it is launched in December 2002. MAESTRO is a photodiode array spectrometer that will make solar occultation measurements of atmospheric attenuation during satellite sunrise and sunset to investigate the dynamical and chemical processes affecting stratospheric ozone. The precursor instrument to MAESTRO, the SunPhotoSpectrometer, was launched August 29, 2000 from Vanscoy, Saskatchewan as part of the main high-altitude balloon payload during the MANTRA (Middle Atmosphere Nitrogen TRend Assessment) 2000 field campaign. Sunrise occultation measurements made from a float altitude of 37 km have resulted in the retrieval of vertical profiles of ozone and nitrogen dioxide. Of particular relevance to the MAESTRO project are measurements of the A and B bands of molecular oxygen, which will be used for retrieving vertical profiles of atmospheric temperature and pressure on orbit. Molecular oxygen measurements made during the MANTRA campaign will be used to validate line-by-line models for MAESTRO temperature and pressure retrievals.

## A32B-0056 1330h POSTER

### Attitude Determination for Limb-scanning Satellites: The "KNEE" at 305 nm

Chris E Sioris[1] (csioris@nimbus.yorku.ca); Christian von Savigny[1]; Richard L Gattinger[2]; Jack C McConnell[1]; Ian C McDade[1]; Erik Griffioen[1]; Edward J Llewellyn[2]; The Odin Team[3]

[1]York University, 4700 Keele Street, Toronto, ON M3J 1L3, Canada

[2]University of Saskatchewan, 116 Science Place, Saskatoon, SK S7N 5E2, Canada

[3]Odin web page, http://www.snsb.se/Odin/Odin.html

A technique based on observation and modelling of ultraviolet radiative transfer is developed to determine pointing to < 1 km accuracy for satellite instruments viewing Earths limb. The method consists of locating the knee, defined as the maximum in the limb radiance profile, at a wavelength of 305 nm. The tangent altitude of this observational point (pixel or image, depending on whether or not the instrument is an imager) is known from radiative transfer modelling and is insensitive to tropospheric clouds, stratospheric aerosol, temperature, surface albedo and change in azimuth angle. Observations over several orbits with OSIRIS (optical spectrograph and infrared imager system) onboard the ODIN satellite and model calculations show the knee at 305 nm is at ~44 km. The insensitivity of the knee to these spatially variable geophysical parameters implies that the instrument measuring the limb radiance profile need not be an imager for this technique to be applicable. Although there is some sensitivity to SZA, ozone number density and pressure, it is predictable using appropriate model atmospheres and scattering geometry. Previously [e.g. McPeters et al., 2000], the knee at 345-355 nm was suggested for attitude sensing but our calculations and OSIRIS observations have shown this to be so sensitive to clouds and SZA that there is no knee in this wavelength range for certain scenarios. Internal scattering limits this technique with OSIRIS to wavelengths >300 nm. Odin is a Swedish-led satellite project funded jointly by Sweden (SNSB), Canada (CSA), Finland (Tekes) and France (CNES).

## A32B-0057 1330h POSTER

### Stratospheric & Tropospheric Production of Nitrous Oxide: New Insights

Sheo S. Prasad[1] (1-925-426-9341; ssp@CreativeResearch.org)

Edward C. Zipf[2] (1-412-963-6493; edczipf@aol.com)

[1]Creative Research Enterprises, P.O.Box 174, Pleasanton, CA 94566, United States

[2]Physics Department, University of Pittsburgh, Pittsburgh, PA 15260, United States

Nitrous oxide ($N_2O$) is very important as a powerful greenhouse gas and the dominant source of stratospheric NO. Current uncertainties in its sources and sinks and the origin of its mass-independent isotopic enrichment warrant a discussion of a recent significant development.

• Since no production was seen by Estupinan et al (ESNW)[1] in photolysis of $O_3/O_2/N_2$ mixture at 532 nm, the excited $O_3$ capable of forming $N_2O$ ($O_3{}^{N2O}$) in Zipf-Prasad (ZP)[2] experiment is not produced in $O(^3P)$,$O_2$ recombination. It is likely a minor byproduct (reaction (1a)) of the termolecular quenching of $O(^1D)$ by $O_2$.

