponding grid
➜ perturbation of the 3D air temperature forcing field

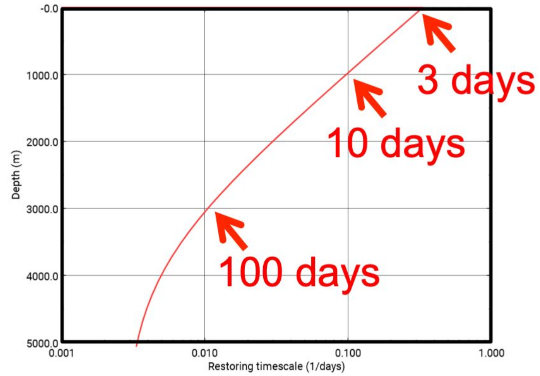
Ocean Reconstruction
- ERA5 surface fluxes*
- ORAS5 restoring at the surface
- EN4 v4.2.1 nudging in the subsurface
- 5 difference initial conditions

➜ Atmospheric forcing: tas*, heat fluxes*, humidity, precipitation, surface winds

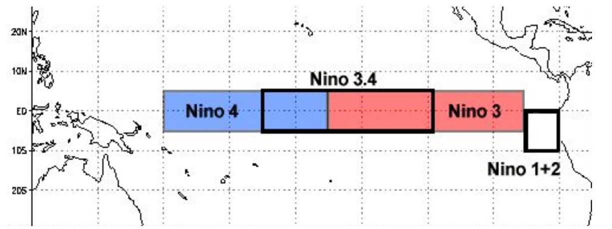
➜ Surface restoring coefficients γ_T = -200 W/m²/K, γ_S = -750 kg/m2/s/psu

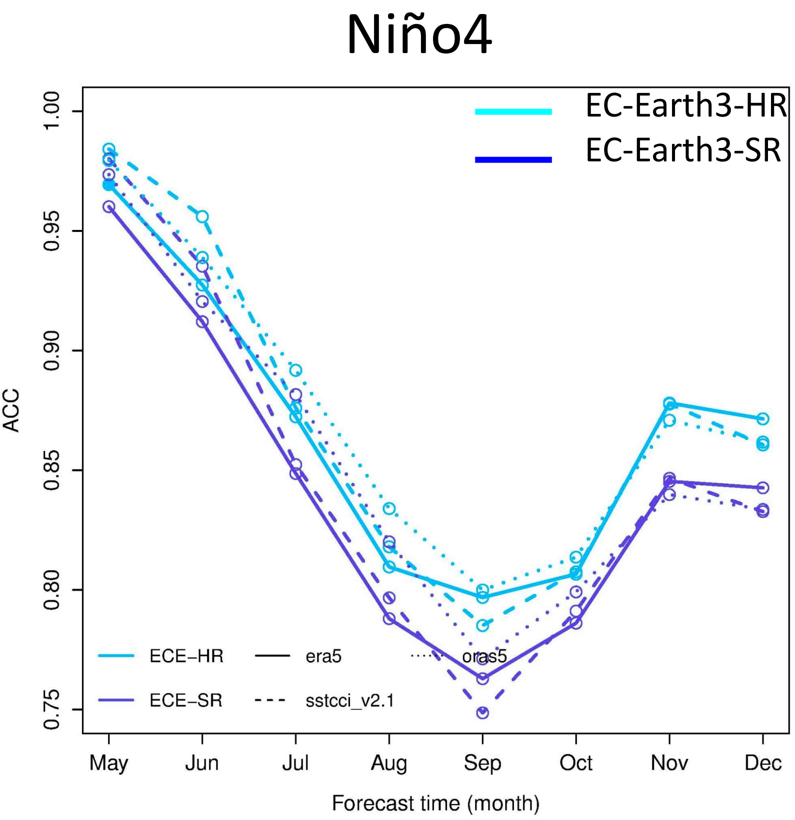
➜ 3D nudging (temperature and salinity)

