

there is also a multi-year record of ozonesonde observations. From seven locations in the western Pacific (Hong Kong; Taipei; Cheju Island, Korea; and Naha, Kagoshima, Tsukuba, and Sapporo, Japan), a site in the central Pacific (Hilo, HI), and a site on the west coast of the U.S. (Trinidad Head, CA) both a seasonal and event specific picture of tropospheric ozone over the North Pacific emerges. At all of the sites there is a pronounced spring maximum through the troposphere. There are, however, differences in the timing and strength of this feature. Over Japan the northward movement of the jet during the spring and summer influences the timing of the seasonal maximum. The ozone profiles suggest that transport of ozone rich air from the stratosphere plays a strong role in the development of this maximum. During March and April at Hong Kong ozone is enhanced in a layer that extends from the lower free troposphere into the upper troposphere that likely has its origin in biomass burning in northern Southeast Asia. During the winter the Pacific subtropical sites (latitude 25N) are dominated by air with a low-latitude, marine source that gives low ozone amounts particularly in the upper troposphere. In the summer in the boundary layer at all of the sites marine air dominates and ozone amounts are generally quite low (<25 ppb). The exception is near large population centers (Tokyo and Taipei but not Hong Kong) where pollution events can give amounts in excess of 80 ppb. During the TRACE-P intensive campaign period (February-April 2001) tropospheric ozone amounts were rather typical of those seen in the long-term records of the stations with multi-year soundings.

A62A-0146 1330h POSTER

Model analysis of sulfate and SO₂ over the Asian-Pacific region during Spring 2001: Sources, distributions, and intercontinental transport

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During Spring 2001, two field campaign programs, the Transport and Chemical Evolution over the Pacific (TRACE-P) and the Aerosol Characterization Experiment-Asia (ACE-Asia), were conducted over the north-western Pacific, with a common goal of understanding the impact of the growing pollution sources from the Asian continent to the regional and global atmosphere. We have used the Georgia Tech/Goddard Global Ozone Chemistry Aerosol Radiation and Transport (GOCART) model to simulate sulfate aerosol and its precursor SO₂ that predominantly originate from anthropogenic sources. Model results are compared with aircraft measurements during TRACE-P and ACE-Asia. Model results show that anthropogenic emissions from Asia dominates SO₂ and sulfate loading over the western Pacific at mid- and lower latitudes (< 45N), however, transport from Europe could account for as much as 60-80% of SO₂ and 30-40% of sulfate at latitudes of 45N and higher over large area of Asian continent and Pacific. Asian pollution plumes often reached the west coast of the U.S., contributing to about 30% of sulfate loading during Spring 2001. URL: <http://code916.gsfc.nasa.gov/People/Chiu>

A62B MCC: Hall D Saturday 1330h

Transport and Effects of Anthropogenic Pollutants: ITCT 2K2, Including PEACE III Posters (joint with GC)

Presiding: D Parrish, NOAA Aeronomy Laboratory; D Jaffe, University of Washington, Bothell

A62B-0147 1330h POSTER

Characteristic of Atmospheric Fine Structure of Ozone, Carbon Monoxide, and Humidity During PEACE in Winter and Spring 2002

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Ozone, carbon monoxide, reactive nitrogen species, nonmethane hydrocarbons, aerosols, water vapor, and carbon dioxide were measured on board Gulfstream II aircraft during the Pacific Exploration of Asian Continental Emission (PEACE) phase A (January 2002) and phase B (April and May 2002) over the western Pacific. Water vapor distribution in the upper troposphere and the lower stratosphere is interesting because the measurements in such regions are limited even though water vapor is recognized as an important greenhouse gas. Latitudinal and vertical distributions of water vapor were discussed in terms of atmospheric fine structure, and the in situ water vapor measurements and the model data from ECMWF analyses were compared. Qualitatively the latitudinal and vertical distributions agreed well, but many fine structures were not reproduced in the model due to its coarse resolution in the model. The model tends to underestimate the water vapor mixing ratios, especially when especially when relative humidities over ice are close to 100% or higher. Atmospheric layers were examined using in situ measurements of ozone, carbon monoxide, humidity. Layers were defined as an enhancement relative to local backgrounds, which were determined using a mode-based method [Stoller et al., 1999]. Using ozone, carbon monoxide, and relative humidity, we found 59 layers (0.14 layers/km) in PEACE-A. Stratospheric air and polluted air were the dominant layer sources in PEACE-A.

URL: <http://www.eorc.nasda.go.jp/AtmChem/GLACE/PEACE/htdocs/index.html>

A62B-0148 1330h POSTER

Horizontal and Vertical Distributions of SO₂ Observed During the PEACE Missions

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Measurements of sulfur dioxide (SO₂) were made by a significantly modified pulsed-fluorescence analyzer during the PEACE (Pacific Exploration of Asian Continental Emission) B aircraft missions, which were conducted over the East Asian Pacific rim/Western Pacific region in spring 2002. The SO₂ data are successfully obtained up to approximately 5 km during the whole flights. The mixing ratios of SO₂ show a large variability ranging from <100 pptv to 15 ppbv. The SO₂ variability is mainly controlled by the switching of continental and maritime air masses. Enhanced SO₂ levels due to gfreshh continental outflow events are found below 2 km regions over the Sea of Japan. Several plumes, whose mixing ratios elevated as high as >10 ppbv, are attributed to emissions from volcanic islands around Japan. Although the continental emissions and outflow make large contribution to the mixing ratio levels, variations, and distributions of SO₂ around the East Asian continental rim and the western Pacific regions, volcanic activities also significantly inject large amount of SO₂ into the lower atmosphere of the regions. The SO₂ data are compared with those from PEACE-A and previous campaigns (e.g., PEM-West A and B, PEACAMPOT). Relative importance of the contribution from anthropogenic and volcanic emissions on the SO₂ distributions in this region is discussed.

A62B-0149 1330h POSTER

Estimation of the contribution of inter-continental transport during the PEACE-A campaign by using a global chemical model

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A quasi-realtime calculation system for the global distribution of O₃, NO_x, HO_x, and NMHCs by using a photochemical GCM for the troposphere, which is driven by daily reanalysed and forecasted dynamical field, has been developed. The model is based on the version 5.4g of the Center for Climate System Research / National Institute for Environmental Studies (CCSR/NIES) AGCM, on which stratospheric photochemical model (Takigawa et al., 1999) is based. We are also developing the tropospheric photochemical model (Sudo et al. 2000). In the present configuration, the chemical component of the model predicts the concentration of 54 chemical species between the surface and approximately 20km altitude, including 94 gaseous reactions, 25 photolytic reactions, 4 liquid-phase reactions, and 1 heterogeneous reaction on the surface of sulfate aerosols. The photolysis rates are calculated online with AGCM radiation flux, three dimensional distribution of chemical species, and temperature. The model also includes surface emission, wet/dry deposition, and NO_x production by lightning. The concentration of O₃ in the stratosphere is prescribed based on satellite data and the result of stratospheric photochemical model. The horizontal resolution is T42, with 32 layers in the vertical. The reanalysis dynamical field at 12Z of previous day, and 5day forecast dynamical fields of every 6 hours are taken from NCEP every day. With 4 dimensional data assimilation of the reanalysis dynamical fields, the model is driven by the quasi-realtime real dynamical field. And then, a 5 day forecast of the global distribution of ozone and other chemical species is executed once a day.

