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Importance of the Webb, Pearman, and Leuning (WPL) correction for the measurement of small CO_2 fluxes

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Temperature dependence of quantities in Eq. (1)

The WPL correction is given by

$$F_c = \overline{w'\rho_c'} + \mu \frac{\overline{\rho_c}}{\overline{\rho_d}} \overline{w'\rho_w'} + (1 + \mu\,\sigma)\overline{\rho_c} \frac{\overline{w'T'}}{\overline{T}}, \qquad \text{(S1)}$$

Most quantities in Eq. (S1) are temperature dependent. The relevant temperature-dependent quantities of the second term of Eq. (1) are $\overline{\rho_c}/\overline{\rho_d}$ and in the third term $(1 + \mu\,\sigma)\overline{\rho_c}/\overline{T}$ (essentially σ and $\overline{T}$). The numerical values are taken from a book chapter (Foken et al., 2021) with extensive tables based on the current ITS-90 (Preston-Thomas, 1990) and TEOS-10 (Feistel et al., 2010;Wright et al., 2010) standards. The book should have been published long ago but is now scheduled for December 2021.

Especially the third term is of interest since it has the more significant influence on the WPL correction according to the present study. The results for a constant assumed value of ρ_c= 0.00078 kg m^{-3} are given in Fig. S1. Note: The density of CO_2 is about a factor of 1.55 greater than that of dry air, and the factor is almost independent of temperature.

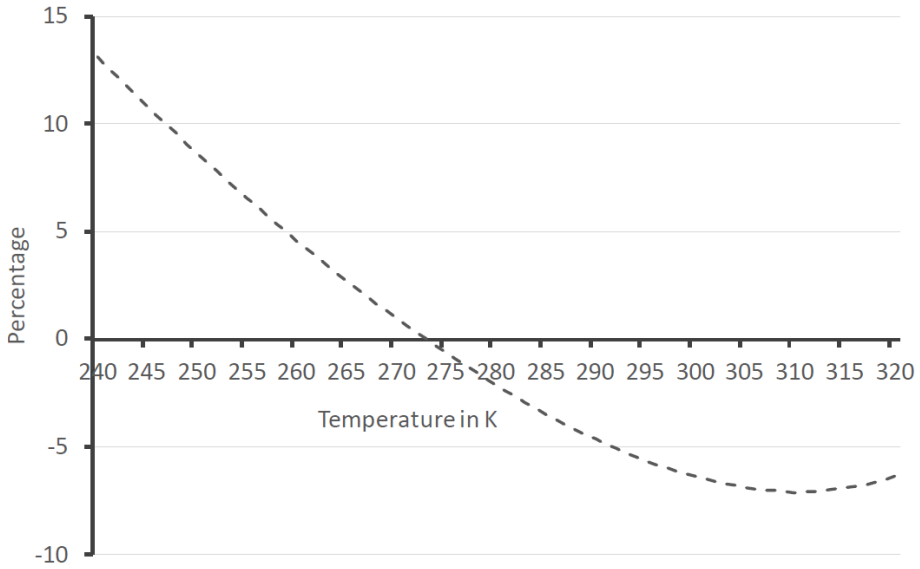

Figure S1: Percentage of the temperature dependent parts of the third term in relation to the value at 273 K (constant density of carbon dioxide) for kinematic sensible heat flux

If the sensible heat fluxes are used in energetic units (correction with air density and specific heat at constant pressure), there is nearly no temperature dependency (Fig. S2).

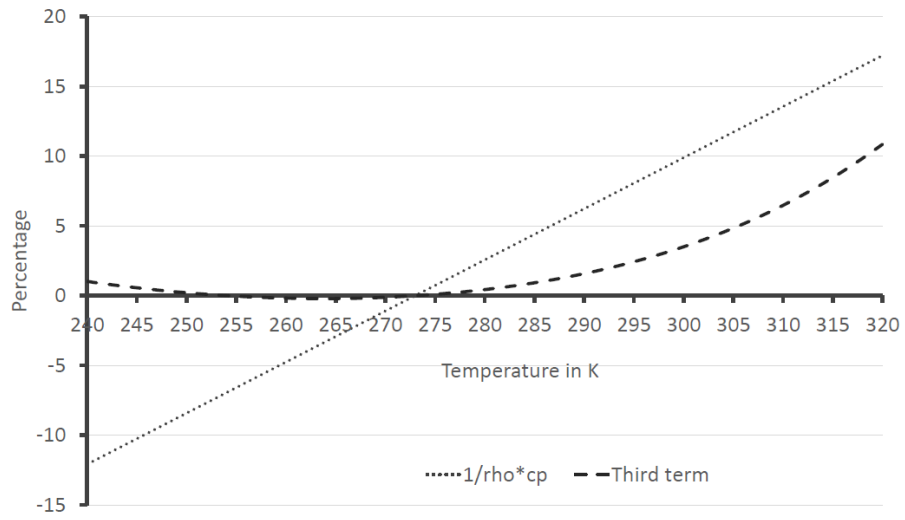

Figure S2: Percentage of the temperature dependent parts of the third term in relation to the value at 273 K (constant density of carbon dioxide) for energetic sensible heat flux. Additionally, the percentage of the term $1/(\rho_d\, c_p)$ in relation to the value at 273 K is shown

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