# Project Details

**ROSES ID:** NNH20ZDA001N
**Selection Year:** 2020
**Program Element:** Focused Science Topic

**Topic:** Long Term Variability and Predictability of the Sun-Climate System

**Project Title:**
Top-Down Solar Influence on the Madden-Julian Short-Term Climate Oscillation

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**Summary:**
OBJECTIVES: The objective is to evaluate the significance of solar variability in influencing tropical deep convection, the 30-60 day Madden-Julian Oscillation (MJO), and resulting effects on subseasonal to decadal weather and climate at northern midlatitudes in winter-spring.

METHODS/TECHNIQUES:
In year 1, new 27-day solar multiple linear regression (MLR) analyses will be carried out for tropical lower stratospheric static stability and several quantities that are more directly diagnostic of the intensity of deep tropical convection (outgoing longwave radiation, divergent winds). This will test and extend previous evidence that solar-induced changes in upwelling and static stability in the tropical lower stratosphere are the initiators of solar influences on tropical deep convection and the MJO.

In year 2, the dependence of the 27-day solar modulation of the MJO on MJO phase will be investigated. In particular, efforts will focus on testing previously reported evidence that 27-day solar UV minima are associated with enhanced eastward propagation of the MJO past the Maritime Continent barrier. In addition, analyses of WACCM6 model data will determine whether this advanced GCM is able to simulate the observed 27-day solar modulation of the MJO.

In year 3, further analyses of WACCM6 model data will determine whether this model is able to simulate an 11-yr solar modulation of the MJO. Any obvious deficiencies in WACCM6 that might preclude simulation of the 27-day and 11-yr modulations will be identified. Work will also begin on compositing of filtered climate variables to determine whether lagged effects on intraseasonal climate of the 27-day and 11-yr solar modulations of the MJO can be detected. at northern midlatitudes in boreal winter-spring.

In year 4, the intraseasonal climate analyses will be completed. Also, a comprehensive investigation will be conducted of whether modulation of the MJO by the solar cycle and by the quasi-biennial oscillation (QBO) can assist in understanding observed influences of both the QBO and the 11-yr solar cycle on the occurrence of sudden stratospheric warmings (SSWs) at high northern latitudes in winter (known as the Holton-Tan and Labitzke-van Loon effects). SSWs have significant tropospheric weather consequences.

SIGNIFICANCE/RELEVANCE: The MJO is the strongest of the intraseasonal oscillations, which have important derivative effects on extratropical circulation and weather, including impacts on storminess and temperature in the United States (e.g., http://www.cpc.ncep.noaa.gov/products/intraseasonal). The main significance of the proposed work is that it will lead to a better evaluation of the role of solar variability on both the 27-day and 11-year time scales for influencing the tropical MJO and its derivative effects on intraseasonal and decadal climate variability. It will also test whether a state-of-the-art coupled climate model with daily solar forcing can simulate this influence. The proposed work will directly contribute to Focused Science Topic #4: Long-Term Variability and Predictability of the Sun-Climate System as described in para. 5.2 of Appendix B.5 (Heliophysics Living With a Star Science) of the ROSES 2020 solicitation. It focuses on ``the impacts of solar variability on the terrestrial climate'', specifically investigating how the upper stratospheric region driven directly by solar influences is linked, via the MJO, to tropospheric processes where human activities are concentrated. It incorporates space-based observations, both directly in satellite outgoing longwave radiation data, which are a measure of tropical convection, and indirectly as essential inputs to meteorological reanalyses, which are the main climate data source for the proposed work.

# Publication References:

no references