the Tropospheric Ozone Production about the Spring Equinox (TOPSE) experiment provides the calibration dataset. This model shows regions of layering of stratospheric air in the troposphere with a ubiquity that has been suggested by recent observational studies but has yet to be duplicated by chemical transport models. The regional distribution of tropopause folding during the TOPSE February-May 2000 study period shows a maximum in the Gulf of Alaska and along the western edge of British Columbia, which would significantly impact the stratospheric contribution of ozone to the North American free troposphere.

A71D-0129 0830h POSTER

NAT Clouds and NOx Near the Tropical Tropopause: Implications for HNO_3

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The presence of nitric acid clouds near the cold tropical tropopause was recently demonstrated using multi-wavelength measurements from the Halogen Occultation Experiment (HALOE). This finding was based on spectral identification using model predictions of the HALOE response to a variety of particle types. Tropical nitric acid clouds (TNCs) were found to exist primarily as nitric acid trihydrate (NAT), and occasionally as liquid ternary HNO3-H2O-H2SO4 aerosols (LTA). This progress has revealed an unexplored phenomena in our atmosphere, and raises numerous questions concerning these clouds. TNCs are under investigation using HALOE measurements in conjunction with model calculations. This work has addressed numerous aspects of these clouds including TNC formation mechanisms, relationships between TNCs and the odd nitrogen budget, and trends based on 11 years of HALOE observations. A variety of observed TNC characteristics have been reproduced by model calculations, including their altitude distribution, seasonal variability, and physical particle properties. HALOE TNC observations offer insight concerning HNO_3 near the tropical tropopause. While gas phase HNO_3 measurements in this region are sparse, the abundance of condensed HNO3 inferred from HALOE TNC measurements has implications for gas phase nitric acid, in addition to TNC formation mechanisms.

A71D-0130 0830h POSTER

Stratospheric Tropospheric Exchange Simulated by a Hybrid Isentropic Model

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Simulations of the fine-scale structure of the stratospheric/tropospheric exchange of potential vorticity, water vapor and clouds, and inert atmospheric constituents by the University of Wisconsin (UW) Hybrid Theta Eta Coordinate Model are presented to demonstrate feasibility and accuracy. The current UW Hybrid Model which smoothly transitions from sigma to isentropic coordinates in the upper troposphere realistically captures the fine scale structure of stratospheric tropospheric exchange within amplifying baroclinic waves. The model also provides a means to study the systematic meridional exchange of atmospheric properties and constituents throughout the stratosphere and troposphere that occurs within the thermally forced mean isentropic zonally averaged Hadley circulations. The numerical accuracies of these exchange processes are assessed with respect to the model's ability to appropriately conserve potential vorticity and dry and moist entropy, the results of which are compared to other global model simulations. Detailed numerical simulations will be presented utilizing VIS 5D

A71D-0131 0830h POSTER

Comparison of Rayleigh Lidar and GPS Radio Occultation Temperature Profiles between 30-60 Kilometers in Altitude.

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GPS radio occultation (GPS/RO) soundings have shown great promise to resolve vertical structures of the atmosphere due to their global coverage and vertical sensitivity. Some previous studies of possible vertical wave structures of the upper troposphere and mesosphere found in GPS/RO measurements have had to rely on climatological and zonal analysis due to the paucity of other measurements in that region. Others compare GPS/RO measurements with global climate analysis models, which can smooth out vertical features. The Aerospace Transportable Lidar System (ATLS) collects data in altitude intervals of 37 meters and time increments of 3 or 5 minutes. When averaged over 0.25 km range elements and 15 minute integration time, temperature retrievals are characterized by RMS errors of 1 K over the range 35-65 km. This system has been routinely used to provide accurate ground-truth useful for comparison with other satellite instruments. In this paper, we compare ATLS measurements coincident with GPS/RO retrieved temperature profiles to show remarkable agreement in the vertical temperature structure between 30-60 km above MSL.

