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

No.37

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ABSTRACT

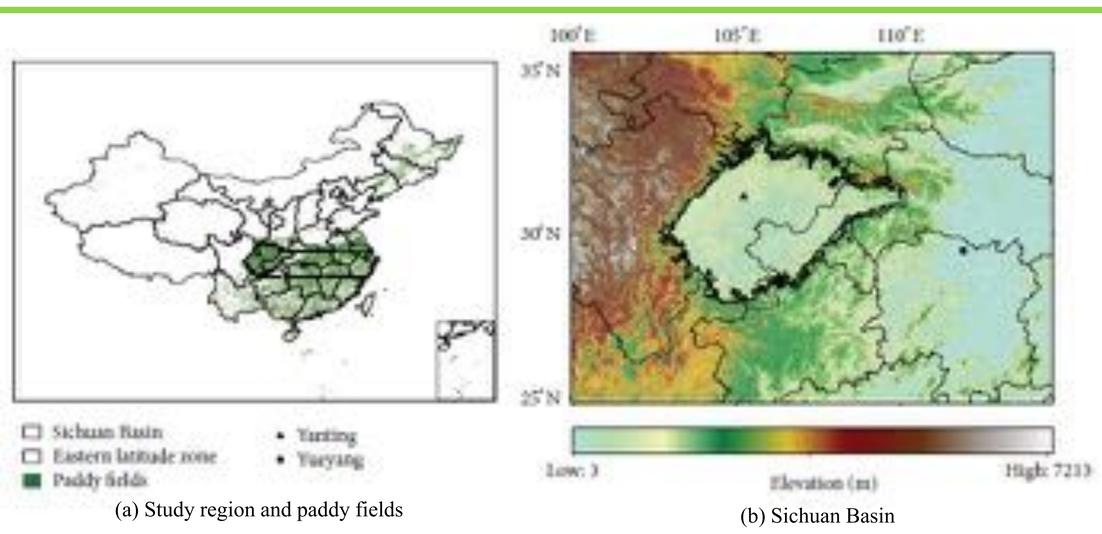
Atmospheric column-averaged methane (XCH_4) observations from GOSAT are analyzed to study the spatiotemporal variation of XCH_4 in China. Furthermore, we investigate the driving mechanism of XCH_4 spatiotemporal variations, especially for high XCH_4 values shown over Sichuan Basin, by analyzing both the emission mechanism of rice planting process and the regional atmosphere dynamic transportation. The results indicate that spatially the Sichuan Basin presents a higher XCH_4 concentration than other regions in China. Seasonally, XCH_4 in 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 XCH_4 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 HYSPLIT model to simulate the atmosphere dynamic transport process, and the result suggests that the typical closed topography of Sichuan Basin, which may lead to CH_4 accumulation and keep it from diffusion, is one possible reason for the high XCH_4 value in winter.

INTRODUCTION

Atmospheric methane (CH_4) is one of the most important greenhouse gases, and the greenhouse effect generated by unit molecule of CH_4 is about 23 times higher than that of atmospheric carbon dioxide (CO_2). Therefore, it will be more effective to reduce the CH_4 emissions to mitigate the potential global warming than reducing CO_2 emissions [1]. In this study, XCH_4 observations from GOSAT, are analyzed to study the spatiotemporal variation of XCH_4 in China and its relationship with regional surface emissions. Furthermore, we investigate the driving mechanism of XCH_4 spatiotemporal variations, especially for high XCH_4 values shown over Sichuan Basin in southwest China.

STUDY AREA AND DATA

The paddy region in Sichuan Basin with elevation less than 1000 meters is chosen to be the study area. In addition, Yanting county , where we conducted ground-based observation of XCO_2 and XCH_4 [6,7], and Yueyang city are chosen to be centers of the atmospheric molecule trajectory simulation (Figure 1).
GOSAT XCH_4 data :Version 02.XX for General User (GU) from the year 2010 to 2013 . The air temperature data :from the China Meteorological Data Sharing System
The dataset of CH_4 emissions: from the Emissions Database for Global Atmospheric Research (EDGAR) v4.2 data for the year 2010 on spatial grid of 0.1° × 0.1°(Figure 2).



(a) Study region and paddy fields (b) Sichuan Basin

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).

