

Sprites are bright optical phenomena occurring above active thunderstorms that last a small fraction of a second. Sprites take on a wide range of forms, which have been previously classified based only on their overall shape. In the past decade, images of sprites were obtained mainly with television-rate cameras, with relatively slow temporal resolution and a large field of view. In the past five years, better imagery of sprites was obtained in either temporal or spatial domain, but generally not both. In 1999 University of Alaska Fairbanks researchers obtained the best spatially resolved 1 ms data of a variety of optical phenomena above a thunderstorm to date. Imaged phenomena included not only a wide variety of sprites but also elves, halos, and sprite aftereffects.

Examples of sprites are taken from this data set and are used to describe their dynamical and stationary brightness features and the temporal ordering in which these features develop and decay. This forms the first classification of many sprite types based on their component features as opposed to their overall form. Dynamical features of sprites include downward tendrils and upward branches. The stationary features, often responsible for much of the sprite structure as observed by TV-rate cameras, include beads, columns and other shapes of brightness, and puffs forming above branches. The durations of the stationary processes are longer than those of the dynamical processes. The stationary processes are in fact only semi-stationary, and they may slowly transform the shape of the bright feature. Sometimes, secondary processes - for example, a new set of tendrils or branches - may originate from the previously established sprite body, resulting in further transformation and longer lifetime of the light emitting region. We also describe a class of sprite aftereffects which include various kinds of upward moving brightnesses, generically termed crawlers.

A62D-05 1630h

Photometric Measurements of High Altitude Luminous Phenomena: Quantitative Comparison with Charge Moment Estimates Derived from VLF Sferics

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A telescopic imaging system was deployed by Stanford University at Yucca Ridge Field Station near Fort Collins, CO during May - July, 2000. Video, photometric, and VLF recordings were conducted in order to study upper atmospheric lightning-related luminous phenomena (e.g. sprites, elves, and blue jets). The telescopic imaging system consisted of a telescopic video imager (1x1 degrees), a wide field of view video imager (9x12 degrees), a telescopic photometer (1x1 degrees), and a wide field of view photometer (3x6 degrees). A crossed-loop magnetic field VLF antenna at the same allowed simultaneous measurement of the electromagnetic impulses (sferics) generated by the causative lightning stroke. On July 2, 2000, an unusual storm occurred with over 280 transient luminous events in a span of 2 1/2 hours. These events were sprite-like but very faint and more frequent than is common for sprites. Charge moment estimates were derived using the VLF data. By comparison, on July 4, 2000 a "typical" sprite-producing storm occurred with both large and small sprite events. These two case studies are presented with a high time-resolution analysis of photometric data and accompanying video and VLF data. In the July 2, 2000 storm the vast majority of the events are remarkably similar in brightness, charge moment, delay from causative sferic, and temporal duration. In the July 4, 2000 storm, however, a wide variety of sprites was recorded. Delayed sprite currents from this day are observed to coincide with brightness peaks in the photometer data. Charge moment estimates and temporal characteristics such as brightness rise and decay time constants, delays, and number of brightness peaks are found to widely vary from sprite to sprite. Models developed to explain features of sprites such as streamer formation and diffuse glow rely on both the amount of charge lowered to ground in a lightning stroke and the speed at which it is lowered. Our study which contrasts the sprites of a highly variable storm with that of one repeatedly producing similar sferics reinforces the results of these models.

A71A MCC: Hall D Sunday 0830h

Pacific 2001 and Pacific Northwest

2001 Air Quality Studies Posters

(joint with B)

Presiding: S Li, Meteorological Service of Canada; T Jobson, Pacific Northwest National Laboratory

A71A-0062 0830h POSTER

Airborne Measurements of Hydrocarbons and Aerosols in the Puget Sound Airshed

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In August 2001, a gas and aerosol measurement campaign was undertaken in Puget Sound from south of Seattle north to the Canadian border. The US DOE Gulfstream 1 aircraft was used to measure meteorological parameters, aerosols and their gaseous precursors. The objectives of this study were to better understand the transport and formation of ozone and particulate matter in the Puget Sound airshed and to develop air quality and meteorological databases for evaluating air quality models used in predicting air quality within this area. The study was coordinated with the Canadian Pacific 2001 study. Real time measurements were made of aerosol number distributions from 3 to 3000 nm diameter and of selected gaseous precursors using standard instrumentation as well as a new proton transfer reaction mass spectrometer. Reactive hydrocarbon compounds, nitrogen oxides, sulphur dioxide, carbon monoxide and ozone were measured on horizontal transects and vertical profiles around Puget Sound in morning and afternoon. Using these observations, this paper will highlight common air quality features as well as some of the complexities related to air quality in a mountain-ringed basin.