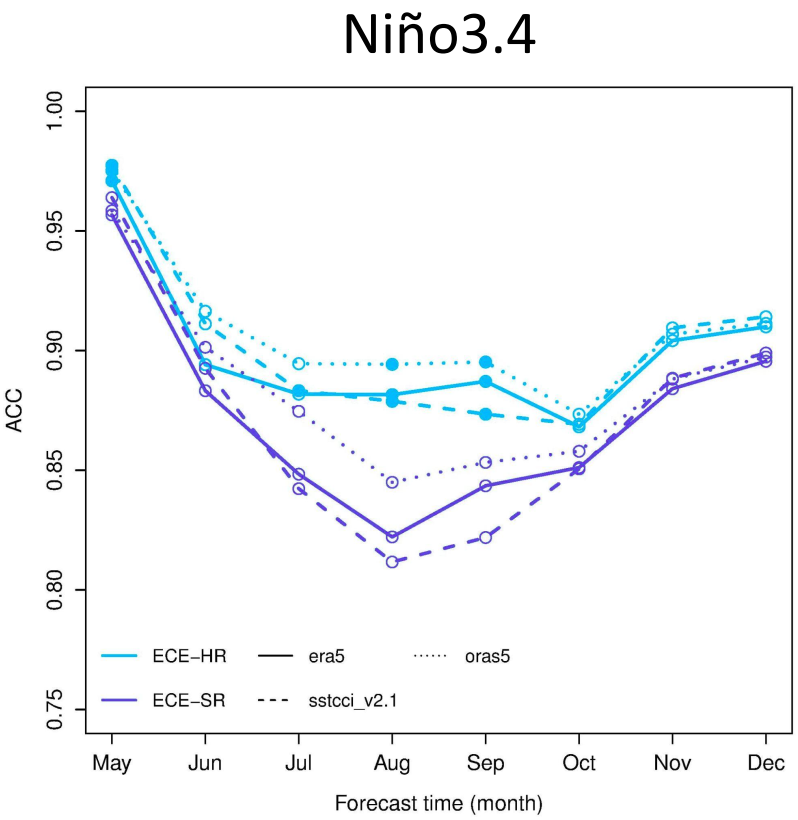


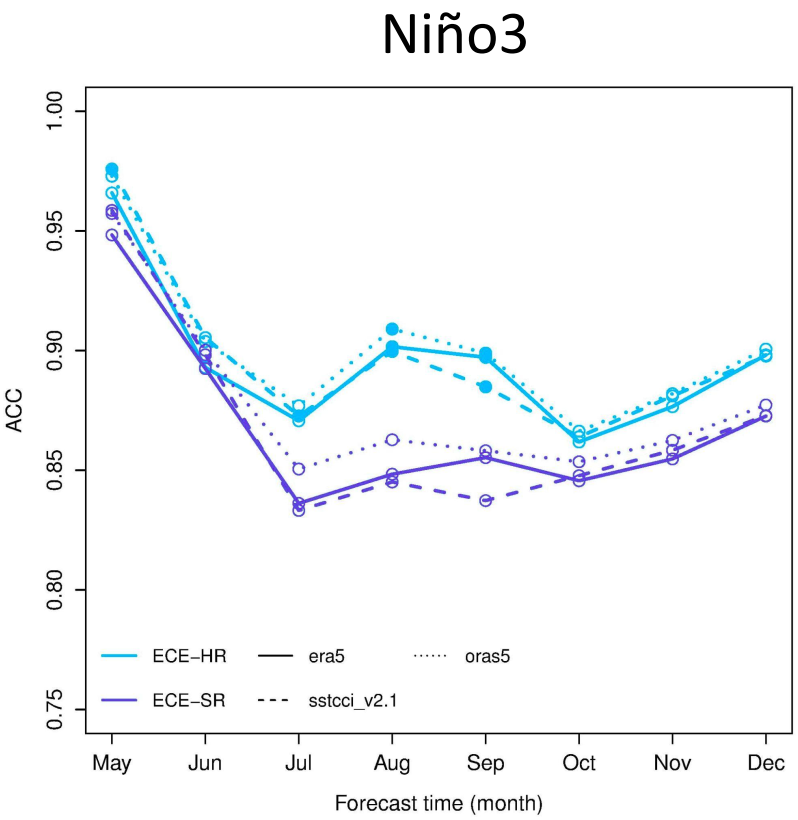


Timeseries ACC Niño regions









Higher skill in the HR system, statistically significant in summer in the central-eastern equatorial Pacific

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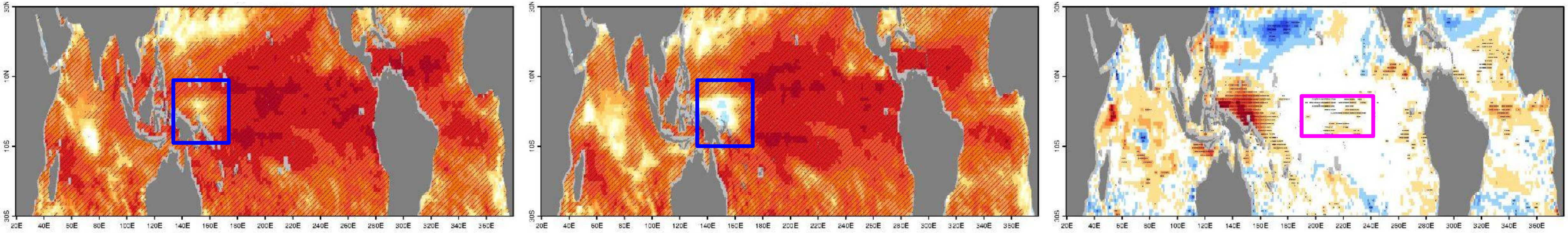
Predictive skill in the tropics

