Supplementary Material

1 Supplementary Texts

1.1 Sensitivity tests

1.1.1 The horizontal boundary

To make sure the NBUC transport in this study is not sensitive to the horizontal boundary we chose, we also have calculated NBUC transport using different criteria. Rühs et al. (2015) has defined the NBUC transport via the integrated meridional velocities between the coast and 33.5°S, and 0-1200m depth (in their supplementary) at 6°S. To be consistent in the intercomparison, we have also calculated the transport using other methods at 6°S. Dossa et al. (2021) uses the ADCP data and define the core of the NBUC as 40km from the coast. To make sure that the NBUC transport is mostly covered, we have also defined the NBUC transport between the coast and 1° away from the coast in the zonal direction. By comparing the ensemble mean (derived from SODA 3.3.2, GLORYS12V1, OFES2, and HYCOM) in different definitions, we found out the NBUC transports on different time scales are generally consistent with each other (Supplementary Figure 1). Discrepancies exist on the annual time scale, in which the maximum transport derived from the edge method is one month earlier than that based on Rühs et al. (2015), and two months earlier than that based on 1° from the coast method. Other than that, we can conclude that the NBUC transport is not sensitive to the definition of the horizontal boundary.

1.1.2 The vertical lower limit of the integral

In this analysis, the meridional velocity is integrated from 1200m to 5m to derive the NBUC transport. 1200m is the lowest depth of the northward NBUC. This depth, however, varies among models due to differences in simulation. Thus, we have calculated the NBUC transport based on other definitions of the lower boundary: the zero velocity as the lower limit and the temperature minimum as the lower limit. The NBUC is a northward current, and the southward South Atlantic Deep Western Boundary Current is below it. Thus, the sign of the meridional flow should be reversed at some depth. Here, we have calculated the climatological depths of the zero velocity as the second definition used in the comparison (1200m as the first definition). The uCDW is also considered as the deepest boundary of the NBUC (Reid, 1989), which is defined as the temperature minimum in the vertical profiles. We have calculated the climatological depths of the temperature minimum as the third definition used in the comparison. Supplementary Figure 2 has shown that, on annual and interannual time scales and for the linear trend, NBUC transport is not sensitive to the lower limit of the integration. Thus, the NBUC transport variance is not sensitive to the difference in the lower boundaries.

