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Atlantic Meridional Overturning Circulation: Estimates of heat transport convergence and ocean mass anomalies

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Changes in sea level in the Atlantic Ocean result from changes in the temperature and salinity (steric changes) of the ocean and from changes in mass. Two observational fields correspond to these components; heat content (from in situ data), and gravity anomalies from the GRACE satellite. Neglecting salinity changes, which have been estimated to have little effect on sea level in the North Atlantic, the sum of the anomalies of these components should match the observed sea level anomalies. Sea level with a nearly 20-yr record has a relatively small and quantifiable error compared with its components. Surface heat and freshwater fluxes can be integrated to produce heat content and mass anomalies expected from surface-only forcing. Discrepancies between modeled and observed fields are the result of heat or mass transport convergences combined with errors in the fields. Using a Kalman filter with an unknown control formulation and high-quality surface fluxes, along with estimates of errors, we model the sea level components for the Atlantic north of 25S, constrained by the observations. From the unknown control (the smoothed residual) we infer heat and mass transport convergence. The regional convergences can be integrated to estimate meridional heat transport (MHT), with suitable assumptions in high latitudes. Comparisons with the RAPID Array MHT anomalies show little correspondence; however, the anomalies in inferred MHT are within the error estimates, for which surface heat fluxes give the largest contribution. The analysis reveals that 1) the observed SSH anomalies in the subpolar gyre are from heat content in the early part of the record and from mass in the latter part of the record; 2) the larger portion of the heat content anomalies throughout the region are caused by heat transport convergences; 3) a correlation between SOI and mass anomalies in the equatorial Atlantic is likely the result of local precipitation anomalies Comparisons of the inferred MHT anomalies will be made with data assimilation products.