Sea surface temperature

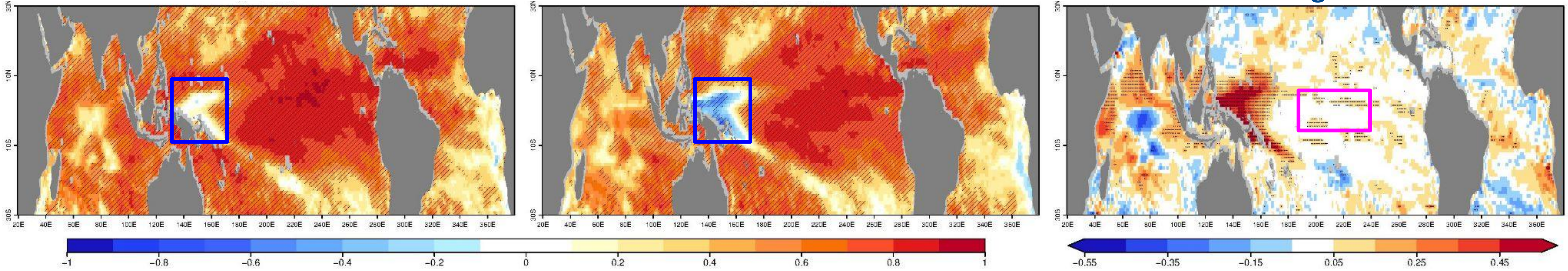
Reference: era5

JJA | High Res | Standard Res | Correlation differences

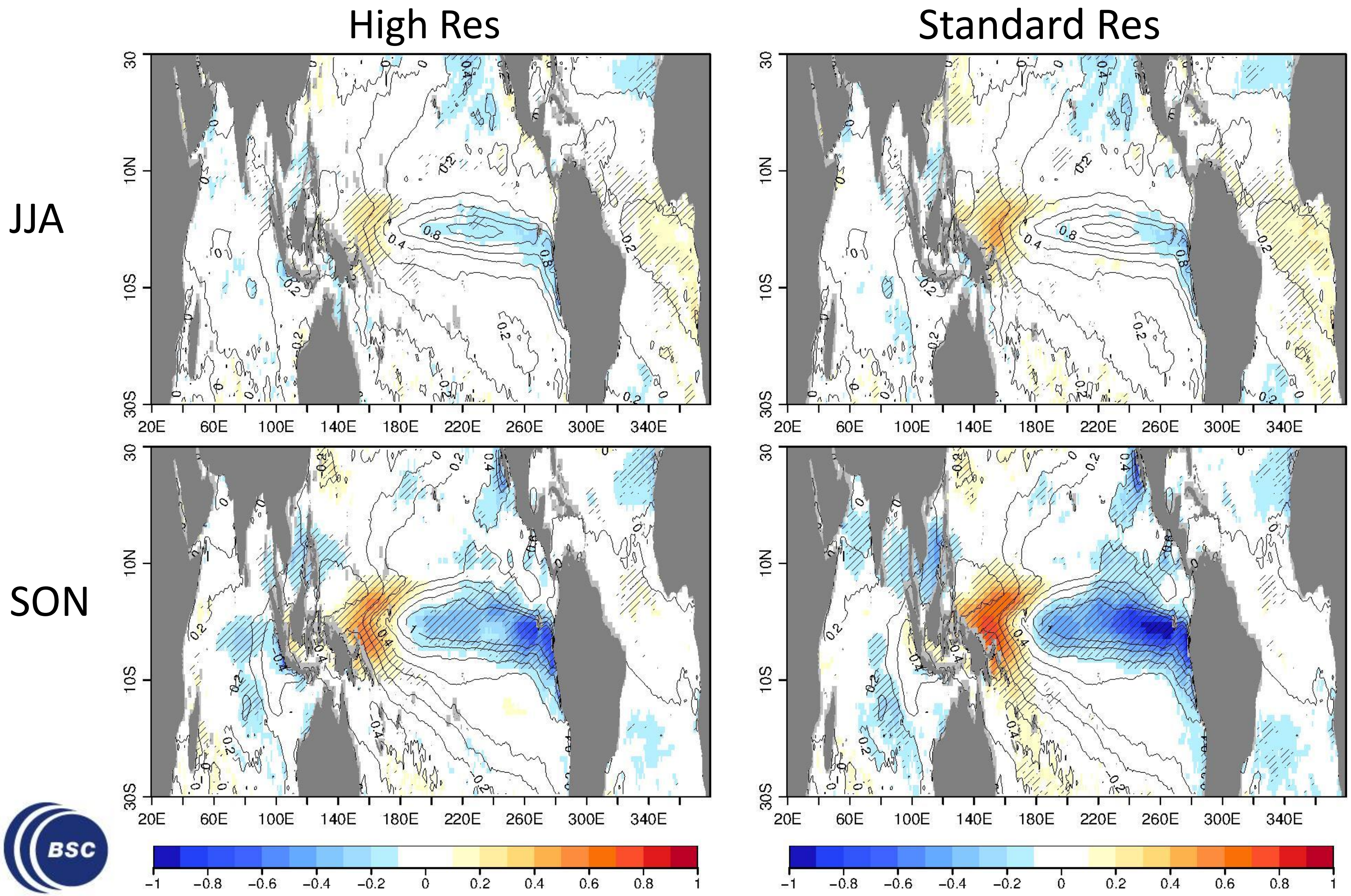


red: improvement
blue: degradation

