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COMPARISON BETWEEN GLOBAL RICE PADDY FIELD MAPPING AND METHANE FLUX DATA FROM GOSAT

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Abstract **:** Methane is one of the main souse of global warming and its emission from rice paddy field is a big issue. To fully investigate the spatial and temporal distribution of methane emission from rice paddy, rice crop calendar mapping and ground water condition data from satellite observation were integrated to IPCC 2006 guidelines. Then, global methane emission inventory from rice paddy was made. Comparison between atmospheric methane concentration from GOSAT and another methane emission inventory was done, and estimation in this study was in good agreement.

Introduction

Methane gas is one of the main sources of global warming [1], and rice cropping accounts for about 20 percent of them [2]. Country level or point based research of methane emission from rice paddy field has been done [3] [5], but spatial distribution or timing of rice cropping and methane emission from that is not fully investigated due to lack of parameters such as climate condition, water regime, and soil condition [4].

The objective of of this study is to create rice paddy field distribution and crop calendar [6] and use satellite derived water indices including V-S-W index [7] from MODIS and LSWC [8] from AMSR-E to estimate rice plant phenology and the water regime of rice paddy. Then, these data are integrated to 2006 IPCC guidelines for national greenhouse gas inventories to estimate the methane emission from rice paddy field globally. Finally, estimated methane emission from the rice paddy was compared with methane concentration in the atmosphere observed by GOSAT and SCIAMACHY and methane emission inventory, EDGAR [10].

Methodology

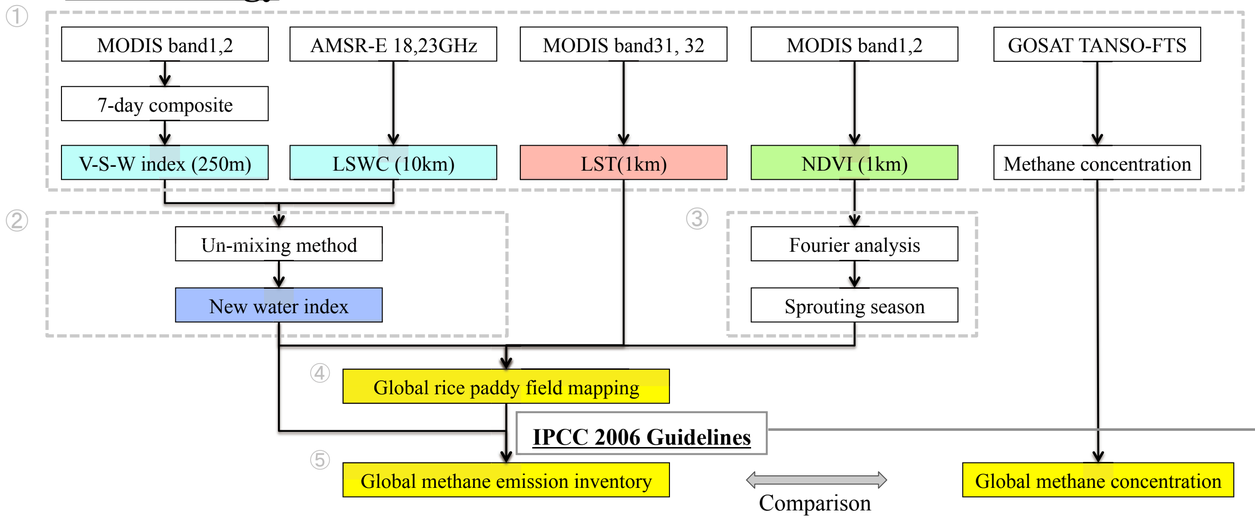

Figure 1. Flow chart of this research.

