

A72D-02 1355h

Cloud properties inferred from surface air temperature changes associated with the presence of ground-based cloud types over land areas

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Surface air temperature changes associated with the presence of clouds (TC), defined as the difference between surface air temperature with and without clouds, are studied using the long-term ground-based cloud datasets from the U.S. and former USSR national meteorological station networks. An approach is developed to separate the cloud longwave effect-related surface air temperature change (LWTC) and the cloud shortwave-effect related surface air temperature change (SWTC) from TC specific for each cloud type. The magnitudes of LWTC and SWTC is then analyzed for each commonly occurring cloud type in the context of their relationships with cloud radiative properties, including cloud amount, albedo and emittance as well as with two other internal climate variables affecting these relationships: near-surface air humidity and snow cover extent. We hope that the cloud type radiative properties and the cloud interaction within the climatic system explored in this empirical study can help better understand the role of clouds in contemporary climatic change. This approach is based mostly on the surface cloud observing system, which is fundamentally different from the satellite observing system.

A72D-03 1410h INVITED

Active Remote Sensing of Clouds

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A variety of research tools are available for studying the macrophysical and microphysical properties of clouds, information of crucial importance to modeling their effects on the radiation balance of the earth/atmospheric system. In this report we summarize the advantages of active ground-based, and planned satellite-borne, remote sensing systems. Although a variety of microwave radar and laser-radar (lidar) techniques are available, it is through the synergism gained from coordinated active and passive remote sensors that the greatest knowledge is gained. The history of this multiple remote sensor approach will be reviewed, and the latest results highlighted.

A72D-04 1430h

Measurements of Ice Water Content in Tropopause Arctic Cirrus during SOLVE (SAGE III Ozone Loss and Validation Experiment)

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The greatest uncertainty in the prediction of future global climate arises from our incomplete knowledge of the interaction of clouds with solar and terrestrial radiation. Cirrus clouds are of special interest due to their location in the upper troposphere, where their unique optical and microphysical properties contribute to local radiative heating, as well as creating a surface for heterogeneous chemical reactions. In this paper, we present observations of high-latitude cirrus clouds which were made during the SOLVE (SAGE III Ozone Loss and Validation Experiment) mission based in Kiruna, Sweden throughout the winter and spring of 1999-2000. The data used in this study were obtained with three instruments: an open-path tunable diode laser hygrometer, a FSSP-300 Particle Measurement System, and a closed-path tunable diode laser hygrometer, which sampled particulate water. The water

content of each cloud encounter was calculated from size distributions obtained by the FSSP. As expected, the structure of the FSSP observations and the closed-path hygrometer particulate water data were similar. However, the closed-path tunable diode laser hygrometer typically reported considerably more condensed water than that calculated from the FSSP particle data. The excess particle water seen by the laser hygrometer provides evidence for larger cirrus cloud ice crystals outside the range of the FSSP (i.e. greater than 20 μ m in diameter).

A72D-05 1445h INVITED

A Step Towards an Advanced Parameterization of Cloud Microphysical Processes

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Consideration of cloud microphysical properties and processes in atmospheric models usually requires reliable and accurate parameterizations. For describing all hydrometeor types by size distribution functions and corresponding budget equations comprising a multitude of processes in an adapted manner is by far too costly.

An alternative is to only deal with certain integrals (i.e. moments of the size spectra as, e.g., water contents) and their tendency equations. Moreover, the parameter formulae should comply with the natural situation of having smaller (cloud) and larger (precipitation) particles which interact by collisions in a complex way.

Many years ago this idea has been elaborated by Kessler (1969) for liquid (warm) clouds. Kessler presented a rate equation for the transformation of cloud water content to rainwater mass (autoconversion) which relies on high intuition and another one for accretion, i.e. for the increase of rainwater content by mutual collection of cloud droplets by raindrops, which is based on a simplistic evaluation of the collection integrals of the spectral budget equation for drops. This first approach to parameterize the evolution of rain water from cloud water is a very important one since almost all clouds start as liquid clouds.

For a long time and also to date these so-called Kessler formulae were the only parameterization available for warm cloud processes. In adopting this idea corresponding formulations have also been derived and extensively applied for mixed and ice cloud microphysics.

The drawback of Kesslers formulation is that it only uses (cloud and rain) water contents such that a differentiation between continental and maritime clouds exhibiting very different size spectra but identical water contents is not possible.

