Spatiotemporal dynamics of CO_2 flux in Basel city centre

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Introduction

Cities are highly heterogeneous mosaics of CO_2 sources and sinks. This study attempts to unravel the complex urban CO_2 flux dynamics by modelling each component separately (i.e. building emissions, traffic, human metabolism, photosynthesis, plant respiration, soil respiration).

Methods

The case study is the city centre of Basel, Switzerland. The models are based on high resolution geospatial, meteorological and population activity datasets. Building emission model is based on Heating Degree Hours and building volume; traffic model is based on traffic counts, road and vehicle types; human respiration on dynamic estimation of population density; biogenic components are modelled according to remote sensing and semi-empirical modelling, calibrated by field in-situ measurements. Model results are compared to Eddy Covariance flux measurements from two tower sites (BKLI, BAES).

Results

The model indicates that building emissions are the most important flux component, while human respiration is also a very important factor. The emission mitigation potential by photosynthesis is high, especially during summer, but it is partly compensated by soil and plant respiration.

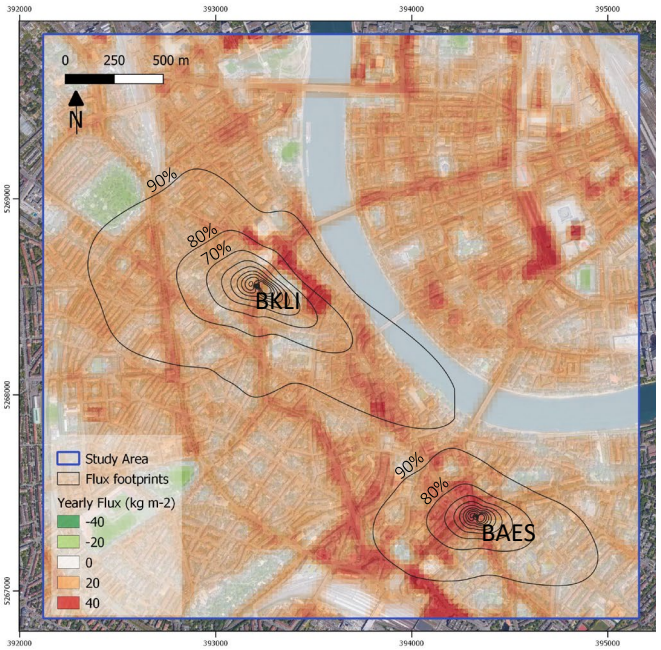
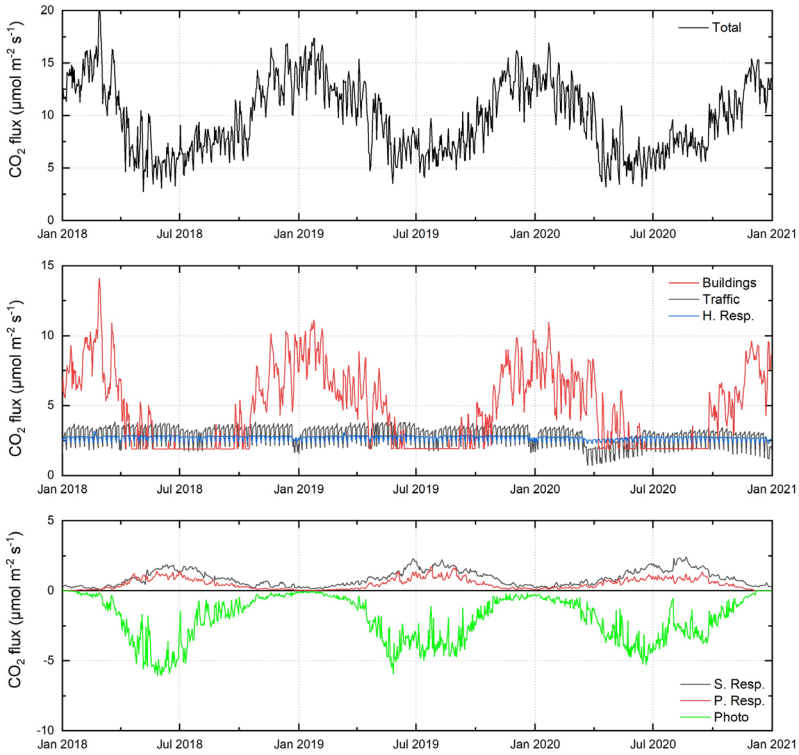


Table: Annual flux totals (kg CO_2 m^{-2} $year^{-1}$) for the study area and the tower flux footprints.

	Study area		BKLI		BAES	
Traffic	4.0	29.7 %	5.6	31.6 %	14.4	51.3 %
Buildings	6.6	48.6 %	7.4	41.8 %	9.1	32.5 %
Human resp.	3.7	27.3 %	4.8	27.3 %	4.3	15.3 %
Soil respiration	1.2	9.2 %	1.5	8.6 %	0.8	2.9 %
Plant respiration	0.7	5.0 %	0.8	4.3 %	0.3	1.2 %
Photosynthesis	-2.7	-19.7%	-2.4	-13.6 %	-0.9	-3.3 %
Total	13.6		17.8		28.1	



Upper Left Figure: Map of modelled total annual CO_2 flux (kg CO2 m^{-2} $year^{-1}$) at 25 m resolution and the long term flux footprints of the two tower sites (BKLI, BAES).

Upper Right Figure: Time-series of the daily mean modeled CO_2 flux of the study area for the period 2018 – 2020 and for the different model components: building emissions, traffic emissions, human metabolism, soil respiration, plant respiration, photosynthesis.

EGU General Assembly 2021

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This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Sklodowska-Curie grant agreement No 836443