Sources and sinks of local-scale CO_2 fluxes in a Nordic city of Helsinki

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The greatest pressure to reduce CO_2 emissions concentrates in urban areas. In order for the cities to find the maximal tools to reduce their CO_2 emissions understanding the temporal and spatial distributions of the sources and sinks are important. High resolution is also a key to quantifying large-scale emissions as errors in the timing, location and magnitude of urban emissions can cascade into the remaining flux components in carbon inversion studies where anthropogenic CO_2 emissions are used as boundary condition for other modelling components.

In this study detailed source and sink partitioning of two eddy covariance sites in Helsinki measuring the net CO_2 flux is made and the spatial variability of local-scale CO_2 fluxes within and area of 6x9 km^2 examined. We use the Surface Urban Energy and Water balance Scheme (SUEWS) which is an urban land surface model resolving the energy and water balances and CO_2 surface exchange at a local-scale. In the model, the anthropogenic CO_2 emissions can be calculated with a bottom-up approach by estimating CO_2 emissions separately from traffic, buildings and human metabolism. For biogenic components, photosynthesis is calculated based on environmental variables (radiation, air temperature, soil moisture, humidity), and soil and vegetation respiration based on air temperature.

In city centre, the main local-sources for CO_2 are traffic and human metabolism whereas in suburban area biogenic components and traffic are contributing to the emissions most. Within the larger study domain, traffic has the greatest contribution followed by human metabolism as estimated from urban mobility data. The local-scale emissions from buildings are negligible due to the central heating system. On an annual level, vegetation respiration exceeds photosynthesis in most areas mainly due to the relatively short growing season.