Koninklijk Nederlands
Meteorologisch Instituut
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Multiyear climate predictions using two initialization strategies

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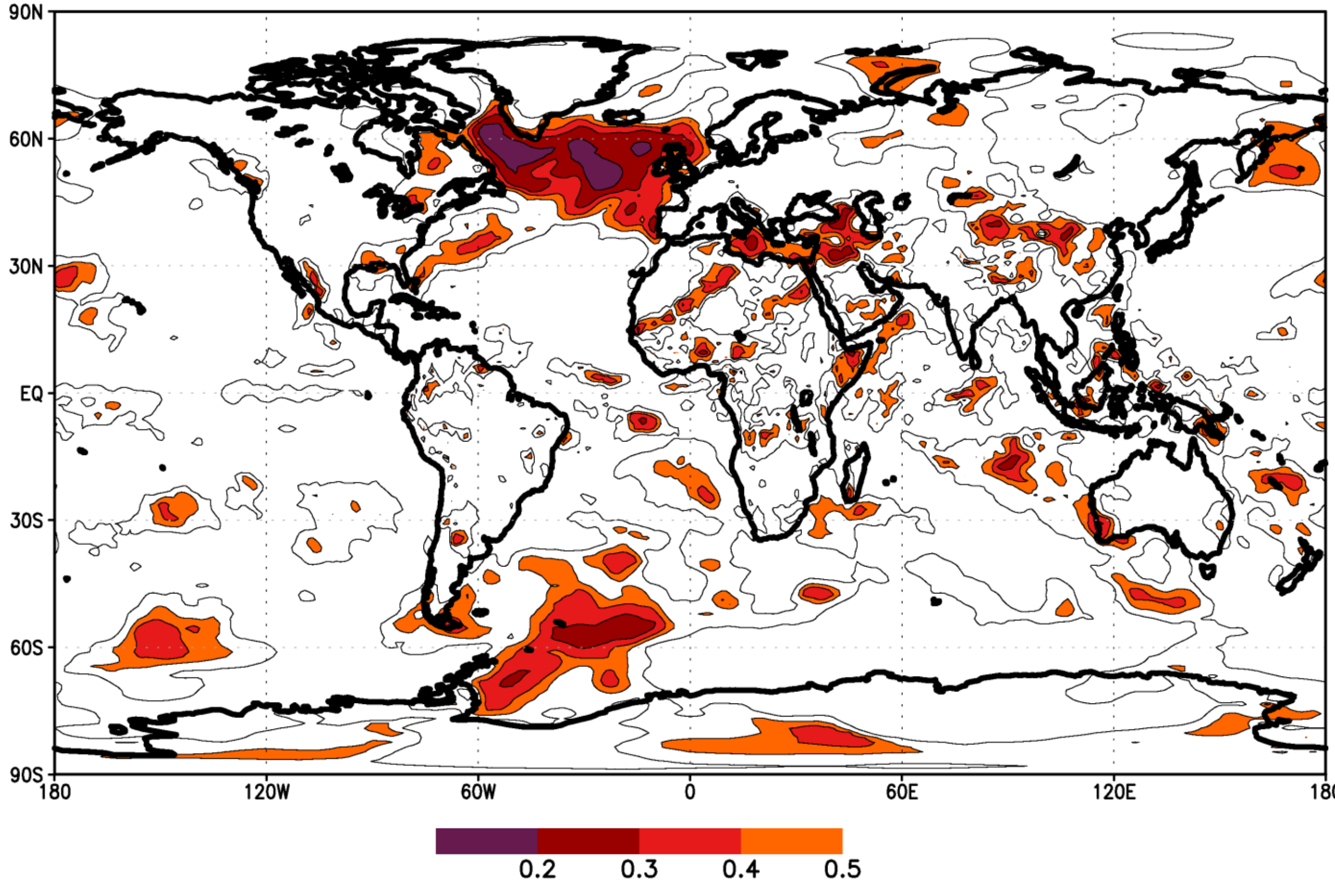
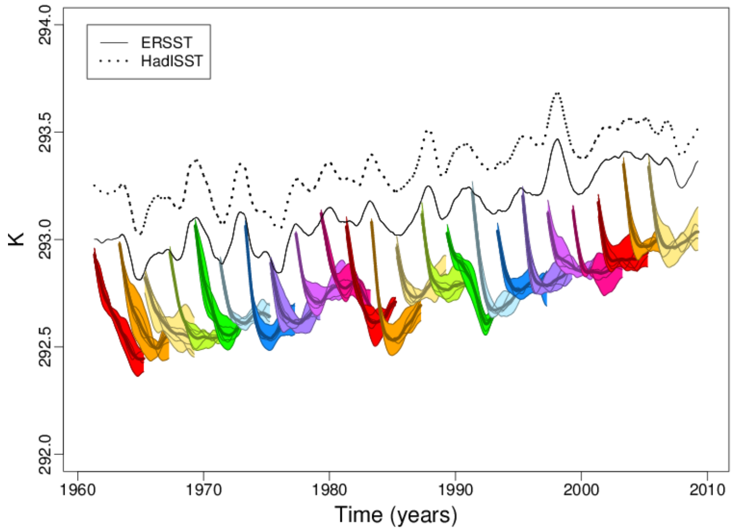
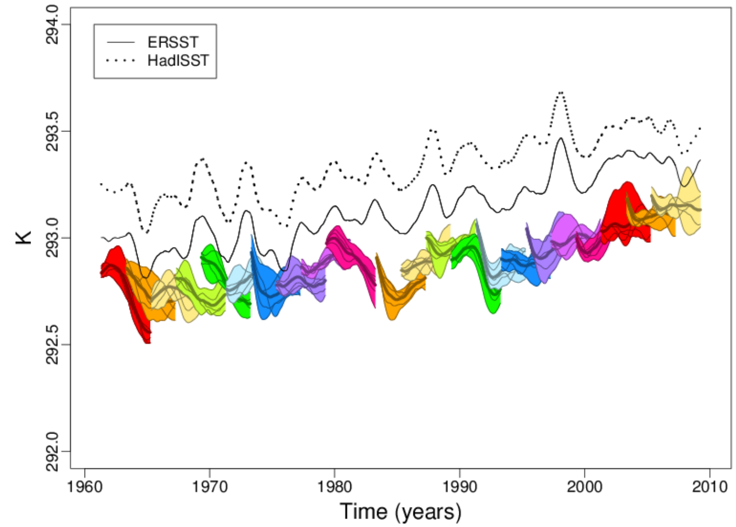
Prognostic potential predictability in EC-Earth (T2m, yr 1-10; without trend)



T. Koenigk, SMHI, pers. comm.

Questions for initialized decadal predictions





See poster *D. Volpi et al* for more details

- What is the impact of different initialization strategies on drift and skill within one coupled model

- What is the impact of sampling (1 yr vs 5 yr start dates) on skill within one coupled model

