A novel initialisation technique for decadal climate predictions

Danila Volpi[1], Virna L. Meccia[1], Virginie Guemas[2], Pablo Ortega[3], Roberto Bilbao[3], Francisco J. Doblas-Reyes[3,4], Arthur Amaral[3], Pablo Echevarria[3], Rashed Mahmood[3] and Susanna Corti[1]

[1] ISAC-CNR; [2] Météo-France; [3] BSC; [4] ICREA

21st September 2021

Workshop: Multi-annual to Decadal Climate Predictability in the North Atlantic-Arctic Sector

Motivation

- To address the model drift caused by initialising the model away from its attractor

SST Global mean climatology
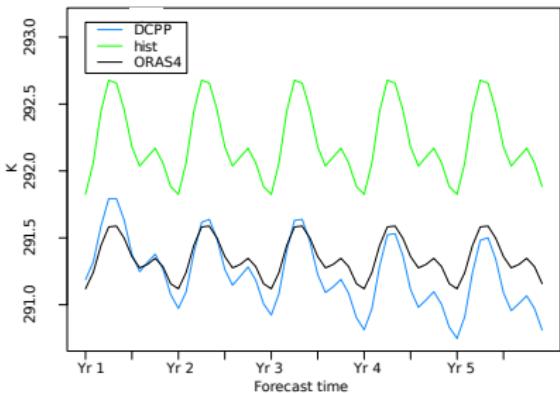
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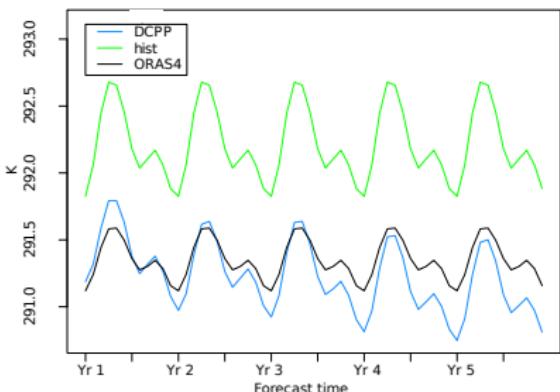
- To tackle the potential inconsistencies between the observed/model distribution of variability

Standard deviation of the barotropic stream function
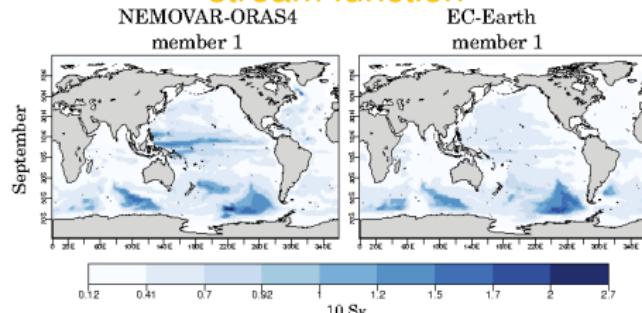
Calculated as the ocean horizontal transport integrated vertically

