[EE] Evening Poster | A (Atmospheric and Hydrospheric Sciences) | A-OS Ocean Sciences & Ocean Environment

[A-OS11]What we have learned about ocean mixing in the last decade

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The study of ocean mixing processes has made great strides in development of observation technology over the last decade. This includes the improvement of micro-scale and multi-scale profilers, innovation of ocean gliders, as well as identifying internal waves and turbulence through echo sounding from an underway research vessel. These new technologies enable field observations of ocean mixing processes to extend much deeper and wider than ever before. The accumulated knowledge of the observed features has stimulated theoretical and modeling studies related to ocean mixing processes such as internal wave-wave interactions, internal wave interactions with background shear, and associated energy cascade down to dissipation scales as well as assessment and reformulation of existing turbulent mixing parameterizations to be incorporated into the global circulation and climate models.
This session encompasses a wide variety of coastal and open ocean mixing processes; from the surface through the interior to the near boundary benthic mixing, including the roles of mixing in the biological processes and productivity of the ocean. Through detailed discussions, we would like to confirm how far our understanding of the ocean mixing processes has advanced over the last decade, defining the new frontier of ocean mixing research to be tackled in the next decade.

[AOS11-P03]Development and application of turbulence estimation using a fast-response thermistor attached to a CTD frame

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A new observational system, microstructure measurements using the CTD-attached FP07 thermistors, was developed in order to widely and frequently perform microstructure observations and then to reveal basin-scale turbulence distributions. Since turbulence estimation with thermistors have not been common due to their insufficient temporal response, assessment of availability was undertaken by comparing energy dissipation rate ε_T from FP07 thermistors with ε_S from shear probes where both the thermistors and shear probes were attached to the same free-fall profiler. ε_T tended to be less than ε_S as ε_S becomes larger in the case without correction for temperature gradient spectra. By correcting the spectra using the single- or double-pole low-pass filter functions with the time constant of 7 millisecond (single-pole) or 3 millisecond (double-pole), respectively, ε_T became consistent with ε_S within a factor of 3 in the range of 10^(-10) <ε_S <10^(-7) W/kg. From the result, fast-response thermistor measurement is concluded to be practical if temperature gradient spectra are appropriately corrected.
Next, influences of “not-free-fall” measurements, that is, variable fall rates of CTD frames were assessed in order to make clear the availability of the CTD-attached measurements. Comparison of turbulence intensities from this method and free-fall profilers at the same depth and location but with temporal difference within about 2 hours show generally good agreement. However, anomalously overestimated data, deviating from a log-normal distribution, appear sporadically in the CTD-attached measurements. They often occurred when the fall rate W [m/s] was small and its standard

deviation W_sd [m/s], was large. These overestimated outliers could be efficiently removed by rejecting data with the criterion of W_sd >0.2 W - 0.06 computed for a 1 second interval. After this data screening, thermal and energy dissipation, χ and ε, from CTD-attached and free-fall profilers were consistent within a factor of 3 in the ranges of 10^(-10) <χ <10^(-7) °C^2/s and 10^(-10) <ε_T <10^(-8) W/kg for 50 m depth-averaged data.
Based on the above method of correction and data rejection, basin-scale distributions of turbulence intensity in the deep northwestern Pacific were shown for the first time by microstructure measurements, further by rejecting data at which W takes local minimum. Turbulence is intensified over rough topography at around seamounts and ridges in regions with strong internal tide. Observed ε_T from the CTD-attached thermistors depended on internal tide energy and squared buoyancy frequency N^2 through comparing with ε_MODEL used in a previous ocean general circulation model (OGCM) which reproduced deep Pacific water-masses fields (Oka and Niwa, 2013). ε_MODEL was much larger than the observed ε_T by more than 10 times, although spatial variability was correlated between ε_T and ε_MODEL. This difference was relaxed to be within a factor of 3 by changing the vertical structure of ε_MODEL far from internal tide generation sites to be proportional to N^2 and the background constant vertical diffusivity to be the observed minimum of 10^(-7) m^2/s. By conducting widespread observations of CTD-attached thermistors with higher spatial and temporal resolutions, more realistic OGCM with better diapycnal diffusivity distribution will be developed in future.