Temporal variations of atmospheric methane and its carbon and hydrogen isotopic ratios observed at Ny-Alesund, Svalbard

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Whole air sampling has been conducted once a week using 800 mL stainless steel flasks at Ny-Alesund (78N, 12E), Svalbard since 1991. The air samples were shipped to Japan and CH4 concentration was measured by using a gas chromatograph equipped with flame ionization detector. Then, aliquots of each sample were collected from the flasks to measure carbon and hydrogen isotopic ratio (d13C and dD) of CH4 by a GC-C-IRMS system at National Institute of Polar Research (NIPR) since 1996 and by a GC-C/P-IRMS system at Tohoku University since 2005, respectively. Thus we will present here comprehensive datasets of CH4 concentration as well as d13C and dD covering more than two years.

As previously reported by Morimoto et al. (2006), the CH4 concentration showed a clear seasonal cycle with a maximum in winter and a minimum in summer: a sharp decrease and a sharp increase were observable during April-July and August-December, respectively, and relatively higher values with large variability were seen for the rest of the year. Significant seasonal cycles were also observed for d13C and dD. The d13C was out of phase with CH4 concentration, of which seasonal maximum and minimum were in June and October, respectively, whereas the dD was well negatively correlated with CH4 concentration.

To constrain seasonal variations of CH4 emissions from biogenic activities, fossil fuel, and biomass burning, we applied one-box model to the measured seasonal variations of CH4 concentration, d13C, and dD. In order to apply the model calculation, we assumed that mean d13C and dD values of CH4 emitted from biogenic activities were -60 and -316 per mil, from fossil fuel were -40 and -175 per mil, and from biomass burning were -24 and -210 per mil, respectively, Contribution of the CH4 sinks was prescribed considering a seasonal cycle of OH calculated by the three-dimensional atmospheric chemical-transport model named CHASER. Consequently, we obtained the seasonal variations of the CH4 sources categorized in the three groups. The results suggested that the biogenic CH4 source was the prominent contributor to the seasonal CH4 cycle, thus enhancement of CH4 emissions from wetlands in the northern high latitudes in late summer would significantly contribute to the observed seasonal variations of CH4 concentration in this region.