

Weakly coupled assimilation for decadal prediction with MPI-ESM

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Thanks to Lars Nerger for PDAF, AWI Bremerhaven

<http://www.fona-miklip.de/>

Pohlmann et al. 2013: Improved forecast skill in the tropics in the new MiKlip decadal climate predictions, GRL.

Brune et al., 2015: Assimilation of oceanic observations in a global coupled Earth system model with the SEIK filter, Ocean Modelling.

Marotzke et al., 2016: MiKlip - a National Research Project on Decadal Climate Prediction, BAMS.

Outline

MiKlip - decadal climate prediction:	2-10 years
Weakly coupled assimilation in MPI-ESM:	nudging, EnKF
Evaluation of decadal hindcasts:	global, SPG
Time dependency of evaluation:	20 year sliding window 1961-2013

How does assimilation quality fit with hindcast quality ?

How does the hindcast evaluation depends on the time period?

“**Mittelfristige Klimaprognose**” = mid-term climate forecast

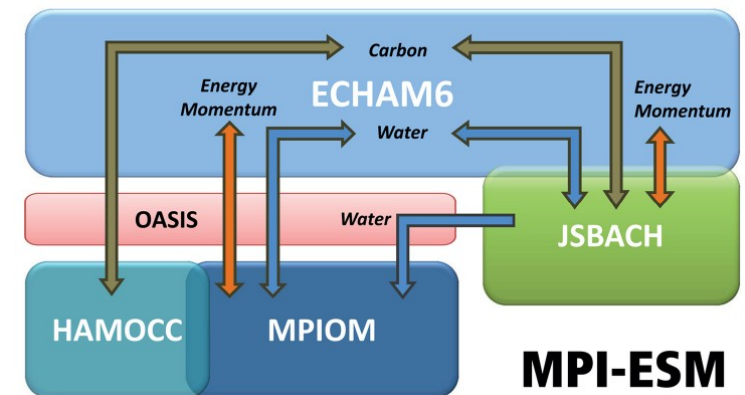
<http://www.fona-miklip.de>, Marotzke et al., 2016, BAMS



Establish decadal prediction system in pre-operational mode
 8 years of funding by German Federal Ministry for Education and Research

Based on coupled global model MPI-ESM:

- atmosphere: ECHAM T63L47 / T127L91
- ocean: MPIOM GR15L40
- coupling: OASIS daily / hourly

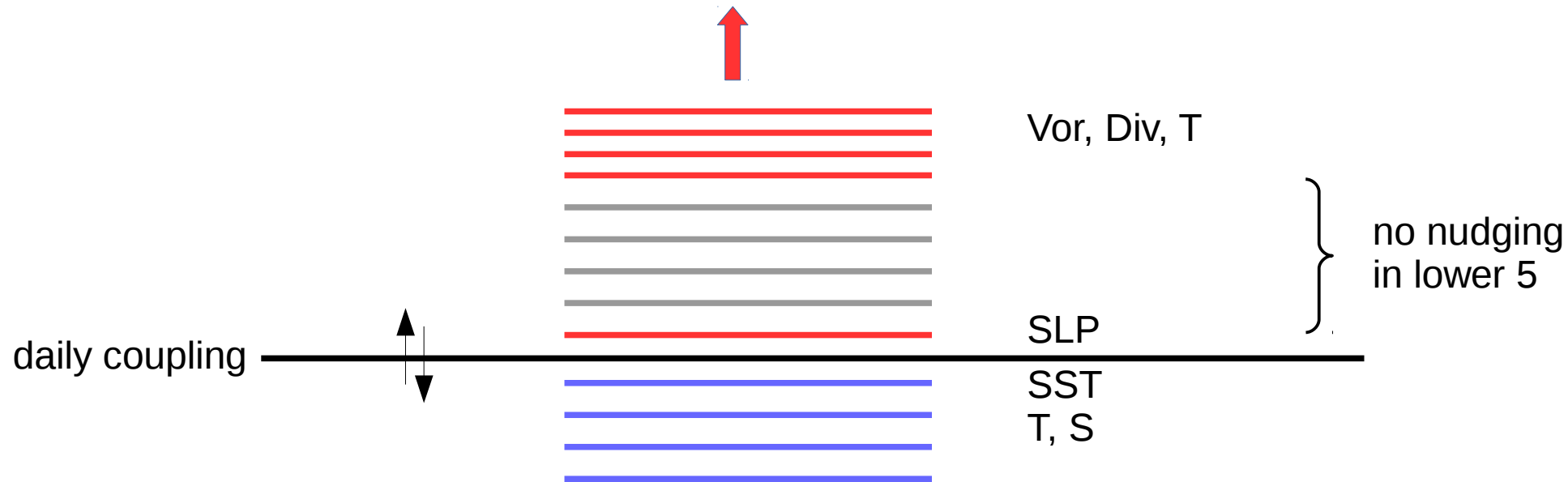


Giorgetta et al. 2013

- External forcing with historical data (past) and RCP-scenarios (future)
- Initialization of atmosphere and ocean with weakly coupled DA
- Observational record very sparse before 1950: assimilation starts in the 1950s
- Evaluation of hindcasts 1961-today

Atmosphere, ECHAM6 T63L47

- Full nudging of Vor, Div, T, SLP to monthly ERA40/ERAInterim



Ocean, MPIOM GR15L40

Pohlmann et al. 2013, GRL

Baseline1

- Anomaly nudging
- T, S to monthly ORAS4

Brune et al. 2015, Oc. Mod.

Ensemble Kalman filter (PDAF)

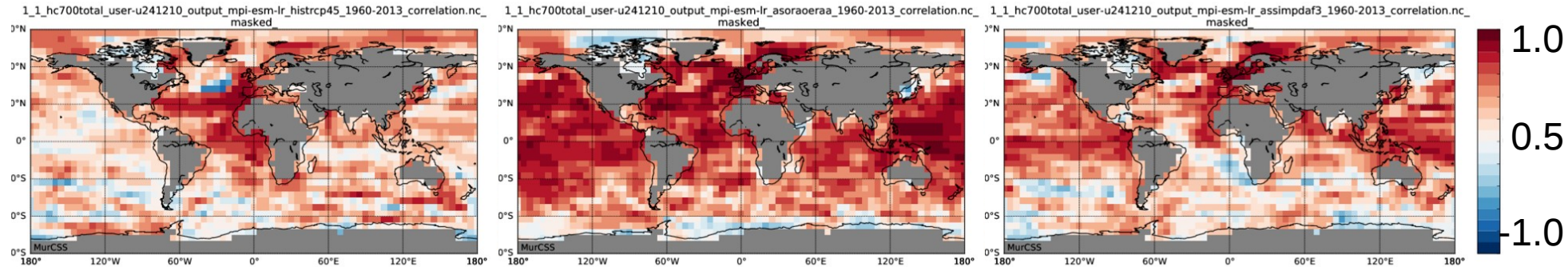
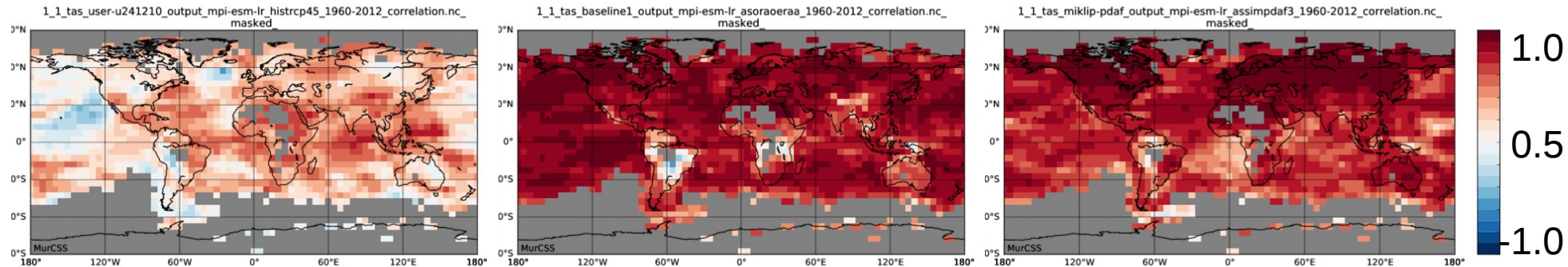
- Full value, 8 members, global
- EN4 T and S profiles + HadISST
- monthly assimilation window

