A Comprehensive Framework for Modeling Emissions from Tropical Soils and Wetlands

Dr. Melanie A. Mayes, Senior Staff Scientist
Multi-scale Processes Team Leader
Earth Sciences Group
Environmental Sciences Division
Climate Change Science Institute
Oak Ridge National Laboratory
Oak Ridge, TN 37831

Tropical wetlands and wetlands soils account for over 2/3 of the global wetland methane (CH_4) emissions. Tropical wetlands are also important contributors to other greenhouse gases such as carbon dioxide (CO_2) and nitrous oxide (N_2O). Emissions from soils and wetlands, however, are neglected in the existing Climate and Environmental Sciences Division (CESD) programs. Gas emissions in soils and wetlands are complicated and are affected by fluctuations in water levels and oxygen (O_2) availability. Most models lack the ability to transition between these conditions and therefore the ability to predict gas emissions. Further, emissions are strongly affected by soil microbes and available sources of energy such as nutrients and minerals. The objective of this project is to develop a modeling framework that represents microbial functions, energy sources, and soil moisture. Fieldwork will be conducted along transects from valleys to ridgetops in a wet tropical forest in Puerto Rico and at a peat bog in Panama. Long-term, continuous measurements of CO_2, CH_4, and N_2O from soils will be made at each site. Lab experiments will measure emissions of CO_2, CH_4, and O_2 from soils under specific water content, nutrient additions, and O_2 concentrations. Microbial functions (or traits) will be identified using advanced genomic techniques as well as by measuring enzyme activity and metaproteomics. The influence of soil minerals and nutrient status will also be measured. Variation in gas emissions will be related to microbial traits; water and O_2 content; and soil characteristics at each field location using modeling. This model will be rich in details, and it will be appropriate for spatial scales ranging from millimeters to decimeters. A simplified modeling approach will also be developed for applications from meters to kilometers. Finally, information about the exact locations and extent of tropical wetlands is lacking, so data from the new Soil Moisture Active Passive satellite will be used to make a new global inventory of tropical wetlands. This project relates microbial traits, soil characteristics, soil water content, and soil O_2 concentrations and uses the information to build models to improve predictions of soil gas emissions in wet tropical soils and wetlands.