SA42A-05 1455h

The Hump in the Ultraviolet Spectra of Polar Mesospheric Clouds

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The scattering spectrum of polar mesospheric clouds (PMC) can be defined as the ratio of the scattered spectrum to the incident solar spectrum. Ultraviolet PMC spectra (200-315 nm) were accurately measured during the northern summer of 1999 by spectrographic imagers on the Midcourse Space Experiment (MSX) satellite. These spectra differ from a pure Rayleigh spectrum (which has a λ^{-4} dependence) and from the background dayglow spectrum (which itself is non-Rayleigh). To first order, the PMC spectra can be represented as the spectra of Mie scatterers with a log-normal distribution having modes of $\sim$50-70 nm and dispersions of $\sim$1.15-1.20. However, the PMC spectrum exhibits a peculiar (anomalous?) "hump" near λ=250 nm. This hump cannot be explained as an instrumental effect or a background contamination effect. The existence of this hump casts some shadow on the usual assumption of a lognormal distribution of Mie scatterers. The implications of this hump for the scattering distribution will be discussed.

SA42A-06 1510h

Two Years of PMC Observations With OSIRIS on Odin

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The Odin research satellite, a joint Sweden, Canada, France and Finland mission, was launched in February 2001 into a sun-synchronous terminator orbit at an altitude of approximately 600 km, with the at ascending node 1800 LT. Its period is 96.7 min, and the maximum latitudinal coverage in the orbital plane is from 82.2 N to 82.2 S. Since spring 2001 the Optical Spectrograph and Infrared Imaging System (OSIRIS) instrument on Odin measures the atmospheric limb brightness by nodding between 6 km and 65 km (stratospheric mode), between 6 and 100 km (stratospheric-mesospheric mode), and between 65 km and 100 km (mesospheric mode). When in one of the last two modes, OSIRIS can detect Polar Mesospheric Clouds (PMC) by measuring the limb-scattered solar radiance from these clouds in the spectral range from 280 nm to 800 nm with a 1 nm resolution. Since the primary goal of OSIRIS is to study the stratospheric ozone, it normally scans the mesosphere once in every 8 days. The only exception is the Northern Hemisphere summer period (2 weeks in July), when OSIRIS operates in mesospheric mode about 80 persent of the time, and the remaining 20 percent are devoted to stratospheric-mesospheric measurements. During the last two years, OSIRIS has detected many PMC in both hemispheres. In this work we present their annual frequency of appearance, spatial and temporal distribution, average height and brightness. The broad spectral range of OSIRIS provides a unique opportunity to obtain PMC color information. In addition we compare cloud particle sizes calculated under the assumption of power and lognormal distributions of uniform spherical Mie scatterers made of ice.

SA42A-07 1525h

Seasonal Temperatures by Potassium Lidar at Spitsbergen, 78°N

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Between June, 2001 and August 2003 the mobile potassium lidar of the IAP Kühlungsborn was installed at Spitsbergen, 78°N. The lidar was in operation during the summer seasons of 2001 and 2003 to observe NLC and temperature at the mesopause region. By adding the data from spring 2002 a complete set of temperatures covering the period from March to October has been obtained. Temperatures below 120 K during mid summer are frequently observed. Wave activities can cause the temperature to drop below 100 K during the coldest period around July 1. During the ROMA campaign 2001 a comparison with temperatures derived by a totally different technique (Falling Spheres) is possible and shows good agreement.

SA42B MCC: 2006 Thursday 1600h

Phenomena of the Summer Mesosphere II *(joint with ED, GC)*

Presiding: **J Thayer,** SRI International; **G Thomas,** University of Colorado

SA42B-01 1600h INVITED

Global Characteristics of PMCs From six Years of SNOE Data

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The Student Nitric Oxide Explorer (SNOE) satellite has successfully measured ten polar mesospheric cloud (PMC) seasons in its six year lifetime. Because SNOE orbits the Earth 15 times a day with high latitude resolution, it is the first to clearly illustrate the global day-to-day variability of PMCs. This is an advantage over other datasets in that we can look at dynamical influences on PMCs, specifically variations in brightness with a 5-day period. SNOE on average detects 10,000 PMCs per season allowing us to successfully study PMC morphology, PMC altitudes, and seasonal variability in observation frequency and brightness. Although PMCs are arguably an indicator of long term global change, we illustrate that they are highly variable on a day-to-day global scale.