To overcome this deficiency and to include typical cloud characteristics several authors extended Kessler's idea by formulating - in addition to the rates of change of mass contents - rates for the corresponding number densities. As a closure condition representative size distributions (e.g. Marshall Palmer) have then to be considered. Unfortunately this procedure has mostly not uniformly been performed for all hydrometeor types and processes and critical parameters have been set constant - an assumption which is crucial.

Surprisingly these suggestions were disregarded in case of the warm rain processes autoconversion and accretion which are basic in the development of each (warm) cloud. Some years ago these mechanisms, however, have been formulated on the basis of the stochastic collection equation resulting in spectral and integral rate equations. Moreover, by reasonable approximations advanced rate equations for the number and mass densities changing by autoconversion and accretion have been developed taking into account different cloud spectrum characteristics.

In that way a complete and consistent set of equations for the time rate of change of number as well as mass densities of cloud and rain, snow and ice particles can be formulated covering the whole range of processes occurring in warm, mixed and ice clouds.

The presentation addresses all items mentioned and concludes with results of numerical experiments which demonstrate the difference between usual and the advanced parameterizations in case of convective clouds.

A72E MCC: 102 Sunday 1330h

Transport and Effects of Anthropogenic Pollutants: ACE-Asia I (joint with OS, GC)

Presiding: T Bates, NOAA Pacific Marine Environmental Laboratory; B Huebert, University of Hawaii; P Russell, NASA Ames Research Center

A72E-01 1340h

Aerosol In Asian Outflow: Correspondence of Size-dependent Aerosol Volatility to Chemistry, Humidity Growth, and Absorption

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During Spring 2001 we participated in the ACE-Asia project, studying the properties of Asian aerosol advected over the North Pacific from the NCAR C-130 aircraft. We also had a smaller suite of instruments aboard the NASA P-3 during TRACE-P. These sequential experiments with similar instrumentation provided a unique opportunity to investigate outflow from East Asia between 5°N and 50°N during the same season. Size distributions were obtained using a variety of instruments, including radial differential mobility analyzer (RDMA), a laser optical particle counter (OPC) and an aerodynamic particle sizer (APS). The RDMA and OPC were operated with heating of the inlet stream, cycling between unheated, 150°C, and 300°C in order to infer size dependent volatility and refractory properties. Size-resolved chemical composition was provided by cascade impactors and single-particle electron microscopy. Bulk ionic composition of 0.1 to 1.5 μ m particles was measured rapidly (5 min) with a Particle Into Liquid Sampler (PILS). Submicron and total aerosol optical properties including scattering, absorption, and humidity dependence [$f(\text{RH})$] were measured with a suite of 4 nephelometers and 2 Particle Soot Absorption Photometers (PSAP).

While the thermal treatment cannot directly differentiate between dust and elemental carbon, we found that the submicron tail of the dust distribution was consistently enough shaped that we could isolate the refractory components of the accumulation mode aerosol from the dust. That enables us to calculate the contributions of each to optical extinction and single scatter albedo.

Given the chemical composition of the aerosol, we can calculate the refractive index, which we use to correct the OPC calibration. After this correction, we found that the volatile volume corresponded closely to measured sulfate and nitrate composition. Refractory volume in the accumulation mode (variable, but generally <0.5 μ m) was well correlated with both PSAP absorption and EC measurements, though it appears that only 30 to 50% of the refractory volume is carbon.

Size-dependent chemical composition was also used to approximate $g(\text{RH})$, particle growth as a result of water condensation as humidity rises. Mie scattering calculations give good agreement with measured $f(\text{RH})$. In general, $f(\text{RH})$ behavior simply mirrored the relative contributions of dust (non-hygroscopic) and accumulation mode (hygroscopic) surface areas. However, variations in accumulation mode composition did affect $f(\text{RH})$. Those changes were reflected in the volatility of accumulation mode particles.

