Project Details

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Project Title:
Diagnostic Investigation of Middle Atmosphere Climate Sensitivity

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Summary:
The middle atmosphere and lower thermosphere (MALT) region is highly variable and has a complex system of drivers. Its physical and dynamical variability is induced almost equally by the variable solar radiation from above and transient weather and climate processes from below. Though the MALT responses to solar variations have been well investigated, relatively little has been done on the long-term variation and its spatial structure induced by the anthropogenic secular trend. Recently, it has become increasingly recognized that one needs to understand and predict climate change from a global perspective including the MALT due to altitude amplification of the anthropogenic radiative forcing.

One difficulty in understanding and projecting the future climate changes comes from inability of identifying and isolating the signals from the external forcing and from different feedback processes in the middle atmosphere climate system. The recently developed climate feedback-response analysis method (CFRAM) provides a framework for estimating the external forcing and various climate feedbacks for the coupled tropospheric atmospheric-oceanic system. We propose to extend the CFRAM for climate feedback studies in the MALT using both the TIMED measurements and outputs of specially designed modeling experiments with the high-altitude GEOS-5 climate model. The extension of CFRAM in the MALT is based on the JHU/APL middle atmosphere radiation module. We propose to apply the extended CFRAM to infer and isolate different mechanisms in the MALT responsible for the interannual variability associated with solar cycle forcing and secular trend associated with anthropogenic radiative forcing. The key scientific questions to be addressed are:

1. How much is the temperature change in the stratosphere and mesosphere due to solar cycle variation, how much due to the human-induced changes in CO2 and O3?

2. What are the differences in the spatial patterns of temperature changes in the MALT induced by the short-term solar, interannual natural variability, and long-term trends in the CO2 and O3 concentrations?

3. How do we quantify the contributions to the differences in the spatial patterns of temperature variations/changes due to differences in the external forcing (natural or anthropogenic), in various climate feedbacks?

Publication References:

no references