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A review of natural aerosol interactions and feedbacks within the Earth system

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Abstract. The natural environment is a major source of atmospheric aerosols, including dust, secondary organic material from terrestrial biogenic emissions, carbonaceous particles from wildfires, and sulphate from marine phytoplankton dimethyl sulphide emissions. These aerosols also have a significant effect on many components of the Earth system such as the atmospheric radiative balance and photosynthetically available radiation entering the biosphere, the supply of nutrients to the ocean, and the albedo of snow and ice. The physical and biological systems that produce these aerosols can be highly susceptible to modification due to climate change so there is the potential for important climate feedbacks. We review the impact of these natural systems on atmospheric aerosol based on observations and models, including the potential for long term changes in emissions and the feedbacks on climate. The number of drivers of change is very large and the various systems are strongly coupled. There have therefore been very few studies that integrate the various effects to estimate climate feedback factors. Nevertheless, available observations and model studies suggest that the regional radiative perturbations are potentially several Watts per square metre due to changes in these natural aerosol emissions in a future climate. Taking into account only the direct radiative effect of changes in the atmospheric burden of natural aerosols, and neglecting potentially large effects on other parts of the Earth system, a global mean radiative perturbation approaching 1 W m^{-2} is possible by the end of the century. The level of scientific understanding of the climate drivers, interactions and impacts is very low.

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