A71D-0132 0830h POSTER

Improved Resolution and Accuracy of Temperature Retrievals from GPS Occultations

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GPS occultations provide global active limb-sounding measurements of the atmosphere under all-weather conditions whereby high vertical resolution profiles of atmospheric refractivity, density, pressure, and temperature (or water vapor) are derived. Sub-Kelvin temperature profiles at sub-kilometer vertical resolution are achievable in the upper troposphere and the stratosphere. The current inversion method is limited by Fresnel diffraction to a vertical resolution of 1–1.5 km. However, more recent techniques bypass this limit by properly taking into account the diffraction effects in the observed signal. These methods can resolve fine-scale vertical structures in the atmosphere. We show that with the higher vertical resolution, the occultations capture sharper tropopause structures with colder temperature minima than the global analyses, thus setting different constraints on the stratospheric-tropospheric exchange of water vapor. By comparing CHAMP and SAC-C occultation events that are temporally and spatially co-located, the resolution, precision, and accuracy of these temperature retrievals are demonstrated.

A71E MCC: 125 Sunday 0830h

Dust Storm Forecasting, Detecting, and Monitoring I *(joint with P)*

Presiding: **W A Sprigg,** University of Arizona**; D Westphal,** Naval Research Laboratory

A71E-01 0830h INVITED

Status and Future of Dust Storm Forecasting

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In recent years, increased attention has been given to the large amounts of airborne dust derived from the deserts and desertified areas of the world and transported over scales ranging from local to global. This dust can have positive and negative impacts on human activities and the environment, including modifying cloud formation, fertilizing the ocean, degrading air quality, reducing visibility, transporting pathogens, and inducing respiratory problems. The atmospheric radiative forcing by the dust has implications for global climate change and presently is one of the largest unknowns in climate models. These uncertainties have lead to much of the funding for research into the sources, properties, and fate of atmospheric dust.

As a result of advances in numerical weather prediction over the past decades and the recent climate research, we are now in a position to produce operational dust storm forecasts. International organizations and national agencies are developing programs for dust forecasting. The approaches and applications of dust detection and forecasting are as varied as the nations that are developing the models. The basic components of a dust forecasting system include atmospheric forcing, dust production, and dust microphysics. The forecasting applications include air and auto traffic safety, shipping, health, national security, climate and weather. This presentation will summarize the methods of dust storm forecasting and illustrate the various applications. The major remaining uncertainties (e.g. sources and initialization) will be discussed as well as approaches for solving those problems.

A71E-02 0845h INVITED

Near-real-time detection and monitoring of dust events by satellite (SeaWiFS, MODIS, and TOMS)

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Over the last few years satellites have given us increasingly detailed information on the size, location, and duration of dust events around the world. These data not only provide valuable feedback to the modelling community as to the fidelity of their aerosol models but are also finding increasing use in near real-time applications. In particular, the ability to locate and track the development of aerosol dust clouds on a near real-time basis is being used by scientists and government to provide warning of air pollution episodes over major urban area. This ability has also become a crucial component of recent coordinated campaigns to study the characteristics of tropospheric aerosols such as dust and their effect on climate.

One such recent campaign was ACE-Asia, which was designed to obtain the comprehensive set of ground, aircraft, and satellite data necessary to provide a detailed understanding of atmospheric aerosol particles over the Asian-Pacific region.

As part of ACE-Asia, we developed a near real-time data processing and access system to provide satellite data from the polar-orbiting instruments Earth Probe TOMS (in the form of absorbing aerosol index) and SeaWiFS (in the form of aerosol optical thickness, AOT, and Angstrom exponent). The results were available via web access. The location and movement information provided by these data were used both in support of the day-to-day flight planning of ACE-Asia and as input into aerosol transport models. While near real-time SeaWiFS data processing can be performed using either the normal global data product or data obtained via direct broadcast to recieving stations close to the area of interest, near real-time MODIS processing of data to provide aerosol retrievals is currently only available using its direct broadcast capability.

In this paper, we will briefly discuss the algorithms used to generate these data. The retrieved aerosol optical thickness and Angstrom exponent from SeaWiFS will be compared with those obtained from various AERONET sites over the Asian-Pacific region. The TOMS aerosol index will also be compared with AERONET aerosol optical thickness over different aerosol conditions, and comparisons between the MODIS and SeaWiFS data will also be presented.

