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Skillful predictions of Atlantic multi-year to decadal variability in the GFDL forecast system

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We analyze retrospective predictions of Atlantic variability with the goal of identifying climate phenomena of high societal significance that could be predicted in the future. We focus on the initialized decadal experiments that were conducted as part of CMIP5 using the GFDL prediction system. Although the dominant source of skill on multi-decadal time scales comes from changing radiative forcing, the Atlantic region stands out as a region where initializing the models can provide additional source of skill from predicting some of the internal variability. We present results from two studies that show encouraging results for predicting Atlantic variability, in the north and tropical Atlantic, respectively. An abrupt North Atlantic warming associated with a decline of the subpolar gyre oceanic circulation and a shift in ecosystem activity has been observed in the mid-1990s. We show that this climate shift in ocean heat content is rather well predicted by the GFDL forecast system, and that initializing the ocean and more specifically the Atlantic Meridional Overturning Circulation is key to capture the dynamics that lead to the warming. We show that accounting for past changes in radiative forcing and the initial state of the global oceans also leads to skillful retrospective predictions of five-year and nine-year averages of Atlantic hurricane frequency. The dominant contributor to forecast skill comes from predicting temperatures over the northern tropical Atlantic minus those in the tropics. We find that forecast quality is improved by combining multiple models. Although promising, we discuss the limited utility of these skillful predictions given that the decadal variability of hurricane activity is dominated by the trend that arises from the sudden increase in North Atlantic hurricane frequency in the mid-90s, which is not predicted by the models. We conclude by highlighting the challenges of forecasting Atlantic multi-year to decadal variability given the relatively short data record, the changes in observing networks and the remaining deficiencies of current climate models yielding imperfect initial conditions.