① Preparing the dataset from MODIS, AMSR-E, and GOSAT data.
② Creating the new water index with LSWC and V-S-W by unmixing method.
③ Assuming the sprouting season of rice by applying Fourier Transform to NDVI time series.
④ Detecting rice cropping phenology where NDVI comes to its peak 60 days after the new water index rise and making the global rice paddy field mapping.
⑤ Estimating methane emission from each rice crops by utilizing the map, the new water index.

$$EF_i = EF_c * SF_w * SF_p * SF_o * SF_{s,r}$$

EF_i	Adjusted daily emission factor for a particular harvested area (kg CH4 / ha * day)	
EF_c	Baseline emission factor for continuously flooded fields without organic amendments (1.3 kg CH4 / ha * day)	
SF_w	Scaling factor to account for the differences in water regime during the cultivation period	Satellite
SF_p	Scaling factor to account for the differences in water regime in the pre-season before the cultivation period	Satellite
SF_o	Scaling factor should vary for both type and amount of organic amendment applied	Statistics
$SF_{s,r}$	Scaling factor for soil type, rice cultivar, etc. (Neglected in this study)	

Figure 2. Equation to estimate the daily methane emission per hectare.

Result and Discussion

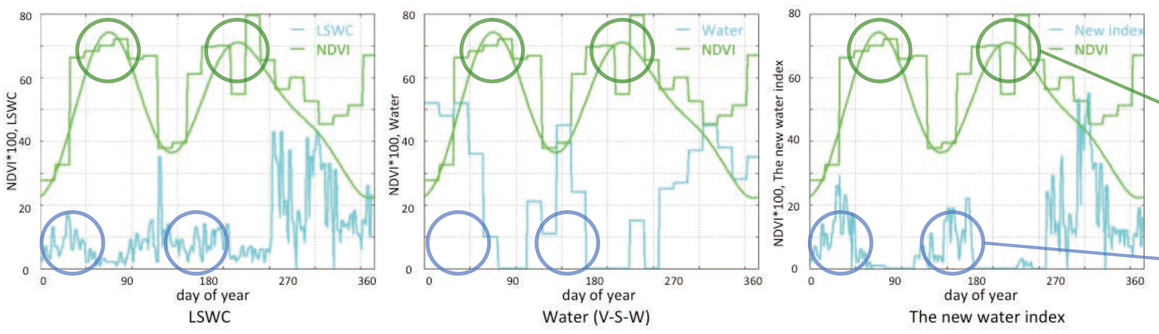

Figure 3. Time series of NDVI and the new water index. (① 15.1N, 103.2E, Thailand)

Water condition during the cultivation affects the estimated methane emission.

Extracted sprouting seasons as the peaks of NDVI by Fourier Transform.

The new water index developed in this study rises sharply 60 days before the extracted sprouting season.

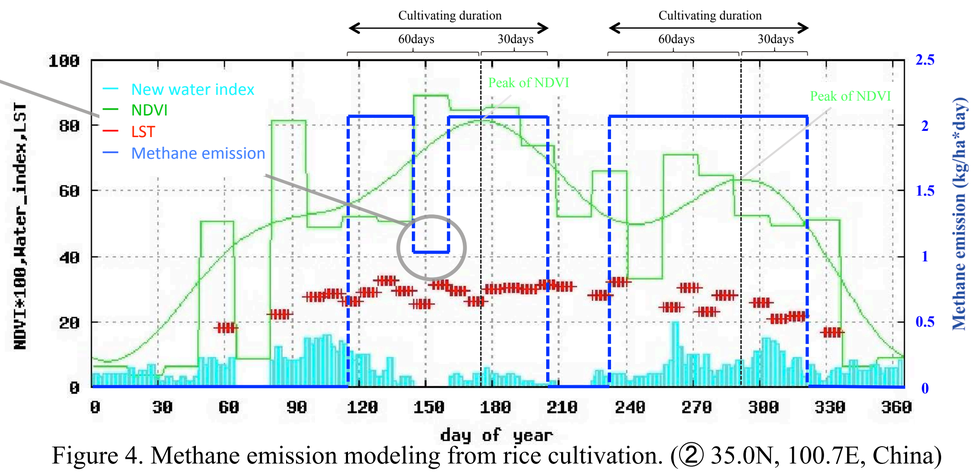

Figure 4. Methane emission modeling from rice cultivation. (② 35.0N, 100.7E, China)

