In situ methane oxidation and methane emission scenarios from Chinese rice fields 'Rice field – Methane' BL/02/C28

Geographic study area: China

Other data: literature data and State Soil Survey Service of China

Context and objectives

Methane (CH_4) and nitrous oxide (N_2O) are two important atmospheric greenhouse gases. The abundance of CH_4 and N_2O in the atmosphere has been continuously increasing since industrialization, with current increasing rates of 7.0 and 0.8 ppb per year, respectively. Irrigated rice fields are considered major anthropogenic sources of atmospheric CH_4 during the flooded (reduced) period of the fields and of N_2O during the remaining non-flooded period. China has about 30 million ha of rice fields. Recently, Li et al. (2004), using a process oriented modelling approach, predicted that CH_4 and N_2O emissions from Chinese rice fields are in the order of 6.4 – 12.0 Tg C per year and 0.29 – 0.41 Tg N per year respectively. Methane emission from irrigated rice fields is controlled by production, oxidation and plant transport.

A significant amount of CH_4 produced in the soil can be oxidized before escaping from the soil. Stable isotope techniques offer a potentially powerful tool to study and quantify the importance of the magnitude of *in situ* CH_4 oxidation in irrigated rice soils (Krüger et al., 2002).

The objectives were as follows:

- Study in situ methane oxidation in irrigated rice fields using stable isotope techniques;
- Provide technical to start-up stable isotope facilities at the Institute of Applied Ecology;
- To evaluate methane emissions from rice fields on a regional scale using different management scenarios.

Methodology

The measurement and method development related to stable isotopes is not straightforward and requires state-of the art equipment and well trained technicians. The main emphasis during the prject is given to assisting the Chinese partners in the start up of their Isotope Ratio Mass spectrometer and in the set-up of state of the art field experiments.
The following methods and techniques were used: Laboratory incubations to study the kinetics of CH_4 oxidation; CH_4 measurements by gas chromatography; Stable isotope analysis from laboratory data.
Extensive experiences in the analysis of land use and management scenarios and evaluating their impact on greenhouse gas missions. The Chinese partners carry out a meta-analysis of the critical factors for greenhouse gas emissions in rice fields and relate these to management options. The distribution of the different management options within northern China and scenarios for future distribution will be investigated

Results

The results can be split up in two activities that were carried out:

1. Assessment of CH_4 mitigation techniques from Chinese rice fields via linear mixed model

For different regions of China field methane emission data and background data were compiled via a meta-analysis. Methane emissions were calculated using a linear mixing model. The effect of several management options was tested via the model: organic matter type and water level management. It was observed that removal of organic matter and optimal water management reduced methane emissions in all regions simulated. From these "extremes" realistic management strategies per region have been developed.

Most potential for methane emission reduction (48-64%) is situated in East, Southwest and South China via optimal organic matter type and application management and water level management.

2. Variation of isotope fractionation during CH_4 oxidation in paddy soils

Next to fact that Chinese researcher were trained in the use of stable isotopes for research the following scientific results were found. Methane oxidation potential of a Chinese rice soil (Shenyang) varied between 0.4 and 1.6 mg/kg/h and highest methane oxidations occurred when organic matter was added. These observation should be fed back into the observation made in (1). Isotope fractionation is a function of land management and the values ranged between 1.02 and 1.04, which agrees with literature data, but confirm that the use of one fractionation factor as was done by Krüger et al. (2002) is not correct.

Products and services

It is anticipated the two peer reviewed publication could be published from these
Anticipated titles are:
1. Assessment of CH_4 mitigation techniques from Chinese rice fields via linear mixed model
2. Variation of isotope fractionation during CH_4 oxidation in paddy soils

Execution

Period: 01/12/2004 – 21/12/2006

Laboratory:
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Discipline

Atmosphere science
Climate change study
Agriculture Environment

Way forward R&D recommendations

The next step with respect to the isotopic techniques used in this project is application of this technique in field experiments to assess in situ methane oxidation rates.
The time period and funding with this bilateral S&T project was insufficient to carry this out.
this could be done experiments could be carried out to understand, which management techniques actually reduce methane emissions

With respect to the observed management scenarios (organic matter type and timing) and water management) long-term field trials should be established to verify in the field the observed simulated mitigation effects. Once this verification is successful actual large scale implementation of the simulated and tested techniques can be carried out.