Investigating cutoff scales in turbulent Ekman flow with a map-based stochastic modeling approach

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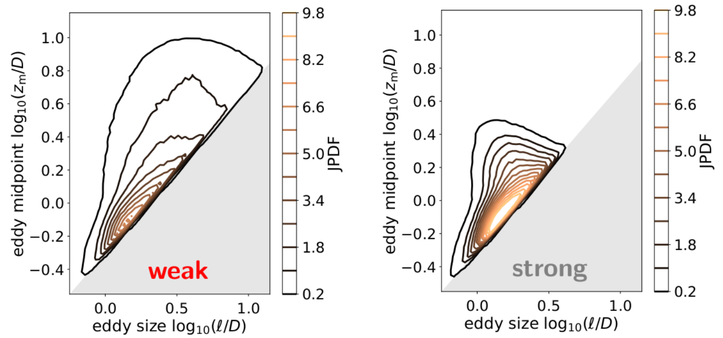
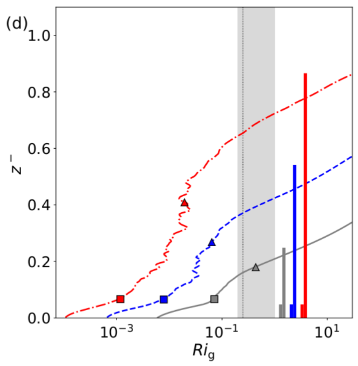
Stratification trims large turbulent scales



$$z^- = \frac{z}{\delta_\star} \qquad Ri_g = \frac{N^2}{S^2}$$



M.K. & H.S. (2022) *Adv. Sci. Res.* **19**:117–136

- Distribution of **eddy size & location**
- Gradient **Richardson number** Ri_g

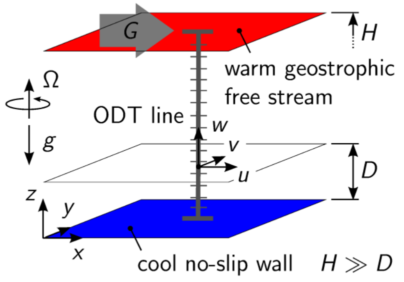
Size of momentum-transporting eddies ⇝ Ozmidov scale $\ell_O = \sqrt{\varepsilon/N^3}$

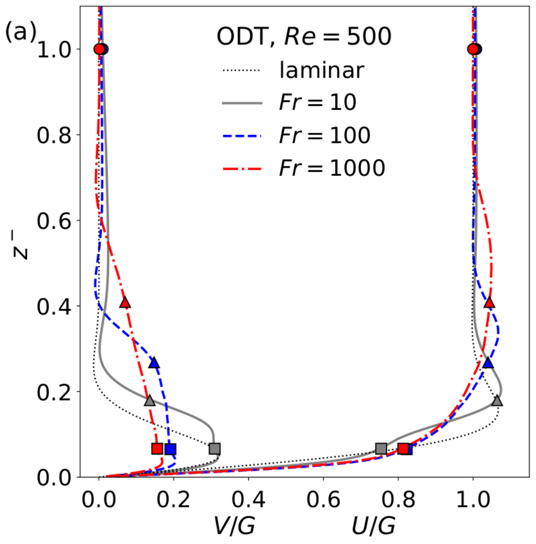
Ozmidov (1965) *Izv. Acad. Sci. USSR Atmos. Oceanic Phys.* **1**:861–871
Li, Salesky & Banerjee (2016) *J. Fluid Mech.* **797**:R3

Ensemble-averaged velocity profiles for stable Ekman flow

$$D = \sqrt{\frac{2\nu}{f}} \qquad Re = \frac{G\,D}{\nu}$$

$$Pr = \frac{\nu}{\kappa} = 1 \qquad Fr = \frac{G^2}{g\,D\,\beta\,(T_{\mathrm{bulk}} - T_{\mathrm{wall}})}$$





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Corrsin scale in shear turbulence

Corrsin (1958) NACA RM 58 B 11
Jacobitz & Schneider (2024) *Phys. Rev. Fluids* **9**:044602

- Family of cutoff scales ...

$$(\ast)\quad \text{Ozmidov scale} \quad \ell_O = \sqrt{\varepsilon/N^3}$$

$$\text{Zeman scale} \quad \ell_Z = \sqrt{\varepsilon/f^3}$$

$$(\ast)\quad \text{Corrsin scale} \quad \ell_C = \sqrt{\varepsilon/S^3}$$

- ... where $(\ast)$ are connected ...

$$Ri = \frac{N^2}{S^2} = \left(\frac{\ell_C}{\ell_O}\right)^{4/3}$$

ℓ_C remains bounded, hence might be a useful metric for neutral Ekman flow