Seasonality of short-term variations in atmospheric CH$_4$ observed at Hateruma and relationship with the regional emissions from East Asia

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National Institute of Environmental Studies (NIES), Japan, has been carrying out in-situ observation of atmospheric CH$_4$ at Hateruma Island (HAT; lat. 24.1°N, long. 123.8°E) since 1996 by using a gas chromatographic system. Since HAT is in the marginal region of the East Asia, air masses from the continental region would cause elevated concentrations of a variety of species including CH$_4$. Such events were often observed especially during late autumn to early spring due to the Asian monsoon. In the previous studies, we revealed a secular increase in the short-term variations of CH$_4$ and its relationship with the emission increase from the continental China. Here, we examined the seasonality of the short-term variations of CH$_4$ in 1996 to 2017. First, we computed the increment of the hourly CH$_4$ ($\Delta$CH$_4$) over the baseline, which was the smoothed averages of CH$_4$ below the 20 percentile in a 101-hour moving time-window. Then the standard deviation of $\Delta$CH$_4$ for each month of each year was computed. The average monthly standard deviations of $\Delta$CH$_4$ show rather stable values in winter (November-February, 18~20 ppb), peaks in May (28 ppb) and September (26 ppb), and a dip in July (11 ppb). We simulated $\Delta$CH$_4$ by a Lagrangian particle dispersion model (LPDM) using the monthly CH$_4$ emission maps of Patra et al. (2009) and EDGAR v4.3.2, respectively. Although the monthly variability of the simulated $\Delta$CH$_4$ based on the Patra et al. (2009) emission maps well reconstructed the observed pattern of the monthly standard deviations, that based on the EDGAR v4.3.2 emission maps showed a maximum in March, which was not consistent with the observed pattern. The simulated maximum variability in March is related to the emission peak in March of the EDGAR v4.3.2 inventory, which is attributed to the maximum emissions from agricultural and livestock sectors. The lack of the spring peak in the observation suggests that the anthropogenic CH$_4$ emission in March of EDGAR v4.3.2 may be overestimated.

Keywords: atmospheric CH4, short-term variation, LPDM