Role of the AMOC as a source of predictive skill on decadal time scales in the GFDL coupled model: promises and limitations

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The ability to predict sudden changes in the AMOC can be of high societal interest given that the temperature-driven AMOC can enhance or partially offset the projected warming for the 21st century. Perfect model predictability studies based on the GFDL CM2.1 coupled model suggested that the AMOC is potentially predictable on decadal time scales, in agreement with other model studies. Such experiments assume perfect knowledge of initial conditions as well as unbiased models. Therefore, a lower predictive skill is expected in the real climate system. We present results from decadal prediction experiments using the same GFDL CM2.1 model in which both the oceanic and atmospheric components were initialized with observations. Comparing these initialized predictions with forced uninitialized experiments provides an estimate of the skill arising from internal variability. Assessing the predictive skill of the AMOC over the 20th century is difficult because of the lack of continuous observations before the RAPID array was deployed. We therefore investigate the predictive skill of two abrupt oceanic changes that were likely driven by the AMOC and occurred in the North Atlantic in 1995-1996 and 2009-2010, respectively. In the mid-1990s, the North Atlantic subpolar gyre warmed abruptly after a period of persistent positive NAO followed by a reverse of the NAO. In 2009-2010 a pronounced cooling of the subtropical gyre has been observed following a strongly negative NAO event. We use the initialized prediction experiments to investigate the role of the AMOC in these two events and the implications in terms of their predictability. We show that the strong oceanic preconditioning and the AMOC-driven increase of North Atlantic salinity played an important role in the mid-90s warming and enhanced the predictability of this event. In contrast, the 2009-2010 AMOC minimum was not preceded by a persistent NAO and shows a more limited skill. We discuss the impact of oceanic and atmospheric resolution in simulating the observed 2009-2010 AMOC minimum and highlight the remaining challenges in properly initializing and thus predicting the AMOC and the asociated climate impacts.