

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.

A62C-04 1430h

Use of Ground-Based Lightning Observations in a 3-D Coupled Cloud/Chemistry Model

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On July 21, 1998, the development and evolution of a supercell over Southern Germany was observed during the European Lightning Nitrogen Oxides Project (EULINOX). The locations and times of occurrence of cloud-to-ground (CG) lightning flashes were recorded by a Lightning Position and Tracking System (LPATS). Total 3-D lightning activity was detected and located by the ONERA VHF Interferometric Mapper (ITF). A cloud-resolving model and accompanying cloud-scale chemical transport model (CSCTM) are used to simulate the evolution and chemical environment of the storm. The CSCTM includes a new parameterization of lightning NO_x production which utilizes flash lengths derived from ITF data. CSCTM passive tracer simulations including only convective transport and lightning NO_x production are used in conjunction with aircraft chemical measurements in the storm anvil to estimate the amount of NO produced per meter of flash channel. In order to study the impact of lightning NO_x production on ozone mixing ratios during the lifetime of the storm, runs of the CSCTM including chemical reactions as well as transport and lightning are employed. The impact of lightning NO_x on downstream ozone production near the tropopause is computed with a chemistry-only version of the CSCTM. Better understanding of the budgets of NO_x and O₃ in the upper troposphere are needed for assessments of climate forcing.

A62C-05 1445h

The influence of environmental state on lightning and convective parameter distributions

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A merged and highly reduced database of TRMM level 1 (precipitation radar, microwave imager, lightning) and NCEP reanalysis (basic state, radiative and surface flux) data has been assembled for three years of the TRMM mission. This allows direct examination of the dependence of convective spectra (as observed through radar reflectivity, microwave brightness temperature and lightning flash rate) on environmental basic states and anomalies. Such analysis may be more physically justified and instructive than traditional geographic and/or seasonal binning. The dependence of convective spectra on several environmental forcing parameters is presented, including surface Bowen ratio (sensible heat to total turbulent flux), net atmospheric radiative flux convergence and net atmospheric enthalpy flux convergence. The latter are basic drivers of net moisture convergence in simple quasiequilibrium models of tropical atmospheric convection.

A62D MCC: 125 Saturday 1520h

Global Electrodynamics: From Sprites to Global Circuit I (joint with SA, AE)

Presiding: R H Holzworth, University of Washington; W A Lyons, FMA Research, Inc.; D Sentman, University of Alaska, Fairbanks

A62D-01 1520h INVITED

Observations of Sprites above Haiti/Dominican Republic Thunderstorms from Arecibo Observatory, Puerto Rico

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In August-September 2001 an experimental campaign has been conducted in Puerto Rico to perform correlative studies of lightning and lightning-induced ionospheric effects. The campaign, which was sponsored by a Small Grant for Exploratory Research from the National Science Foundation to Penn State University, had a broad range of scientific goals including studies ionospheric effects of thunderstorms, studies of VHF-quiet positive leaders and studies of large scale optical phenomena above ocean thunderstorms in tropics. As part of this program we conducted night time video recordings of lightning and large scale luminous phenomena above thunderstorms using a SONY DCR TRV 730 CCD video camera equipped with a blue extended ITT Night Vision GEN III NQ 6010 intensifier with 40 deg field of view. The intensifier provided a monochrome (predominantly green) image output. The video system was deployed at the Lidar Laboratory on the grounds of Arecibo Observatory, Puerto Rico (18.247 deg N, 66.754 deg W, elevation 305 m above the sea level). In this talk we report results of observations conducted between 01 and 03 UT on September 3, 2001. A total of 7 sprite events have been detected above a large thunderstorm system (cloud area exceeding 10⁴ km²) located approximately 500 km from the observational site above Haiti/Dominican Republic. The observed events exhibited typical sprite features documented in other parts of the globe, including single columns, groups of columns, relatively small horizontal glows confined to higher altitudes, as well as two large and impulsive events with the transverse extent \approx 50 km. In this talk we will also report results of preliminary analysis of available ELF electromagnetic signatures associated with the observed events recorded by Stanford University at Palmer Station, Antarctica, Duke University, MIT and Los Alamos Sferic Array in Florida.

Acknowledgments: The GEN III intensifier has been provided by ITT Night Vision Industries. We are grateful to M. Robinson of ITT Industries for support of our program. We thank W. Lyons for useful discussions. We are indebted to S. Gonzalez, Q. Zhou, M. Sulzer, C. Topley, J. Friedman, E. Robles, A. Venkataraman and E. Castro for support of our observations at Arecibo Observatory.

A62D-02 1540h

Electromagnetic signatures of the Puerto Rico blue jet and its parent thunderstorm

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On September 15, 2001, a spectacular blue jet was observed over an oceanic thunderstorm from a vantage point only 200 km distant at Arecibo Observatory, Puerto Rico (PR) [Pasko et al., Nature, 416, 152, 2002]. Unlike previous blue jets documented on video, the PR jet propagated all the way up from the top of the thunderstorm at 16 km altitude to the base of the ionosphere at 70 km altitude and re-illuminated several times afterwards. Broadband (<1 Hz - 250 kHz) electric field data was recorded by the New Mexico Tech sferic system at Dominguito, PR, only a few kilometers north of Arecibo Observatory, while magnetic field data was continuously recorded by Stanford University at Palmer Station, Antarctica. Several minutes prior to the jet, light-intensified video indicated that the storm had an abnormally high flash rate of roughly one per second. A preliminary analysis of the sferic data indicates that an unusually high percentage of the flashes were intraclouds. The blue jet appearance was preceded less than a second earlier by an energetic positive bipolar event which likely marked the onset of a normal-polarity intracloud (IC) flash which transported negative charge upwards. Numerous IC pulses followed the bipolar event up to and during the blue jet event. A couple of the most spectacular IC pulses after the "first stroke" of the jet to the ionosphere were coincident with dramatic re-illuminations of the jet. The polarity of these waveforms indicated that negative charge was being transported upwards, and possibly into the jet towards the ionosphere. This inferred charge motion was counter to that which establishes the fair weather field between the earth and the ionosphere.

A62D-03 1555h

Gigantic transient luminous events with long duration*

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During the Sprites 2002 campaign in Taiwan, five gigantic transient luminous events (TLEs) were observed to occur over an oceanic thunderstorm. The morphology of these transient luminous events appears to be a hybrid of blue jet and sprite. The upper part resembles a sprite while the lower half is jet-like. These events visually span from the lower atmosphere to the E-layer ionosphere at 100 km. The luminous duration of these events ranges between 200ms to 400ms, which is much longer than that of typical sprites. In this paper, the morphology, temporal evolution, and possible generating mechanism of these gigantic TLE events will be presented.

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A62D-04 1610h INVITED

1 ms High Speed Observations of Sprites

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