SON



Lower ENSO-related errors in ECE3-HR

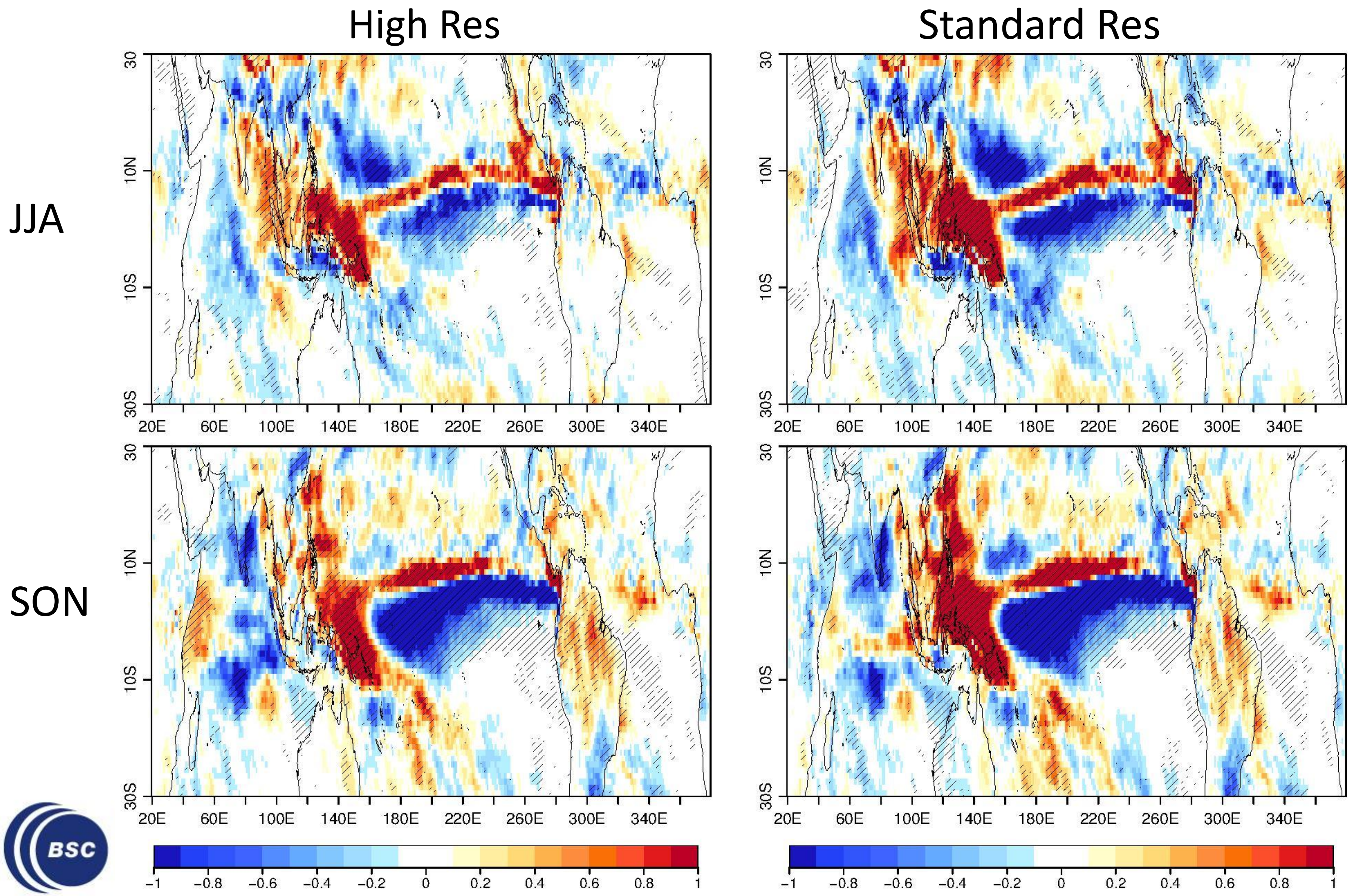


Common ENSO-related biases:

- cold bias in the cold tongue region
- westward extension of ENSO-related SST anomalies

