Supplementary material to

Diurnal fluxes of HONO above a crop rotation

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Calculations of the scalar flux by the aerodynamic gradient method

For unstable conditions, the stability integrated function Ψ was calculated as in Webb (1970) or Paulson (1970):

$$\Psi_{(z-d)/L} = -5.2 \cdot \frac{(z-d)}{L} \quad \text{(S1).}$$

For unstable conditions, it was calculated:

$$\Psi_{(z-d)/L} = 2 \cdot ln\left[1 + \sqrt{1-16 \cdot \frac{(z-d)}{L}}\right] \quad \text{(S2).}$$

The flux of a scalar is given by:

$$F = -u_* \cdot \chi_* \quad \text{(S3).}$$

By replacing χ_* by its expression in equation (1), one gets:

$$F = -u_* \cdot \frac{\kappa \cdot (z-d)}{\varphi_{(z-d)/L}} \cdot \frac{\partial \chi}{\partial z} \quad \text{(S4).}$$

Knowing that Ψ is the integral of φ and noticing the following equality:

$$\frac{\partial z}{\partial[\ln(z-d) - \Psi_{(z-d)/L}]} = \frac{(z-d)}{\varphi_{(z-d)/L}} \quad \text{(S5),}$$

leads to the expression for the flux given in equation (2):

$$F = -\kappa \cdot u_* \cdot \frac{\partial \chi}{\partial[\ln(z-d) - \Psi_{(z-d)/L}]} \quad \text{(S6).}$$

Hence, the slope of χ against the stability corrected logarithmic height, $\ln(z-d) - \Psi_{(z-d)/L}$, multiplied by $-\kappa \cdot u_*$ gives a direct estimate of the flux by the aerodynamic gradient method.

References supplement:

Paulson, C. A.: The mathematical representation of wind speed and temperature profiles in the unstable atmospheric surface layer, J. Appl. Meteorol., 9, 857-861, 1970.

Webb, E. K.: Profile relationships. Log-linear range, and extension to strong stability, Quart. J. Roy. Meteorol. Soc., 96, 67-90, 1970.