

## METHANE CONCENTRATION IN THE ATMOSPHERE OF TERRESTRIAL ECOSYSTEM IN THAILAND

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### Introduction

Recent explosive growth of human activities directed upon the biosphere inevitably led to the ecosystem degradation on global scales. Carbon dioxide, methane and fluorocarbon gases evolved through human activities cause changes in atmospheric composition which in turn may affect the climate and other components of the interacting Earth System.

In order to clarify the basic mechanism of environmental changes on global scale, collaborative research on an international level, through inter-institutional cooperation between Thailand and Japan was originated in 1990 to carry out a long-term observation (1990 - 1994) of 1) the ecosystem changes and 2) the distribution and circulation of some greenhouse gases evolved from biosphere to the atmosphere, with emphasis on Asia and Pacific Regions. The main theme of this research is "*Studies of Global Environmental Change with Special Reference to Asia and Pacific Regions; Integrated Development of Environmental Sciences of the World*" led by Professor Saburo Tamura, Professor Emeritus, University of Tokyo. Under this main theme, there are two main areas;

- (1) climatological mechanism of environmental changes in Asia and Pacific, and
- (2) terrestrial ecosystem mechanism of environmental changes in Asia which are organized by Professor Taro Matsuno and Professor Yasuo Takai, respectively.

In the first area, there are 3 sub-projects;

- 1.1) Atmo-ocean-atmosphere system in West Pacific observation of its dynamism (Prof. Susumu Kato).
- 1.2) Circulation mechanism of CO<sub>2</sub>, O<sub>3</sub> and other rare gases in West Pacific (Prof. Masayuki Tanaka).
- 1.3) Development of climatological models and analytical studies (Prof. Taro Matsuno).

In the second area, there are 3 sub-projects;

- 2.1) Dynamism of greenhouse effect gases in terrestrial ecosystem in Asia (Prof. Hiroki Haraguchi).
- 2.2) Destruction, degradation and changes of tropical forest ecosystems in Southeast Asia (Prof. Yasuo Takai).
- 2.3) Degradation and restoration of ecosystem due to human activities in East Asia (Prof. Satoshi Matsumoto).

Our role in this international collaborative research is one part of (2.1) dynamism of greenhouse effect gases in terrestrial ecosystem in Asia, in which 10 Japanese scientists from different fields, 3 Thai scientists and 1 American scientist are in this research group.

The greenhouse effect was recognized as the absorption and re-emission of solar energy especially infrared radiation by some trace gases in the Earth's atmosphere such as carbon dioxide, chlorofluorocarbons (CFCs) methane and nitrous oxide resulting in an increase of Earth's surface temperature.

Accurate prediction of greenhouse warming involves understanding emission sources, distribution into the atmosphere and interactions among these greenhouse gases. Emission sources of chlorofluorocarbons have been localized to be mainly in North America and Europe (~78 %) by the use of aerosols, foams, refrigeration and air conditioning, and cause ozone depletion in the stratosphere, so that the use of CFCs will be banned by the end of this century. Emission sources of carbon dioxide are accounted by rapid increase in the consumption of fossil fuel, and is now under discussion on the world political base to reduce the consumption rate in the future.

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The emphasis of this present research project in the first year is on methane with respect to the clarification of its emission sources and mechanisms of the cycle concentration distributions in the atmosphere. Since both the use of fossil fuels, and agricultural activities such as rice growing, raising of livestock, and deforestation can be the potential emission sources of methane, therefore the comparative study on methane content in the atmosphere of the agricultural fields and crowded cities will be conducted in Thailand and Japan.

In the second year kinetic behaviors or estimation of emission rates of methane will be determined in the agricultural area and large city area by continuous monitoring. The effect of methane and carbon dioxide on the terrestrial ecosystems in Asian and Oceanic Zones will be field surveyed, and modeling of these greenhouse gas cycles will be established in order to analyze the dynamic distribution of methane in Asian and Oceanic Zones. Roundtable conference for man's impact on the changes of the terrestrial ecosystems caused by these greenhouse gases will be arranged to draw conclusion and recommendations for the next century.

### Experimental Sites and Methods

In order to clarify the potential emission sources of methane 2 sampling sites (Figure 1) were selected;

Site 1 Nonthaburi, Klong Aum agricultural area

Site 2 Chulalongkorn University, 7th floor of Biochemistry Building

Both sites are in the central part of Thailand which are subjected to the southwest monsoon climate. Mean annual precipitation is about 1,550 mm for Thailand overall with distinct wet and dry seasons, and the driest month having a mean precipitation of less than 6 mm. March to May is the period of gradually increasing rainfall which usually decreases sharply on November.

Air samples are collected biweekly by evacuating the plastic bag 4 times to make sure that air sample was in equilibrium with the surrounding. Time of collection was about 7.00 - 7.30 am for site 1, and 8.30 - 9.30 am for site 2. Air temperature difference between dry/wet condition was recorded.

