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Gulf Stream and Deep Western Boundary Currents are key to constrain the future North Atlantic Carbon Uptake

Nadine Goris[1,2], Klaus Johannsen[1], and Jerry Tjiputra[1,2]
[1]NORCE Climate & Environment, Bergen, Norway (nago@norceresearch.no)
[2]Bjerknes Centre for Climate Research, Bergen, Norway

As one of the major carbon sinks in the global ocean, the North Atlantic is a key player in mediating the ongoing global warming. However, projections of the North Atlantic carbon sink in a high-CO_2 future vary greatly among models, with some showing that a slowdown in carbon uptake has already begun and others predicting that this slowdown will not occur until nearly 2100.

For an ensemble of 11 CMIP5-models, we identify two indicators of contemporary model behavior that are highly correlated with a model´s projected future carbon-uptake in the North Atlantic. The first indicator is the high latitude winter pCO_2^{sea}-anomaly, which is tightly linked to winter mixing and nutrient supply, but also to deep convection. The second indicator is the fraction of the anthropogenic carbon-inventory stored below 1000-m depth, indicating the efficiency of dissolved inorganic carbon transport into the deep ocean.

We further use a genetic algorithm to identify sub-regions of different shapes and sizes that optimise the correlations between our indicators and the future carbon uptake in the North Atlantic. Independent of size and shape, the genetic algorithm persistently identifies the gulf stream region as optimal for the first indicator as well as the pathway of the deep western boundary current for the second indicator. When extracting the simulated contemporary AMOC-strengths for the central latitudes and depths of these optimal regions, we also find high correlations between AMOC-values and the North Atlantic future carbon uptake.

Our regional optimisation shows that modelled discrepancies in the future North Atlantic carbon uptake originate in different transport efficiencies of dissolved inorganic carbon from the surface to the deep ocean. We find a strong and highly important link between a model's performance for gulf stream and deep western boundary currents and a model's ability to accurately project the future carbon uptake in the North Atlantic.