T2m (correlation with HadCRUT4, Morice et al. 2012)

historical

anomaly nudging

EnKF



historical

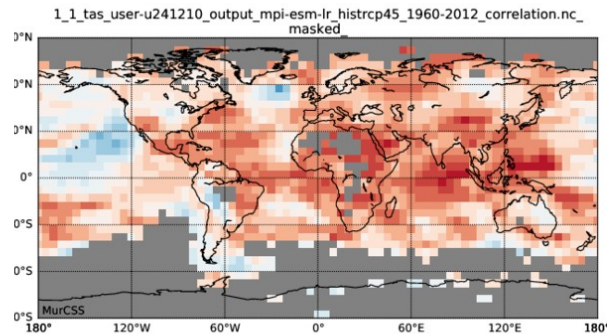
anomaly nudging

EnKF

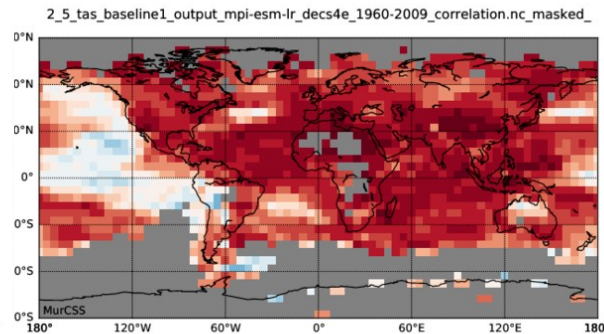
UOHC (correlation with NOAA OCL, Levitus et al. 2012)

T2m (HadCRUT4)

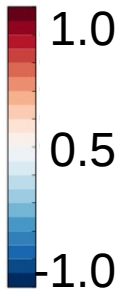
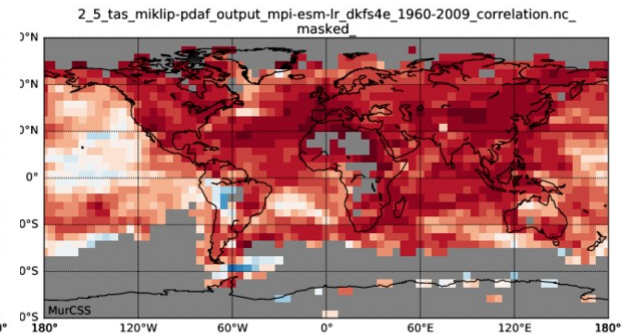
historical



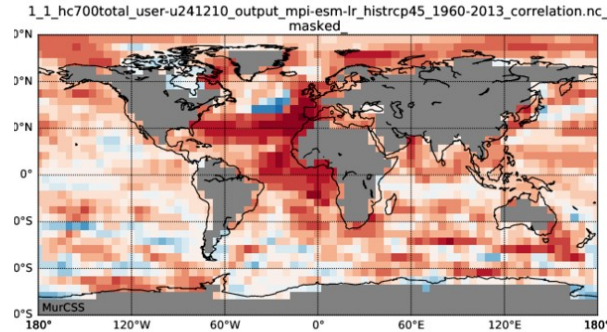
anomaly nudging



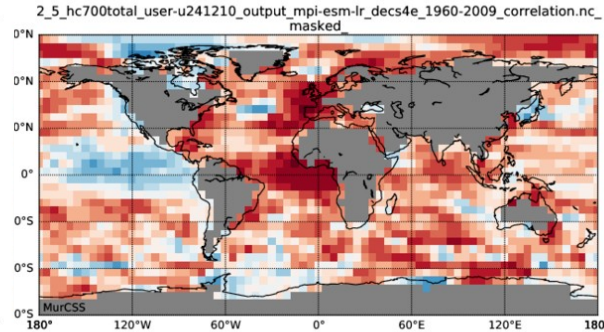
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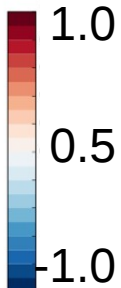
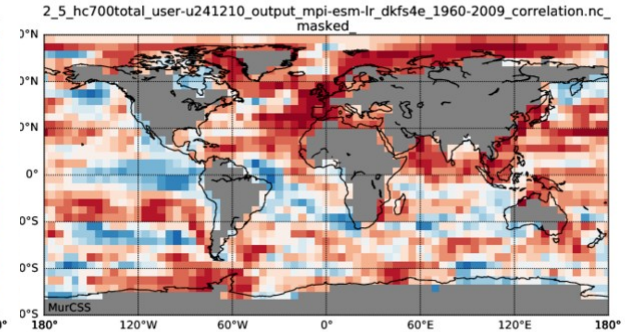
historical



anomaly nudging



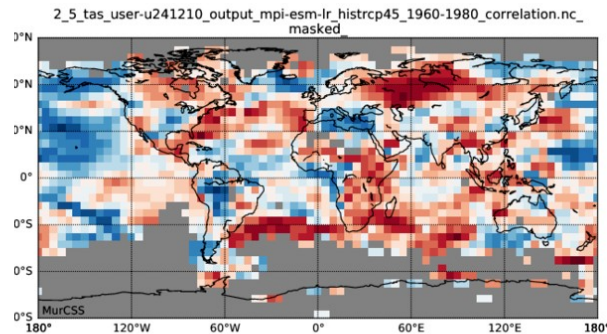
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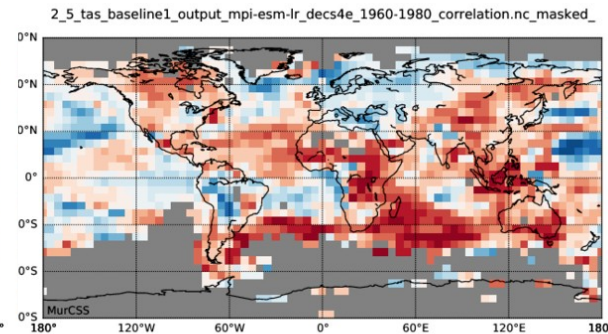
UOHC (NOAA OCL)

