Abstract

The spectral characteristics of turbulence and eddies in the ocean are examined using ARGO profiling float data. Many theories predict the spectral slopes associated with the statistics of ocean macro-turbulence, but there are few observations at depth to guide these discussions. Here, a method developed for estimating the structure function of atmospheric macro-turbulence using rawinsondes is adapted to estimate the structure function and corresponding spectral slope of oceanic macro-turbulence using data collected by ARGO profiling floats. Horizontal structure functions over a range of depths and latitude bands, as well as in eddy-rich and eddy-poor regions will be shown. The structure function evaluated at pressure levels differs from that evaluated along potential density surfaces, consistent with the internal wave spectrum. In pressure coordinates below 45 m at scales larger than 100 km, results follow the Batchelor (1959) theory and smaller scales follow a steeper slope. The potential density coordinates results are consistent with the Batchelor theory for passive tracers at large scales over all depths. The spectral slope's dependence on latitude, depth, and the presence of eddies will also be discussed.

Structure Function and Spectral Slope

The second-order structure function estimates the difference in potential temperature, velocity, or salinity between two locations a distance, \( x \), apart:

\[
D(x) = (T(x) - T(x + d) - u \cdot d)^2
\]

The structure function is related to the temperature variance, kinetic energy, or salinity variance spectrum, respectively, by a simple change of variables, from the structure function, \( D(x) \times \delta x \), to the temperature variance spectrum, \( \tilde{R}(k) \times \delta k \). The relationship between the spectral slope and the structure function slope is, therefore

\[
\gamma_2 = \gamma_1 - 1.
\]

The primary goal of this project is to estimate \( \gamma_y \) from ARGO data over length scales where an inertial range is apparent, and compare to theories that predict \( \gamma_y \).

Temperature Perturbation Maps

![Image 1](https://example.com/image1.png)

Structure Function Results

![Image 2](https://example.com/image2.png)

Conclusions and Future Work

The most immediate and meaningful result is that it IS possible to use ARGO data to calculate structure functions, and infer about the temperature (or salinity) variance spectra. The structure functions are most clear for the pressure-coordinate plots, with discernable small-scale slopes near 2/3, and large-scale slopes near 0. For the results for the depth coordinates show a slope of 0 for all scales. This could be described by the very large scale temperature forcing by climate, but with small-scale eddies stirring. It is an important result that there is so little change in structure function power with depth, when it is known that the temperature variance changes with depth.

In immediate future work, normalizing perturbation regions will allow a comparison for all regions of variance.

Argo Global Distribution

![Image 3](https://example.com/image3.png)

References


Acknowledgements

Thank you to Geel Forget at the Massachusetts Institute of Technology for providing the quality-controlled ARGO data, as well as the basic structure function and spectral slope MATLAB files. Thanks also to Bob Frelich and Chris Farrell for their guidance and input. This project is funded by the NOAA-ESRL/CIES Graduate Student Fellowship.