Project Details

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Project Title:
Atmospheric Coupling via Energetic Particle Precipitation

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Summary:
The goal of the work proposed here is to better understand the degree to which energetic particle precipitation (EPP) couples the upper and lower atmosphere, and the role of meteorology in this coupling. It is well known that EPP affects stratospheric NOx and O3, and that changes in O3 can influence atmospheric temperatures and circulation. Stratospheric processes can influence the troposphere, impacting weather and climate. Still unknown is the degree to which EPP might thus indirectly affect climate. In turn, tropospheric perturbations such as might originate from anthropogenic climate change can be communicated to the middle and upper atmosphere, thereby altering the atmospheric response to EPP through relevant meteorological pathways. Recent work has shown that meteorological conditions are fundamental to controlling the effects of EPP on the atmosphere. Indeed, depending on dynamical activity, EPP effects can be large even when geomagnetic activity is not elevated. Understanding the impact of EPP on the Earth's atmosphere and possibly climate thus requires that we explore the avenues through which the different regions of the atmosphere are coupled via EPP. To achieve the overall goal stated above, the objectives of the proposed work are to answer the following questions:

(1) To what extent has EPP affected atmospheric composition and temperature since 1979?

(2) By what mechanisms does meteorology influence the atmospheric response to EPP, and is there any feedback from EPP on these mechanisms?

(3) How does a changing climate affect the relevant meteorological mechanisms?

These questions will be answered with both satellite measurements and model simulations. The model is the NCAR Whole Atmosphere Community Climate Model (WACCM). Simulations with realistic EPP input specified from particle measurements will be compared to simulations without EPP to investigate EPP effects on atmospheric composition and temperature during the last three solar cycles. Model output will be evaluated by comparing to current and historical satellite observations. We also propose to analyze current satellite data to continue quantifying the flux into the stratosphere each year of NOx produced by EPP.

Demonstration of Relevance to NASA and LWS Objectives:

This proposal addresses the Living With A Star Sun-Climate Theme, for which the strategic objective 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." By investigating the mechanisms by which different atmospheric regions are coupled under the influence of EPP, the work proposed directly addresses this objective. The Sun-Climate Theme places "particular emphasis...on coupling of the upper and lower atmosphere", which is the main topic of the work proposed here. The proposed work targets the processes by which EPP effects on the middle and upper atmosphere are communicated to other regions of the atmosphere, potentially altering the Earth's climate. The work proposed here also focuses on how the atmospheric response to precipitating particles is affected by climate change; this is also in line with the LWS Sun-Climate Theme, which "targets the pathways by which ongoing climate change influences the atmospheric response to solar forcing, both directly and via upward coupling".

Publication References:

no references