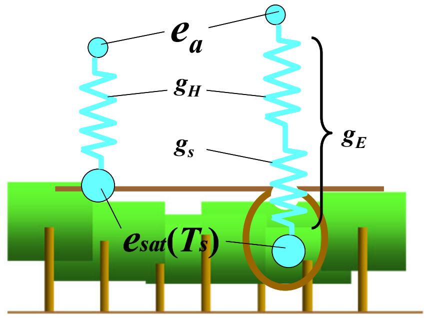
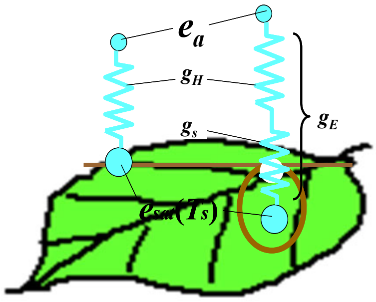
g_Hについて

群落: $$g_H = \frac{\kappa^2 u}{\left(\ln \frac{z-d}{z_0}\right)^2}$$



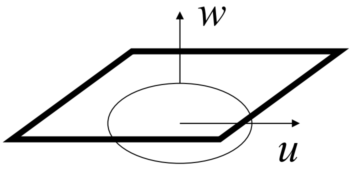
個葉: $$g_H = k\sqrt{\frac{u}{l}}$$



1

群落

まずは**運動量フラックス**



$$\frac{\rho l^2 w}{l^2} u = \rho u w$$

(kg m/s)/(m²s)

kg/(m²s) m/s

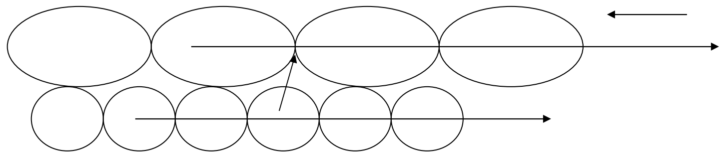
$$\overline{\rho u w} = \rho\overline{(\bar{u}+u')(\bar{w}+w')} = \rho\overline{u'w'}$$

(kg m/s)/(m²s) = Ns/ (m²s) = N/m²

運動量フラックスは**せん断応力**

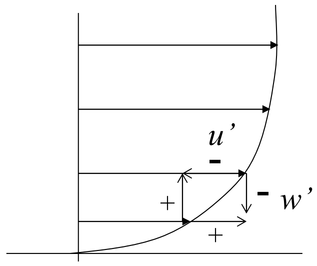
2

運動量フラックスはせん断応力



$$\tau = -\rho\overline{u'w'} \quad \text{(kg m/s)/(m}^2\text{s) = N/m}^2$$

$\overline{u'w'} < 0$



3

フラックスは拡散係数で表現できる

$$F = -K\frac{dC}{dz}$$

$$\mathrm{m^2/s}\ \frac{\mathrm{kg/m^3}}{\mathrm{m}} = \mathrm{kg/(m^2s)}$$

$$\mathrm{m^2/s}\ \frac{\mathrm{mol/m^3}}{\mathrm{m}} = \mathrm{mol/(m^2s)}$$

$$\mathrm{m^2/s}\ \frac{\mathrm{(kg\ m/s)/m^3}}{\mathrm{m}} = \mathrm{(kg\ m/s)\ /\ (m^2s)}$$

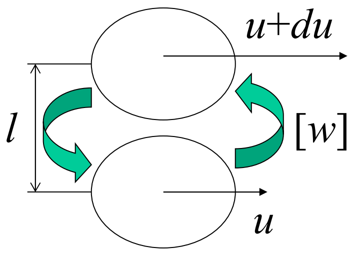
運動量濃度

$$\tau = -\rho\overline{u'w'} = K_M\frac{d(\rho u)}{dz}$$

$$= \rho K_M\frac{du}{dz}$$

4

運動量フラックスで考える



Prandtlの混合距離理論

$$[w] = l\left|\frac{du}{dz}\right| \qquad \frac{[w]}{l} = \left|\frac{du}{dz}\right| \ \ (/\mathrm{s})$$

単位時間当たり交換運動量

$$\rho l^3 du\left|\frac{du}{dz}\right| = \rho l^4 \frac{du}{dz}\left|\frac{du}{dz}\right|$$

$$-\rho\overline{u'w'} = \frac{1}{l^2}\rho l^4\frac{du}{dz}\left|\frac{du}{dz}\right| = \underbrace{\boxed{\rho l^2\left|\frac{du}{dz}\right|}}_{K_M}\frac{du}{dz} = \tau$$

