Project Details

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Project Title:
Atmospheric Effects of Solar Proton Events and Galactic Cosmic Rays

PI Name: Charles Jackman
PI Email: Charles.H.Jackman@nasa.gov
Affiliation: Goddard Space Flight Center
Project Member(s):
- Bardeen, Charles G; Co-I; National Center for Atmospheric Research
- Fleming, Eric L.; Co-I; Atmospheric Chemistry and Dynamics Branch
- Mertens, Christopher J; Co-I; NASA Langley Research Center
- Randall, Cora E; Co-I; University of Colorado
- Marsh, Daniel Robert; Co-I; National Center for Atmospheric Research

Summary:
The proposed work will extend studies begun three years ago under the LWS investigation entitled Long-term Atmospheric Effects of Solar Proton Events and their Contribution to the Polar Solar Cycle Variations. The proposed work will provide further quantification on solar proton events (SPEs) and their atmospheric influence. The work will also quantify the chemical influence on the atmosphere from galactic cosmic rays (GCRs). The objectives of this effort will be to answer the following questions:

1) How do SPE effects on middle atmospheric ozone depend on high-latitude interannual dynamical variability?

2) How does the upper mesosphere respond to SPE-induced changes in the middle atmosphere, including the effect on polar mesospheric clouds?

3) How do GCRs influence the chemical composition of the atmosphere over decadal time-scales?

We will use a global model, the NCAR Whole Atmosphere Community Climate Model (WACCM), as well as satellite measurements to address these questions. WACCM is a global chemistry climate model, whose domain extends from the ground to about 140 km. WACCM includes the chemistry and physics of the troposphere, stratosphere, mesosphere, and lower thermosphere and incorporates a module for the computation of polar mesospheric clouds. WACCM can also be utilized in a new Specified Dynamics version (SD-WACCM), which is driven by assimilated winds and temperatures, to more closely reproduce actual dynamical conditions for particular time periods. This will enable us to better separate the impacts of SPEs and GCRs from other atmospheric variations for specific time periods.

Previously computed daily average ion pair production rates for SPEs, which were calculated from proton flux data, will be used in studies addressing the first two questions. The third question will be addressed with ionization rates for GCRs from the NASA Langley Nowcast of Atmospheric Ionizing Radiation for Aviation Safety (NAIRAS) investigation.

The proposed work is directly relevant to the Living With a Star Sun Climate Theme. It will improve the understanding of how SPEs and GCRs impact the middle atmosphere, whose coupling with the troposphere can influence the climate system.

Publication References:

Summary: no summary

Reference: von Clarmann, T.; Funke, B.; López-Puertas, M.; Kellmann, S.; Linden, A.; Stiller, G. P.; Jackman, C. H.; Harvey, V. L.; (2013), The solar proton events in 2012 as observed by MIPAS, Geophysical Research Letters, Volume 40, Issue 10, pp. 2339-2343, doi: 10.1002/grl.50119

Summary: no summary

Reference: Duderstadt, Katharine A.; Dibb, Jack E.; Schwadron, Nathan A.; Spence, Harlan E.; Solomon, Stanley C.; Yudin, Valery A.; Jackman, Charles H.; Randall, Cora E.; (2016), Nitrate ion spikes in ice cores not suitable as proxies for solar proton events, Journal of Geophysical Research: Atmospheres, Volume 121, Issue 6, pp. 2994-3016, doi: 10.1002/2015JD023805

Summary: no summary

Reference: Duderstadt, K. A.; Dibb, J. E.; Jackman, C. H.; Randall, C. E.; Schwadron, N. A.; Solomon, S. C.; Spence, H. E.; (2016), Comment on "Atmospheric ionization by high-fluence, hard spectrum solar proton events and their probable appearance in the ice core archive" by A. L. Melott et al, Journal of Geophysical Research: Atmospheres, Volume 121, Issue 20, pp. 12,484-12,489, doi: 10.1002/2016JD025220