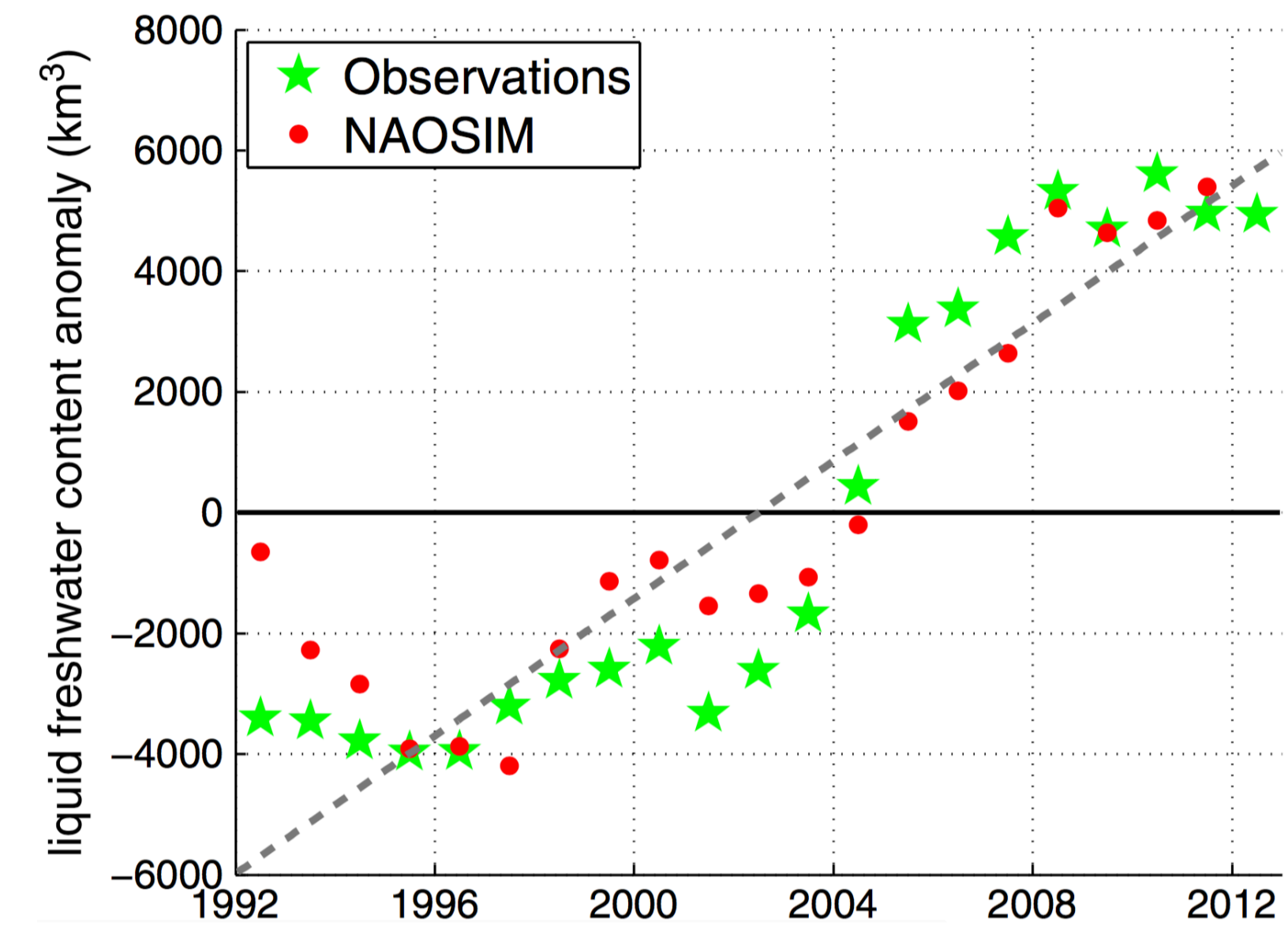