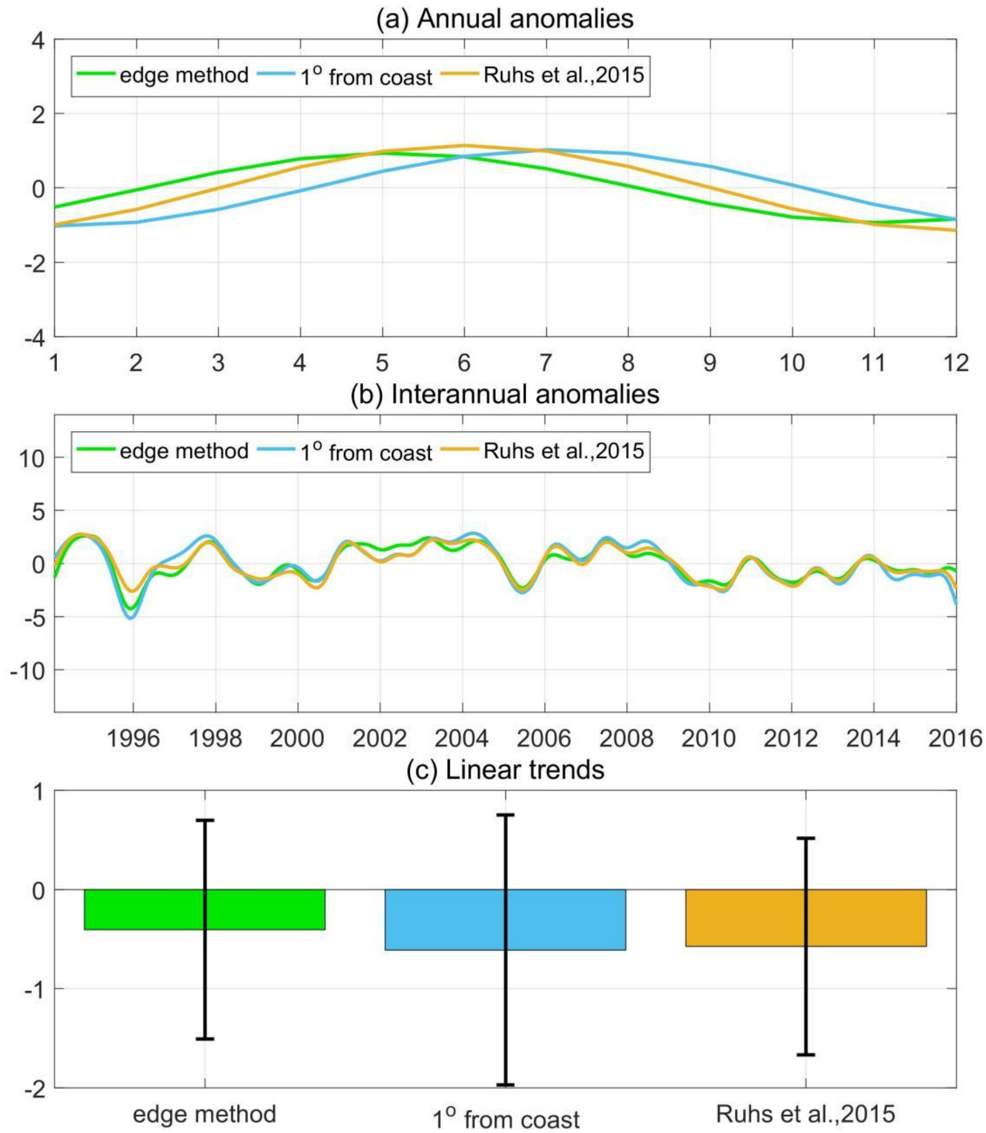
2 Reference

Dossa AN, Silva AC, Chaigneau A, Eldin G, Bertrand A (2021) Near-surface western boundary circulation off Northeast Brazil Progress In Oceanography 190:102475 doi:https://doi.org/10.1016/j.pocean.2020.102475

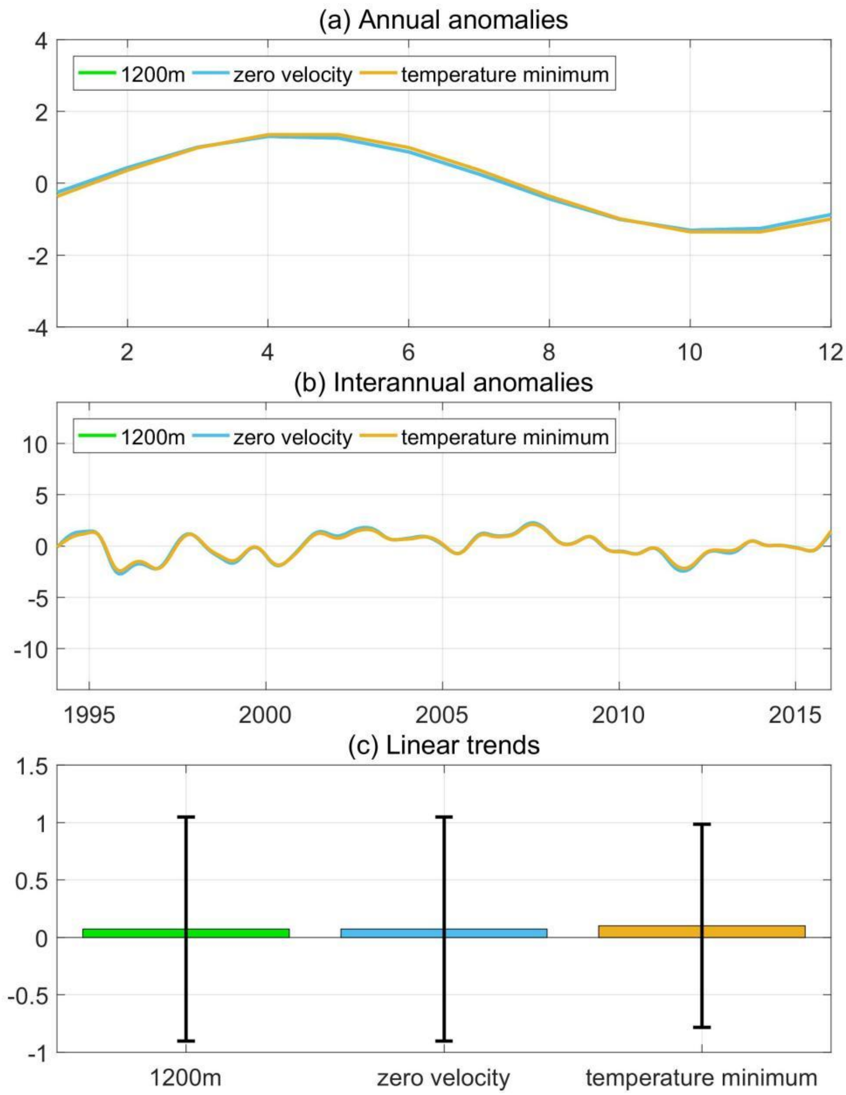
Reid JL (1989) On the total geostrophic circulation of the South Atlantic Ocean: Flow patterns, tracers, and transports Progress In Oceanography doi:10.1016/0079-6611(89)90001-3