Quantile matching experiment -QM-
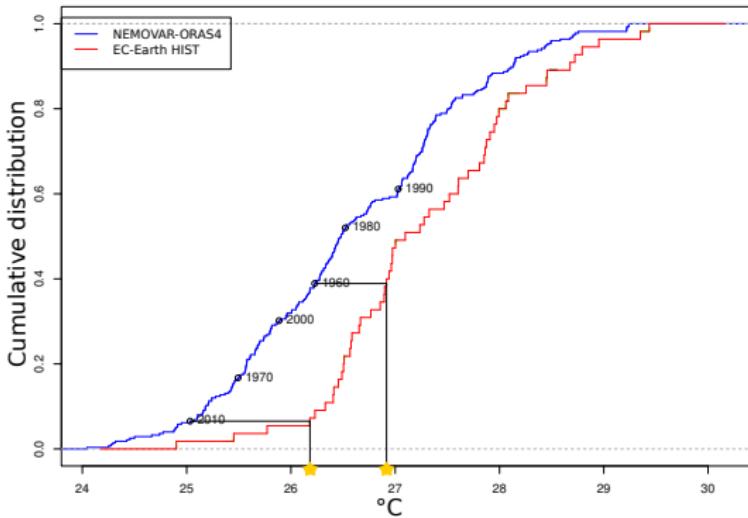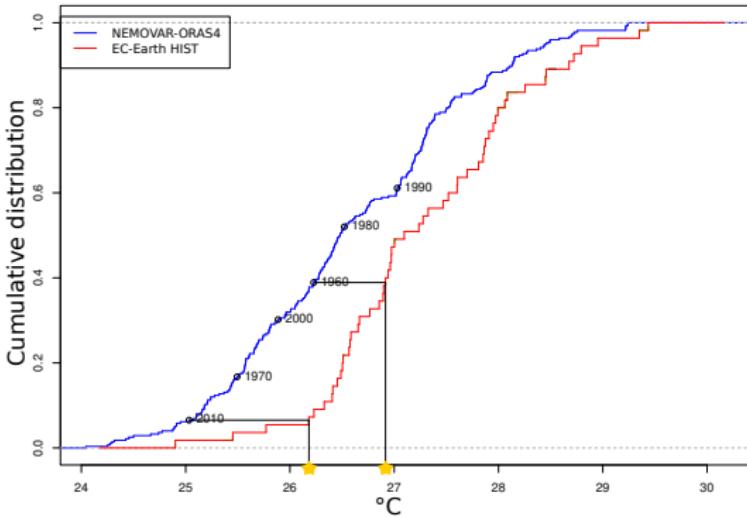
Implementation

- quantile matching calculated for each ocean model variable, at each grid point.
- 2 2D vars, and 14 3D vars
- calculated for 5 members and 55 start dates

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Experiment comparison

The model in use is EC-Earth 3.3.1

QM

- 10 ensemble members
- 5-year long hindcast
- 55 start dates (November 1960-2014)

FFI

- 10 ensemble members
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Identical ensemble generation

Initial conditions

- Atm./surf.: ERA40/ERA-Interim
- Ocean: Quantile matching to NEMOVAR-ORAS4
- Sea ice: nudged simulation to NEMOVAR-ORAS4

Initial conditions

- Atm./surf.: ERA40/ERA-Interim
- Ocean: replacement with NEMOVAR-ORAS4
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- Compared with 15 historical simulations

