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Quantifying spatial and temporal variability of methane emissions from a complex area source: case study of a central Indiana landfill

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Atmospheric methane is a powerful greenhouse gas that is responsible for about 17% of the total direct radiative forcing from long-lived greenhouse gases (IPCC 2013). While the global emission of methane is relatively well quantified, the temporal and spatial variability of methane emissions from individual area or point sources are still poorly understood. Using 4 field methods (aircraft-based mass balance, tracer correlation, vertical radial plume mapping, and static chambers) and a new field-validated process-based model (California Landfill Methane Inventory Model, CALMIM 5.4), we investigated both the total emissions from a central Indiana landfill as well as the partitioned emissions inclusive of methanotrophic oxidation for the various cover soils. This landfill is an upwind source for the city of Indianapolis, so the resolution of m^2 to km^2 scale emissions, as well as understanding the temporal variability for this complex area source, contributes to improved regional inventory calculations. Emissions for the site as a whole were measured using both an aircraft-based mass balance approach as well as a ground-based tracer correlation method, permitting direct comparison of the strengths, limitations, and uncertainties of these two approaches. Because US landfills are highly-engineered and composed of daily, intermediate, and final cover areas with differing thicknesses, composition, and implementation of gas recovery, we also expected different emission signatures and strengths from the various cover areas. Thus we also deployed static chambers and vertical radial plume mapping to quantify the spatial variability of emissions from the thinner daily and intermediate cover areas. Understanding the daily, seasonal and annual emission rates from a landfill is not trivial, and usually requires a combination of measurement and modeling approaches. Thus, our unique data set provides an opportunity to gain an improved understanding of the emissions from a complex area source, an essential requirement for developing improved urban-scale greenhouse gas inventories relevant for addressing mitigation strategies. We report on the results here.