Two tales of initializing decadal climate predictions with ECHAM5/MPI-OM model

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Introduction

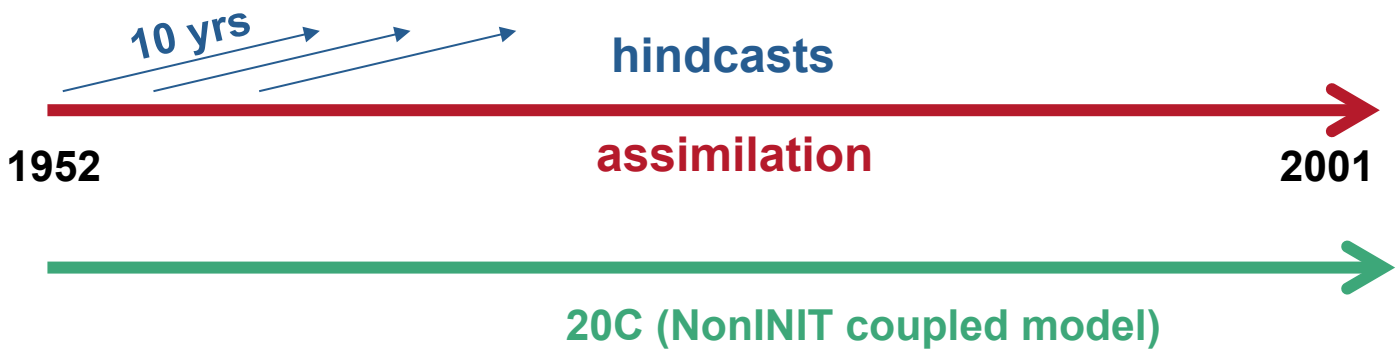
- Quantitative forecasts starting from ocean initial conditions that are based on a dynamically consistent reanalysis of past and present observations.
- We investigate decadal climate prediction with the MPI-M coupled climate model ECHAM5/MPI-OM considering two different initialization strategies:
  - Ocean reanalysis product
  - Ensemble of ocean-forced experiments

Outline

- Overview of decadal prediction system and initialization approaches
- Results of decadal prediction experiments
  - Focus on surface temperature and upper-ocean heat content
- Comparison with the MPI-M CMIP5 decadal prediction experiments
- Conclusions

Initialization by GECCO ocean synthesis

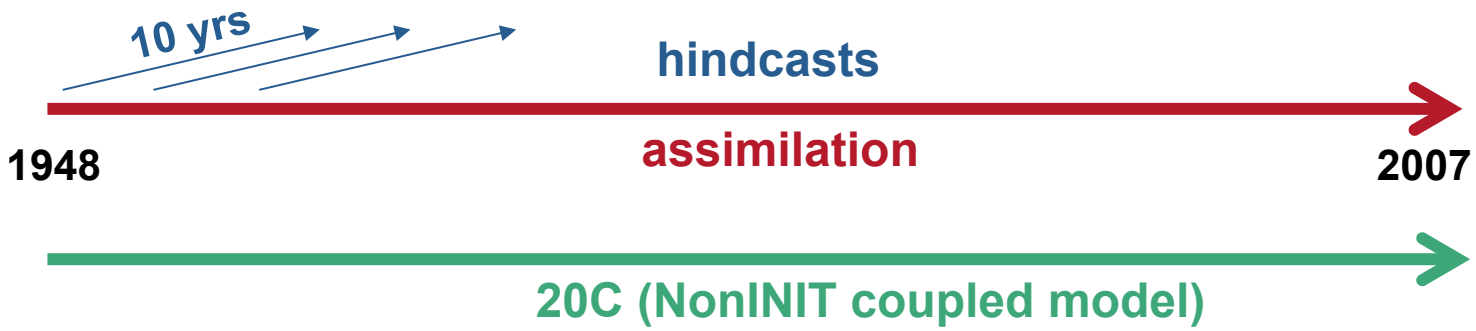
- **Model: ECHAM5/MPI-OM T63L31/1.5L40 (IPCC AR4 model).**
- **Include changes in greenhouse gases and sulphate aerosols (SRES A1B scenario); no volcanoes.**
- **Include initial condition information: assimilate 3D T&S from GECCO (1952-2001).**
- **No initialization in the top ocean model layer.**
- **Use anomalies to avoid model drift.**