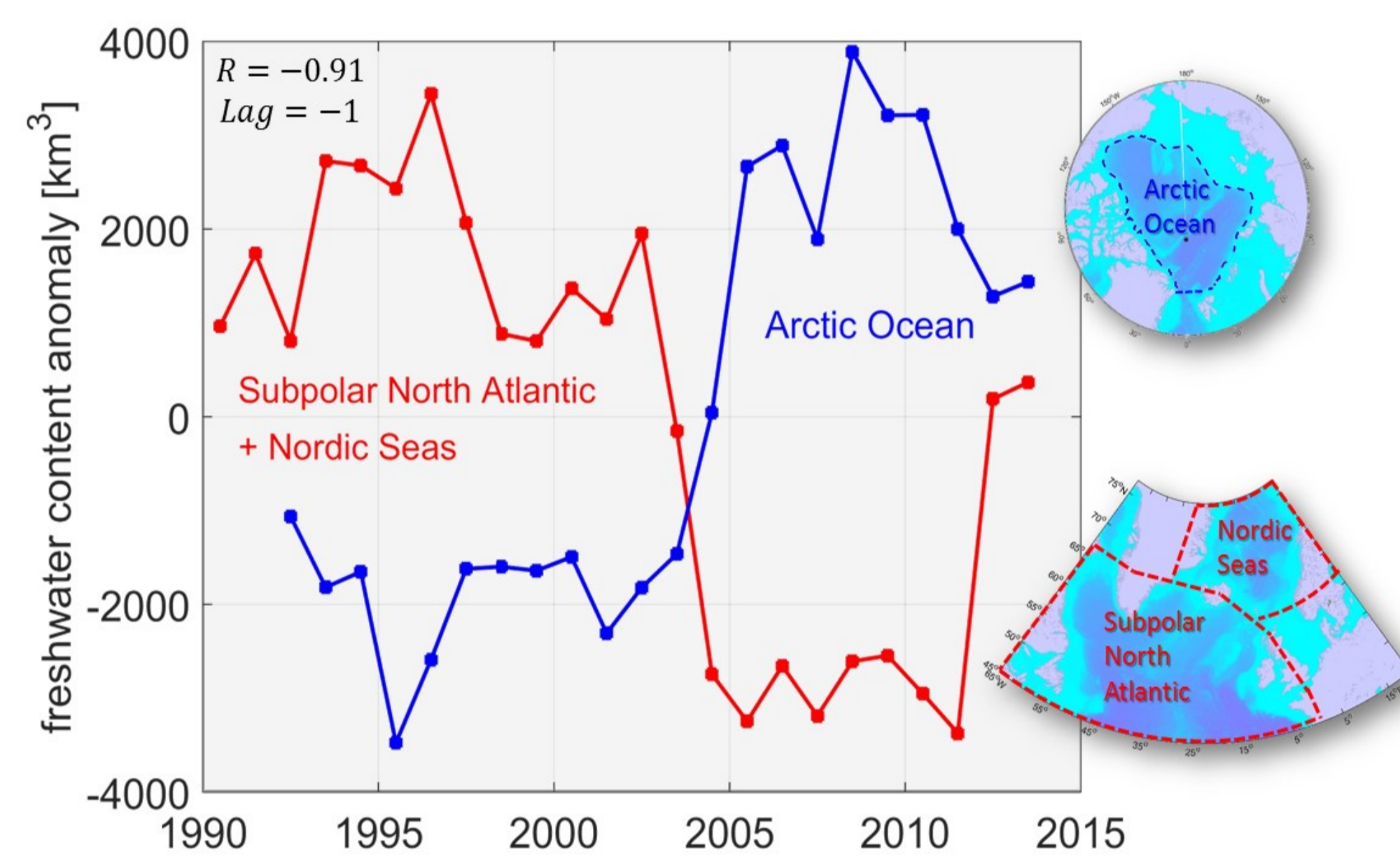