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Near surface temperature correlation with GISTEMP dataset
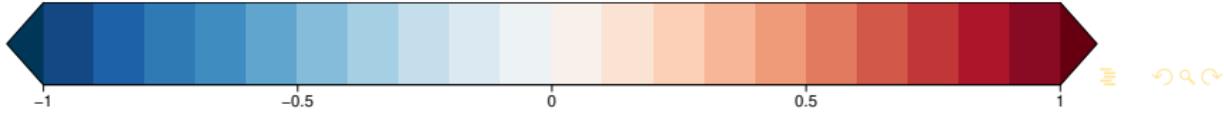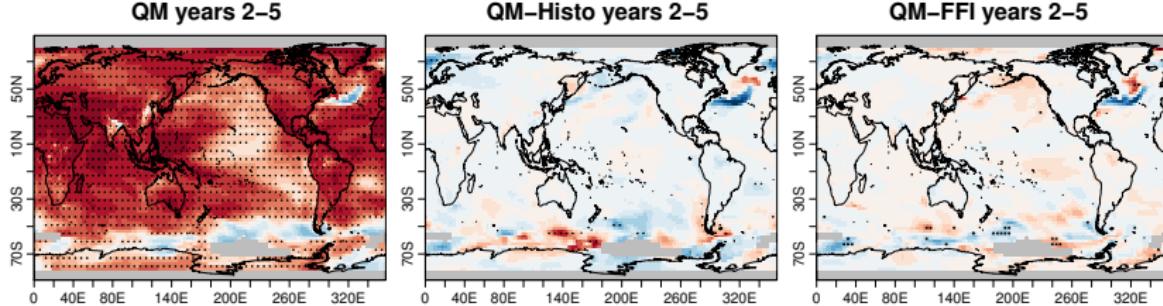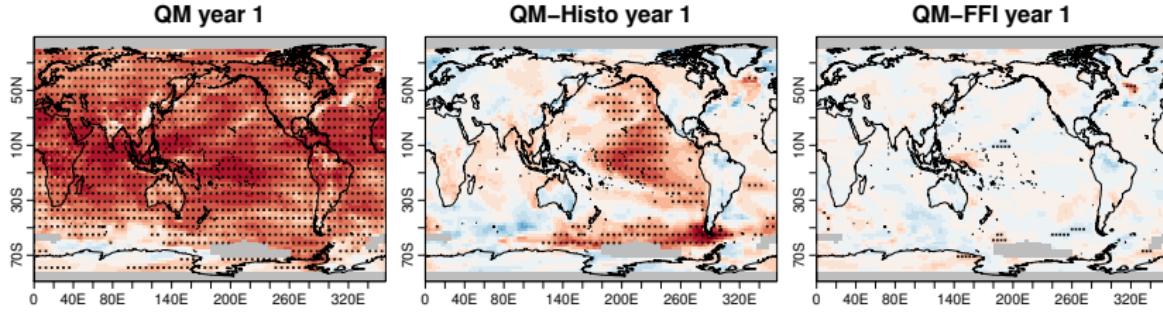
Convection
February-March-April mixed layer depth in the Labrador Sea
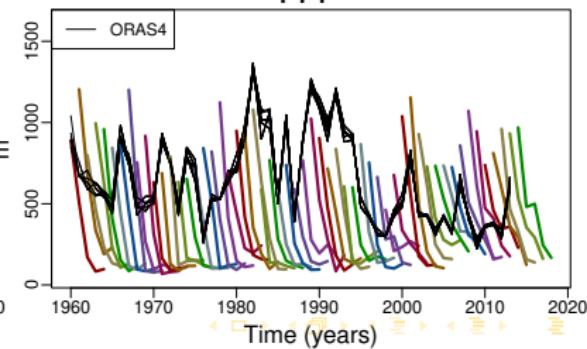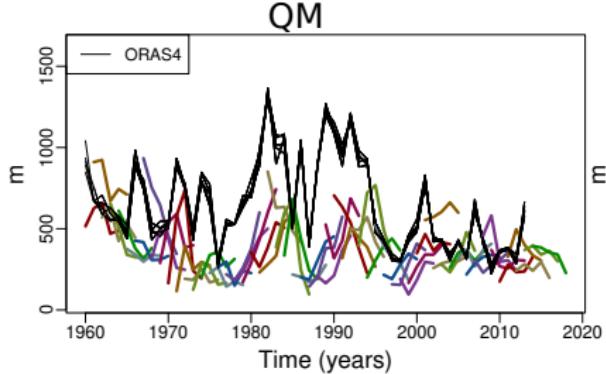