T2m (HadCRUT4)

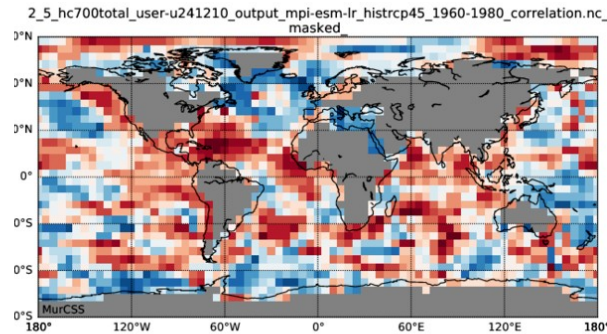
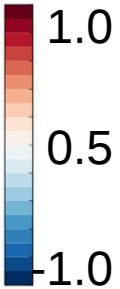
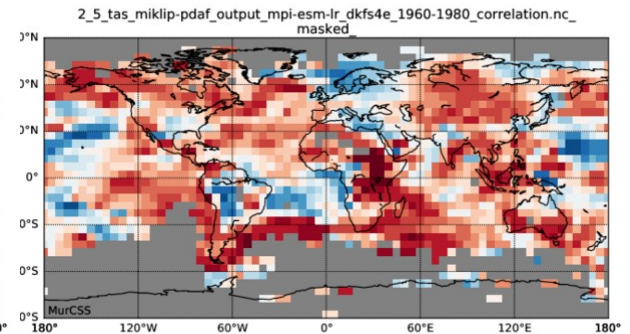
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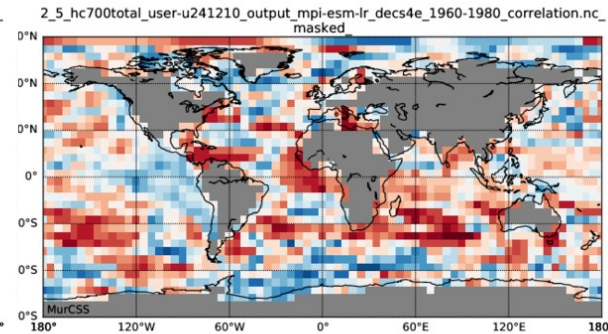
anomaly nudging



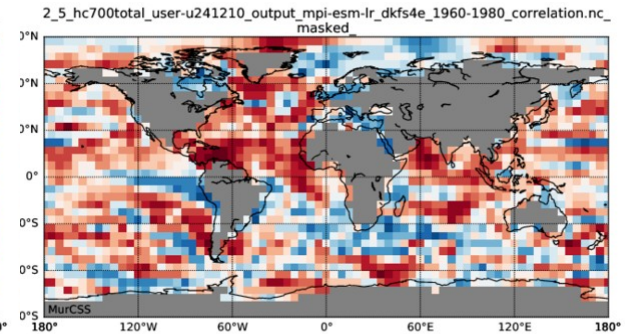
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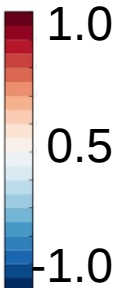
historical



anomaly nudging



EnKF



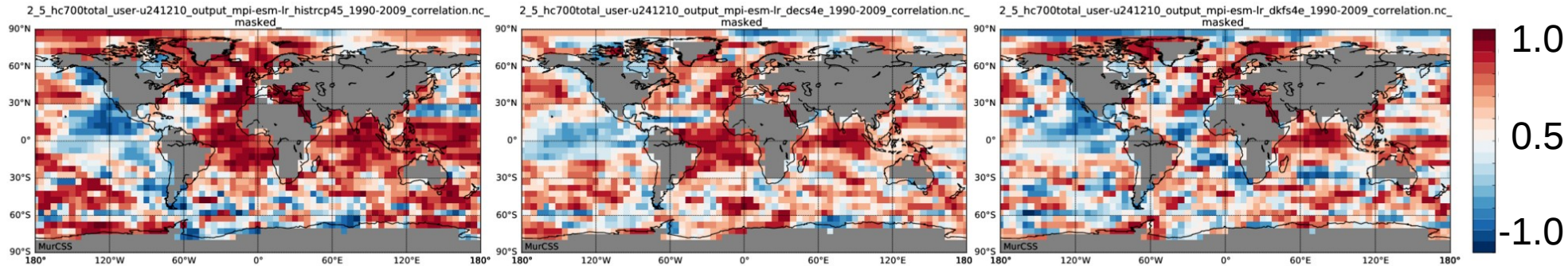
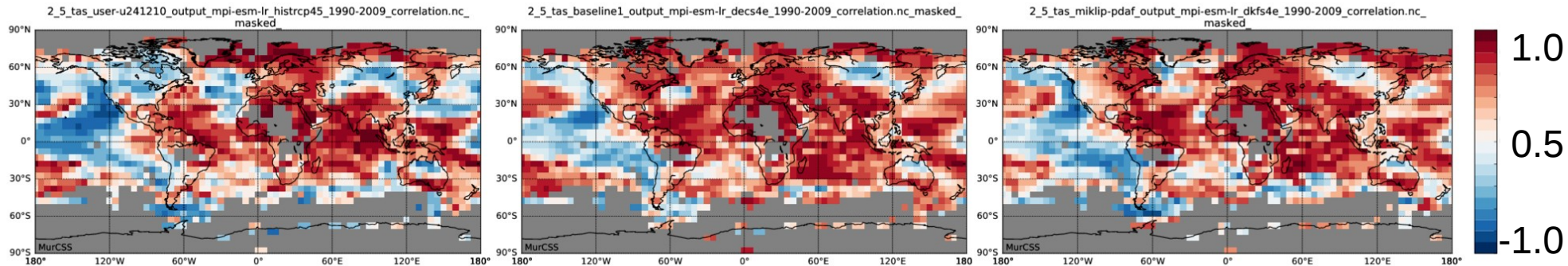
UOHC (NOAA OCL)

T2m (HadCRUT4)

historical

anomaly nudging

EnKF



historical

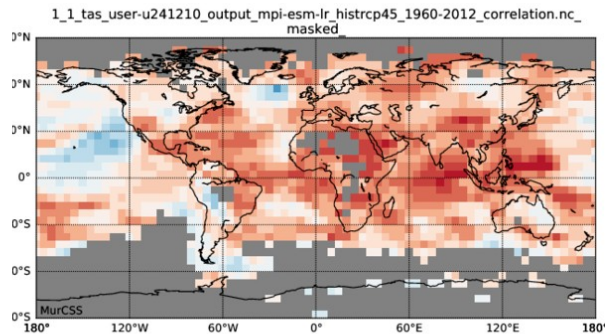
anomaly nudging

EnKF

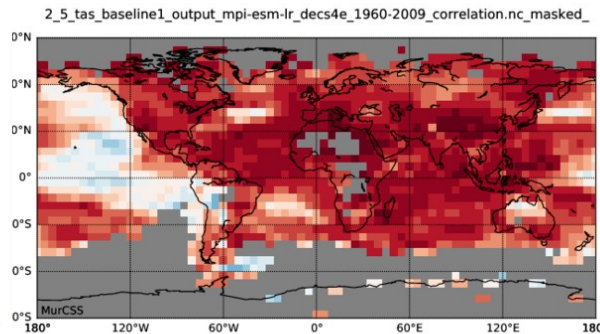
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T2m (HadCRUT4)