Motivation

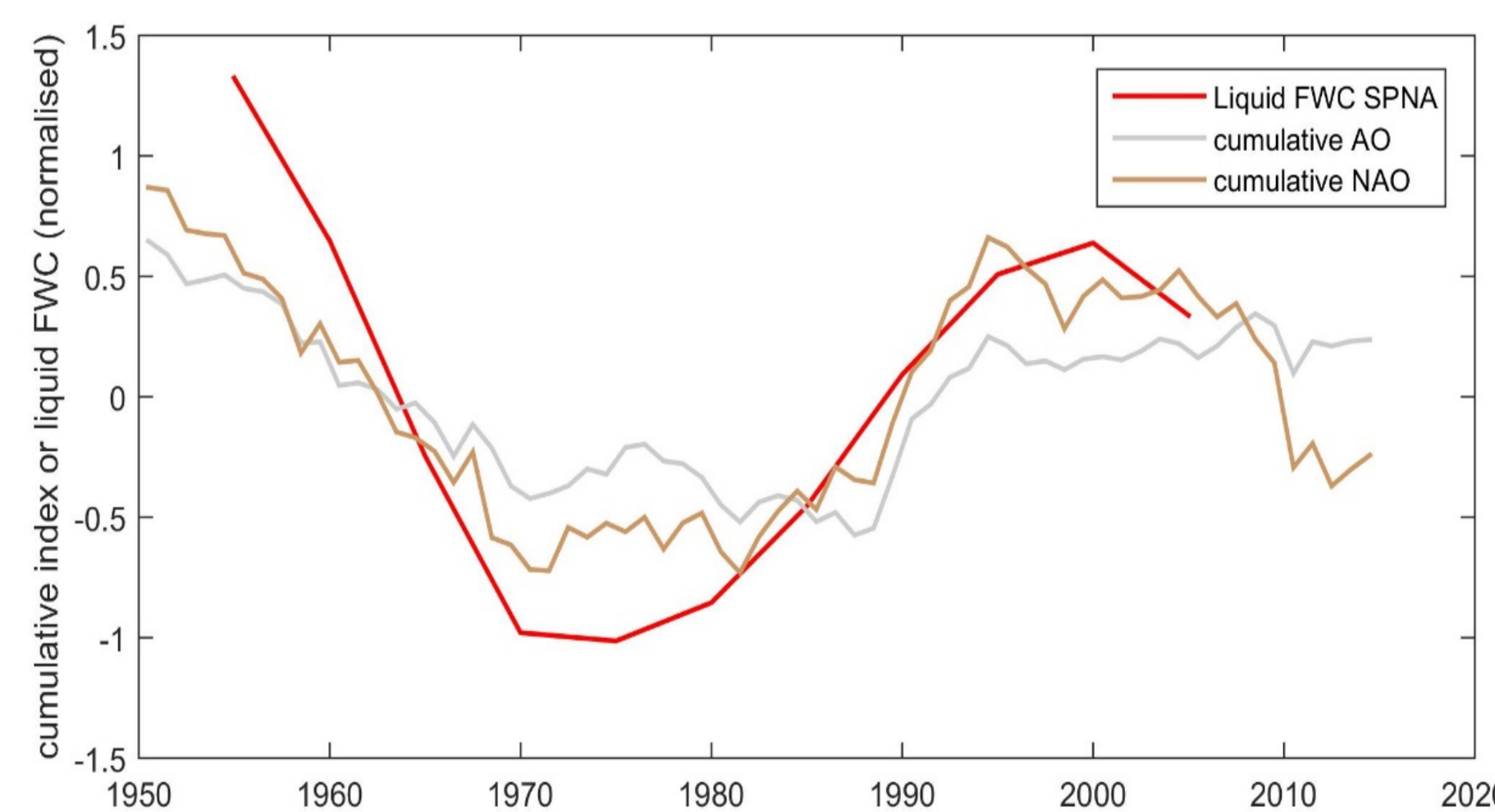
Freshwater content anomalies in the Arctic and North Atlantic oceans: What is the effect of wind forcing?



According to observations, the liquid freshwater content of the Arctic Ocean increased by around 10,000 km³ between 1992-2012 (Rabe et al. 2014).



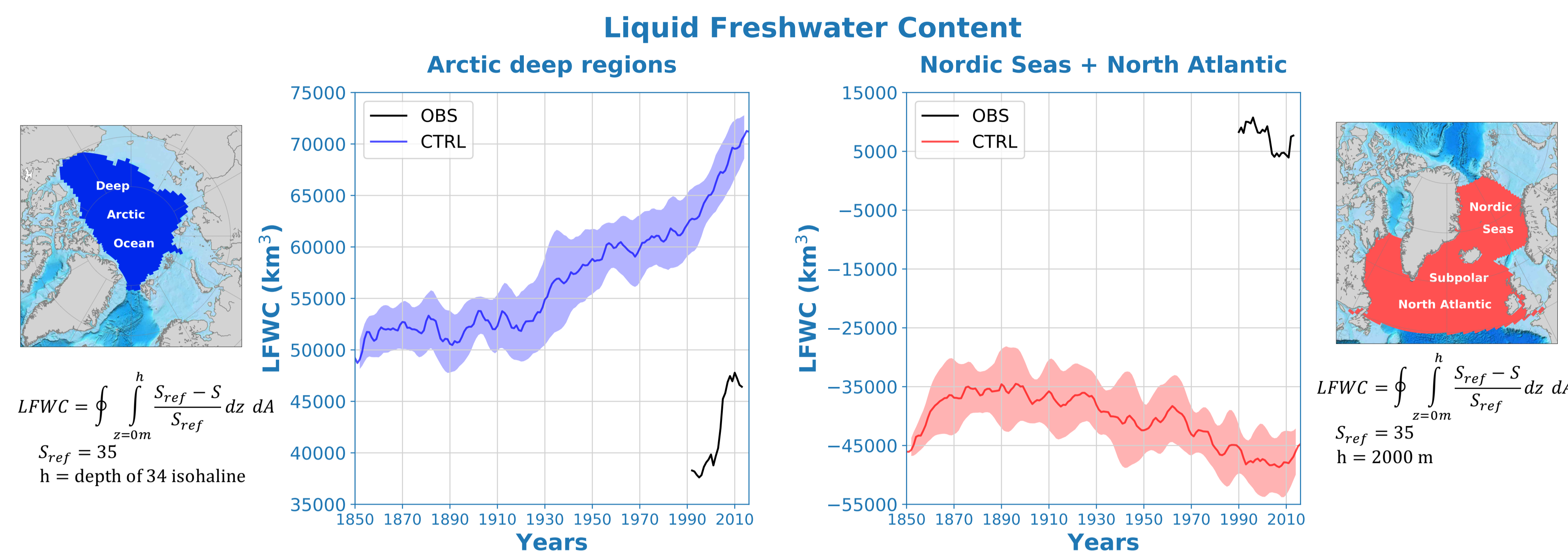
The freshwater content anomalies of the Arctic Ocean, and the Subpolar North Atlantic and the Nordic Seas show a significant anti-correlation (95 % confidence). Moreover, the similar size and the timing of freshwater anomalies suggest an oscillation between them (Horn et al. in prep).



