Improved Mechanistic Understanding of Natural Gas Methane Emissions from Spatially Resolved Aircraft Measurements

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Confidence in basin-scale methane (CH_4) emission estimates from oil and gas (O&G) operations hinges on an in-depth understanding, objective evaluation and continued improvements of both top-down (e.g. aircraft measurement based) and bottom-up (e.g. component-/facility-level measurements and engineering calculations) approaches. Enhancing the spatio-temporal resolution of top-down and bottom-up methods may allow improved reconciliation analysis of reported differences in O&G related CH_4 emission estimates. This presentation summarizes the first spatially-resolved CH_4 emission estimates from an aircraft mass balance in the U.S. Fayetteville shale gas play for 10 km x 60 km sub-regions. Refinements of the aircraft mass balance method were needed to reduce the number of potential methodological biases (e.g. data and methodology). The refinements include an in-depth exploration of the definition of upwind conditions and their impact on calculated downwind CH_4 enhancements and total CH_4 emissions, and taking into account small but non-zero vertical and horizontal wind gradients in the boundary layer. Optimal meteorological conditions and employment of multiple measurement platforms led to reduced uncertainty estimates compared to some previous studies. We identify higher emitting sub-regions, and localize repeating emission patterns as well as differences between days. In addition, we use spatio-temporally resolved NG industry reported activity data for the specific flight periods to offer explanations for the observed spatio-temporal CH_4 emission patterns. The increased resolution of the top-down calculation will for the first time allow for a spatially resolved comparison with a high resolution bottom-up CH_4 emission estimate based on facility-level emission measurements, concurrent activity data and other data sources.

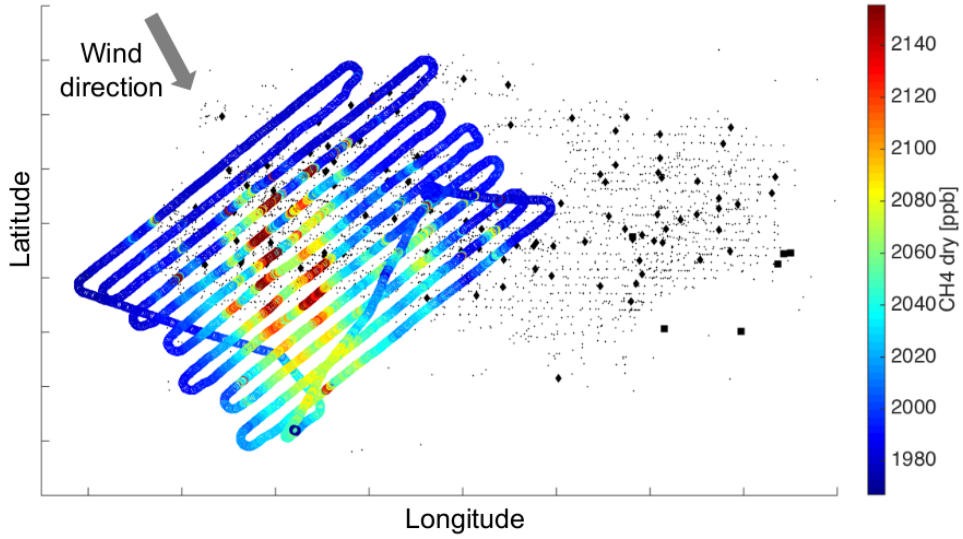

Figure 1. Raster flight pattern over parts of the Fayetteville shale gas basin and resulting methane levels indicate higher emitting sub-regions. A single flight example is shown as part of multiple flights in other parts of the basin, as well as repeats.