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CO_2, CH4 and particles flux measurements in Florence, Italy

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We report a synthesis of seven years of eddy covariance (EC) flux measurements in the city of Florence, Italy. The measurement site is located in a densely urbanized area in the central city area, where fluxes are governed by anthropogenic emissions, considering the lack of green-space in the flux footprint. EC flux measurements of CO_2 are made long-term since seven years, while short-term campaigns have been aimed at measuring CH4 and particles fluxes. CO_2 and CH4 densities are measured with fast open-path sensors, while particles in the range 0.32 – 7.00 μm optical diameter are measured with a custom-built optical counter. CO_2 long-term fluxes are always a net source, with a small inter-annual variability associated with a high seasonality, ranging from 39 to 172% of the mean annual value in summer and winter respectively. CH4 fluxes to the atmosphere are relevant, representing about 8% of CO_2-equivalent emissions, and do not exhibit any significant seasonality. Relative contributions of road traffic and domestic heating to observed emissions has been estimated through multi-variate analysis combined with inventorial data and emission proxies such as traffic counters and gas network flow rates, revealing that domestic heating accounts for more than 80% of observed CO_2 fluxes. Heating and road traffic are instead responsible for only 14% of observed CH4 fluxes, while the major residual part is likely dominated by gas network leakages. Particles flux data show a smaller seasonal trend and a pronounced weekend decrease, highlighting that the contribution of heating to particle emissions is relatively small compared to road traffic. Dynamics at hourly time scales during week and week-end days allows the analysis of the coupled role of emission strength and atmospheric processes such as advection and entrainment in regulating atmospheric concentrations. This set of observations highlights the potential of urban EC flux measurements as a validation tool for inventorial based estimates, and as a planning and verification tool for emission reduction policies that may be applied by city administrators. Challenges and limitations of EC in urban environments are finally highlighted.