Impact of Different Ocean Reanalyses on Decadal Climate Prediction[1]

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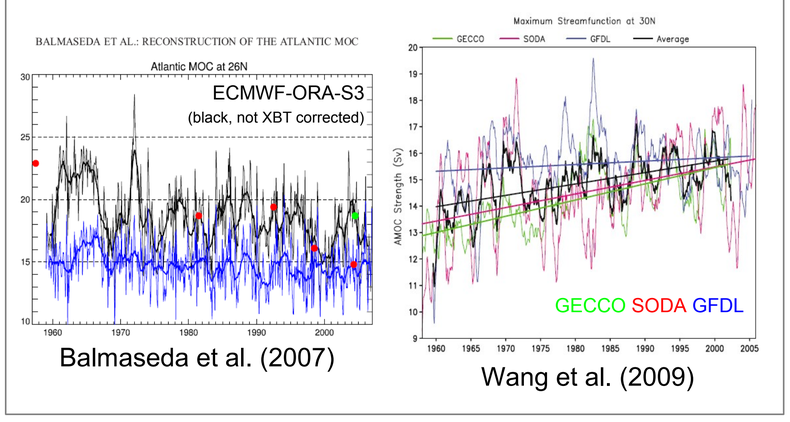
Motivation

AIM: Comparing the suitability of three recent ocean state estimates (GECCO[2], SODA[3], ECMWF-ORA-S3[4]) for initializing the MPI climate forecast system

METRIC: Fidelity and forecast skill of key climate parameters in the North Atlantic: SST, OHC, MOC*

Ocean Reanalyses disagree about MOC

Trend & variability at about 26N in various products



Balmaseda et al. (2007) | Wang et al. (2009)

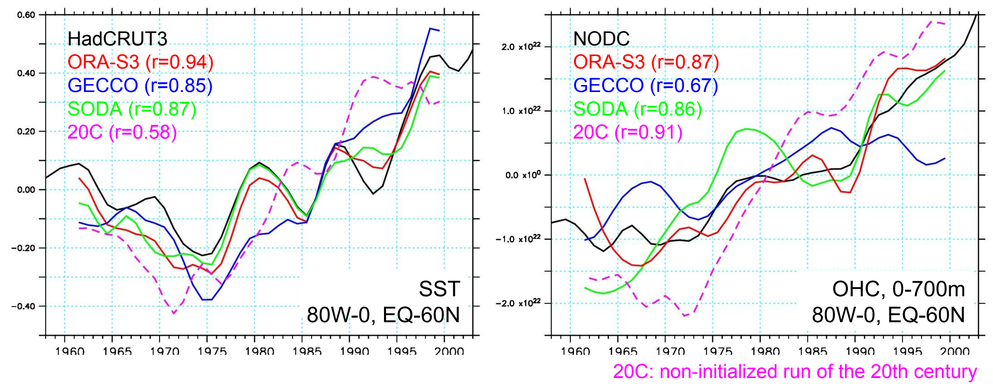
Forecast Procedure

Assimilation: Nudging anomalies of 3-dim temperature- & salinity-fields of the observational estimates into our coupled model (here T31L19 - GR30L40) with a 10-day restoring time scale (cf. Pohlmann et al., 2009). ► compare fidelity

Hindcasts: The assimilation runs are then used to initialize 10-year-long hindcasts starting from each year between 1960 – 2001. ► compare skill

Assimilation & Fidelity

North Atlantic SST and OHC

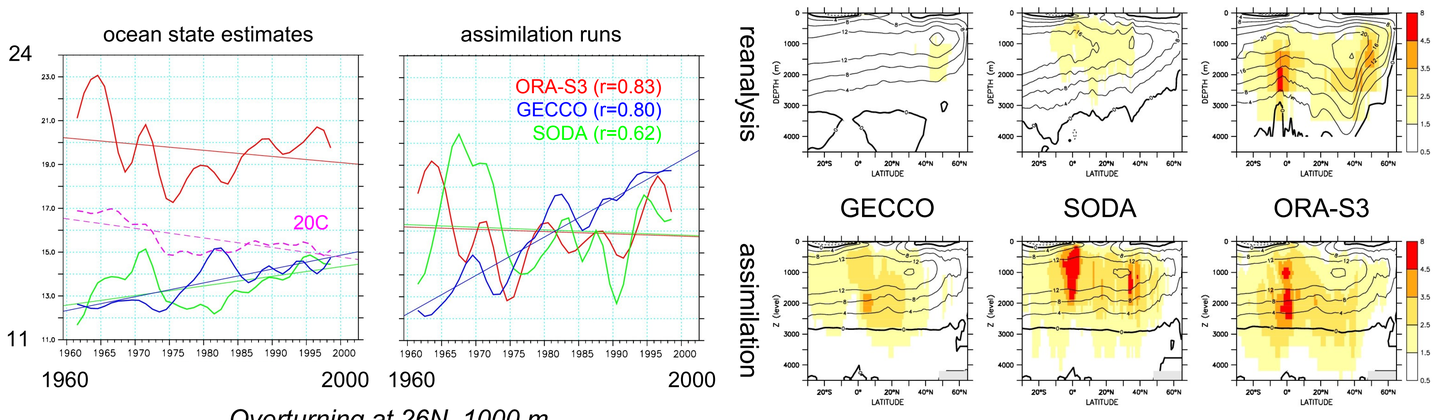


20C: non-initialized run of the 20th century

Correlation coefficients of North Atlantic SST (left) and upper level OHC (right) between observations (black) and all assimilation experiments & 20C (pink)

- lower OHC correlations in GECCO-assim
- SST correlations are low & OHC rms errors (not shown) are high in 20C
- Fidelity is overall highest in case of ORA-S3-assim.

