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Two Aerodyne Aerosol Mass Spectrometers (AMS) were operated at the three main field sites during the PACIFIC 2001 experiment in the Lower Fraser Valley, Canada during the summer of 2001. The instruments deliver quantitative mass loadings of volatile and semi-volatile components of sub micron particles, including sulfate, nitrate, ammonium and the volatile organic fraction. Total mass of these components is delivered in near real time, together with mass size distributions of key components. Slocan Park is an urban background site in Vancouver. The site at Langley is a suburban/rural site to the south-east of Vancouver which received air principally from Washington State during the experiment. Sumas Mountain is a forested mountain location to the east of Vancouver and is further from urban sources. An AMS instrument was operated at Langley throughout the duration of the experiment, whilst the other operated at Slocan Park for the first part of the experiment before being relocated to Sumas for the last week. In this paper we present results showing the variability of the aerosol chemical composition as a function of location and photochemical activity. A significant accumulation mode was observed at all three sites that was principally composed of sulfate and organic material with a smaller contribution from nitrate. The temporal behavior and size distributions of these components suggest that they are internally mixed and indicative of a regional background mode. A significant mode at smaller sizes was also observed in urban environments and when urban plumes affected the sites removed from local sources. The mode was principally composed of organic material and there was little inorganic mass evident in the mode. As the air mass ages the mode becomes less dominant, the modal diameter increases, and the fraction of sulfate and nitrate present increases. Although the AMS instrument cannot discriminate individual organic components some significant information is possible using a combination of identification of key mass fragments and also by employing ion series analysis in the mass spectra. These approaches are introduced and used to show that the large mode associated with urban particulate that peaks below 200 nm is composed principally of aliphatic fragments, whilst the organic present in the accumulation mode and apparently internally mixed with the sulfate is composed of oxidised fragments. The variability of these modes in periods of differing photochemical activity will be investigated.

A71A-0088 0830h POSTER

Nonmethane Hydrocarbons Measurements in Vancouver Region during Pacific 2001 Study

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Nonmethane hydrocarbons $NMHCs$ and carbonyl compounds constitute important precursors of free radicals, which govern atmospheric photochemical processes. To investigate the impact of these radical precursors on regional photochemistry, diurnal cycles of NMHCs and carbonyls were studies during 10-31 August at several sites as part of the Pacific 2001 field study in the Vancouver region, British Columbia, Canada. The mixing ratios for total NMHCs exhibited strong diurnal patterns and varied from 1 to 20 parts per billion *ppb*. For sites near forests, the dominant NMHCs were isoprene and the monoterpenes of alpha-pinene and beta-pinene. The maximum values reached nearly 3 ppb These species exhibited strong diel cycles, owing to the interactions between local emissions and chemical sinks. In this presentation, the focus will be on these biogenic hydrocarbons to ascertain their relative importance on the photochemical activity experienced in the airshed of Vancouver. Results from the 2001 field campaign will be integrated with long-term records of biogenic hydrocarbons for the region with the view to elucidate the time of year when biogenic compounds can be more effective in contributing to regional oxidant production.

A71A-0089 0830h POSTER

Pollutant Build-Up Over the Strait of Georgia and The Role of Mesoscale Flow Patterns on Onshore Transport

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The Pacific 2001 Field Study was characterised by two periods of pollutant build-up as evidenced by relatively high particle sulphate and nitric acid concentrations. The most complete dataset is for the second period from 26-28 August and thus more in-depth meteorological analysis is focusing on these days. Low level flow analyses, upper air soundings, Lidar and back-trajectories were used to investigate the movement of air over the Georgia Basin. This area includes the land mass of the Lower Fraser Valley and two main waterways: the Strait of Georgia and the Strait of Juan de Fuca. The complex interaction of flows through these Straits can play a key role in determining the pollution load offshore of Vancouver. Along with airmass stability and local winds, diagnosing the predominance of flow from the Strait of Juan de Fuca over the Strait of Georgia may offer a useful tool for predicting pollution potential in this area.

During the 26-28 period, sulphate and nitric acid levels were observed to initially increase over the Gulf Islands portion of the Strait of Georgia followed 1-2 days later by similar peaks inland, over the Lower Fraser Valley. This pattern suggests that the Strait may play an important role in the life cycle of pollutants emitted or formed in the region. Indeed, areas of localised weak flow and stagnation are known to exist over the Gulf Islands portion of the Strait of Georgia. Meteorological data suggests that both the larger scale flow through the Straits and the sea breeze circulation were instrumental in the advection of pollutants from this area inland.

A71B MCC: Hall D Sunday 0830h

Lightning and Storm Electrification I Posters *(joint with AE)*

Presiding: **R E Orville,** Texas AM University**; M Stolzenburg,** University of Mississippi

A71B-0090 0830h POSTER

Lightning Activity over Tahiti Island

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The lightning activity has been recorded during the last four years with the help of a net of CIGRE Lightning Flash Counters installed all around Tahiti island. Furthermore, an extrapolation in time is done for the last thirty years using the registration (keraunic level) of the main meteorological station of Mto-France. Tahiti is a circular mountainous island with a 30km diameter and culminating at 2.200m The effect of the relief on the lightning activity measurement is discussed. A mean value of 90 days of thunderstorm per year has records. The daily, monthly, seasonal or yearly lightning activity over Tahiti is analysed. FFT analysis revel strong correlations with the cold phase of the ENSO (Nia) and the and the MJO or the TISO. On other hand, the daily lightning activity is confronted to the various stability indices based on the layer stability concepts (Showalter, Adedokun, Telfer). The sounding balloons executed twice a day by Mto-France allow the computation of such indices.

