Characteristics of methane vertical distributions over India

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Methane, the second most important greenhouse gas after carbon dioxide, accounts for 27% of India's greenhouse gas emissions [Garg et al., 2011]. Methane emissions from South Asia including India have a great contribution to global methane emissions [e.g., Patra et al., 2013]. Chandra et al. [2017] discussed the seasonal variations of methane columns over India by using methane column amounts data from the short-wave infrared (SWIR) band of Thermal and Near-infrared Sensor for Carbon Observation (TANSO)-Fourier Transform Spectrometer (FTS) on board Greenhouse gases Observing SATellite (GOSAT) and simulations by an Atmospheric General Circulation Model-based Atmospheric Chemistry-Transport Model (AGCM-ACTM). In this study, we have analyzed seasonal variations of methane vertical profiles over India by using MIROC4.0-based ACTM (MIROC4-ACTM) [Patra et al., 2018] and GOSAT/TANSO-FTS thermal infrared (TIR) band (hereafter referred as “GOSAT-TIR”).

Following the method proposed by Chandra et al. [2017], we calculated total column methane (XCH_4) and partial column methane ($XpCH_4$) from MIROC4-ACTM σ-pressure coordinates; here, $\sigma = 1.0–0.8$ is defined as Lower Troposphere (LT), $\sigma = 0.8–0.6$ as Mid-Troposphere 1 (MT1), $\sigma = 0.6–0.4$ as Mid-Troposphere 2 (MT2), $\sigma = 0.4–0.2$ as Upper Troposphere (UT), and $\sigma = 0.2–0.0$ as Upper Atmosphere (UA). In the MIROC4-ACTM simulations, two schemes of for emissions from wetlands and rice paddies are adapted [Cao et al., 1996 and Walter et al., 2001].

First, comparisons of XCH_4 and $XpCH_4$ between the Cao and WH schemes showed large differences over India in summer and autumn. Overall, seasonal variations of $XpCH_4$ derived from the Cao schemes of MIROC4-ACTM showed better agreements to the seasonal variations based on GOSAT-TIR than those based on the previous work (AGCM-ACTM) in the three regions over India: Arid India (AI), Eastern Indo-Gangetic Plain (EIGP), and Southern Peninsula (SP). In the UA layer, MIROC4-ACTM $XpCH_4$ values were closer to GOSAT-TIR $XpCH_4$ values in the all three regions. In the LT layer, MIROC4-ACTM $XpCH_4$ values were much higher than $XpCH_4$ values from the other two data in the all three regions. In the MT1 layer, MIROC4-ACTM $XpCH_4$ were closer to $XpCH_4$ in contrast to AGCM-ACTM presented in the previous work in the AI and SP regions. As for the EIGP region, variations in XCH_4 and $XpCH_4$ were relatively large due to variations in elevations, which makes it difficult to draw meaningful conclusions.

Keywords: methane, India, MIROC4-ACTM