For each injection 1 ml of air sample was injected via an automatic sample injection loop of a gaschromatograph (Shimadzu GC-14APF equipped with the data processor Chromatopac CR4AD, operation temperature 40 °C for Porapak N column, 50 °C for injection part and 200 °C for FID detection. The flow rate of N<sub>2</sub> used as carrier gas is 1.25 kg.cm<sup>-2</sup>, H<sub>2</sub> is 0.7 kg.cm<sup>-2</sup> and air is 0.5 kg.cm<sup>-2</sup>, respectively. Standard methane (2.2 ± 0.1 ppm in N<sub>2</sub>) was purchased from TIG and yield the average retention time of 1.62 min.

### Results and Discussion

Figures 2 and 3 summarize the methane concentrations in the atmosphere during August 1991 - July 1992, which fluctuate between 1,800 - 3,500 ppbv. Site 1, Nonthaburi which is an agricultural area on canal side showed the average methane concentration of 2,402 ± 550 ppbv. Site 2, Department of Biochemistry, situated on Phya Thai road showed the average methane concentration 2,111 ± 201 ppbv. Reversed relationship between methane concentration and temperature can be observed especially in the agricultural area (Site 1. Nonthaburi); thus CH<sub>4</sub> concentration increased when temperature and moisture decreased. Methane concentration in the atmosphere of Bangkok has not shown any relationship with temperature, although the temperature and moisture profiles in Bangkok are similar to that in Nonthaburi. The average methane concentration in the atmosphere from the 2 Sites in Thailand during August 1991 - July 1992 is 2,257 ± 450 ppbv. Since the globally averaged concentration of CH<sub>4</sub> increased from 1,559 ppbv in September 1980 to 1,685 ppbv in September 1988 (Khalil and Rasmussen, 1990), the methane concentration of 2,257 ppbv measured in Thailand could be too high, therefore continuous monitoring of methane concentration in the atmosphere of Bangkok in parallel with atmospheric carbon dioxide concentration have been started in August 1992. It is hoped that the flux and emission behavior of both greenhouse gases will be more clearly understood from the continuous 24 hours records.

### Reference

Khalil, M.A.K. and Rasmussen R.A. (1990) Atmospheric methane: Recent global trends. *Environmental Science and Technology* 24:549-53.

Table 1 Concentration of Atmospheric Methane (Aug. 1991 - Jul. 1992)

Year	Month	Methane Concentration (ppbv)	
		Site 1 Nonthaburi	Site 2 Bangkok
1991	Aug.	2,141	1,878
	Sep.	2,518	1,988
		2,116	2,361
	Oct.	2,994	1,845
		2,615	2,594
	Nov.	2,737	2,160
		3,314	2,506
1992	Dec.	3,491	2,394
		3,097	2,255
	Jan.	2,965	2,161
		3,156	2,062
	Feb.	2,736	2,057
		1,822	1,967
	Mar.	2,305	2,186
		1,955	2,019
	Apr.	1,844	1,886
		1,914	1,934
	May	1,956	2,006
		1,940	1,956
	Jun.	1,886	2,243
		1,875	2,000
	Jul.	1,931	2,040
		1,950	2,053
Annually averaged		2,402 $\pm$ 550	2,111 $\pm$ 201

Methane concentrations are expressed in parts per billion by volume (ppbv), and the annually averaged methane concentration from both sites in Thailand during August 1991 - July 1992 is 2,257  $\pm$  430 ppbv.

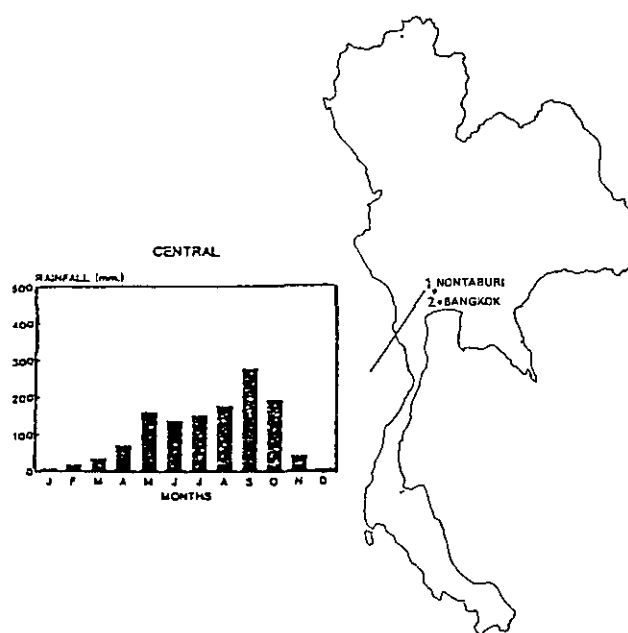
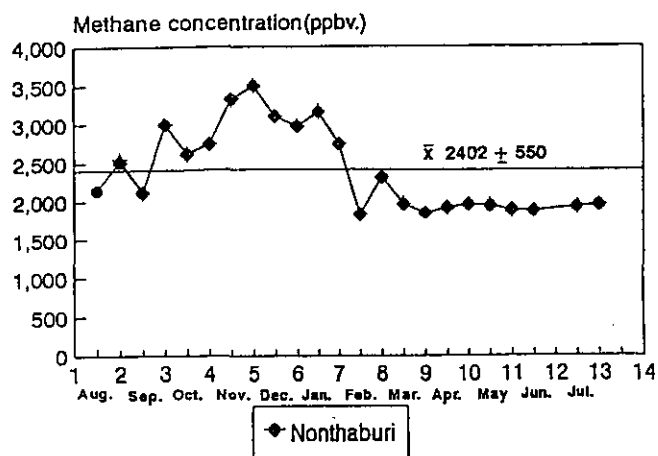
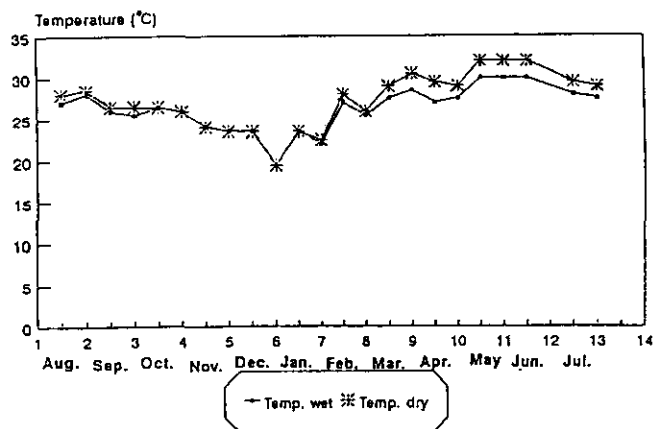