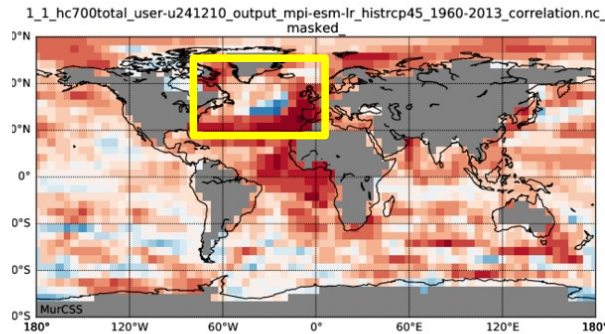
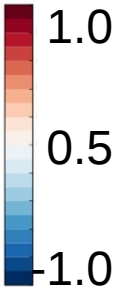
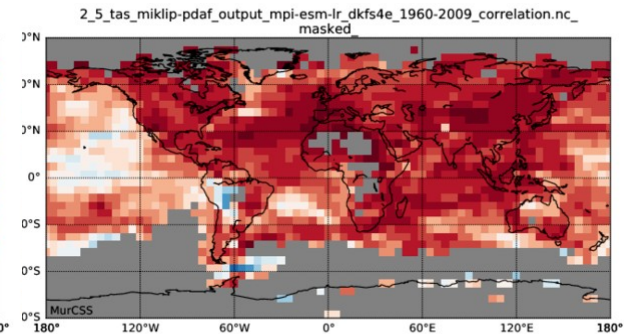
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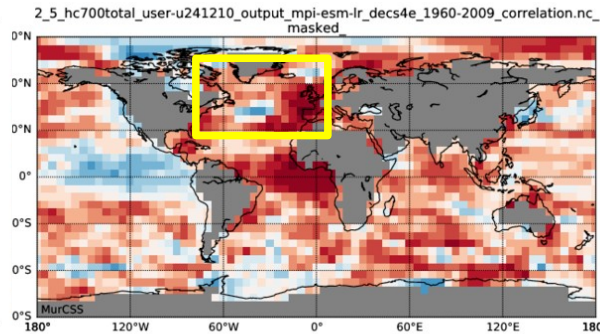
anomaly nudging



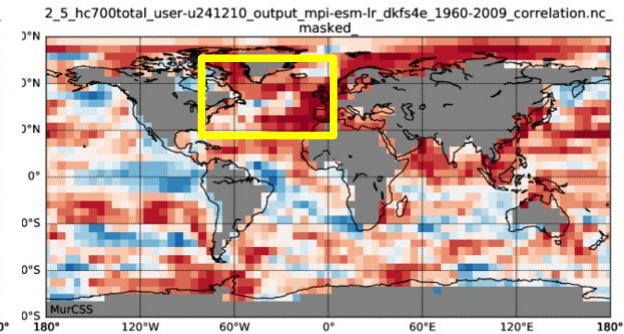
EnKF



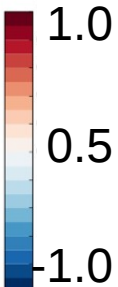
historical



anomaly nudging



EnKF

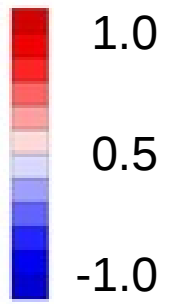
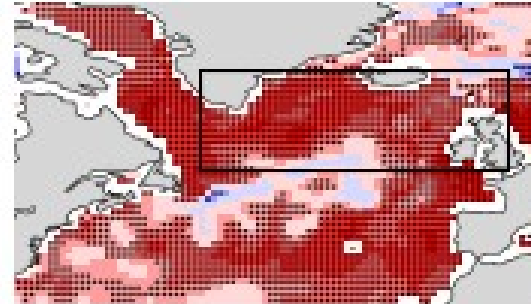
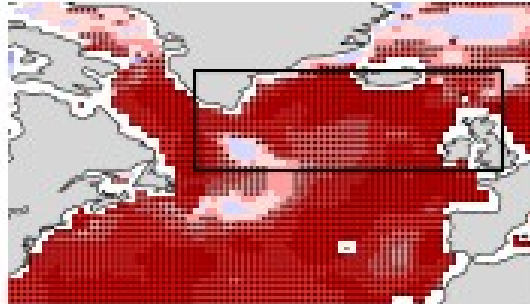
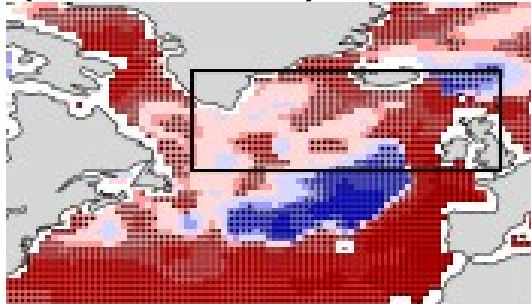


UOHC (NOAA OCL)

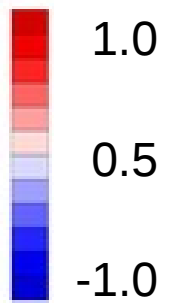
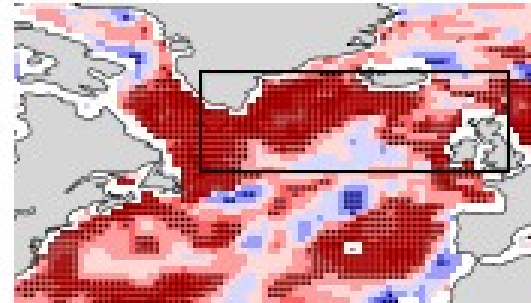
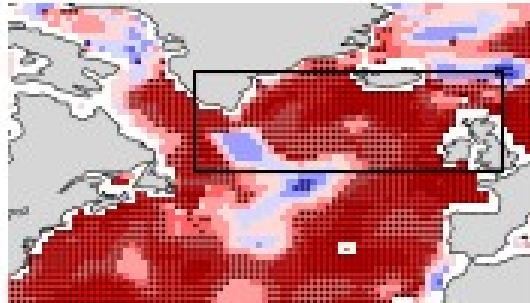
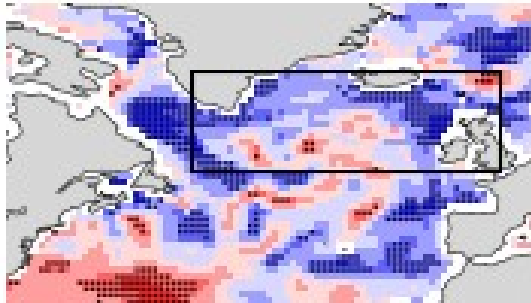
→ North Atlantic

UOHC (NOAA OCL)

