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Impacts of natural and vorced Climate Variability on the Gulf of Mexico

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In our previous study (Liu et al. 2011), the potential impact of future anthropogenic global warming on the Gulf of Mexico (GoM) is examined by using a downscaled high-resolution ocean model constrained with the surface forcing fields, initial and boundary conditions obtained from the IPCC-AR4 model simulations under A1B scenario. The simulated volume transport by the Loop Current (LC) is reduced by 20 - 25% during the 21st century, consistent with a similar rate of projected reduction in the Atlantic Meridional Overturning Circulation. The reduced LC and the associated weakening of the warm LC eddy have a large cooling impact in the GoM, particularly in the northern basin. Therefore, the northern GoM is characterized as the region of minimal warming. Associated with the underestimated cooling effect by the reduced LC in low-resolution models, such as the IPCC-AR4 models, is lack of the reduced warming feature in the northern GoM. The observed sea surface temperature in the northern GoM during the 20th century clearly shows long-term SST variability similar to the Atlantic Multidecadal Oscillation (AMO). The amplitude of the multi-decadal signal in the northern GoM is as large as 0.5oC, which is comparable to the model-projected SST increase in the northern GoM by 2030. This means that the model-projected SST increase in the northern GoM can be doubled or nearly negated due to natural variability until the mid-21st century. Therefore, here we explore the impact of natural climate variability on the forced response of the GoM in the 21st century by performing dynamic downscaling of the IPCC-AR4 climate models to the GoM region. The Miami Isopycnic Coordinate Ocean Model coupled to Atmospheric Mixed Layer (MICOM-AML) is used as the downscaling model. The model domain contains the Atlantic Ocean between 100E and 20E bounded north and south by 65N and 20S, respectively, with the fully eddy-resolving horizontal resolution of about 10km in the GoM and lower resolution elsewhere. The regional MICOM-AML will be initialized and integrated for each decade-averaged period between 2000 and 2100. The atmospheric forcing and initial-boundary conditions will be derived from the IPCC-AR4 climate model simulations under three CO2 emission scenarios. All experiments will be performed for both positive and negative AMO phases to estimate and quantify the impact of natural variability on the forced response of the LC and its impact on GoM. The potential implications of natural and forced thermal changes in the northern GoM on pelagic fish species and their spawning patterns are also discussed.