A72E-02 1355h

Regional and Temporal Variability in the Chemical Composition of Individual Particles Sampled During ACE-Asia

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During the Asian Pacific Regional Aerosol Chemical Characterization Experiment, ACE-Asia, size and chemical composition of individual particles were evaluated with high temporal resolution using a transportable Aerosol Time-of-Flight Mass Spectrometer (ATOFMS) aboard the NOAA Research Vessel Ronald H. Brown (14 March - 20 April 2001). During the campaign, the chemical composition, number concentration, and temporal variability of aerosol particles were assessed under different synoptic meteorological patterns and at various locations and distances from continental influences. Periods with pristine marine characteristics, high loadings of mineral dust, and air parcels modified by anthropogenic emissions were encountered. Size-resolved chemical characteristics of sampled particles are discussed in detail, with special focus given to the chemical associations and the degrees of aging, reaction, and/or mixing, which can alter the optical properties of these particles. Changes in the aerosol physical-chemical characteristics due to heterogeneous reactions are discussed in terms of single particle mass spectral ion markers (e.g., sulfate and/or nitrate). Results from ATOFMS characterization studies of relevant source samples (dust, coal combustion, biomass/biofuel burning, vehicular emissions) are also presented and compared to those obtained from ACE-Asia ambient data to illustrate the determination of probable sources from a single particle perspective.

A72E-03 1410h

Measurements of the Microphysics and Size Distributed Composition of Aerosol Particles at the Kosan Supersite, Jeju Island, Korea During ACE-ASIA and Their Influence on Cloud Microphysics

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Measurements of particle number, size distribution and chemical composition of aerosol were made at the Kosan supersite on the island of Jeju during the ACE-ASIA experiment. The measurements of chemical composition included those from an Aerodyne Aerosol Mass Spectrometer, which can deliver quantitative information of the mass of a range of volatile and semi-volatile aerosol components in near real time. These include sulfate, nitrate, ammonium, and the total organic fraction. The instrument also delivers measurements of the size-distributed mass of these components. In addition to the AMS, multi stage Berner impactors were also run for both mass collection on aluminium foil substrates and chemical analysis using Teflon substrates. The substrates were chemically analysed for a range of inorganic species, carbonate, a range of simple organic ions and also the water soluble organic fraction. The latter were subdivided by functionality: neutrals, mono and di carboxylic acids, and poly-carboxylic acids. A second sampling location on the mountain-side of Jeju was used to sample cloud microphysical parameters during the experiment. Measurements were made of liquid water content and cloud droplet number as a function of size during cloud events sampled during the experiment. We will show that the largest contributor to the accumulation mode particle mass is sulfate, with a variable contribution from the organic fraction. The organic is observed to be internally mixed with the sulfate in a mass mode centred at around 400 nm and using AMS data and the analyses from the impactors is oxidised and water soluble. The largest constituents of this component of the aerosol were di and poly carboxylic acids. There was little evidence for a mode of organic particles, typical of urban outflow at Jeju, indicating the particulate had been significantly processed between source and arrival at the sampling site. Little nitrate was observed in the sub micron aerosol at Jeju, but significant nitrate was seen throughout the experiment in the coarse mode. Depletions of chloride in sea salt were as large as 80 % and there is significant evidence from both the mass fragmentation from the AMS and the correlation with Ca and the ion balance in the impactor data that nitrate was also lost to mineral dust. The cloud droplet microphysics was seen to vary widely depending on the air mass history and extent of processing of the particles before arrival at the site.

A72E-04 1425h

Evidence of Heterogeneous Surface Chemistry in Asian Springtime Aerosol: a Focus on the Interactions of Fine Asian Mineral Dust with Urban Plumes

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The chemical composition of water-soluble fine particles was investigated on the NCAR C-130 during the Asian Pacific Regional Aerosol Characterization Experiment (ACE-Asia), March 30 to May 5, 2001. Measurements were made with a Particle-Into-Liquid Sampler coupled with two Ion Chromatographs (PILS-IC). This approach involves collecting particles into a purified water flow for on-line analysis with a dual channel IC for simultaneous anion/cation measurement. For particles smaller than 1.3 μ m diameter, the following ions were measured continuously every 4 minutes: sodium, ammonium, potassium, magnesium, calcium, chloride, nitrate, and sulfate. During ACE-Asia a large dust storm was sampled as it mixed and evolved with pollution in the Yellow Sea. First encountered in the Sea of Japan on April 8, the relatively pure dust was situated above a pollution layer. An ion balance suggests that most of the fine water-soluble dust component was calcium carbonate. The following consecutive flights were carried out three days later on April 11 and 12; the aircraft sampled in the Yellow Sea and showed that the plume had now mixed into the boundary layer and had become modified by heterogeneous reactions with urban/industrial emissions. The rapid bulk composition measurements provide clues to the particle heterogeneous chemistry in the mixed dust-pollution plumes. These measurements suggest that fine particles in mixed plumes of dust and pollution were at times composed of varying and evolving concentrations of calcium carbonate, calcium nitrate, ammonium sulfate, and ammonium nitrate. Based on back trajectories, the spatial distribution of these species appeared to be related to influences from emissions from

specific urban centers. The evidence for these various fine particle components will be discussed.