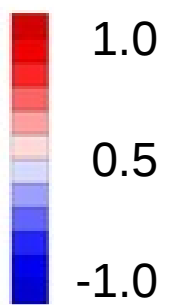
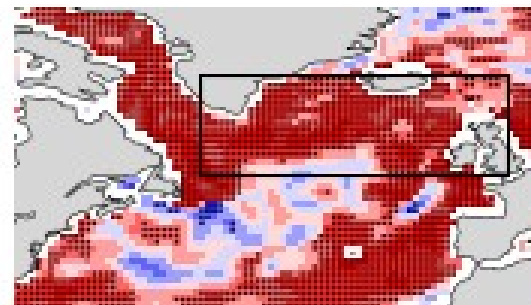
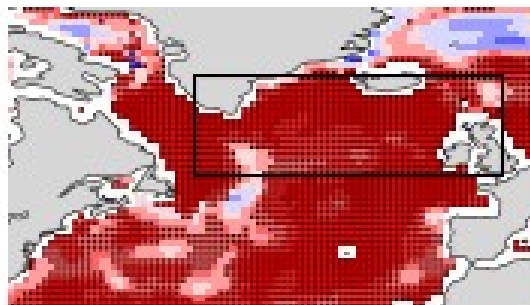
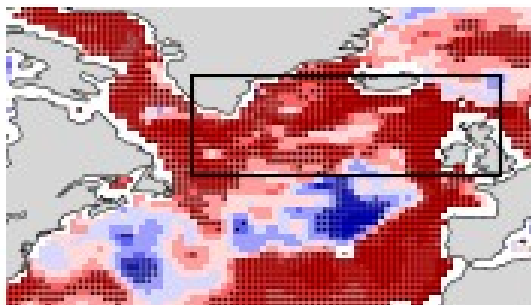
1961-2013



1961-1981



1990-2009



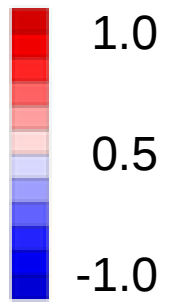
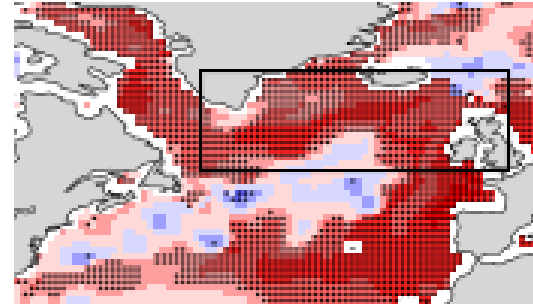
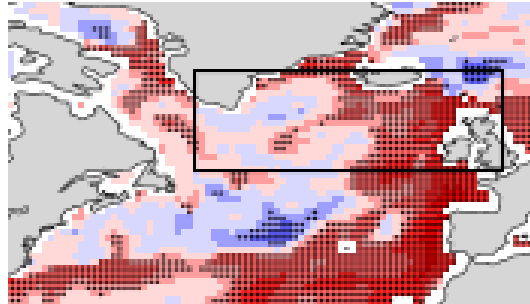
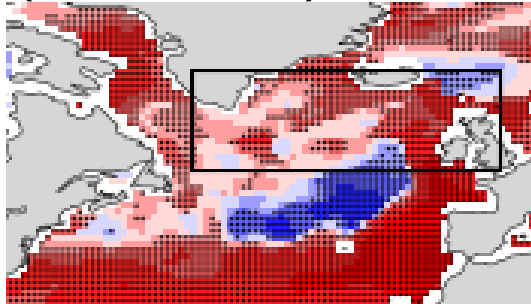
historical

anomaly nudging

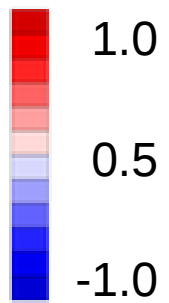
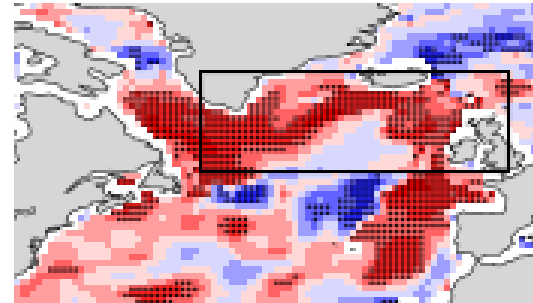
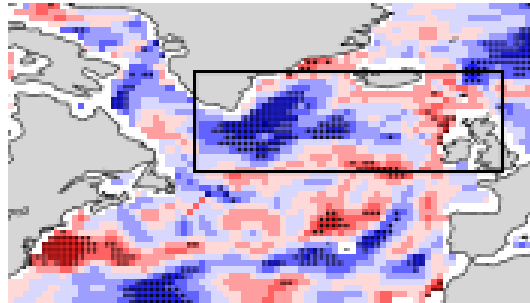
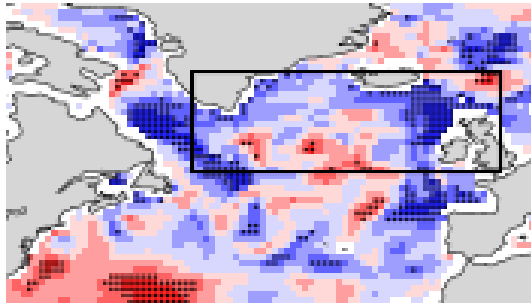
EnKF

UOHC (NOAA OCL)

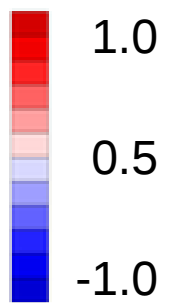
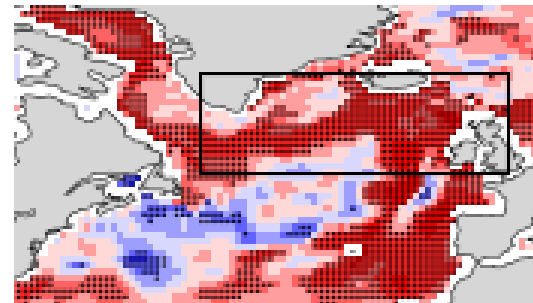
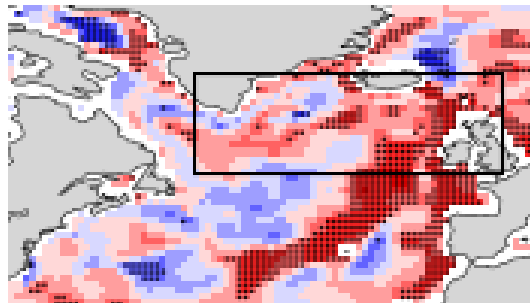
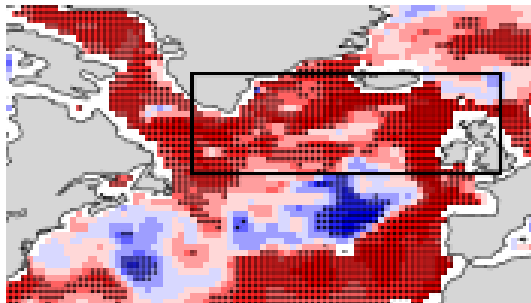
1961-2013