By using this model, we conducted simulations on global distributions of several chemical species during the PEACE-A campaign. The model well reproduced the CO increase correspond with the passing of cold front in flight#02. In some flights, European anthropogenic surface emission was estimated to be an important origin of CO around Japan. In flight#01, the ratio of European CO to total CO was estimated to be 40% at most.

A62B-0150 1330h POSTER

Intercontinental Transport of Ozone and Aerosols from East Asia to North Pacific: Meteorological Aspects Associated with the Long-range Transport

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The long-range transport of photochemical pollutants on the continental scale has been studied through the Intercontinental Transport and Chemical Transformation (ITCT) 2k2. The mission took place in April-May 2002 over the eastern and western Pacific, mainly in the northern hemisphere. Meteorological studies associated with the long-range transport of pollutants from East Asia to North Pacific were done to provide a better understanding of the intercontinental transport and chemical transformation of anthropogenic pollution and to assess the consequences of the pollution. In addition, measurements of major air pollution gases such as O₃, CO, SO₂, NO_x as well as physico-chemical properties of atmospheric aerosols were made at three Korean sites (Pohang, Gosan, and Anmyon-do). According to five times of ozone-sonde measurements at Pohang, Korea during intensive field campaign, the maximum ozone partial pressure appeared at about 22-26km above mean sea level. Trajectory analysis shows that it takes 4-10 days of air mass to reach from Asia to North America over 500 hPa pressure level in the spring of 2001, greatly depending on the pressure pattern over the north Pacific and geostrophic wind of upper layer. It is noted that the vertical transport mechanism of pollutants in the source region of pollution should be considered to enhance our understanding of gas photochemistry over remote marine atmosphere as well as the performance of photochemical transport model.

A62B-0151 1330h POSTER

Spatial Distributions of Tropospheric Carbon Dioxide Over the Western North Pacific During Winter and Spring.

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Atmospheric CO₂ concentration was observed using a research aircraft (Gulfstream II) over the western North Pacific during the Pacific Exploration of Asian Continental Emission (PEACE) phase A (6 - 22 January 2002) and phase B (20 April - 16 May 2002). 13 and 12 flights were conducted during phase A and B, respectively, with its latitude range of 22 - 42 north latitude and maximum altitude of about 13 km. The primary objective of PEACE is to investigate chemical and transport processes of the continental outflow over the western North Pacific. Quantitative understanding of CO₂ spatial and temporal distribution is important for understanding global carbon cycle, as its vertical distribution and seasonal change is scarcely revealed. The atmospheric air is taken and pressurized by a diaphragm pump and dried by a Nafion drier and a chemical desiccant column (Mg(ClO₄)₂). In situ measurement was carried out on board the aircraft using Li-Cor model 6262 non-dispersive infrared analyzer, and the CO₂ concentration is determined against the high and low CO₂-in-air standard gases based on the NIES (National Institute for Environmental Studies) standard scale. The response time is about 6 seconds, and the signal noise is in about ± 0.1 ppmv. The observed CO₂ concentration is generally high in low altitude and low in high altitude. High CO₂ concentration

relative to the average CO₂ distribution is sometimes observed during the flights. Its difference is about 8 ppmv at most. Trajectory analysis suggests that the observed air with high CO₂ concentration is often affected by continental outflow. The averaged CO₂ vertical distribution shows seasonal difference. The CO₂ concentration decreases with altitude in winter at all latitude, however the CO₂ concentration observed over 2.0 km at north of 25 north latitude in spring is almost constant. These differences are considered to be principally induced by phase delay of atmospheric CO₂ change from the boundary layer to upper troposphere. Latitudinal difference of CO₂ concentration at selected altitude band is also revealed during winter and spring. In winter, CO₂ concentration generally increases with latitude at all altitude band, but in spring, highest CO₂ concentration is observed between 25 - 40 north latitude, and the concentration is relatively low in high latitude.

A62B-0152 1330h POSTER

NMHC emissions from Asia: sources and transport

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Recent rapid industrialization and economic growth in Asia changed the industrial structure, land use, and peoples lifestyle resulting in a dramatic change in the amount and composition of the gas emissions from Asia. Because emissions can be transported very rapidly once convected to the free troposphere, Asian emissions can affect both local and regional air quality and climate. To access the impact of changing emission from Asia, an airborne observation campaign PEACE (the Pacific Exploration of Asian Continental Emission) phase-A and B were conducted in January and April - May 2002, respectively, sponsored by NASDA (National Space Development Agency of Japan).

The concentrations of NMHCs (nonmethanehydrocarbons) and halocarbons were obtained by whole air sampling and subsequent gas chromatography analyses in the laboratory. Quantified onboard the aircraft were CO, CO₂, O₃, NO, NO₂, NO_y, H₂O, SO₂, aerosols, and condensation nuclei. The experiment was conducted in the vicinity of Japan and PEACE-A and B represent the local winter and spring weather conditions. The trace gas distributions in the lower troposphere were often influenced by local pollution (i.e. from Japan, Korea) while those of the long-range transport (i.e. from Europe) were occasionally seen in the upper troposphere. This is confirmed by the air mass age estimation using the ratios of short-lived gases (i.e. C₂H₄) vs. more stable compounds (i.e. CO). Emissions from China were distinguished using data obtained from ground-based sampling and measurements. Transport from China was seen both in the lower troposphere and upper troposphere. Some case studies on source identification will be discussed.

URL: <http://www.eorc.nasda.go.jp/AtmChem/GLACE/PEACE/htdocs/index.html>

A62B-0153 1330h POSTER

Tropospheric Ozone Over Northern China From Ozone-sonde Observations During PEACE Period

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There is relatively limited tropospheric ozone observation in vast landmass of China. Observational ozone data are vital for assessing the impacts of domestic pollutant emissions on the atmospheric environment in China and as input to the regional and global chemical transport models. During the PEACE mission periods in winter 2002, simultaneous measurements of ozone vertical profile were made at three sites in northern China using ECC ozonesonde systems. These sites are situated along the mid-latitude transport corridor over northern China extending from the northwest boundary at Urumqi, Xinjiang Province across Xining, Qinghai Province to the northeast coast at Beijing, Hebei Province. The aim of the study is to compare and contrast the vertical distributions of tropospheric ozone in the air masses coming from central Asian continent, over mainland China and out-flowing to the Pacific and to explore the influence of domestic Chinese pollutant emissions on the vertical distribution of tropospheric ozone over China. In this paper, the results are presented. The characteristics of vertical distributions of tropospheric ozone at these northern sites will be compared with that in a southern China site at Hong Kong.