ENSO-related errors following Beverley et al. 2023

Implication for forecasting the impacts of ENSO

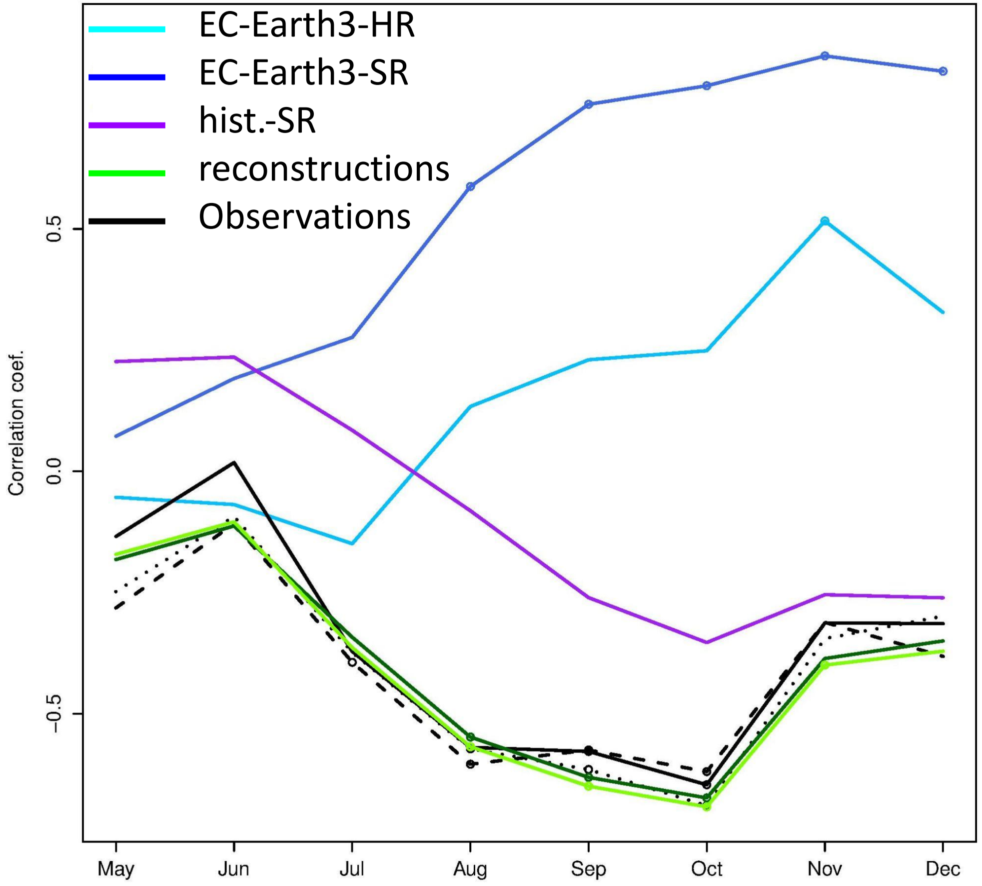


Too much precipitation associated with ENSO over the Maritime Continent, particularly in SR