A72E-05 1440h

Constraining the Single Scatter Albedo of Asian Dust Using In-situ Measurements

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During the Spring of 2001, the optical properties of Asian aerosol were measured in-situ from the National Center for Atmospheric Research C-130 aircraft as part of the Aerosol Characterization Experiment (ACE-Asia). Measurements were made predominantly over the eastern Yellow Sea, east of Korea in the Sea of Japan, and to the north and west of Japan, in the Korean Strait. In most cases, aerosol in this region was found to be either a mix of fine- and coarse-mode aerosol (separated at an aerodynamic diameter of 1 micron) or it was dominated by coarse-mode aerosol. The highest aerosol concentrations were nearly always dominated by coarse-mode aerosol, which had a significantly higher single scatter albedo (SSA=0.97) than did the fine-mode aerosol (SSA=0.86). In a first-order analysis, the coarse mode aerosol is assumed to be mineral dust when it is non-hygroscopic.

Here we address the issue of how to use these optical measurements, combined with size distribution, chemical and morphological data to constrain the single scatter albedo of Asian dust. First we ask how accurately we were able to measure the single scatter albedo of both the total aerosol and - separately - the fine and coarse modes of the aerosol, given uncertainties in the aircraft inlet passing efficiency, plumbing losses, and instrument accuracy. Further, we question whether the coarse mode aerosol can properly be considered "dust". Electron micrograph images of the aerosol indicate that the Asian aerosol was generally a mixture of dust, soot and other components of a variety of morphologies. In many of these images, soot and other constituents appear to be attached to the larger dust particles. Assuming that the non-dust components of the aerosol are more light-absorbing than the dust itself, our measured value of SSA for the coarse mode aerosol only allows us to place a lower limit on the single scatter albedo of the dust alone. Aerosol microphysical (i.e. size distribution) and chemical data are also used to determine the accuracy of calling the sub-micron aerosol "pollution" and the super-micron aerosol "mineral dust". Finally, using a model, we address the question of whether the in-situ constraints on SSA for Asian dust result in improved estimates of radiative forcing for the ACE-Asia study region.

A72E-06 1455h

Clear-column closure studies of lower tropospheric aerosol extinction during ACE-Asia using airborne sunphotometer, airborne in-situ and ship-based lidar measurements

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The Asian Pacific Regional Aerosol Characterization Experiment (ACE-Asia) studied aerosol outflow from the Asian continent to the Pacific basin. It was designed to integrate suborbital and satellite measurements and models to reduce the uncertainty in calculations of the climate forcing due to aerosols. Closure experiments are an important step towards reducing these uncertainties. Closure studies have revealed important insights about aerosol sampling and inadvertent modification in such previous aerosol studies as TARFOX, ACE-2 and SAFARI 2000. In this paper we assess the consistency (closure) between solar beam attenuation measured by the 14-channel NASA Ames Airborne Tracking Sunphotometer (AATS-14) and derived from airborne in situ and ship-based lidar methods during the Spring 2001 phase of the ACE-Asia field experiment. Aboard the CIRPAS Twin Otter, AATS-14 measured solar beam transmission at 14 wavelengths between 354 and 1558 nm, yielding aerosol optical depth (AOD) spectra and columnar water vapor (CWV). Vertical differentiation in profiles yielded aerosol extinction spectra and water vapor concentration. Aboard the same aircraft aerosol extinction has also been derived from in situ measurements of scattering (nephelometers) and absorption (particle soot absorption photometer, PSAP) or calculated from particle size distribution measurements (mobility analyzers and aerodynamic particle sizers). Twin Otter vertical profiles flown near the R. V. Ronald H. Brown allowed extinction profile comparisons with a Micro Pulse Lidar operated aboard the ship. The extinction profiles obtained by the different techniques show good agreement for the vertical distribution of aerosol layers. However, the level of agreement in absolute magnitude of the derived aerosol extinction varied among the aerosol layers sampled.