EC-EARTH experiments

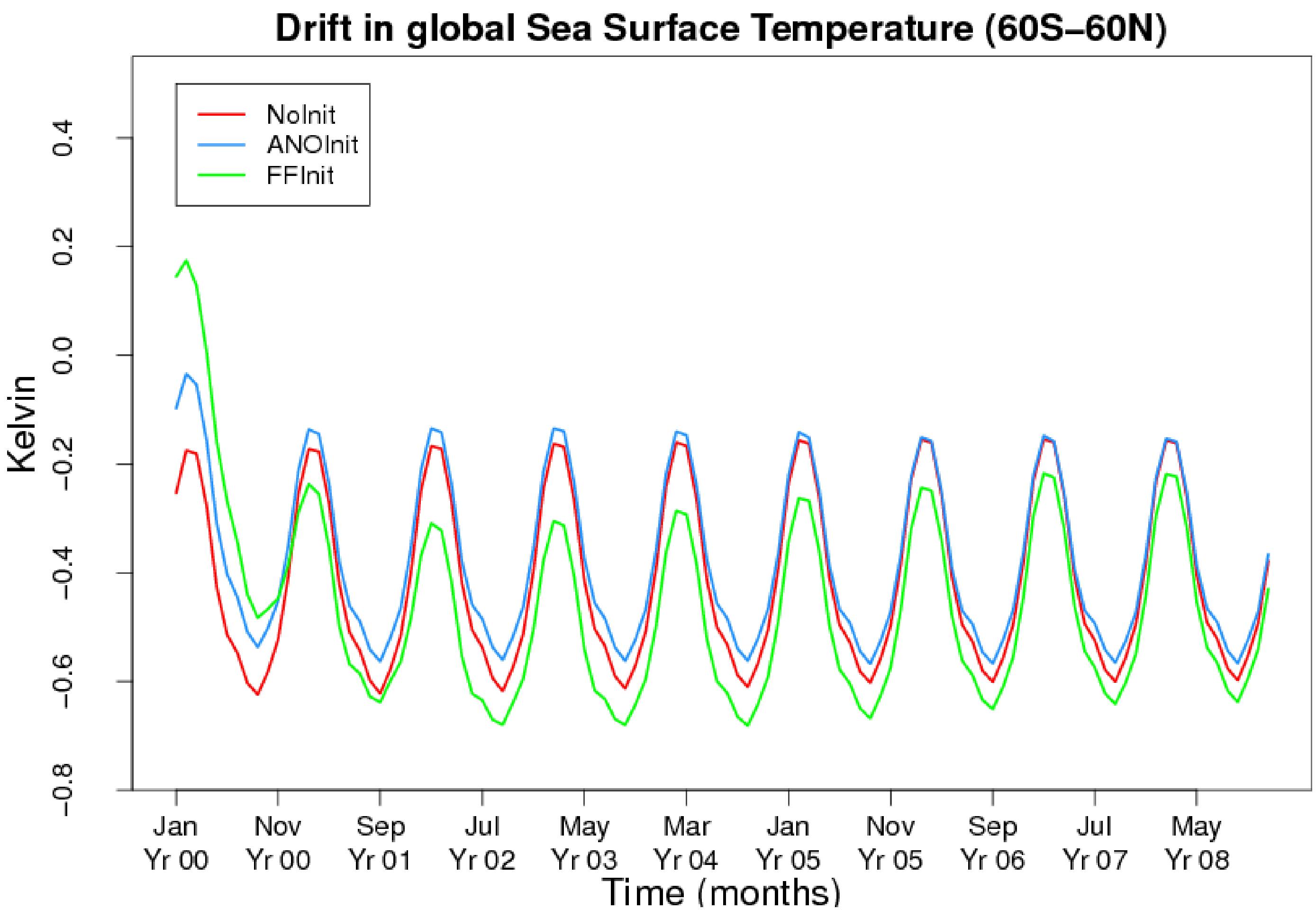
- EC-Earth V2.3 (CMIP5 version, T159L62 IFS, 1 degree NEMO)

- Initial conditions: ERA40/interim atmosphere land,ORAS4 ocean, ice from Drakkar V4.3 forced ocean/ice model

FULL state initialisation for atmosphere and ocean

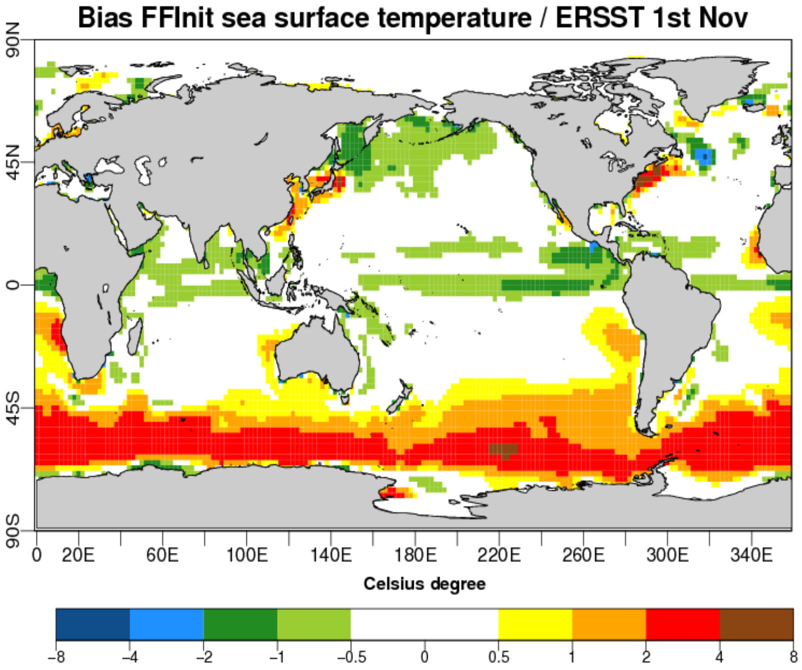
ANOM initialisation (anomaly on top of climatology from historical runs) for ocean and sea ice.

- 10 members at each starting date for FULL, 5 for ANOM
- New compared to GRL paper: **1) annual start dates 2) three methods for anomaly initialisation**

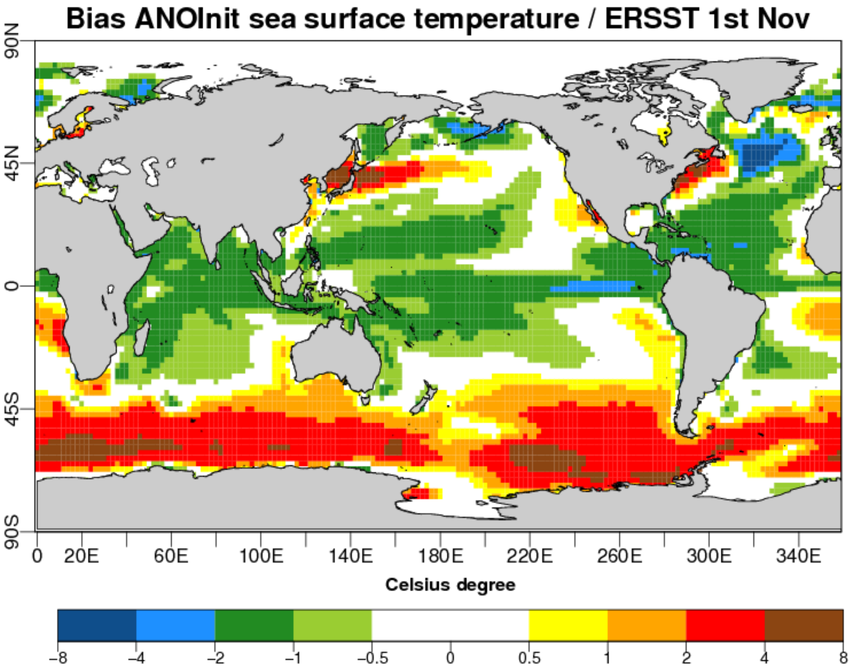

Drift in global Sea Surface Temperature (60S–60N)
NoInit
ANOInit
FFInit
Kelvin
0.4
0.2
0.0
−0.2
−0.4
−0.6
−0.8
Jan Yr 00
Nov Yr 00
Sep Yr 01
Jul Yr 02
May Yr 03
Mar Yr 04
Jan Yr 05
Nov Yr 05
Sep Yr 06
Jul Yr 07
May Yr 08
Time (months)

