Decadal forecast experiments

Authors: Andreas Sterl, Royal Netherlands Meteorological Institute (KNMI)

Introduction: The climate model ECEarth v2.3 (Hazeleger et al. 2012) is used to investigate the impact of the spatial distribution of observations on the skill of decadal climate forecasts. For eight start dates three different ocean restart files were combined with five atmosphere files, forming three small ensembles. To test the impact of initialization at depth, an experimental ensemble was performed in which all values (T, S, velocity) below 2 km were replaced by the time mean of the eight different restart dates. The analysis is limited to the subpolar gyre as this is the only region where forecast skill goes beyond the forced trend (Van Oldenborgh et al. 2012).

Results: Model runs started from the same initial conditions should develop similar anomaly patterns in order to have forecast skill. The similarity is measured by the pattern correlation coefficient (PCC) and the area-averaged normalized root-mean-square difference (RMSD) between runs. To eliminate noise we calculate them for all combinations of ensemble members and average the results. PCC and RMSD for temperature for one start date are shown in Figure 1. The PCC (RMSD) decreases (increases) with time, indicating increasing divergence of the ensemble. The signal of increasing divergence is already visible at the surface in the first year and penetrates into depth with time. The penetration occurs stepwise during winter, presumably through deep convection events.
Figure

Figures:

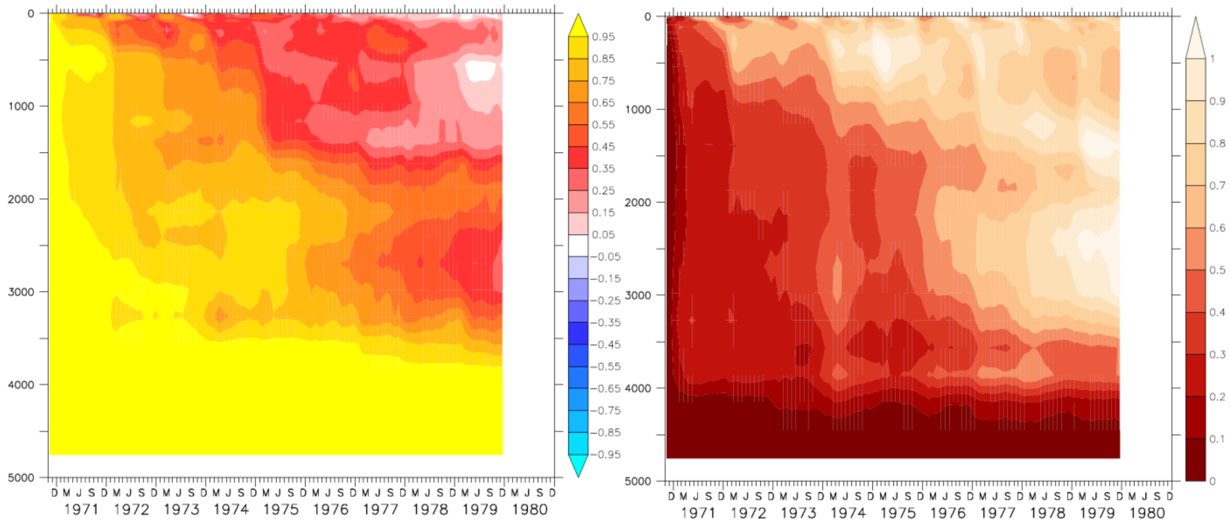

Figure 1: PCC (left) and RMSD (right) for temperature in the subpolar gyre in the North Atlantic, averaged over all combinations of runs from one ensemble for start date 1970.

The ocean affects the atmosphere via its surface, especially the heat flux. The fast deterioration of a coherent signal at the surface suggests that each ensemble member creates its individual interaction with the atmosphere, regardless of the ocean's initial state. Accordingly, the heat fluxes from different members are not correlated after the first year.

Conclusion:
Although the runs need to be further analysed, some preliminary conclusions can be drawn:

- The different members of an ensemble evolve similarly and only diverge slowly at depth. However, their evolution is not necessarily in the direction of the observed one.
- At the surface the divergence is fast. After the first year anomalous surface fields have no resemblance between ensemble members.
- This is especially true for the heat flux, through which the ocean influences the atmosphere.
- Changing the initial state below 2 km has no influence.