A62B-0154 1330h POSTER

Airborne Trace Gas and Aerosol Measurements During ITCT 2k2

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From mid-April through mid-May of this year a NOAA Aircraft Operations Center WP-3D Orion aircraft was deployed to Monterey, California to study the inflow to the western US from the eastern Pacific. The scientific payload was chosen to study intercontinental transport and chemical conversion and its potential impact on the US. The payload included an ozone photochemistry suite, i.e. measurements of ozone, its precursors, products and by-products of the photooxidation, and anthropogenic tracers. Aside from the aerosol

size distribution, bulk and single particle composition were measured. The flight plans incorporated survey flights along the coast, overflights of the ground site in Trinidad Head, ship plume studies, a visit to the Los Angeles basin and west-east transects (off- to on-shore) along the transport axis. This overview will describe the payload and flight operations from Monterey. Composite profiles of ozone, total nitrogen oxides, and carbon monoxide will be compared to those derived from our previous missions.

A62B-0155 1330h POSTER

Remote, Near Real Time Monitoring of Measurements on the WP-3D During the ITCT 2k2 Study

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A system was developed to transmit and display in near real time several aircraft and chemical measurements on the WP-3D during the ITCT 2k2 field campaign. The ability to monitor system performance remotely and in near real time provided important benefits. Most importantly, scientists not on board the plane were able to monitor the status and behavior of their instruments, which resulted in shorter downtime to troubleshoot and fix anomalous instrument behavior. Secondly, modelers and flight planners were given timely feedback regarding the location and magnitude of measured pollutants. This information assisted in the planning of sequential flights and in determining if mid-flight alterations of the flight plan were prudent. The remotely monitored parameters included aircraft latitude, longitude, altitude, temperature, relative humidity, aerosol density, and CO, O₃, NO, NO₂, NO_y, HNO₃, and SO₂ concentrations. The system was devised to allow for quick and simple expansion of parameters. Key components and performance characteristics of this system will be detailed.

A62B-0156 1330h POSTER

Comparison of observed chemical distributions during the presence and absence of Asian transport events during ITCT 2002

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Episodes of inflow to the West Coast of air clearly influenced by recent Asian emissions were sampled from the NOAA WP-3D aircraft during the ITCT project in April and May 2002. The aircraft also sampled episodes of inflow in which recent Asian emissions were not clearly apparent. These latter episodes are influenced, in part, by recirculation of air from North America and by longer-term transport over the relatively source-free Pacific Ocean. The frequency of occurrence and distributions of chemical species, with a focus on the reactive nitrogen species, for these latter episodes will be compared to distributions characteristic of more recent Asian input during the ITCT project.

A62B-0157 1330h POSTER

Airborne Observations of Transport and Removal of Nitric Acid During ITCT 2002

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The long-range transport of pollutants is studied using measurements of trace gases obtained from the NOAA WP-3 aircraft during the Intercontinental Transport and Chemical Transformation (ITCT) experiment in April and May 2002. Flights were conducted in the free troposphere over the eastern Pacific Ocean and western Continental U.S. at altitudes up to 8 km. Correlations between fast response (1 s) measurements of nitric acid and carbon monoxide are used to characterize the sampled air masses. Several stratospheric intrusions were encountered, where elevated nitric acid and ozone mixing ratios were coincident with low carbon monoxide mixing ratios. Two different nitric acid to carbon monoxide relationships were observed in air masses transported from Asia. Nitric acid was uncorrelated with carbon monoxide when nitric acid was removed during transport, whereas nitric acid was positively correlated with carbon monoxide during transport that occurred ahead of the cloud bands associated with frontal systems. These different air mass types are further distinguished by their NO_y partitioning. The distribution of reactive nitrogen species in the free troposphere is used to compare background tropospheric composition to the trace gas composition of transported air masses. The removal of nitric acid during transport is important for determining the lifetime of NO_x in the troposphere.

A62B-0158 1330h POSTER

Observations of the Conversion of Nitric Acid to Ammonium Nitrate Over California During ITCT 2002

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Photochemical processing of anthropogenic emissions from the west coast of the continental US was examined from the NOAA WP-3 aircraft on several flights during the Intercontinental Transport and Chemical Transformation (ITCT) experiment in May 2002. Airborne measurements of fine particle (< 1 micron diameter) composition, fine particle volume, trace gases, and gas-phase particle precursors are used to describe gas-to-particle conversion observed within the planetary

boundary layer over Los Angeles, San Francisco, and the neighboring valleys. Correlations of fast response (1 s) measurements of nitric acid, carbon monoxide, and particle volume are used to identify the sources of the measured ammonium nitrate particles. Conversion of gas-phase nitric acid to ammonium nitrate particles was observed both in regions characterized by high ammonia emissions from livestock sources and in the Los Angeles urban plume upwind of agricultural emissions of ammonia. In an air mass that was transported to an altitude of 4 km over the mountains surrounding Los Angeles, all observed nitrates were partitioned to the particle phase. This partitioning was caused by the sharp decrease in the ammonium nitrate dissociation constant with decreasing ambient temperature when this air mass was lifted from the ground. This conversion of nitric acid to ammonium nitrate during transport is important for understanding fine particle concentration and the lifetime of NO_x emissions in the troposphere.