Bias after 3 months

Full

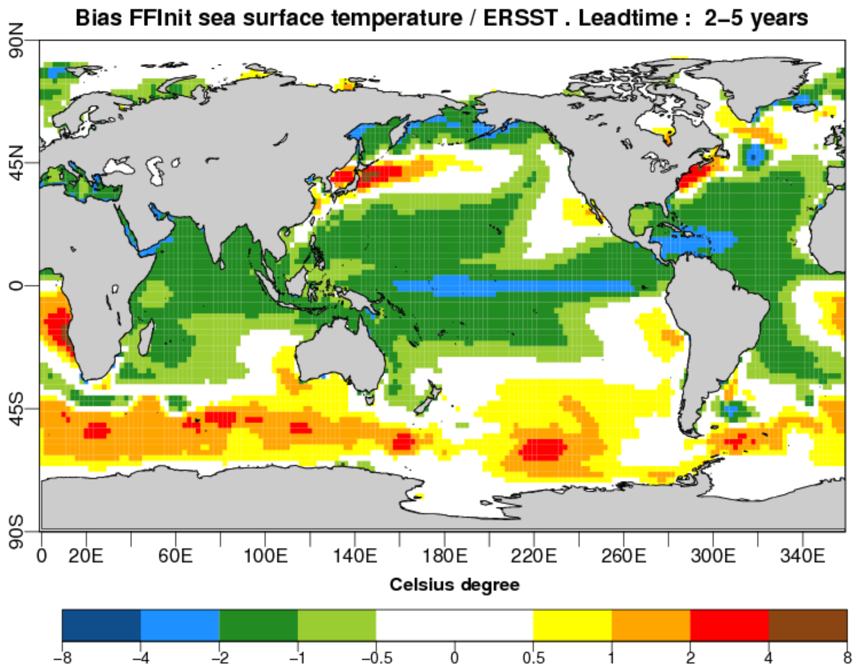


Anomaly

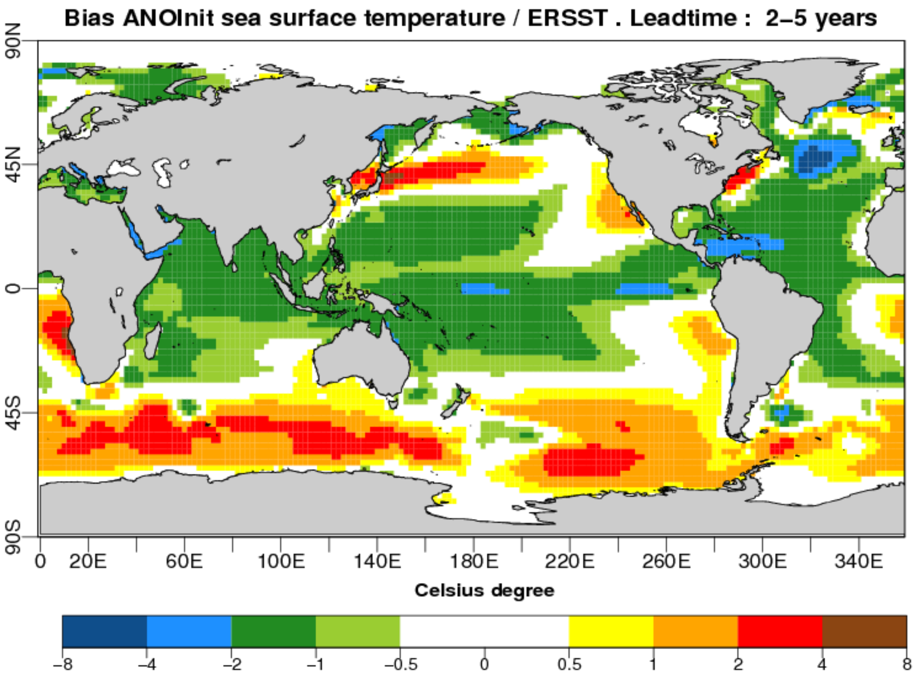


Bias after 2-5 years

Full

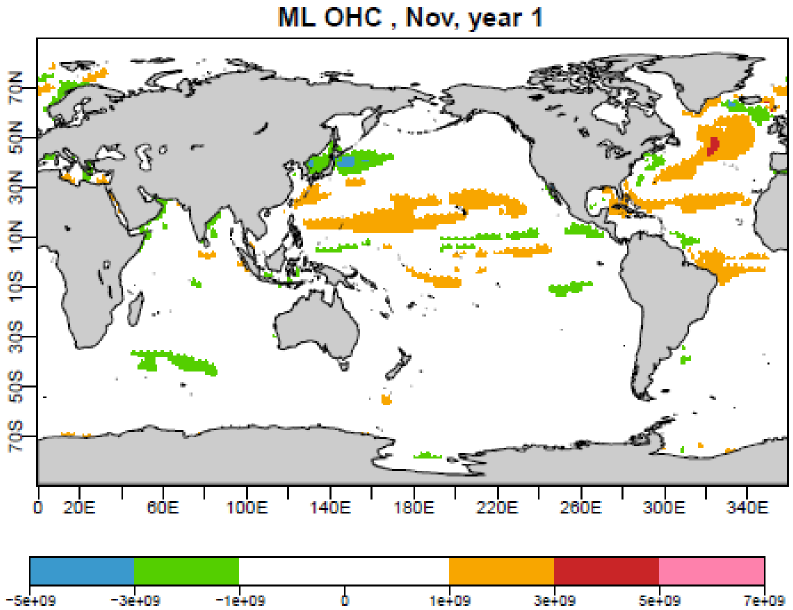


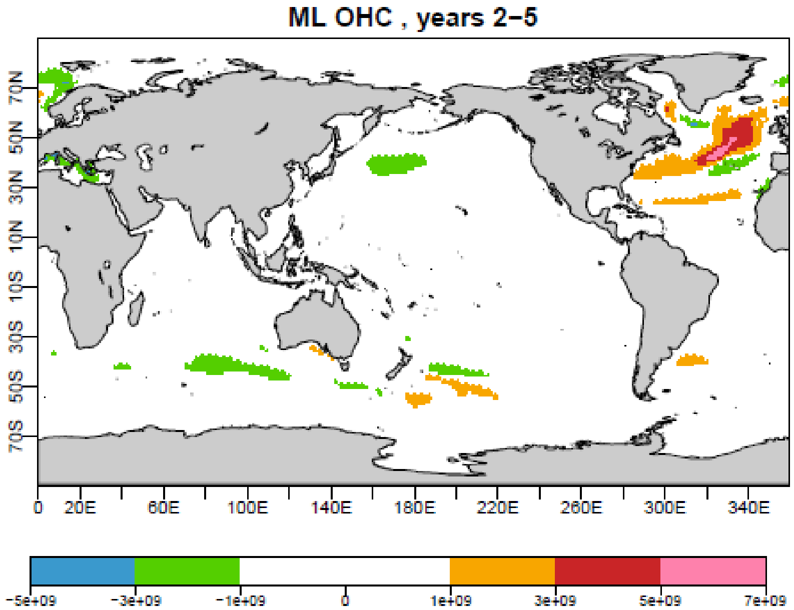
Anomaly



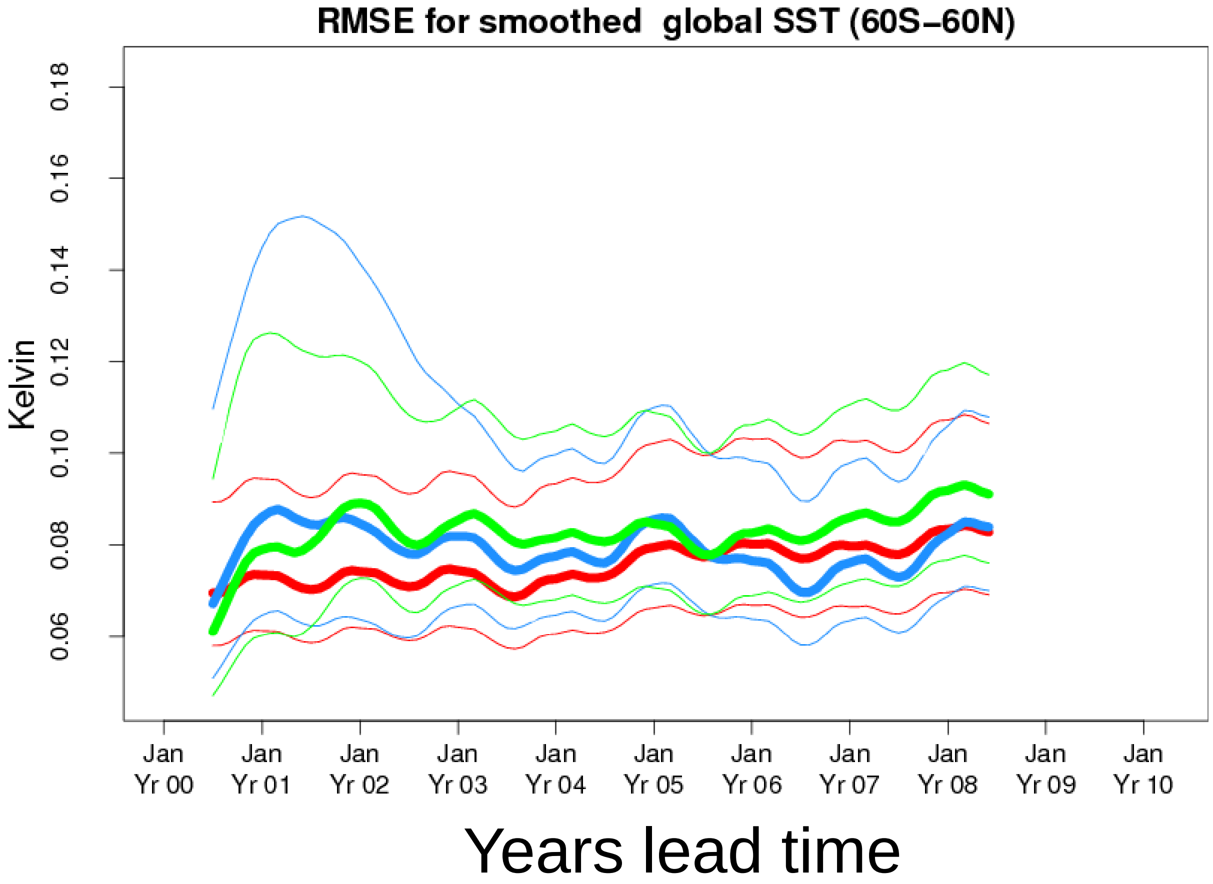
Mixed layer heat content

(ANOM minus FULL)





RMSE of reforecasts (global)

