A New Technique for Airborne Measurements to Characterize Methane Emissions

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Methane (CH4) is the second-largest contributor to anthropogenic radiative forcing and has a significantly higher global warming potential than carbon dioxide (CO2). CH4 has an atmospheric lifetime of about a decade – significantly shorter than CO2 and other greenhouse gasses – so monitoring and reduction of CH4 emissions represents a “lever” to reduce near-term climate impacts. While oil and natural gas operations represent a large fraction of global methane enhancements, there are other significant thermogenic emissions (methane created through heating in the Earth’s crust), such as coal mining and natural seeps. Additionally, there are biogenic CH4 emissions (created through biological processes) that arise from biomass storage and ruminant animals. Simultaneous measurements of CH4 and C2H6 (ethane) -- the primary and secondary compounds in natural gas -- allows for source classification as biogenic or thermogenic. Accurately quantifying contributions from various sources, both spatially and temporally, is an important step towards building local, regional, and global CH4 emission estimates.

This talk details the integration of a compact laser spectrum analyzer and lightweight environmental sensors onto an unmanned aerial vehicle for direct, efficient, and repeatable CH4 and C2H6 flux quantification and source characterization. This design combines rapid sampling (~1 Hz) of chemical and meteorological data with a highly mobile platform capable of three dimensional plume profiling at finescale (~1m) spatial resolution relative to target sources. Here we present system development, calibration, and initial results from field measurements around targeted sources that may be at or below the detection limits of higher altitude aircraft and/or satellite surveys. In situ sampling of CH4 plumes on scales of tens to hundreds of meters (up to 1 km) provides complementary data for larger surveys; contextualizing local source contributions at a regional scale and demonstrating improvements to facility-level emission estimates, which will help inform policy decisions.

Figure 1. Pre-flight preparations of unmanned aerial system for direct methane flux mesurements.