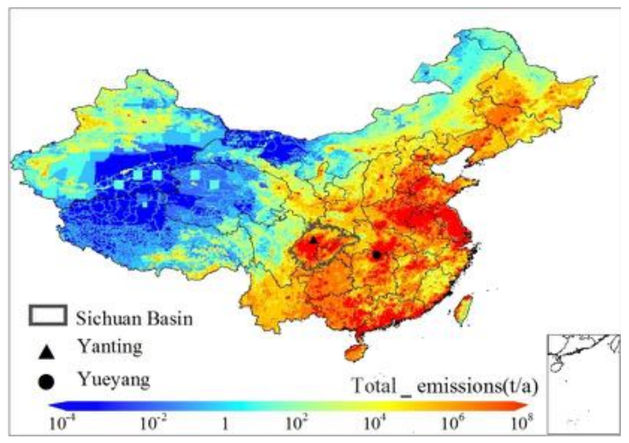


Figure 2 Amount of CH_4 emissions in China region in 2010 from EDGAR 4.2 data (color bar of the emission value are shown by taking their base 10 logarithms).

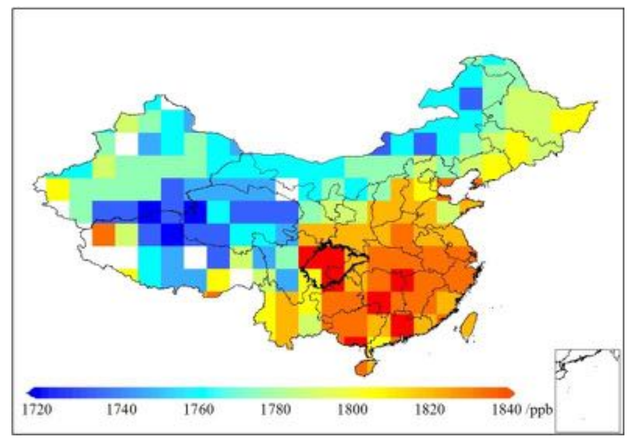


Figure 3 Spatial distribution of XCH_4 aggregated into 2.5°× 2.5° from GOSAT observations spanning from January 2010 to December 2013.

RESULTS

- The spatial distribution of GOSAT XCH_4 is generally consistent with that of CH_4 emission and abnormal high XCH_4 values can be seen in Sichuan Basin (Figure 2,3,4).
- During the rice harvesting season of August to September, XCH_4 data are higher than that in early stage of rice growing in April. The abnormal high XCH_4 are shown in the winter (Figure 5).
- The influence of CH_4 emissions from sources other than rice paddies; Bottom-up emission inventory data are not likely big causes of the observed winter high XCH_4 value in Sichuan Basin (Figure 6).
- The typical closed topography of Sichuan Basin, which may lead to CH_4 accumulation and keep it from diffusion, is one possible reason for the extreme high XCH_4 value in winter (Figure 7,8).

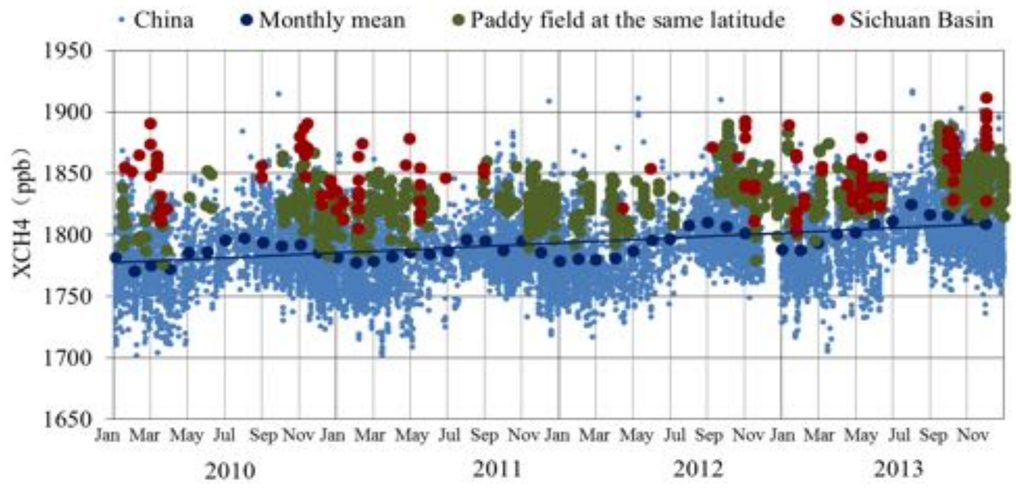


Figure 4. The seasonal variation of all the GOSAT XCH_4 data over China land region (light blue dots), the Sichuan Basin (red dots) and the rice paddy fields (dark green dots) in the same latitude zone from January 2010 to December 2013. The dark blue dots are the monthly mean for land region and the blue line shows the corresponding trend from linear fitting.