Pohlmann et al. (2009)

Initialization by NCEP-forced MPI-OM

- The same ocean model for data synthesis and forecasts.
- Initial condition information: an ensemble of NCEP-forced MPI-OM integrations for the period 1948-2007.
- The ensemble mean 3D fields of T&S anomalies are nudged into the coupled model to create initial conditions for the hindcast experiments.
- Use anomalies to avoid model drift.



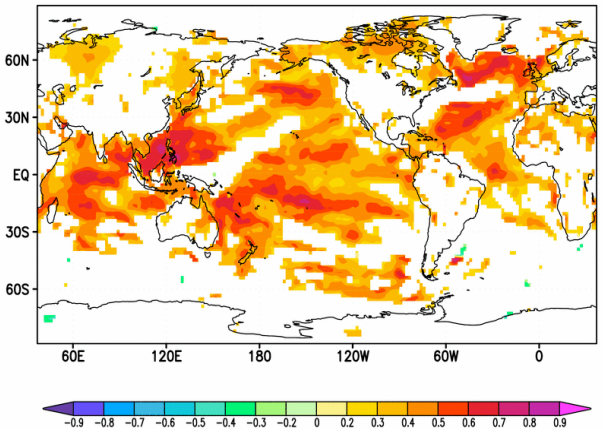
Matei et al. (2011)