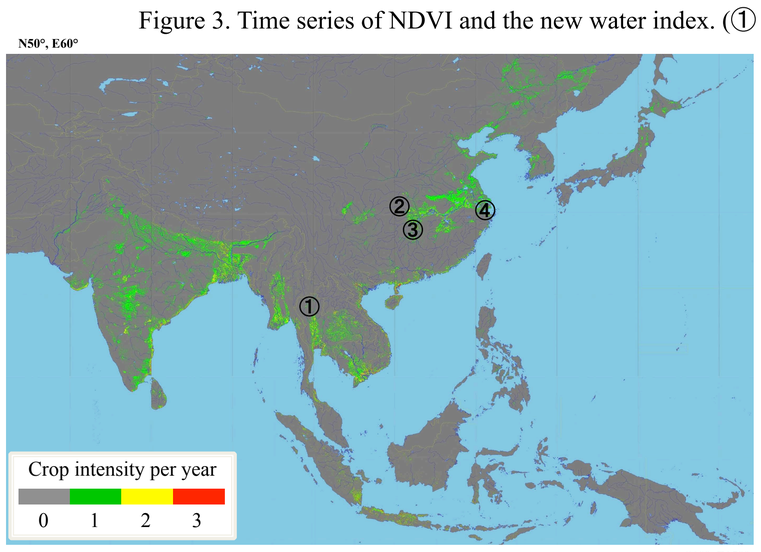

Figure 5. Rice crop intensity map in Asia (2010).

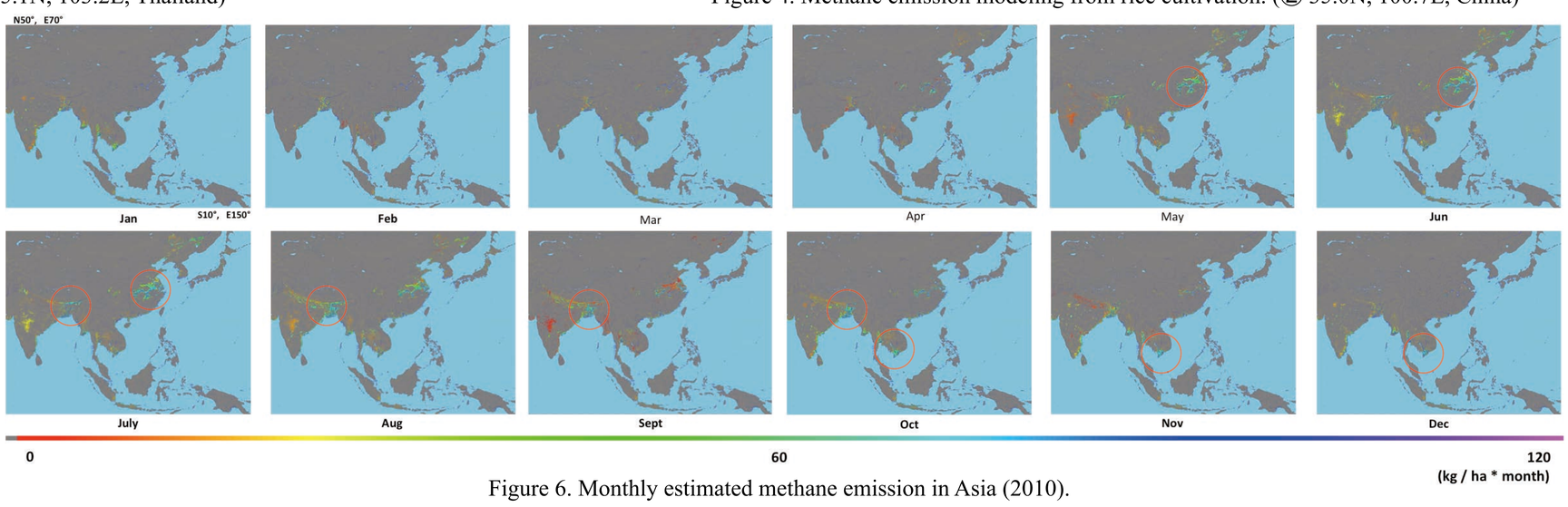

Figure 6. Monthly estimated methane emission in Asia (2010).