1961-1981



1990-2009



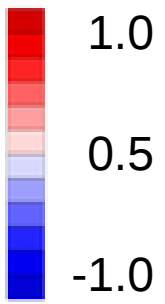
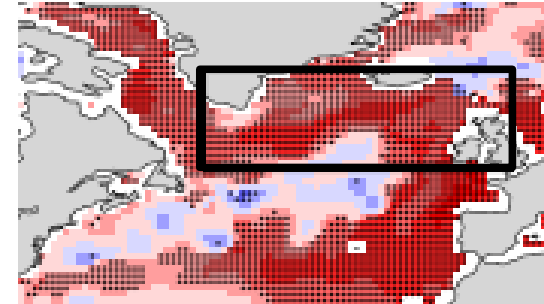
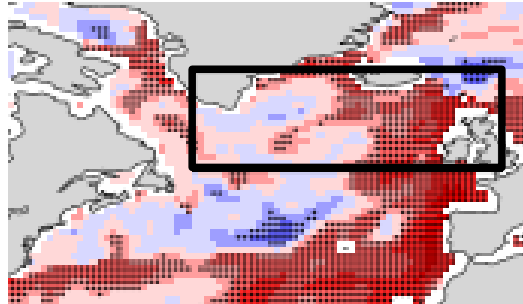
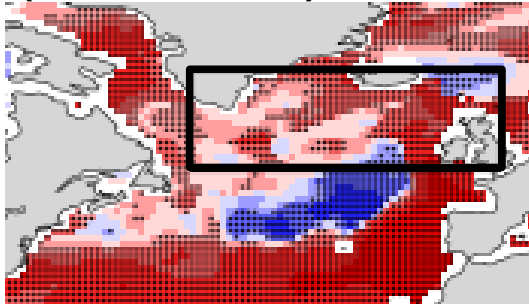
historical

anomaly nudging

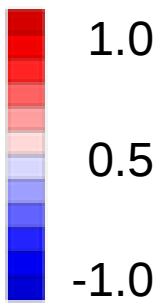
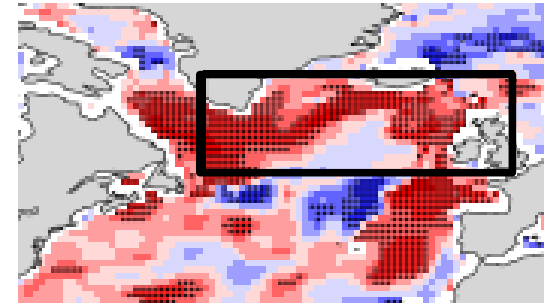
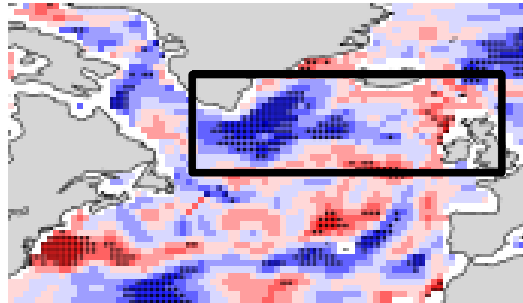
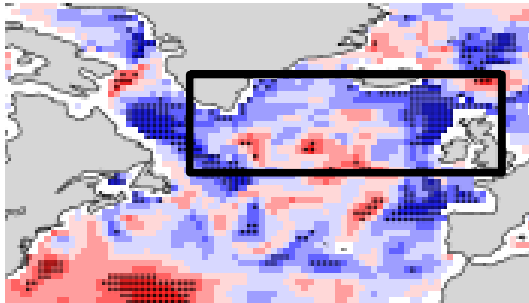
EnKF

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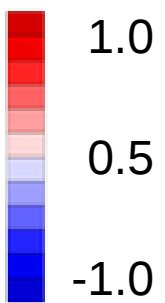
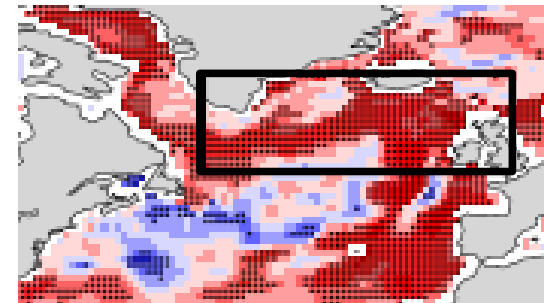
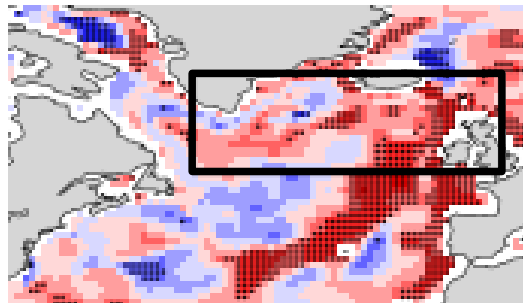
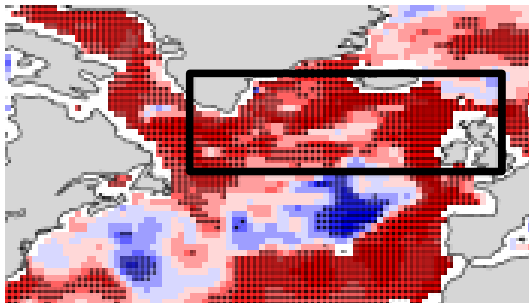
1961-2013



1961-1981



1990-2009



historical

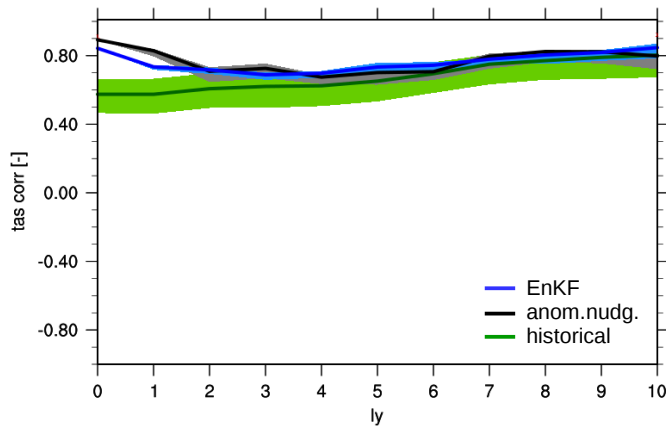
anomaly nudging

EnKF

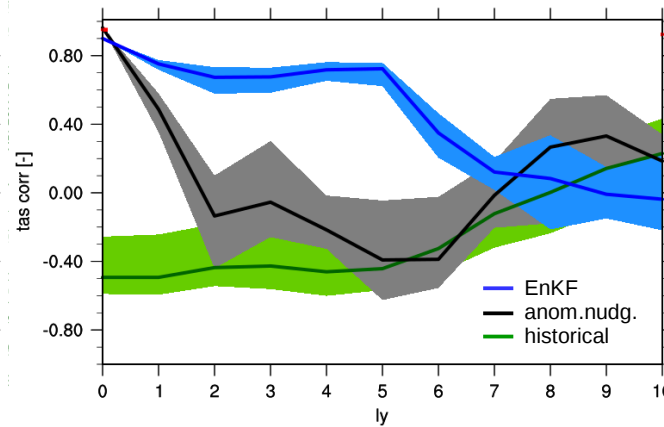
→ subpolar gyre mean

T2m (HadCRUT4)

