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Isotopic fingerprinting of atmospheric methane in Western Canada compared to oil and gas well emissions

Sebastien Ars[1], Gabriela González Arismendi[2], Doug Worthy[1], Karlis Muehlenbachs[2] and Felix Vogel[1]

[1] Environment and Climate Change Canada

[2] University of Alberta

Both industry and governments are now committed to massive reductions of methane emissions to the atmosphere. To most efficiently achieve these ambitious goals, detailed information on the concentration and isotopic composition of atmospheric methane and its putative sources are necessary. Here, we combined the concentration of atmospheric methane and its carbon isotopic composition acquired by ECCC successively in three different sites in Alberta and Saskatchewan from 2016 to 2020 with contour maps of isotope compositions methane from thousands of surface casing vent flows (SCVF), ground migration and production gases samples collected across the region. A concomitant variation of the atmospheric methane concentration and $\delta^{13}C$ was observed depending on wind direction reflecting the known geographic variation $\delta^{13}C$ of SCVF and production gases. Atmospheric measurements of $\delta^{13}C$ of methane coupled with HYSPLIT-STILT footprints show a strong gradient within the WCSB similar to independent measurements of $\delta^{13}C$ of methane from production wells and SCVF, which validate the fact that the oil & gas sector is the main source of methane in the region. In some locations, there is a systematic difference in $\delta^{13}C$ of methane between SCVF and production gases. A more detailed study is underway to evaluate what proportion of anthropogenic methane emission may come from SCVF *versus* production facilities to help stakeholders prioritize remediation efforts and improve regulatory protocols.