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Discussions

Interactive comment on "Diapycnal mixing across the photic zone of the NE-Atlantic" *by* Hans van Haren et al.

Anonymous Referee #3

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This is an observational study of diapycnal mixing and the corresponding nutrient flux in the upper ocean across a quasi-latitudinal transect in the Northeast Atlantic Ocean. The data cover a rather long distance from 30deg.N to 62deg.N. The measurements were mainly temperature and conductivity profiles (from which the density or potential density profiles were obtained) with a carefully modified CTD system, and the turbulent kinetic energy dissipation rate and the diapycnal diffusivity were estimated based on the overturning (Thorpe) scale analysis. In general, the methodology of the analysis is reasonable, and useful information on turbulent mixing characteristics along the transect is obtained. However, I cannot recommend this manuscript for publication in the present form due to the major concerns as detailed in the following.

First of all, I find the major point that the authors try to make (i.e., "nutrient availability

for phytoplankton in the euphotic surface waters may not be affected by the physical process of global warming") is not convincing at all. For me, the point is not even relevant to what the data have shown. Obviously, the exact response of the upper ocean to global warming could be rather complicated, and I do agree with the authors that the global warming may not necessarily lead to a change in vertical turbulent exchange, but the results presented in the manuscript are by no means evidence for this. One may expect to see clear trend of upper ocean mixing (and corresponding material fluxes) at a certain location under continuing warming, but in such a large region covering more than 30 degrees, the underlying dynamics controlling diapycnal mixing could be very different from place to place, thus the spatial difference in mixing seen along the transect cannot be simply taken as a result of the difference in stratification (or "warming" by solar radiation).

More technically, although I do appreciate the authors' efforts in estimating turbulence and mixing characteristics from carefully conducted CTD measurements (via overturning scale analysis), I cannot be convinced by the subtle mixing (and flux) variability revealed by their estimates. As well acknowledged by the authors, even with the microstructure measurements one cannot expect to get an estimate with insignificant uncertainty. I agree that the overturning (Thorpe) scale analysis could be very useful in getting a rough estimate of mixing intensity when more direct measurements are not available, but using it to reveal subtle spatial (or temporal) variability could be misleading. For this purpose, direct microstructure measurements are certainly much more reliable. On the other hand, ocean turbulence is certainly a stochastic process with both significant dynamical variability (which could be taken as deterministic linked to certain dynamical processes generating turbulence) and intermittency. As such, for the purpose of evaluating spatial variability of turbulent mixing, one should look at turbulence statistics. How many data points are used to get the reported averages? How does the PDF in each corresponding depth range look like? What are the confidence intervals of the reported averages? Are the noted differences/variabilities really significant?

To conclude, I agree that the reported analysis gives useful information about mixing characteristics along the sampled transect, but without clear information of the underlying mechanisms and robust constraint on the reliability and significance of the reported mixing variability, one cannot be led to the points that the authors try to make. In particular, the results presented in the manuscript do not seem to lend any support to the authors' argument on the global warming impact on upper ocean mixing and nutrient flux trend. The authors may choose to simply emphasize their mixing estimates from the overturning scale analysis, with clear indication of the underlying uncertainties.

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