$O(^1D)+ O_2 + O_2$ -> $O_3{}^{N2O} + O_2{}^{*\#}$(1a)

$O(^1D)+ O_2 + O_2$ -> $O_3$ (highly dissociative singlets)+ $O_2{}^{*\#}$(1b)

The rate coefficient, $k_{1a}$, needed to model ZP's quantum yield ($\Phi$)of $N_2O$ is $\sim 4x10^{-33}$ $cm^{-6}$ $s^{-1}$. The reaction (1b) or its parallel $O(^1D) + N_2 + O_2$ -> $O_3$ (highly dissociated triplets) + $N_2$ (R2) probably made a minor contribution to ZP's $\Phi$ since the lifetimes of the relevant excited $O_3$ is < 1 ns. Reactions (1b) & (2) amount to termolecular quenching of $O(^1D)$ since excited singlet and triplet $O_3$ dissociate.

•The $\Phi$ of $N_2O$ in ESNW and Maric & Burrows (MB)[3] experiments with 266/254 nm via the "true" $N_2O$, $O(^1D)$ association may have been even lower than $3x10^{-7}$. Due to the reactivity of highly stretched molecules, the third generation $N_2O$ ($N_2O^{**(3)}$) in the chain of events that produces $N_2O$ from the initial $N_2$, $O(^1D)$ association may be prone to loss by $O_2$ (via possible reaction $N_2O^{**} + O_2$-> $N_2 + O_3{}^*$) when $n(O_2)$ -> $n(N_2)$. Thus, the idea that almost all of $N_2O$ observed by ESNW & MB was due to excited $O_3$ needs consideration. Their data suggest a smaller yield.

• Possibly, valuable information about the origin and properties of excited $O_3$ may be hidden under this difference. As the first step towards progress, we need to check if the differences in ZP's and ESNW's results can be narrowed by better experiments. ZP had used a spectrally coarse light source. ESNW got a larger yield of $N_2O$ than MB by reducing $O_3$, and the residence time of the product $N_2O$ in the region affected by the photolysis. A rapid loss of $N_2O$ was observed by Black et al[4] in a set up where some products of the $O_3$ photolysis at 254 nm could react with $N_2O$ on the surface of reaction-chamber. Surface loss of $N_2O$ was probably not a concern in experiments at pressures > 20 atm and steel vessels. It could be a problem at 1 atm in narrow cylindrical vessels of pyrex with surface-to-volume ratio (S/V) > 1.

•More experimental studies of $N_2O$ production from $O_3{}^{N2O}$in air are therefore needed, using flowing gas (for lesser residence time) and reaction vessels with small S/V (for reduced surface loss). If $O_3{}^{N2O}$ produces $N_2O$ then low-lying excited singlet and triplet states of $O_3$ may do the same in the denser troposphere (Prasad[5]). This possibility needs study since it may potentially compensate for the lesser efficiency of $O_3{}^{N2O}$ in atmospheric production of $N_2O$ in the new scheme of $O_3{}^{N2O}$ formation by only $O(^1D)$. Scanning of the entire $O_3$ absorption region with spectrally finely resolved irradiation is therefore also needed.

[1]Ph.D. Thesis, Georgia Tech, 2001; [2]GRL., 25, 4333, 1998; [3]J. Photochem. Photobio. A, 66, 291, 1992; [4]J. Photochem., 22, 369, 1983; [5]JGR., 102, 21,527, 1997.

## A32B-0058 1330h POSTER

### Observations of a Heterogeneous Source of OClO from a Reaction of ClO with an Ice Surface

J R. McKeachie[1] (949-824-3005; jmckeach@uci.edu)

Matt F. Appel[1] (mappel@uci.edu)

Thorsten Benter[2] (tbenter@uni-wuppertal.de)

Ralph N. Schindler[3]

[1]University of California, Irvine, University of California, Irvine, CA 92697-2025, United States

[2]Bergische Universitaet GH Wuppertal, FB9, Gauss Str. 20, 42097, Wuppertal, Germany

