Coupled reanalyses of NorCPM1 contributed to CMIP6 DCPP

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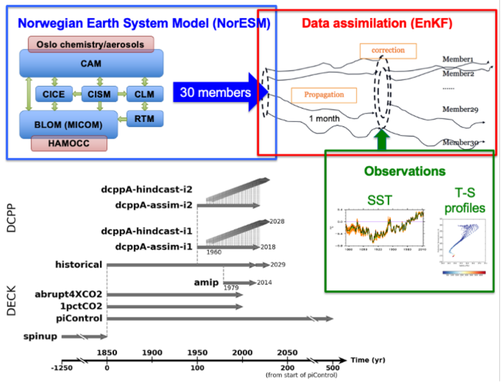
1. Introduction

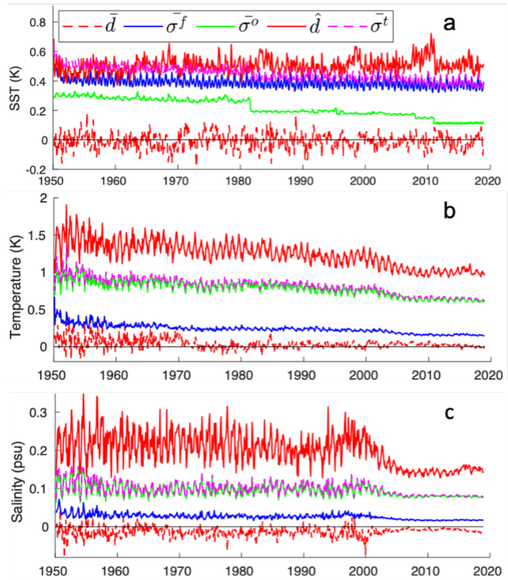


- NorCPM1 combines the NorESM1-ME and the EnKF (Bethke et al., submitted).
- NorESM1-ME is based on the CESM1, but the ocean component is an updated version of MICOM (Bentsen et al., 2013) and the atmospheric chemistry is included.
- The CMIP6 external forcings are implemented in NorCPM1.

2. Data assimilation

- A deterministic variant of the EnKF (DEnKF; Sakov and Oke, 2008)
- SST from HadISST2/OISSTV2 and T-S profile from EN4 dataset over 1950-present
- Monthly anomaly assimilation (AA) with 30 ensemble members
- Localization with the Gaspari and Cohn function and localization radius varying with latitude (Wang et al., 2017)
- Moderation technique of Sakov et al. (2012) for inflation
- assim-i1: climatology 1980-2010
- assim-i2: climatology 1950-2010, jointly updated ocean-sea ice (SCDA)
- assim-i1b: climatology 1950-2010

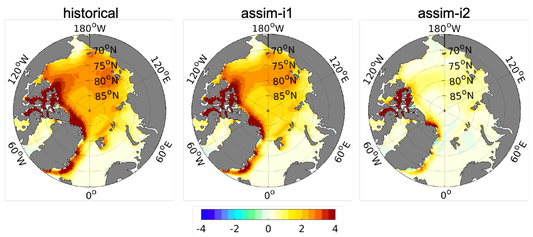
3. Global assimilation statistics



Assimilation statistics of assim-i1. Bias $\bar{d}$ (red dashed lines), ensemble spread $\bar{\sigma}^f$ (blue lines), observation error $\bar{\sigma}^o$ (green lines), RMSE $\hat{d}$ (red solid lines) and the total error $\bar{\sigma}^t$ (pink lines) for SST (a), ocean temperature (b) and ocean salinity (c).
Highlight: The system is stable (no systematical drift), but overestimates its accuracy (i.e., a too small ensemble spread).