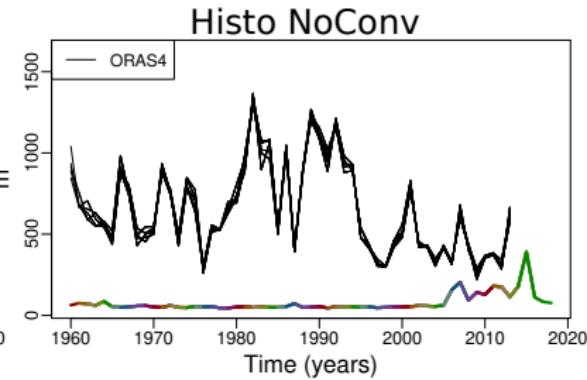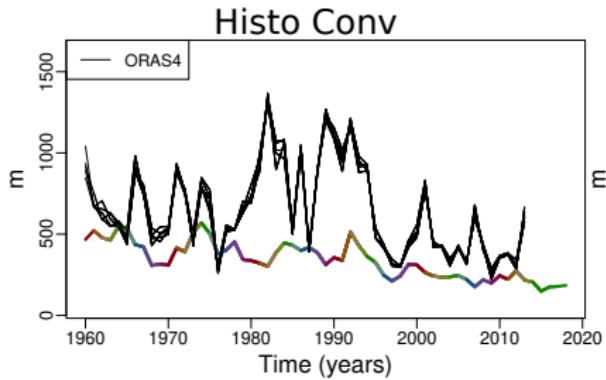
Mixed layer depth and Barotropic stream function skill
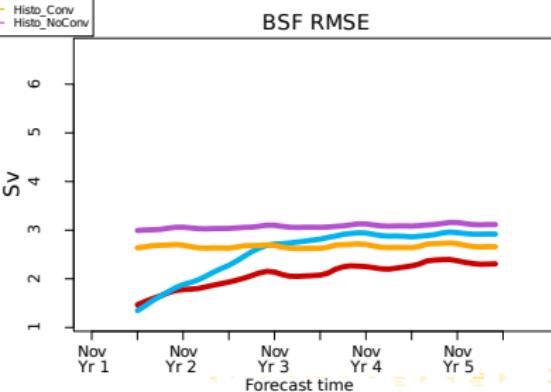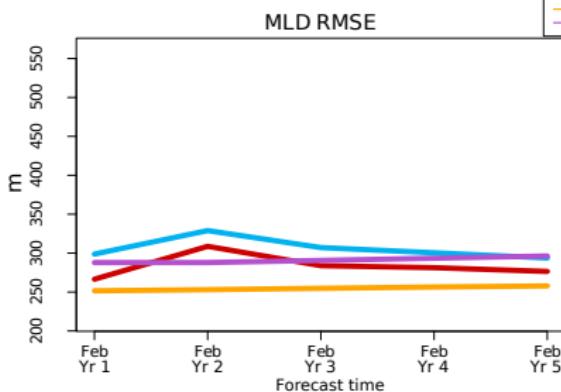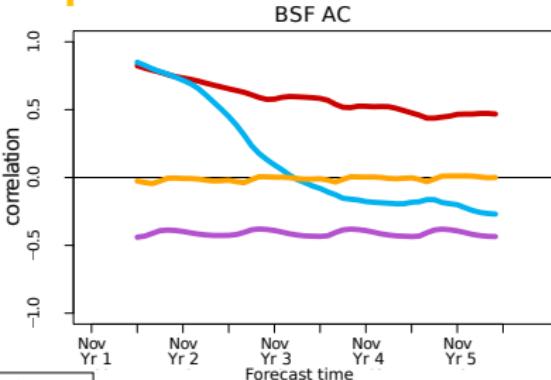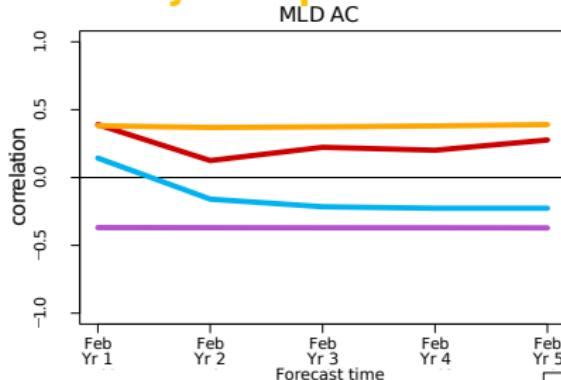
AMOC correlation
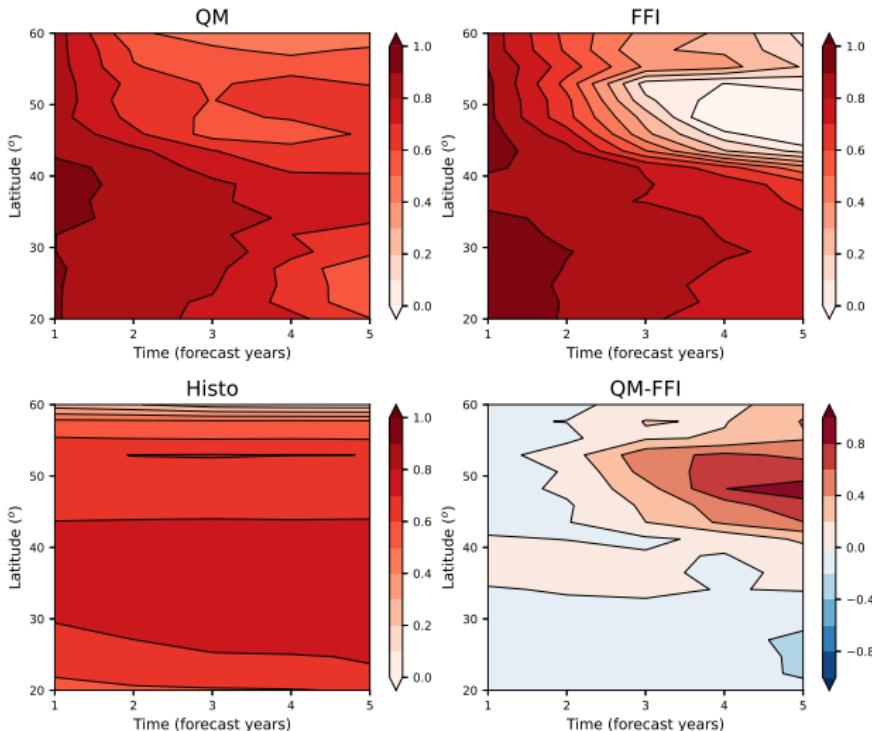
Summary

