Isotope Variations in Atmospheric Methane Over the Last Two Millenia

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Methane (CH_4) is an important greenhouse gas that is emitted from multiple natural and anthropogenic sources. Atmospheric levels of CH_4 have varied on various timescales in the past, but in many cases the causes of these variations are not understood. Analysis of the isotopic composition of CH_4 preserved in ice cores provides evidence for the environmental drivers of variations in CH_4 mixing ratios, because different sources and sinks affect the isotopic composition of CH_4 uniquely. We have analyzed ($\delta^{13}C$) of CH_4 in air trapped in Greenland ice cores over the last 2 millennia and find that the carbon isotopic composition underwent pronounced centennial-scale variations between 200 BC and 1600 AD without clear corresponding changes in CH_4 mixing ratios. The long-term CH_4 increase observed over this period is accompanied by a small overall $\delta^{13}C$ decrease. Two-box model calculations suggest that the long-term CH_4 increase can only be explained by an increase in emissions from biogenic sources. The centennial-scale variations in isotope ratios must be primarily due to changes in biomass burning, which are correlated with both natural climate variability including the Medieval Climate Anomaly, and with changes in human population, land-use and important events in history.

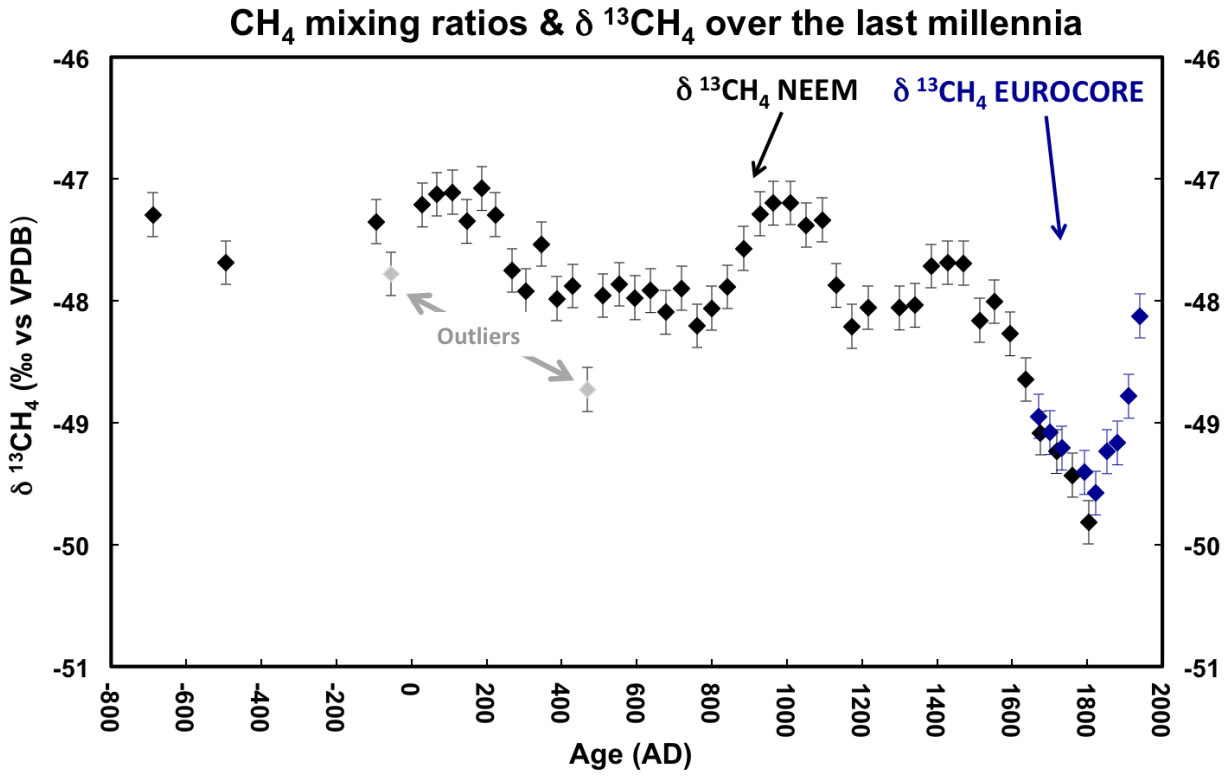

Figure 1. The $\delta^{13}C$ record of CH_4 over the last 2 millennia as determined from the NEEM (black) and EUROCORE (blue) ice cores.