University at Buffalo
Department of Civil, Structural and Environmental Engineering
School of Engineering and Applied Sciences

Environmental and Water Resources Engineering

Global oceanic methane emissions estimated from neural network mapping

Abstract: Oceanic emissions represent a highly uncertain term in the atmospheric methane budget and are thought to be highly sensitive to environmental change. The primary limitation in constraining this term is the very sparse sampling of dissolved methane distributions in the surface ocean mixed layer, which is needed to compute the air-sea flux. Here, we aim to overcome this limitation using statistical mapping methods. We compiled archives of shipboard observations and atmospheric records (from 1980-present) to generate a large dataset of methane supersaturation in surface waters, which although sparse is well distributed between basins and shelf and open-ocean environments. Artificial Neural networks were then trained to map the climatological methane distribution as a function of net primary production (NPP), seafloor depth, and phosphate concentration, which serve as predictors for different methane production mechanisms. Our approach yields a global methane flux of 2.3 +/- 1.1 Tg/yr from the ocean to the atmosphere, which is lower than the range adopted by recent IPCC reports (5-25 Tg/yr), but towards the upper end of estimates extrapolated from individual cruise data (0.3-3 Tg/yr). Our work also provides important insights into methane production mechanisms in the open ocean. Away from coastlines, our statistical model finds a significant negative relationship between methane supersaturation and phosphate availability, supporting the hypothesized production of methane from methyl phosphonate in P-limited environments. Our method is currently being adapted to constrain methane outgassing from the Great Lakes and other large freshwater bodies, which likely represent a larger term in the atmospheric budget.

Thomas Weber, PhD
Assistant Professor
Department of Earth and Environmental Sciences
University of Rochester

Weber's research focuses on the "biological pump," a suite of microbial processes that transfers carbon from surface waters to the deep ocean, out of contact with the atmosphere. It drives and responds to global climate change on decadal to millennial timescales. His research uses numerical models to understand various processes that control the strength of the biological pump and their sensitivity to environmental change.

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