Surface temperature predictability

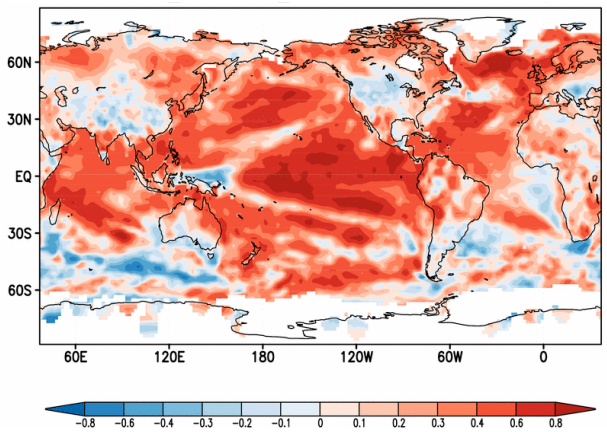
NCEP-hindcasts SST/SAT skill

Consistent picture of COR and RMSE skill scores

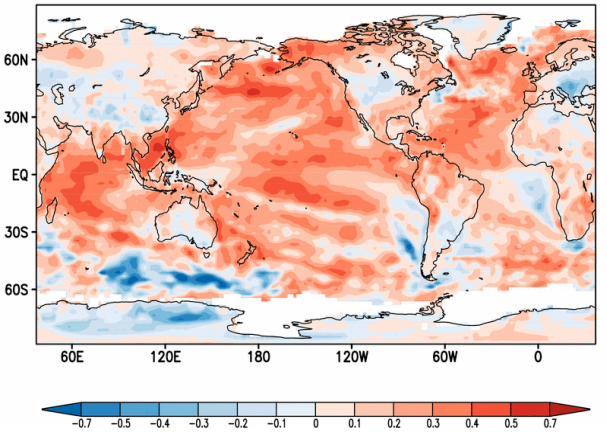
COR skill yr1



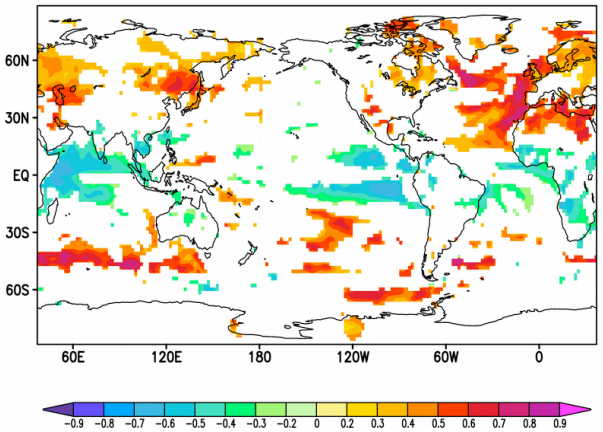
COR_{hind}-$COR_{NonINIT}$ yr1



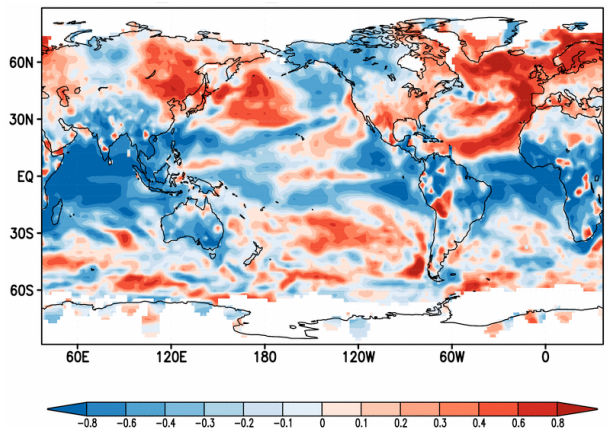
RMSE skill yr1



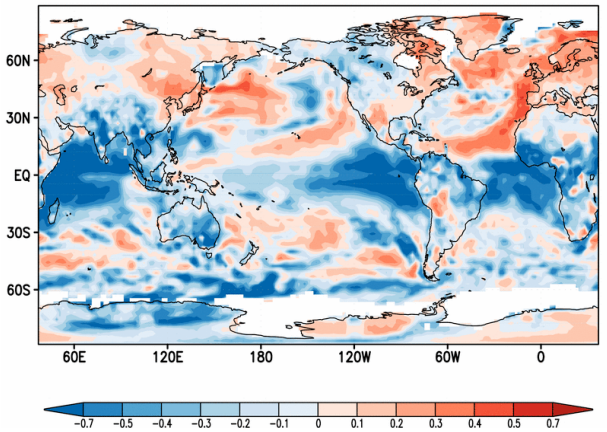
COR skill yr2-5



COR_{hind}-$COR_{NonINIT}$ yr2-5



RMSE skill yr2-5



Observations: HadISST (SST); NCEP GHCN/CAMS (SAT)

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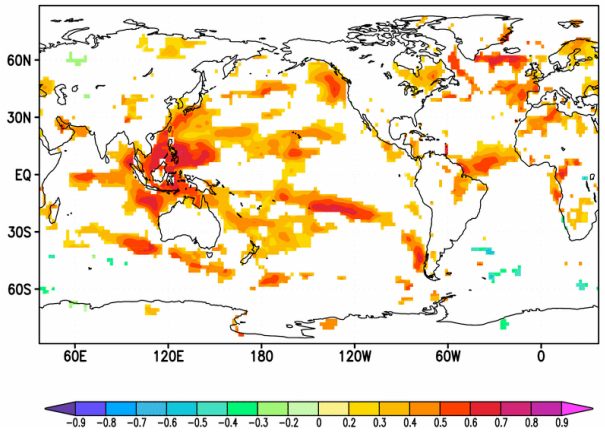
Matei et al. (2011)