SA42B-02 1615h

Comparisons of Southern and Northern Polar Mesospheric Clouds Based on Lidar Observations

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Since the first lidar observation of polar mesospheric clouds (PMC) in 1989 by a Na lidar at Andoya, extensive PMC observations have been made by lidars in both the northern and southern hemispheres. The lidar observations provide precise information on PMC altitudes, layer structure, and the diurnal and seasonal variations. Recently, the lidar observations at three Antarctic locations (South Pole, Davis, and Rothera) enable us to study the southern PMC properties in detail. The southern PMC exhibit some characteristics that are different from their northern counterparts, e.g., differences exist in the mean altitudes. However, there is large geophysical variability in PMC altitude and brightness in both hemispheres. Here we present a detailed comparison of the southern and northern PMC altitude distributions and brightness and their seasonal variations. The differences and similarities will be determined and possible causes for the differences will be discussed.

SA42B-03 1630h INVITED

Current Issues in Multidimensional Modeling of the Extratropical Middle Atmosphere

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The environment in which Polar Mesospheric Clouds (PMCs) form, the summer high latitude mesopause region, presents unique challenges for multidimensional middle atmospheric models. To simulate the strong dynamical cooling requires an accurate simulation of both the large scale meridional circulation and of small scale breaking gravity waves. In addition, the chemistry and transport of water vapor must be considered in order to obtain a self consistent picture of the relative humidity at the mesopause. Finally, chemical effects such as ozone and atomic oxygen heating are also important. Two and three dimensional models have been generally successful at obtaining the general features of the mesopause environment. However, recent attempts to model some of the more subtle aspects of the PMC distribution, their environment and their variation have been less successful. Issues such as PMC height, north-south differences,and solar cycle variations have pointed to differences between various models which need to be reconciled in order that possible global change effects can be understood. In this talk, I will present a review of these modeling issues, emphasize the connection with how various models are formulated and suggest tests and avenues for future model development.

SA42B-04 1645h

Interactions between polar mesospheric clouds and the meteoric metal layers

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Polar mesospheric clouds overlap in altitude with the layers of metal atoms that are produced by the ablation of meteoroids entering the atmosphere. This paper will examine several of the probable interactions between PMCs and metals. The Fe layer exhibits "bite-outs" where essentially all of the Fe atoms in the vicinity of a strong PMC are removed. Na and K atoms disappear completely below 90 km in the high-latitude summer mesosphere, and the undersides of these layers exhibit extremely small scale-heights. These features indicate that the metals are removed rapidly from the gas phase by adsorption on the ice particles, at a rate that exceeds their replenishment by meteoric ablation and vertical transport. It has been speculated that the incorporation of these metals into the ice lowers the photoelectric work function sufficiently to explain the observation of positively-charged ice particles. Another very interesting possibility is that metal-containing molecules actually provide the condensation nuclei for forming ice particles at the mesopause. In this paper we will report new laboratory studies of the uptake of Fe, Na and K on low-temperature ice, and a measurement of the photo-electric work function of Na in ice. An atmospheric model incorporating the experimental results will be used to address the nucleation problem, and also to show that the metal depletions are indeed explained by heterogeneous uptake. An important conclusion is that there appears to be a permanent layer of small (less than 20 nm) particles above 85 km throughout mid-summer at high latitudes.

SA42B-05 1700h

Understanding of Polar Mesosphere Summer Echoes: Where do we Stand?

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We shortly review our current physical understanding of the physics of polar mesosphere summer echoes (PMSE) in the scope of our recently updated theory of reduced electron diffusivity in the presence of charged ice particles. Based on the available observational data base from both ground based and rocket borne observations we critically assess our physical understanding of PMSE properties like (among others) observed seasonal variation, signal strength, spectral width, aspect sensitivity, relation to the occurrence of noctilucent clouds, relation to the occurrence of electron biteouts, electric fields, and the morphology of mesospheric neutral air turbulence. Finally, we identify remaining open questions and discuss the need for future investigations.

