SA52A CC: 518 C Friday 1030h

Global Change in the Upper Atmosphere and Ionosphere I *(joint with SM)*

Presiding: **R A Akmaev,** University of Colorado**; G M Keating,** George Washington University

SA52A-01 1030h INVITED

Trends in Polar Mesospheric Clouds: What do Satellites Tell Us?

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Polar mesospheric clouds (PMC) have been observed at altitudes of 80 to 85 km from the ground since 1885 and from satellites since 1969. They occur at high latitudes during a three month period starting about one month before the summer solstice. PMC are composed of small ice particles, which form during the polar summer when the upper mesosphere reaches temperatures of less than 130 K, so that even the few parts per million of water vapor available at those altitudes becomes highly supersaturated. There are now several sets of satellite measurements of PMC, each of which cover a decade or longer with the same instrument or multiple copies of the same instrument on different satellites. We will focus on two of these datasets. The first from the Solar Backscatter UltraViolet [SBUV and SBUV/2] instruments on the NOAA polar-orbiting meteorological satellites, which provide over a quarter century of measurements beginning in 1978. The second from the Stratospheric Aerosol and Gas Experiment [SAGE II], which began operation in 1984. These measurements show that the number of PMC observed each season exhibit a strong anti-correlation with the solar Lyman-alpha flux. While there is no clear long-term trend in the frequency of occurrence of all PMC, there is evidence that the frequency of brightest PMC are increasing. There is also clear evidence that the average brightness or albedo of the PMC observed by the SBUV instruments has increased over the past quarter century. Recent modeling results by Thomas et al. have shown that this increasing brightness is consistent with the increase in mesospheric water vapor over the same period. We will discuss the implications of these findings in terms of our understanding of global change.

SA52A-02 1050h INVITED

Long-Term Mesopause Temperatures Over Fort Collins, CO (41N, 105W)

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Temperature measurements from 1991 through 2003 using the sodium lidar at altitudes of 80 to 105 km have been analyzed in terms of annual, semiannual, and episodic (Pinatubo volcano) variations as well as an 11 year solar cycle response and a trend. Trends lie between about -1 K/yr and +1 K/yr and during the summer show a local minimum between 90 and 95km whereas trends during the winter have a local minimum above 100km. Inclusion of an episodic variation shifts trends by roughly +0.5 K/yr and makes the trends about the same during periods of positive and negative QBO winds at the equator. Disregarding the episodic variation, the trend for periods of negative QBO winds is about +0.5K/yr larger than that for periods of positive QBO winds. The solar response is relatively insensitive to inclusion of the episodic variation but is generally smaller for periods of negative QBO winds compared to positive QBO winds.

SA52A-03 1110h

The Temperature Trend near the Mesopause as Measured Using the Hydroxyl Airglow

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Measurement of the relative intensities of lines in the rotational structure of the vibration-rotation bands of the hydroxyl airglow emission provides a ready means to obtain the temperature in the region from which the emission arises. Following a discussion of the limitations of the method, we present a time series of such measurements extending over 35 years. The time series is sparse over the first two decades, but includes a period of systematic frequent measurements extending over one full solar cycle. The analysis of the time series leads to the conclusion that there has been no measurable change in the temperature over the period covered. This result is in agreement with several modeled results that predict a change of less than 1 K/decade, and with some observational results, but is in contrast with some other sets of observations, including some obtained using the same method.

SA52A-04 1125h

Near-IR CO_2 Bands in the Mesosphere and Their Effect for Doubled CO_2 Conditions

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Absorption of solar energy by the near-infrared (NIR) CO_2 bands provides an essential source of heating in the mesosphere. Between 65 and 85 km, this source can exceed 1 K/day and contribute up to 30 % to the total solar heating. Calculation of the solar heating in the NIR CO_2 bands requires consideration of complex non-local thermodynamic equilibrium (NLTE) processes in the CO_2 molecule. The relatively small energy effect and narrow altitudinal region of importance, as well as the necessity to consider complicated NLTE processes, have accounted for the absence of an adequate parameterization for the NIR CO_2 bands up to now. Recently such a parameterization has been developed and implemented into the Canadian Middle Atmosphere Model (CMAM). To examine the role of the NIR CO_2 bands in the mesospheric energetics, this model has been used in a series of multi-year experiments for conditions of perpetual July. Numerical experiments have shown that inclusion of the NIR CO_2 heating results in a significant thermal response of up to 8 K in the mesosphere for the current CO_2 amount but does not significantly change the model thermal response induced by doubling of CO_2.

SA52A-05 1140h

The Response of the Mesopause Region to Natural and Anthropogenic Climate Forcing Simulated in a 3D Chemistry Climate Model

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The HAMMONIA general circulation and chemistry model resolves the atmosphere from the Earth's surface up to about 250 km. This newly developed model combines the 3d dynamics from the ECHAM5 model with the MOZART3 chemistry scheme and some extensions to account for important processes in the upper atmosphere. It is designed to study interactions between chemistry, dynamics and radiation in the whole atmosphere, but in particular in the mesosphere and lower thermosphere (MLT) region. This study concentrates on the response of dynamics and trace gases, in particular ozone and water vapor, in the MLT region to solar and anthropogenic climate forcing. Results of different simulations with HAMMONIA for low and high solar activity on the one hand and for present day and doubled CO2 concentration on the other hand are presented. The magnitudes of these natural and anthropogenic changes are compared and their statistical significance is analysed. Finally, we address the effect of the different types of forcing on the energy budget.

SA53A CC: 518 C Friday 1330h

Global Change in the Upper Atmosphere and Ionosphere II *(joint with SM)*

Presiding: **E C Weatherhead,** Cooperative Institute for Research in Environmental Sciences (CIRES)**; M J Jarvis,** British Antarctic Survey

SA53A-01 1330h

Updated Laboratory Studies of $CO_2(\nu_2)$-O Vibrational Energy Transfer

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We will present the latest results from our laboratory measurements of the $CO_2(\nu_2)$-O vibrational relaxation rate constant. The O + CO_2 vibrational excitation process is a key contributor to both the CO_2 15-μm emission intensity and to the upper atmospheric energy budget in the 75-120 km altitude range. Through collisions with the ambient O atoms, the ground vibrational state of CO_2 is efficiently excited to its lowest excited vibrational state, with one quantum of energy in the ν_2 bending mode. In the near-space environment, a sizable fraction of this population relaxes via 15-μm spontaneous IR emission, which effectively converts ambient kinetic energy into radiative energy that passes into space. The vibrational relaxation measurements on the $CO_2(\nu_2)$-O system performed to date using our transient diode laser absorption spectroscopy apparatus will be summarized, including the latest information on temperature dependence in the relevant 150-500 K range. Possible extensions to the experiment will also be discussed, including the possibility of measuring energy transfer rates involving higher-energy CO_2 levels pumped through absorption of solar radiation.

SA53A-02 1345h

Effect of Middle-Atmospheric Greenhouse Cooling on Global Change in the Upper Atmosphere

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Carbon dioxide and water vapor are the primary greenhouse warming gases in the troposphere but they mainly act as cooling agents in the middle and upper atmosphere. The "greenhouse cooling" in the 15-μm CO_2 band has been evaluated in several modeling