**Methane concentrations observed from space over monsoon Asia:**

**Signals of methane emissions from rice cultivation and biomass burning**

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We focus on the CH4 distribution over monsoon Asia, which is one of the main CH4 source regions as it contains 90% of global rice paddies and active fire areas. In the wet season, the CH4 emission from rice cultivation dominates in most of the areas, controlling the seasonality of the CH4 concentration there. We analyzed the SCanning Imaging Absorption SpectroMeter for Atmospheric CHartographY (SCIAMACHY: V5.5, provided by C. Frankenberg), as well as the Greenhouse Gases Observing Satellite (GOSAT) CH4 products from NIES (V2) and RemoTeC (V2) to reveal the features of seasonality of CH4.

The column-averaged CH4 concentration data observed by SCIAMACHY (SCIA-xCH4) are archived into the grids (1.0° x 1.0°) on monthly basis, and then compared with the bottom-up CH4 emission inventory data from rice cultivation archived by Yan et al. (2009). We also compared the SCIA-xCH4 with the land-surface water coverage (LSWC), the normalized difference vegetation index (NDVI), and the fire-detection index.

Seasonal variation of the SCIA xCH4 over the typical rice paddy fields is consistent with that of CH4 emission from rice cultivation. In the wet season, the CH4 concentration increases as the LSWC increases, followed by NDVI enhancement over most rice paddy regions. This feature is most clear in the Ganges basin.

To investigate the extent where the effect of rice cultivation is significant, time series of SCIA xCH4 for all over the regions in monsoon Asia are categorized into 11 groups by applying cluster analysis. The features of seasonal variation of SCIA xCH4 over mid-India and the foot of the Himalaya Mountains are similar to those over the Ganges basin, though these areas are not rice paddy fields, suggesting significant CH4 transport from the Ganges basin. The effect of rice cultivation seems to reach to the Takla Makan Desert.

Analysis of the GOSAT shows the similar temporal and spatial distribution of atmospheric CH4 concentrations to that obtained by SCIAMACHY in wet season, though its seasonality is somewhat different in dry season.

We also show the effect of biomass burning on CH4 variation in dry season from combined analysis of MOPITT CO.