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Spatial variability of local-scale CO_2 emissions in Helsinki

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Cities are characterised by temporally and spatially variable air pollutant and carbon dioxide (CO_2) emissions which often are correlated. For cities to improve their environmental awareness and preparation for climate change, tools to examine planning strategies and these emissions are needed. We focus on simulating local-scale urban CO_2 emissions, as this is where many urban planning interventions can take place but top-down or inventory methods commonly may not work.

We examine the spatial variability of net CO_2 exchange and the impact of different planning scenarios across Helsinki (Finland) at the local scale using Surface Urban Energy and Water balance Scheme (SUEWS). Biogenic CO_2 components (respiration and photosynthesis) are parameterized using local environmental variables to give spatial variability. Anthropogenically driven emissions (traffic, buildings and human metabolism) are considered. The model output has good correspondence to eddy covariance observations in semi-urban and highly built-up city centre. The model reproduces both the diurnal pattern of CO_2 exchanges and the differences between the different surface covers well. In an area with predominately natural emissions the model captures the vegetation uptake and respiration well, particularly in summer when the vegetation is most active.

The model is run for a 2-year period using measured meteorological data as forcing. The 6x9 km^2 study area is divided into 250x250 m^2 grids. Model parameters are estimated from lidar data (1 m resolution) and data provided by the City of Helsinki. Separation of grid population densities to day and night are made using mobility data.

Traffic and human metabolism are almost equally important CO_2 sources in the city centre. This can have important implications for other pollutant emissions as many emissions are often described as a ratio to carbon emissions. Most buildings in Helsinki use district heating and thus local CO_2 emissions are minor throughout the simulated area. In addition to realistic emissions, the potential of SUEWS to be used to support urban planning is demonstrated.