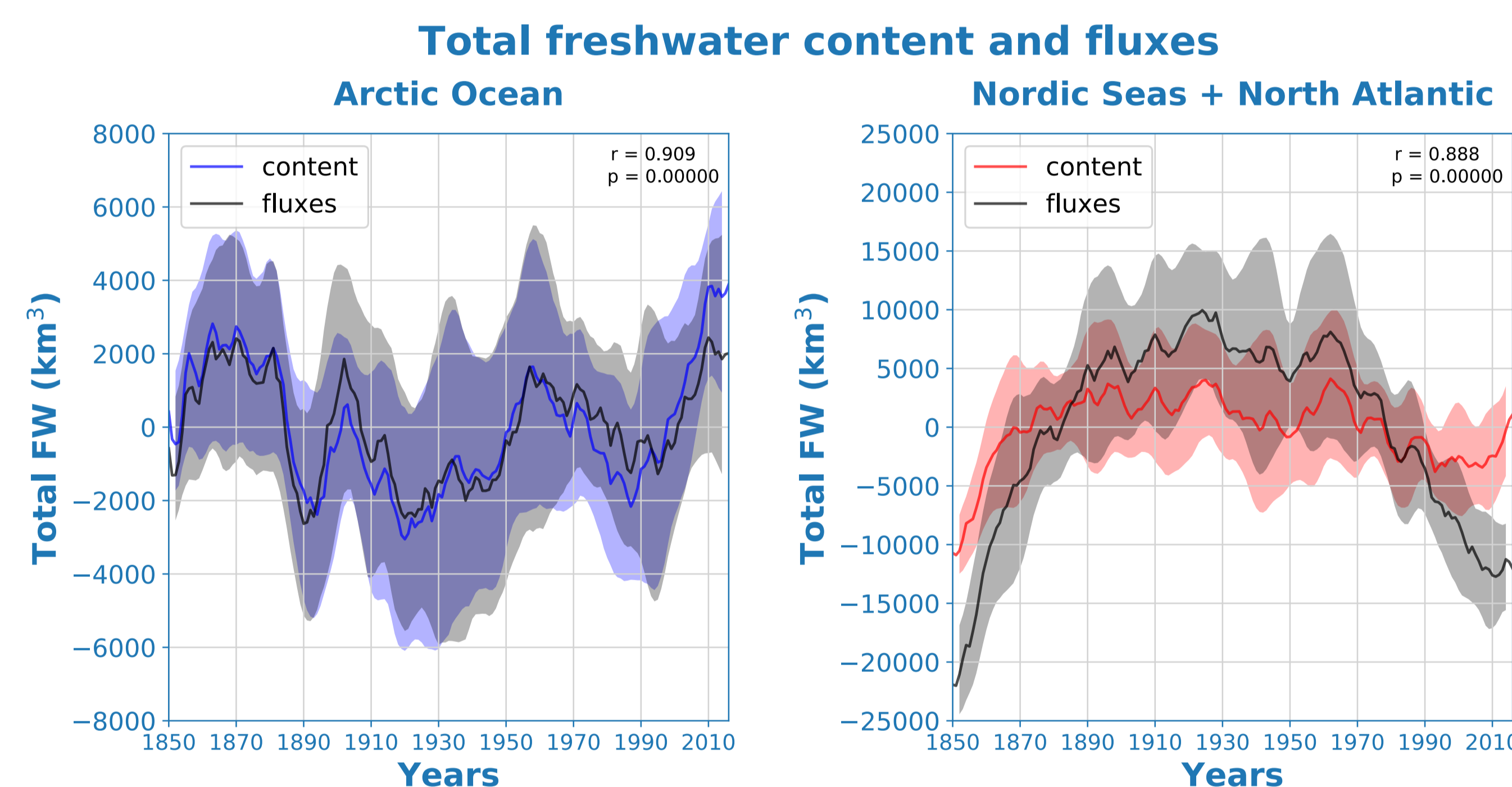
The evolution of liquid freshwater content in the Subpolar North Atlantic correlates with time series of cumulative AO and NAO indices (Horn et al. in prep).

