## SA41C-06 1140h

### A Semi-Annual Study of the Micrometeor Influx in the Mesopause

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We present and discuss results from the first six months of a year-long observation campaign of the micrometeor influx in the upper atmosphere using the dual-beam 430 MHz Arecibo Observatory radar. The AO radar detects decelerating particles in the size range 0.5-100 microns for which precise altitude; instantaneous Doppler velocity (rms errors of the order of 10-100 m/sec) and (constant) deceleration are obtained. This provides a tool for the study of a mass-region of the interplanetary dust distribution and its influence to the mesopause that was previously inaccessible to ground-based instruments and helps bridge the gap between spacecraft dust measurements and traditional meteor radar capabilities. The meteor rate detected inside the 305 m-diameter radar beam peaks at sunrise ($\sim$40 events per minute) when the radar points near the apex. We find the meteor flux rate as well as the geocentric velocity distribution to be strongly dependent on the topocentric declination implying a function with radiant ecliptic latitude. In addition, we present estimations of the total micrometeor mass flux derived from these observations, resulting in $\sim$2000 tons of meteoric material deposited over the whole earth each year in the 80-120 km altitude region. Preliminary results also show that the mass flux peaks in June (i.e. a function of ecliptic longitude) in agreement with diurnal measurements of metallic densities derived from lidar observations.

## SA41C-07 1155h

### Simultaneous Observations of Neutral Ca and K Metallic Layers from Arecibo and the Possible Influence of Micrometeoroids on Sporadic Layers

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We present a few cases of simultaneous lidar observations of neutral Ca and K metallic layers from Arecibo. During several nights, sudden enhancements in both metals were seen in the early morning hours and we tried to correlate this with the occurrence of meteor showers. Our observations show that the sporadic layers were strong during the weak Lyrids showers in June, as compared with those that occurred during the presence of fast meteor showers like the Eta-Aquarids and the Perseids. The occurrence of early morning sporadic layers appears to be consistent with the increase in meteor activity during that period, which has been reported earlier in the literature. Thus, we investigated the seasonal variations observed in sporadic micrometeoroids using the Arecibo Observatory radar operated in the meteor mode. This study revealed an increase in the sporadic activity of micrometeoroids in June, which may be partly responsible for the occurrence of strong neutral layers seen during early morning hours in the summer. Apart from this, we will discuss the different characteristics of Ca and K layers observed at Arecibo and relate them to the mesospheric chemistry.

# SA42A MCC: 2006 Thursday 1340h

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

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

## SA42A-01 1345h INVITED

### Noctilucent Clouds and Mesospheric Water Vapor: Past and Future

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Observations of long-term (here: 10 to 25 years) variations of NLC brightness have often been explained by postulating similar, positively correlated long-term variations of the mesospheric H2O mixing ratio. The weak point in these arguments has always been, however, that until today it is not possible to measure the postulated variations of water vapor mixing ratio at NLC altitudes ( 83 km) with an accuracy and duration as required to really support the argument. Even more unsettling is the fact, that the scenario develops just into the opposite direction. All available long-term ground-based and satellite-borne observations of the H2O mixing ratio at 70 km altitude show clearly, but unexpectedly, that since the summer of 1995 this ratio decreases near-continuously, while over the same period satellite-borne observations show the mean NLC albedo to increase significantly. We have therefore studied the sensitivity of the volume backscatter coefficient of NLC layers on the ambient H2O mixing ratio by means of our 3-D COMMA/IAP model. Our results show, as expected, that a decrease in the mesospheric H2O mixing ratio should cause a strong non-linear decrease of NLC volume backscatter coefficient. Hence, our and other models fail to explain the observed long-term anticorrelation of NLC brightness and mesospheric H2O mixing ratio. From this we conclude that the lately observed increase of NLC brightness is either primarily driven by an atmospheric parameter other than the H2O mixing ratio or due to an odd latitude dependence of the long-term variations of H2O mixing ratio above 80 km altitude. This situation makes a robust prediction of future changes in NLC brightness very difficult.

