Geophysical Research Abstracts
Vol. 12, EGU2010-3772, 2010
EGU General Assembly 2010

Aerosol Effects on Upper Tropospheric Ice Clouds in NCAR CAM: Uncertainties and Challenges

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Cirrus clouds composed of ice crystals have an annual global average frequency of occurrence of about 30%. Cirrus clouds scatter shortwave radiation (SW) and absorb and emit longwave terrestrial radiation (LW), thereby modifying the global radiative balance. While the influence of aerosols on cloud droplet nucleation has received considerable attention from the climate research community, the effects of aerosol particles on ice formation are currently insufficiently understood and present another level of challenge for both observations and modeling (IPCC, 2007). In this presentation a modal aerosol treatment which predicts both aerosol mass and number, and internal mixing between aerosol components in the NCAR Community Atmospheric Model (CAM) will be used to estimate aerosol effects on cirrus clouds and climate. Sensitivities to two different ice nucleation parameterizations (Liu and Penner, 2005) and Barahona and Nenes (2008; 2009) will be discussed. Uncertainties due to the number and property of ice nuclei (IN), growth rate of ice crystals and GCM's subgrid variabilities in the relative humidity and vertical velocity are studied. Challenges for the modeling of aerosol-ice cloud interactions in global models will be discussed including uncertainties in the measurement of ice crystal number and size distribution, homogeneous versus heterogeneous ice nucleation mechanisms and IN chemical properties, and GCM's subgrid variabilities in vertical velocity and humidity.