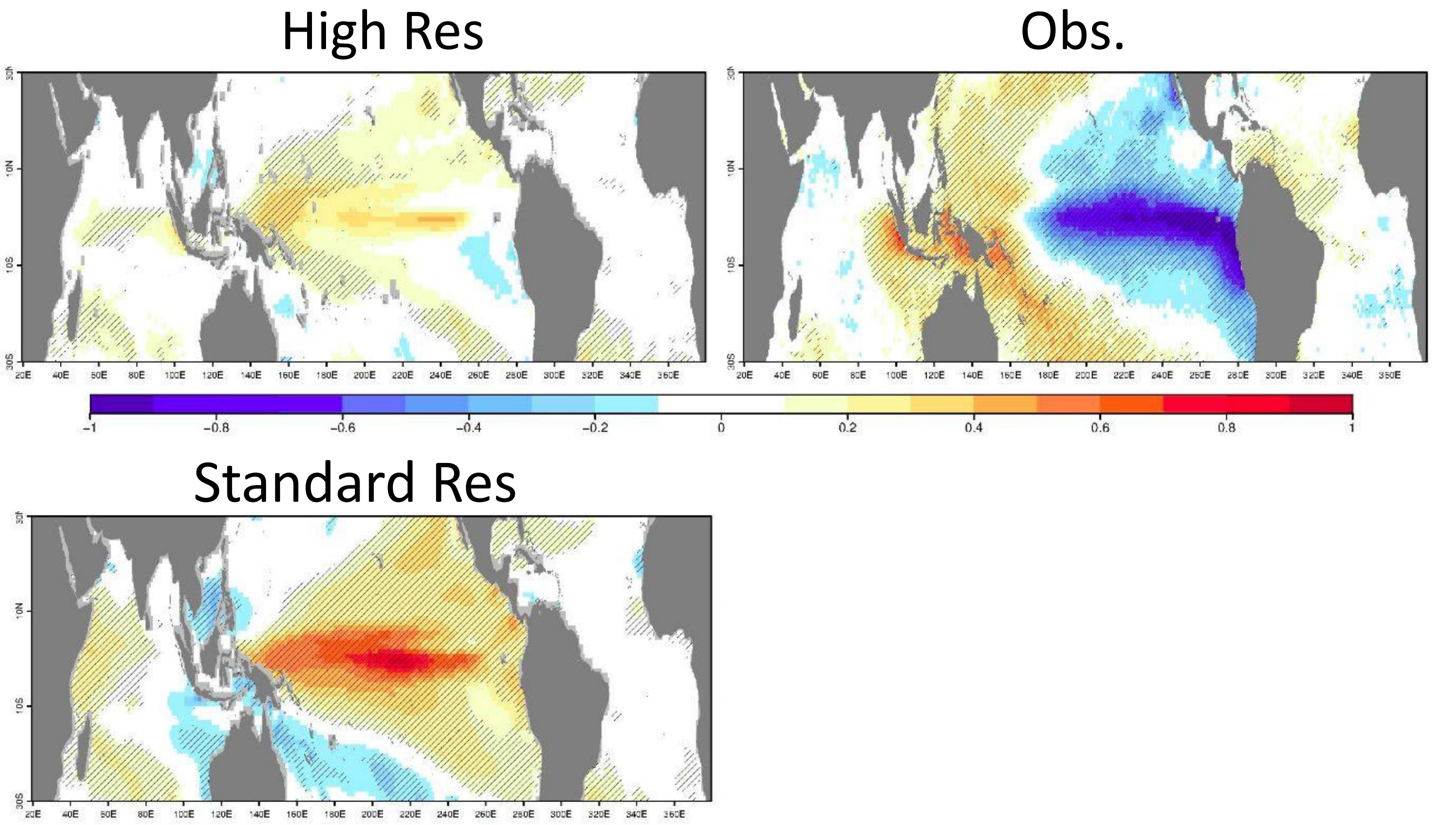
ENSO-related errors following Beverley et al. 2023

