2022 Workshop: Middle and Upper Atmosphere Coupling during Sudden Stratosphere Warmings

Long title
Advances in Vertical and Lateral Coupling Studies of Middle and Upper Atmospheres during Sudden Stratosphere Warmings
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Description

This workshop provides a platform to discuss advances made in the investigations related to the response of mesosphere and lower thermosphere (MLT) thermal structure, dynamics, and its chemical composition during the disturbance in the polar vortex or sudden stratosphere warmings (SSW). The MLT region is well mixed with many major and minor chemical species. CO2, CO, and O3 are dominant variable chemical components in the mesosphere and atomic oxygen and nitrogen are the predominant species in the lower thermosphere. Recent studies described the effects of SSW on the MLT both at the polar and tropical latitudes using a wide spectrum of instruments (e.g., meteor radars, satellites) and models. Atmospheric waves propagating to the mesosphere during SSWs play a significant role in changing the dynamics, thermal structure, and composition which in turn cause a change in the mean meridional circulation. Furthermore, mesospheric cooling is stronger during SSWs due to adiabatic and infrared cooling caused by gravity waves and CO2. Thus, the investigations of planetary waves, gravity waves, tides, and chemical composition in the MLT using ground-based, and space-born instruments are of great importance. The simultaneous observations at different latitudes from the high-to-tropical region will be of importance to ascertain the changes in the global mean circulation due to disturbed polar weather. Furthermore, it has been observed that the chemical species are transported from the polar-to-tropical region through the mean circulation during SSWs. This workshop welcomes short presentations related to the advanced studies on the vertical and latitudinal

coupling of the atmosphere (MLT) through winds, waves, tides, temperatures, and variability of chemical composition during SSWs using various methods including ground and space-based measurements, and model estimates.

Agenda

10:00 McArthur Jones Jr

10:15 Larisa Goncharenko

10:30 Zishun Qiao

10:45 Jack Wang

11:00 Ruth Lieberman

11:15 Saswati Das

11:30 Jens Oberheide "IT response to SSW as observed by GOLD and COSMIC-2"

11:45 Quan Gan

Justification

The simultaneous and continuous observations that monitor the MLT (60-120 km) thermal structure and dynamics to study the variability of gravity waves, planetary waves, and tides involve great challenges. But the recent progress in developing ground-based radar networks, and satellite measurements made it easy to study the MLT region. The ground-based MLT radars (Meteor, MST and MF) are used to study the winds and waves, but the recent ICON mission is capable of providing winds at different latitudes. Hence, the combined observations of ground-based radars and ICON will of great importance to study the MLT dynamics during SSW. Furthermore, the recent NASA developed GOLD, ICON missions attained significant importance to delineate the temperature and other parameters of the MLT region along with the existed SABER, MLS satellites. Recent models provide some wind information for the wave analysis in the MLT, but still, there is an ambiguity between the direct observations and model simulations.
Sudden Stratosphere Warmings (SSWs) are a polar atmospheric phenomenon, and it shows a significant effect on the MLT dynamics, composition and as well on mean circulation. Simultaneous ground and space-based observations allow investigations of gravity waves, planetary waves, tidal propagation and their interaction in the MLT

will lead to new insights into the MLT region. Further, the filtering of gravity waves in the stratosphere also results in a change in the MLT dynamics. Therefore, the vertical coupling of the different regions of the atmosphere through the waves, tides and latitudinal coupling studies are high in demand to check the existing theories of global mean circulation and thereby its impact on the surface weather. The campaigns of the NASA GOLD and ICON missions to study the winds and temperatures in the MLT during SSW will be an added advantage to the existing ground-based and space-born observations. So, now is the time to hold a CEDAR workshop on the recent advances in understanding MLT dynamics during SSWs, hoping the community researching this aspect can come together to present, discuss, and propose new ideas.

Summary

We had a very successful workshop with an excellent discussion of the presented findings. We especially want to express thanks to Zishun Qiao for her assistance running the workshop. Ruth Lieberman presented work tracing the origins and emergence of the 2-day wave seen in SSWs. Larisa Goncharenko showed exciting observations of TIDs in the ionosphere in different sectors associated with SSWs. Zishun Qiao gave a comprehensive presentation on the mechanisms of the Q6DW during SSW periods. Jack Wang discussed the origins of Q10DW and their relationship with non-linear wave-wave interactions resulting in "child" waves. McArthur Jones Jr shared a study of nighttime TEC depletions associated with SSWs that explored its origins as found with modeling. Saswati Das shared results of changes in composition during SSWs, especially NOx. Jens Oberheide shared work that investigated the depletion of O/N2 in the thermosphere, along with an excellent description of the dynamical mechanisms responsible for this depletion. Quan Gan examined the phenomenon of a Q6DW seen in the EIA during SSW periods and discussed potential reasons for this observation.

One clear theme emerged from the workshop: SSWs have the potential to disturb the atmosphere & ionosphere globally. Even with many scientists focusing research energy into this phenomenon, there are still many open questions and discoveries to be made in this area.

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Short Presentations

Keywords
Sudden Stratosphere Warming, Vertical Coupling of the Atmosphere, Planetary Waves, Tides, MLT region

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