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Generation and evolution of tropical Atlantic barrier layers

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We study the mechanisms behind the generation and evolution of western tropical Atlantic barrier layers by investigating small-scale processes attached to the regional circulation of the tropical Atlantic using output from an eddy-resolving numerical simulation at 4-km resolution forced by atmospheric reanalysis data. The spatial distribution of near-surface mean salinity biases in the simulations was seen to match the spatial distribution of the differences in mean barrier layer thickness (BLT) to the observations, indicating that resolving the processes of barrier layer formation and evolution is particularly important to accurately simulate the tropical ocean. In overall terms, the temporal and spatial patterns of observed BLT (as estimated with ARGO and CTD profiles) are fairly well reproduced by the simulation. Seasonal variability of BLT is pronounced in the northwestern tropical Atlantic, with a peak in the winter month of February and a drop in the spring month of May. The 4-km resolution simulation, due to its fully eddy-resolving character, shows details of the relation between the North Brazil Current (NBC) variability and associated eddies and the barrier layer formation and evolution. Localized barrier layers larger than 70 m are formed inside the NBC rings in July, mainly due to deeper isothermal layer depth in the ring. During September to November, barrier layers are thicker in the periphery than in the core of the NBC rings. Horizontal advection of freshwater from the Amazon river is the most dominant mechanism forming the barrier layers here. In the tropical region north of 14°N, away from the influence of NBC eddies, the thick winter BLTs are mainly due to horizontal advection and tilting of salinity fronts and partly due to a stretching mechanism.