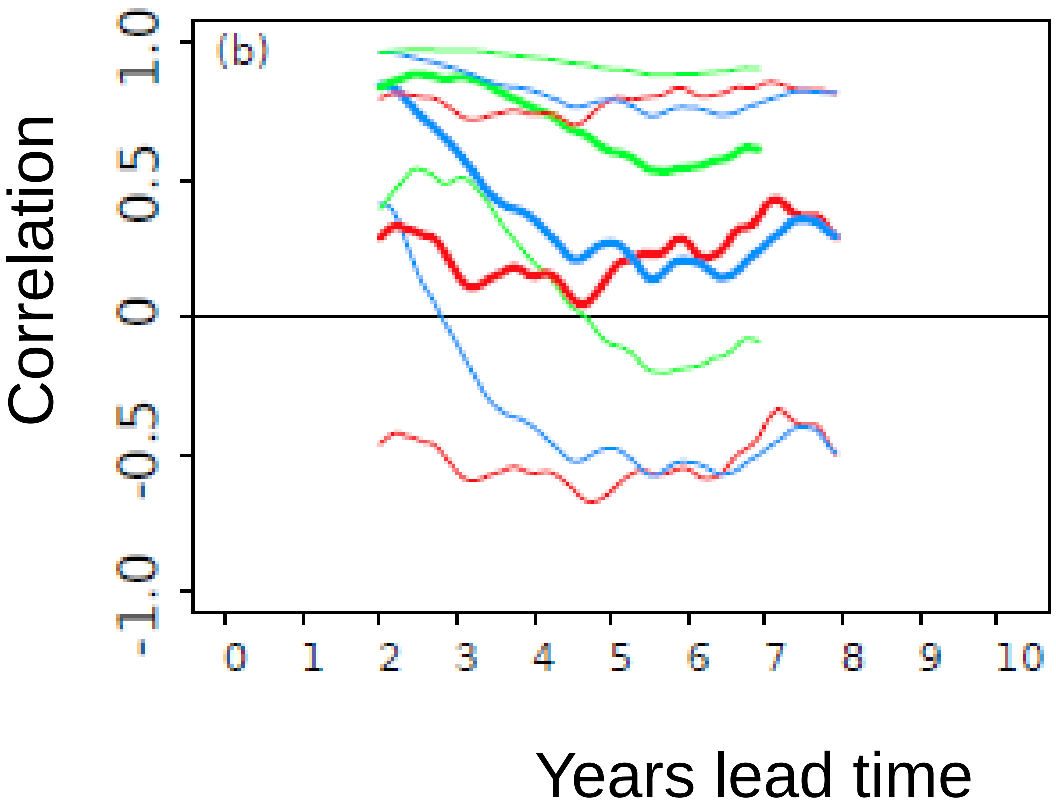


FULL

ANOM

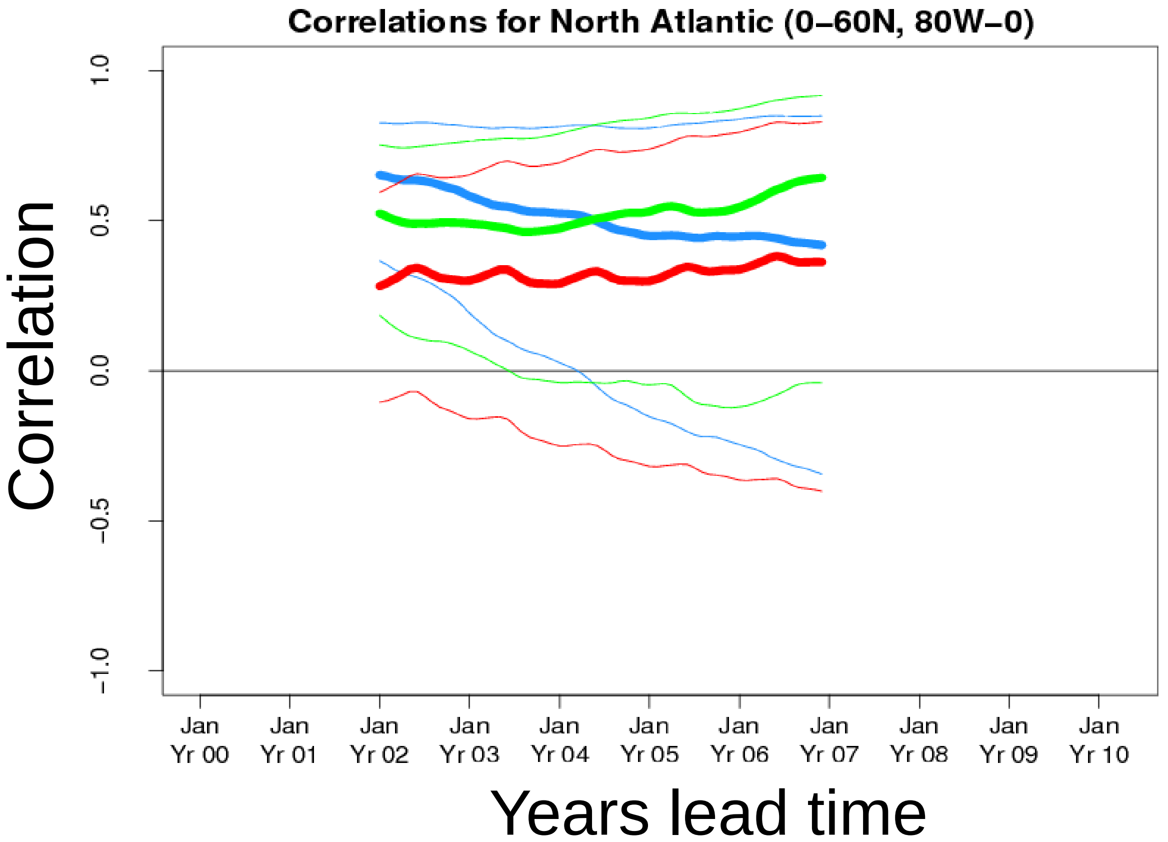
NOINIT

North Atlantic scores with 5 yearly start dates



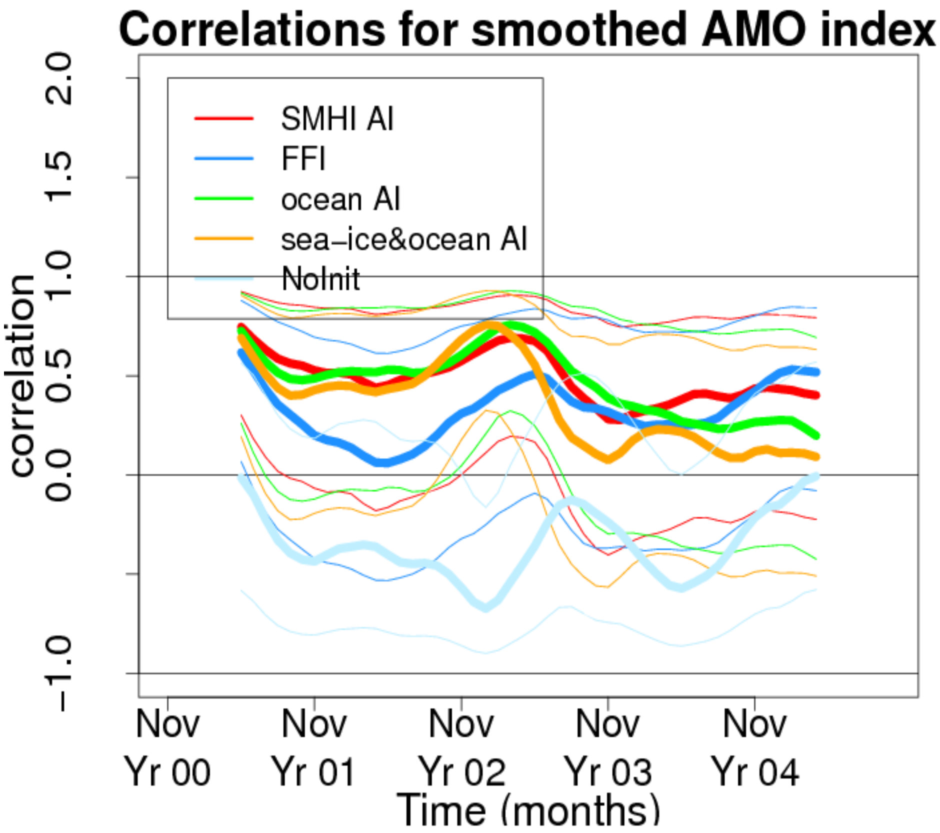
FULL
ANOM
NOINIT

North Atlantic scores with annual start dates



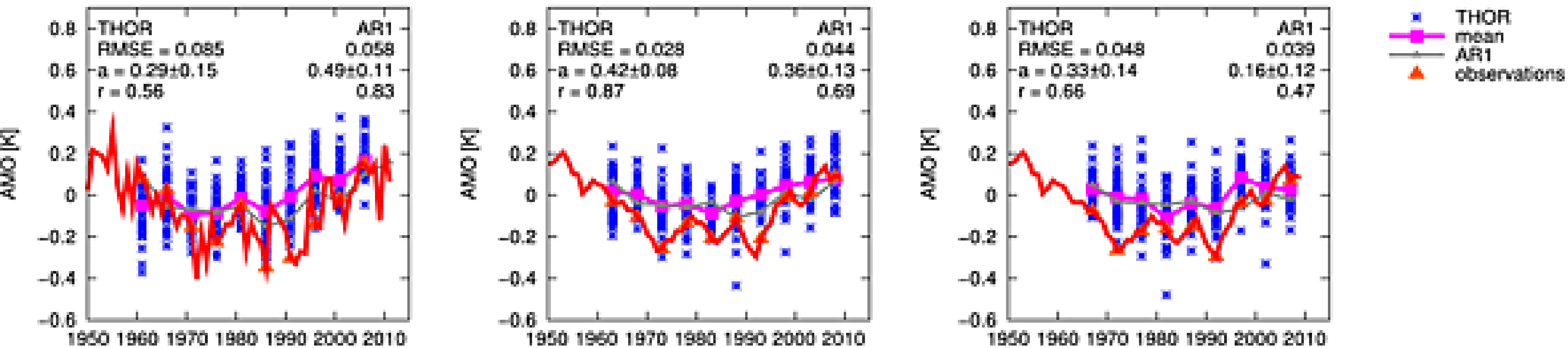
FULL
ANOM
NOINIT

North Atlantic scores with alternative anomaly initialisation



But…hard to beat damped persistence

1 yr | 2-5 yr | 6-9 yr



