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Diagnosing eddy heat transport variability in the North Atlantic from satellite and in-situ observations

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The meridional flux of heat by mesoscale eddies constitutes an important component of the total North Atlantic meridional heat transport across the northern boundary of the subtropical gyre, a region that is of vital importance to the northern branch of the Atlantic Meridional Overturning Circulation (AMOC). Temporal and spatial variations in the eddy heat transport are particularly important and can influence the hydrography and dynamics of both the subtropical and subpolar North Atlantic.

This study focuses on the temporal variability of the meridional eddy heat transport and on the changes in its spatial pattern in the North Atlantic between 35°N and 55°N. The analysis is based on the combined use of satellite observations of sea surface height anomalies (SSHA) and sea surface temperature (SST) over the 25-year period from 1993 to 2017. The vertical structure of the meridional eddy heat transport is reconstructed from a composite analysis of Argo profile data and statistics of eddy trajectories in altimetric SSHA.

The analysis of the meridional eddy heat transport in the North Atlantic based on surface observations reveals significant variability on inter-annual time scales. Most strikingly, the average eddy heat transport in some regions has almost doubled in recent years. The largest changes are observed between 35°N – 45°N and 50°W – 60°W in the extension of the Gulf Stream. Another region of particular interest is the zonal section along approximately 47°N. Mesoscale eddies forming between the northward flowing North Atlantic Current (NAC) and the southward flowing Western Boundary Current (WBC) provide a means for the local exchange of heat in this region. The NAC is also characterized by relatively strong eddy heat fluxes at depth (∼30% of the surface value at 700 m), presumably related to a deep thermal front associated with the jet. All these variations in the eddy heat flux provide a significant contribution to the variability of the total oceanic heat transport (up to 50%), suggesting a potentially important forcing mechanism in the climate system. Mechanisms of the eddy heat flux variability are also discussed.