

Eric Jensen – Abstract

Cirrus susceptibility to changes in ice nuclei: physical processes, model uncertainties, and measurement needs

Eric Jensen  
NASA Ames Research Center

One of the proposed concepts for mitigating the warming effect of increasing greenhouse gases is seeding cirrus cloud with ice nuclei (IN) in order to reduce the lifetime and coverage of cold cirrus that have a net warming impact on the earth's surface. Global model simulations of the net impact of changing upper tropospheric IN have given widely disparate results, partly as a result of poor understanding of ice nucleation processes in the current atmosphere, and partly as a result of poor representation of these processes in global models. Here, we present detailed process-model simulations of tropical tropopause layer (TTL) transport and cirrus formation with ice nuclei properties based on recent laboratory nucleation experiments and field measurements of aerosol composition. The model is used to assess the sensitivity of TTL cirrus occurrence frequency and microphysical properties to the abundance and efficacy of ice nuclei. The simulated cloud properties compared with recent high-altitude aircraft measurements of TTL cirrus and ice supersaturation. We find that abundant effective IN (either from glassy organic aerosols or crystalline ammonium sulfate with concentrations greater than about 100/L) prevent the occurrences of large ice concentration and large ice supersaturations, both of which are clearly indicated by the in situ observations. We find that concentrations of effective ice nuclei larger than about 50/L can drive significant changes in cirrus microphysical properties and occurrence frequency. However, the cloud occurrence frequency can either increase or decrease, depending on the efficacy and abundance of IN added to the TTL. We suggest that our lack of information about ice nuclei properties in the current atmosphere, as well as uncertainties in ice nucleation processes and their representations in global models, preclude meaningful estimates of climate impacts associated with addition of ice nuclei in the upper troposphere. We will briefly discuss the key field measurements needed to constrain ice nucleation processes.