Optimization of Methane Emissions in the United States Gulf Region Using Aircraft-based Measurements Across Frontal Boundaries

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The United States Gulf and lower Midwest region are a hotspot for anthropogenic methane (CH_4) emissions, with the largest contributions coming from the oil/gas and animal agriculture sectors. During frontal weather events, airflow is directed across the region in a manner that combines CH_4 enhancements from these various sources into a large, easily observable enhanced plume greater than 100 ppb in magnitude. In this study, we take CH_4 and ethane (C_2H_6) observations from the Atmospheric Carbon Transport-America campaign for seven flights that cross frontal systems in the Midwest and Gulf and adjust emissions from the oil/gas and animal agriculture sectors such that modelled CH_4 and C_2H_6 enhancements produced by WRF-Chem simulations match the observed plume. From the CH_4 optimization we find that there is more CH_4 than projected by the EPA Gridded CH_4 Inventory by about a factor of 1.5. Results from the joint CH_4-C_2H_6 optimization indicate that this increase is due to an underestimation of emissions from the oil/gas sector (1.4–2.8 times larger than inventory estimates), whereas deviations from expected animal agriculture emissions are not necessary to explain the observed signals. Our results for the oil and gas sector match synthesis work from recent literature, and reject the possibility that this increase compared to inventories is due to a potential bias in daytime-only measurements of gas facilities. Modelled CH_4 from this study is able to produce a near-perfect match with observations across the 7 flights ($r > 0.9$), providing confidence in the results and raising the possibility of using trace gas measurements along frontal crossings to solve for emissions in other regions of the U.S.

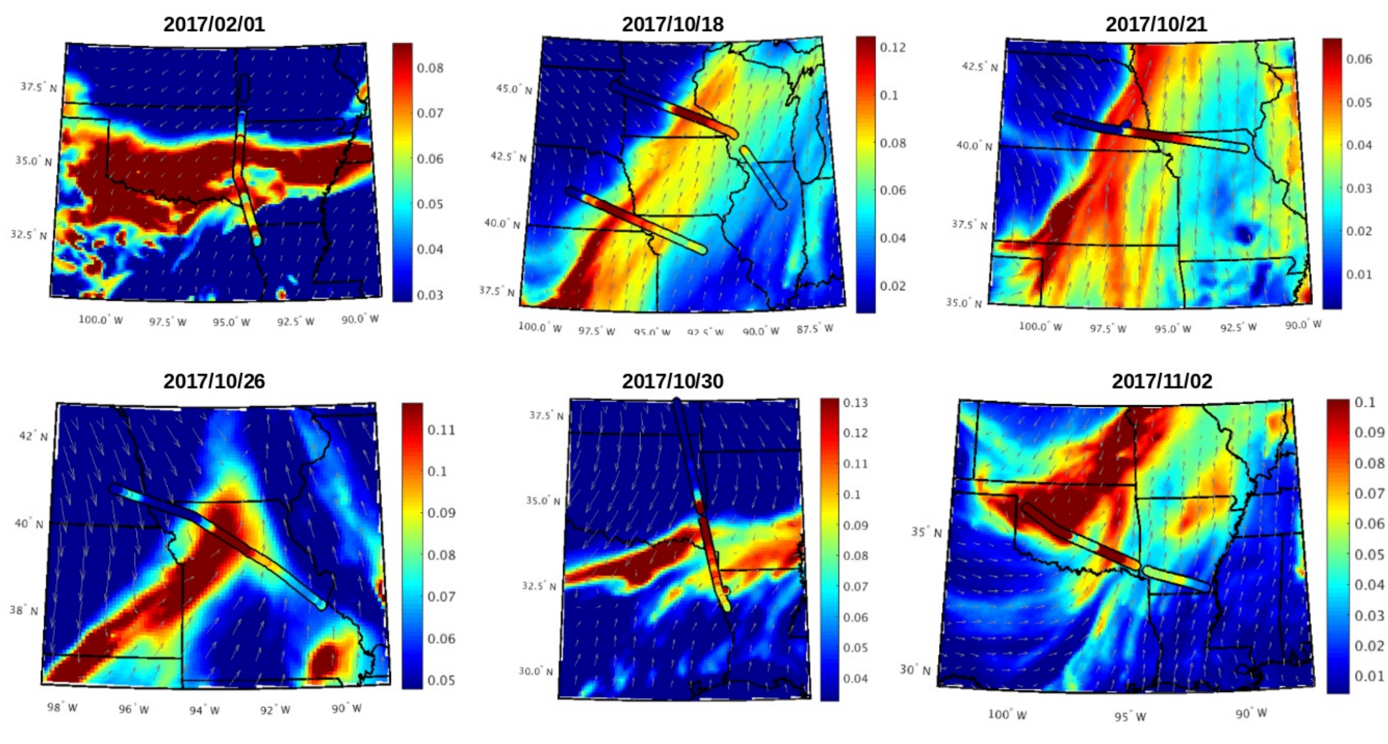

Figure 1. Modelled vs. observed CH_4 enhancements (in ppm) for the seven flights used in this study. Model results shown in each image were created using WRF-Chem and are a snapshot of projected enhancements at 18Z at a height of 300 m above ground level using unadjusted emissions from the EPA Gridded Methane Inventory.