

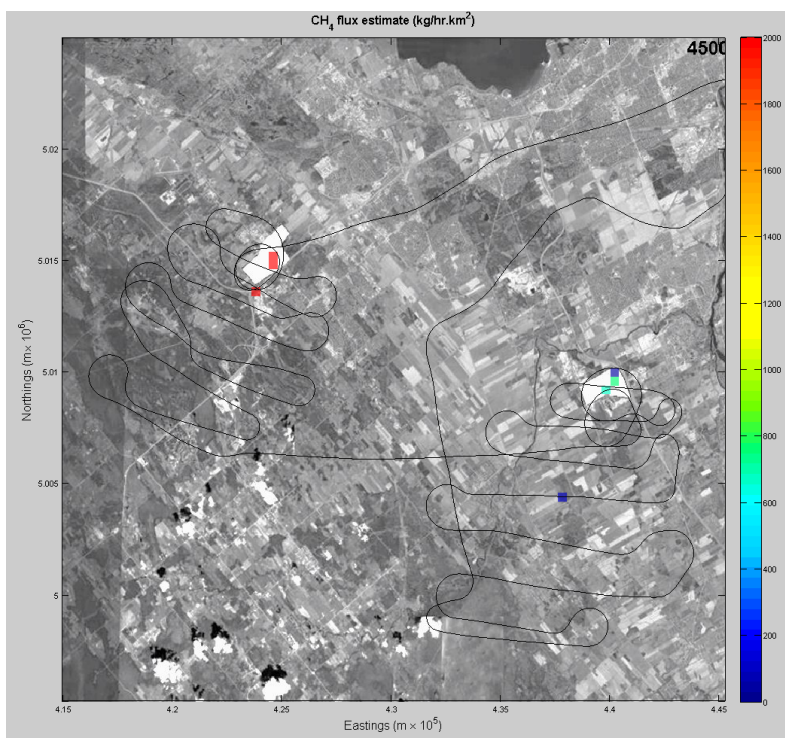
# Locating and Quantifying Methane Gas Emissions Using Remotely Obtained Concentration Data from Aircraft

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We describe our method for detecting, locating and quantifying gas emission rates to the atmosphere using remotely obtained gas concentration data from aircraft. The method has been developed for oil and gas exploration to map natural methane seeps that confirm the presence of hydrocarbon systems. We combine concentration data with extensive wind field data for the area of interest and use a simple Gaussian plume eddy dispersion model to tackle the inverse problem of locating and quantifying emission sources. The same technique is directly applicable to detecting, locating and quantifying other gases of environmental concern and was deployed as part NOAA's recent Barnett Shale survey in Texas. We demonstrate the method's performance using test flight data collected from the vicinity of known methane sources, such as landfills and flare-stacks. We describe the principles of how the data analysis works to provide a split Bregman L2-L1 optimisation solution over a grid of potential source locations. Using this optimisation result as a starting point we can then employ a fully Bayesian implementation of reversible jump Markov chain Monte Carlo inference to provide estimated values and uncertainties for the number, spatial extent, emission rates and locations of sources, unconstrained by a spatial grid. The Bayesian approach also allows for assessment of bias effects, for example in wind direction and other meteorological parameters.



**Figure 1.** Methane emission flux map from a 70-minute test flight over two landfills in Canada (shown as white polygons). Figure shows a 900km<sup>2</sup> area taken from the gridded optimisation result for a 100x100 cell reconstruction over 1600km<sup>2</sup>. The code for this runs on a simple laptop in a couple of minutes. Concentration data was collected at 1 Hz to ~1ppbv precision, the aircraft flew at ~200m altitude; the aircraft track is shown by the black line, the fluxes given are for 400x400m area cells.