URL: http://www.iap-kborn.de

SA42B-06 1715h

Simultaneous Observations of Temperature, PMSE, NLC and Potassium at Spitsbergen, 78°N

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Between 2001 and 2003 a potassium lidar was installed near Longyearbyen (78° N) on the north polar island of Spitsbergen which is part of the archipelago Svalbard. The potassium lidar is capable of detecting noctilucent clouds (NLCs) and of measuring temperatures in the mesopause region, both under daylight conditions. At the same place a series of meteorological rockets (falling spheres) were launched in during the ROMA campaign in 2001 which gave temperatures from the summer mesopause to the stratosphere. The location of the lidar was close to the Sousy-Radar which has frequently observed PMSE throughout the summer periods of 2001 and 2003. We give an overview on the NLC and PMSE measurements and compare the results with temperatures in the same altitude region derived from the meteorological rockets. The NLC and PMSE appearance with height and season is in agreement with the climatological variation of water vapor saturation derived from the temperature measurements.

SA42B-07 1730h INVITED

Observations of Polar Mesospheric Clouds and Aurora from the International Space Station

Donald R Pettit

NASA JSC,, Houston, TX, United States

This is a featured presentation.

SA51A MCC: Level 1 Friday 0830h

Phenomena of the Summer Mesosphere III Posters *(joint with ED, GC)*

Presiding: **J Thayer,** SRI International; **G Thomas,** University of Colorado

SA51A-0482 0830h POSTER

Laboratory Studies of Ice Growth in the Presence of Oxygen Atoms

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In the mesopause region, where noctilucent clouds (NLCs) form and polar summertime echoes are present, atomic oxygen is the dominant reactive species. Observations by Gumbel *et al.* (1998) reveal sharp gradients and distinctive minima in oxygen atom concentration coinciding with observed NLC layers. These observations suggest an interaction between oxygen atoms and NLC particles. Recent laboratory studies conclude that the uptake coefficient of atomic oxygen on ice is not large enough to change the gas-phase concentrations in the mesosphere lower thermosphere (MLT) region (Murray and Plane, 2003). However, the question of whether or not atomic oxygen can affect the formation and growth of ice has not been experimentally addressed. To gain insight into possible interactions between atomic oxygen and ice surfaces, we directly measure ice growth rates at temperatures associated with the summertime mesopause region (110-150 K), with and without exposure of the growing ice layer to partially dissociated oxygen. A liquid nitrogen cooled cryostat is used to control the temperature of a gold mirror in a high vacuum chamber. Water vapor, either from the residual background or from an introduced source, is allowed to condense on the mirror. A microwave discharge is used to partially dissociate an oxygen stream, which is sampled into the chamber through a small orifice facing the gold mirror. Grazing angle Fourier transform infrared reflection absorption spectroscopy (FTIR-RAS) is used to monitor the rate of ice growth. Preliminary results at 130 K indicate that the ice growth rate in the presence of oxygen slows when the microwave discharge is activated and the ratio of water to oxygen is low. For H_2O/O_2 = ∼0.3 %, at a total chamber pressure of about 7 μTorr, the growth rate reduction amounts to 24±9 %. Changes in the FTIR-RAS absorption profile of the OH stretching vibrations are also noted, which may indicate changes in ice morphology. Both results suggest that the presence of atomic oxygen influences how ice forms and grows, though more extensive experimentation is required to solidify this conclusion. This testing is underway and results will be presented and discussed.

Gumbel, J., D. P. Murtagh, P. J. Espy, and G. Witt, "Odd Oxygen measurements during the Noctilucent Cloud 93 rocket campaign," *Journal of Geophysical Research*, Vol. 103, No. A10, 1998, pp. 23,399-23,414.