Rühs S, Getzlaff K, Durgadoo JV, Biastoch A, Böning CW (2015) On the suitability of North Brazil Current transport estimates for monitoring basin-scale AMOC changes Geophysical Research Letters 42:8072-8080 doi:https://doi.org/10.1002/2015GL065695

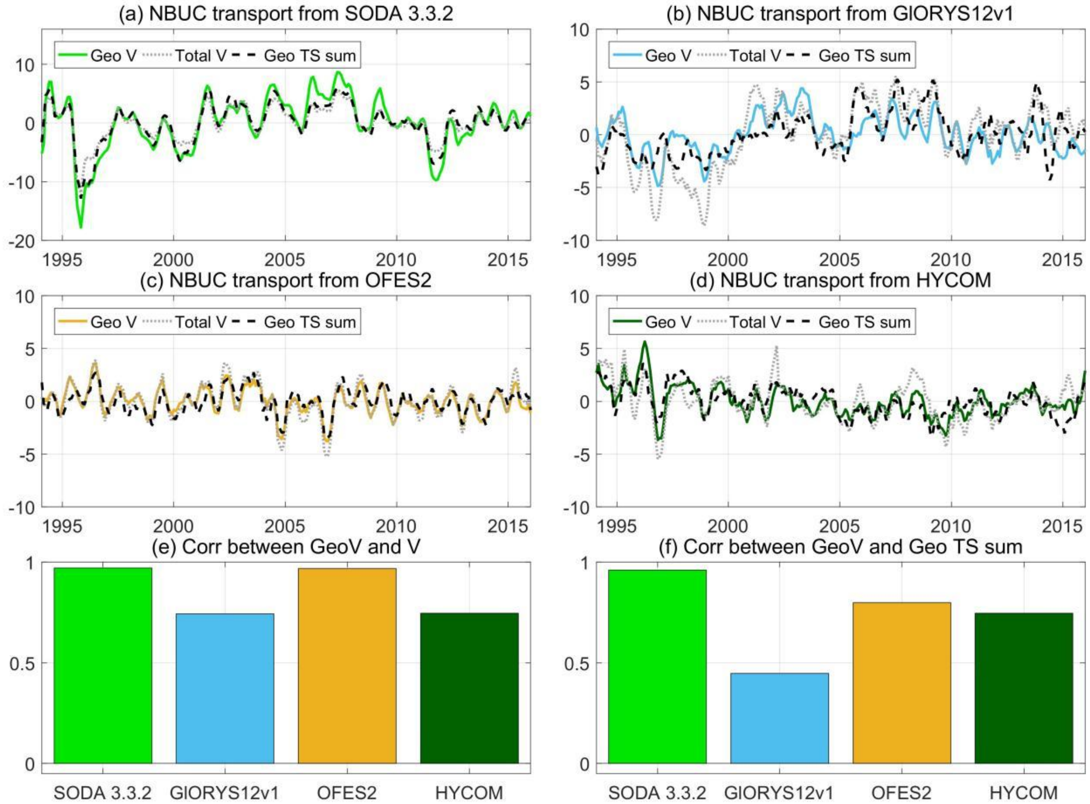
3 Supplementary Figures



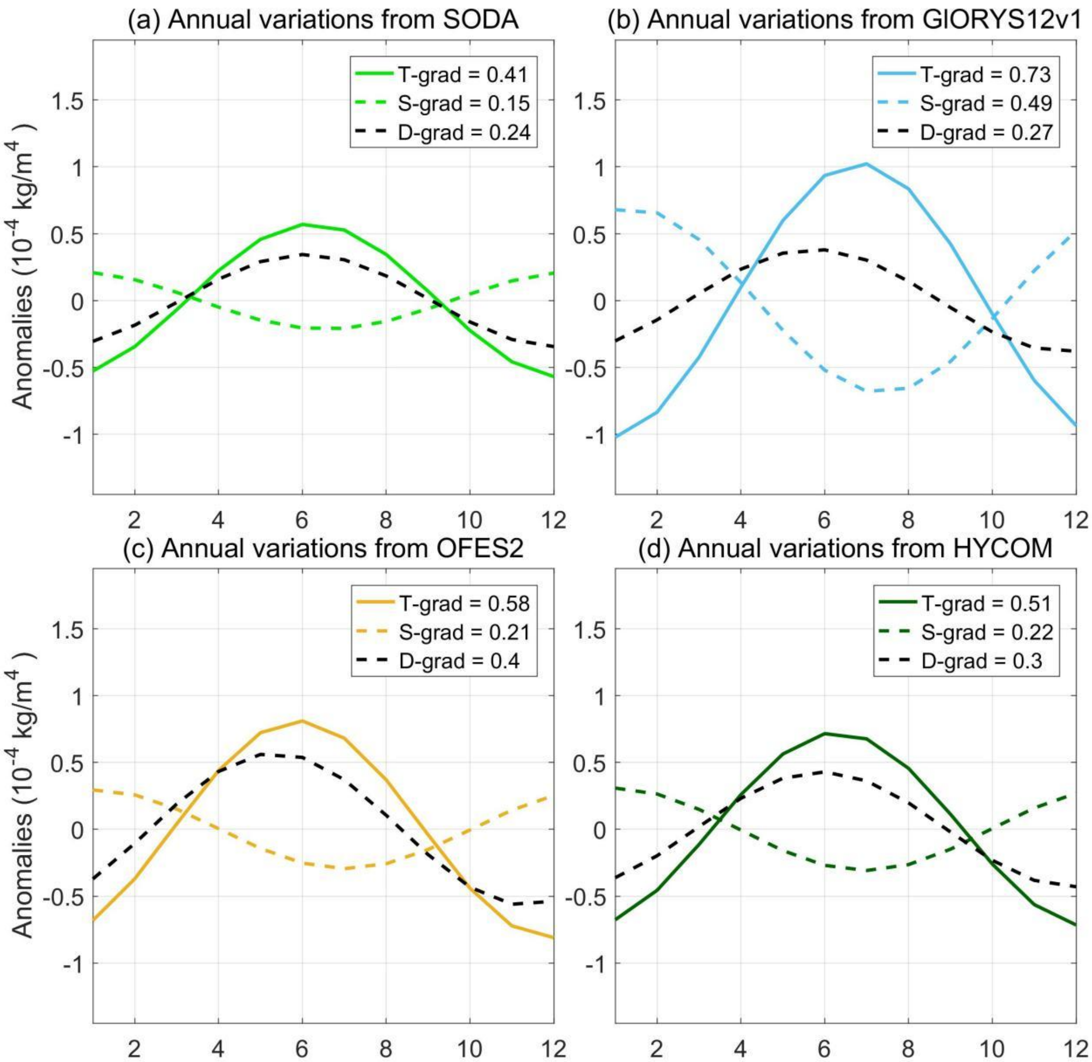
Supplementary Figure 1. Time series of (a) annual, (b) interannual anomalies, and (c) linear trends of the NBUC geostrophic transport if a different horizontal boundary is chosen. All methods are compared at 6°S because the definition from Rühs et al. (2015) is at 6°S. The time series are based on the ensemble mean of SODA 3.3.2, GLORYS12V1, OFES2, and HYCOM. The error bars in (c) denote 90% confidence level for the linear trends. The units for NBUC transport anomalies are Sv. The units for the slope of the linear trend are Sv/10 years.