Issues to address

- The drift coming from initialising the predictions away from the model attractor;

- the inconsistencies between the observed/model variability amplitudes.

Quantile matching experiment

The initial condition is the model state which is identically located in the model distribution as the observed initial state in the observed distribution.

Results: improvements of the QM

- skill improvements in the subpolar gyre region for SST and ocean heat content throughout the whole forecast period.

- It avoids a collapse of deep convection in the Labrador Sea that occurred in FFI, although this does not translate into an improved skill compared to the historical simulations. $\rightarrow$ mixed layer depth signal is probably dominated by the trend.

- skill improvements in the western Subpolare Gyre region of the barotropic stream function.

- skill improvements of the AMOC during the whole forecast period at high latitudes.

Future work

- Use the QM technique to create the reference files for a nudging simulation of ocean (temperature and salinity) and sea ice (sea ice concentration);
- Use the nudging simulation to initialise all the model components and run the hindcasts.

Thank you!

Future work

Towards more consistency between the model components

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- Use the nudging simulation to initialise all the model components and run the hindcasts.

Thank you!

Volpi et al. (2021): Front. Clim. 3, doi: 10.3389/fclim.2021.681127.

Heat content 0-300m correlation with EN4 data
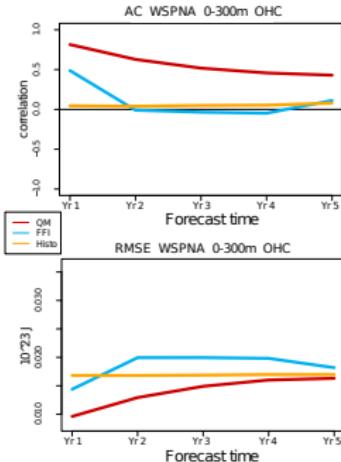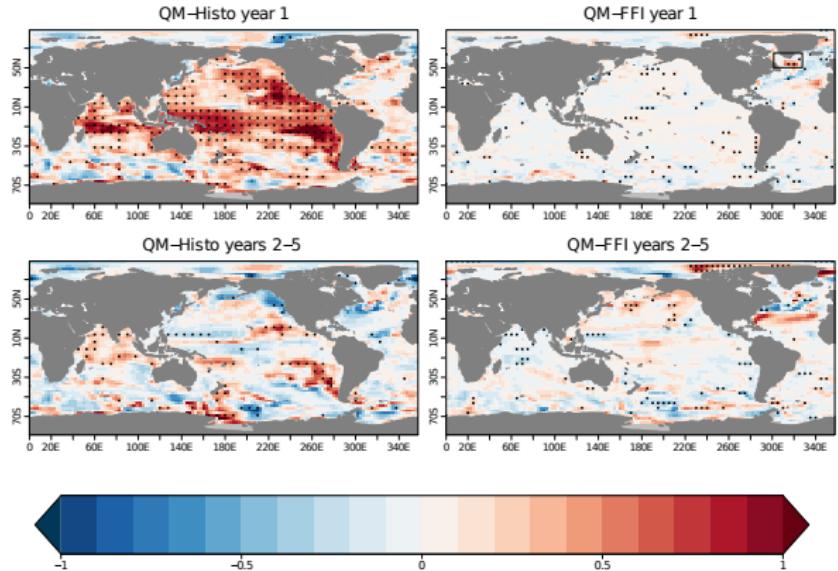
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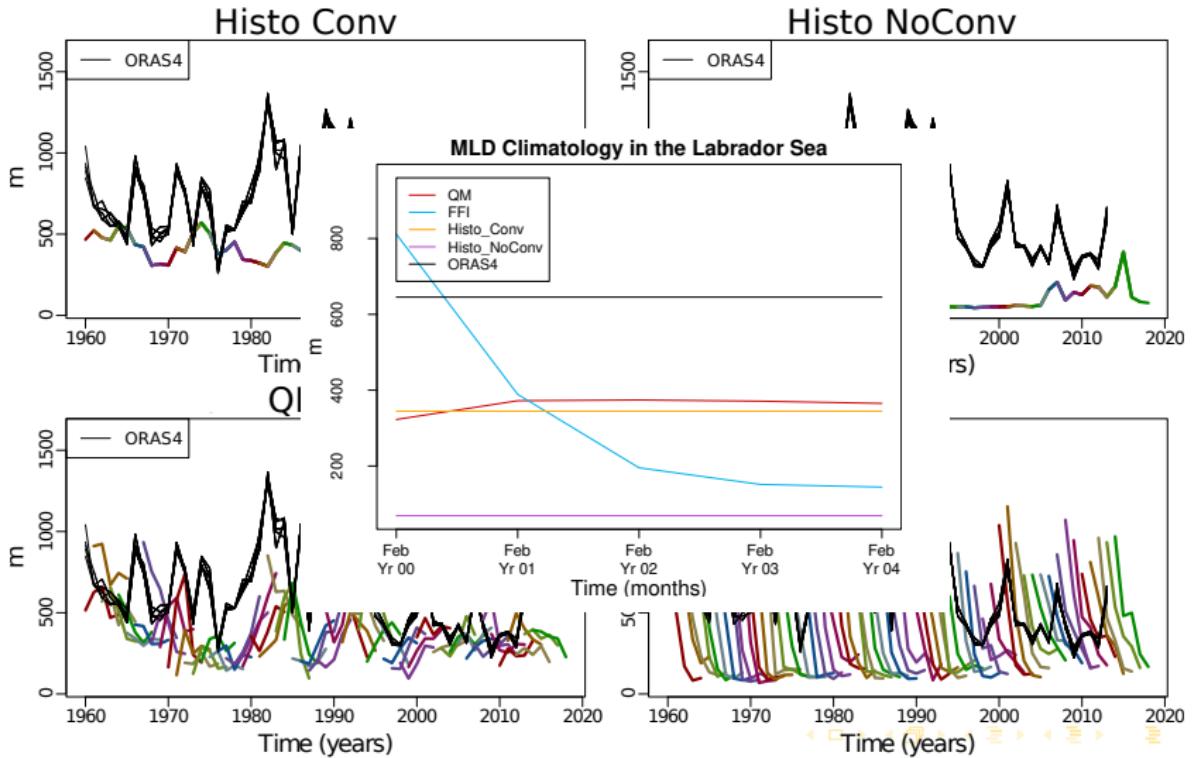
AMV
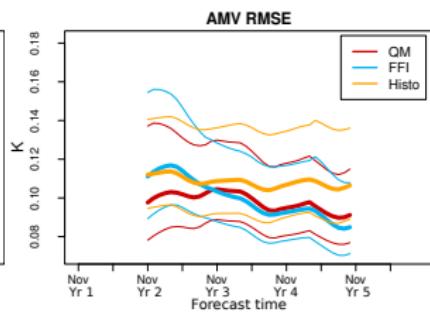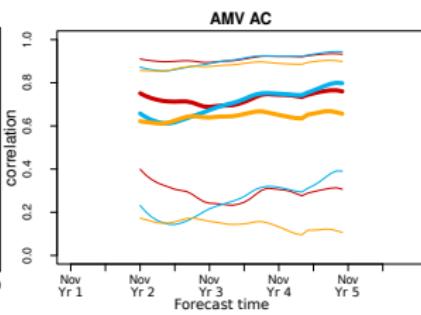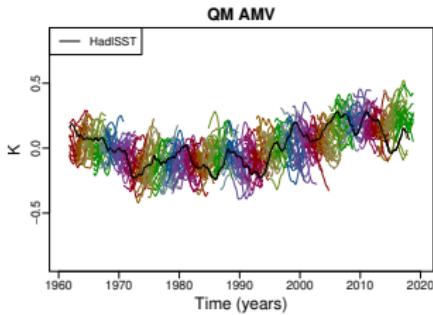
- Calculated as the difference between the regional SST anomalies in the North Atlantic (0° to 60° N and 80° to 0° W) and the global mean SST anomalies (between 60° S and 60° N)

