Geophysical Research Abstracts,
Vol. 11, EGU2009-3869, 2009
EGU General Assembly 2009

High-Temporal-Resolution Measurement of Methane Ebullition From a Stratified, Eutrophic Lake

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Significant amounts of methane can be released to the atmosphere from freshwater lakes, particularly through bubbling. However, spatial and temporal heterogeneity in ebullition has complicated efforts to accurately measure such methane emissions. In 2007, bubbling from the Upper Mystic Lake in Massachusetts, US was strongly episodic, with peak fluxes at the water surface approaching 200 ml/m^2/d in late summer and fall, while average bubble fluxes were approximately 30-45 ml/m^2/d. However the temporal resolution of these measurements was only of the order of a week. In 2008, under-water bubble traps were equipped with pressure sensors that measured the gas collected every 5 minutes. Episodes of bubbling were almost synchronous throughout the lake and tended to last for several days, though the amount and composition of gas released from the sediment varied considerably between sites. The onset of bubbling episodes is correlated with drops in hydrostatic pressure that occurred during periods of low lake water levels. Ebullition fluxes in 2008 were a factor of 2 less than 2007 fluxes, although the spatial pattern of bubbling was similar in both years, with deeper locations generally bubbling more than shallow sites. However, in some cases fluxes varied by as much as a factor of 20 between stations that were only 15-30 m apart, which indicates that sediment methane sources could be highly localized. The mixing ratio of methane present in the collected gas ranged from 30% to 90%, and was generally higher at locations that bubbled more. The partial pressure of total methane present in the lake sediments was found to be 2 ± 0.25 atm in a meter-long freeze core taken at a location 20m deep, which is consistent with the methane composition of gas bubbled at the site.