3.021 Past variations of atmospheric methane and its isotope ratios reconstructed from firn air and ice core measurements.

Presenting Author:

Taku Umezawa, National Institute for Environmental Studies, Center for Environmental Measurement and Analysis, Tsukuba, Japan, umezawa.taku@nies.go.jp

Co-Authors:

Satoshi Sugawara, Faculty of Education, Miyagi University of Education, Sendai, Japan

Kenji Kawamura, National Institute of Polar Research, Tachikawa, Tokyo, Japan

Takanori Sugiyama, Graduate School of Science, Tohoku University, Sendai, Japan

Prabir Patra, Japan Agency for Marine-Earth Science and Technology, Yokohama, Japan

Kentaro Ishijima, Japan Agency for Marine-Earth Science and Technology, Yokohama, Japan

Takuya Saito, National Institute for Environmental Studies, Center for Environmental Measurement and Analysis, Tsukuba, Japan

Shinji Morimoto, Graduate School of Science, Tohoku University, Sendai, Japan

Shuji Aoki, Graduate School of Science, Tohoku University, Sendai, Japan

Takakiyo Nakazawa, Graduate School of Science, Tohoku University, Sendai, Japan

Abstract:

Analyses of air occluded in polar ice cores and porous layers of ice sheets (firn) have shown secular increase of atmospheric CH_4 abundance at decadal and longer time scales over the industrial era, but our understanding of historical changes in CH_4 sources is still limited. Carbon and hydrogen isotope ratios ($\delta^{13}C$ and δD) of CH_4 are useful tracers of different CH_4 sources, which have their own characteristic isotope signatures. Earlier works have tried to reconstruct $\delta^{13}C$ and δD changes over the last decades from firn air analyses. However, precise reconstructions of $\delta^{13}C$ and δD in both polar regions and their inter-polar differences have been difficult because of limited sample availability and variety of uncertainties associated with the lack of atmospheric CH_4 concentration history before 1980s, large corrections for isotopic fractionation due to molecular diffusion in firn, and measurement offsets among laboratories who have contributed to Arctic and Antarctic datasets. We here analyzed CH_4 concentration, $\delta^{13}C$ and δD in firn air from YM85 and Dome Fuji in Antarctica and North GRIP (NGRIP) in Greenland, as well as two Antarctic ice cores (G15 and H15) based on the same analytical techniques and scales. In addition, we measured NGRIP firn air for halocarbons as strong constraints on diffusivity profile in our firn-air transport model. In our presentation, we address problems in reconstructing $\delta^{13}C$ and δD histories from ice cores and firn air, present the reconstructed $\delta^{13}C$ and δD variations in both polar regions, and discuss changes in CH_4

emissions from different source categories over the last decades using a chemistry transport model.