Project: **867**

Project title: **Suitability of the ocean observing system components for initialization**

Project lead: **Mojib Latif**

Report period: **1.1.2014 - 31.12.2015**

Text: maximum of two pages including figures.

A long-standing problem in climate models is large sea surface salinity (SSS) and sea surface temperature (SST) biases in the North Atlantic. These biases are largely originated from a too zonal path of the North Atlantic Current and also from a too weak Atlantic Meridional Overturning Circulation (AMOC). We performed integrations of the Kiel Climate Model (KCM) with and without applying a freshwater flux correction over the North Atlantic (Park et al., submitted). It is based on the idea that realistic density field by a SSS correction could help to better represent horizontal and overturning circulations, thereby reducing the cold SST bias. It also tests the usefulness of salinity observations from satellites in improving climate model performance in the North Atlantic sector.

We found that cold SST bias in the control run is markedly reduced when freshwater flux is corrected (Fig. 1). The effect on SST is most pronounced in the mid-latitudes where a warming on the order of 5°C is observed. This cold bias reduction attributes to a northward extension of the subtropical gyre and melting sea ice in the Labrador Sea. This experiment suggests the realistic simulation of North Atlantic SSS is an important factor to improve climate model simulations of North Atlantic mean climate.

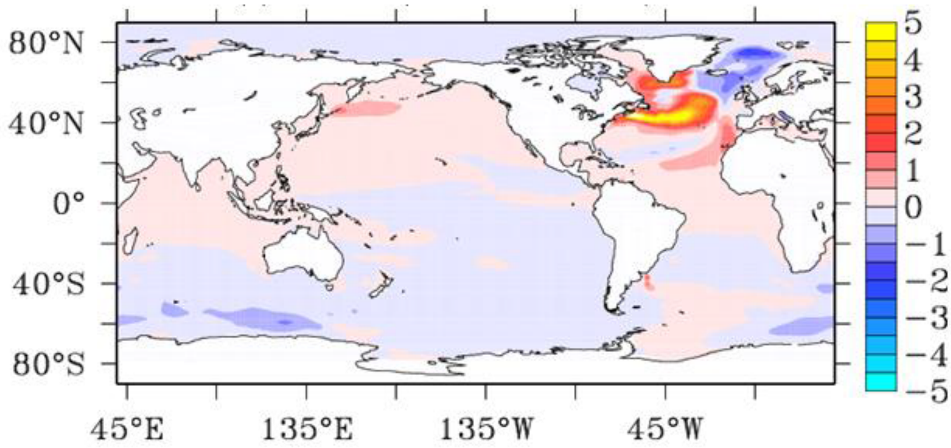

Figure 1: Sea surface temperature (°C) difference between the freshwater flux correction run and the control run.

The AMOC strengthens when applying a freshwater flux correction over the North Atlantic (Fig. 2), as suggested by the afore-mentioned SST changes. We define an AMOC index as the maximum of the zonally averaged Atlantic overturning streamfunction at 30°N. This index is enhanced by about 3 Sv in the freshwater flux-corrected integration relative to that in the reference run. Moreover, the vertical extent of the North Atlantic Deep Water (NADW) cell becomes larger (not shown). Both the stronger AMOC and its larger vertical extent are more realistic in comparison to ocean re-analyses and inverse calculations. The outflow of the NADW at 30°S is only slightly stronger in the freshwater flux-corrected integration, by approximately 1 Sv. Consistent with the stronger AMOC, the northward heat transport is enhanced in the latitude range 30°S-40°N, with largest increases on the order of about 0.1 PW in the subtropical South and North Atlantic (not shown). The stronger AMOC is an interesting result, given that the flux correction provides a net freshwater input to the North Atlantic. If homogeneously distributed that gain would tend to slow the AMOC. Thus, it is the spatial pattern of the freshwater flux correction that matters to AMOC strength.

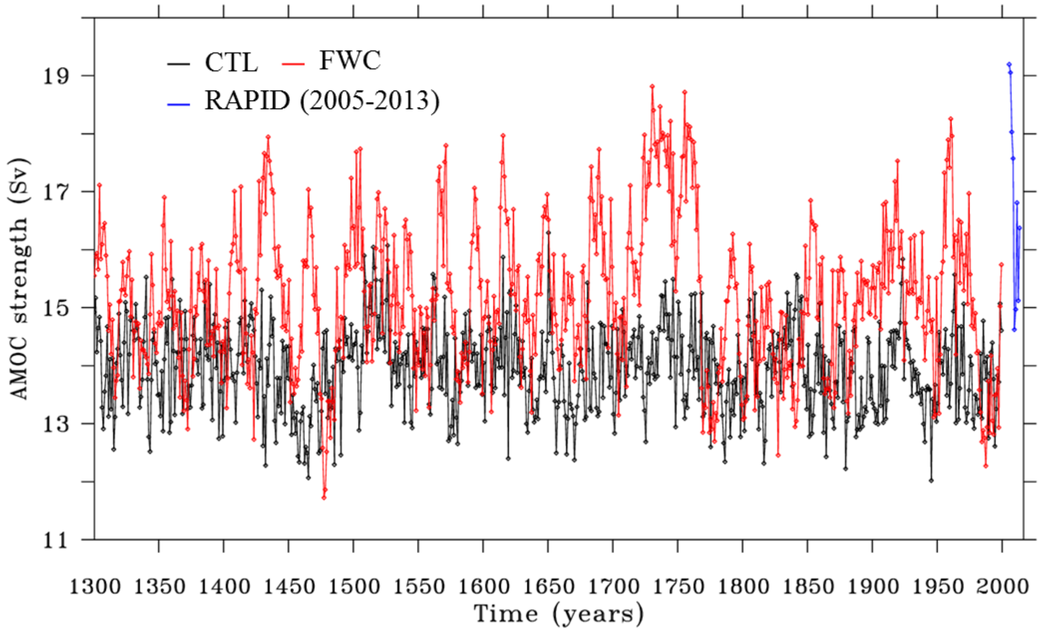

Figure 2: Time series of the AMOC index (Sv). The black curve depicts the AMOC index from the control run, the red curve from the integration employing a freshwater flux correction in the North Atlantic. The blue curve on the very right side is the AMOC time series at 26.5°N from the RAPID array.

In summary, the freshwater flux correction applied to the KCM over the North Atlantic considerably enhances the simulation of the basin-scale circulation of the North Atlantic Ocean and the representation of North Atlantic SSTs, which is a major result of this study. Significant differences between the simulations with and without applying a freshwater flux correction over the North Atlantic are not restricted to the surface and also seen at subsurface levels in the upper kilometre of the North Atlantic, suggesting the realistic simulation of North Atlantic SSS is a key to improve climate model simulations of North Atlantic sector mean climate.

Reference:

Park, T., Park, W. and Latif, M., Impact of North Atlantic Surface Salinity Bias on the Atlantic Meridional Overturning Circulation and Atlantic Multidecadal Variability in the Kiel Climate Model. Submitted to Climate Dynamics.