A71B-0091 0830h POSTER

The Role of Cloud Base Height in the Convective Vigor and Flash Rate of Thunderstorms

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Earlier studies of atmospheric convection have established the following results: (1) Convective Available Potential Energy (CAPE) over tropical land areas is of the same order as over warm ocean regions, (2) updraft strengths in continental clouds are more than twice those in oceanic clouds, (3) cumulonimbus updraft widths are larger over land than over ocean, (4) thermal widths in the planetary boundary layer over land increase with the depth of the boundary layer. The present study is concerned with tests of the hypothesis that cumulonimbus updraft width scales with cloud base height, and the greater the width, the more efficient is the conversion of CAPE to updraft kinetic energy. The greater the kinetic energy, the greater is the lightning flash rate. Comparisons are made between cloud base height inferred from routine thermodynamic measurements throughout the tropics and thunderstorm flash rates (in proximity to the surface stations) observed by the Lightning Imaging Sensor on the NASA TRMM (Tropical Rainfall Measuring Mission) satellite. These comparisons indicate that, on average, thunderstorm flash rates increase exponentially with cloud base height, with an order of magnitude change in flash rate for a change in height from 500 m values typical for tropical oceans, to 2500 m values typical of extreme tropical continental conditions. These correlations, found to be statistically significant, support the foregoing hypothesis.

A71B-0092 0830h INVITED POSTER

Lightning Activity During the 1999 Superior Derecho

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On 4 July 1999, a severe convective windstorm, known as a derecho, caused extensive damage to forested regions along the United States/Canada border, west of Lake Superior. There were 665,000 acres of forest destroyed in the Boundary Waters Canoe Area Wilderness (BWCAW) in Minnesota and Quetico Provincial Park in Canada, with approximately 12.5 million trees blown down. This storm resulted in additional severe weather before and after the occurrence of the derecho, with continuous cloud-to-ground (CG) lightning occurring for more than 34 hours during its path across North America. At the time of the derecho the percentage of positive cloud-to-ground (+CG) lightning measured by the Canadian Lightning Detection Network (CLDN) was greater than 70% for more than three hours, with peak values reaching 97% positive CG lightning. Such high ratios of +CG are rare, and may be useful indicators of severe weather.

A71B-0093 0830h POSTER

Three-Dimensional Radar and Total Lightning Characteristics of Mesoscale Convective Systems

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Preliminary analysis of three-dimensional radar and total lightning characteristics for two mesoscale convective systems (MCSs) occurring in the Dallas-Fort Worth, Texas area during 12-13 October 2001 and 7-8 April 2002 are presented. This study utilizes WSR-88D Level II radar (KFWS), Vaisala GAI Inc. Lightning Detection and Ranging II (LDAR II), and National Lightning Detection Network (NLDN) data to gain a better understanding of the structure and evolution of MCSs, with special emphasis on total lightning. More specifically, this research examines the following topics: 1) the characteristics and evolution of total lightning in MCSs, 2) the correlation between radar reflectivity and lightning flash origins in MCSs, 3) the evolution of the dominant cloud-to-ground (CG) lightning polarity and peak current in both the stratiform and convective regions of MCSs, and 4) the similarities and differences in mesoscale structure and lightning behavior between the two MCSs being studied.

Results thus far are in good agreement with previous studies. For example, CG lightning polarity in both MCSs is predominately negative (∼90%). Also, the storm cells within the MCSs that exhibit very strong updrafts, identified by high (> 50 dBZ) radar reflectivities, weak echo regions, hook echoes, and/or confirmed severe reports, have higher mean lightning flash origin heights than storm cells with weaker updrafts. Finally, a significant increase in total lightning production (from ∼10 to ∼18 flashes/min) followed by a significant decrease (from ∼18 to ∼12 to ∼5 flashes/min) is evident approximately one-half hour and ten minutes, respectively, prior to tornado touchdown from a severe storm cell located behind the main convective squall line of the 12-13 October 2001 MCS. These preliminary results, as well as other total lightning and radar characteristics of two MCSs, will be presented.

A71B-0094 0830h POSTER

Cloud-to-Ground Lightning Characteristics, 1989-2000: West Coast Percent Positive Anomaly

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In the period from 1989 to 2000, the National Lightning Detection Network recorded over 250 million cloud-to-ground (CG) lightning flashes. Climatological analysis of the cloud-to-ground flashes, in the form of lightning flash density and percentage of positive polarity maps, reveal significant geographical variations.