Finally, we will discuss the climate implication of our studies using the combined satellite and AERONET observations.

A71E-03 0900h INVITED

Lessons on Dust Emissions Derived from Experimentation and Development of a Model for Owens (dry) Lake, CA Dust Emissions

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Dust storm forecasting requires modeling of the vertical flux of wind erosion resuspension particles smaller than 10 micrometers (Fa) that is verified by measurement. Experiences in modeling and measurement of Fa over several years at Owens Lake, a large dust-source area in California, may be given in the form of lessons.

The first of these lessons is the inhomogeneity of emissions over the lake surface. The inhomogeneity changes with time so that the positions of "hot spots" on the lake surface move in time even though the surface sediment texture and composition remains almost constant. A second lesson is that parts of the lake almost never produce dust. In fact, of the more than 200 square km surface of the lake, the potentially dust-emitting dry lake bed is almost always smaller than 130 square km. A third lesson is that although there were brief periods during which Fa was not coupled with sand movement (that is PM10 emissions were directly suspended without the mechanism of sandblasting) the overwhelming dominant dust production mechanism was sandblasting. That is, the vertical flux of dust Fa was proportional to the horizontal flux of sand q; ie. Fa = Kq. The K in this equation is a constant and is particular to a given location on the lake surface. A fourth lesson is that q is more variable over the lake surface than is K. Therefore, a practical method for estimating the emission of dust Fa was to measure q at many places and estimate K's as averages for the large active areas of the lake.

Our model of dust emissions for Owens Lake required high quality measurements of PM10 at several locations near the shoreline of Owens Lake and use of a transport model for emitted dust from the lake surface. We estimated K (equal to Fa/q) for the most active areas of dust emissions at Owens Lake as follows: (1) Sand fluxes (q) were measured in a grid of 130 sand flux samplers. The grid has a separation distances of 1 km. (2) Concentration of PM10 were measured at several locations along the shoreline of Owens Lake. (3) Concentrations were modeled using CALPUFF. Initially, a "first guess" value for Fa/q was used with the 130 q values to give the Fa (vertical fluxes of PM10) for each square kilometer of Owens Lake. These Fa values were used in the model and the concentration field is calculated. (4) The ratios of the calculated concentrations at the locations of the TEOM instruments to the actual concentrations are found. Using the mean of these ratios the "first guess" Fa/q value is adjusted so that the predicted and measured concentrations agree one Fa/q value is found for each hour of a dust storm. (5) Owens Lake was divided into three areas having similar surface characteristics. Using appropriate data selection, one-hour Fa /q values that apply to the three distinct source areas of the lake were calculated.

A71E-04 0915h INVITED

Dust Aerosol Modeling: Step Toward Integrated Environmental Forecasting

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A number of models for real-time predicting of the atmospheric dust life cycle has been developed over recent years. Driven by atmospheric models, they are capable to predict dust process with generally reasonable accuracy. Components of an operational regional dust forecasting model will presented in more details.

However, there are several aspects that limit dust models to further improve the quality of dust forecasts. Research areas that offer new dust modeling developments will be discussed. For example, significant improvements could be expected by model assimilation of lidar-based observations. Another promising application is improved treatment of dust-productive soil sources, (including their seasonal variability) by use of very high-resolution data on vegetation cover and soil features.

Being coupled on-line and with two-way dust-radiation feedback interactions with the atmospheric model drivers, future dust models will be capable to improve conventional weather forecasts as well. The approach of such model coupling will be elaborated, considering it as a component of future more complex integrated environmental modelling systems.

A71E-05 0930h

Forecasting Dust Storms Using the CARMA-Dust Model and MM5 Weather Data

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An operational model for the forecast of dust storms in Northern Africa, the Middle East and Southwest Asia has been developed for the United States Air Force Weather Agency (AFWA). The dust forecast model uses the 5th generation Penn State Mesoscale Meteorology Model (MM5), and a modified version of the Colorado Aerosol and Radiation Model for Atmospheres (CARMA).