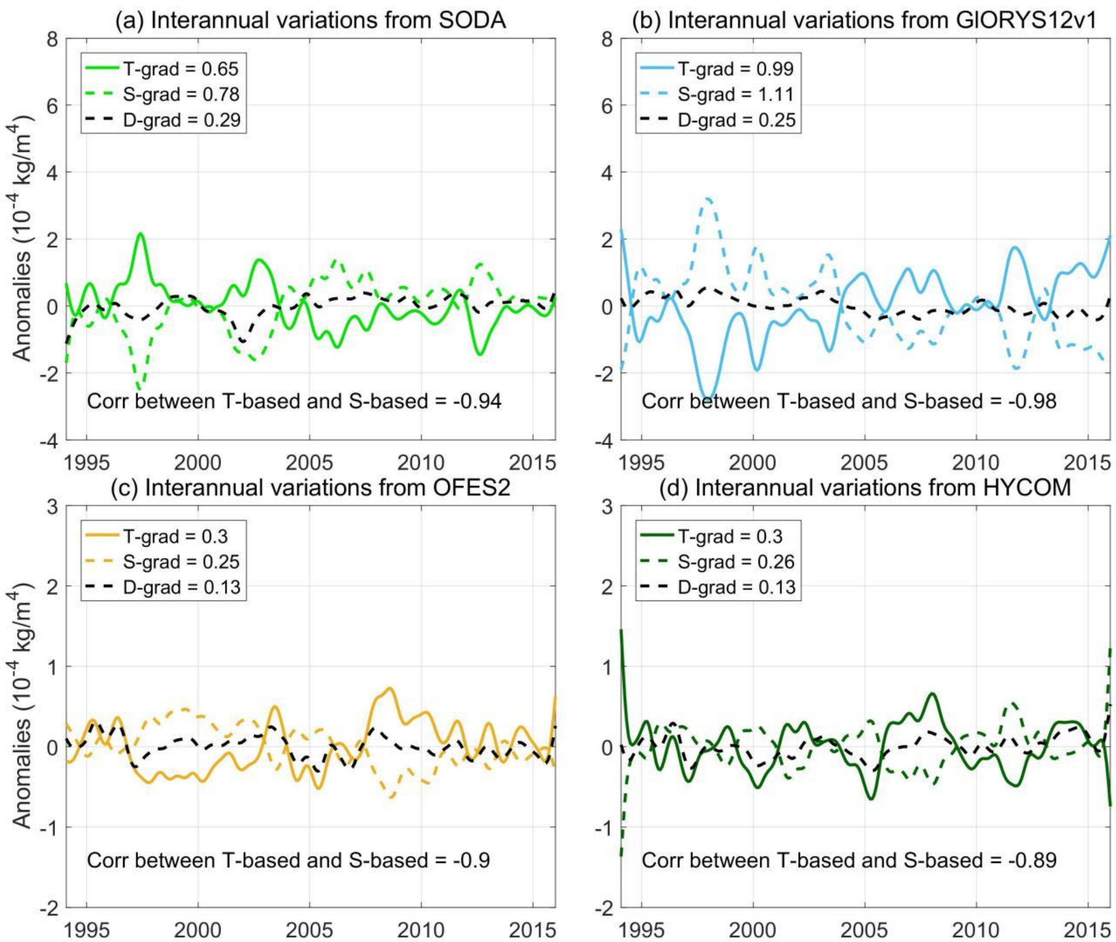
Supplementary Figure 2. Time series of (a) annual, (b) interannual anomalies, and (c) linear trends of the NBUC geostrophic transport if a different vertical boundary is chosen. All methods are compared on average between 6°S and 11°S based on the ensemble mean of SODA 3.3.2, GLORYS12V1, OFES2, and HYCOM. The error bars in (c) denote 90% confidence level for the linear trends. The units for NBUC transport anomalies are Sv. The units for the slope of the linear trend are Sv/10 years.