This work is supported by the cooperative project 03F0729E (RACE II, Regional Atlantic Circulation and Global Climate), funded by the German Federal Ministry for Education and Research (BMBF)

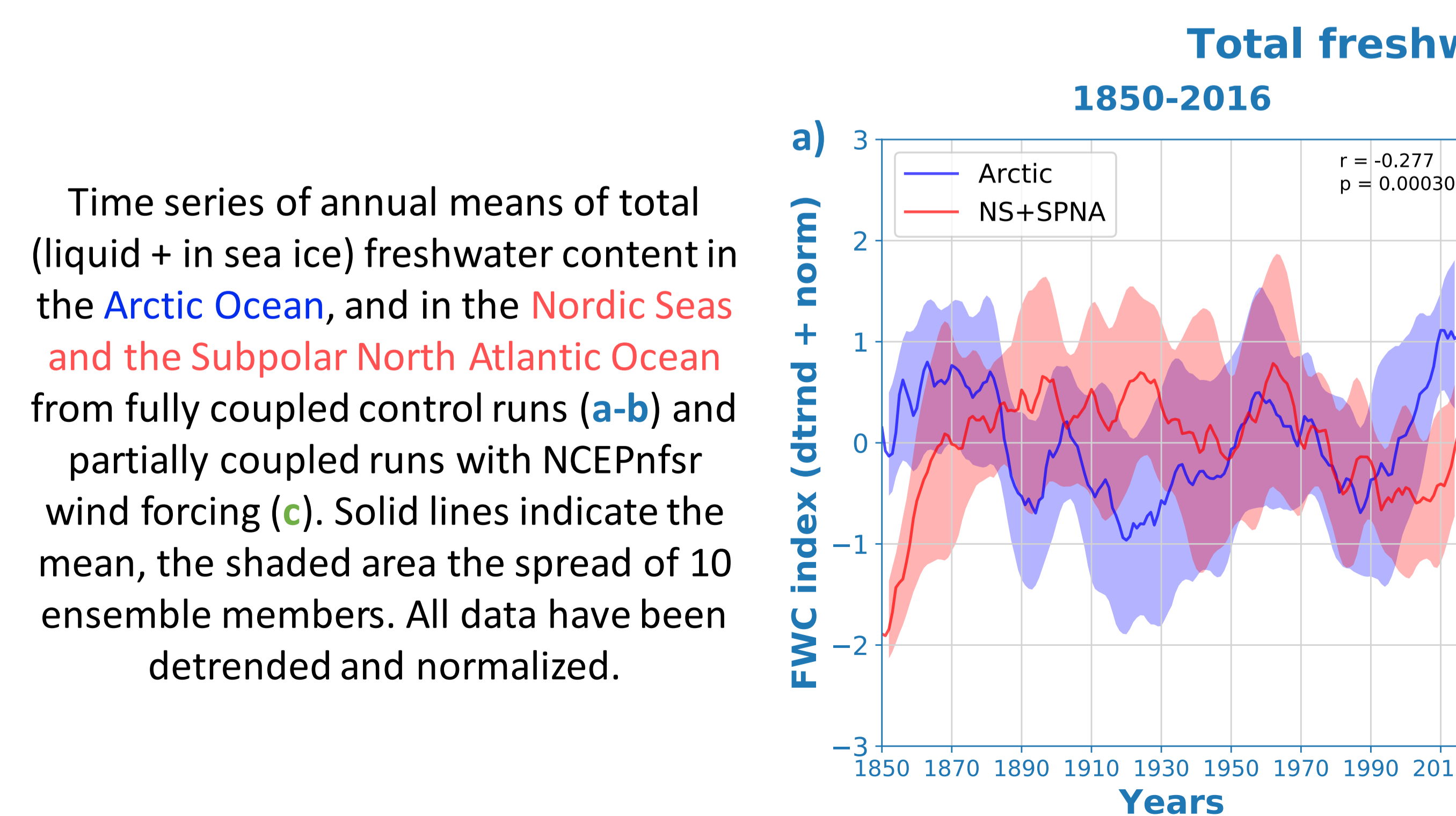
1850 Fully coupled historical control runs of the Max Planck Institute Earth System Model (MPI-ESM) 2016



Time series of annual means of liquid freshwater content from fully coupled control runs. Solid colored lines indicate the mean, the shaded area the spread of 10 ensemble members. Observational data in black are from Horn et al. in prep.



