Isotope Variations in Atmospheric Methane Over the Last Two Millenia

T. Röckmann\(^1\), C. Sapart\(^1\), G. Monteil\(^1\), M. Prokopiou\(^1\), R.V.D. Wal\(^1\), P. Sperlich\(^2\), J. Kaplan\(^3\), K. Krumhardt\(^3\), C.V.D. Veen\(^1\), S. Houweling\(^1\), M. Krol\(^1\), T. Blunier\(^2\), T. Sowers\(^4\) and P. Martynerie\(^5\)

\(^1\)Institute for Marine and Atmospheric Research, Utrecht University, Utrecht, Netherlands; 303-497-4988, E-mail: t.roeckmann@uu.nl
\(^2\)Centre for Ice and Climate, Niels Bohr Institute, University of Copenhagen, København DK-2100, Denmark
\(^3\)Ecole Polytechnique Federale de Lausanne, Route Cantonale, Switzerland
\(^4\)Earth and Environmental Systems Institute, Geosciences, Penn State University, University Park, PA 16802
\(^5\)Laboratoire de Glaciologie et Géophysique de l'Environnement, University of Grenoble, Grenoble, France

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.