A parameterisation of shear-driven turbulence for ocean climate models.

L. Jackson[1], R. Hallberg[2] and S. Legg[1]

1. Atmospheric and Oceanic Sciences, Princeton University, Princeton, NJ

2. Geophysical Fluid Dynamics Laboratory, Princeton, NJ.

In preparation for Journal of Physical Oceanography

February 9, 2007

[0]*Corresponding author address:* Dr. L. Jackson, GDFL, Forrestal campus, Route 1, Princeton, NJ. Email: Laura.Jackson@noaa.gov

Abstract

We present a new parameterisation for shear-driven, stratified, turbulent mixing which is pertinent to climate models, in particular the shear-driven mixing in overflows and the Equatorial Undercurrent. Critically for climate applications this parameterisation is simple enough to be implemented implicitly which allows the parameterisation to be used with timesteps that are long compared to the time on which the turbulence evolves and acts.

We express the mixing in terms of a turbulent diffusivity which is dependent on the shear forcing and a length scale which is the minimum of the width of the low Richardson number region ($Ri = N^2/|\mathbf{u}_z|^2$, where N is the buoyancy frequency and $|\mathbf{u}_z|$ is the vertical shear) and the buoyancy length scale over which the turbulence decays ($L_b = Q^{1/2}/N$ where Q is the turbulent kinetic energy). This also allows a decay of turbulence vertically away from the low Richardson number region over the buoyancy scale: a process which our results show is important for mixing across a jet.

We conduct high-resolution non-hydrostatic simulations of shear-driven stratified mixing in both a shear layer and a jet. The results of these simulations support our theory and are used, together with discussions of various limits and reviews of previous work, to constrain parameters.