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Variability in carbon dioxide fluxes for dense urban, suburban and woodland environments in southern England

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The net exchange of carbon dioxide between the surface and atmosphere can be measured using the eddy covariance technique. Fluxes from a dense urban environment (central London), a suburban landscape (Swindon) and a woodland ecosystem (Alice Holt) are compared. All sites are located in southern England and experience similar climatic and meteorological conditions, yet have very different land cover. The signatures of anthropogenic and biogenic processes are explored at various (daily, seasonal and annual) timescales. Particular emphasis is placed on identifying the mixture of controls that determine the flux. In summer, there are clear similarities between the suburban and woodland sites, as the diurnal behaviour is dominated by photosynthetic uptake. In winter, however, vegetation is largely dormant and human activity determines the pattern of fluxes at the urban and suburban sites. Emissions from building heating augment the net release of carbon dioxide in cold months. Road use is a major contributor to the total emissions, and the diurnal cycle in the observed fluxes reflects this: in central London roads are busy throughout the day, whereas in Swindon a double-peaked rush-hour signal is evident. The net exchange of carbon dioxide is estimated for each site and set in context with other studies around the world. Central London has the smallest proportion of vegetation and largest emissions amongst study sites in the literature to date. Although Swindon's appreciable vegetation fraction helps to offset the anthropogenic emissions, even in summertime the 24h total flux is usually positive, indicating carbon release. Comparison of these three sites in a similar region demonstrates the effects of increasing urban density and changing land use on the atmosphere. Findings are relevant in terms of characterising the behaviour of urban surfaces and for quantifying the impact of anthropogenic activities.