Figure 1 Mean Seasonal Pattern of Precipitation of the Central Region of Thailand and the 2 Experimental Sites

a. Site 1: Methane level during Aug. 1991 - Jul. 1992



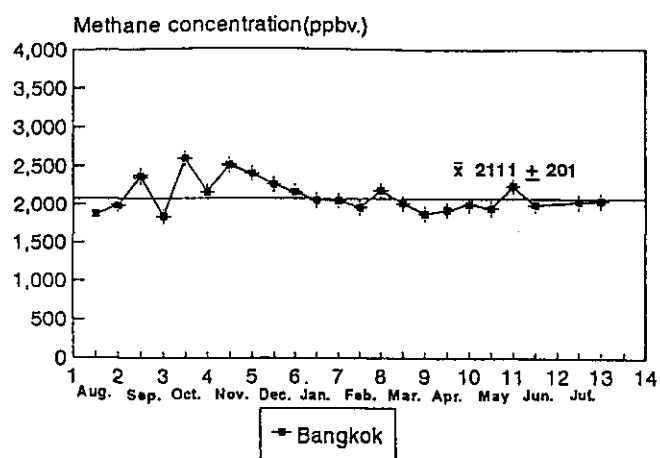
b. Site 1: Temperature during Aug. 1991 - Jul. 1992



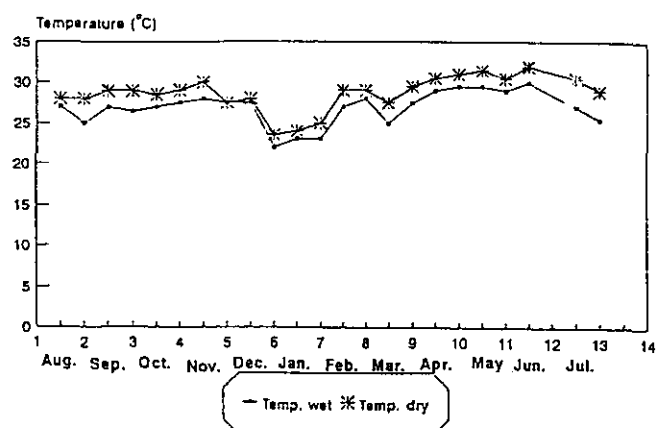
Collection time 7.00-8.00 AM (Aug.-Dec. 1991)  
Collection time 9.00-9.20 AM (Jan.-Jul. 1992)

Figure 2 Profile of Atmospheric Methane in Nonthaburi with Respect to Seasonal Change

- a. Site 2: Methane level during Aug. 1991 - Jul. 1992



- b. Site 2: Temperature during Aug. 1991 - Jul. 1992



Collection time 7.00-8.00 AM (Aug.-Dec. 1991)

Collection time 9.00-9.20 AM (Jan.-Jul. 1992)

Figure 3 Profile of Atmospheric Methane in Bangkok with Respect to Seasonal Change

## Appendix 1

### Subproject 2.1 Dynamism of Greenhouse Effect Gases in Terrestrial Ecosystem in Asia.

#### 1. Organization

##### [Group leader]

Hiroki Haraguchi  
(Analytical Chemistry)

Nagoya University, School of Engineering

##### [Members]

Japan:	Yoshihiro Makide (Atmospheric Chemistry)	University of Tokyo, Isotope Research Center
	Motoyuki Suzuki (Chemical Engineering)	University of Tokyo, Institute of Engineering and Technology
	Makoto Kimura (Soil Science)	Nagoya University, School of Agriculture
	Kenji Notsu (Geochemistry)	University of Tokyo, Faculty of Science
	Yoshiyuki Nozaki (Marine Chemistry)	University of Tokyo, Institute of Oceanography
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