Supplementary Material

1 Flux Computations

The flux-gradient methodology assumes that, in the atmospheric surface layer, the flux of a certain scalar is a function of: the gradient of the said scalar measured at two heights, the delta between the measurement heights, and an appropriate eddy-diffusivity coefficient, in a manner analogous to the parametrization of molecular diffusion (see, for example, Businger (1986) and Baldocchi et al. (1988))

The flux of a certain scalar (F_c) can, therefore, be represented as (Eq. (S1)):

$$F_c = -K_c \left(\frac{dc}{dz}\right), \tag{S1}$$

In Eq. (S1) K_c is the eddy-diffusivity coefficient (in $m^2\ s^{-1}$), *dc* represents the gradient of concentration and *dz* the difference between the two sampling heights. When F_c is positive, an outgoing flux is moving from the surface to the atmosphere (and the surface is, therefore, acting as a source of the scalar *c*), while the opposite is true if the flux is negative (and, in this case, the surface acts as a sink).

By appropriately scaling K_c on the sampling heights and a scale length, flux can be, instead, expressed as the product of a transport velocity and a difference in concentration, following the aerodynamic method (Monin and Obukhov, 1954); (Simpson et al., 1998)) and the formulation of (Beine et al., 2003), Eq. (S2)):

$$V_c = k \frac{u_*}{ln\left(\frac{z_2}{z_1}\right) - \Psi_H\left(\frac{z_2}{L}\right) + \Psi_H\left(\frac{z_1}{z_2}\right)}, \tag{S2}$$

In Eq. (S2) k is the Von Kármán constant (assumed equal to 0.4), u_* represents friction velocity, z_1 the lowermost sampling height, z_2 the uppermost sampling height, L is the Obukhov length and ψ_H is the universal similarity function represented as Eq. (S3):

$$\Psi_H = \begin{cases} 2\ln\left[\frac{1-\sqrt{1-16\frac{z}{L}}}{2}\right] \; if \; \frac{z}{L} < 0 \\ -17\left[1 - \exp\left(-0.29\frac{z}{L}\right)\right] \; if \; \frac{z}{L} > 0 \end{cases}, \tag{S3}$$

In Eq. (S3) z/L is the stability parameter.

References

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