

Impacts of Land-Surface Processes on Regional Weather, Climate, and Hydrology

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Integrated Land Ecosystem–Atmosphere Processes are the complex interactions (including biophysical, hydrological, and biogeochemical interactions) between the land-surface and the atmosphere. Hereby, aerosols play an important role as connectors. Aerosols are an integral part of the atmospheric hydrological cycle and the atmosphere's radiation budget, with many possible feedback mechanisms that are not yet fully understood: (1) the impact of meteorological (climatic) factors like wind, temperature and precipitation on the natural aerosol burden and (2) possible effects of aerosols on climate parameters and biogeochemistry. The most easily understood interaction between aerosols and climate is the direct effect (scattering and absorption of shortwave and thermal radiation). Interactions with the hydrological cycle, and additional impacts on the radiation budget, occur through the role of aerosols in cloud microphysical processes, as aerosol particles can exhibit the property to act as cloud condensation nuclei (CCN) and ice nuclei (IN).

The formation of ice in clouds is required for snow and most rainfall. Dust and soot particles can serve as ice nuclei, but biological ice nuclei are capable of catalyze freezing at much warmer temperatures. Here, we present ice nucleation experiments from the laboratory testing different minerals, fibers, pollen, berries, fungi, and bacteria. Our results show that the ice nucleation activity is not depending on one distinct morphological or chemical feature but can be related to very different substances and is strongly depending on the surface properties of the aerosol particle. In general, the surface functional groups located at the interface must have the ability to attract water molecules and to order them in an ice like structure. This can be achieved in rather different ways on very different interfaces. Thus, the number of possible ice nuclei is very large and still not all possible particles have been tested.