Mapping Sources of Methane Emissions Over the Barnett Shale in Texas

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We have developed and used a novel airborne survey technique to estimate the mass release rates and locations of numerous major sources of methane emissions to the atmosphere within the Barnett Shale in Texas, USA. This is one of the largest and longest established shale gas production areas in North America, producing 14% of U.S. shale gas. The survey area covers 3600km2 of the densest production area; which includes 5,828 producing wells (mostly gas) and associated infrastructure. Many of the inferred source locations show a clear correlation to gas processing plants and compressor stations visible in Google Earth. The distribution of inferred source emission rates supports the “heavy tail" hypothesis of relatively few sources emitting a disproportionately large fraction of total emissions.

Combining individual source emission rates we have produced a lower bound estimate for total emissions of 12,595 kg/hr from the survey area, which would constitute 0.96% of the area's average gas production (with an estimated one standard deviation range of 0.78% to 1.13%). This is a lower bound estimate because of our method's detection threshold, but includes all emission categories: not just those related to oil and gas. Our survey technique was developed for mapping naturally occurring gas seeps as an aid to hydrocarbon exploration and is called “LightTouch™”. It uses a reversible jump Markov chain Monte-Carlo approach to analyse gas concentration and meteorological data from sixteen 4-hour flights. Atmospheric background methane concentrations are treated as a spatio-temporal Markov random field with anomalous concentrations attributed to local sources via a Gaussian plume atmospheric eddy dispersion model. Flights are at a height of 165m and multiply traverse areas at 2.5km line spacing, revealing local gas plumes aligned with the wind (see figure below). Our experimental design provided multiple coverage of the survey area during the 9-day campaign, with 24 data sets covering a central 900km2 area; these provided consistency checks and revealed numerous transient emission events. For survey areas containing a greater variety of methane emitters, our location information could be used to help attribute emissions across source categories: e.g. oil and gas, landfills, electrical power generation, coal production, animal feed lots, etc. The heavy-tail distribution of source emission rates naturally assists mitigation efforts by focusing attention and resources on the most significant sources.

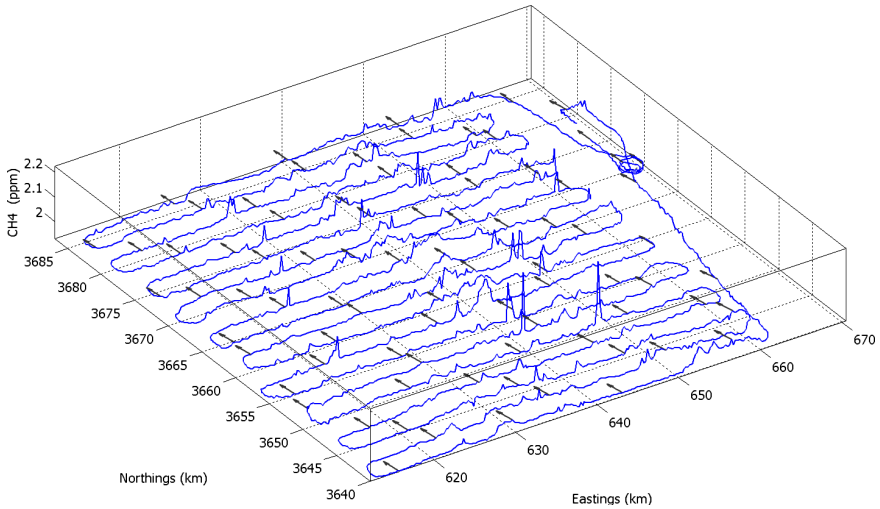

Figure 1. Raw methane concentration data from Flight 1007, showing correlation of local concentration anomalies with air movement vectors (black arrows). The flight area is 45x45km and aircraft flew at 165m altitude.