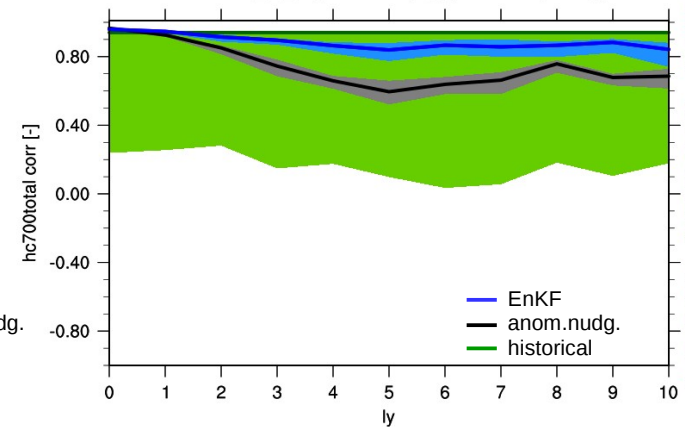
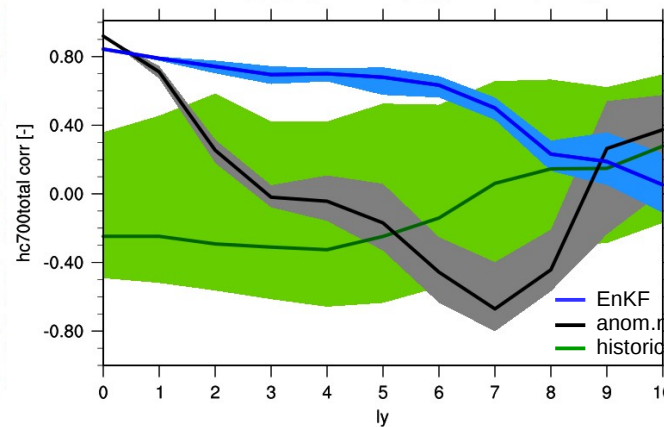
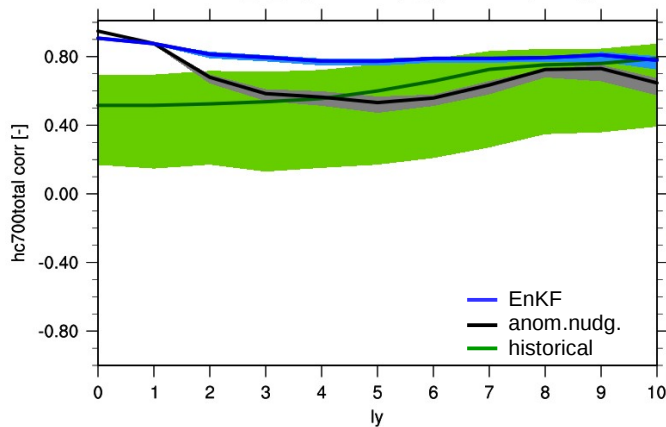
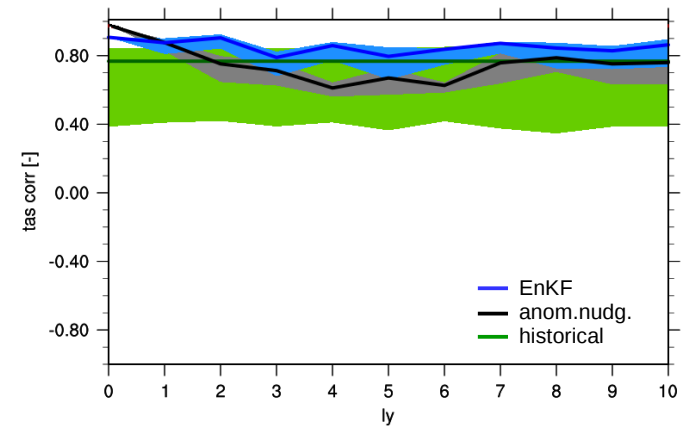
1961-2013



1961-1981



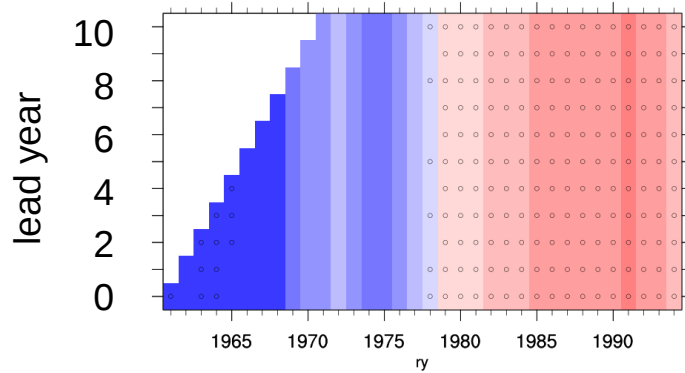
1990-2009



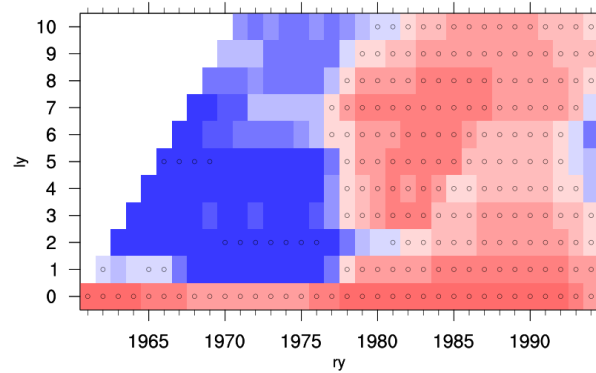
UOHC (NOAA OCL)

T2m (HadCRUT4)