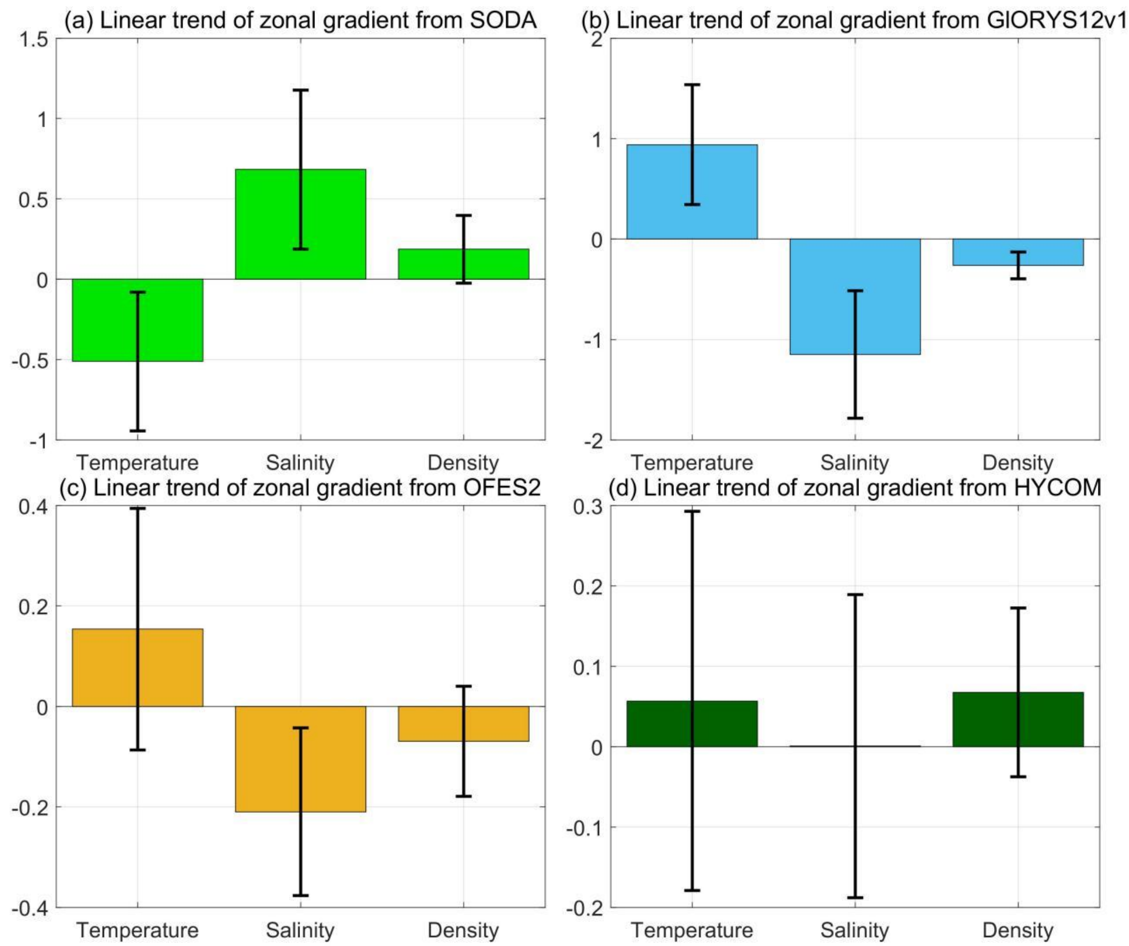
Supplementary Figure 3. Comparison in NBUC transport derived from the meridional velocity (denoted as Total V), the density-based geostrophic velocity (denoted as Geo V), and the sum of salinity-based and temperature-based geostrophic velocities (denoted as Geo TS sum) in (a) SODA 3.3.2, (b) GLORYS12V1, (c) OFES2 and (d) HYCOM. (e) the correlation coefficients between Geo V and Total V, and (f) between Geo V and Geo TS sum. All correlation in (e and f) has passed 90% confidence level. The NBUC transports are averaged between 5°S and 11°S, and the units for NBUC transport are Sv.



Supplementary Figure 4. Time series of the annual temperature, salinity and density zonal gradient averaged within the NBUC region in different products: (a) SODA 3.3.2; (b) GLORYS12V1; (c) OFES2; and (d) HYCOM. The colored solid lines denote the temperature zonal gradient, the colored dashed lines denote the salinity zonal gradient, and the black dashed lines denote the density zonal gradient. One standard deviation of each type of annual variability is listed in the legend. The unit of the zonal gradients is $\mathrm{kg/m^4}$.



Supplementary Figure 5. Time series of the interannual temperature, salinity and density zonal gradient averaged within the NBUC region in different products: (a) SODA 3.3.2; (b) GLORYS12V1; (c) OFES2; and (d) HYCOM. The colored solid lines denote the temperature zonal gradient, the colored dashed lines denote the salinity zonal gradient, and the black dashed lines denote the density zonal gradient. One standard deviation of interannual variability is listed in the legend. The correlation coefficients between temperature zonal gradient and salinity zonal gradient time series are listed in each figure. All the correlation coefficients satisfy the 90% confidence levels (not shown). The unit of the zonal gradients is $\mathrm{kg/m^4}$.



Supplementary Figure 6. Linear trends of temperature, salinity and density zonal gradient averaged within the NBUC region in different products. The error bars indicate the 90% confidence level of the linear trend. The units for the slope of the linear trend are $\mathrm{kg/m^4}$ per 10 years.