A62B-0159 1330h POSTER

Measurements of the Hydroxyl Radical and Sulfuric Acid from the NOAA P3 during ITCT 2002

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A new chemical ionization mass spectrometer (CIMS) for measurement of OH and sulfuric acid was deployed on the ITCT 2002 mission. The wingpod mounted CIMS instrument weighed less than 600 lbs and used a total of less than 1 kW of 400 Hz power. Data was obtained on all of the science flights out of Monterey, CA. In general, very low OH number densities were observed on the flights that focused on high altitude transport of Asian pollution. On many occasions air parcels were intercepted containing enhanced levels of CO, NO_y, and particulates. However, the OH levels in these air masses were very low and near the detection limit of the instrument of 2e5 molec. cm⁻³. This result is consistent with the observed low dew points (TD < -240 K) and NO_x concentrations. This conclusion will be tested by comparison to predictions by photochemical box models. The sulfuric acid number densities were also usually very low (< 1e6 molec. cm⁻³) on these flights probably due to removal by cloud processing and uptake by particles during the week long transit time from Asia. However, on the 5/10/02 and 5/17/02 flights high levels of sulfuric acid strongly correlated with CO were observed in a few plumes of Asian origin. The P3 aircraft was also used to study the effects of ship emissions and pollutant transport into and out of West Coast metropolitan areas. Data from a good example of this type of experiment on May 8, 2002 will be presented. The first part of the flight was used to investigate ship emissions in the marine boundary layer and the last half explored San Francisco, Oakland and the Central Valley. During the ship plume study high levels of sulfuric acid (> 2e7 molec. cm⁻³) were observed that corresponded to transects of ship emission plumes. These sharp spikes were overlaid on a broad background of relatively high levels (> 5e6 molec. cm⁻³) of sulfuric acid in the marine boundary layer. This background level is much higher than in other portions of the marine boundary layer sampled on this mission and is approximately equal to the background levels in San Francisco or Los Angeles. These data along with elevated ozone, particulate sulfate and NO_y values indicate that ship emissions are significantly perturbing the atmospheric chemistry of large portions of the marine boundary layer.

A62B-0160 1330h POSTER

Measurements of marine vessel emissions and resulting plume chemistry off of the California coast during ITCT 2002.

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Marine vessel emissions and downwind plume chemistry were studied off of the California coast from the NOAA WP-3D aircraft during the Intercontinental Transport and Chemical Transformation (ITCT) project in spring 2002. Simultaneous in-plume measurements of NO, NO₂, NO_y, HNO₃, SO₂, O₃, CO, CO₂, and aerosol particle concentration were made in the marine boundary layer. Emissions factors measured during ITCT are presented and compared with other studies. The agreement between these observations and modeled vessel inventory estimates is discussed. Ship plume chemistry was studied for up to 100 km downwind of the source, representing 3 hours of chemical processing in a near Lagrangian experiment. Rapid oxidation of NO_x to other NO_y species and formation of O₃ were characteristic of the ship plumes. Ozone enhancements of 5 ppbv were detected in the furthest downwind transects in plumes a few hours old. Enhancements of HNO₃ in plumes were small or not detectable, while NO_y losses of over 50% were detected. This suggests an efficient loss mechanism for HNO₃, presumably aerosol particles and/or deposition to the sea surface. These results have implications for the application of large-scale vessel emissions inventories in regional and global models.

A62B-0161 1330h POSTER

Enhancement of VOCs in a Fresh and an Aged Forest Fire Plume

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Airborne measurements of some oxidized and non-oxidized volatile organic compounds (VOCs) were performed off the U.S. west coast, over California and during two transfer flights over the U.S. in April and May of 2002 as part of the ITCT 2K2 campaign. Many VOCs were strongly enhanced in the outflow from two forest fires, one burning in Sandford, Utah and the other one on the Yucatan Peninsula in Mexico. The ratios of various VOCs from the two fires were used to estimate the transport time of the investigated air from the Yucatan fire to the measurement location, which showed good agreement with trajectory calculations. The measured enhancement ratios were compared to previous fire emission ratios and also to measurements in the Los Angeles basin and in the outflow from other point sources (ships and a power plant). It was found that acetonitrile was only released in significant amounts from the forest fires, demonstrating the usefulness of the measurement as an indicator for biomass burning emissions.

A62B-0162 1330h POSTER

Properties and Distributions of Aerosol Particles Transported from Asia to the West Coast of the United States During ITCT 2002

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During the Intercontinental Transport and Chemical Transformations experiment in April and May, 2002, airborne measurements were made of particle microphysical and chemical properties and of trace gases. Layers of air containing enhanced number and mass concentrations of particles transported from Asia were encountered near the West Coast of the United States on several flights. During the most concentrated events, the aerosol layers were found at different altitudes than were those containing enhanced concentrations of CO, NO_y, and organic tracers of biomass and anthropogenic emissions. This vertical separation suggests different sources and/or different transport processes for the two layer types. Particles within the aerosol-rich bands were significantly enhanced in fine and coarse particle mass relative to surrounding air. The sources and chemical characteristics of the different layers will be evaluated using trajectory studies and measurements of trace gas composition and single particle composition determined from laser ionization/time-of-flight mass spectrometry.

A62B-0163 1330h POSTER

Observations of Gaseous Mercury Over the Eastern North Pacific: Gradients, Transports, Variability, and Lifetime Calculations

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Toxic Mercury vapor, a ubiquitous trace gas found in the background boundary layer at concentrations of about 1ngm-3, is incompletely characterized regarding its sources, sinks and distribution throughout the atmosphere.

Observations of Total Gaseous Mercury, TGM, were made aboard the NOAA WP-3 in spring of 2002 during the Intercontinental Chemical Transformation program (ITCT2K2) with a Tekran TGM analyzer modified to eliminate its known altitude dependence. The ITCT2K2 flights originated from Monterey, CA, ranged 50,000-km over the Eastern Pacific, extended as far North as the NW tip of Washington, and were primarily made in westerly flows. The troposphere was repeatedly sounded from near sea level to above 7 km. Sampled air masses were days to weeks from known anthropogenic sources of Hg. However, given that elemental Hg, Hg(0), which comprises the great majority of TGM, is thought to have an atmospheric residence time of about 1 year our TGM observations revealed a remarkable troposphere, dominated by spatial and temporal complexity and not, well mixed, as expected. In addition to spatial complexity, soundings have a pronounced vertical TGM gradient with concentrations dropping by about a factor of 5 between sea level and the tropopause. Contrarily, about 25% of the soundings do not exhibit significant altitude dependence. These observations of pronounced spatial/temporal inhomogeneities remote from known sources of TGM are incompatible with their often-quoted residence time of one year. Hence we were prompted to apply C. Junges (1974) reasoning and theoretical determination that, a trace gas residence time and variability should be inversely proportional, to this data set. Junges notes that his formalism:

STANDARD DEVIATION / MEAN CONCENTRATION = 0.14 / RESIDENCE TIME

is only valid if the distribution of sources and sinks are similar. As we know that TGM has both geographical and seasonal inhomogeneities in sources and sinks, we believe that our 3min. resolution ITCT2K2 TGM data set, together with its long trans Pacific fetch are particularly suitable for this residence time determination. Analyzing the data by flight the TGM residence time averaged 102 days with a modest SD = 23 days.

Should these TGM vertical gradient and revised residence times be globally confirmed they would force major revisions in atmospheric reservoir, source and sink estimates.

A data set of similar size was collected over the Western North Pacific off the Asian coast in spring 2001(ACE-Asia). Downwind of the continent and its many anthropogenic TGM sources, application of Junges hypothesis produced a much shorter Junges residence time averaging 12 days with a standard deviation of 3 days.