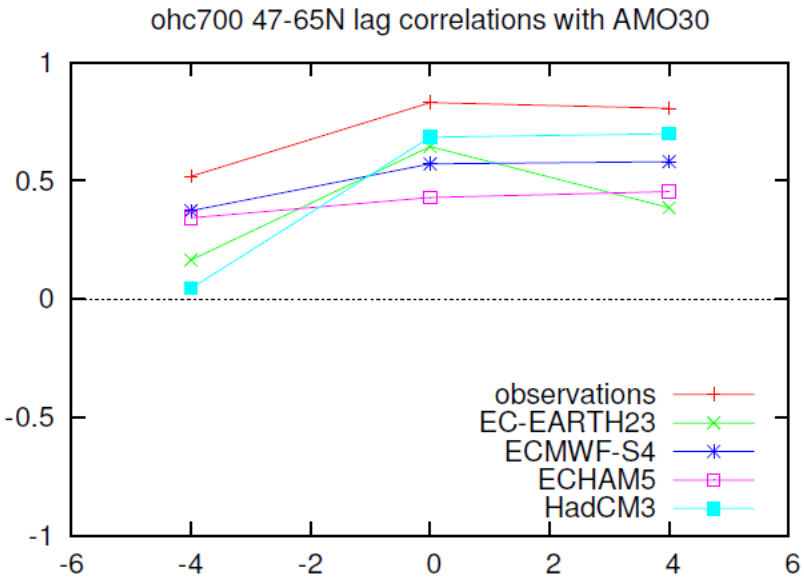
r_{model}=0.56
r_{ar1} =0.83

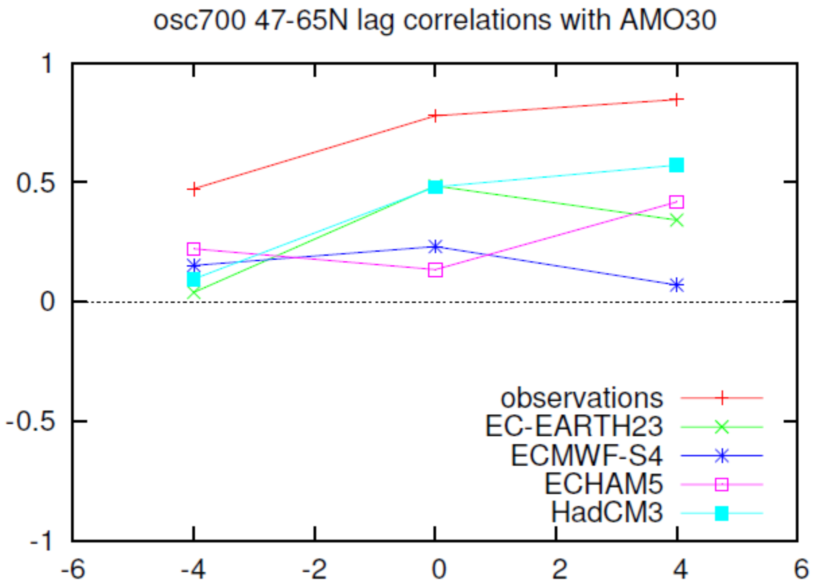
r_{model}=0.87
r_{ar1} =0.69

r_{model}=0.66
r_{ar1} =0.47

Hazeleger et al. Predicting multiyear North Atlantic Ocean variability
JGR Oceans 2013

But…models get skill for different reasons





← AMO lags AMO leads →

← AMO lags AMO leads →

Lagged correlations between ocean heat content (0-700m) in subpolar gyre and the AMO

