Project Details

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Program Element: Sun Climate

Project Title:
Climate Impacts of Solar Variation-Induced Changes in Tropospheric Particle Formation, CCN, and Cloud Properties

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Summary:

Sun supplies most of the energy for the Earth's atmospheric and climate system. The meas-ured 0.1% level of the long-term total solar irradiance (TSI) variations (i.e., solar direct effect on climate change) is generally considered to be too small to account for the apparent correlation between observed historical solar variations and climate changes, which may imply an indirect solar forcing unaccounted for. In order to clearly defined the consequences of human activity on climate and accurately predict the climate change on decadal and longer time scales, possible indirect impacts of solar activity on Earth s climate have to be identified, formulated, and in- cluded in the climate models. The main objective of this project is to investigate solar indirect climate impacts via solar variations-induced changes in tropospheric particle formation, CCN, and cloud properties.

There are two main research objectives of this proposal. The first one is to study impact of solar variations (both TSI and cosmic ray flux) on global new particle formation and cloud con- densation nuclei (CCN) concentration, using a recently developed global size-resolved aerosol model (GEOS-Chem +APM). It is well known that particle nucleation rates are sensitive to T, RH, and precursor gas concentration ([H2SO4]). The ion-mediated nucleation (IMN) rates also depend on ionization rates. Our recent global modeling study indicates that IMN may contribute significantly to the number abundance of particles in most part of troposphere. We propose to study the possible response of CCN concentrations to solar variations via nucleation and growth of secondary particles. Our initial study indicates that solar variations can lead to CCN change at a magnitude that can cause important climate forcing. Our second research objective is to incor-porate this solar indirect radiative forcing associated with CCN change into the recently released Community Earth System Model (CESM). CESM is a coupled climate model composed of four separate models simultaneously simulating the earth's atmosphere, ocean, land surface and sea-ice, and one central coupler component. The CESM allows researchers to conduct fundamental research into the earth's past, present and future climate states. By including a physics-based me-chanism of solar variation-induced change of CCN concentrations in the CESM, we will study the magnitude of this solar indirect radiative forcing under different atmospheric conditions (pre-industrial, present, and future emission and climate).

This project is highly relevant to the strategic objective of the Sun-Climate Theme of the NASA LWS, which is to deliver the understanding of how and to what degree variations in the solar radiative and particulate output contribute to changes in global and regional climate over a wide range of time scales.

Publication References:

Summary: no summary

Reference: Ma, Xiaoyan; Yu, Fangqun; (2012), Effect of spectral-dependent surface albedo on Saharan dust direct radiative forcing, Geophysical Research Letters, Volume 39, Issue 9, doi: 10.1029/2012GL051360