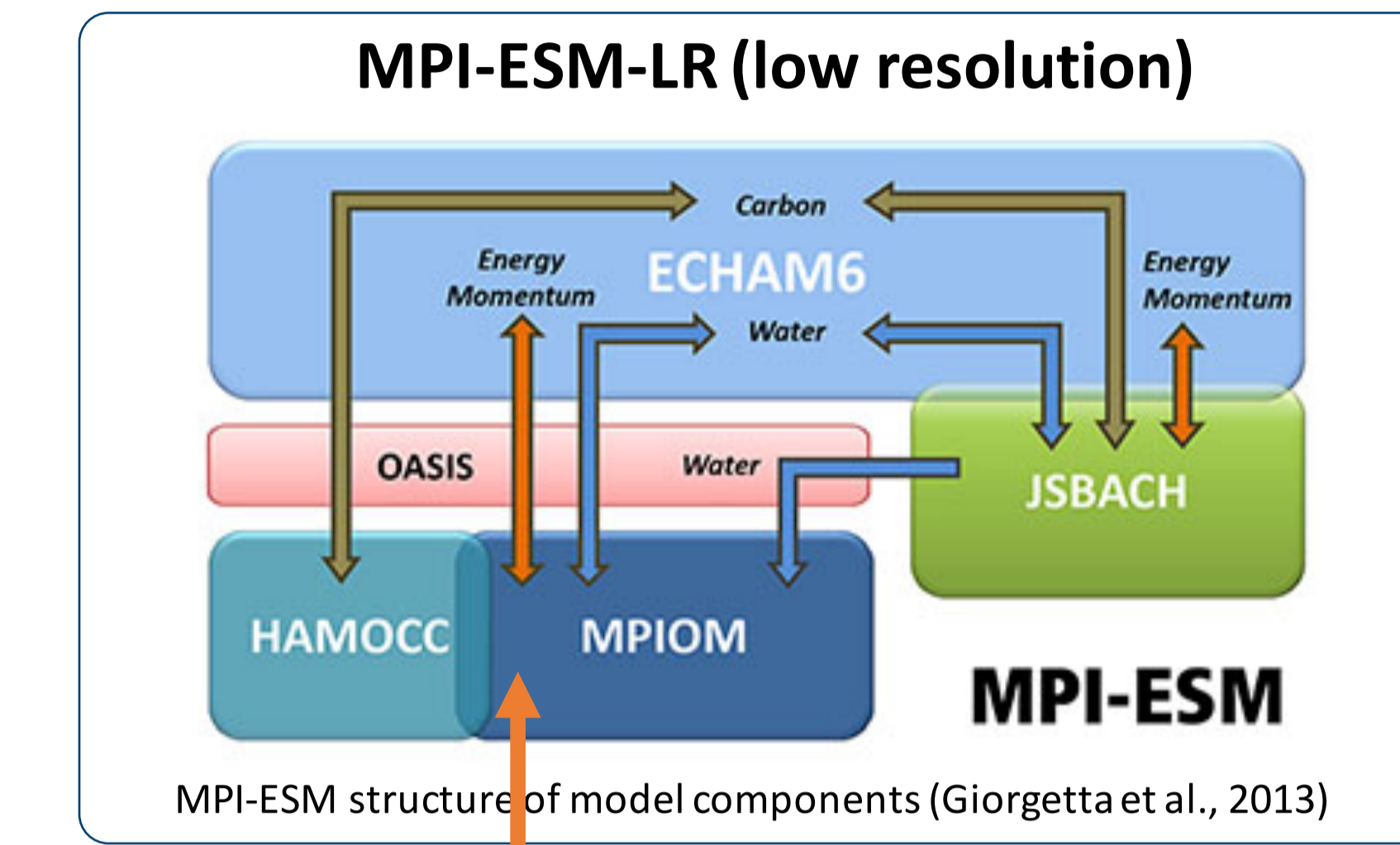
Time series of annual means of total (liquid + in sea ice) freshwater content and cumulative fluxes from fully coupled control runs. Solid lines indicate the mean, the shaded area the spread of 10 ensemble members. All data have been detrended.



Time series of annual means of total (liquid + in sea ice) freshwater content in the Arctic Ocean, and in the Nordic Seas and the Subpolar North Atlantic Ocean from fully coupled control runs (a-b) and partially coupled runs with NCEPnfsr wind forcing (c). Solid lines indicate the mean, the shaded area the spread of 10 ensemble members. All data have been detrended and normalized.

Results

Partially coupled runs with wind stress forcing from NCEPnfsr wind data using the Modini approach (Thoma et al. 2015) 1850 1979 2016



Observations Energy/Momentum Modini Thoma et al. 2015

The Modini approach is a partial coupling technique that enables the MPIOM, the ocean component of the MPI-ESM to be driven by prescribed 6 hourly wind stress anomalies, while maintaining consistency of heat and energy exchanges between the atmosphere and ocean.