In the Pacific Coastal region of the United States, the prominent variation observed is the high percentage of positive CG flashes. The high percentage (∼ 50%)) dominates the coastline and just offshore, which is up to five times greater than percent positive values along any other U.S. coastline. The values of percent positive decrease drastically a few kilometers inland, which coincides with a dramatic increase in the total (positive and negative) CG lightning flash density and increase in average elevation. Seasonal analysis of CG characteristics shows that the region with a high percent of positive CG's has very little variation in the total number of CG's. This is unlike the rest of the US, which tends to have a distinct maximum in the warm season. The highest percent of positive CG flashes along the Pacific Coast has a maximum in the winter season and a minimum in summer. This min / max pattern is also seen in other parts of the U.S., but the values along the Pacific tend to be much greater. Three meteorological variables that previous researchers have determined affects the percentage of positive CG's are: environmental instability, vertical wind shear, and the height of the charge separation process. This study conducts a statistical analysis to determine how each of these variables contributes to the Pacific Coast anomaly.

A71B-0095 0830h POSTER

Thunderstorm Charge Regions Inferred From the Vector Electric Field in Combination With Data From a Lightning Mapping Array in STEPS

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Balloon-borne electric field meter data are combined with lightning mapping and T-28 aircraft data to infer charge within several thunderstorms occurring during the STEPS field program in the summer of 2000. The electric field data are presented as three-dimensional vectors along the balloon?s path. This permits more detailed statements to be made about the shape, extent, and polarity of charge within thunderstorms than are possible using the traditional one-dimensional Gaussian interpretation of the vertical electric field. Three-dimensional plots of all data sources together also offer strong visual clues that aid in identifying regions of charge in thunderstorms. The charges inferred from the balloon data are found to be consistent with observations from the lightning mapping array and aircraft observations of the electric field. The vector interpretation of the electric field is also found to be consistent with the one-dimensional Gaussian technique, especially in cases where the electric field profile is relatively simple. In more complex cases, the vectors supplement and clarify the one-dimensional charge inferences.

A71B-0096 0830h POSTER

Additional analyses of possibly inverted-polarity electrical structures in thunderstorms during STEPS

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We first showed preliminary evidence of possibly inverted-polarity electrical structures in thunderstorms at the AGU Fall meeting in 2000. The evidence that such might exist came from the polarity of peaks in the profile of the vertical component of the electric field and inferred charge structures using a one-dimensional form of Gauss's law. These were compared to typical (i.e., noninverted) conceptual models of storm structure. Realizing the uncertainties from use of these techniques, we have been exploring additional ways to help determine the gross electrical structure of thunderstorms. The data sets from STEPS offer two additional sources for inferring charge regions: the lightning mapping array and three-dimensional vector analysis of the electric field profiles. At the time this abstract was due, analyses of four possibly inverted-polarity electrical structures in the convective region were underway. The analysis thus far from one storm strongly suggests that it had an inverted-polarity electrical structure. The assessment of all four candidate electrical structures will be presented at the meeting.

A71B-0097 0830h POSTER

New Mexico Thunder Storms Observed by the Lightning Mapping Array, An Overview of One Season

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The lightning mapping array, LMA, was operated in New Mexico during the 1999 storm season, mid July to September. We have isolated a number of storms that spent their entire life close enough to the mapping array to be examined with good resolution. We have characterized the evolution these storms by examining different parameters. Interesting features that we will show including the number and extent of the lightning flashes, the frequency of ICs and CGs, the initial altitudes, and the charge structure as inferred from the LMA data.

A71B-0098 0830h POSTER

Locations of Electric Charge in Developing Thunderstorms

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Information on the early growth of net charge in thunderstorms is valuable for understanding cloud electrification. Although typical mature thunderstorms have charge regions that appear horizontally extensive, the lightning and aircraft data available to date suggest that the initial charges in a cloud are confined to relatively small volumes. In this study we use balloon soundings of the electric field vector to determine the location of the charges present before and during the first few lightning flashes in two thunderstorm cells. These data are compared to the radiation sources detected by the New Mexico Tech Lightning Mapping Array (LMA) from the early flashes. Of special interest in this regard is the location of the mid-level negative charge in the balloon soundings, since this charge is only weakly indicated by the comparatively few radiation sources from positive-polarity breakdown detected by the LMA. As a further means of understanding early electrification we also compare the charge locations to precipitation structures and types and to electrical alignment signatures of ice crystals that are evident in data collected by the New Mexico Tech 3-cm dual polarization radar.

A71B-0099 0830h POSTER

Further Studies of the Electrical Alignment of Ice Crystals in Thunderstorms

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Polarimetric radar studies have shown that ice crystals within the upper levels of thunderstorms are often canted with respect to the horizontal by a large electric field, especially the large field that exists just before a lightning flash. In the summer of 1999 we used the New Mexico Tech 3-cm wavelength, dual polarization radar to investigate electrical alignment of ice crystals in storms occurring over Langmuir Laboratory. In situ electric field measurements were made with balloon-borne instruments in several storms of these storms. For these storms we also have information on the three-dimensional paths of lightning flashes from the New Mexico Tech Lightning Mapping Array. This study presents our initial comparisons of these three datasets. The comparisons suggest that polarimetric radar measurements can often reveal locations above about 6.5 km altitude (and below radar echo top) where the vertical component of the electric field is zero. In some situations the comparisons indicate that the polarity of the vertical component of the electric field can also be inferred from the radar data. The long term goal of this study is to determine how much of a storm's electrical structure can be deduced from the combined remote measurements of dual polarization radar and lightning mapping. Progress toward this goal will be reported in the presentation.

