Summary of the First Workshop of Methane Working Group

(Toward an adequate quantification of CH_4 emissions from land ecosystems: Integrating field and in-situ observations, satellite data, and modeling)

March 13-14, 2006

National Center for Ecological Analysis and Synthesis

Santa Barbara, CA

During the workshop (see Appendix A for the agenda), we confirmed that our goals of this working group are: 1) to identify key issues in quantifying CH_4 emissions from land ecosystems through conducting comparisons of model and field observations for different geographical locations and ecosystems; 2) to parameterize and extrapolate process-based models at regional and global scales and explore the uncertainty of CH_4 emissions; and 3) to couple process-based estimates with inversion modeling approaches to constrain the uncertainty with air-borne, satellite, and *in-situ* observed datasets and to identify the factors, mechanisms, and controls to the uncertainty of emissions at large-scales.

We recognized that, to achieve our goals: 1) further elucidating mechanisms of CH_4 emissions from wetlands, rice paddies, and lakes is needed; 2) datasets of CH_4 production, consumption and transport from different geographic and climatic zones should be organized to parameterize our process-based models; 3) a set of key parameters (e.g., Q_{10}, CH_4 production response to soil temperatures) and a number of benchmark sites for testing process-based models need to be established (e.g., Sallies Fen site, a long-term dataset existed since 1989 including CH_4 flux and weather data, could be one of them. We need identify other sites representing different wetland types); and 4) the spatially-explicit datasets of extent of wetlands, rice paddies, and riverine systems are required. Further, we identified a number of critical issues to be dealt with in proceeding our integration efforts: 1) temporal scaling issues -- controls and factors in modulating CH_4 emissions from wetlands, rice paddies, and lakes at hourly, daily, monthly, seasonally, and annually time steps; (2) spatial scaling issues -- from the complexity of a single plot to heterogeneous landscapes with respect to large variations of CH_4 emissions; (3) the limited knowledge of mechanisms of CH_4 emissions associated with different types of wetlands (e.g., flooding in southern wetlands vs. permafrost thawing in northern peatlands). Specifically, the limited understanding of mechanisms of CH_4 production (e.g., acetate substrate availability) and CH_4 transport pathways (e.g., plant-aided transport and bubbles) present some difficulties for constructing more process-based models and further parameterizing these models.

To make progress on our first goal, our strategy is to conduct a number of synthesis studies (meta-data analyses), which are to generalize the relationships among physical and biological factors and CH_4 emissions (White, Crill, and Turetsky will lead this task). To make progress on our second goal, we strive to use the organized datasets to refine our parameterizations of existing process-based models in conducting regional analyses (Zhuang and Gedney will lead this task). Our third goal is to constrain the uncertainty of CH_4 emissions at regional and global scales. The current estimates are

between 120 and 325 Tg CH_4 yr^{-1} from the global wetland and rice paddies, the uncertainty ranges in a factor of 2. To constrain this significant uncertainty of emissions, we will first constrain the uncertainty of distributions of wetland at the globe. Our first approach is to use TOPMODEL to generate wetland distribution at monthly time step and then compare them with remote sense-based model estimates. We will then use regional datasets to validate these simulations. The possible datasets including Hudson Bay lowlands (Roulet), Yukon Delta (Able), Siberia(Smith), Alaska (Hankel and MacDonald), western Canada peatland maps, Amazonian wetland (Melack), rice paddy maps, global lake and wetland database (Walters has overlay data using ASTER data). Our second approach is to use statistical relationships between lake and wetland areas to determine global wetland extent. Besides total area of wetland, we need a better classification of wetlands and lakes so that they are well represented in our large-scale model simulations. To constrain the uncertainty of CH_4 fluxes (emissions), we will quantify the uncertainty at multiple scales. The possible approaches include (1) taking data that already exist and perform Monte Carlo analyses and data mining; (2) making use of satellite column inversion data (e.g., Bergamaschi's paper used different priors to play with wetland contributions); (3) using a top-down approach to explore uncertainty using data assimilation and inversion approaches (e.g., MATCH and CTM), perhaps embedding some of the process-based models from this working group.

Despite the gaps we identified, there are extensive datasets and state-of-the-art understanding of mechanisms of CH_4 emissions within and outside of this working group. We therefore put forward several immediate research topics: (1) to conduct a study for the Amazon basin to examine how CH_4 emissions are sensitive to different landscapes and wetland types using modeling approach; (2) to conduct multiple model comparison study with different sets of wetland masks of the globe; (3) to inventory CH_4 emissions from rice paddies, wetlands, plants for the last several decades; (4) to conduct synthesis study based on empirical approach to elucidate the mechanisms of CH_4 emissions for the temperate region and Arctic region (meta-data analysis); (5) to validate wetland distribution including lakes; (6) for completeness of CH_4 sources, to investigate possible approaches for inventorying emissions from different sources (e.g., biomass burning, geologic sources (mud volcano, hydrocarbon seeps); and (7) identify the type of experiments and data needed in the future studies.