The rest of the coupling remains the same as in the original model configuration. Thus the atmospheric model component ECHAM6 still computes its own wind field and responds to the external forcing only through receiving coupled parameters from MPIOM (Thoma et al., 2015).

Highlights

MPI-ESM overestimates liquid freshwater content in the Arctic, and underestimates it in the Nordic Seas and in the Subpolar North Atlantic. Model results are closer to observations when prescribed wind forcing is used.

In both domains the total (liquid and in sea ice) freshwater variability can be explained by the variability of fluxes across bordering sections. Significant correlations with confidence > 99.9% in both model configurations. Ensemble spread is much smaller when prescribed wind forcing is used.

Fully coupled control runs show some anti-correlation between the two domains for limited periods of time with large ensemble spread. No clear connection in recent decades.

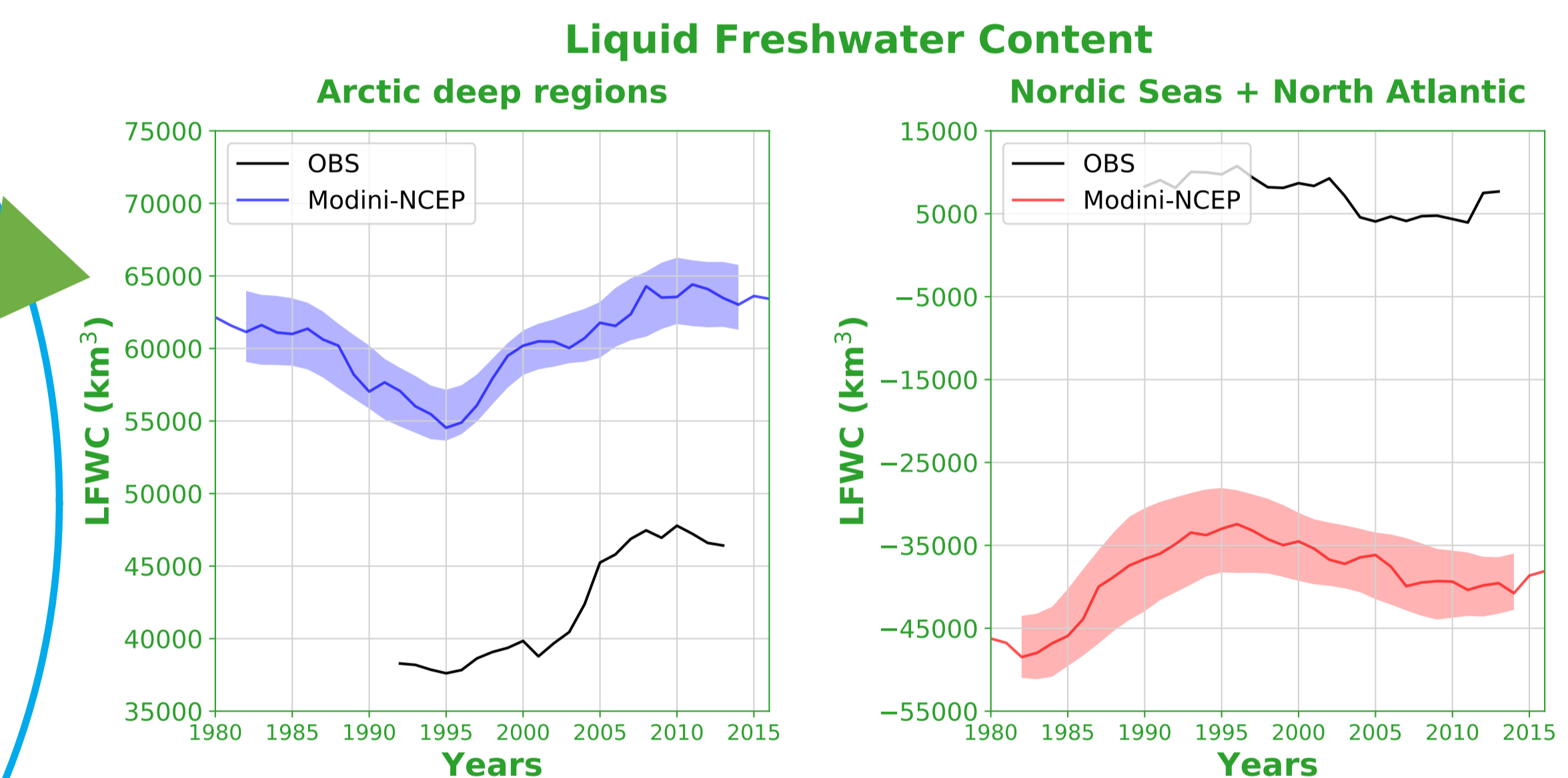
Modini runs with prescribed wind forcing show significant anti-correlation for recent decades with an oscillating behavior. Ensemble spread is small.