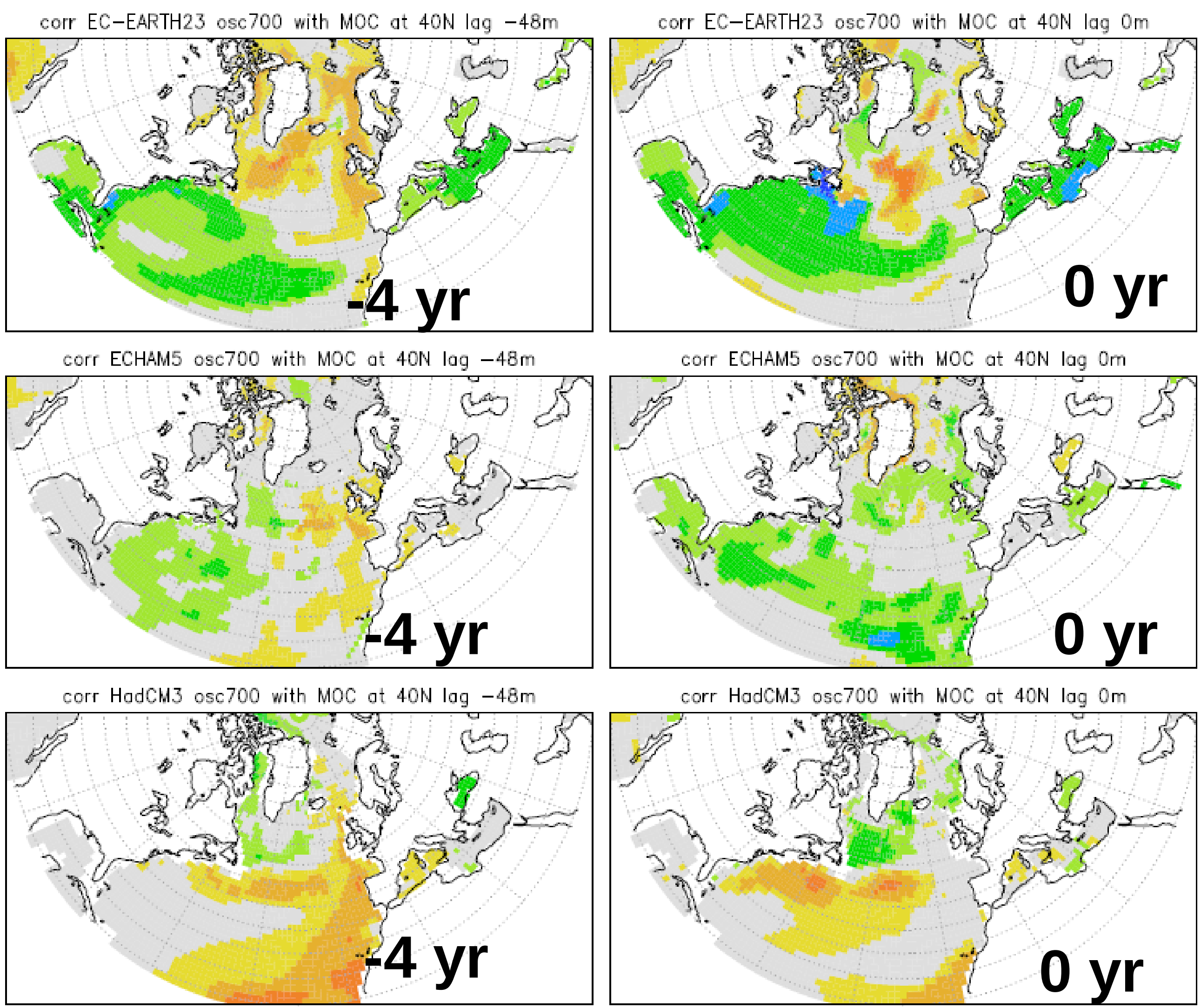
Hazeleger et al. Predicting multiyear North Atlantic Ocean variability
JGR Oceans 2013

Salt content – MOC relation

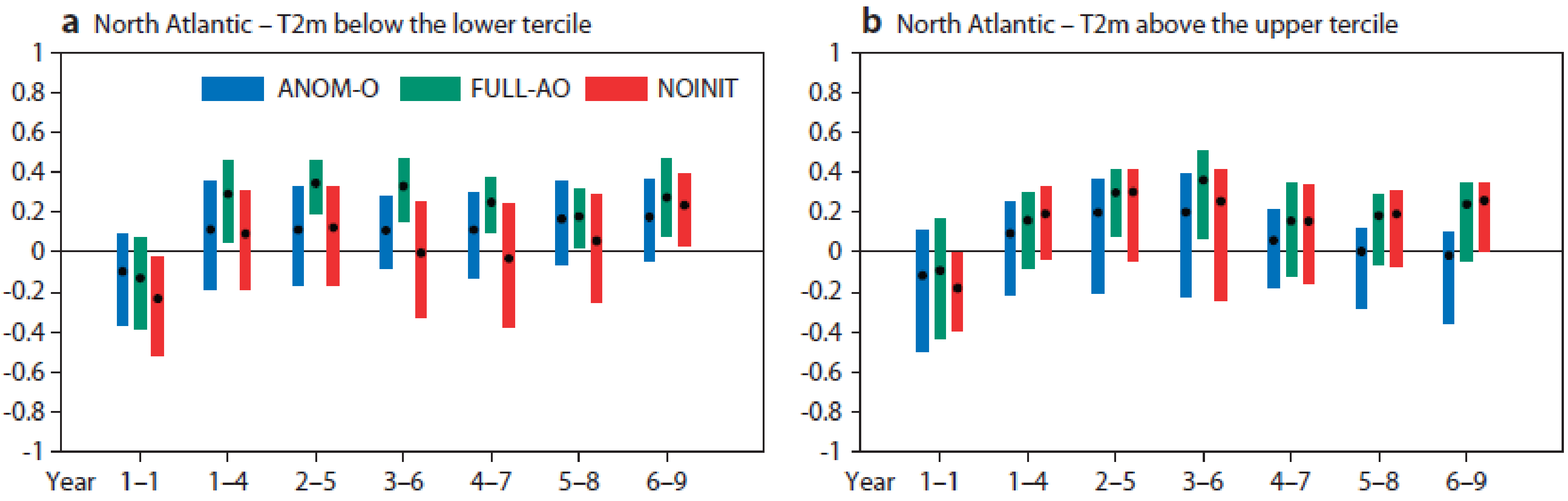
EC-Earth V2.3

ECHAM5-OM

HADCM3

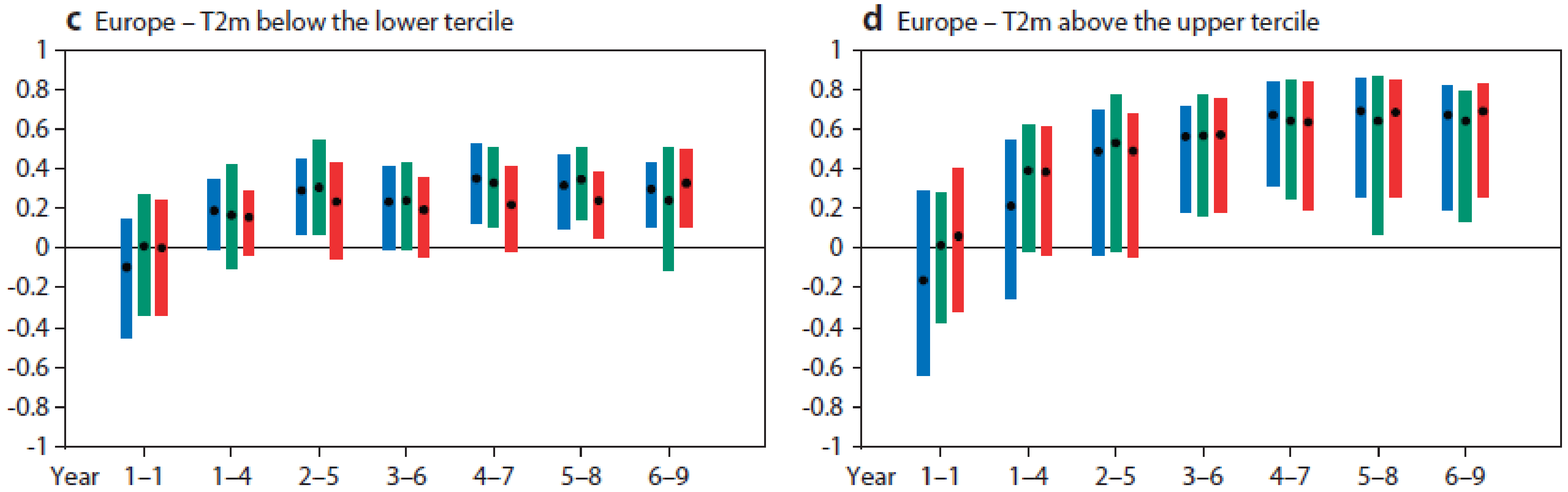


North Atlantic probabilistic skill scores



Brier skill score: compares predicted probability of events to a climatological reference forecast (based on 5 yr restarts).