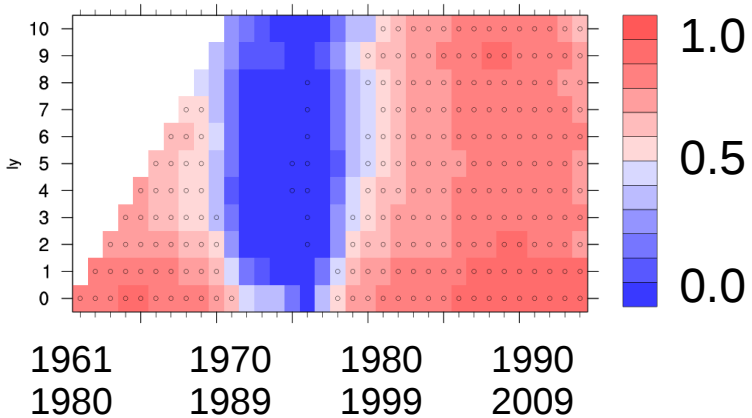
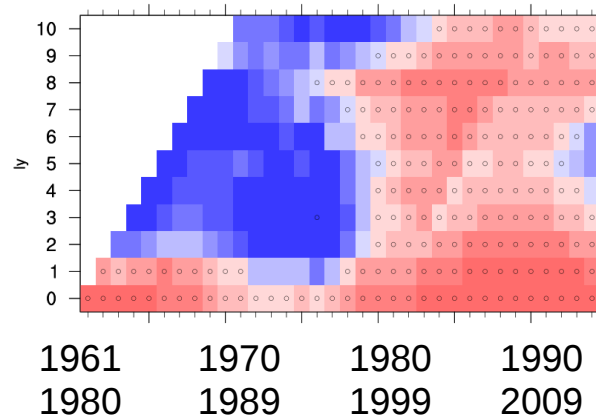
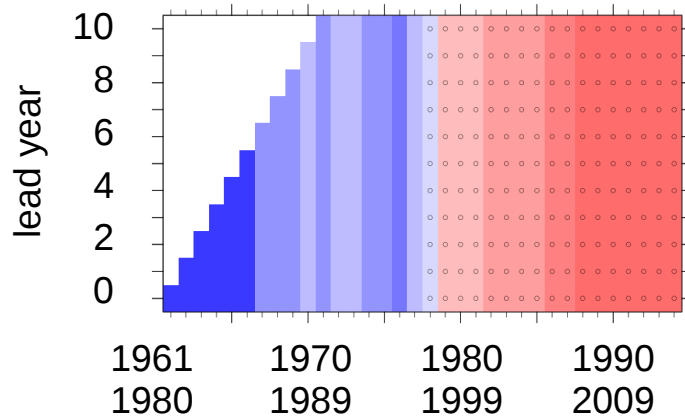
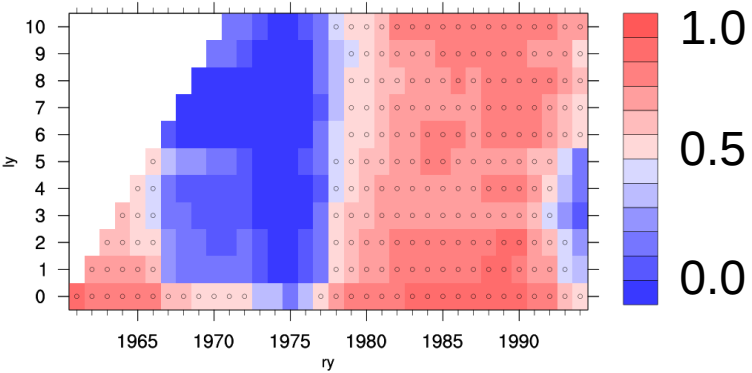
historical



anomaly nudging



EnKF



historical

anomaly nudging

EnKF

UOHC (NOAA OCL)

Summary

Decadal climate prediction in MiKlip with MPI-ESM-LR:

- Different types of weakly coupled assimilation,
- May work for lead years 1 to 5, 1961-2013.

Time dependency of hindcast evaluation:

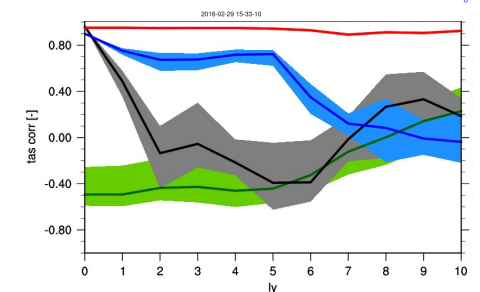
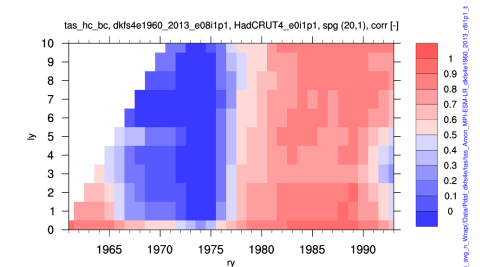
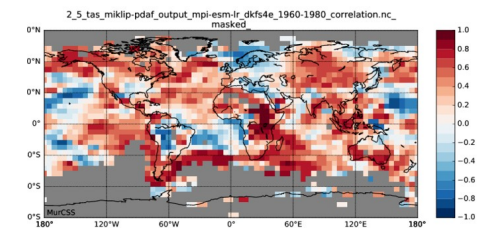
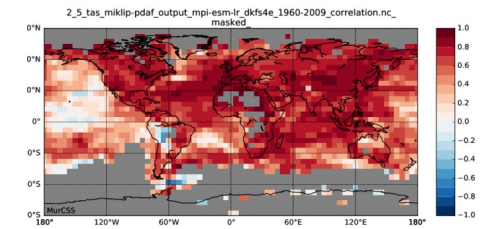
- Strong regional time dependency,
- Address forecast uncertainty.

How does assimilation quality fit with hindcast quality ?

- Good assimilation = good hindcast: not always true,
- Model deficiencies vs assimilation.

What is the right time period for hindcast evaluation ?

- Longer period delivers more robust statistics,
- Sliding window analysis adds the details.



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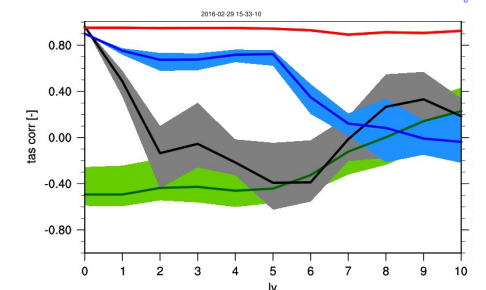
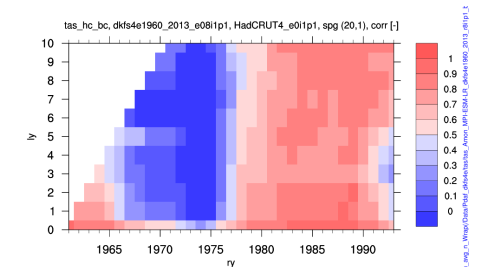
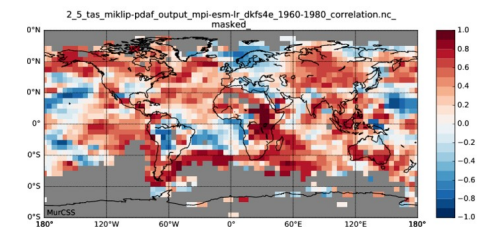
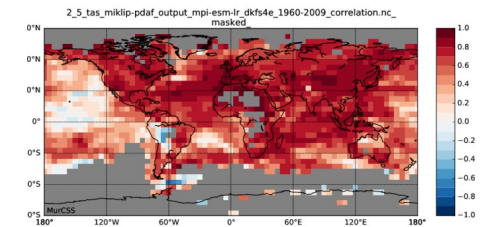
- Strong regional time dependency,
- Address forecast uncertainty.

How does assimilation quality fit with hindcast quality ?

- Good assimilation = good hindcast: not always true,
- Model deficiencies vs assimilation.

What is the right time period for hindcast evaluation ?

- Longer period delivers more robust statistics,
- Sliding window analysis adds the details.



Next: Improve weakly coupled DA, but keep the hindcast perspective.

The End