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The influence of aircraft speed variations on sensible heat flux measured by different airborne systems

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The eddy correlation method is a common way for the direct determination of turbulent fluxes from in situ measured data. Airborne measurements are an effective source for precise in situ data that describe the turbulent state of the atmosphere. Normally the turbulent exchange of sensible heat is defined from the covariance between vertical velocity and potential temperature. Both wind and temperature are sampled and stored as time series aboard research aircraft. Thus the usual method to obtain their covariance is to average the measured time series over time. However, Crawford et al. (1996) showed that the time average is inappropriate for airborne eddy correlation flux calculations. If the aircraft speed through the turbulent field is not constant because it is correlated with vertical air motion, some types of structures are sampled more densely than others. Therefore, a space average is used as a aircraft speed correction to the time average.
The presentation will show a comparison of heat-flux calculations using time and spatial averaging methods. Data of the airborne measurement systems M^2AV, Helipod and DO 128 are used for the analysis. These systems vary in size, weight and aerodynamic characteristics. The M^2AV is an unmanned aerial vehicle (UAV) with a 2 m wingspan and a maximum take-off weight of about 6 kg. The helicopter-borne turbulence probe Helipod has a diameter of 0.6 m and weights about 300 kg whereas the Dornier 128 weights 4350 kg and has a wingspan of 15.55 m.
Different flights of these airborne systems are analysed and compared. The largest difference between heat fluxes calculated using time and spatial averaging were found for the smallest aircraft of this analysis (as predicted by Crawford et al., 1993), the UAV. It is also found that these differences are small and increase with increasing flux values.

Reference: Crawford, T. L., McMillen, R. T., Dobosy, R. J. and MacPherson, I., 1993: Correcting Airborne Flux Measurements for Aircraft Speed Variation. Boundary-Layer Meteorol., 66, 237–245.