ENSO influence in the western Pacific

Correlation Blue Hole and Niño3.4 SSTA

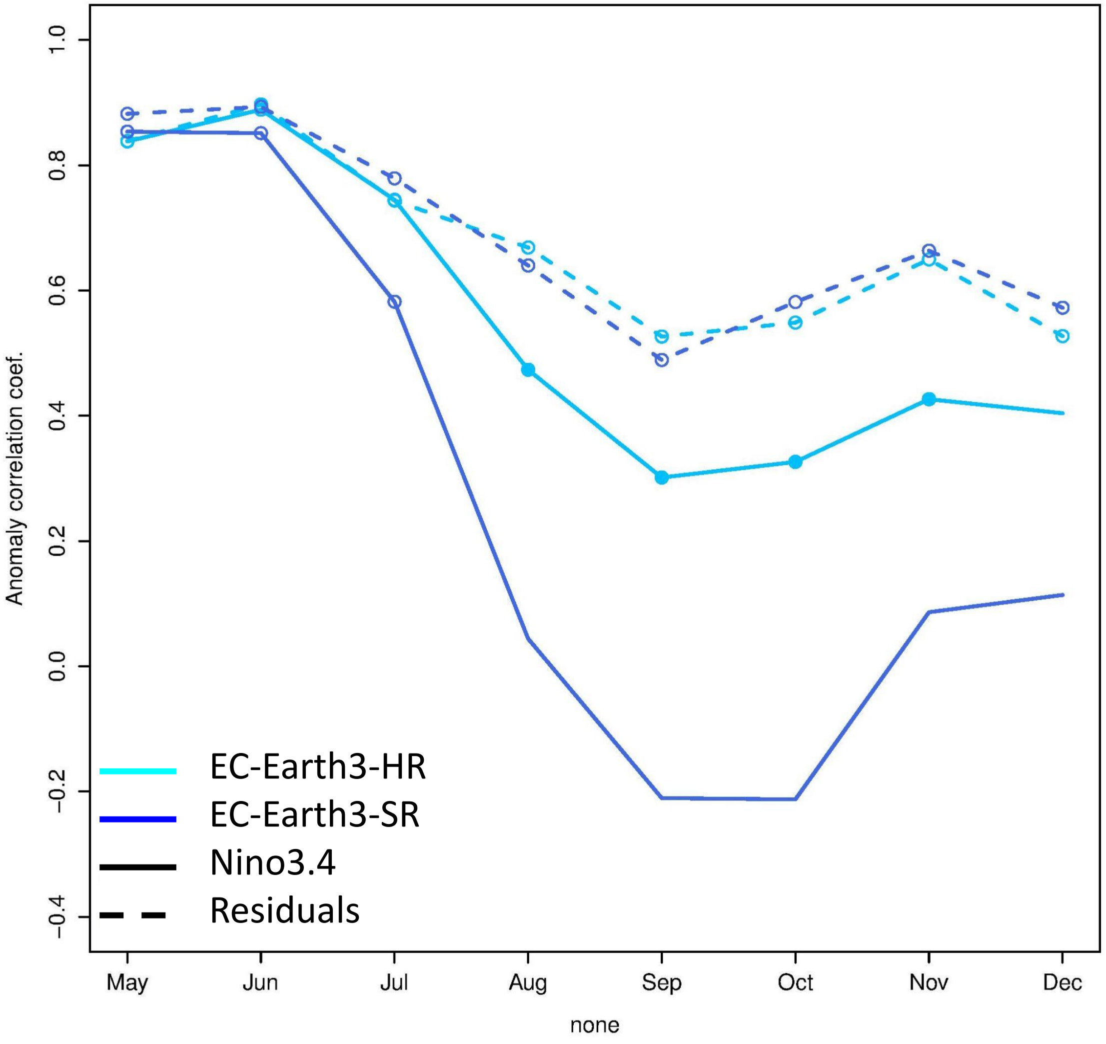


Regression maps of ASO W. Pac. onto SON SST



The model shows a behaviour between ENSO and this region opposite to that of the observations.

Loss of skill in the Western Pacific region



Drastic loss of skill in the western tropical Pacific, more pronounced in ECE3-SR.

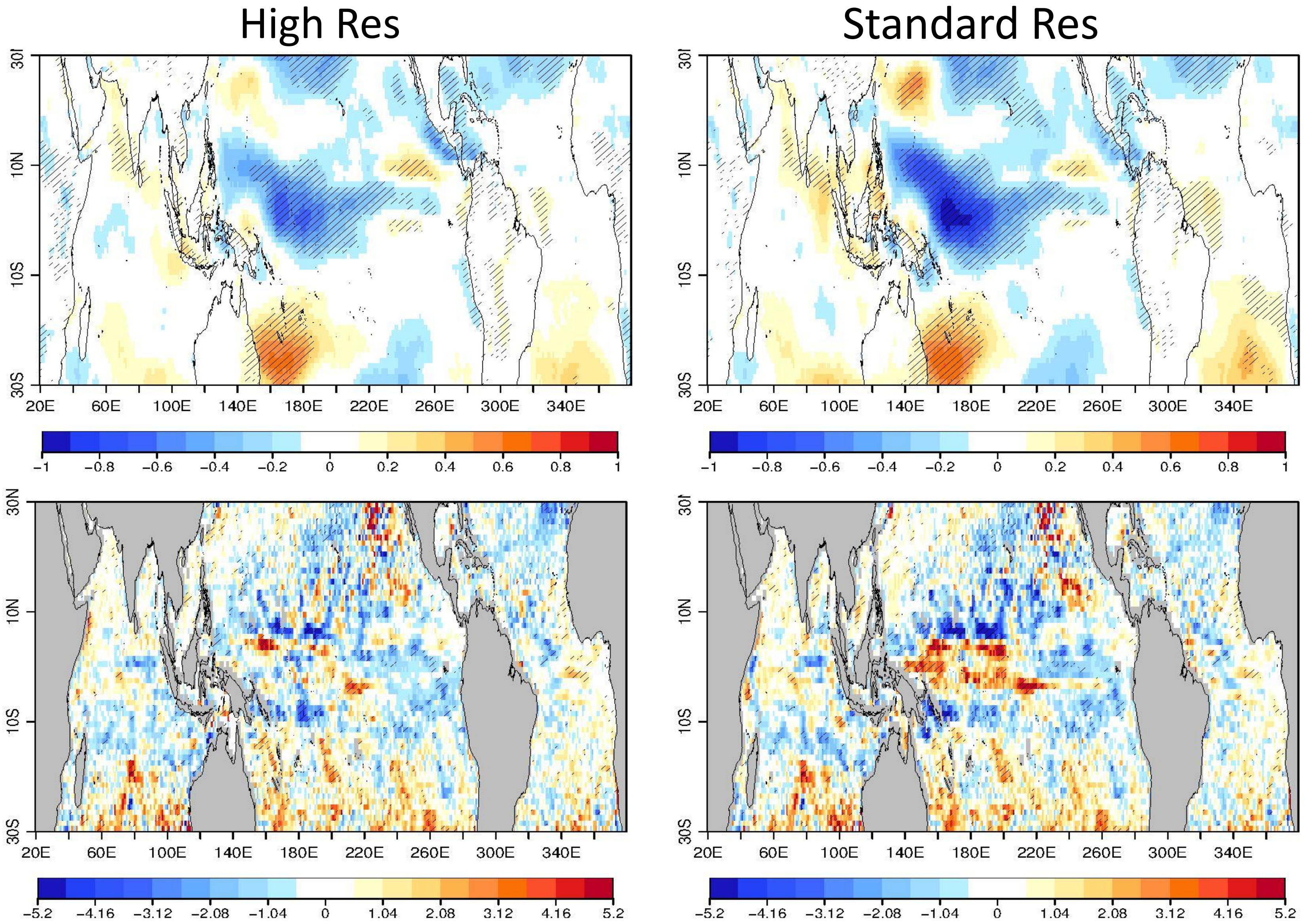
The predictive skill in the region is better when removing the ENSO signal.

