The effect of marine biological activity on aerosol generation and cold cloud formation

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Sea salt particles are a major contributor to atmospheric aerosol. Recent observations have indicated that these and other marine derived particles can be enriched in organic material (OM), particularly during periods of high primary production. This OM can impact atmospheric particulate matter loading and the ability of particles to act as cloud condensation and ice nuclei, with subsequent consequences for the global radiative budget.

Here we report the effects of marine biological activity on aerosol generation and cloud formation potential. Aerosols were produced by plunging jets and glass frits from 1000L mesocosms containing three phytoplankton species cultured in artificial seawater, exudates derived from phytoplankton, a bacterial culture, and a natural seawater microbial community. The 14-day experiments simulated bloom development as evidenced by changes in cell numbers. At each sampling time, aerosolized particles were size discriminated under dry and 80% humidified conditions, collected, and characterized. Bubble-size spectra were determined. To interpret relationships between biological activity and aerosol size distributions, we characterized concentrations of dissolved and particulate organic matter, transparent exopolymer particles, and microgels; numbers of phytoplankton and virus-like particles; and the proportion of live:dead bacteria. Aerosols were collected on substrates for single particle chemical analyses using electron and X-ray micro-spectroscopy. Water uptake and ice nucleation capabilities for temperatures as low as 200 K were determined.

As phytoplankton growth reached stationary phase, the number of particles smaller than 100 nm increased threefold. Ice active particles in a population characterized by a sea salt core with OM coating are 1.0-5.0 μm in diameter. Water uptake is observed until 220 K and 60% RH. Immersion freezing occurs between 80% and 100% RH. Deposition ice nucleation occurs below 215 K and around 70% RH. Our experiments show that biological activity can affect marine derived aerosol, with implications for cloud formation and the radiative budget.

Impact of long term wetting on hydrology and biogeochemistry of a peat bog in Ontario, Canada

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Peatlands of the northern hemisphere store vast amounts of carbon but also contribute to global methane emissions. As large areas in the boreal and temperate zones are predicted to undergo significant changes in climate and concomitant changes in hydrology, it is crucial to understand the response of peatlands to altered climatic and hydrological boundary conditions. In this study we investigated the response of peatlands to long term wetting, as especially in winter for large areas wetter conditions have been predicted. We hypothesized that long term wetting will result in changes in vegetation, concomittant changes in peat decomposability and also nutrient input from the adjacent water body.

To this end, we chose the Luther Marsh site in Ontario, Canada, that has been partly flooded since the 1950s due to the construction of a reservoir. Water management in the reservoir flooded a large part of the peatland, but also causes seasonal flooding and draining, shifting hydrological flow patterns and vegetation gradients. Hydrology was monitored by means of piezometers and pressure transducers over one growing season over a transect of 7 sites from the reservoir to the inner, pristine part of the bog. At the same sites, we obtained pore water chemistry data and dissolved gases.

Partial flooding resulted in obvious changes in vegetation, increased nutrient availability, and thus increased decomposition activiy in the wet part. This was reflected more narrow CH_4 to CO_2 ratios in the pore water and higher concentrations and calculated turnover rates. Advective transport removed decomposition end products and introduced nutrient enriched reservoir water, as indicated by elevated pH amd increased concentrations in Ca and Mg. DOC quality as assessed by fluorescence spectroscopy also gradually approached quality indices observed in the reservoir.

This study demonstrated that partial flooding of a peatland significantly changes vegetation and the nutritional status, resulting in a shift towards more CH4 production and higher turnover rates.

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