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Quarterly Progress Report (July - September 2011)

Source characterization and temporal variation of methane seepage from thermokarst lakes on the Alaska North Slope in response to Arctic climate change

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QUARTERLY PROGRESS REPORT
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Summary

The goals of this research are to characterize the source, magnitude and temporal variability of methane seepage from two representative thermokarst lake areas within the Alaska North Slope gas hydrate province, assess the vulnerability of these areas to ongoing and future arctic climate change and determine if gas hydrate dissociation resulting from permafrost melting is contributing to the current lake emissions. Work during this quarter has continued to focus on preparing presentations of the results related to all of the projects Tasks. The next quarter will also be dedicated to publishing the primary data from this project. Once the bulk of this primary data is published (efforts and scope described below) the group will focus on synthesizing the results from the separate tasks. This synthesis effort will subsequently address the final milestone related to the project to "Integrate laboratory results and complete a comprehensive analysis of methane seepage in thermokarst lake settings". Analyses have focused on four main lake locations referred to in this report: Lake Qalluuraq (referred to as Lake Q) and Lake Teshekpuk (both on Alaska's North Slope) and Lake Killarney and Goldstream Bill Lake (both in Alaska's interior). Additional sites (Burial Lake and Quartz Lake) have been added by Wooller to supplement Task 8.

Tasks 1 - 4 and 6: These tasks relate to field activities and have been completed and reported on in previous quarterly reports.

Task 5.0 – Quantifying the short-term variability in methane emissions. Katey Walter Anthony: During the past quarter, the Walter Anthony group completed the development of a new method of dissolved methane concentrations in aquatic ecosystems using tunable diode laser spectroscopy. We submitted a manuscript on this work (Sepulveda-Jauregui et al. in review). This work is in review for publication at Limnology and Oceanography: Methods. We also finalized summer monitoring of dissolved gas concentrations (using new and traditional methods) and diffusive flux of methane from the Fairbanks thermokarst lake during the open water season, providing a full year of data on dissolved gas dynamics in the lake to complement the ebullition data series. We began work with an ice growth model to couple the dissolved gas and ebullition data with the goal of providing a full annual methane emission model for the lake. We also carried out measurements of gases and other physical and limnological parameters on 35 lakes along a N-S transect in Alaska in order to place our intensive measurements in the Fairbanks thermokarst lake into a larger Alaska context. We are now in the process of analyzing data for presentation at the AGU meeting in December and subsequent preparation of a manuscript for peer review publication.

Sepulveda-Jauregui, A., Martinez-Cruz, A. Strohm, A. Walter Anthony, K.M., Thalasso, F. In review. New method for on-site measurement of dissolved gas in water using Infrared tuneable diode laser absorption spectroscopy. Limnology and Oceanography Methods.

Task 7.0 - Methane oxidation in Alaskan thermokarst lakes. Mary Beth Leigh (UAF) and Ruo He (UAF): Studies aimed at identifying aerobic methanotrophs, their functional genes and oxidiation potential in sediments and water samples from several locations have been completed using stable isotope probing (DNA and PLFA-based) and other genomic approaches. To date, two manuscripts have been submitted. One has been tentatively accepted to *Environmental*

Microbiology, pending revisions. The second manuscript has been invited for resubmission by The ISME Journal, which is planned for the next few weeks. Three additional manuscripts are in advanced stages of preparation, and submission is planned within the next month. An additional study investigating methane oxidation during anaerobic conditions has nearly been completed and a fifth manuscript is in preparation on this subject. Integrative data analyses are also underway since the recent arrival of additional geochemical data (e.g. methane and nutrient data along core profiles) for inclusion in these microbial manuscripts.

Manuscript conditionally accepted (pending revisions):

He, R. M. J. Wooller, J. W. Pohlman, J. Quensen, J. M. Tiedje, M. B. Leigh. Diversity of active aerobic methanotrophs along depth profiles of arctic and subarctic lake water column and sediments. Environmental Microbiology.

Manuscript submitted, rejected and invited for resubmission

He, R. M. J. Wooller, J. W. Pohlman, C. Catranis, J. Quensen, J. M. Tiedje, M. B. Leigh. Identification of functionally active aerobic methanotrophs in sediments from an arctic lake using stable isotope probing. The ISME Journal.

In response to a reviewer's requests to provide environmental data from the cores used for microbiological mesocosms, Pohlman has analyzed methane concentration profiles from 5 sites cored in July 2009. These data are being included in the revised versions of the manuscripts led by Ruo He.

Task 8.0 - Establishing a long-term record of the variability in methane emissions in relation arctic climate change. Matthew Wooller (UAF) and Pohlman (USGS): The analyses of Lake Q are complete and a manuscript describing the results has been prepared and was submitted on Aug 31st 2011 to a special issue of the Journal of Paleolmnology (JoPL). The manuscript is currently in review. This paper includes biomarker data generated by German collaborators with Pohlman and our project. This JoPL special issue is dedicated to climate change records from arctic lakes. Decisions from the journal were expected within the previous quarter and are still pending. The technologies developed and applied to analyze the Lake Q west core have also been applied to two other long cores accessed by Wooller et al. (one from the Brooks range [Burial Lake] and covering the period ~25,000 years to present) and one from the discontinuous permafrost region in the interior of Alaska (Quartz Lake, ~12,000 year to present). A manuscript documenting results from Quartz Lake is complete and is has been submitted to the special issue of JoPL mentioned above. A full manuscript is complete from Burial Lake and is still being circulated amongst the co-authors for comments. Completion of the Burial Lake paper was expected within the last quarter but will be undergoing further modifications to accommodate comments from the co-authors.

Matthew J. Wooller, et al. (in review) A ~12,000 year record of the variability in methane emissions from an arctic wetland related to climate change. Journal of Paleolimnology.

Matthew J. Wooller et al. (in review) 11,000 years of climate and limnological change from Quartz Lake, Alaska. Journal of Paleolimnology.

Matthew J. Wooller et al. (in preparation) A record of Late Quaternary climate change in the northwestern Brooks Range, Alaska derived from stable isotopic analyses of chironomids. Quaternary Research.

Presentations:

Matthew J. Wooller et al. (Oct 2011) 11,000 years of climate and limnological change from Quartz Lake, Alaska. Oral presentation to the American Water Resources Association, Fairbanks Alaska.

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