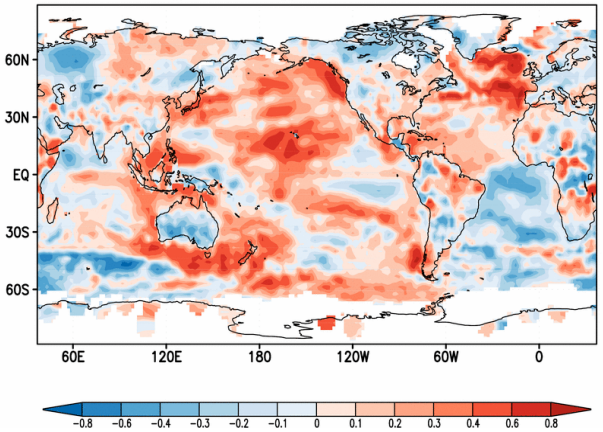
GECCO-hindcasts SST/SAT skill

Different picture of COR and RMSE skill scores

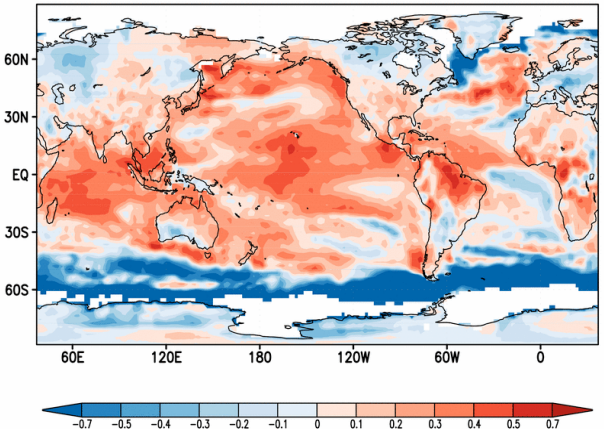
COR skill yr1



