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Modelling global emissions of bacteria and fungal spores acting as ice nuclei

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Primary biological aerosols, like bacteria and fungal spores, have been shown in laboratory studies to be efficient ice nuclei (IN) and an important component of the biological aerosol population in the atmosphere (Diehl et al., 2006; Kieft, 1988; Jaenicke et al., 2007). It is necessary to know their global emissions in order to investigate their potential impact on clouds and precipitation.

Bacteria in general and those with ice nucleating abilities in particular are commonly found on plant leaves (Lindemann et al., 1982), which aids in determining global bacteria concentrations depending on different plant functional types. Plant functional types and their seasonally changing leaf area index from the JSBACH dynamic vegetation model (Raddatz et al., 2007) were combined with observed near surface bacteria concentrations (Burrows et al., 2009a) to calculate bacteria emissions within the ECHAM5-HAM general circulation model (GCM) (Lohmann et al., 2007) for an online calculation of bacteria emissions.

A review of available fungal spore concentration data has been undertaken by Dallafior and Sesartic (2010). Those data from literature have been assigned to an ecosystem and converted to surface fluxes. The fluxes have been calculated offline based on ecosystem areas from JSBACH and fungal spore properties (mass and density).

The average global fungal spore number concentrations (10^4 m^{-3}) were found to be two orders of magnitudes lower than the modelled average number concentrations of bacteria (10^6 m^{-3}) and mineral dust (10^8 m^{-3}).

The inclusion of bacteria acting as IN in ECHAM5-HAM leads to only minor changes in cloud formation and precipitation on a global level, however, changes in the liquid water path and ice water path can be observed, specifically in the boreal regions where tundra and forests act as sources of bacteria. Following Santl Temkiv et al. (2009) we assumed 10% of available bacteria to act as IN.

The addition of fungal spores acting as IN in ECHAM5-HAM has an even lesser impact. A slight increase in ice crystal number concentration over vegetated areas can be observed for the assumption that all fungal spores act as IN. However, due to their low number concentration fungal spores seem to have only a very minor impact on clouds and precipitation on the global scale.

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