Bias of jet in the North Atlantic and its relation to SST in the PRIMAVERA air-sea coupled historical runs

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There are evidences from previous numerical simulation studies using atmospheric general circulation models that capturing fine structures of midlatitude SST fronts are important to simulate the storm track and eddy driven jets with realistic intensity and latitude. Therefore, representation of midlatitude SST fronts appears important to reproduce the realistic stormtracks and jets also in air-sea coupled climate models such as the CMIP5 models.

However, the resolutions of CMIP5 models are not necessarily high enough to capture the fine SST structure, and the models are known to have biases in both jet stream and storm track in the North Atlantic. Climatological mean jet tends to be too zonally oriented, while storm track intensity is too weak compared to the observation. Interesting fact is that the CMIP5 models with relatively high resolution tend to better capture the zonal tilt of the North Atlantic jet and intensity of storm track in winter than the lower resolution ones. This implies a potential that using state-of-the-art climate models of higher resolution may reduce the atmospheric circulation biases through a better representation of midlatitude SST fronts.

In this study, we focus on the circulation bias of stormtrack and jet in the PRIMAVERA climate models which follows the CMIP6 HighResMIP protocol. The horizontal resolution in the models is 1 degree or finer, which is sufficient to represent the SST gradients relevant to the stormtrack and jets. We find that the jet and SST front in winter show consistent bias to be oriented too zonal in the PRIMAVERA models. Storm track activity is realistically strong but shifted equatorward and the associated bias of the westerly momentum-flux convergence is consistent with the bias of the jet. Therefore, the known climatological mean bias of too zonal jet in CMIP5 appears not so much explained by the horizontal resolution of climate models. Nevertheless, the observed low-frequency variability which shows a regime-like behavior of the North Atlantic jet is fairly well simulated in the PRIMAVERA models, where the probability of each regime’s occurrence is influenced by the strength of SST front in the PRIMAVERA models. As a superposition of the regimes, the SST front may still show a modest but significant contribution to better reproduce the observed climatological mean state.

Keywords: High resolution models, PRIMAVERA, circulation bias, SST front, Gulf Stream