## SA42A-02 1405h

### Water Vapor Enhancement in the Polar Summer Mesosphere and its Relationship to Polar Mesospheric Clouds

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Polar mesospheric water vapor exhibits a strong seasonal cycle, with summer mixing ratios dramatically higher than in winter. It is generally accepted that vertical transport from 50 km altitude towards the mesopause is one driver behind this change, however, upwelling alone cannot explain observed H2O changes. H2O near 83 km increases from 1 ppmv in winter to over 8 ppmv in summer, and upwelling accounts for roughly half of this increase. It has been suggested that evaporation of polar mesospheric clouds (PMCs) should produce a layer of enhanced water vapor. This idea was challenged using particle measurements from the Halogen Occultation Experiment (HALOE) to derive the equivalent gas phase H2O contained in PMCs. Comparing these estimates to HALOE water vapor measurements suggests that PMC evaporation is a large component in H2O enhancement near 83 km during summer.

## SA42A-03 1420h INVITED

### Long-Term Trends Derived from Satellite PMC Data

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The recent availability of long-term PMC data sets from satellites provides the opportunity to evaluate possible PMC trends over the past few decades. Satellite PMC data have daily coverage to characterize seasonal variations, sufficient detections for each season to give good statistics, quantitative information for physical analysis, and coverage of both hemispheres to evaluate global behavior. Multiple PMC data sets are available from the SBUV and SBUV/2 instruments on the Nimbus-7 and NOAA TIROS polar orbiting satellites. These overlapping data sets now provide more than 24 years of continuous data from November 1978 to the present, typically with concurrent measurements from multiple instruments during each PMC season. The SAGE II instrument has also accumulated more than 17 years of PMC data since 1985. Analysis of these lengthy data sets shows a clear anti-correlation between seasonally averaged PMC occurrence frequency and solar UV activity over the past two solar cycles, in agreement with model predictions. The SBUV data also show a significant long-term increase in PMC brightness in both hemispheres, approximately +4%/decade in the Northern Hemisphere and +7%/decade in the Southern Hemisphere. These results can be compared with information about trends in plausible source mechanisms such as mesospheric water vapor and temperature. Model results suggest that PMC brightness changes are consistent with observed long-term water vapor changes. Additional factors probably contribute to the overall PMC response for individual seasons. Future satellite instruments (SBUV/2, OMPS) will continue the SBUV PMC data record for an additional 10-20 years. Hopefully, further improvements in modeling will allow these data to become useful in characterizing the trends in atmospheric parameters.

## SA42A-04 1440h

### Can Water Vapor Increases Explain Long-term Variability in the Brightness and Occurrence Frequency of Mesospheric Clouds?

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It is now well established that stratospheric water vapor (H2O) has undergone significant increases (of the order of 1 percent/year), at least since measurements began in the 1960's, and are likely to have occurred over nearly the entire 20th century. The principle of continuity of hydrogen atoms calls for similar changes in the mesosphere. This is confirmed by recent reports of non-polar trends (0.5-1 percent per year) in H2O at 70 km as measured by the HALOE instrument on board of UARS. These trends apply to the recent period 1992-2002. It has been long suspected that water vapor variability can explain much of the variability of mesospheric clouds (MC). We consider this possibility from two aspects: (1) observationally, a long-term increase in the albedo and occurrence frequency of bright MC has been observed in SBUV and SBUV-2 data series, as well as a 10-11 year periodic component presumably related to solar cycle changes, and (2) theoretically, the CARMA microphysical model predicts an exponential dependence of MC brightness with H2O. In this paper, we compare theoretical expectations with the observed trends in albedo and occurrence frequency. Our results show that long-term increases in H2O at polar latitudes, combined with observed solar modulation in H2O, are fully capable of explaining the variability in MC brightness, although details are still uncertain (e.g. north-south differences). The measured albedo changes observed by SBUV/SBUV-2 may also contain the signal of a recent reversal of the water vapor trend since 1996. Although there is yet no evidence for long-term trends in mesopause region temperature (or temperature variability), we illustrate the model sensitivity to possible long-term cooling/warming near the mesopause. It will be necessary to conduct simultaneous measurements of these controlling factors in the presence of MC in order to sort out their relative importance.

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 $\lambda^{-4}$ 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 ∼50-70 nm and dispersions of ∼1.15-1.20. However, the PMC spectrum exhibits a peculiar (anomalous?) "hump" near $\lambda$=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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