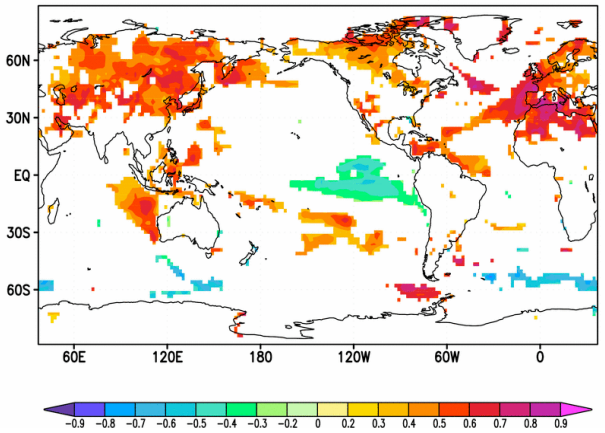
COR_{hind}-$COR_{NonINIT}$ yr1



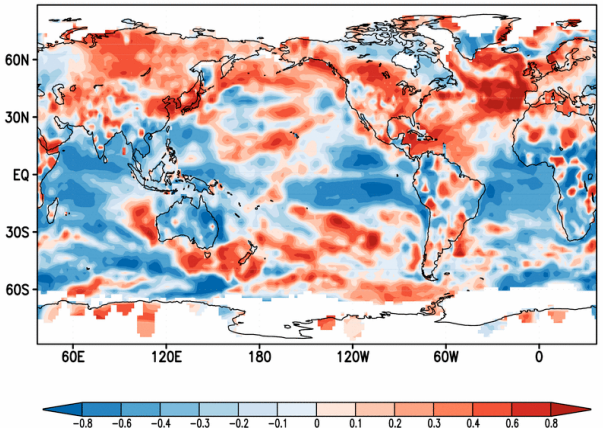
RMSE skill yr1



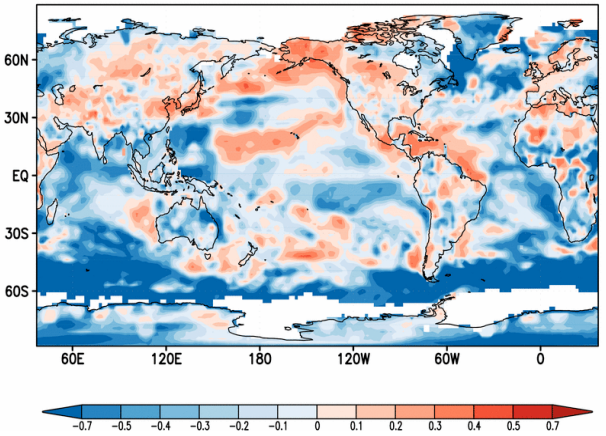
COR skill yr2-5