As much of the variability observed during ACE is certainly due the proximity of diverse nearby TGM sources, Junges sampling criteria is clearly violated. Hence the trans -Pacific 100-day lifetime is the more relevant estimate for the remote oceanic reaches.

During ACE- Asia distinct plumes and multiple layering of TGM with maximum concentrations elevated more than 5X background were found beyond 1,000 km from their likely continental source (Shanghai). Across

the Pacific during ITCT2K2 similar layering was encountered. Remarkably, a single TGM plume (3X background) was encountered at 6km mixed with a variety anthropogenic pollutants on a trajectory suggesting a rapid trans Pacific transit with minimal dilution or loss enroute.

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Decadal Ozone Trends in the Eastern Pacific

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Measurements during ITCT 2K2 characterized the springtime, eastern Pacific ozone distribution at two ground sites, from the NOAA WP-3D aircraft, and from a light aircraft. Asian anthropogenic emissions are believed to have increased substantially over the 2 decades preceding the study. Here we will compare the 2002 ozone distribution with measurements made in the region over the 2 previous decades. This comparison provides substantial evidence that the photochemistry in the springtime troposphere of the Pacific has changed in response to the increasing anthropogenic emissions. Preliminary analysis of the available data suggests that ozone levels of the Eastern Pacific have systematically increased by about 0.5 ppbv/yr., i.e. about 10 ppbv in the last two decades.

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their attempts to meet the new NAAQS for Ozone and Particulate Matter. The size of Asian economies, their reliance on fossil fuels, and their rapid industrialization suggests that the importance of trans-Pacific air pollution will increase. This presentation will examine policy implications of Asian emissions under three of the IPCC future emission scenarios. We will also identify an array of domestic policies that States and counties in non-attainment areas may consider to reduce the concentrations of ozone and PM. Further, we will examine the potential for reducing local concentrations by devising policy instruments for reducing emissions where they can be reduced at a lower cost. For this work, we will draw on policy experience from regional air pollution in the European Union and evaluate options for devising policy instruments within the institutional framework of the Asia Pacific Economic Cooperation.

A62B-0166 1330h POSTER

Aircraft Measurements of Long-Range Transport of Ozone, CO, Non-Methane Organic Compounds, and Particles in the Eastern North Pacific Troposphere during Spring 2002

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As part of the Photochemical Ozone Budget of the Eastern North Pacific Atmosphere Spring 2002 (PHOBEA-II/ITCT 2K2) research campaign, we employed a small aircraft to collect vertical profiles of ozone, CO, and non-methane organic compound (NMOC) mixing ratios and total aerosol scattering over a remote location along the North Pacific coastline of Washington state. Thirteen research flights were conducted from March 29 through May 23 and several well-defined polluted layers were measured at altitudes between 0.5 and 6 km. These polluted layers varied in thickness (0.3 to 3 km) and were characterized by elevated and highly correlated levels of ozone, CO, NMOC, and total aerosol scattering of green light (tsg, $\lambda = 550$ nm). The two most polluted vertical profiles were measured on April 15 and May 17, when ozone and CO mixing ratios exceeded 80 and 250 ppbv, respectively, and tsg surpassed 20 Mm^{-1} . The high correlation between these species, coupled with subsequent analyses of back-trajectories and global satellite images, indicate that these events were due to long-range transport of emissions from the Eurasian continent. Specifically, our analyses suggest that the primary source of pollution on April 15 originated from urban and industrial activity in Eastern Asia, while the pollution measured on May 17 originated from Siberian boreal forest fires. This is also supported by the much higher ratio of aerosols to CO measured on May 17 compared with April 15. Combining these data with measurements from previous PHOBEA campaigns, we find trans-Pacific transport pollution layers can have vastly different ratios of Δozone to ΔCO and Δtsg to ΔCO (where Δ denotes the difference between the polluted and background levels). Several factors appear to be important in determining these ratios, including heterogeneous chemistry and stratospheric subduction of ozone into the troposphere.

A62B-0167 1330h POSTER

Measurements of polluted air masses from Eurasia at a surface site in the Pacific Northwest: the importance of transport mechanisms on the chemical composition

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Springtime measurements of carbon monoxide (CO), ozone (O₃), nonmethane hydrocarbons

(NMHCs), and aerosols were collected at Cheeka Peak Observatory (CPO), located at 48.3 N and 124.6 W, during the Photochemical Ozone Budget of the Eastern North Pacific (PHOBEA-I and II) experiments, 1997-98 and 2001-02. The purpose of these experiments was to quantify the long-range transport (LRT) of pollutants from the Eurasian continent to the Pacific Northwest (PNW) United States and examine the impact on the photochemical O₃ budget and local air quality in this region. During this study, 8 distinct LRT events were documented at CPO, when the transport of Eurasian industrial pollution, dust, or haze from Asian biomass burning was measured. These events were defined by enhanced CO (up to 190 ppbv), O₃ (up to 60 ppbv), NMHCs, and aerosol scattering coefficients (reaching 40 Mm^{-1}). However, aircraft measurements over CPO (0-6 km) during the spring of 2001 and 2002 indicate that LRT events were often observed at altitudes above 2 km. For example, several aircraft vertical profiles collected during this experiment measured elevated CO and O₃ above 2 km due to LRT that did not correlate with enhanced measurements at CPO. In addition, not all LRT events contained elevated O₃, possibly due to different sources or the result of loss due to HOx chemistry in the boundary layer, or precipitation and heterogeneous chemistry along the transport path. These observations are employed in our subsequent analysis of the transport mechanisms bringing Eurasian pollution to the CPO surface site and how these transport pathways influence the chemical composition of the air masses observed at CPO.

A62B-0168 1330h POSTER

Determination of OH during Trans-Pacific Transport of Pollutants using NMHC Ratios and Backward Trajectories: Role of Heterogeneous Chemistry

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We have identified a number of episodes of trans-Pacific long-range transport from observations during the PHOBEA (Photochemical Ozone Budget of the Northeast Pacific) project taken during the spring from 1997-2002. During these experiments 281 whole air samples have been collected and used to help identify 12 LRT events. Because the principal loss of these NMHCs is reaction with the OH radical, and as a result of the different OH rate constants we can use the measured ratios of ethane, ethyne, propane, butanes and CO, along with trajectories to estimate the concentration of the OH radical during transport. Backward trajectories were calculated from NOAA's HySplit Ready model to determine the transport time for each LRT event. This makes it possible to compare the OH concentration for various types of LRT events. An important question to address with these observations is how does the calculated OH concentration vary with air mass history, especially precipitation, and the presence of aerosols. Using the data from 1997-2002 allows us to examine 12 different long-range transport episodes, including some with substantial levels of mineral dust and/or seasalt. Preliminary results of these analyses suggest an important role for heterogeneous chemistry in determining the oxidative environment of the North Pacific atmosphere.