A71B-0100 0830h POSTER

Ice Crystal Orientation in Cirrus: Secondary Torque on Plate Crystals in Diverging Electric Fields

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Electric torques align atmospheric ice crystals such that one diameter of the crystal is along the field direction. There is an aerodynamic torque due to forces exerted by the surrounding air on crystals falling through it, which tend to align crystals horizontally. In addition there is also a weaker secondary electrical torque on plate crystals in electric fields with a diverging spatial dependence. For example, a plate crystal near an electrical line charge experience a torque which tends to rotate the crystal so that its second diameter lies parallel to the line of charge. This implies that near a vertical line charge the induced electrical torques tend to align one plate crystal diameter radially with respect to the line and the second diameter vertical. If such a field is turned on and is of sufficient magnitude, plate crystals initially oriented horizontally will rotate ninety degrees so that one diameter is vertical. Thus, optical effects resulting from reflection will be much stronger.

The primary torque is modeled and compared to that found in the literature. A simple model demonstrates the role of this secondary torque, which is demonstrated in the laboratory utilizing aluminum foil "crystals" near charged conducting rods. The effect is also demonstrated in a laboratory chest freezer with ice crystal plates nucleated in a supercooled cloud. These crystals are reoriented near a charged metal rod with orientation changing by application of a square wave with variable frequency. Results are applied to the production of optical phenomenon in the atmosphere and the ability of oriented ice crystals to reflect a laser beam under conditions of different orientation and varying electric fields.

A71B-0101 0830h POSTER

Laboratory Study of Electrical Corona From Vapor Grown Ice Crystals

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A static diffusion chamber has been used to grow ice crystals from the vapor in order to study the production of corona by ice crystals under conditions of controlled temperature, ice supersaturation and pressure. Crystals were grown on fine glass filaments at temperatures ranging from -4 °C to -40 °C which were then subjected to an electric field with a small set of parallel plates inside the diffusion chamber. Threshold voltages for the initiation and cutoff of coronal discharge were measured as a function of chamber pressure which ranged from 850 mb to 300 mb. Growth and discharge under conditions of simultaneously controlled temperature, ice supersaturation and air pressure simulated the conditions of atmospheric ice crystals in electrified environments and ensured that crystal edges and vertices remained sharp prior to the production of corona. Discharge under conditions of sublimation were also explored. These results are compared with the earlier work of Griffiths and Latham (1974) who measured the threshold voltages of large ice particles (greater than 3mm) at temperatures from 0 °C down to about -20 °C and found that the apparent conductivity of the ice particles under examination decreased markedly below about -18 °C. We address the question of whether there may be realistic circumstances under which ice particles exhibit sufficient conductivity at temperatures below -20 °C and at high supersaturation such that they play a role in charging or initiation of lightening discharges.

A71B-0102 0830h POSTER

Microphysical Properties and the Decay of Electric Fields in Florida Anvils

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Herein we present in-situ observations of particle concentrations and sizes with simultaneous in-situ observations of electric field in thunderstorm anvils over or near Kennedy Space Center Florida. The observations were made at 8 to 10 km altitude from the Univ. of No. Dakota Citation jet aircraft during June 2000 and June 2001 in a project to examine electrical decay time in these anvils. Simultaneous radar reflectivity histories of the storms and anvils were determined using the Patrick Air Force Base WSR74C 5 cm radar. The microphysical observations were made with several different instruments which spanned particle sizes from a few microns to several millimeters, thus from frozen cloud droplets to large aggregates. They show that when electric fields are strong (> 20 kV/m) the entire size distribution of particles is significantly greater than when electric fields are weak (< 1 kV/m). As the aircraft flew from near the convective core of a storm toward the downwind edge of the anvil, particle concentrations in all size ranges gradually decrease. The electric fields decreased much more abruptly than the decrease in particle concentrations and showed much greater variability. Not surprizingly there is not a direct connection between the observed microphysics at a given location and the observed electric field. However, in regions with strong electric fields the microphysical observations showed a surprizing consistency of particle concentrations of all sizes from one storm to another. This consistency may have implications for the decay of electric fields in anvils in the absence of active charge separation and will be discussed.

A71B-0103 0830h POSTER

Laboratory Simulation of Lightning at the Nevada Terawatt Facility

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Lightning experiments have been performed at the Nevada Terawatt Facility in a collaboration between the Department of Physics at the University of Nevada and the Department of Atmospheric Sciences at the Desert Research Institute in Reno, Nevada. A high energy "Z-Pinch" electrical discharge device capable of delivering 1 million amps of current at 1 million volts of electrical potential has been used at lower power levels to simulate real magnitude lightning discharges in the atmosphere in the presence of particles. A pressure and temperature controlled discharge chamber has been incorporated into the Z-pinch setup in order to investigate the effects of the presence of supercooled drops, ice crystals, and aerosols on electrical discharge characteristics and the production of NOx under conditions of controlled temperature, air pressure, discharge power and duration. Discharge time characteristics under different conditions were investigated with control of external electrical parameters. Electrode and electrodeless discharge configurations have been investigated. Results are presented along with future plans for continued use of the lightning setup for further investigations of electrical discharges in the atmosphere and in plasma environments. Diagnostic capabilities include streak camera and high speed video imaging in addition to spectroscopy from infrared to x-ray wavelengths.