COR_{hind}-$COR_{NonINIT}$ yr2-5



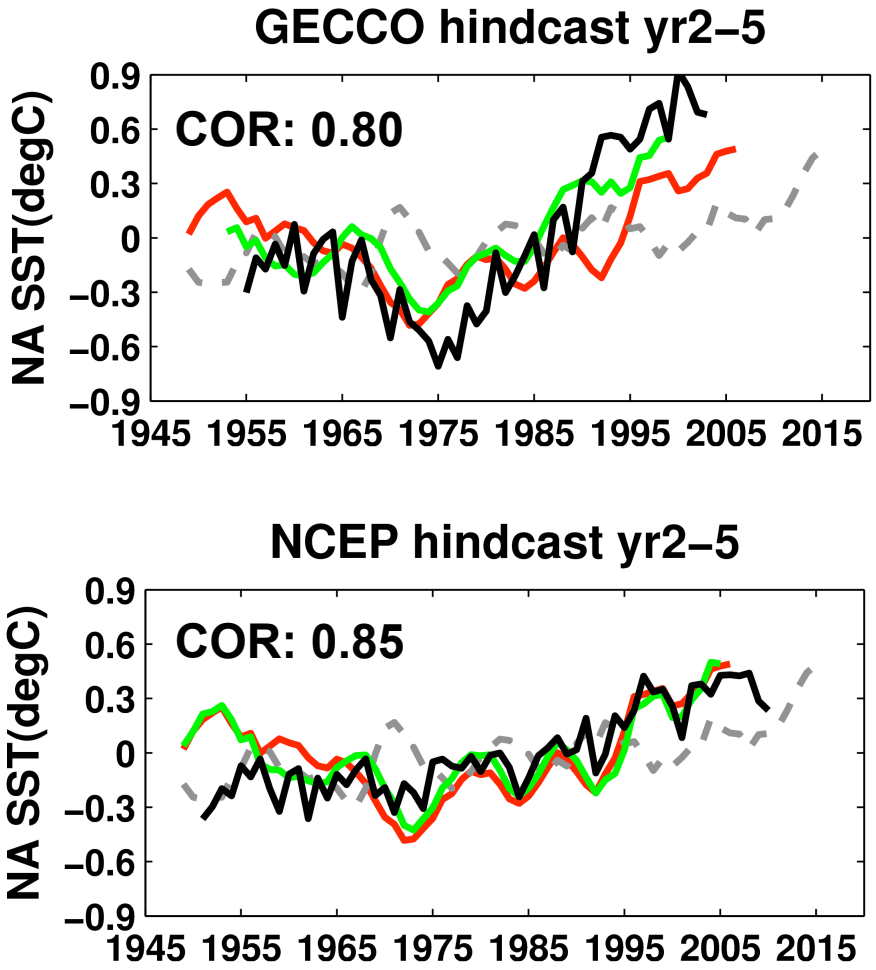
RMSE skill yr2-5

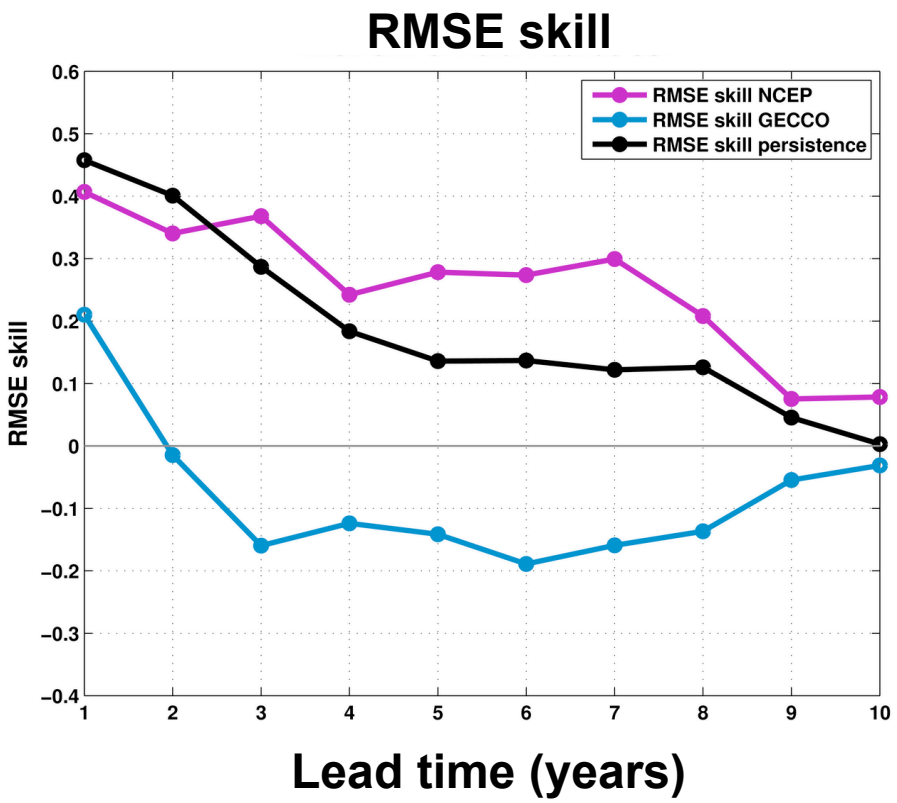


Observations: HadISST (SST); NCEP GHCN/CAMS (SAT)

Matei et al. (2011)