[3]Institut fuer Physikalische Chemie der Universitaet, Kiel, Ludewig-Meyn-Str. 8, D-24098, Kiel, Germany

Experiments presented in this contribution demonstrate a heterogeneous source of several chlorine oxides, including Cl2O, Cl2O3, and OClO, from a flow of ClO radicals passed over glass or ice surfaces. ClO radicals were passed over these surfaces in a flow system monitored by UV-VIS absorption spectroscopy and Time-of-Flight mass spectrometry. It is suggested that a ClOH2O complex formed in the flow system is responsible for deposition of the ClO radicals onto the glass/ice surface, and several reaction pathways resulting in the formation of observed products are presented. The observation of OClO evolving from an ice surface after ClO radicals have been introduced to it carries some possible atmospheric implications, as there is currently a missing source of OClO in the chemically perturbed polar vortex. The ClO/BrO reaction system is currently believed to be the only source of OClO in the stratosphere, and several studies show this reaction system to severely underestimate OClO production in the polar vortex. It is suggested this new heterogeneous source of OClO from a ClOH2O reaction with an ice surface could carry implications on the total OClO budget.

## A32B-0059 1330h POSTER

### Raman Spectroscopy and Microphysics of Single PSC Precursor Particles Suspended in a Quadrupole Trap

David M Sonnenfroh[1] ((978) 689-0003; sonnenfroh@psicorp.com)

Amy J R Hunter[1] ((978) 689-0003; hunter@psicorp.com)

Wilson T Rawlins[1] ((978) 689-0003; rawlins@psicorp.com)

[1]Physical Sciences Inc., 20 New England Business Center, Andover, MA 01810, United States

Polar stratospheric clouds (PSCs) consist primarily of solid nitric acid trihydrate (NAT) particles, which are thought to nucleate via HNO3 uptake on background sulfuric acid particles at temperatures below 195 K. The mechanism for this process is uncertain, and depends on whether the sulfuric acid particles are solid or liquid at these temperatures. Previous results from laboratory and field measurements are mixed; our previous single-particle laboratory experiments showed that binary H2SO4/H2O particles at stratospheric compositions are essentially metastable in the liquid phase when cooled to PSC temperatures. Currently, we are investigating the detailed microphysics of binary (H2SO4/H2O) and ternary (HNO3/H2SO4/H2O) single particles suspended in an electrodynamic levitator, using optical elastic scattering and Raman spectroscopy to observe changes in phase and composition. Single-particle Raman spectra for supercooled binary particles exhibit spectral distributions which alter markedly with decreasing temperature down to 190 K. The variations signify increasing dissociation of HSO4(-) to SO4(-2) with decreasing temperature, consistent with measurements for bulk solutions. Upon gradual warming of supercooled liquid binary particles, some of them freeze briefly in a narrow "window" of the phase diagram, near 210 K and 60 weight per cent H2SO4. We will discuss the Raman spectroscopy and microphysical behavior of the liquid and frozen particles for both the binary and ternary systems.

This research was supported by the NASA Atmospheric Effects of Aviation Program.

# A32C MC: 123 Wednesday 1330h

## Predictability of the North American Monsoon System I

*Presiding:* **R Oglesby**, NASA/MSFC/GHCC

## A32C-01 1330h INVITED

### Modelling and Predicting the North American Monsoon System: Status and Prospects

David S Gutzler (505-277-3328; gutzler@unm.edu)

University of New Mexico, Dept of Earth Planetary Sci., Albuquerque, NM 87131, United States

The regional summer climate regime across Southwest North America provides an extreme challenge to numerical models. Precipitation in this semiarid monsoonal domain is modulated by a daunting combination of complex topography, ocean-atmosphere and land-atmosphere fluxes, midlatitude synoptic systems, organized mesoscale convective processes, and subgrid-scale deep convective clouds. To add to this complexity, verification data needed to facilitate model simulation improvement are sparse across much of the domain. This talk discusses some recent North American Monsoon System (NAMS) simulations and outlines a strategy for progress on modeling and predicting the NAMS, to take place in concert with field activities associated with the upcoming North American Monsoon Experiment (NAME).