Europe probabilistic skill scores



FULL

ANOM

NOINIT

Conclusions full state vs anomaly initialization

Drift is highest in FULL and can be traced back to known biases in EC-Earth

Warm Southern Ocean bias develops fast → atmospheric processes
Cold bias develops slower → atmospheric & oceanic processes

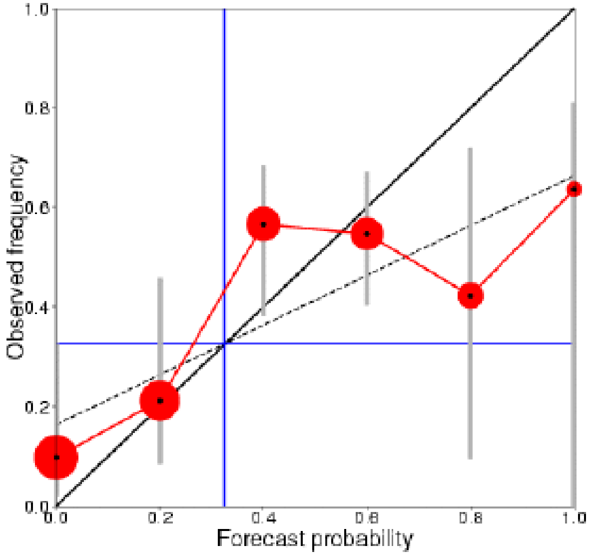
FULL and ANOM have similar skill scores. Most skill from external forcing except for North Atlantic, where ANOM outperforms FULL

Indication for probabilistic skill over Europe on multiyear time scales

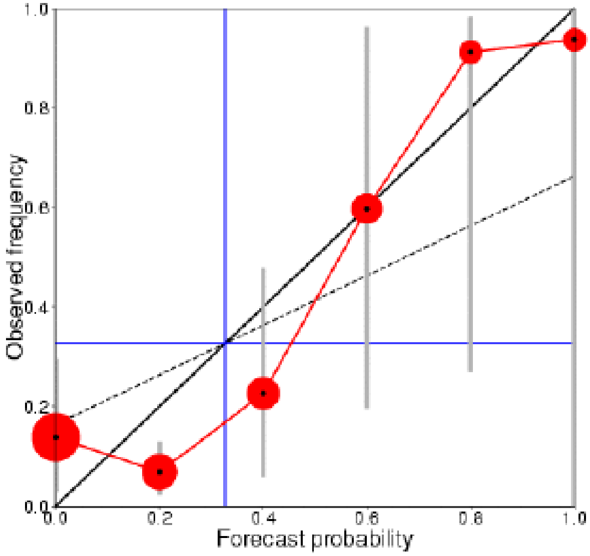
But … Sampling has substantial impact on skill scores

But … This is a single model study using statistical scores, but mechanisms differ among models and should be understood and verified against observations!

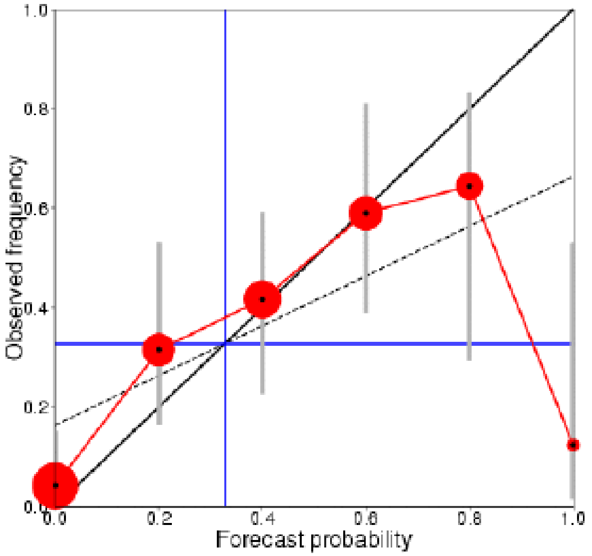
a) T2m Europe (land only) 2-5 yr NOINIT
Below lower tercile



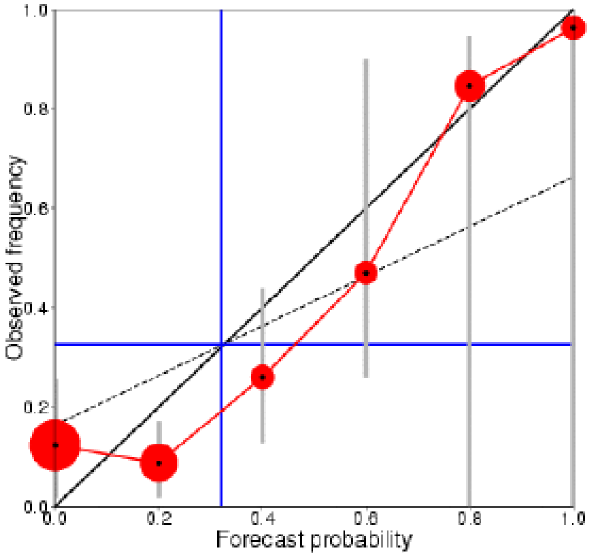
b) T2m Europe (land only) 2-5 yr NOINIT
Above upper tercile

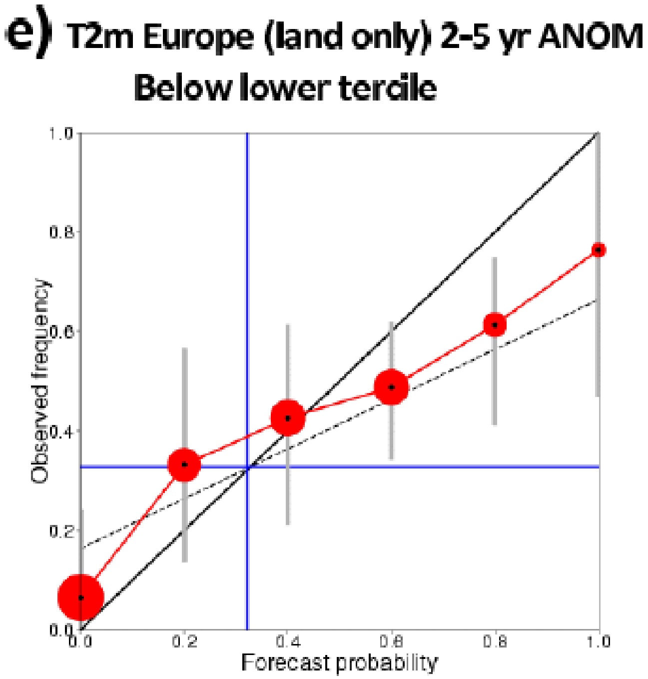


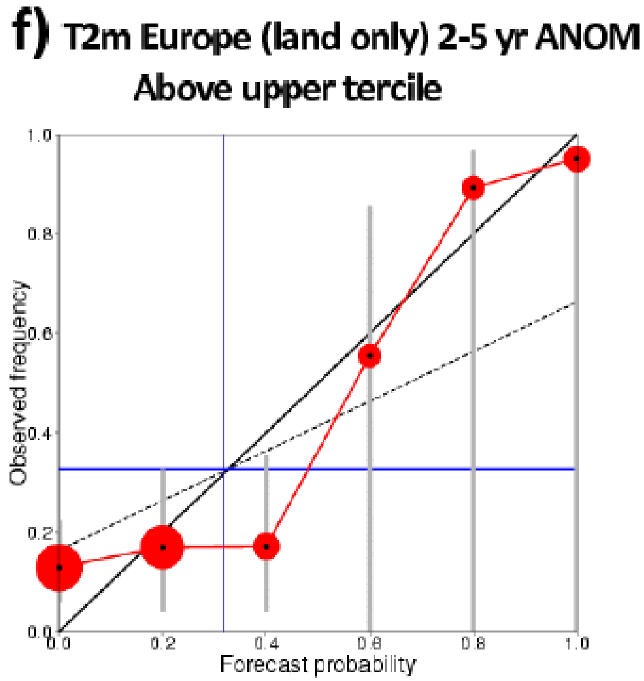
c) T2m Europe (land only) 2-5 yr FULL
Below lower tercile