A72E-07 1530h

Influence of Relative Humidity on Aerosol Radiative Efficiency

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Several recent field studies of aerosol radiative effects in which we participated: namely INDOEX99 (Indian Ocean), MINOS2001 (Crete, Mediterranean), and ACE-Asia 2001 (Sea of Japan) were all characterized by strong large scale relative humidity gradient leading to widespread haze conditions over diverse oceanic regions. We hypothesize that relative humidity plays an important role in aerosol radiative forcing efficiency. For example, our analysis indicates that mean aerosol forcing efficiency over the Sea of Japan was surprisingly conservative (60 Wm⁻²). We present numerical results based on the chemical analysis and radiative transfer that the 15 percent change of RH leads to increase of aerosol forcing efficiency of as much as 6-10 Wm⁻². We present also direct radiometric observations of aerosol radiative forcing taken from Research Vessel R. H. Brown during the ACE-Asia experiment. The mean value of aerosol optical thickness over Japanese Sea was 0.42 at 500 nm, and single scattering albedo (SSA) 0.94 on the basis of optical and chemical analysis. We have found large correlation ($r^2 = 0.78$) between SSA and relative humidity (RH). Aerosols, mostly of anthropogenic and mineral origin, lead to a diurnal average reduction of 25.0 Wm⁻² in the surface solar radiation, an increase of 13 Wm⁻² in the atmospheric solar absorption, and an increase of 12.0 Wm⁻² in the reflected solar radiation at the top-of-the-atmosphere (based on CERES satellite SSF dataset).

A72E-08 1545h

The Radiative Impacts of Multicomponent Aerosols Containing Dust (MCA-D) Over the ACE-Asia Study Domain

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ACE-Asia data revealed that atmospheric mineral dust aerosols were often internally mixed (aggregated) with other chemical species. Since both climate studies (e.g., IPCC) and remote sensing retrievals treat atmospheric aerosols as an external mixture of distinct aerosol types (such as dust, sulfates, black carbon), it is important to determine the magnitude of radiative impacts of MCA-D.

An integrated analysis of the aerosol time-of-flight mass spectroscopy and electronic microscopy data was performed to identify the composition and morphology of MCA-D as a function of size in the clean and polluted marine conditions under varying dust loadings. Several representative MCA-D size distributions were reconstructed and then used in computations of optical characteristics.

A radiative transfer code which accounts for gaseous absorption, and absorption and multiple scattering by aerosols and clouds was employed to model the radiative effects of MCA-D. The predicted TOA radiative forcing, radiative forcing at the surface, and heating rates will be presented. The limitations of such an approach for predicting the radiative effects of MCA-D and assumptions made will be discussed.

A72E-09 1600h

The Sensitivity of MISR Multi-angle Imaging Aerosol Retrievals Over Dark Water to Assumed Particle Properties, Based on ACE-Asia Field Observations

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On six occasions spanning the ACE-Asia field experiment in Spring 2001, the multi-angle imaging MISR instrument, flying aboard the NASA Earth Observing Systems Terra satellite, took high-resolution data over a 360-km-wide swath, coincident with observations by multiple instruments on two or more participating surface and airborne stations. The cases capture a range of clean, dusty, and polluted aerosol conditions, and represent some of the best opportunities during ACE-Asia for comparative studies among intensive and extensive aerosol observations, in their environmental context. Over thirty ACE-Asia investigators are participating in a study that pulls together the multi-platform observations, to create as complete a picture as possible of atmospheric and surface conditions for these six cases. For several cases, environmental detail available at the time of satellite over-flight is unprecedented.

This presentation uses results from the multi-platform study as ground truth, to critically test the sensitivity of MISR aerosol retrievals to assumed particle microphysical properties, a key step in refining the satellite multi-angle retrieval algorithms. We review the assumptions made in the MISR algorithms about particle microphysical properties for sea salt, sulfate, biomass burning, and mineral dust components in light of the coincident field data, and discuss the sensitivity of the dark water retrieval algorithm to column aerosol optical depth and aerosol component mixture.

