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Using atmospheric in-situ measurements of $^{13}CH_4$ to investigate methane emissions in Western Canada

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The climate change impact of methane is significant and the recent increase in its atmospheric concentrations raises great concerns. Across Canada, methane emissions are unevenly distributed with a large part attributed to the Western Canadian Sedimentary Basin (WCSB), which is the fourth largest reserve of fossil fuels in the world. The WCSB extends from northeastern British Columbia to southwestern Manitoba, encompassing Alberta and southern Saskatchewan. The extraction of hydrocarbons mostly takes place in the provinces of Alberta and Saskatchewan and is a large source of methane.

According to recent international agreements, the Government of Canada has committed to reducing methane emissions by 40 to 45% by 2025 based on 2012 levels. However, a recent study using atmospheric measurements of methane concentrations in the region showed that methane emissions from the oil and gas sector might be nearly twice that reported in Canada's National Inventory (Chan et al., 2020). More investigations are required to better understand the discrepancy between these two estimates.

In this study, we use atmospheric observations of $\delta^{13}C$ measured successively at three locations across the WCSB between 2016 and 2020 to help identify the influence of different types of methane sources across the provinces of Alberta and Saskatchewan. We compare our atmospheric measurements with compilations and isotope contour maps of fugitive methane from energy facilities across the basin. Combining these measurements with trajectories computed with the HYSPLIT model developed by NOAA, we show a gradient in the methane isotopic signature across Alberta: methane being more depleted in southwestern Saskatchewan than northwestern Alberta. We also used the HYSPLIT5-STILT dispersion model to derive footprints during our measurements and estimate methane contributions of these two provinces using an optimization based on the isotopic measurements.

Chan et al. 2020: