ASSIGNMENT 2

30/03

given u_*
Q_0
direction at 60 –
θ_0
$V_{10}, V_{40}, V_{60}, V_{80}, V_{100}$

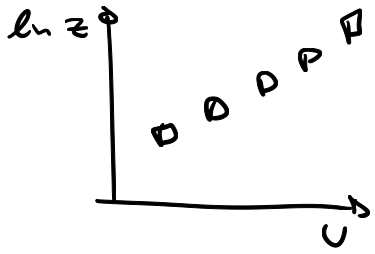
① compute $1/L$

$$\frac{1}{L} = \left(\frac{k g}{\theta_0}\right) - \frac{Q_0}{u_*^3}$$

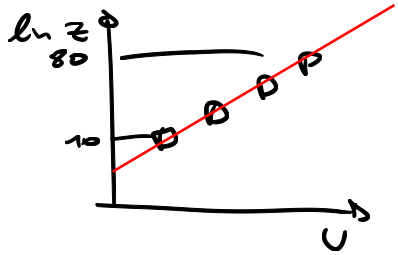
build pdf

② for wind direction $\in [60°, 120°]$
select for neutral condition $\Rightarrow L^{-1} < 0{,}0008$

ⓐ compute average V at each height + error bars



ⓑ fit line



$$\ln z = aU + b$$
$$y = ax + b$$

ⓒ compute u_*, z_0

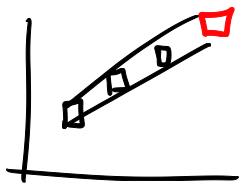
$$U(z) = \frac{u_*}{k} \ln \frac{z}{z_0} = \frac{u_*}{k}(\ln z - \ln z_0) \Rightarrow \ln z = \frac{U k}{u_*} + \ln z_0$$

$$\Rightarrow \ln z = \underbrace{\frac{k}{u_*}}_{a} U + \underbrace{\ln z_0}_{b}$$

look in the table to compare

$z_0 = b$
$u_* = \frac{k}{a}$

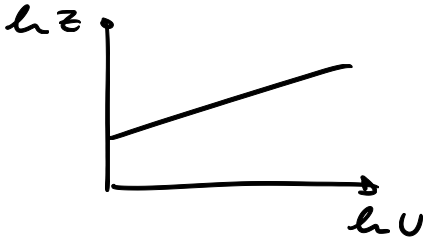
(d) compute U_{100}



compute % difference from U_{100} extrapolated and U_{100} real

(e) compute α

$$\alpha = \frac{d \ln U}{d \ln z} = \frac{1}{\ln \frac{z}{z_0}}$$



$$\ln z = a \ln U + b$$

$$a = \frac{dy}{dx} = \frac{d \ln z}{d \ln U} \Rightarrow \alpha = \frac{1}{a}$$

IMPLIED z_0 ?

(f) α at $z=60$, $z=80$

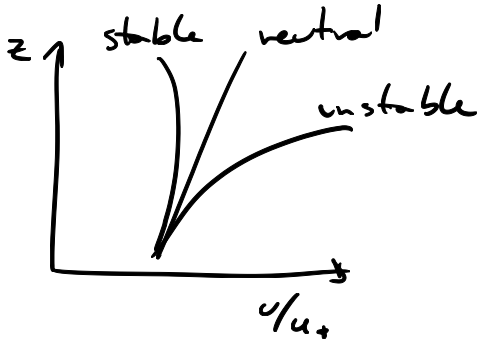
$$\alpha = \frac{\ln (U_2/U_1)}{\ln (z_2/z_1)}$$

(g) predict U_{100}

$$U(z) = U_{ref} \left(\frac{z}{z_{ref}} \right)^{\alpha} \quad \text{with} \quad z_{ref} = 80\ m$$

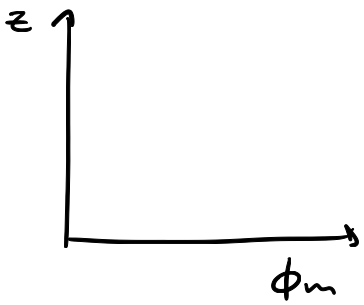
(h) comparison ↷ plot everything

(3)



?

(4) $\phi_m\left(\frac{z}{L}\right) = \dfrac{\frac{dU}{dz}}{\frac{u_*}{kz}}$



$\phi = 1 + 4.8\,\frac{z}{L}$ for stable

$\phi = \left(1 - 19.3\,\frac{z}{L}\right)^{-1/4}$

↓ NOT SURE IF IT IS THAT SIMPLE

if $\phi_m = 1 \Rightarrow$ neutral log law

(5) $U(z) = \frac{u_*}{k}\left[\log\left(\frac{z}{z_0}\right) - \Psi_m\left(\frac{z}{L}\right)\right]$

$\phi_m = \dfrac{\frac{dU}{dz}}{\frac{u_*}{kz}} \Rightarrow \frac{dU}{dz} = \frac{u_*}{kz}\phi_m \Rightarrow \int_0^U dU = \frac{u_*}{k}\int_{z_0}^{z}\frac{1}{z}\phi_m\,dz$

stable: $\phi = 1 + 4.8\,\frac{z}{L}$

$$U = \frac{u_*}{k}\int_{z_0}^{z}\frac{1}{z}\left(1 + 4.8\,\frac{z}{L}\right)dz = \frac{u_*}{k}\int_{z_0}^{z}\frac{1}{z} + \frac{4.8}{L}\,dz$$

$$= \frac{u_*}{k}\left[\ln\frac{z}{z_0} + \frac{4.8}{L}(z - z_0)\right]$$

$\Rightarrow \Psi_m = -\frac{4.8}{L}(z - z_0)$

unstable: $\phi = \left(1 - 19.3\,\frac{z}{L}\right)^{-\frac{1}{4}}$

$$U = \frac{u_*}{k}\int_{z_0}^{z}\frac{1}{z}\left(1 - 19.3\,\frac{z}{L}\right)^{-1/4}dz$$

$$= \frac{u_*}{k}\int_{z_0}^{z}\left(z^4 - 19.3\,\frac{z^5}{L}\right)^{-\frac{1}{4}}dz$$