URL: <http://www-misr.jpl.nasa.gov>

A72E-10 1615h

Distribution and radiative forcing of Asian dust and anthropogenic aerosols from East Asia simulated by SPRINTARS

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A three-dimensional aerosol transport-radiation model, SPRINTARS (Spectral Radiation-Transport Model for Aerosol Species), has been developed based on an atmospheric general circulation model of the Center for Climate System Research, University of Tokyo/National Institute for Environmental Studies, Japan to research the effects of aerosols on the climate system and atmospheric environment. SPRINTARS successfully simulates the long-range transport of the large-scale Asian dust storms from East Asia to North America by crossing the North Pacific Ocean in springtime 2001 and 2002. It is found from the calculated dust optical thickness that 10 to 20% of Asian dust around Japan reached North America. The simulation also reveals the importance of anthropogenic aerosols, which are carbonaceous and sulfate aerosols emitted from the industrialized areas in the East Asian continent, to air turbidity during the large-scale Asian dust storms. The simulated results are compared with a volume of observation data regarding the aerosol characteristics over East Asia in the spring of 2001 acquired by the intensive observation campaigns of ACE-Asia (Asian Pacific Regional Aerosol Characterization Experiment) and APEX (Asian Atmospheric Particulate Environmental Change Studies). The comparisons are carried out not only for aerosol concentrations but also for aerosol optical properties, such as optical thickness, Angstrom exponent which is a size index calculated by the log-slope exponent of the optical thickness between two wavelengths, and single scattering albedo. The consistency of Angstrom exponent between the simulation and observations means the reasonable simulation of the ratio of anthropogenic aerosols to Asian dust, which supports the suggestion by the simulation on the importance of anthropogenic aerosols to air turbidity during the large-scale Asian dust storms. SPRINTARS simultaneously calculates the aerosol direct and indirect radiative forcings. The direct radiative forcing of Asian dust at the tropopause is negative over ocean, on the other hand, positive over deserts, snow, and sea ice in the clear-sky condition. The simulation also shows that it depends not only on aerosol mass concentrations but also on the vertical profiles of aerosols and cloud water.

A72E-11 1630h

Regional-Scale Chemical Transport Modeling in Support of the Ace-Asia Experiment

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Chemical Transport Models (CTMs) are playing increasingly important roles in the design, execution, and analysis of large-scale atmospheric chemistry field studies. They are being used in forecast-mode to enhance flight planning by enabling the representation of important three-dimensional atmospheric chemical structures (such as dust storm plumes, polluted air masses associated with large cities, and widespread biomass burning events) and how they evolve over time. CTM forecasts play the additional important roles of providing a 4-dimensional contextual representation of the

experiment, and facilitating a quicker analysis of the field results. CTMs also facilitate the integration of the different measurements and measurement platforms (e.g., aircraft, ground stations and satellite observations). Finally, CTMs play an important role in evaluating and helping to improve emission estimates.

We developed the Chemical weather FORcasting System (CFORS) to assist in the analysis of field experiments. CFORS was applied in the design and execution of the TRACE-P, ACE-Asia and the ITCT-Y2K intensive field experiments. In this paper we present a brief overview of the CFORS system, and focus on the use of the CTM on the analysis of the Ace-Asia data.

ACE-Asia produced a high density of data from multiple independent measurements, and a wide variety of different types of data. These include: a) in-situ measurements from ground stations, on board ships, and on various aircraft platforms; b) remote sensed data from satellites; and c) vertical distributions from ground based lidars. This data spans vast temporal and spatial scales, and illustrates the needs and challenges of integrating these data into a consistent data analysis set. In this paper we plan to illustrate efforts to integrate measured and modeled data into a comprehensive data set for analysis by measurers and modelers. We will also outline future directions and challenges.

A72E-12 1645h

Sources, Transport, and Characteristics of aerosols over the Asian Pacific Region: A Global Model Analysis of in-situ and Satellite data During ACE-Asia

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We present here an analysis of aerosol sources, transport, and distributions from the Georgia Tech/Goddard Global Ozone Chemistry Aerosol Radiation and Transport (GOCART) model. Model results of aerosol and precursor concentrations and optical properties are compared with observations during the Aerosol Characterization Experiment - Asia (ACE-Asia) in Spring 2001. The observations include concentrations of DMS, SO₂, sulfate, OC, and BC, extinction profile and optical thickness of aerosols from ship, aircraft, ground station, and satellite remote sensing. Close interactions between the model and observations make the model a useful tool to link the observations in a wide range of spatial and time scales to understand sources, composition, anthropogenic/natural contributions, and intercontinental transport of aerosols.

URL: <http://code916.gsfc.nasa.gov/People/Chin>

A72F MCC: 125 Sunday 1520h

Fine-Scale Vertical Structures in the Upper Troposphere/Lower Stratosphere and Their Roles in Climate and Weather Processes: Hypotheses, Observations, and Models II (joint with P, GC)

Presiding: M de la Torre Jurez, Jet Propulsion Laboratory; M Alexander, Colorado Research Associates Division, NorthWest Research Associates, Inc.