## A32C-02 1350h

### Simulating Extreme Summer Precipitation Patterns in the North American Monsoon Region using the CCM3/HRBATS Model

Andrea N Hahmann (520-621-6619; hahmann@atmo.arizona.edu)

Andrea N. Hahmann, Institute of Atmospheric Physics, The Univ. of Arizona, Tucson, AZ 85721, United States

Current climate integrations with the National Center for Atmospheric Research Community Climate Model (CCM3) show a very pronounced dry bias in summer precipitation over the North American Monsoon System (NAMS) region. Additionally, summer

precipitation totals in this region show a smaller than observed interannual variability and a weak response to changes in SSTs. To understand the reasons behind the CCM3 misrepresentation of monsoonal processes in the NAMS region, we have chosen to examine model simulation during two extreme years: 1984 (wet) and 1993 (dry). These two years were selected according to observed precipitation totals in the northernmost portion, i.e. Arizona and New Mexico, of the NAMS region.

Ensemble AMIP-type simulations with CCM3 in its standard configuration (i.e., at T42 resolution and coupled to its standard land surface model; LSM) show only small differences in precipitation over the NAMS region between the two chosen extreme years. When CCM3 is coupled to BATS and integrated over several years with SSTs for the two contrasting years, the differences in summer precipitation remain much smaller than the observed differences. In a final experiment, CCM3 is coupled to the fine-mesh version of BATS (named HRBATS), which is described in Hahmann and Dickinson (2001). This model allows for explicit representation of sub-grid variations in vegetation and soils and the inclusion of fractional ocean areas. In these simulations, a very pronounced difference in precipitation, comparable to the observed precipitation differences, is seen between the two contrasting years. The possible physical mechanisms that might explain these differences are explored in this talk. Possible reasons include the presence of the waters of the Gulf of California, which might provide a moisture source, and the better representation of snow cover over the prior winter and spring seasons.

### A32C-03 1405h

## Examinations of Linkages Between the Northwest Mexican Monsoon and Great Plains Precipitation

Stephen M Saleeby[1] (970-491-8424; smsaleeb@atmos.colostate.edu)

William R Cotton[1] (970-491-8593; cotton@atmos.colostate.edu)

[1]Colorado State University, Department of Atmospheric Science Colorado State University, Fort Collins, CO 80523, United States

The Regional Atmospheric Modeling System (RAMS) is being used to examine linkages between the Mexican monsoon and precipitation in the Great Plains region of the United States. Currently, available datasets have allowed for seasonal runs for July and August of the 1993 flood year in the midwest US and the 1997 El Nino year. There is also a plan to perform a full monsoon season simulation of the drought summer of 1988 once precipitation data becomes available. Preliminary results of this ongoing study are presented here.

The model configuration consists of a 120km resolution coarse grid that covers a region from west of Hawaii to Bermuda and from south of the equator up into Canada. Two 40km resolution nested grids exist, with one covering the western two-thirds of the United States and Mexico and the other covering the Pacific ITCZ. A 10km fine grid and 2.5km cloud resolving grid are spawned over the region of monsoon surges to explicitly resolve convection. The model is initialized with NCEP reanalysis data, surface obs, rawinsonde data, variable soil moisture, and weekly averaged SST's. RAMS is running with two-stream Harrington radiation, one moment microphysics, and Kuo cumulus parameterization.

The completed 1993 and 1997 seasonal simulations are now being examined and verified again NCEP reanalysis data and high resolution precipitation data. Initial model results look promising when verified against the NCEP upper level fields, such that the model is able to capture the large scale dynamics. For the duration of both seasonal runs, RAMS successfully simulates the mid and upper level geopotential heights, the temperature, and winds. The large scale 700mb and 500mb anti-cyclone over the US and Mexico is resolved, as well as the easterly flow over Mexico. Model fields are also being examined to isolate monsoon surge events which are characterized by increased precipitation over the Sierra Madres and a northward moisture surge into the northern extent of the Gulf of California and southern Arizona.

