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Interactive comment on "A new method to assess mesoscale contributions to meridional heat transport in the North Atlantic Ocean" *by* Andrew Delman and Tong Lee

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Note: The original reviewer comments are indicated in italic font below, with the author responses and manuscript edits following in non-italic font.

This paper is well written and I recommend publication after some revision/addition.

Thanks to the reviewer for the very thoughtful, helpful comments on this manuscript. We have addressed the reviewer's comments point by point below.

The paper points to its novel aspect a being a new way to do the separation of the eddy vs. large-scale contributions, and primarily as a different view than the Hall and Bryden (1982) separation of the baroclinic component of the heat transport. As such, I think the authors should directly compare some of the computations and maps to the Hall and Bryden method.

For example, in Figure 3, would the HB82 eddy term look different? Same in Figure 4, etc. Jayne and Marotzke (Rev. of Geophys. 2001) did some comparisons of the HB82 decomposition vs. the other time-varying heat transport terms.

A key difference between our decomposition method and that used in HB82 is that HB82 first used a depth average to separate barotropic and baroclinic components of the temperature flux. Later in HB82, a zonal average is used to decompose the baroclinic component further; we use the zonal average first to separate the overturning and zonal-deviation components. We have computed HB82's barotropic and baroclinic components, and the baroclinic zonal-deviation component (what they call the eddy flux) from the POP output. Time mean and interannual/decadal standard deviations of the HB82 eddy flux are shown alongside the mesoscale and time-deviation temperature fluxes in Figure 15. We have described the results of this analysis in Section 5.2, for example:

"To the south and north of this active mesoscale region, all of the "eddy" formulations have much lower time-mean values, with the exception of the baroclinic eddy term which peaks as high as 0.35 PW at 36°N. However, the definition of the baroclinic eddy flux includes large-scale gyre flows that have a baroclinic component, and the baroclinic eddy contribution is generally comparable to or smaller than the large-scale contribution to time-mean MHT (Figure 4a)." (lines 414-418)

Figure 5 seems to indicate that the separation between their large-scale vs. mesoscale is not very great. That is the spatial filter they used doesn't seem to really separate the *spatial scales well, and the spectra in Figure show there isn't really a strong scale separation, especially in the temperature. It should be commented on.*

Figure 5 (now Figure 6 in the revised manuscript) does not really provide an indication of the how well the spatial filter separates the large scale and mesoscale v and T. This is because the figure shows the zonally-smoothed product of v and T, which in the case of the mesoscale component is a rectified flux of the mesoscale v and T onto larger scales. In the revised manuscript, the new Figure 3 shows the v and T decomposition along several transects, to show the scale separation between mesoscale and large-scale explicitly. The reviewer correctly notes that the scale separation is not as distinct in temperature, and the temperature spectra is also more red-shifted towards larger scales (Figure 2). However, this is not an impediment to generating substantial mesoscale temperature fluxes when temperature anomalies are advected by mesoscale velocities.

Some enhancements to our method near boundaries have improved the physical interpretation of our results; the benefit is that the cumulative mesoscale volume transport in a transect (as well as across distances » 10° longitude within transects) is near zero. Figure 3 shows that the large-scale velocity field preserves the large-scale volume transport (i.e., the barotropic streamfunction), and therefore represents features such as the Gulf Stream as a coarse-resolution model might represent them. The other examples of large-scale and mesoscale temperature flux structure in Figure 3 (at 28°N and 34°N) illustrate further how this decomposition can diagnose the contributions of large-scale vs. mesoscale velocity and temperature structure, as described in Section 3.1:

"Most of the non-overturning temperature flux is associated with the large-scale component at both latitudes; however, the mesoscale temperature flux (MTF) switches sign from negative at 28°N to positive at 34°N (Fig. 3d,h). The reason for this is the temperature difference between the core of the northward boundary current and the southward recirculation 2° to the east. At 351 m depth (a representative depth for lateral temper-

ature gradients in the thermocline), the temperature at 28°N is lower in the boundary current than it is in the interior recirculation (Fig. 3b), as isopycnals tilt upward sharply approaching the Florida coast. However, at 34°N the temperature peak along the zonal profile is coincident with the boundary current (Fig. 3f), and the temperature peak also has more of a mesoscale signature that explains why the vMTM contributes the most to the MTF (Fig. 3h)." (lines 204-212)

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