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Advanced tilt correction from flow distortion effects on turbulent CO_2 fluxes in complex environments using large eddy simulation

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As a novel approach for the quantification of turbulent vertical exchange in complex environments with unavoidable obstructions of the wind field, we developed a combination of numerical flow modelling (here around the tower's 3D superstructure) with eddy covariance measurements, to account for the errors originating from flow distortion induced tilt angles. Through further development of the commonly used planar fit and double rotation approaches, the additional direction-dependent flow correction allows the determination of the correct vertical turbulent fluxes. We applied the developed method to a 10 Hz dataset of 3D wind-components, temperature, carbon dioxide, and water vapour, as measured on top of a military radio tower above the city of Münster in northwest Germany during spring and summer 2007. Remarkable differences appeared between the turbulent exchange rates calculated with commonly used methods and the flux values derived from the advanced methods. The highest deviations of 16.8 % were obtained for the momentum flux, comparing the new approach to traditional tilt correction algorithms. Pronounced differences of 12.5 % and 9.5 % diurnal net fluxes were computed for carbon dioxide and water vapour, respectively.