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# Theoretical and Observational Studies of the Global Distribution of Diapycnal Diffusivity in the Deep Ocean

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## Abstract

Global mapping of diapycnal diffusivity in the deep ocean is essential to improve the ability of global ocean circulation models to predict future climate change. This article summarizes the theoretical and observational work on the global mapping of diapycnal diffusivity of the author's research group during the past 10 years.

First, we have carried out numerical experiments to see how the energy supplied from the semidiurnal internal tide and atmospheric disturbances cascades through the deep ocean internal wave spectrum down to dissipation scales. We showed that this energy transfer process is dominated by the latitude-dependent, internal wave-wave interaction termed *parametric subharmonic instability*. This implies that enhanced fine-scale near-inertial current shear causing strong diapycnal diffusivity should not be found at latitudes farther than about 30° from the equator. This theoretical prediction has been validated through detailed expendable current profiler (XCP) surveys carried out throughout the world's oceans. Furthermore, based on the results of the XCP surveys, an empirical relationship has been found between the diapycnal diffusivity inferred using fine-scale parameterization and the local energy density of the semidiurnal internal tide; by incorporating the numerically predicted energy density of the semidiurnal internal tide at each longitude and latitude into the resulting empirical formula, we have obtained a global map which shows that diapycnal diffusivity is significantly enhanced around prominent topographic features in the latitude range from 20° to 30° (mixing hotspots). Finally, the validity of the resulting global map of diapycnal diffusivity has been confirmed through direct turbulence measurements carried out at key locations in the North Pacific.

**Key Words** : Diapycnal diffusivity, mixing hotspot, internal wave-wave interaction, *parametric subharmonic instability*, near-inertial shear, internal tide, expendable current profiler, microstructure profiler

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