Within the coarse grids, the RAMS model has successfully resolved the low-level jet that persists in the Gulf of California and the local maximum in mixing ratio that persists over the gulf. It has also captured the upslope flow over the Sierra Madres that forces the moist air into the higher elevation to the east. This provides the necessary lifting and moisture for the development of intense convection and resulting large amounts of precipitation that occur along the Sierra Madre mountain range. Examination of model-predicted low-level moisture transport reveals that moisture advected from the Gulf of California is the primary monsoon moisture source, rather than the Gulf of Mexico. Time averages of moisture transport, mixing ratio, winds, and precipitation for July 1993 reveal the prominent diurnal cycle variations that exist due to radiative effects and land-sea interactions; the maximum in convection, precipitation rate, and moisture transport occurs around 00Z.

Seasonal accumulated precipitation amounts in the model are successful in predicting the placement of precipitation and relative amounts for most of the 40km continental grid, but there is an overestimation of precipitation along the northern Sierra Madre Occidental and an underestimation in the US mid-west. During the 1993 flood summer, much of the mid-west US precipitation fell in association with mesoscale convective systems; it is suspected that other cumulus parameterizations may provide better prediction of sub-grid scale convective precipitation.

URL: http://hugo.atmos.colostate.edu/www/monsoon/monsoon.html

### A32C-04 1420h

## Stretched grid GCM simulations of the onset of the North American Monsoon

E. Hugo Berbery[1] (301 405 5351; berbery@atmos.umd.edu)

Michael Fox-Rabinovitz[2] (foxrab@atmos.umd.edu)

[1]E. Hugo Berbery, Department of Meteorology 3427 CSS Bldg University of Maryland, College Park, MD 20742, United States

[2]Michael Fox-Rabinovitz, ESSIC/Department of Meteorology University of Maryland, College Park, MD 20742, United States

Numerical experiments with a variable resolution general circulation model (GCM) are employed to investigate the mesoscale features of the circulations associated with the North American monsoon. The GEOS (Goddard Earth Observing System) stretched-grid (SG) GCM with enhanced resolution over the U.S. was run with two SG-configurations. The first configuration is obtained by redistribution of the grid points originally at a global uniform 2x2.5 degree grid, while the second one redistributes a 1x1 degree grid. The stretched grids have approximately 60 km and 40 km uniform resolution over the U.S., and immediate vicinity, for the model dynamics and orography, while physics is resolved at a 2x2.5 and 1x1 degree uniform global resolutions, respectively. Along with higher regional resolution, the 40km/1x1 grid has better resolved the land-sea differences.

Earlier research has shown that mesoscale components (not simulated by typical global models) are critical to resolve the monsoonal circulations over North America. Here, four subregions of interest were identified; they are the core monsoon region in Northwestern Mexico, the Arizona monsoon, the southern Great Plains and the northern Great Plains. The evolution of precipitation during the 1993 warm season for each region was analyzed and compared to high resolution rain gauge observations. The onset of precipitation over Arizona occurred about one month after the onset at the core monsoon region, although this may vary from season to season. The simulations also reproduce the decay of precipitation over the southern Great Plains that has been linked to the onset of the monsoon; over the northern Great Plains, where historical flood records were broken, heavy precipitation was also reproduced, both in intensity and frequency.

Results also indicate that the two configurations adequately represent the main components of the monsoon and its onset, but the 40 km/1x1 version also resolves the low-level jet over the Gulf of California that develops in conjunction with the onset of precipitation over Arizona. On the other hand, this jet was not captured by the 60 km/2x2.5 version suggesting that both the dynamical forcing (including orography) and the physical forcing (including land?sea differences) need to be adequately resolved to reproduce the structure of the monsoon. It is suggested that 40 km/1x1 or finer resolutions are needed for efficient representation of mesoscales in SG-GCM simulations.