A71B-0104 0830h POSTER

Electrification of the Atmosphere by the Underground Sources Causing Lightnings and Corona Discharges

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An estimate of the electric charges, fields and currents at the atmosphere/Earth boundary and near it is given basing on the analyses of the published data gathered during and after the 17 January 1995 strong (magnitude 7.2) and shallow (17.2 km) earthquake in Kobe, Japan: on the luminous effects (lightnings and luminous volumes expanding and rising from the ground); measurements of electric conductivity across the fault; determination of strength and porosity of the samples obtained by drilling the ground down to the depth of about 1.8 km and some other. Numerical simulations are based on the specially developed 3D code taking into account nonuniform conductivity and mechanical separation of charges in the fault zone and motion of ions both in the ground and in the atmosphere under the action of transient electric fields. The existence of high electric fields for about 1-100 seconds (in spite of high conductivity in the ground, especially in a wide "crushed" zone around the central part of the fault) is the continuous generation and separation of electric charges during the continuous or "start-stop" type displacement the fault walls with the duration of each charging pulse of about 1-10 ms. The width of this zone with high electric fields, sufficient for production of lightnings and corona discharges in the atmosphere, is about several km. It is defined by processes of electric diffusion of the electric charges (upwards along the fault and in the lateral directions from the fault) through the ground and production of new and motion of preexisting atmospheric ions above the ground. The length of this zone is the length of the fault (i.e. in that case about 10-30 km). The estimated charge at the ground surface before lightning discharge is about several Coulombs, that is the value typical for a small thundercloud. In our case the lightnings and other types of earthquake lights are ignited by the underground sources.

A71B-0105 0830h POSTER

The power versus frequency behavior of lightning at VHF

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Previous studies have indicated that the power of lightning VHF emissions is roughly proportional to the inverse square of the frequency. The FORTE satellite was used to examine the VHF spectrum of lightning in the 26-48 MHz region. Numerical Electromagnetics Code software was used to theoretically model the antenna response of FORTE's log-periodic antenna as both a function of frequency and angle. The theoretical model accurately predicted the locations in frequency of dropouts in sensitivity and also showed a relatively flat response outside of these regions. The frequencies with a predicted flat response were used to characterize the power spectral behavior of lightning. Some significant departures from the inverse square behavior were found, particularly for some cloud-to-ground attachment and narrow bipolar events (NBEs). Dart-leader attachment processes were characterized by a much softer spectrum (power falls off much faster with increasing frequency) than inverse squared while several NBEs were found which had a harder spectrum.

A71B-0106 0830h POSTER

Theoretical Simulation and Experimental Investigations of the Surge Response of a Tower Model of Vertical Conductor

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The steel tower surge impedance is one of the basic parameters for the anti-lightning design. Therefore, since Jordan, a lot of experiments and theories are proposed, however, there are no established theories. This is the stumper which is known as "the vertical conductor problem" in the present-day electric engineering. Therefore, it is given up to make the problem clear, and the present-day situation is about to adopt the numerical analysis which can explain the phenomenon comparatively well.

As for surge impedance on a tower model of a vertical conductor, we have a theoretical formula by Lundholm. The theory of Lundholm looks like to be a perfect theory, however, this formula does not coincide with the experimental results. Thus, there is the strange situation that the Jordan's formula of the wrong theory agrees with the experiments more correctly. Hara et al. derived experimental formula. Moreover, one of the authors proposed a theoretical formula of surge impedance; considering the existence of ground surface, and without ground surface. The former formula is very similar to the experimental formula of Hara et al..

In this research, these theoretical formulas of surge impedance are examined by the simulation analysis of vertical conductor with the help of Numerical Electromagnetic Code (NEC-2) and the experimental results of that. In the measurement at an actual tower, however, it is difficult to stretch a current lead wire vertically from the tower top, where the current lead wire acts as a vertical lightning channel. Measurements on reduced-scale models are more economical than those on full-sized towers, and are flexible in setting up various experimental arrangements. It is, however, not easy to maintain the accuracy of the measurement, since the geometrical size of the measuring devices is large relative to the measured system. The simulation and experimental analysis of surge response are carried out in the several arrangements of the current lead wire and the current source: (i) vertical and at the top of vertical conductor, (ii) vertical and a little far from the top of vertical conductor, and (iii) horizontal and far from the top of vertical conductor. In all the cases, the voltage measuring wire is placed at the perpendicular to the current lead wire. Each of the arrangement of the current lead wire affects the measured surge impedance of the vertical conductor and these will be explained in this research in detail.

If a travelling wave propagates along the vertical conductor at the velocity of light, the reflected wave from the ground should return to the top of the vertical conductor just after the round-trip time of the travelling wave in the vertical conductor. We ascertained these phenomenon in the both measured and computed results. The agreement between the measured and computed results is also quite well with minor difference. The experimental set up of the model to be analyzed in this paper is verified with the simulation result of the equivalent circuit model by the EMTP.

