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Mean Atlantic Subtropical Cells in the CMIP6 models

Yao Fu[1], Peter Brandt[2,3], Franz Philip Tuchen[2], Joke F. Lübbecke[2,3], and Chunzai Wang[1]
[1]State Key Laboratory of Tropical Oceanography, South China Sea Institute of Oceanology, Chinese Academy of Sciences, Guangzhou, China (yfu@scsio.ac.cn)
[2]GEOMAR Helmholtz Centre for Ocean Research Kiel, Kiel, Germany
[3]Kiel University, Kiel, Germany

The Atlantic Subtropical Cells (STCs) consist primarily of poleward Ekman divergence in the surface layer, subduction in the subtropics, and equatorward convergence in the thermocline that largely compensates the surface Ekman divergence through equatorial upwelling. As a result, the STCs play an important role in connecting the tropical and subtropical Atlantic Ocean, in terms of heat, freshwater, oxygen, and nutrients transports. However, their representation in state-of-the-art coupled models has not been systematically evaluated so far. In this study, we investigate the performance of the Coupled Model Intercomparison Project phase 6 (CMIP6) models in simulating the Atlantic STCs. Comparing model results with observations, we first present the simulated mean state with respect to ensembles of the key components participating in the STC loop, i.e., the meridional Ekman and geostrophic flow at 10°N and 10°S, and the Equatorial Undercurrent (EUC) at 23°W. We then examine the inter-model spread and the relationships between these key components. We find that there is a general weak bias in the Southern Hemispheric ensemble Ekman transports and mixed-layer geostrophic transports in comparison to the observations. The inter-model spread of mean EUC strengths are primarily associated with the intensity of the mean wind stress in the tropical South Atlantic among the models. Since the poleward Ekman transports induced by the trade winds are regarded as the driver of the STC loop, our results point out the necessity to improve skills of coupled models to simulate the Southern Hemisphere atmospheric forcing in driving the Atlantic STCs.