Correlation for the surface temperature residuals
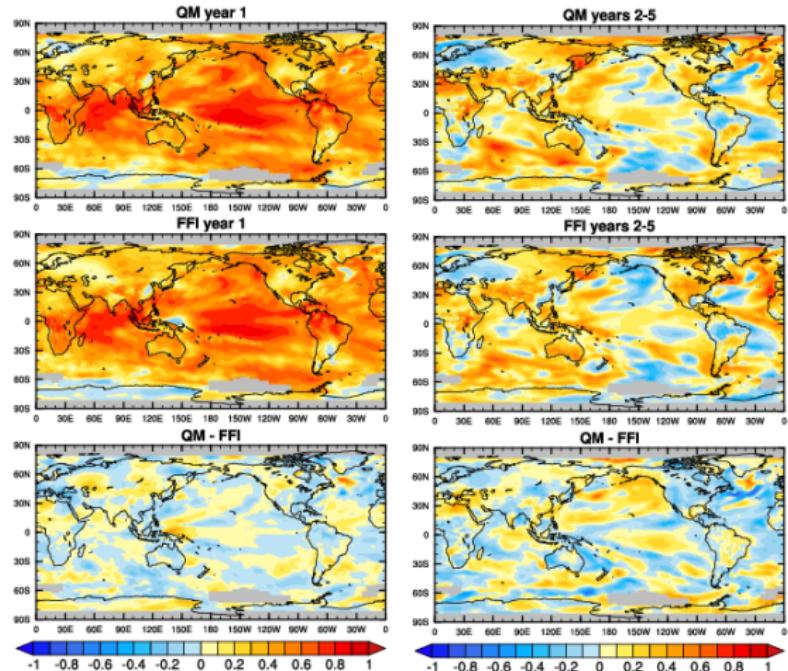
Comparison with Anomaly initialization hindcast
SST correlation difference using only 5 members

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