Methane in NACP - Recommendation for a Workshop

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BACKGROUND

Methane is a greenhouse gas second only in importance to carbon dioxide. Globally, approximately 80% of methane production is biogenic and 20% comes from fossil sources such as leakage from natural gas production and coal mining. Mitigation of methane emissions may be more practicable and economical in the short-term than minimization of carbon dioxide emissions (Hansen et al. 2000).

As an end product of anaerobic metabolism, methane is an analogue to CO2 in aerobic metabolism. Aerobic consumption of methane is common in soils and aquatic enviroments and this consumption is a critical control on overall emissions. The biochemistry of methane production and consumption at the cellular level is relatively well understood however the link between the microbial processes and ecosystem level processes such as net primary production are not well quantified and modeled.

Compared to carbon dioxide, the sources of methane to the atmosphere are much more concentrated spatially. The five major sources of methane in North America are (1) wetlands, (2) landfills, (3) enteric fermentation in animals, (4) animal waste disposal, and (5) fossil sources including leakage from natural gas distributions systems and coal production. Other sources such as (6) sewage disposal, (7) paddy rice cultivation, (8) biomass burning may be important regionally and/or seasonally. Some of these sources are already well-quantified based on detailed process studies and extensive statistics on activities of economic importance. For example, production of methane directly from enteric fermentation in animals can be broken down by animal species on an annual basis to the county level (e.g. Westberg et al. 2001). Methane emission from waste lagoons and other waste processing facilities from animal management are not nearly as well quantified as the direct emissions.

There are only two important sinks for atmospheric methane. The major sink is reaction of methane with hydroxyl radical. The lifetime of methane against this sink is approximately 8-10 years and accounts for ~90% of methane destruction. Methane is consumed by aerobic microbial activity in soils. The soil methane sink is surprisingly fragile and sensitive to management perturbations such as nitrogen fertilization (Mosier et al. 1990). Biological consumption of methane is critical to the regulation of almost all sources. Net fluxes may be only 50% to 10% of gross methane production.

The NACP requires detailed information on the sources of CH4 and estimates of these sources need to be resolved at a 500-1000 km scale spatially and sub-daily temporally to integrate with the atmospheric measurements at tall towers and aircraft profile sites. The spatial requirements will be even finer for intensive campaigns over limited areas. The requirements for integration with atmospheric measurements demands a geographically resolved accounting of sources in the categories discussed above. Process information may already be adequate to represent some of these sources such as direct emissions from animals (Westberg et al. 2001) and rice paddies (Sass et al.). In contrast, we do not have process models for reliable prediction of methane emissions from natural wetlands. Ultimately, we need adequate models to estimate methane sources and non-atmospheric sinks for 500-1000 km scale regions. Not all of the 8 major sources listed above will occur in all regions.

Development of improved process models for a number of sources such as wetlands is required. Model development requires a number of well characterized sites with frequent flux meausurements. For example, in natural wetlands appropriate measurement technologies such as automated chambers and eddy correlation could be applied to sites where ecosystem processes are also being well-characterized. Models should include both gross production and the important consumption processes. Small modifications in ecosystems such as changes in water level can lead to large modifications in the consumption processes leading to enormous changes in net fluxes. The new models should take some hydrological features, especially water table dynamics, into account. Appropriate data on water table dynamics will be required.

Methane measurements should be included at all tall tower sites and aircraft profile sites. Most eddy covariance flux sites are located in dry land areas. For those eddy covariance sites already located in wetlands, high frequency measurements of methane ought to be included assuming that the measurement technology is available. Very few wetland sites are included in Ameriflux and several ought to be added for the NACP. Eddy covariance will not be an appropriate technology for measurement of all systems. For important sources such as fossil methane and landfills, additional process quantification is still necessary and a variety of measurement approaches should be attempted.

A continental bottom-up methane inventory will be constructed for comparison to the analysis from atmospheric methods. The process models for methane can be put into a data assimilation framework for integration with the atmospheric measurements.

RECOMMENDATION

Only limited expertise on methane was represented at the September NACP meeting at NCAR. Therefore, we recommend inviting a group of experts to discuss the following three questions:

1. What are the criteria for prioritizing and selecting process studies of methane sources and sinks?

2. What needs to be measured and modeled? What are the needs for long and short-term measurements and what are the needs for manipulative experiments?

3. How will the information collected be incorporated into the integrative analyses of NACP?

Participants: Approximately 20 experts from the US, Canada, and Mexico will be invited along with about 6 local participants (Bartlett, Crill, Frolking, Hurtt, Keller, Li). The experts will be familiar with measurements and modeling of the range of methane sources and the soil sink. They will also include experts on atmospheric measurements and models and the instrumentation for measurement of methane at a variety of scales. Economists and geographers familiar with energy and waste disposal issue will be recruited. Additionally, a number of NACP leaders and program managers will be invited to provide the over-arching NACP perpsective.

Venue: The workshop will be held at the University of New Hampshire, Complex Systems Research Center

Dates: The workshop should be held by March 2002. A specific date will be selected after discussions with key participants.

Product: Report of recommendations for inclusion of CH4 in NACP with answers to the 3 questions above.

Preliminary Budget Items:

Airfare, lodging, and per diem for 20 participants
Site costs
Salary (1 month for Karen Bartlett - to organize and report)
UNH Overhead

The organizers will review these costs with Karen Bushold and present a budget upon request of the program managers.

List of Potential Participants:

UNH Participants

Name	Expertise
Patrick Crill	Wetland and anthropogenic sources, soil sinks (Organizer)
Changsheng Li	Rice sources, process models (Organizer)
Michael Keller	Wetland sources, soil sinks (Organizer)
Steve Frolking	Wetland sources, wetland hydrology modeling, process models
George Hurtt	Ecosystem models
Karen Bartlett	Wetland and anthropogenic sources, soil sinks (Organizer/Rapporteur)

NACP Participants:

Name	Expertise
Steve Wofsy	NACP Planning Leader
Robert Harriss	NACP Planning Leader, Methane Guru
Diane Wickland	NACP Program Manager
Lisa Dilling	NACP Program Manager

Outside Methane Experts (a potential list):

Name	Expertise
Bill Reeburgh	Wetland sources, methane consumption
Hal Westburg	Animal sources
Steve Whalen	Animal waste, wetland sources, methane consumption
Stan Tyler	Isotopic methods, rice sources
Ron Sass	Rice sources, process models
Ed Dlugokencky	Atmospheric measurements
Jean Bogner	Landfill sources
Nigel Roulet	Wetland sources, wetland hydrology
Lars Hedin/Student	Isotopic dilution approach
Navin Ramankutty	Agricultural geography
Shashi Verma	Eddy Covariance measurements of CH4
Wei Min Hao	Fire emissions
TBD	Remote sensing of wetlands
TBD	Fossil Sources
TBD	Economist/Geographer - Fossil, Landfill
TBD	Economist/Geographer - Agricultural activities
TBD	Process models
TBD	Anthropogenic sources, Mitigation

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