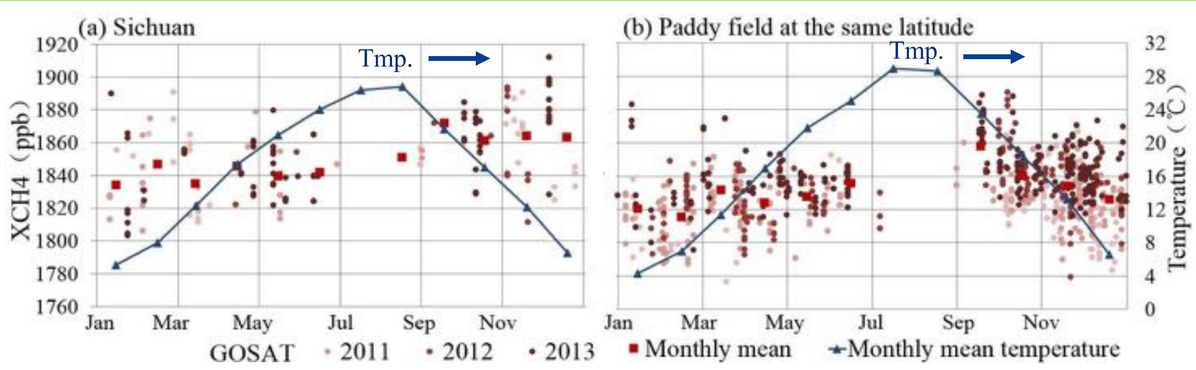


Figure 5. Comparison of XCH_4 value from GOSAT and the corresponding surface air temperature values from weather stations in (a) the Sichuan Basin and (b) the rice paddy fields in the same latitude region. the abnormal high XCH_4 data are shown in the winter when the CH_4 emissions from rice paddy fields are weak and the surface air temperature is low

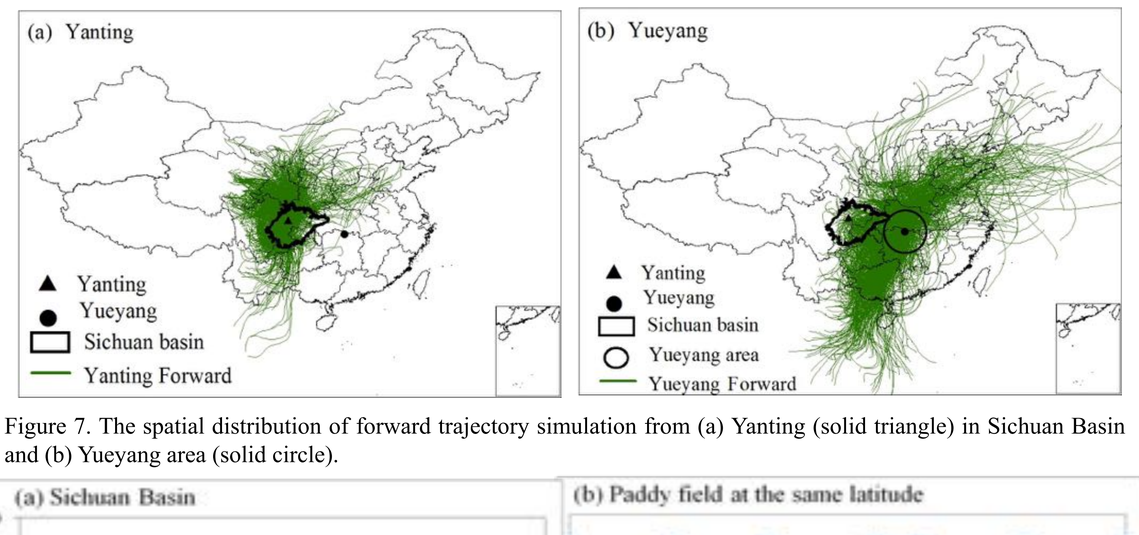


Figure 7. The spatial distribution of forward trajectory simulation from (a) Yanting (solid triangle) in Sichuan Basin and (b) Yueyang area (solid circle).