A71B-0107 0830h POSTER

A New Instrument for Measuring Energetic Radiation From Triggered Lightning

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In this presentation, we describe a new instrument built at the Florida Institute of Technology for measuring x-rays and gamma-rays from rocket-triggered lightning. During the summer of 2002, the instrument was placed less than 25 m from the 11 m tall launch tower at the International Center for Lightning Research and Testing (ICLRT) at Camp Blanding, Florida. The instrument consists of a 5" by 3" cylinder of NaI(Tl) scintillator attached to a 5" photomultiplier tube (PMT) detector, plus a control detector, identical in every way but with no scintillator attached to the PMT. Great care was taken to reduce false signals from the electrically noisy environment. Both detectors are battery operated and placed inside a thick aluminum, watertight box, sealed to prevent RF noise and light leaks. Data are transmitted to a National Instruments PCI 5102 data acquisition card and PC via fiber optic links. The output signals from the preamplifiers attached to each PMT are digitized with 8 bit resolution every 1 microsecond, and the data acquisition is triggered externally by the current measured (threshold = 4.5 kiloamps) at the launch tower, which usually corresponds to the occurrence of the return strokes. For each trigger, a total of 1 second of data are acquired simultaneously for both PMTs with 0.1 seconds of pre-trigger data. This technique allows individual signals to be analyzed to distinguish real x-rays from noise or other false signals. On 2002 July 20 and 25, 5 rockets were launched from the tower under thunderstorm conditions, resulting in a total of 5 triggered lightning flashes containing at least 24 return strokes terminated on the launch tower. During these lightning events, large amounts of energetic radiation (>>10 keV) in the form of x-rays and gamma-rays and/or energetic electrons were observed just prior to 20 of the 24 recorded return strokes, depositing on average tens of MeV into the detector per stroke. We shall present an overview of the design of the instrument and its performance in the laboratory and field environments.

A71B-0108 0830h POSTER

Energetic Radiation Associated with Cloud-to-Ground Lightning

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Over the past three summers we have measured an increase in energetic radiation (gamma-rays or fast electrons) that is associated with cloud-to-ground lightning. The observed increase ocurrs over a time period of a few hundred microseconds and ocurrs before the return stroke.

In addition to the radiation data, we have fast electric-field change and lightning-rod current data for all cases, and data from the New Mexico Tech Lightning Mapping Array (LMA) data for some of the cases presented.

A71B-0109 0830h POSTER

Aircraft Observations of a Lightning Channel in STEPS

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The South Dakota School of Mines and Technology T-28 Storm Penetration Aircraft participated in the Severe Thunderstorm Electrification and Precipitation Study (STEPS) during the summer of 2000. An analysis of the New Mexico Institute of Mining and Technology Lightning Mapping Array (LMA)-indicated flashes and the T-28 position during the penetration of a tornadic thunderstorm on 29 June suggested that an intracloud lightning flash traveled in front and slightly below the T-28s flight path. At the time of the horizontally extensive flash, the T-28 was making a north to south pass 17 km east (downshear) of the main updraft. A model was created to simulate the electric field that would be sensed by the T-28 as it passed a line charge deposited by such a flash. The model allowed for the adjustment in the polarity, density, position, and rotation of an infinite line charge as well as the assignment and placement of charge regions, relative to the T-28 flight path/line charge intersection point, forming a general thunderstorm tripole charge structure. Using the aircraft flight path/line charge intersection as the origin, a reasonable similarity between model output and actual T-28 electric field data was achieved when a line charge of -0.02 mC/m was placed 77 meters in front and 27 meters below the aircraft and then rotated 45 degrees about the z-axis towards the aircrafts right wing and 50 degrees counterclockwise about the x-axis (aircraft flight path). Although the position of the line charge was the dominant influence, an inverted tripole thunderstorm charge structure tilted 30 degrees in the downshear direction produced increased similarity between model and T-28 data. Subsequent analysis of video obtained from the right wing-mounted video camera showed that a lightning channel did form in front of and slightly below the aircraft position and sloped downward from right to left as viewed from the approaching aircraft. This analysis provides an opportunity for in situ verification of the LMA and supports current interpretation of LMA data. It also provides the opportunity to determine the lightning channel characteristics from a horizontally extensive cloud flash.

A71B-0110 0830h POSTER

Lightning NOx Parametrization

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NOx produced by lightning flashes (LNOx) are certainly the most significant natural source of this element in the upper troposphere. Storms modify and transport this production together with NOx created by anthropic activity in the PBL.

Evaluations of LNOX presented in this paper are based on three and two-dimensional lightning activity observations by VHF-interferometry conducted during this ten past years. We consider local parameters (flashes length, microphysical and dynamical properties of the storm cell) within different types of storms observed during the campaigns ORLANDO 92 Florida, EULINOX 98 South Germany and STERAO-A 96 Colorado. Comparisons with commonly used parameterizations show that empirical relations between maximum storm cell height and maximum flashes rate do not always correspond with observations. Thus, this kind of parameterizations cannot describe accurately the behavior of all kinds of storms.

