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Methane Estimates in the Northeastern US using Continuous Measurements from a Regional Tower Network

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In the past decade, there has been a scientific focus on improving the accuracy and precision of methane (CH4) emission estimates in the United States, with much effort targeting oil and natural gas producing basins. Yet, regional CH4 emissions and their attribution to specific sources continue to have significant associated uncertainties. Recent urban work using aircraft observations have suggested that CH4 emissions are not well characterized in major cities along the U.S. East Coast; discrepancies have been attributed to an under-estimation of fugitive emissions from the distribution of natural gas. However, much of regional and urban research has involved the use of aircraft campaigns that can only provide a spatio-temporal snapshot of the CH4 emission landscape. As such, the annual representation and the seasonal variability of emissions remain largely unknown. To further investigate CH4 emissions, we present preliminary CH4 emissions estimates in the Northeastern US as part of NIST's Northeast Corridor (NEC) testbed project using a regional inversion framework. This area encompasses over 20% of the US and contains many of the dominant CH4 emissions sources important at both regional and local scales. The atmospheric inversion can estimate sub-monthly 0.1-degree emissions using observations from a regional network of up to 37 in-situ towers; some towers are in non-urban areas while others are in cities or suburban areas. The inversion uses different emission products to help provide a prior constraint within the inversion including anthropogenic emissions from both the EDGAR v42 for the year 2008 and the US EPA for the year 2012, and natural wetland CH4 emissions from the WetCHARTs ensemble mean for the year 2010. Results include the comparison of synthetic model simulated CH4 concentrations (i.e., convolutions of the emission products with WRF-STILT footprints + background) to mole-fractions measured at the regional in-situ sites. The comparison provides an indication as to how well our prior understanding of emissions and incoming air flow matches the atmospheric signatures due to the underlying CH4 sources. We also present a preliminary set of CH4 fluxes for a selected number of urban centers and discuss challenges estimating highly-resolved methane emissions using high-frequency in-situ observations for a regional domain (e.g. few constraints, skewness in underlying fluxes, representing incoming background, etc.). Overall, this work provides the basis for a year-long inversion that will yields regional CH4 emissions over the Northeast US with a focus on Eastern urban areas.