Development of RANS boundary condition for AMR-Wind

Document all notes here.

1 RANS ABL grid stretching

2 RANS k-ϵ ABL boundary conditions

Implemented in `MOData.cpp` as `calc_phi_m_alinot()`:

$$\phi_m(\zeta) = \begin{cases} (1 - \beta_m \zeta)^{-1/4}, & \zeta < 0 \\ 1 + \gamma_m \zeta & \zeta > 0 \end{cases} \tag{1}$$

where $\zeta = z/L$ (see [1])
Implemented in `MOData.cpp` as `calc_phi_eps_alinot()`:

$$\phi_\epsilon(\zeta) = \begin{cases} 1 - \zeta & \zeta < 0 \\ \phi_m(\zeta) - \zeta & \zeta > 0 \end{cases} \tag{2}$$

The following calculations are implemented in `ShearStress.H`.
As `ShearStressAlinot.calc_mu()`

$$\mu_{t0}(z) = \frac{\rho \kappa u_* z}{\phi_m(\zeta)} \tag{3}$$

As `ShearStressAlinot.calc_eps()`

$$\epsilon_0(z) = \frac{u_*^3}{\kappa z} \phi_\epsilon(\zeta) \tag{4}$$

As `ShearStressAlinot.calc_tke()`

$$k_0(z) = \sqrt{\frac{\kappa u_* z \epsilon_0(z)}{C_\mu \phi_m}} \tag{5}$$

$$k_0(z) = \sqrt{\frac{\mu_{t0}(z) \epsilon_0(z)}{\rho C_\mu}} \tag{6}$$

As `ShearStressAlinot.calc_omega()`

$$\omega_0(z) = \frac{\epsilon_0(z)}{C_\mu k_0(z)} \tag{7}$$

References

[1] Alinot, C., and Masson, C. k-ϵ model for the atmospheric boundary layer under various thermal stratifications. *Journal of Solar Energy Engineering 127*, 4 (06 2005), 438–443.