When detailed lightning activity data are available, a local distribution of LNOx production based on observed lightning length can be proposed. We derive two types of vertical parameterizations of LNOx production, the first from 2D lightning activity observations versus the storm cell height and the second from graupels content deduced from radar information

URL: http://www.onera.fr

A71B-0111 0830h POSTER

Houston Environmental Aerosol Thunderstorm (HEAT) Project 2004/2005

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For over thirteen years the National Lightning Detection Network (NLDN) has been in operation collecting cloud-to-ground (CG) lightning data for the continental United States. Geographical areas of enhanced lightning flashes, or hot spots, have been detected in this data set. One such observed hot spot is near the city of Houston, Texas, the most polluted city in the United States. The phenomenon has been studied with the available data and hypotheses made as to the reason for the lightning hot spot. However, more comprehensive data sets are needed in order to further examine this occurrence. The Houston Environmental Aerosol Thunderstorm (HEAT) Project will obtain the data sets necessary for further study of the hot spot near Houston and is planned for the summers of 2004/2005. The primary goals of HEAT are to examine the effects of pollution, the urban heat island, and the complex coastline on storms and lightning characteristics in the Houston area. In addition we will determine the relative amounts of lightning-produced and convectively transported NOx

URL: http://www.met.tamu.edu/ciams/heat/index.html

A71B-0112 0830h POSTER

Test of the Transmission Line Model and the Traveling Current Source Model with Triggered Lightning Return Strokes at Very Close Range

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We test the two simplest and most physically different return stroke models, the transmission line model (TLM) and the traveling current source model (TCSM), by comparing model-predicted electromagnetic field waveforms and field derivative waveforms at 15 m and 30 m from triggered lightning return strokes with the first microsecond of comparable measured waveforms. In the TLM, the return stroke process is modeled as a current wave starting at the base of the lightning channel and propagating upward along the channel with constant waveshape and constant speed, as if the channel were a transmission line. In the TCSM, the return stroke process is modeled as a current source traveling upward with a constant speed and injecting a current wave (derived from the dart leader charge) into the channel which propagates downward with the speed of light and terminates on ground without reflection. The electric and magnetic fields were calculated from Maxwells equations given the temporal and spatial distribution of the channel current specified by the return stroke models. Electric and magnetic fields and their derivatives were measured 15 and 30 m from rocket-triggered-lightning during the Summer of 2001 at the International Center for Lightning Research and Testing at Camp Blanding, Florida. We present data from a five return stroke flash, S0105, and compare the measured data with model-predicted results for three assumed lightning return stroke speeds, v = $1x10^8$ m/s, v = $2x10^8$ m/s, and v = $3x10^8$ m/s (the speed of light). The results presented show that the TLM works reasonably well in predicting measured electric and magnetic fields if return stroke speeds during the first microsecond are chosen to be between $1x10^8$ m/s and $2x10^8$ m/s, and works even better for the field derivatives for return stroke speeds near $2x10^8$ m/s. The TCSM does not adequately predict the measured close electric fields and close electric and magnetic field derivatives during the first microsecond. On theoretical grounds, the TLM might be expected to give better results than the TCSM for return stroke propagation along a dart leader channel that is conducting but contains no net charge density. Perhaps the bottom 100 to 200 m of the channel produced by the triggered-lightning dart leader and traversed by the return stroke in the first microsecond or so of return stroke propagation indeed has a low charge density because the corona sheath surrounding the dart leader has insufficient time to develop at the bottom of the dart leader.

A71C MCC: Hall D Sunday 0830h

Coupling of Iron in the Atmosphere and Ocean Posters *(joint with B, OS)*

Presiding: **P Ginoux,** NASA Goddard Space Flight Center**; W Gregg,** NASA Goddard Space Flight Center

A71C-0113 0830h INVITED POSTER

Incorporating Iron Dynamics into a 3D Ocean Biogeochemical Model

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Iron biogeochemistry has been incorporated into the ocean component of the NCAR Community Climate System Model (CCSM). The ecosystem model of Moore et al. (2002), which includes explicit iron cycling within the upper ocean ecosystem, has been embedded into the 3D POP ocean model component of the CCSM. The ecosystem model includes multiple phytoplankton functional groups and allows for multiple potentially limiting nutrients. Phytoplankton growth rates may be limited by available nitrogen, phosphorus, iron, silicon (diatoms only), and/or light levels. Iron / carbon ratios vary between phytoplankton groups and as a function of iron availability. Phytoplankton functional groups incorporated into the model include diatoms, coccolithophores, nitrogen-fixing diazotrophs, and a generic small (pico- nano-sized) phytoplankton group. This presentation will focus on how iron influences ecosystem community structure as a key limiting nutrient and how iron cycles in the upper ocean. The model includes an atmospheric source for iron from mineral dust deposition and a sedimentary source for iron in shallow water regions. The relative roles of these two iron sources will be examined. Residence times and iron budgets for surface waters and in the upper ocean will be estimated from the model output.

