Preliminary Assessment of Methane Concentration Variation Observed Over Sichuan Basin by GOSAT in China

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ABSTRACT

Atmospheric-column-averaged methane (XCH4) observations from GOSAT are analyzed to study the spatiotemporal variation of XCH4 in China. Furthermore, we investigate the driving mechanism of XCH4, spatiotemporal variations, especially for high XCH4 values shown over Sichuan Basin, by analyzing both the emission mechanism of rice planting process and the regional atmospheric dynamic transportation. The results indicate that spatially the Sichuan Basin presents a higher XCH4 concentration than other regions in China. Seasonally, XCH4 in the Sichuan Basin during rice harvest season is generally higher than that in early cultivation period. However, comparing to paddy area in the same latitude zone, Sichuan Basin shows a relatively higher XCH4 value during the winter of non-cultivation period when the emissions from rice paddies are weak and surface air temperature is low. We use the HYVSPLIT model to simulate the atmospheric dynamic transport process, and the result suggests that the typical closed topography of Sichuan Basin, which may lead to CH4 accumulation and keep it from diffusion, is one possible reason for the high XCH4 value in winter.

INTRODUCTION

Atmospheric methane (CH4) is one of the most important greenhouse gases, and the greenhouse effect generated by unit molecule of CH4 is about 23 times higher than that of atmospheric carbon dioxide (CO2). Therefore, it will be more effective to reduce the CH4 emissions to mitigate the potential global warming than reducing CO2 emissions [1]. In this study, XCH4 observations from GOSAT, are analyzed to study the spatiotemporal variation of XCH4 in China and its relationship with regional surface emissions. Furthermore, we investigate the driving mechanism of XCH4, spatiotemporal variations, especially for high XCH4 values shown over Sichuan Basin in southwest China.

RESULTS

The spatial distribution of GOSAT XCH4 is generally consistent with that of CH4 emission and abnormal high XCH4 values can be seen in Sichuan Basin (Figure 2,3,4).

During the rice harvesting season of August to September, XCH4 data are higher than that in early stage of rice growing in April. The abnormal high XCH4 are shown in the winter (Figure 5).

The influence of CH4 emissions from sources other than rice paddies: Bottom-up emission inventory data are not likely big causes of the observed winter high XCH4 value in Sichuan Basin (Figure 6).

The typical closed topography of Sichuan Basin, which may lead to CH4 accumulation and keep it from diffusion, is one possible reason for the extreme high XCH4 value in winter (Figure 7).

CONCLUSIONS

Our result from studying the CH4 variations in Sichuan Basin, especially the abnormal higher value during winter, and their driving factors demonstrate a certain potential of using GOSAT-XCH4 for investigating the regional CH4 changes. This study presents preliminary results of CH4 in China, and a further investigation of the CH4 in the basin is still necessary as more satellite observations of CH4 with improving accuracy are available in the coming future to further study the CH4 variations and regional emissions [8].

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REFERENCES


Figure 1. (a) Paddy fields distribution in China, the Sichuan Basin (black line polygon) and the comparative study regions (within two horizontal lines) at the same latitude zone to the east of the basin, and (b) the terrain elevation of the Sichuan Basin. Also showed in (a) and (b) are the locations of Yanting (solid triangle) and Yueyang (solid circle).

Figure 2. Amount of CH4 emissions in China region in 2010 from EDGAR 4.2 data (color bar of the emission value are shown by taking their base 10 logarithm). A

Figure 3. Spatial distribution of CH4 aggregated into 2.5×2.5° from GOSAT observations spanning from January 2010 to December 2013.

Figure 4. The seasonal variation of all the GOSAT XCH4 data over China land region (light blue dots), the Sichuan Basin (red dots) and the rice paddy fields (dark green dots) in the same latitude zone from January 2010 to December 2013. The dark blue dots are the monthly means for land region and the blue line shows the corresponding trend from linear fits.

Figure 5. Comparison of XCH4 value from GOSAT and the corresponding surface air temperature values from weather stations in (a) the Sichuan Basin and (b) the rice paddy fields in the same latitude region: the abnormal high XCH4 data are observed in the winter when the CH4 emissions from rice paddy fields are weak and the surface air temperature is low.

Figure 6. The density of the backward simulated trajectories, which are gridded into 0.5 by 0.5 degree grids, from Yanting in the Sichuan Basin for each month in 2013.