A62B-0169 1330h POSTER

ITCT 2K2: Trans-Pacific Transport of Anthropogenic Semi-Volatile Organic Compounds

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During Spring 2002, high volume air samples were collected for anthropogenic semi-volatile organic compounds (SOCs) at Cheeka Peak Observatory as part of the ITCT 2K2 and PHOBEA2 campaigns. The samples were analyzed for a wide range of SOC, including organochlorine pesticides, current use pesticides, and polycyclic aromatic hydrocarbons, in both the atmospheric gas and particulate phases. An Accelerated Solvent Extraction system was used to clean and extract the polyurethane foam plugs that were used to trap gas-phase SOC and to extract glass fiber filters that were used to trap particulate-phase SOC. The concentration of SOC in the air samples was correlated with air trajectories, and the concentration of other air pollutants, in an attempt to distinguish between Asian and North American source emissions.

A62B-0170 1330h POSTER

Trinidad Head, California: New NOAA/CMDL Baseline Observatory for Monitoring Asian Atmospheric Effluents

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Long-range transport of dust and air pollution from Asia to the Mauna Loa, Hawaii, Atmospheric Baseline Observatory has been documented since the early 1970s. In a single year, as many as 30 distinct pollution flow events from Asia have been observed there. Some flows last a few hours, whereas others persist for up to 5 days. More recently, it has been recognized by both measurements and satellite photos that there are significant numbers of air pollution flow events from Asia into North America along a broad front, ranging from the north slope of Alaska to central California. There is a valid concern that ozone and ozone precursors advecting from Asia could eventually put California into noncompliance with federal air-quality regulations. As a component of the Intercontinental Transport and Chemical Transformation (ITCT) program, NOAA/CMDL established an atmospheric monitoring observatory (April 2002) at Trinidad Head, California in collaboration with Humboldt State University, to monitor both the inflow of air pollution from Asia as well as regionally influenced air. The station monitors aerosols, ozone (continuous surface and weekly ozonesonde balloon profiles), radiation, and halocarbon and carbon cycle trace gases (weekly flasks). Data from Trinidad Head are monitored via the internet at CMDL in Boulder. Plans call for the installation of a GC/MS for the measurement of PAN, hydrocarbons, and certain halocarbons, and for vertical profiles of trace gases and ozone to be obtained (with light aircraft) upwind and above the site on a weekly basis. It is expected that the Trinidad Head observatory will expand measurement programs over the next 5 years and be in operation for many decades to come.

A62B-0171 1330h POSTER

VOC Measurements at Trinidad Head, CA During ITCT 2K2

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In-situ measurements of a wide suite of volatile organic compounds (VOCs) were made at Trinidad Head, CA during April and May 2002 as part of the ITCT 2K2 experiment. Approximately 54 compounds, including non-methane hydrocarbons (NMHCs), oxygenated VOCs, and halogenated compounds were quantified hourly during the experiment. The range of chemical lifetimes of these compounds, spanning hours to decades, and their sources, encompassing direct biogenic, direct anthropogenic, and secondary production in the atmosphere, can provide insight into the photochemical history and important emission sources influencing observed air masses.

Local or regional emissions had a significant impact on our observations 25 to 50% of the time, depending on the constraints used. Methyl-t-butyl ether (MTBE) was a useful marker for this influence since it is used as a gasoline additive in parts of the U.S. and has a lifetime in the atmosphere of a few days. In conjunction with modeled air mass back-trajectories, this enables us to examine the composition and chemical properties of air entering North America from the Pacific Ocean.

Filtering the data to remove recent continental influence decreased the mean concentrations of NMHC and oxygenated VOC, and increased the mean dimethylsulfide (DMS) concentration, as expected for a species of marine origin.

Analysis of this data requires an understanding of the rapidly changing background that many compounds are undergoing in the spring. Background concentrations of benzene decreased by approximately 70% during the course of the study. Background concentrations for other compounds also changed depending on their lifetime with respect to OH and on the nature of their emission or production mechanisms. At all times, CO was the dominant contributor to the total OH reactivity. Oxygenated VOCs were on average several times more abundant than the NMHC, and collectively formed the second most important component of the total OH reactivity, approximately equal with methane.

Factor analysis allowed us to segregate the compounds into different source categories, such as industrial emissions, biogenic, and local anthropogenic emissions (mainly automobiles). Source categories developed from this dataset provide a useful tool for understanding other measurements of chemical composition and aerosol properties made simultaneously at this site.

A62B-0172 1330h POSTER

Comparison of Size-Resolved Aerosol Chemical Composition Measurements Made Under Ambient and Low Relative Humidity Conditions at Trinidad Head During the ITCT 2k2 Experiment

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Two co-located, 8-stage rotating drum impactors were deployed at the Trinidad Head site from April 21 May 26, 2002 as part of the Intercontinental Transport and Chemical Transformation (ITCT) 2k2 experiment. One of the samplers operated at ambient relative humidity while the other had a heated inlet tube that maintained the relative humidity at a low value. The impactation substrates from these samplers were analyzed using synchrotron X-ray fluorescence at the Advanced Light Source (Lawrence Berkeley National Laboratory). The extreme sensitivity of this analytical technique permitted the quantification of nearly all elements between sodium and lead with 3-hour time resolution. The data from these paired samples will be used to show how drying the aerosol affected the mass distribution of the common soil elements, sea salt, and non-sea-salt sulfate at this coastal site.

A62B-0173 1330h POSTER

The View from the Mountain - Comparing ITCT 2K2 Aerosol Data with the Long-Term Aerosol Record at Mount Lassen, Ca.

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The Intercontinental Transport and Chemical Transformation 2002 (ITCT 2K2) field program collected time- and size-resolved aerosol samples at Mt. Lassen, CA. Comparison of these samples with the decade-plus record of routine aerosol sampling at Mt. Lassen demonstrates that the ITCT 2K2 samples are typical of the long-term chemistry of the Asian continental aerosol plume. In addition, the long-term record at Lassen puts the detailed ITCT 2K2 findings into temporal context: analysis of the Lassen data yields estimates of the frequency and inter-annual variability of transpacific transport, and confirms that the Asian plume is the dominant source of fine aerosol at this site.