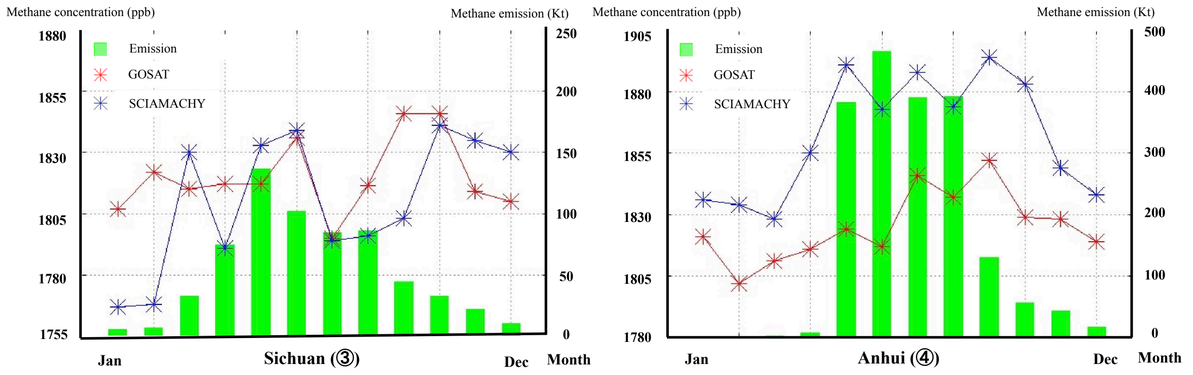

Figure 7. Comparison between estimated methane emission and methane concentration at prefecture level in China.

Table 1. Top 20 methane emitting country from rice paddy and the world total (2010).

Coutry	Emission (100Gt)	EDGAR(100Gt)	Coutry	Emission (Gg)	EDGAR(Gg)
China	9,301	14,130	United States	289.2	394.6
India	8,201	3,979	Nigeria	279.8	321.3
Indonesia	2,985	2,658	Pakistan	196.8	851.2
Thailand	2,350	2,185	South Korea	177.7	309.8
Bangladesh	2,286	2,213	Nepal	156.8	360.1
Vietnam	2,149	1,820	Iran	130.7	145.2
Myanmar	1,442	1,555	Philippines	122.5	1,075
Canbodia	486.3	489.3	Laos	88.15	115.7
Japan	363.7	764.9	Mali	83	51.82
SriLanka	296.7	264.9	Guinea	76.89	58.62
			World total	31,750	35,060

Figure 7 shows the result of comparison between atmospheric methane concentration and the estimated methane emission. In both prefecture, estimated methane emission comes to its peak from May to August, and methane concentration observed by GOSAT and SCIAMACHY comes to its peak from June to September. From the result, we can conclude that positive relationship between two of them was found, and it takes one or two months for the emitted methane to go up to the atmosphere above from the ground rice paddy.

In Table 1, the estimation in this study is similar to EDGAR in most country except China and India, and the total of methane emission is 31,750Gg 3,300Gg smaller than EDGAR.

Conclusion

A global rice paddy field distribution and crop calendar are mapped. Along with the mapping and satellite based ground water observation, methane emission from rice paddy is estimated globally. From this result, when and where methane is emitted from rice paddy can be known. Then, comparison between methane concentration from satellite observation and the result in a regional scale shows a positive relationship. Further study comparing the methane emission inventory and the methane concentration will help us understand the air transport of methane gas.

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