NCEPnfsr Saha et al. 2010

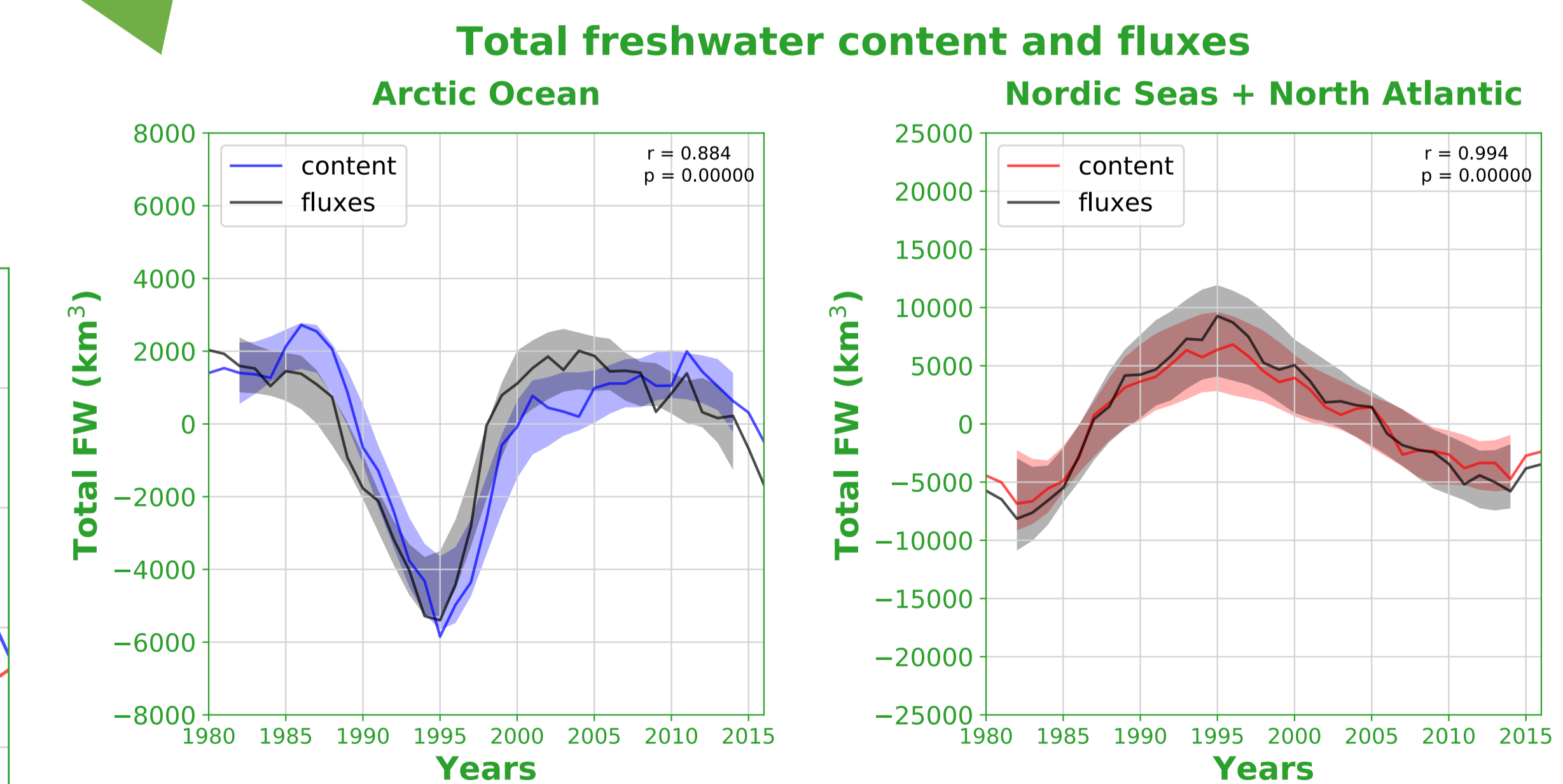
Anomalies, applying them to model climatology
Wind speed data

Interpolation, Calculation from ocean momentum
Wind stress data

Wind stress anomalies



Time series of annual means of liquid freshwater content from partially coupled runs with NCEPnfsr wind forcing. Solid colored lines indicate the mean, the shaded area the spread of 10 ensemble members. Observational data in black are from Horn et al. in prep.



Time series of annual means of total (liquid + in sea ice) freshwater content and cumulative fluxes from partially coupled runs with NCEPnfsr wind forcing. Solid lines indicate the mean, the shaded area the spread of 10 ensemble members. All data have been detrended.