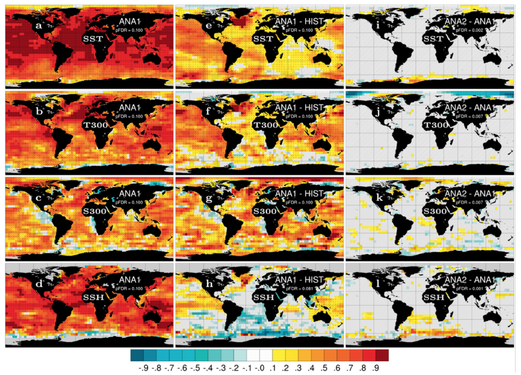
4. Effect of AA on mean state

Highlight: The relative impact of DA on the biases is thus mostly below 10 % of its absolute magnitude, except for the Arctic.

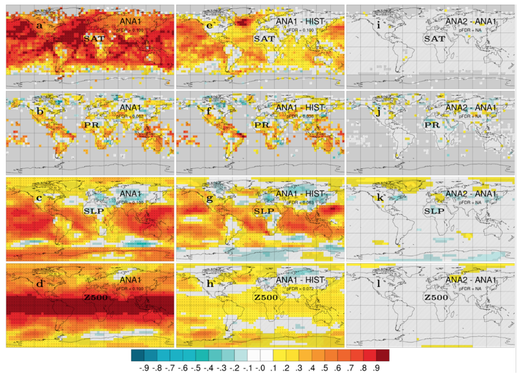


November-March climatological biases of sea ice thickness (SIT) in historical (left), assim-i1 (middle) and assim-i2 (right)

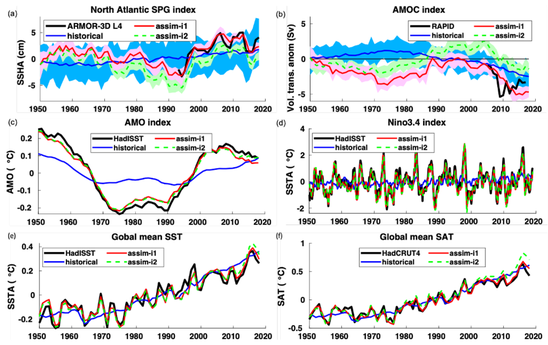
5. Ocean and atmosphere variability



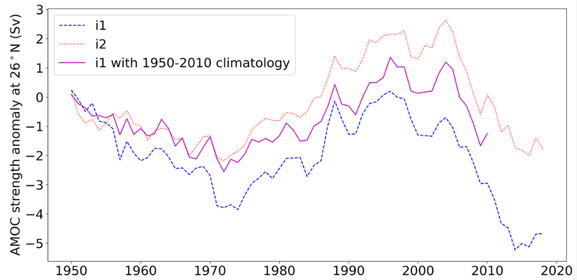
ACC for annual SST (a), 0-300m temperature (b), 0-300m salinity (c) and sea surface height (d) for assim-i1. assim-i1 - historical (e-h), assim-i2 - assim-i1 (i-l).



ACC for annual 2m temperature (a), precipitation (b), sea level pressure (c), and 500 hPa geopotential height (d) for assim-i1. assim-i1 - historical (e-h), assim-i2 - assim-i1 (i-l).



(a) Annual-mean Subpolar gyre ([15-60 °W, 48-65 °N]) SSH. (b) Annual-mean AMOC at 26.5 °N. (c) AMO index. (d) Niño-3.4 index. (e) Global-mean SST. (f) Global-mean SAT.



Annual-mean AMOC at 26 °N from assim-i1 (dotted red), assim-i1b (solid purple) and assim-i2 (stippled blue). The assim-i1b reanalysis experiment is identical to assim-i1, but uses the climatological period 1950-2010 (same as in assim-i2) for computing assimilation anomalies.

Highlight: (1) The EnKF is very beneficial for the system. (2) assim-i1 and assim-i2 overall show comparable performance. (3) Stronger AMOC in assim-i2 is primarily caused by the different climatological period but also partly by the update of sea ice with SCDA.

References

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