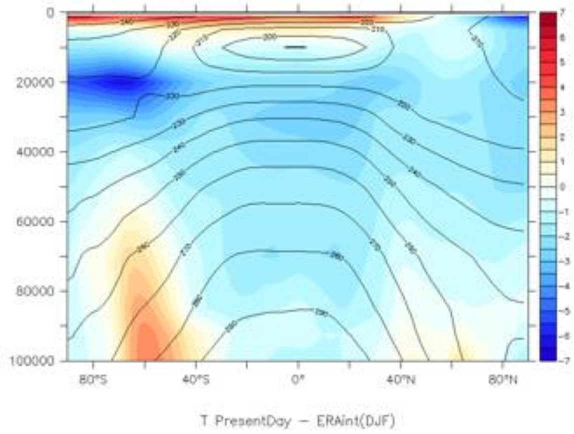
d) T2m Europe (land only) 2-5 yr FULL
Above upper tercile

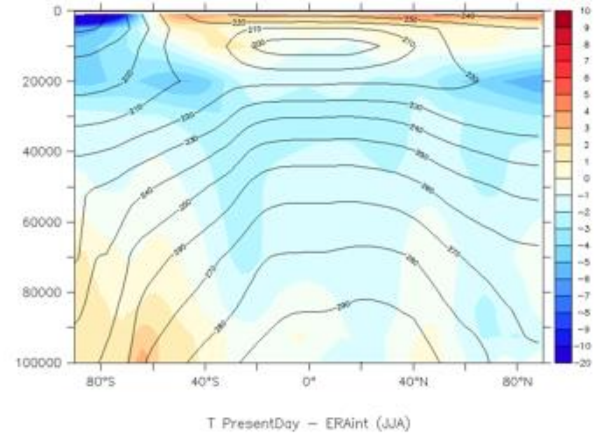



e) T2m Europe (land only) 2-5 yr ANOM
Below lower tercile
1.0
0.8
0.6
0.4
0.2
0.0
0.0
0.2
0.4
0.6
0.8
1.0
Observed frequency
Forecast probability


f) T2m Europe (land only) 2-5 yr ANOM
Above upper tercile
1.0
0.8
0.6
0.4
0.2
0.0
0.0
0.2
0.4
0.6
0.8
1.0
Observed frequency
Forecast probability

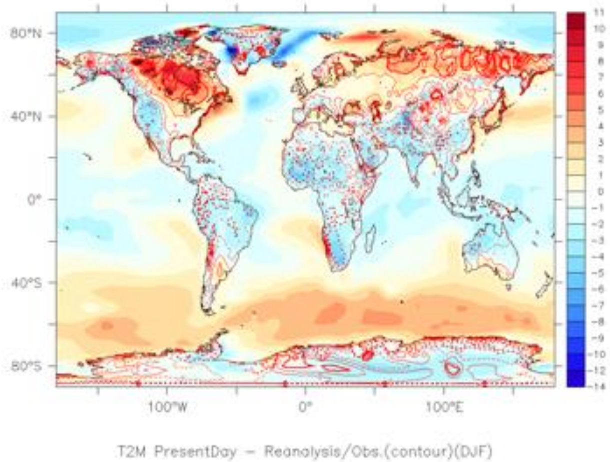
Temperature bias

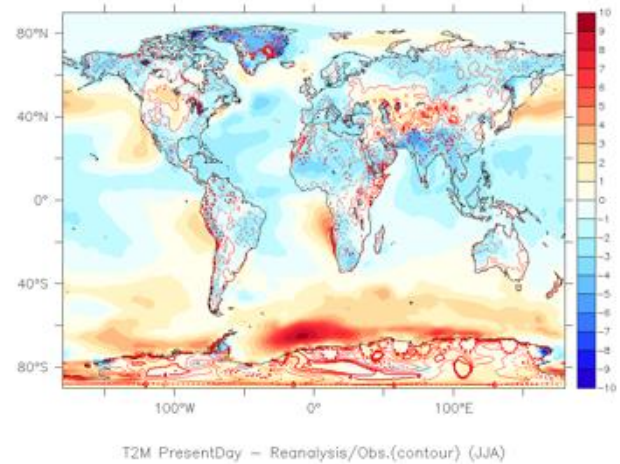




DJF

JJA





Hazeleger et al Climate Dynamics 2012

Effect vegetation on predictability (Weiss et al 2012)

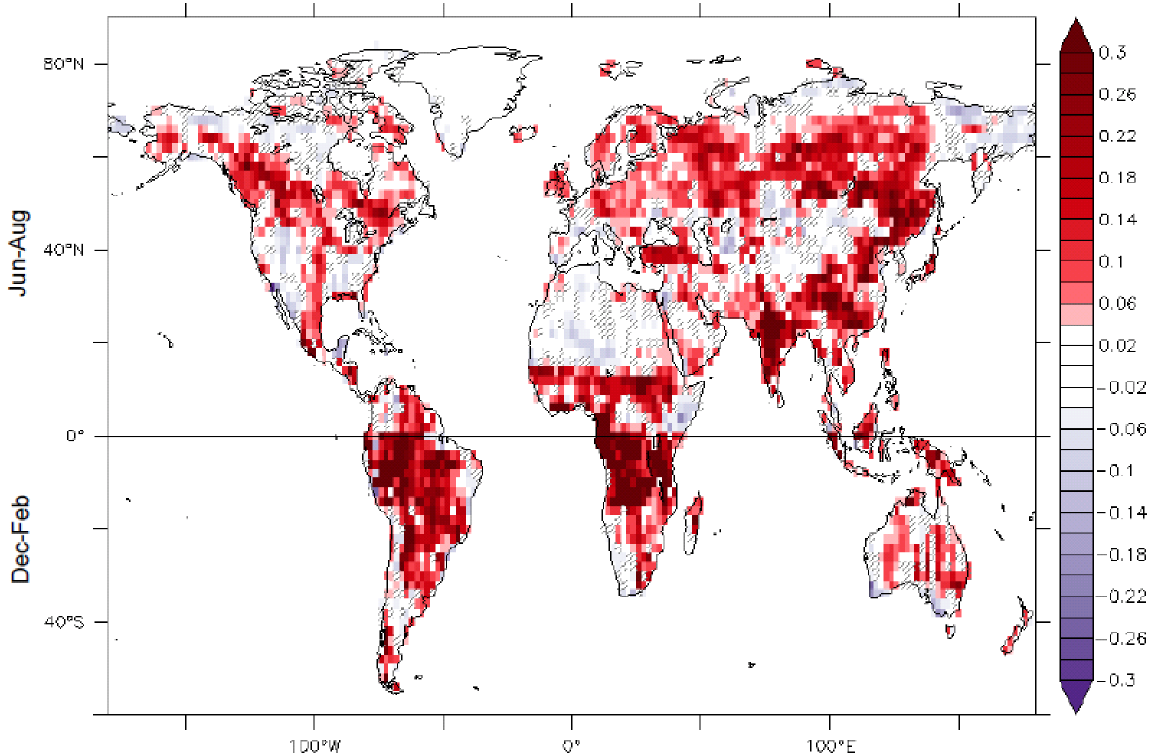


Figure 3. Gain in potential predictability of evaporation during summer due to switching from climatological to time varying LAI values (PP of Exp E2 minus E1, 2000-2010). Summer is defined as in Fig 1. Hatched areas are not statistically significant at 95% level.