### A32C-05 1435h

## SEASONALITY OF MODEL-BASED MOISTURE-FLUX QUANTITIES OVER THE NORTH AMERICAN MONSOON REGION

David A Salstein[1] (781-761-2288; salstein@aer.com)

Richard D Rosen[1] (781-761-2288; rdrosen@aer.com)

[1]Atmospheric and Environmental Research, Inc., 131 Hartwell Ave., Lexington, MA 02421

We examine differences among atmospheric general circulation models in their ability to reproduce the seasonal variation in the distribution of moisture and its fluxes over the continental United States, using results from the second Atmospheric Model Intercomparison Project. Currently output from 16 models is available from the AMIP-2 experiment, which covers the period 1979-1995. The model moisture flux divergence is calculated from the difference between evaporation and precipitation fields using the water balance equation, and it is compared against the vapor divergence in the NCEP-NCAR reanalysis. Water vapor fluxes from the reanalysis indeed reveal a distinct seasonal cycle, with inflow from the Gulf of Mexico, becoming particularly strong in the summer. In fact, summer is the only season in which evaporation exceeds precipitation in the models over the conterminous US, leading to an overall moisture flux divergence. Focusing on the North American Monsoon Experiment domain 2, model and reanalysis results indicate a northward advance of moisture flux divergence from May to August, with a subsequent retreat southward by October. Model precipitation has a similar signature, though it fails to reach as northern a latitude as that of the reanalysis. Monthly anomalies in the time series of model-based moisture divergence over the NAME-2 region reveal some especially strong years, though not well correlated with the estimates from the reanalysis. We analyze in detail the Sud and Walker NASA/GSFC model to diagnose the capability of a GCM with sophisticated cloud and boundary-layer physics to produce this seasonal progression of the moisture flux divergence.



### A32C-06 1450h

## Interannual Rainfall Variations in the North American Summer Monsoon Region

Qi Hu (402-472-6642; qhu2@unl.edu)

University of Nebraska-Lincoln, 237 L.W. Chase Hall, Lincoln, NE 68583-0728, United States

The following questions are addressed in this study using an array of data and statistical methods: 1) does the North American monsoon region have a single dominant monsoon system, 2) if it has more than one, what are they, and 3) what are major causes of interannual monsoon rainfall variations in these systems? Results showed two dominant summer monsoon systems in the region: one in south-central Mexico, south of $26^\circ$N latitude, and the other in the southwestern United States and northwestern Mexico. Monsoon rainfall variations in these regions are usually opposite to each other and have different causes. The interannual variations in monsoon rainfall in south-central Mexico were highly affected by interannual variations in the Intertropical Convergence Zone (ITCZ) in the eastern tropical PacificA northern (southern) position of the ITCZ, often related to cooler (warmer) than normal sea surface temperatures in the eastern tropical Pacific Ocean, corresponded to strong (weak) monsoon.

The land memory effect was evident in interannual variations of monsoon rainfall in the southwestern United States, showing by strong correlations of the summer rainfall variation vs. antecedent winter precipitation anomalies in the western United States. However, the effect was not robust but varied fairly regularly. It was strong from approximately 1920-1930 and disappeared from 1931-1960. It regained its strength from 1961-1990 but weakened again since 1990. The forcing of this variation was identified as a multidecadal variation in atmosphere circulations in the North Pacific-North American sector and the land memory effect is part of this variation. This multidecadal variation has to be included in prediction methods in order for them to correctly describe seasonal and interannual variations in summer rainfall in the North American monsoon region.

# A32D MC: 133 Wednesday 1330h

## Advances in Aerosol Science and Technology II

***Presiding:*** **K D Perry,** San Jose State University; **L A Barrie,** Pacific Northwest National Laboratory

### A32D-01 1330h

## An Overview of the ACE-Asia Aerosol Characterization Experiment Intensive Observations During the Spring of 2001

Barry J Huebert (1-808-956-6896; huebert@soest.hawaii.edu)

University of Hawaii, Dept. of Oceanography, Honolulu, HI 96822, United States

The objectives of the ACE-Asia experiment are to 1) determine the physical, chemical, and radiative properties of the major aerosol types in the Eastern Asia and Northwest Pacific region and investigate the relationships among these properties, 2) quantify the interactions between aerosols and radiation in the Eastern Asia and Northwest Pacific region, and 3) quantify the physical and chemical processes controlling the evolution of the major aerosol types and their physical, chemical, and radiative properties. To achieve these objectives, scientists from 13 countries made intensive observations in the spring of 2001 using three ships,