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$Momentum\ (\nu) = 1\ x\ 10^{-6}\ m^2s^{-1}$

$Thermal\ (\kappa_T) = 1.4\ x\ 10^{-7}\ m^2s^{-1}$

$Salt\ (\kappa_S) = 1\ x\ 10^{-9}\ m^2s^{-1}$

$TKE\ Deep\ Ocean\ (\epsilon) = 10^{-9}\ Wkg^{-1}$

$TKE\ Surface\ Ocean\ (\epsilon) = 10^{-5}\ Wkg^{-1}$

$TKE\ Low\ Atmosphere^*\ (\epsilon) = 10^{-3}\ Wkg^{-1}$

$$\boldsymbol{Kolmogorov}: \quad \boldsymbol{L_k \sim 2\pi\left(\frac{\nu^3}{\epsilon}\right)^{\frac{1}{4}}}$$

Momentum

$Surface\ Ocean$: $L_k \sim 2\pi\left(\frac{(1\ x\ 10^{-6}\ m^2s^{-1})^3}{10^{-5}\ Wkg^{-1}}\right)^{\frac{1}{4}} = 3.53\ x\ 10^{-3}\ meters$

$Deep\ Ocean$: $L_k \sim 2\pi\left(\frac{(1\ x\ 10^{-6}\ m^2s^{-1})^3}{10^{-9}\ Wkg^{-1}}\right)^{\frac{1}{4}} = 3.53\ x\ 10^{-2}\ meters$

$$\boldsymbol{Batchelor}: \quad \boldsymbol{L_b \sim 2\pi\left(\frac{\kappa^2\nu}{\epsilon}\right)^{\frac{1}{4}}}$$

Thermal

$Surface\ Ocean$: $L_b \sim 2\pi\left(\frac{(1.4\ x\ 10^{-7}\ m^2s^{-1})^2 \cdot (1\ x\ 10^{-6}\ m^2s^{-1})}{(10^{-5}\ Wkg^{-1})}\right)^{\frac{1}{4}} = 1.32\ x\ 10^{-3}\ meters$

$Deep\ Ocean$: $L_b \sim 2\pi\left(\frac{(1.4\ x\ 10^{-7}\ m^2s^{-1})^2 \cdot (1\ x\ 10^{-6}\ m^2s^{-1})}{(10^{-9}\ Wkg^{-1})}\right)^{\frac{1}{4}} = 1.32\ x\ 10^{-2}\ meters$

Salt

$Surface\ Ocean$: $L_b \sim 2\pi\left(\frac{(1\ x\ 10^{-9}\ m^2s^{-1})^2 \cdot (1\ x\ 10^{-6}\ m^2s^{-1})}{(10^{-5}\ Wkg^{-1})}\right)^{\frac{1}{4}} = 1.12\ x\ 10^{-4}\ meters$

$Deep\ Ocean$: $L_b \sim 2\pi\left(\frac{(1\ x\ 10^{-9}\ m^2s^{-1})^2 \cdot (1\ x\ 10^{-6}\ m^2s^{-1})}{(10^{-9}\ Wkg^{-1})}\right)^{\frac{1}{4}} = 1.12\ x\ 10^{-3}\ meters$

The scales at which turbulent mixing transitions to molecular diffusivity is an order of magnitude greater in the deep ocean relative to the surface layer. This conclusion expected as the greater the dissipation rate, the more energy is within the energy spectrum, resulting in a smaller scale.

Atmosphere

* Kantha. L., & Hocking W. **Dissipation rates of turbulence kinetic energy in the free atmosphere: MST radar and radiosondes** J. Atmos. Solar & Terr. Physics (2011) https://doi.org/10.1016/j.jastp.2010.11.024

$$\boldsymbol{Kolmogorov}: \quad \boldsymbol{L_k \sim 2\pi \left(\frac{\nu^3}{\epsilon}\right)^{\frac{1}{4}}}$$

$Momentum\ (\nu) = 15\ x\ 10^{-6}\ m^2 s^{-1}$

$Thermal\ (\kappa_T) = 20\ x\ 10^{-6}\ m^2 s^{-1}$

$\boldsymbol{Momentum}$

$$ABL: \quad L_k \sim 2\pi \left(\frac{(15\ x\ 10^{-6}\ m^2 s^{-1})^3}{10^{-3}\ Wkg^{-1}}\right)^{\frac{1}{4}} = 8\ x\ 10^{-3}\ meters$$

$$\boldsymbol{Batchelor}: \quad \boldsymbol{L_b \sim 2\pi \left(\frac{\kappa^2 \nu}{\epsilon}\right)^{\frac{1}{4}}}$$

$\boldsymbol{Thermal}$

$$ABL: L_b \sim 2\pi \left(\frac{(20\ x\ 10^{-6}\ m^2 s^{-1})^2 \cdot (1\ x\ 10^{-6}\ m^2 s^{-1})}{(10^{-3}\ Wkg^{-1})}\right)^{\frac{1}{4}} = 9\ x\ 10^{-3}\ meters$$

The scale of turbulent mixing of momentum appear to be similar orders of magnitude for momentum in both the surface ocean and atmosphere. However, the thermal mixing occurs at an order of magnitude smaller in the atmosphere suggesting a greater amount of energy in the atmosphere relative to the ocean surface.