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Combining urban scale inversions and process-based information from sectors of economic activity in the Indianapolis Flux Experiment (INFLUX) to monitor CO_2 emissions

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The Indianapolis Flux Experiment (INFLUX) aims at quantifying emissions of anthropogenic carbon using top-down methods and process-based information (Hestia) at very high resolution over the city of Indianapolis (IN). At present, 9 sensors measuring continuously atmospheric mixing ratios of GHG have been deployed, with additional flask samples of isotopic ratios, one eddy-flux site measuring the surface energy and CO_2 fluxes, frequent aircraft flight measurements of GHG, and a column-integrated surface based sensor (FTS-TCCON). Additional meteorological instruments were deployed to assess the accuracy of the modeling system by measuring vertical profiles of several meteorological variables (wind, turbulent mixing height, temperature), from both ground-based and airborne instruments. The inverse modeling system combines the atmospheric transport model WRF in Four-Dimensional Data Assimilation mode with a Lagrangian Particle Dispersion Model to simulate the local atmospheric dynamics over the area. The system was coupled to the high resolution emissions from the Hestia product at the hourly time scale for each individual economic activity sector.
We present here the contribution from the different activity sectors as observed by the current atmospheric observation network. The capability of the system to detect and constrain seasonal and spatial signals in the emissions is inferred from sensitivity experiments. Whereas several sectors are widely distributed in space and observed by the whole GHG sensors network, we show that large point sources from industrial and utility sectors are less frequently observed and difficult to simulate correctly in our initial WRF simulations. However, these sectors represent a large fraction of the total emissions in the area. Consequently, seasonal changes in the atmospheric circulation and the sector emissions impact directly the distribution of the final error reduction of the inverse system. We finally estimate the potential of our current system to detect major changes over the course of the year in the different sectors depending on the spatial resolution of the modeling system, its related uncertainty primarily due to errors in transport simulations, and the locations of measurement sites over the area.