Project Details

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Project Title:
Solar effects on global climate due to cosmic rays and solar energetic particles

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Summary:
We propose to investigate the role of galactic cosmic radiation (GCR) and solar energetic particle precipitation in generating aerosols and cloud condensation nuclei (CCN) in Earth's lower atmosphere. This potential source of CCNs may affect the properties of clouds and hence the global radiation balance and climate. We will first model cosmic ray particle entry into the atmosphere by using a global model of Earth's magnetosphere--ionosphere--thermosphere system and particle tracing to obtain cosmic ray incidence rates. These will be used to calculate air ionization rates throughout the depth of the troposphere. We will then employ a novel model that simulates particle formation and evolution from molecular scales, typical of the ionized species produced by energy deposition, to the sizes commonly sampled in the lower atmosphere. This model's input consists of the air ionization rates, as well as the state of the ambient environment. Predictions regarding the size and composition of the particles over time will then be analyzed for potentially significant effects. In the proposed work we will: 1. Produce detailed maps of cosmic ray induced ionization in the troposphere for different levels of geomagnetic activity; 2. Connect the formation rate of ultrafine aerosols and CCN to the deposition rate of GCR solar particles for a range of background atmospheric conditions; 3. Investigate the sensitivity of aerosol production to solar variability on time scales ranging from hours to the 11-year sunspot cycle; 4. Compare predicted signals in atmospheric aerosol properties with reported changes in climatic parameters, testing the significance of possible correlations between solar variability and climate change; 5. Develop parameterizations that describe CCN as a function of solar state, and ambient conditions, for use in more detailed cloud and climate modeling studies.

Publication References:

no references