Project Details

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Project Title:
Solar Forcing of Climate through Stratospheric Ozone Changes

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Summary:
There is compelling evidence that solar variability is implicated in climate change, but no credible mechanism has been established to date. The main difficulty in establishing a mechanism is that changes in total solar radiation absorbed at the surface are too small to explain observed changes in climate. We propose to investigate a mechanism that amplifies the influence of the sun through UV-induced ozone changes in the stratosphere. We will test our hypothesis by investigating various historical periods that have anomalous temperature and solar activity levels such as the Maunder Minimum and the Medieval Maximum. We propose a four-pronged approach to study the solar forcing of climate through stratospheric ozone changes. We will first investigate the well-documented changes in the ozone layer and their associated climate changes for the last two solar cycles. We will model the response of ozone in the stratosphere to UV changes using a 2-D photochemical model that includes the effects of realistic quasi-biennial oscillation and catalytic chemistry. The radiative forcing due to ozone changes will be modeled using the MODTRAN code and compared to data from NCEP/DOE Reanalysis II. The changes in stratospheric ozone and radiative forcing will be used as input to an idealized GCM to drive changes in heating rates and the stratospheric zonal wind patterns. These changes will affect the strength of the stratospheric polar vortex by changing the propagation of upwelling planetary-scale waves, which in turn can effect tropospheric dynamics. Therefore, the ozone-induced changes in stratospheric winds can indirectly affect tropospheric climate. The experience gained from the idealized GCM will be used to carry out more realistic investigations using the Whole Atmosphere Community Climate Model of NCAR. We will analyze the state of the paleoclimate climate using the most recently obtained data and compare the model-predicted impacts with these data. We have shown that the tropospheric Northern Annular Mode is influenced by changes in the solar UV radiation, suggesting that a mechanism of solar influence on climate involves modulation of this mode. Our proposed mechanism couples the changes in solar UV emission to those of ozone and ultimately tropospheric dynamics. If we successfully demonstrate that this mechanism is at work in the best climate models, this study will open a door to future space-borne observations of the solar-climate relationship.

Publication References:

Summary: "

Reference: Yuk Yung / California Institute of Technology-Solar Forcing of Climate through Stratospheric Ozone Changes

Summary: no summary

Reference: Ruzmaikin, Alexander; Feynman, Joan; Jiang, Xun; Noone, David C.; Waple, Anne M.; Yung, Yuk L.; (2004), The pattern of northern hemisphere surface air temperature during prolonged periods of low solar output, Geophysical Research Letters, vol. 31, issue 12, p. L12201, doi: 10.1029/2004GL019955