Forecast skill of North Atlantic SST

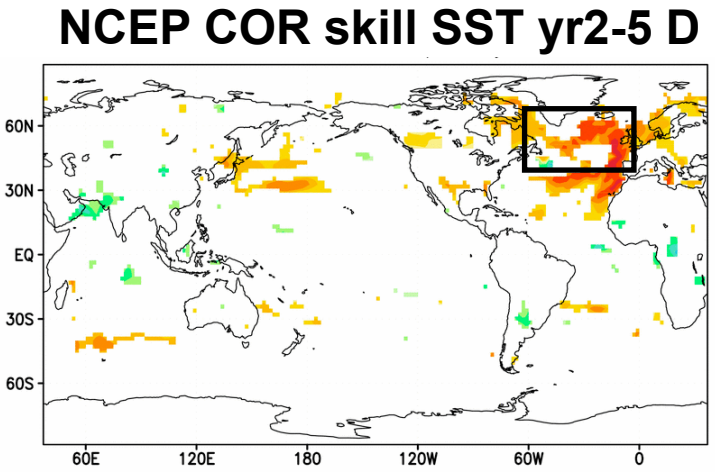


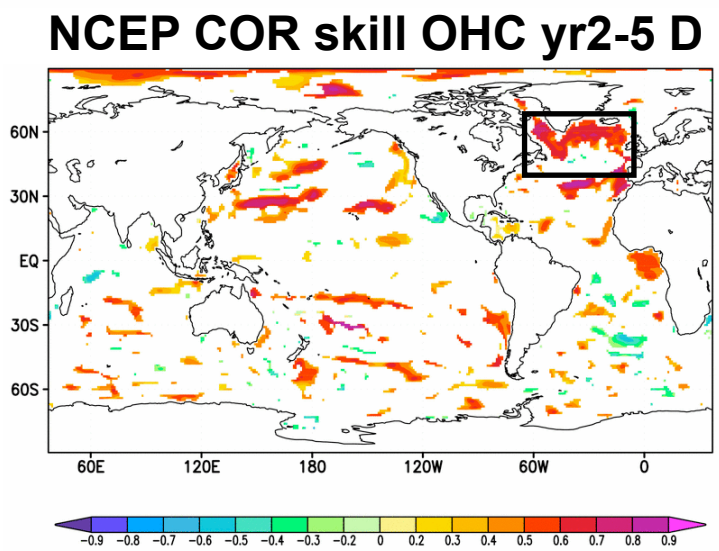


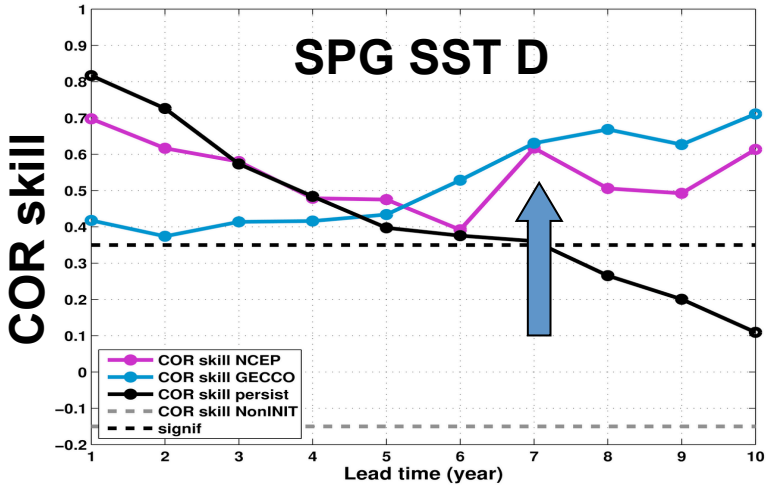
Observations **Assimilation** **Hindcast** **NonINIT**

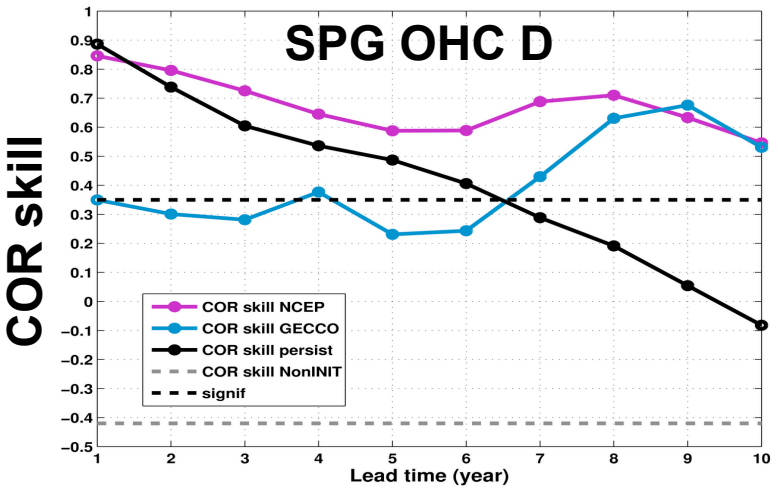
Matei et al. (2011)