Murray, B. J, and J. M. C. Plane, *personal communications*, 2003

SA51A-0483 0830h POSTER

Polar Mesospheric Clouds as Seen by the Halogen Occultation Experiment

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Data from the Halogen Occultation Experiment (HALOE) are being used to study Polar Mesospheric Clouds (PMCs), their long-term variations with time, northern and southern hemispheric asymmetries, and variations with latitude. HALOE has been observing the polar summer region since the end of 1991, which has provided 12 northern and 12 southern seasons of data. HALOE typically makes 2-3 sweeps through the high latitudes each summer that provide approximately 600 polar observing opportunities each PMC season. These observations can vary with latitude and time for each summer season, and since PMC occurrence frequency will depend on latitude and time, the HALOE PMC observations are normalized to the SME climatology as described by Shettle et. al. (2002) so that interannual comparisons can be made. We will present the seasonal PMC occurrence frequency and extinction, and the seasonally averaged temperature and water vapor at PMC altitudes for both the northern and southern hemisphere. PMC altitude distributions for each hemisphere and occurrence frequency with latitude and time in a season will be shown. Occurrence frequency results versus time show good agreement with the SME distribution.

SA51A-0484 0830h POSTER

Summertime Shuttle Plume Transport to the Arctic Using Lower Thermospheric Wind Observations

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Recent observational evidence indicates that space shuttle main engine water vapor exhaust can travel to the Arctic and create polar mesospheric clouds (PMCs). If this phenomenon is repeatable, then hundreds of metric tons of water vapor could be ushered into the Arctic lower thermosphere every summer from the shuttle and other mid-latitude launches worldwide. The shuttle-PMC link is a stringent test of our understanding of constituent transport near 110 km. We address it by compiling satellite observations of lower thermospheric winds from NASA's Upper Atmospheric Research Satellite (UARS) for use in a parcel advection model that includes effects of season, altitude, local time and latitude. We find that satellite wind climatologies yield plume motion in the direction observed but significantly slower than inferred from our observations. Reported peak wind speeds from chemical release experiments are generally higher than those from satellites in the 100-110 km region. If wind speeds are as high as the chemical release data indicate, the inferred plume motion can be reproduced. We use recent summertime shuttle plume observations from a microwave instrument measuring water vapor in the Arctic to help constrain the transport.

SA51A-0485 0830h POSTER

The response of PMCs to Shuttle Water Vapor Plumes in the Arctic

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Recent work shows evidence that space shuttle water vapor exhaust can travel to the Arctic and form polar mesospheric clouds (PMCs), visible about a week after launch. A ground-based microwave spectrometer in northern Norway (69° N) has been measuring water vapor in the upper atmosphere since 1995. These data reveal that several space shuttle plumes injected in the summer were detected by the microwave spectrometer one to three days after launch. To explore whether each of these Arctic shuttle plumes leads to PMC formation, we analyze satellite PMC data collected by Solar Backscatter Ultraviolet (SBUV/2) instruments following each case where an Arctic shuttle plume was observed. Some shuttle plumes lead to significant observed PMC responses, while others lead to weaker or no observed responses. Since the orbits of most SBUV/2 instruments drift in local time and the PMC lighting conditions evolve during the season and with latitude, we examine the observational conditions for each case to quantitatively determine the detection capability of SBUV/2 following each Arctic plume observation. Using the comprehensive coverage of SBUV/2 over the polar cap, we will also quantify the spatial and temporal extent of any burst of PMC activity following a shuttle launch.

SA51A-0486 0830h POSTER

Rocket-borne Probes for Charged Ionospheric Aerosol Particles

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Two types of rocket-borne probes are described for detecting charged aerosol particles in the ionosphere. The first are flat charge-collecting surfaces on the skin of the rockets that have returned data in four experimental campaigns. The collection surfaces have behind them permanent magnets that shield the probes from electrons. Some of the probes also have an electrical bias to repel light, positive ions. The current that is recorded is thus from heavier charged aerosol particles. This heavy charge carrier current is converted to a charge number density. The second type of probe, under development, is an electrostatic mass analyzer in which different ranges of mass are collected within the payload on surfaces with different bias potentials

URL: http://debye.colorado.edu/research.html#Rocket