Atlantic MOC before & after the assimilation



Overturning at 26N, 1000 m

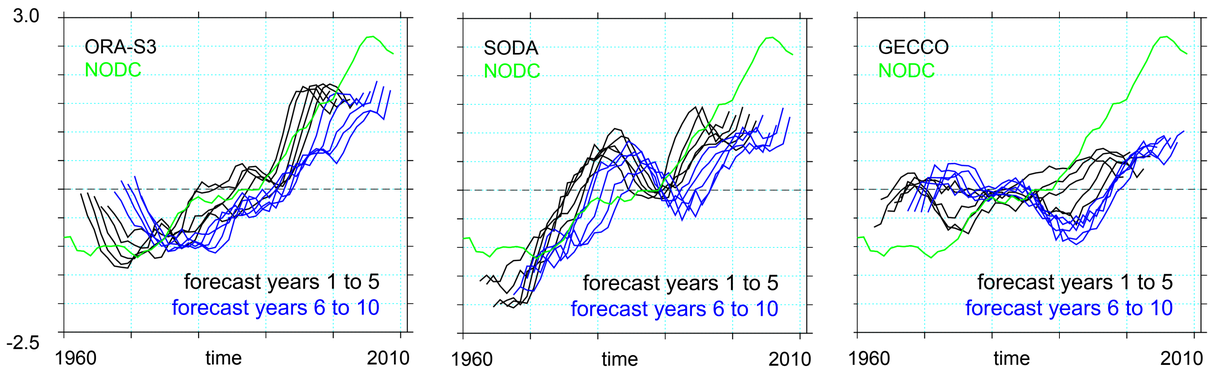
Basin wide overturning: mean and stdev

- MOC characteristics in all assimilation runs and their respective reanalysis products corroborate previous findings about the contradictory MOC behavior at 26N

- Assimilation leads to strong modification of the MOC variability (incl. trend) in case of SODA and GECCO, whereas variability is much more conserved when nudging with ECMWF-ORA-S3

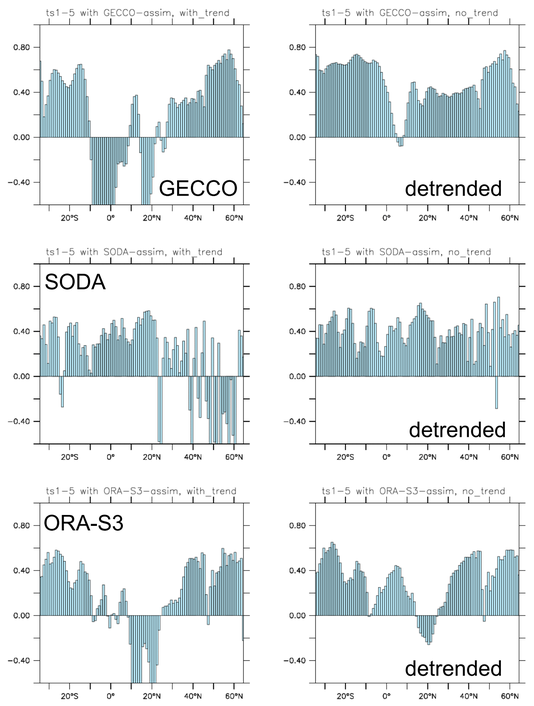
Hindcasts & Skill

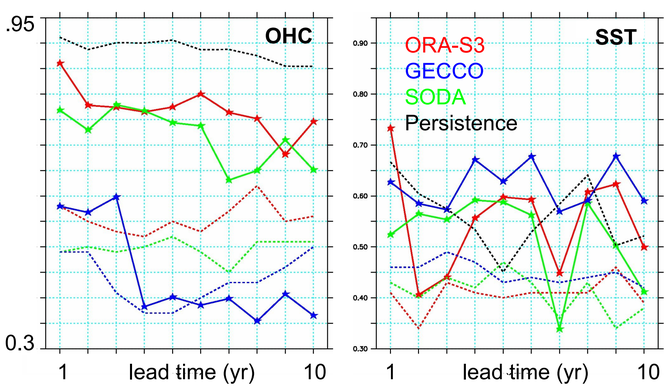
North Atlantic indices



Predicted evolution of North Atlantic OHC (0-700 m) as function of forecast year

Atlantic MOC





Correlation coefficients (with respect to NODC and HadCRUT3) as function of the forecast year

- GECCO-init excites an oscillatory OHC mode in our forecast system
- Unlike SST, OHC is clearly less predictable in case of GECCO-init
- Improved MOC forecast skill in the first pentad over broad latitudinal bands in all hindcast runs
- Improved MOC forecast skill at almost all latitudes when linear trend is taken out

Skill scores of max. MOC for years 1-5 based on correlation coefficients (cc) with respect to the particular assimilation runs. The reference forecast is persistence:
$(cc - cc_{persistence}) / (1 - cc_{persistence})$

Conclusions

- ORA-S3 is the most suitable ocean state estimate for initializing the MPI forecast system,
- … showing overall highest degrees of fidelity in the North Atlantic (SST, OHC, MOC),
- ... and best forecast skill for upper-level OHC

References

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8. THOR: Thermohaline Overturning – at Risk? www.eu-thor.eu
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* SST: Sea Surface Temperature; OHC: Ocean Heat Content; MOC: Meridional Overturning Circulation

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