# Aerosol impacts on climate and biogeochemical cycles

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Aerosols play an important role in our understanding of the Earth's climate through direct interactions with atmospheric radiation and indirect interactions by modifying cloud properties. These impacts take place on timescales in the troposphere of days to weeks. Longer timescale impacts of aerosols on climate through biogeochemical feedbacks are less well understood. Aerosols transport mass which may include nutrients or toxins across long distances and have been shown to effect the production of ecosystems that are distant to the aerosol source. The purveyors of these important nutrients are often naturally emitted aerosols such as mineral dust, volcanic ash, or biomass burning aerosols. Natural aerosols have generally received less study than anthropogenic aerosols, but here we use model simulations of preindustrial and present day aerosols to isolate the relative importance of different aerosol types for various climate impacts. Radiative forcings for the different aerosol types are estimated from the literature. We also give estimates for the contributions of various aerosol sources and types to nutrient transport in the atmosphere.

The impacts of aerosols on ecosystem production feedback onto the climate by changing the amount of carbon emitted or sequestered by the affected ecosystem. In addition, aerosols modify the carbon uptake capacity of the land surface and the ocean by altering climate through these biogeochemical effects and the more commonly referenced direct and indirect cloud effects.

Here we present the first quantitative assessment of the total indirect effects of aerosols onto climate through their effects on biogeochemical cycles. The aerosol indirect biogeochemistry effect is found to be similar in magnitude to the aerosol direct effect, with higher uncertainties, and yet the impacts on climate could be even greater because the biogeochemical impacts take place over longer time scales. The cooling influence of the indirect biogeochemical effects suggests that abatement costs for projected $CO_2$ concentrations could be underestimated. Due to the potential importance for our understanding of the land-atmosphere-ocean coupled climate and for policy, aerosol indirect effects on biogeochemistry warrant greater consideration in studies of aerosol and climate interactions.

# Characterization of Corn Rhizosphere (*Zea mays*) Grown in Metal-contaminated Soil

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As industrialization encroaches on agricultural settings, it has become increasingly more important to investigate the microbe-mineral interactions within the rhizosphere. Currently, there is an incomplete understanding of metal contaminants and distribution (i.e., the bioavailability of different forms of metals) in soils that result in the uptake and accumulation in plants [1]. A more focused study on metal concentrations in edible plants is important to avoid possible risks to human health [2]. In this study, the examination of the rhizosphere was made possible by developing a new embedding procedure resulting in successful preservation of the inorganic and organic materials, i.e., structure and chemistry, within the rhizosphere (Figure 1).

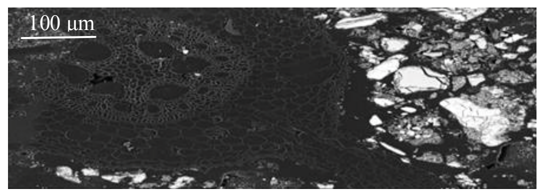


**Figure 1:** A BSE-SEM micrograph of a soil core containing roots and soil, i.e., rhizosphere.

ICP-AES analysis demonstrated that concentrations of bioavailable metals (Cd, Cu, Pb and Zn) were higher within the rhizosphere than the bulk soil. While the bacterial communities within the bulk soil and rhizosphere were capable of using similar types of carbon for growth, i.e., biodiversity was not affected by the growth of corn, the activity of the bacterial community inhabiting the rhizosphere (measured by using the Biolog Ecoplate™ system) was greater than the soil control. This increase in activity, which was reflected by a decrease in pH in the rhizosphere, can presumably be expected to influence heavy metals uptake by plants. The use of scanning electron microscopy combined with energy dispersive spectroscopy (SEM-EDS) and wavelength dispersive x-ray spectroscopy (SEM-WDS) revealed the presence of particles containing lead (Pb). Under these conditions, the use of micro-synchrotron x-ray fluorescence (micro- XRF), x-ray absorption fine structure (XAFS) and x-ray absorption near edge structure (XANES) are required to probe the spatial and chemical relationships of plant roots and the soils in which they grow.

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