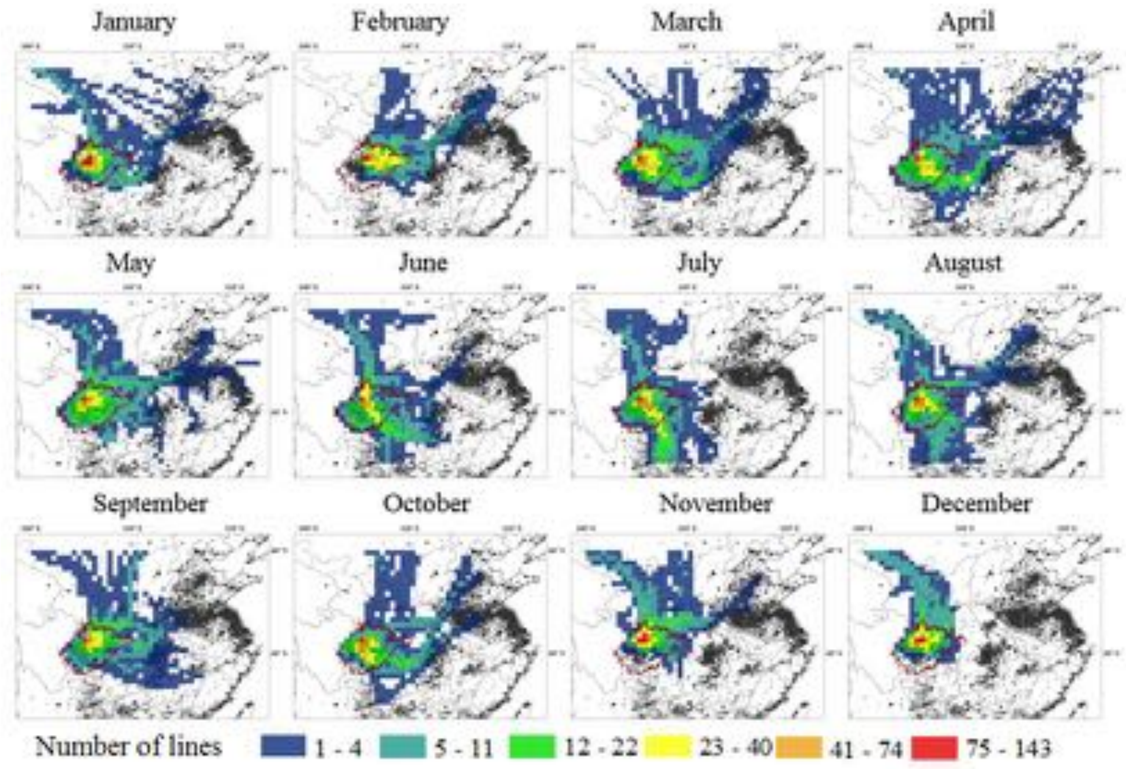


Figure 6. The density of the backward simulated trajectories, which are gridded into 0.5 by 0.5 degree grids, from Yanting in the Sichuan Basin for each month in 2013.

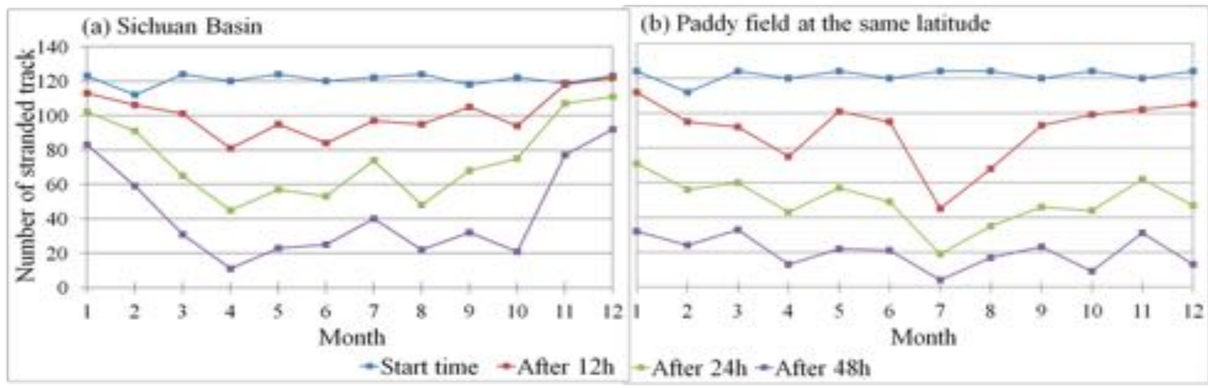


Figure 8. The number of trajectories that still stay inside the study area of (a) the Sichuan Basin and (b) the circle region centering on Yueyang with 2.5° radius after 4 different transport times (0, 12, 24, and 48 hours).

CONCLUSIONS

Our result from studying the CH_4 variations in Sichuan Basin, especially the abnormal higher value during winter, and their driving factors demonstrate a certain potential of using GOSAT-XCH_4 for investigating the regional CH_4 changes. This study presents preliminary results of CH_4 in China, and a further investigation of the CH_4 in the basin is still necessary as more satellite observations of CH_4 with improving accuracy are available in the coming future to further study the CH_4 variations and regional emissions [8].

ACKNOWLEDGEMENT

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