A71C-0114 0830h POSTER

Modeling the Influence of Different Processes on Iron Solubilization in Mineral Aerosols: From the Gobi Desert to the North Pacific Ocean

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Atmospheric transport is the only known means to deliver dissolved iron from the continents to remote oceanic areas. Dissolved iron is one of the necessary nutrients for photosynthesis of microscopic, single-celled marine organisms (phytoplankton) that grow abundantly in oceans around the world. Alteration of dissolved iron fluxes may substantially affect ocean ecosystem productivity and even exert a global-scale influence on climate by affecting the rate at which atmospheric CO2 is fixed by oceanic biota. On continents, iron mainly exists in forms of highly insoluble minerals (iron-oxides and iron-aluminosilicates) and the processes that can solubilize iron in mineral aerosols during their long-range transport remain poorly understood. In this work we attempt to elucidate the key processes that control the solubilization of iron in mineral aerosols using a simple Lagrangian box model to simulate the transport and chemical alteration of iron-containing mineral aerosols as they are transported from the east coast of China to the remote western North Pacific Ocean. Model parameters and initial conditions are set using a combination of soil and aerosol data from the Gobi Desert, as well as from measurements made during specific PEM-West B flights that encountered dust storm plumes over the Pacific Ocean that had originated in China. Our preliminary results indicate that the amount of acidic pollutants in the air along the dust transport pathways can have a significant effect on the amount of iron that is solubilized in advecting mineral aerosols. This suggests that there may be a link between the flux of the dissolved iron to the remote North Pacific Ocean and the rate at which pollutants such as sulfur dioxide, nitrogen oxides, and ammonia are emitted in East Asia.

A71C-0115 0830h INVITED POSTER

Iron and Ecosystem Response to Surface Ocean-Lower Atmosphere Interactions in the North Pacific Ocean Gyre

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Here, we report measurements of iron and aluminum in surface and subsurface waters during March and May of 2001 on transects between central California and Hawaii. A large cloud of Asian dust was detected during April 2001 and there was a clear signal in surface water iron due to aerosol deposition on the May transect. Iron and aluminum concentrations increased synchronously by 0.5 and 2 nM along the southern portion of the transect from background values in March (0.1 to 0.2 nM Fe). Elevated iron concentrations were found to a depth of 100 m. These changes occurred in a ratio that is close to the crustal abundance ratio of the metals, which indicates a soil aerosol source. Soil aerosol concentrations along the transect were estimated using the real-time Navy Aerosol Analysis and Prediction System (NAAPS). The NAAPS results and direct observations of aerosol iron concentration at Mauna Loa Observatory on Hawaii indicate low aerosol concentrations near Hawaii and a large meridional gradient with maximum concentrations in the boundary layer north of 30° N. However, the change in surface water iron and aluminum concentration was highest south of 25° N, near Hawaii. This suggests that the iron and aluminum concentration changes were the result of local processes, rather than a reflection of the broad-scale distribution of aerosol. Anomalously low wind velocities (1 m/s) at the start of the May transit produced a thin (5-10 m), warm surface layer. We suggest that this trapped aerosol at the surface during daylight and led to the iron concentration increase, perhaps through photochemical reduction of particulate iron. Iron concentrations then decreased to background on the day that trade winds returned. A mass balance calculation suggests that the solubility of aerosol iron would have to be near 100% to support the observed increase during the 5 day period of low winds. The absence of a significant increase in particulate iron concentration lends support. While the aerosol fluxes are not well enough constrained to make this conclusion completely robust, it seems most consistent with the observations. There are only weak signals in the biological parameters we monitored (variable fluorescence, chlorophyll concentration, *Trichodesmium* cell abundance or macronutrients) that corresponds to the iron concentration change. However, there may not have been sufficient time for the ecosystem to respond to the effects of iron deposition in oligotrophic waters.

A71C-0116 0830h POSTER

Atmospheric Transport and Input of Iron to the Southern Ocean

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While Australia is not generally considered to be a major source of mineral dust to the atmosphere, at least compared to Asian and African desert regions, it does appear to be the main source of mineral material to the Southern Ocean region south of Australia and New Zealand. In common with most of the greater Southern Ocean, this region contains high nitrate, low chlorophyll (HNLC) waters. Recent open ocean iron enrichment experiments in this region have demonstrated that phytoplankton growth and biomass are limited by iron availability. However the flux of atmospheric iron to this open ocean region is poorly known with very few direct measurements of mineral aerosol levels and input.

Using mineral aerosol samples collected on Macquarie Island and at Cape Grim, together with other chemical data, air mass trajectories and satellite data, the spatial and temporal variability of aerosol iron transport and input to the Southern Ocean region south of Australia is estimated.

A71C-0117 0830h POSTER

Coupled Iron-Phosphorus Cycling in Surface Seawater Mediated by Photoreduction of Fe-rich Dust

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Nutrient concentrations are exceedingly low in the oligotrophic waters of the open ocean. One source of the micronutrient iron (Fe) to these regions is deposition of continentally-derived dust. Photolytic reduction of Fe is believed to be a key process in rendering bioavailable the Fe present in dust particles delivered to surface seawater. Fe(III)-oxyhydroxides, in general, have a strong affinity for sorption of phosphate, and Fe-oxyhydroxides present in dust derived from continental soils can be highly enriched in phosphate. Therefore, solubilization of Fe(III) phases via photoreduction may liberate phosphate to surface seawater. Because biological productivity in oligotrophic regions of the open ocean can be limited by phosphate as well as by iron, this process could be an important avenue for providing two essential, limiting nutrients to support primary productivity in these regions. Alternatively, if Fe-rich

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