5

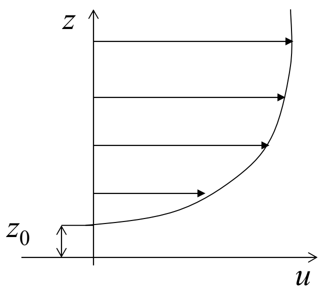
- $l = \kappa z \quad \kappa$: カルマン定数
- $\tau, -\rho\overline{u'w'}$ は高さ方向で一定：コンスタントフラックス層
- $-\overline{u'w'} = u_*^{\,2}$ を導入

$$\rho u_*^{\,2} = \rho l^2\left(\frac{du}{dz}\right)^2$$

$$u_* = \kappa z\frac{du}{dz}$$

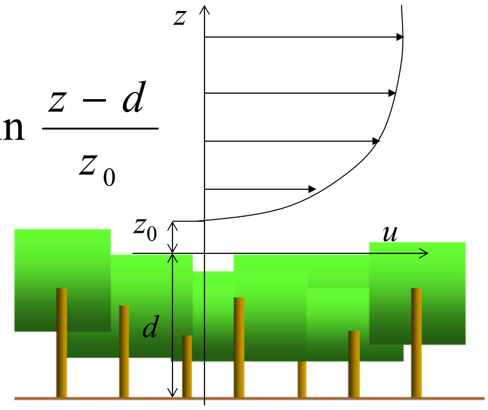
風速対数則

$$u = \frac{u_*}{\kappa}\ln\frac{z}{z_0}$$



6

$$u = \frac{u_*}{\kappa} \ln \frac{z-d}{z_0}$$



さて、ある条件で

$$K_M = K_H = K_E = \kappa u_* (z-d)$$

$$H = -K_H \frac{d(\rho c_p T)}{dz}$$ を考えてみよう。

7

$$\frac{H}{\rho c_p} = -K_H \frac{dT}{dz} = -\kappa^2 (z-d)^2 \frac{du}{dz}\frac{dT}{dz}$$

$$= -\kappa^2 \frac{du}{d \ln z} \frac{dT}{d \ln z}$$

$-dT$

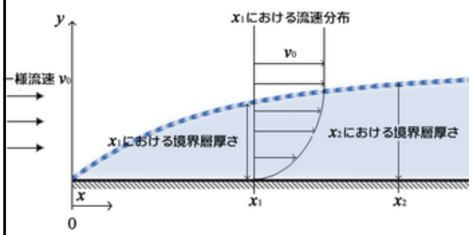
$$H = \rho c_p g_H (T_s - T_a)$$ より

$$g_H = \frac{\kappa^2 u}{\left(\ln \frac{z-d}{z_0} \right)^2}$$

8

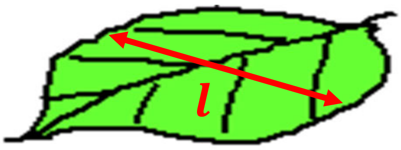
個葉

$$g_H = k\sqrt{\frac{u}{l}}$$



$$g_H = 1.4 \times \frac{0.664\rho_a D_h R_e^{\frac{1}{2}} P_r^{\frac{1}{3}}}{l}$$

$$g_H = \underline{0.93\rho_a D_h^{\frac{2}{3}} \nu^{\frac{1}{6}}} \sqrt{\frac{u}{l}}$$



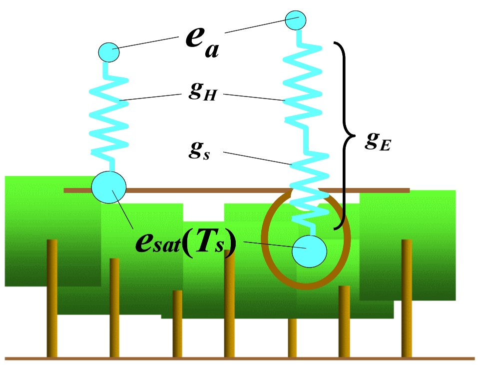
$$S = l^2$$

9

遮断蒸発

$$\lambda E = \frac{\Delta(R_n - G) + \rho c_p g_H (e_{sat}(T_a) - e_a)}{\Delta + (1 + g_H/g_s)\gamma}$$

$g_s \rightarrow \infty$ ： **完全湿面**



10