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The growth and decay mechanisms of barrier layers in the northwestern tropical Atlantic are studied by investigating small-scale processes embedded in the regional circulation of the tropical Atlantic using output from an eddy-resolving numerical simulation at 4 km resolution forced by an atmospheric reanalysis. The simulation reproduces well the temporal and spatial patterns of barrier layer thickness (BLT) estimated with Argo and CTD in situ profiles. As seen from an analysis of the salinity and temperature vertical gradient balances, localized large barrier layers form inside North Brazil Current rings during late-June to July because of a thickening of the isothermal layer in the rings due to horizontal temperature advection, stretching of isotherms and tilting of temperature fronts. These barrier layers decay when the isothermal layer reduces again due to the above mechanisms. Further to the north, along the North Equatorial Current, the seasonal variability of BLT is highly pronounced. Thick winter (January to early-March) barrier layers locally grow as the base of the mixed layer shoals mainly due to a tilting of the salinity fronts and partly due to stretching of the isohalines, horizontal salt advection and vertical turbulent mixing. The short-term barrier layers in this case decay due to a deepening of the mixed layer, whereas they get completely eroded in spring by a shoaling of the isothermal layer due to surface temperature stratification. This work highlights that barrier layers are localized phenomena at times growing solely due to ocean dynamics, without a surface freshwater influx.
Presentation file
saha-presentation.pdf
Meeting name
PIRATA-24/TAV Meeting
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