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Quantifying oil and gas methane emissions from the US Gulf Coast and Appalachian basins using aircraft observations of ethane and methane

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Any decrease in global methane emissions will contribute towards reducing the impacts of climate change. Recently, many nations around the world enacted the Global Methane Pledge to make substantial reductions in methane emissions over the coming decade. A good understanding of methane and its sources is required to effectively target emission reduction policies in anthropogenic sectors and meet these pledges.

Total emissions of methane at both global and regional scales can be estimated from atmospheric observations of methane using inverse modelling techniques. However, the attribution of these total emissions estimates to their sources can be difficult when sources are closely located or when there is uncertainty in the spatial distribution of sources in bottom-up inventories. This is the case for many regions of the world, limiting our ability to understand specific sources.

The method presented in this work aims to improve on this issue and reduce the overall uncertainties involved with quantifying sector-level emissions by using a co-emitted tracer and its emissions ratio relative to methane to partition methane emissions by source. The emission ratios are included as spatially and temporally varying parameters, with their own uncertainties, and are jointly estimated along with emissions. This allows for any variability and uncertainty in the ratio to be statistically propagated through the inverse model and incorporated into the final estimates of sectoral methane emissions. This is a critical step when employing tracers, as they can bias source sector results if not applied accurately.

In this work, we use this novel method with ACT-America aircraft observations of methane and ethane to estimate monthly methane emissions from oil and gas basins across the USA. We show that trends in oil and gas methane emissions varies between basins. We also find that ethane:methane ratios vary largely between basins, which highlights the importance of including the uncertainty in these ratios in any model using ethane as a tracer for fossil fuel emissions.