A62B-0174 1330h POSTER

Atmospheric Aerosol Conditions Over the Central California Coast During ITCT-2K2

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The atmospheric aerosol conditions over the Monterey, CA region during the Intercontinental Transport and Chemical Transformation 2002 (ITCT-2K2) field study are characterized using a combination of ground-based measurements, satellite data, and aerosol model simulations. From April 24 to May 18, 2002 we conducted ground-based lidar and sun photometer measurements at the Naval Research Laboratory in Monterey, CA (36.59 deg N, 121.85 deg W, altitude=55 meters) in support of ITCT-2K2. Our surface site was located within a quarter mile of the Monterey County Airport, the base of operations for the NOAA WP-3D aircraft during ITCT-2K2. A Micro Pulse Lidar (MPL) with a wavelength of 523 nm was used to characterize the vertical distribution of the aerosols while a sun photometer, part of the AERONET world-wide network of sun photometers with wavelength channels of 440, 670, 870, and 1020 nm, was used to measure the aerosol optical thickness (AOT) of the atmosphere and to obtain an estimate of the columnar aerosol size distribution. In addition, throughout the ITCT-2K2 time period the Navy Aerosol Analysis and Prediction System (NAAPS) a global, tropospheric aerosol model generated 5-day forecasts (at 6-hour intervals) of the spatial (horizontal and vertical) concentrations of dust, sulfate, and smoke on a 1x1 degree grid. The ground-based measurements along with the historical output from NAAPS and satellite optical depth data (e.g. SeaWiifs, AVHRR) are combined to characterize the regional aerosol conditions over the central California coast during ITCT-2K2 and to detect and characterize the Asian dust events that occurred. Aerosol concentrations over the region were typically low during this time period with average mid-visible AOT values of approximately 0.1. Only two, relatively mild, Asian dust events occurred on and about May 4-5 and May 15-16 with mid-visible AOT values of approximately 0.2.

A62B-0175 1330h POSTER

Transpacific pollution during ITCT-2K2: Interpretation using global 3-D model

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The intercontinental transport of pollution links issues of regional air quality, climate change, and global change in atmospheric composition. The ITCT-2K2 field study took place in April-May 2002 with the primary focus of characterizing Asian pollution (ozone, aerosols, their precursors and related species) transported across the Pacific to the western coast of North America. To provide a global perspective on these observations and to represent our current understanding of sources, deposition, transport and processing of pollutants, the GEOS-CHEM 3-D global chemical transport model is used. Direct comparisons between measured and modeled concentrations allow us to assess our understanding of these mechanisms. The relationships between measured species (O3-CO, O3-NOx, etc.) and those calculated by the model are used to probe model biases and to separate the effect of different mechanisms. Specific events are used to understand processes governing the Pacific inflow of pollutants to the western United States. We finally discuss the role of Asia for enhancing surface ozone and aerosol concentrations over North America.

A62B-0176 1330h POSTER

Factors Regulating the Seasonal Cycle of Inter-continental Air Pollution Transport between Asia, the United States and Europe

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This talk will demonstrate the interdependency of air quality in the northern hemisphere on the emissions and subsequent transport of pollutants from each of the major industrialized continental regions. We examine the contribution that emissions from continental regions in the northern hemisphere make to the composition of the remote troposphere. We also examine the processes that control the concentration of reactive pollutants in continental boundary layers over the United States, Europe and East Asia and export from these boundary layers to the global troposphere. We use the MOZART-2 (Model of Ozone and Related Tracers, version 2) global chemical tracer model with tagged CO from fossil fuel and biomass burning emissions from each region. In conjunction with CO measurements from the Climate Monitoring and Diagnostic Lab (CMDL), we examine the influence that each regions emissions have on remote surface locations in the northern hemisphere. We find that the remote troposphere of the northern hemisphere contains a mixture of CO emitted from different continental regions the contributions of which vary seasonally as a function of emissions, meteorology and atmospheric lifetime. To examine factors regulating the concentration distributions of O3, CO, NOx, PAN and HNO3 over the United States, Europe and Asia and their export to the global troposphere, we quantify and compare the seasonal contributions of chemistry, advection, convection and deposition to boundary layer concentrations of each chemical species and examine the horizontal and vertical fluxes of each species out of each regions boundary layer to the global troposphere.

A62B-0177 1330h POSTER

A Backward Modeling Study of Intercontinental Pollution Transport Using Aircraft Measurements

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In this paper we present simulations with a Lagrangian particle dispersion model to study the intercontinental transport of pollution from North America during an aircraft measurement campaign over Europe. The model was used for both the flight planning and a detailed source analysis after the campaign, which is described here with examples from two episodes. First, forward calculations of emission tracers from North America, Europe and Asia were made to understand the transport processes. Both episodes were preceded by stagnant conditions over North America, leading to the accumulation of pollutants in the North American boundary layer. This pollution was then exported by warm conveyor belts to the middle and upper troposphere, and transported rapidly to Europe. Concentrations of many chemical trace species (CO, NO_y, CO₂, acetone, and several VOCs; O₃ in one case) measured aboard the research aircraft were clearly enhanced in the pollution plumes compared to the conditions outside the plumes. Backward simulations with the particle model were introduced as an indispensable tool for a more detailed analysis of the plume's source region. They make trajectory analyses, which to date were mainly used to interpret aircraft measurement data, obsolete for establishing source-receptor relationships.

Using an emission inventory, we could decompose the tracer mixing ratios at the receptors (i.e., along the flight tracks) into contributions from every grid cell of the inventory. For both North America plumes, we found that emission sources contributing to the tracer concentrations over Europe were distributed over large areas in North America. In one case, the region around New York was clearly the largest contributor, but in the other case, sources in California, Texas, and Florida contributed almost equally. Smaller contributions were made by sources reaching from the Yucatan peninsula to Canada in this case.

A62B-0178 1330h POSTER

Pollutant Transport During the Spring Months to the West Coast of the United States

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During the Intercontinental Transport and Chemical Transformation (ITCT) 2K2 field campaign, April 22 to May 19 2002, a wide range of chemical species were measured over the west coast of the U.S. and adjacent Pacific Ocean. Both aircraft and ground-based measurements were made. The MOZART chemical transport model driven by forecast meteorological fields was used to provide forecasts of chemical species (ozone, CO, NOx and PAN) and inert diagnostic species during the ITCT campaign. The diagnostic species provided tracers of rapid transport to the west coast of the U.S. from emission regions located in North America (over both the U.S. and Mexico), eastern Asia (including emissions from biomass burning and anthropogenic sources), the eastern Pacific maritime boundary layer and Europe. Recirculation of pollution from North America had very little effect on free-tropospheric concentrations off the west coast of the U.S. The eastern Pacific maritime boundary layer also had little impact in the free troposphere. The west coast was most directly affected by biomass burning sources and anthropogenic emission sources over Eastern Asia with occasional evidence of rapid transport from European sources. Deep and strong tropopause folds were also forecast to influence the west coast of the U.S. during ITCT, and in at least one instance were verified by the measurements. During this talk we further explore the long-range transport of pollutants to the west coast of the U.S. during spring 2002, as well as in other years over the last decade.