Significant work has been done in previous studies within and outside of this working group. Therefore we proposed to organize a special issue /section for a proper journal to hold some of our findings. The target journal is *Journal of Geophysical Research- Biogeosciences* (Reeburgh volunteered to contact the Journal Editor). The tentative titles and authors of these papers are listed in Appendix B. To achieve the goals of our working group, we need gather as many data as possible and attract a critic mass of both process-based and inversion modelers in order to synthetically make use of these datasets in our synthesis efforts. Thus we will propose an oral/poster session for Fall AGU, 2006. The session will gather scientists who are conducting CH_4 studies in the field and *in-situ* measurements, satellite atmospheric CH_4 concentration observations, theoretical explorations, biogeochemistry and inversion modeling (Zhuang will lead this activity).

Actions have been taken during the workshop: (1) We established a contact with NCEAS with respect to data archival (Wickland, Dlugokencky, Crill, Turetsky, Zhuang), Wickland volunteered to be responsible for coordinating data submissions to NCEAS; (2) We decided the data format within the group -- the data collected date, location, fluxes, vegetation type, ecosystem type, relevant metadata (in addition to metadata requirements listed by NCEAS), chamber size, measurement type (campaign, weekly, etc.) should be documented; (3) We noticed there is a need to unify the units for CH_4 cycling studies, we suggested to use mg CH_4 m^{-2} day^{-1} for methane fluxes (emissions) from wetlands; (4) We gave the working group an acronym -- Synthesis of Wetland Area Methane Production Intensity (SWAMPI); (5) we scheduled that the next workshop will be held on March 15-16, 2007.

Appendix A. Agenda

Schedule for the First Workshop of Methane Working Group

(Toward an adequate quantification of CH_4 emissions from land ecosystems: Integrating field and in-situ observations, satellite data, and modeling)

March 13-14, 2006

National Center for Ecological Analysis and Synthesis, Santa Barbara, CA

March 13, 2006

9:00 a.m.	Introductory talk (Director of NCEAS)
9:15 a.m.	Meeting goals and project overview (Zhuang)
9:25 a.m.	Observation presentations Patrick Crill Katey Walter Kimerly Wickland Sergei Zimov Bill Reeburgh
10:15 a.m.	Discussion and question period
10:35 a.m.	Snack and Coffee Break
11:00 a.m.	Observation presentations conti. Merritt Turetsky Jeffrey White Michael Keller Aslam Khalil
11:40 a.m.	Discussion and question period
12:00 -	Lunch
1:30 p.m.	Regional estimates presentations Nicola Gedney Ed Dlugokencky John Melack Qianlai Zhuang
2:10 p.m.	Discussion and question period
3:00 p.m.	Snack and Coffee Break
3.30 p.m.	Discussion --Key things to accomplish on Tuesday --Breakout groups --Visions on products and deliverables

4:30 p.m. Breakout groups -- Charges of each group

5:00 p.m. adjourn
6:30 p.m. Group Dinner

March 14, 2006

8:30 a.m. NCEAS Ecological Metadata collection and archiving
(Rick Reeves, NCEAS)
8:45 a.m. Organizing breakout groups

9:20 a.m. Breakout groups discussion --- both groups will touch:
1. Current data availability for conducting site and regional estimates
2. Future data priority
3. Products and deliverables

10:30 a.m. Snack and Coffee Break

10:50 a.m. Breakout Groups

12:00 - Lunch

1:30 p.m. Breakout group A summary to the workshop
2:30 p.m. Breakout group B summary to the workshop

3:00 p.m. Snack and Coffee Break

3:30 p.m. Wrap-up
--- Combine charges of A and B, common charges
--- Observations, variability, scaling, and regional estimates
--- Tasks between now and the second workshop
--- Products and deliverables (Special issues, individual papers, data Protocol etc.)

5:00 p.m. Adjourn

Appendix B. Temporary title and authors for special issue /section in JGR-Biogeosciences

	Author/Contact	Place-holder Title
1	Patrick Crill	A Source of Methane in Amazon Upland Forests
2	Aslam Khalil	In-Field Controls on Methane Emissions from Rice in China
3	Aslam Khalil	A History of Methane Emissions from China Over the Past 30 Years.
4	Jeff White/Kim Wickland	Synthesis of Methane Emissions from Northern Wetlands
5	Jeff White	Mesocosm Experiments
6	Katey Walter	Isotopic Composition of Methane Emissions in Siberia
7	Qianlai Zhuang & Nic Gedney	Comparisons of Modeled Wetland Methane Emissions with multiple wetland databases
8	John Melack	Methane Emissions from the Balbina Reservoir
9	John Melack	Methane Emissions from the Rio Negro Basin
10	John Melack	Methane Emisions from Reservoirs in Northeast Brazil (Ivan Lima)
11	Dave McGuire/Merritt Turetsksy	Wetland Experiments
12	Rob Striegl et al.	Methane emission from the Yukon river and its tributaries
13	Kutzbach	Eddy covariance measurements of CH4 in polygonal tundra, northern Siberia
14	Forbrich	A portable methane analyzer for chamber measurements
15	Qianlai Zhuang	Modeling methane emissions from eastern Asian rice paddies
16	Jeff Chanton, Lia Chasar, James Prater	Natural radiocarbon abundance of methane as a function of wetland type

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