AFWA conducted a 60 day evaluation of the dust model to look at the model's ability to forecast dust storms for short, medium and long range (72 hour) forecast periods. The study used satellite and ground observations of dust storms to verify the model's effectiveness. Each of the main mesoscale forecast theaters was broken down into smaller sub-regions for detailed analysis. The study found the forecast model was able to forecast dust storms in Saharan Africa and the Sahel region with an average Probability of Detection (POD)exceeding 68%, with a 16% False Alarm Rate (FAR). The Southwest Asian theater had average POD's of 61% with FAR's averaging 10%.

A71E-06 0945h

Near real-time verification of dust models: Possibilities and uncertainties for dust storm forecasting and analysis

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As aerosol transport models move from coarse global climate simulations to temporal and spatial scales of meteorology modeling and forecasting, there is an increasing need for real time verification of particle concentrations and optical depths. Clearly, improvement of dust forecasting is highly dependant on the proper joining of smaller-scale dust sources to the regional and sometimes continental dust clouds. This can in part be done through aerosol data analysis by both numerical and more subjective (forecaster) means. However, global aerosol data sets are few in number and are often inconsistent with one another. Real time aerosol data of the nature required to be utilized in an aerosol model or by a forecaster is very limited. While all data has some benefit when utilized properly it is unclear how the current set of rapidly produced aerosol products can be objectively included in dust forecast methods. In this paper we give an overview of available data and diagnose uncertainties for forecasters using the Navy Aerosol Analysis and Prediction System (NAAPS). We discuss the application and uncertainties applying satellite data such as that from TOMS, SeaWiFS, GOES, MSG, and MTSAT. We also examine less traditional data sets such as near real time data from AERONET Sun photometers and surface/shipboard visibility measurements.

A71F MCC: 102 Sunday 0830h

Chemistry and Microphysics of Aerosol Particles I

Presiding: **P Hamill,** San Jose State University**; P DeMott,** Colorado State University

A

A71F-01 0830h INVITED

Are Organic Aerosols Good Cloud Condensation Nuclei?

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The ability of a set of organic-containing aerosols to act as cloud condensation nuclei has been measured in the laboratory using a thermal-gradient diffusion chamber operated at a fixed supersaturation. We observe that particles composed of soluble organics, such as malonic acid and adipic acid, activate at dry particle diameters in agreement with Kohler theory predications assuming the solutes are fully soluble and the droplet has the surface tension of water. Surprisingly, we also observe that sparingly soluble azelaic acid and cis-pinonic acid particles also activate, perhaps because they are being formed in a supersaturated, amorphous state or that their activation is aided by surface uptake of water. Mixed organic/ammonium sulfate particles have also been studied, and a range of behavior is observed. Soluble species such as malonic acid enhance activation through the vapour-pressure lowering effect whereas a thick coating of stearic acid on ammonium sulfate makes the particles totally inactive. Lastly, we have observed that pure oleic acid particles, which show no indication of activation when pure, can be activated after exposure to gas-phase ozone. The atmospheric implications of our results will be discussed. An interesting issue is the degree to which we can quantitatively model our results by assuming the surface tension of the growing droplet is that of water, i.e. without the need to invoke the surface-tension-lowering effect due to surface-active organics.

A71F-02 0850h INVITED

Uptake of Water by Organic Films: the Influence of Degree of Oxidation on CCN Ability

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In order to understand the climatic significance of the presence of large mass fractions of organic compounds in atmospheric particles, the influence of organic constituents on the cloud nucleating abilities of atmospheric aerosol must be established. We have used a quartz crystal microbalance to study the uptake of water onto a series of organic films of differing hydrophobicity as a function of relative humidity. Room temperature results of the uptake onto dodecane, mono- and di-acids and mono- and di-alcohols will be presented. Gas-condensed phase modelling using UNIFAC predicts the uptake curves for some partially oxidized substrates (1-octanol, octanoic acid, 1,5 dipentanol) moderately well, but has much lower accuracy for dodecane, malonic acid or 1,8 dioctanol. Quantitative comparisons of the model with measurements will be presented, and the causes for the differences in accuracy will be discussed.