ENSO-related variability is improved in this region in HR.

Interplay between winds and mixed layer

uas
JJA

Recon.
MLD
May



Wind bias inherent in the model:
too strong easterlies in the west Pacific and too few variability

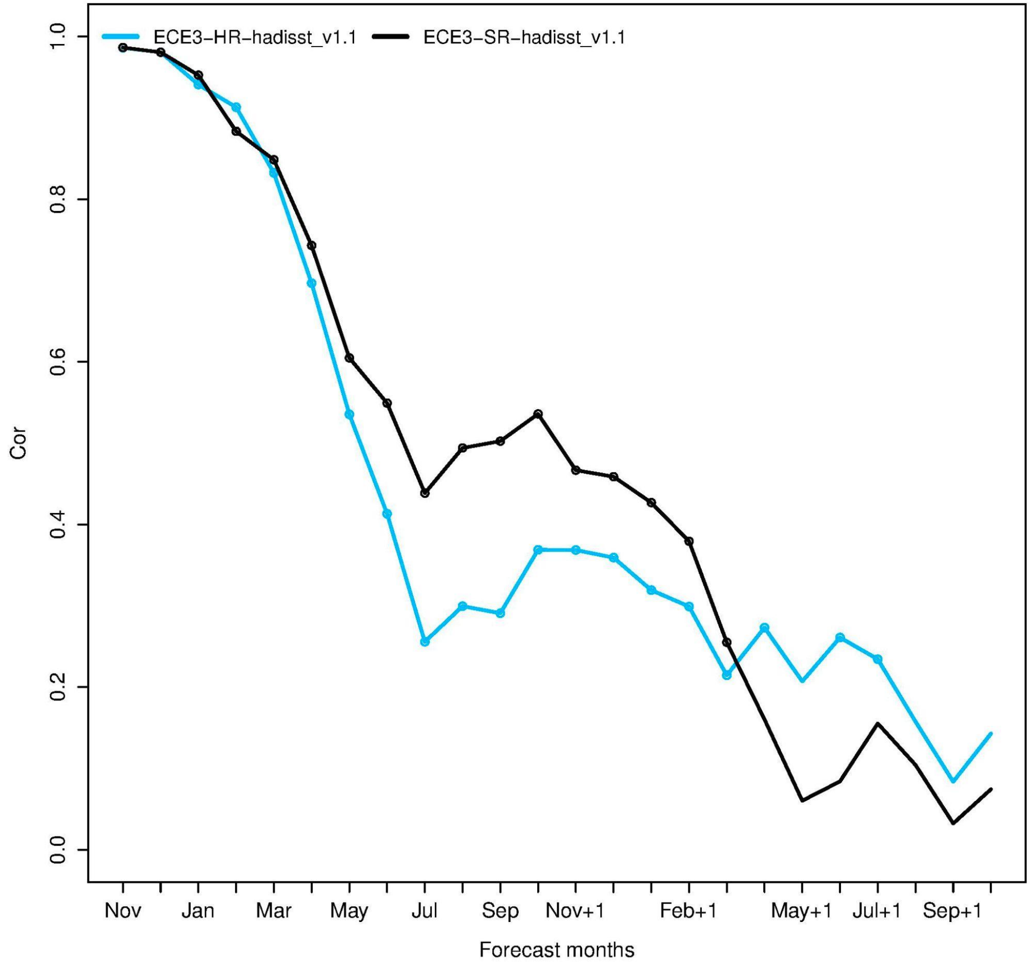
Initialisation errors particularly in the standard resolution

Multi-year prediction system

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

Niño3 SST - Nov. init



Any questions?

Thanks for your attention

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HR simulations:
16 times more consumption than SR on Marenostrum4

only for the HR simulations	CHSY	CPU (Mh)	GHG emissions (tCO_2e)
Tuning	16 700	16,7	
Reconstructions	11 000	7,2	
Seasonal forecast	15 300	15,9	
Multi-year forecast	15 300	71,6	13,9

To give a comparative order of magnitude, to meet the 1.5°C objective of Paris Agreement, each individual would have to emit a maximum of 2 tCO_2 per year.