A72F-01 1520h

An Overview of Small Scale Structure in the Troposphere and Lower Stratosphere

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The presence of vertically narrow structures in vertical profiles of ozone were first noted and discussed three decades ago by Gordon Dobson. Considerable work has been done on the origin and evolution of these structures in the intervening years, including the implications of small-scale transport for polar and mid-latitude ozone variability, as well as climate change. This talk will offer a concise review of these results.

A72F-02 1535h INVITED

Ozone and climate change in the lowermost stratosphere

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While NH ozone changes above about 20 km have been relatively monotonic in time over the last 20 years, the changes in the lowermost stratosphere (which account for most of the column changes) exhibit much more variability. Recently there has been considerable attention paid to a possible dynamical component to these changes. Two distinct mechanisms have been suggested: changes in planetary-wave drag (and hence in ozone transport), and changes in the structure of the tropopause (including tropopause height). The published evidence presented so far has been empirical, based on statistical studies. Important questions include the mechanisms behind these changes and how they affect ozone, the attribution of past changes, and the prediction of future changes. These questions are addressed, with particular attention paid to the possible role of fine-scale structures in the tropopause region.

A72F-03 1555h INVITED

Laminar Cirrus Clouds in the Tropical Tropopause Layer

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Optically thin, laminar cirrus clouds occur with very high frequency in the tropical tropopause layer (TTL). In this presentation, I will review the observations and properties of these clouds. The importance of the clouds will be discussed, including radiative forcing, local TTL thermal budget, and dehydration of air entering the stratosphere. Next, an explanation will be given for why these clouds occur with high frequency only in the TTL. The requirements for generation of persistent, laminar clouds include thermal stability, slow ascent (resulting in supersaturated air), and relatively small ice crystals. Measurements and modeling studies suggest that all of these criteria are met in the TTL. Finally, I will discuss the important open issues concerning laminar cirrus in the TTL. These issues include the importance of wave motions not resolved in large scale models in the cloud formation and the effectiveness of dehydration by the laminar clouds.

A72F-04 1610h

Scaling Analysis of Airborne Observations Near the Tropopause

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Scaling analysis is used to identify tracer-like and non-tracer-like behavior of various species, and also to detect the transition from atmospheric variability to instrumental noise. The effects of the fractal aircraft trajectory are also discussed.

A72F-05 1625h INVITED

The Structure of the Tropical Tropopause Region

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Temperatures in the tropical tropopause region display a significant amount of fine-scale structure as measured by radiosondes, with their excellent height resolution. The tropopause itself often appears as a sharp discontinuity, marking a clear boundary between the troposphere and the overlying stratosphere, while at other times the boundary is more gradual, and the tropopause less well defined. In the northern-hemisphere summer months a marked cold point is frequently present above the standard lapse rate tropopause, while the sharper tropopauses tend to occur most frequently in the northern-hemisphere winter months. The reasons for these differences will be discussed in terms of Kelvin waves and the Brewer-Dobson circulation. Since the latter is responsible for the transport of stratospheric ozone to midlatitudes, there are possible implications for climate variability.

A72F-06 1645h INVITED

Examination of Temperature and Stability Behavior Near the Tropopause Using GPS, Global Analyses and CCM3

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The region near the tropopause is interesting as the transition between the radiatively controlled stratosphere and the radiatively and convectively controlled troposphere. Properly representing the behavior in this internal boundary regime poses a significant challenge to models not surprisingly given that the mechanisms responsible for maintaining the height and structure of the tropopause continue to be debated in the literature.

We have used a combination of GPS occultation observations, global analyses and the CCM3 GCM to examine real, analyzed and modeled temperature and lapse rate behavior in this regime. We examined individual profiles as well as zonal means and variability. We see the tropopause height is systematically too high in the model at mid to high latitudes. Somewhat surprisingly, at high latitudes, the observed tropopause altitude is higher in the winter rather than in the summer hemisphere. The CCM3 partially captures this effect but the transition latitude is too low. The CCM3 lapse rate variability is smaller than observed by a factor of two or more and the locations of relative maxima in the model variability differ significantly from the observed behavior. Signatures of atmospheric waves observed by GPS in the lower tropical stratosphere are not captured