URL: <http://dataserver.acd.ucar.edu/ITCT/>

A62B-0179 1330h POSTER

Chemical weather forecasts using the MOZART-2 global model in ITCT 2K2

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The Model for Ozone and Related Chemical Tracers (MOZART-2) was used as part of the Intercontinental Transport and Chemical Transformation field campaign (ITCT 2K2) conducted in Spring 2002 over the western United States and eastern Pacific. MOZART, a global chemical transport model, was used to forecast future chemical conditions, including the distributions of CO, NOx, O3, and other trace species. These forecasts, along with those from several other global and regional models, were used to aid in the flight planning process. Of particular interest were forecasts of the timing and location of long-range pollution transport events from Asia. MOZART was also re-run using analyzed meteorological input fields.

We will evaluate the performance of the MOZART forecast and analysis simulations. We will present several cases studies comparing the model results with the observations taken aboard the NOAA P3 aircraft during the field campaign. We will discuss some of the strengths and weaknesses of the chemical forecasts, and will evaluate the improvement in model results when using analyzed meteorology versus forecast meteorology. We will also use tagged emission tracers in the model to attribute source regions to the observed pollution plumes.

URL: <http://www.gfdl.noaa.gov/~lwh/lwh-agu-fall2001.html>

A62B-0180 1330h POSTER

A Modeling Study of Stratospheric Intrusion During the Intercontinental Transport and Chemical Transformation 2002 Field Project

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One of the major goals of the Intercontinental Transport and Chemical Transformation 2002 Field Project (ITCT 2K2) is to characterize the chemical compositions of offshore air masses along the western coast of the United States and to determine the relation of these compositions to the sources and sinks of ozone (O3) and aerosols. Forecasts and measurements conducted during the field project suggest that one significant source of O3 is the stratosphere, and indeed it is well known that stratosphere-troposphere exchange (STE) is an important natural process that contributes to the budget and variability of O3 in the troposphere.

An example of a signature of STE was that measured on 25th April 2002 by the National Oceanic and Atmospheric Administration (NOAA) WP-3D aircraft and forecast by back-trajectories from the trajectory software FABTraj. The signature consists of a peak in O3 adjacent to a peak in CO, in the vicinity of a cut-off low over south-east California. In the current case study, the NOAA Aeronomy Laboratory three-dimensional photochemical transport model is used in an attempt to capture and quantify this STE event. The model domain employed is a stereographic projection of the northern hemisphere. Results from the model simulations will be compared with the aircraft measurements, and the stratospheric contribution to the O3 content in the troposphere over the west coast will be discussed.

A62C MCC: 125 Saturday 1330h Lightning, Meteorology, and Climate I (joint with AE)

Presiding: W Beasley, University of Oklahoma; C Noble, University of Oklahoma

A62C-01 1330h

Lightning and Climate Variability

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Global lightning activity is related to many important climate parameters such as surface temperature, atmospheric instability, convective rainfall, deep convective cloud cover, upper tropospheric water vapor, etc. A convenient way of monitoring global and regional lightning activity over long periods of time is via the Schumann resonance (SR), a lightning index that can be absolutely calibrated, and continuously monitored at very low costs. In this presentation the advantages of setting up a network of SR stations for climate studies will be presented. Initial analysis of SR data from a single station in the Negev Desert, Israel, shows remarkable agreement with the daily regionally-integrated upper tropospheric water vapor (UTWV) concentrations over tropical land regions, obtained from the NOAA NCEP reanalysis product.

Upper tropospheric water vapor is a key element of the earths climate. Some climate models predict UTWV to increase by 20% for every 1 K increase in surface temperatures. Continental deep convective storms that transport large amounts of water vapor into the upper troposphere dominate the variability of global UTWV, while also being the storms that produce the majority of our planets lightning. We find a clear 5- and 9-day periodicity in both the lightning and water vapor time series. The agreement between the variability of SR intensities and global UTWV values suggests that measurements of the Schumann resonance could

supply a cheap, continuous, long-term measure of the variability of tropical continental convection, thereby helping us further understand our global climate system and future climate change.

URL: <http://luna.tau.ac.il/~colin>

A62C-02 1350h

Determination of Thundercloud Ice Characteristics from Satellite Observations of Lightning

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Satellite-borne NASA/MSFC devices for the detection of global lightning (the OTD and the LIS) offer the opportunity to explore relationships between lightning frequency f and other thundercloud parameters: more specifically, to determine from measurements of f precipitating and non-precipitating ice fluxes. Computations predict that f is proportional to the product of the downward flux f_g of graupel through the body of the thundercloud and the upward flux f_i of ice crystals into its anvil. This raises the possibility of determining, on a global basis, values of f_g and/or f_i from the lightning measurements. An examination of data from LIS and the TRMM Microwave Imager suggests that thunderstorms with the highest frequency of total lightning also possess the most pronounced microwave scattering signatures at 37 and 85 GHz. A log-linear relationship was shown to exist (one for each frequency) between the number of optical lightning pulses produced by each storm and the corresponding microwave brightness temperatures. These relationships are consistent throughout the seasons in a wide variety of regimes, suggesting that global relationships exist between lightning activity and cloud ice content.

A62C-03 1410h INVITED

Toward Application of Lightning Observations to Weather Forecasts and Warnings

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Once lightning mapping systems became fast enough to locate lightning in real or near-real time, it became possible to consider applications of lightning data to weather operations. The first system to be used routinely in such a way was the LLP direction-finder network deployed around 1980 by the Bureau of Land Management to help detect range and forest fires started by cloud-to-ground lightning. In 1987, a federal interagency group collaborated with the State University of New York at Albany to put together a trial National Lightning Detection Network for a three-year evaluation of possible applications to weather operations. During this trial, the National Weather Service determined that the lightning ground-strike data are useful for detecting the presence, configuration, and evolution of storms and storm systems, and so subsequently procured lightning strike mapping data for federal use that has continued to the present. Research since then has suggested that detection of positive cloud-to-ground lightning may also be useful, when combined with radar data, to help identify some severe storms, though the conditions under which this is possible are still being investigated. Furthermore, cloud-to-ground flash data can be assimilated into forecast models to improve the initial conditions, and hence the forecasts, of the models.

More recently technology has advanced to the point that mapping all types of lightning is feasible. Because typically more than 70% of the lightning flashes produced by a storm do not strike ground, such technologies, at a minimum, would increase sampling rates to identify thunderstorms more quickly and reliably. However, different types of lightning also provide different information about storms. Cloud-to-ground lightning tends to indicate the formation and descent of precipitation, while cloud flash rates appear to be associated more closely with updraft and graupel evolution. Research is underway to determine and quantify these relationships better and to develop techniques for using such relationships to warn of and forecast hazardous weather.