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Methane Leakage from Oil & Gas Operations. What have we learned from recent studies in the U.S.?

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Methane, the principal component of natural gas, is a powerful greenhouse gas. Methane losses from the natural gas supply chain erode the climate benefits of fuel switching to natural gas from other fossil fuels, reducing or eliminating them for several decades or longer. Global data on methane emissions from the oil and gas sector is uncertain and as a consequence, measuring and characterizing methane emissions is critical to the design of effective mitigation strategies.

In this work, we synthesize lessons learned from dozens of U.S. studies that characterized methane emissions along each stage of the natural gas supply chain. These results are relevant to the design of methane measurement campaigns outside the U.S.

A recurring theme in the research conducted in the U.S. is that public emissions inventories (e.g., The U.S. Environmental Protection Agency's National Greenhouse gas Inventory) tend to underestimate emissions for two key reasons: (1) use of non-representative emission factors and (2) inaccurate activity data (incomplete counts of facilities and equipment). Similarly, the accuracy of emission factors and the effectiveness of mitigation strategies are heavily affected by the existence of low-probability, unpredictable high emitters-which have been observed all along the supply chain- and are spatiotemporally variable.

We conducted a coordinated campaign to measure methane emissions in a major gas producing region of the U.S. (Barnett Shale region of Texas) using a diversity of approaches. As part of this study we identified methods for effective quantification of regional fossil methane emissions using atmospheric data (through replicate mass balance flights and source apportionment using methane to ethane ratios) as well as how to build an accurate inventory that includes a statistical estimator that more rigorously captures the magnitude and frequency of high emitters. We found agreement between large-scale atmospheric sampling estimates and source-based estimates (custom inventory). With measured oil and gas methane being roughly twice what estimates based on the U.S. Environmental Protection Agency's National Greenhouse gas Inventory would suggest. Ten percent of oil and gas facilities in the region –the high emitters or fat tail of the distribution- account for 90% of the emissions.

We observed significant regional heterogeneity (e.g., local practices, technologies used, physical properties of the reservoirs) during the production, processing, transportation, and use of natural gas, describing this heterogeneity is critical to constructing accurate methane emission inventories. The lessons learned in the U.S. provide robust methodological guidelines that can be used to extend our understanding of the climatic implications of global oil and gas methane emissions with regards to, accurate quantification, reporting, and mitigation of methane emissions.