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On the gap in the spectra of atmospheric turbulence

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Eddy-covariance flux measurements require a researcher to separate the mean and fluctuating parts, i.e. to choose an averaging period τ. The choice is not at all straightforward, as the energy spectra of the turbulence, mesoscale and synoptic structures may overlap. Yet, often enough there exist a gap in the spectra, separating the turbulence proper and mesoscale motions. At the gap scale the spectrum falls almost to zero, and the dependence of the flux on the averaging period becomes especially weak.

This study was concerned with the time scale of the gap in the cospectra of surface fluxes and its dependence on the environmental conditions. The data were collected during March – December 2004 at a grassland site in Co. Cork, Ireland. Gill R3-50/LI-7500 were mounted on a tower at 3 m height and sampled at 10 Hz. Continuous time series were split in subrecords of 2^{16} points (109 min) and subject to multi-resolution flux decomposition. The 5th order polynomials were fitted to the resulting cospectra, and the gap scale τ_g identified by the first root or extremum occurring after the turbulence peak. The gap was present in 80-85% of cases, although the scatter in the values of τ_g was strong.

During the day τ_g was found to fall from circa 16 to 4 min as the wind speed $\overline{u}$ increases from 1 to 7 ms^{-1}, but no dependence on $\overline{u}$ was present during the night. Increase of stability z/L from -0.3 to 0.3 resulted in the decrease of τ_g from 30 to 4 min. Average (over 10 months) value of τ_g is near 7 minutes during the night and 11 minutes during the day, this being about 40% higher for momentum flux.

Annual (cumulative) fluxes computed at 27 and 7 min averaging intervals were found to differ by only 1–3%, which is of the order of instrumentation errors and, most likely, may be neglected in practice. Thus the concern about missing long-term contribution to the total transport may not have serious grounds. Although large at each individual period, it is negligible due to its erratic nature, when averaged over a very long time.