

Variations of atmospheric methane concentration and its carbon and hydrogen isotopic ratios at Churchill, Canada

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Methane (CH₄) is the second most important anthropogenic greenhouse gas after CO₂. High-precision measurements of carbon and hydrogen stable isotopic ratios of CH₄ ($\delta^{13}\text{CH}_4$ and $\delta\text{D-CH}_4$) provide additional constraints to contributions of individual CH₄ sources to atmospheric CH₄ variations. Since 2007, we have conducted an air-sampling program at Churchill, Canada (58.44°N, 93.50°W) on the northern perimeter of the Hudson Bay Lowland, the second largest wetland area in the world i.e. one of the most important CH₄ source regions at northern high latitudes. In this study, we present temporal variations of CH₄, $\delta^{13}\text{CH}_4$ and $\delta\text{D-CH}_4$ at this site.

We observed long-term increase in the CH₄ concentrations at Churchill since 2007, which is consistent with the trend reported by the global observation networks such as NOAA/ESRL/GMD. The CH₄ concentration at Churchill is generally higher than that at Ny-Ålesund (78.55°N, 11.56°E), a northern high-latitude background station away from regional CH₄ sources. On the other hand, $\delta^{13}\text{CH}_4$ and $\delta\text{D-CH}_4$ at Churchill are lower than those at Ny-Ålesund, plausibly reflecting regional CH₄ emissions. Clear seasonal cycles of the CH₄ concentration and $\delta^{13}\text{CH}_4$ were observed; seasonal maximum and minimum of the CH₄ concentration take place in January-February and June-July, respectively, while those of $\delta^{13}\text{CH}_4$ were in May and October, respectively. Seasonal cycles of $\delta\text{D-CH}_4$ were obscure but observable. The seasonal phases of these variables were up to one month earlier than those at Ny-Ålesund. The cause of the difference could be attributable to wetland emissions in the surrounding region. Short-term variations of the CH₄ concentration were observed year around, but pronounced in summer. By inspecting relationships between the CH₄ concentration and the isotopic ratios, we found that the predominant CH₄ source of the short-term CH₄ variations is wetlands in summer but fossil fuels in winter.

Keywords: methane, carbon and hydrogen isotopic ratios, Hudson Bay Lowland, wetlands