Internal wave generating turbulent mixing in the Canada Basin

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The Arctic Ocean is well known as "calm ocean" because of the low internal wave energy level than the other open oceans. However, understanding of internal wave field in the Arctic is still missing, where the other oceans are relatively well investigated. In order to explore the internal wave field, total 5 Ice-Tethered Profilers with Velocity (ITP-V; ITP70, ITP77, ITP78, ITP79, and ITP80), which measure salinity, temperature, and velocity were deployed in the multi-year ice floe in the Canada Basin. These were utilized from August 2013–May 2015 with 3 hours interval down to 250 m and collected data down to 750 m twice a day. The key characteristic in the upper Canada Basin is anticyclones spanning over the pycnocline. Our study is focused on additional role of anticyclones as an amplifier of near-inertial internal wave (NIW) in the negative vorticity field. Among the various eddy encounter, we focused on ideal eddy encounters that shows NIW trapping and amplification. Especially, a shallow anticyclone detected on mid-October 2014 at depths of 40 to 80 m showed vigorous turbulent mixing by the amplified NIW at the bottom of it with the amplitude of 0.11 m s^{-1} (Figure 1a). The near-inertial component generated 10^{-4} m^2 s^{-1} order of eddy diffusivity from the fine-scale parameterizations (Alford and Pinkel, 2000; Gregg, 1989; and Kunze et al., 2006, Figure 1b). The NIW packet showed tendency to propagate eastward to a deeper layer from the backward rotated shear analysis and vertical wavenumber rotary spectrum. Also, we applied fine-scale parameterization of Kunze et al. (2006) to 750 m with 250 m vertical segment. R_ω the from shear and strain variance ratio from the vertical wavenumber spectra was estimated from at depths of 500 and 750 m in order to avoid effect from double diffusion at the Pacific Winter Water layer. The average value had a range of 1.47–2.02, which is much lower than 7, the representative value of mid-latitude ocean (Kunze et al., 2006). The estimated eddy diffusivity at the depths of 375–750 m showed as small as the molecular diffusivity of 1.4×10^{-7} m^2 s^{-1} from all ITP-Vs (Table. 1). However, those shallower than 375 m showed the values with an order of 10^{-4}–10^{-5} m^2 s^{-1} suggesting relatively strong mixing probably due to the internal gravity waves.

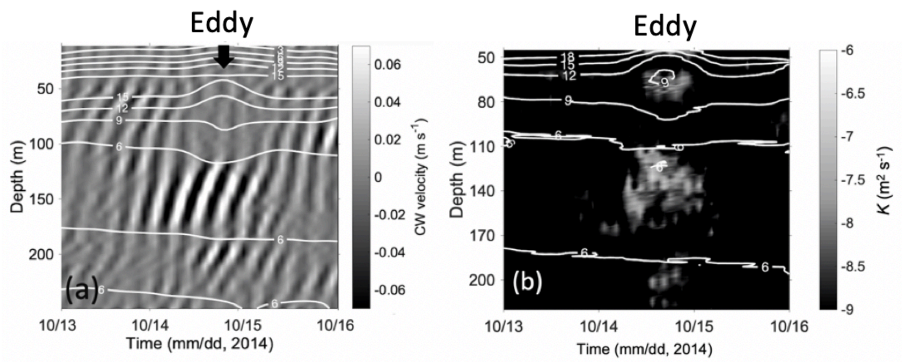

Figure 1. (a) Near-inertial clockwise component velocity in terms of depth. (b) Eddy diffusivity from the method suggested by Gregg (1989). White contours in both panels are iso-buoyancy depth in order to indicate anticyclone.

References

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