Forecast skill of Subpolar Gyre SST and upper-ocean heat content









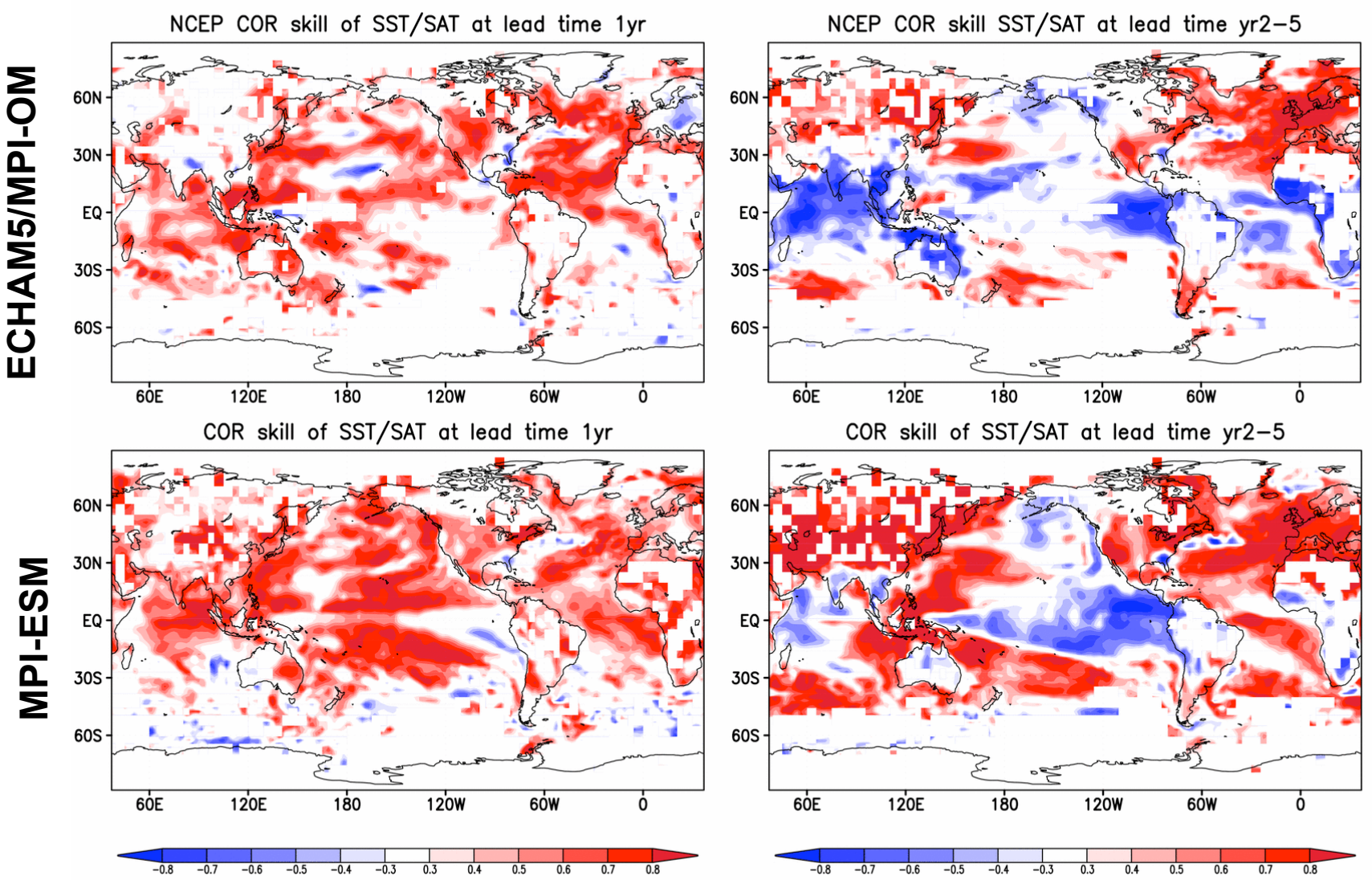
Observations: HadISST (SST); OHC (NODC)

Preliminary results from MPI-M CMIP5 decadal predictions

CMIP5 MPI-M decadal prediction setup

- MPI-ESM:
  - ECHAM6 T63L47/MPI-OM GR15L40
  - Initialisation from NCEP-forced MPI-OM covering 1948-2010
  - An ensemble of 10 hindcasts are performed initialised end of 1960,1965… 2010
  - Ensemble generation by lagged-initialisation (atm & oc perturbation)
  - Includes vulcanic forcing

Forecast skill SST/SAT: ECHAM5/MPI-OM (AR4) vs. MPI-ESM (CMIP5)



Conclusions

- **Significantly enhanced predictive skill through initialization for North Atlantic and Mediterranean SST up to a decade in advance. Over land, SAT skill improvement is found over north-western Europe, Northern Africa, and central-eastern Asia.**
- **North Atlantic Subpolar Gyre region stands out as the region with the highest predictive skill beyond the warming trend, in both SST and upper ocean heat content predictions.**
- **The dominant mechanism for North Atlantic climate predictability can be attributed to the initialization of the AMOC. (AMOC predictability - poster TH77A, Session C37).**
- **Ocean experiments forced with the observed history of the atmospheric state constitute a simple but very successful alternative strategy for the initialization of skilful climate predictions over the next decade.**
- **MPI-ESM shows skill improvement over the tropical Pacific and Eurasian continent when compared to ECHAM5/MPI-OM.**

THANK YOU!