URL: <http://www.pnl.gov/pnw2001/>

A71A-0063 0830h POSTER

AIRPACT Air Quality Forecasting for August 2001

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The AIRPACT air-quality forecasting system was operational during the month of August, 2001, and provided daily forecasts of ozone and associated species throughout the PNW2001 period. The AIRPACT (air indicator report for public awareness and community tracking) project was supported by the U.S. EPA through the EMPACT program. The modeling effort within this project resulted in the assembly of a highly automated air quality forecasting system using MM5 meteorology coupled with a regional emissions sub-system, which both drove the CALMET-CALGRID Eulerian air-quality model. Results were posted to the project web-site and distributed via ftp each morning before operations decisions were finalized. Modeling outputs included 24-hour animations of estimated gridded area emissions and predicted gridded hourly average mixing ratios for ozone, among other species. A verification system for comparing AIRPACT results against the Washington Department of Ecology telemetered surface monitor data was in development during PNW2001. The various measurement components of PNW2001, in combination with the Ecology monitoring network, provided an excellent opportunity to compare AIRPACT ozone predictions with ozone observations from multiple measurement schemes, including surface monitors, aircraft sampling, and ozonesondes. The AIRPACT prediction verification against surface monitors at six downwind sites near Seattle, WA for August 2001 resulted in a normalized bias of 15% and a normalized gross error of 51%. Comparisons of AIRPACT predictions against ozonesondes and aircraft measurements are presented graphically in this poster. URL: <http://www.airpact.wsu.edu>

A71A-0064 0830h POSTER

The Pacific 2001 Air Quality Study: An Overview

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The Pacific 2001 Air Quality Study was an initiative aimed at providing scientific understandings of the smog problems in the Lower Fraser Valley that straddles the border between British Columbia and the State of Washington. Its main objectives are (1) to determine the horizontal and vertical distribution of fine particulates and ozone in the LFV airshed. In particular, to determine the transition from an emission-dominated regime to a formation-controlled regime in the valley, (2) to determine the physical and chemical characteristics of fine particulates in the LFV airshed, and to determine the changes in these properties in the region, (3) to identify the major physical and chemical processes in the formation of secondary aerosols and ozone, (4) to determine the roles of biogenic and anthropogenic (transportation sector) emissions in SOA and ozone formation. The field study was carried out in August 2001, with five ground sites that aim to address different aspects of the smog problem. The Cassier Tunnel site addresses the emissions from the light-duty transportation sector while a site at the Slocan Park site addresses air quality issues in an urban suburban setting, where a mixture of primary particles and secondary particulate matter is expected. Impact from anthropogenic precursors such as the oxidation of aromatic hydrocarbons is expected at this site. At the Langley Ecole Lochiel site, measurements are aimed at the transition from urban to rural settings and the formation of particulate matter from agricultural practices. The Sumas Mountain site addresses the impact of ammonia emissions in the inner valley east of the Sumas Mountain, the visibility reduction issue, and the interaction between urban pollution and biogenic emissions. A forest site at the Golden Ears Park site to aims to understand the formation process of biogenic particulate matter from precursors such as monoterpenes, and how this process will impact on the PM in the valley overall. At all sites, extensive sets of measurements were carried out, including particle physical and chemical characterization. Two aircraft were deployed to determine the spatial PM distribution in the valley. The measurements have revealed important features of smog problems in the valley and provide a scientific basis for further policy formulation.

URL: <http://www.msc.ec.gc.ca/pacific2001>

A71A-0065 0830h INVITED POSTER

From Pacific '93 to Pacific 2001:
Modelling Strategies and ChallengesWeimin Jiang¹ (1-613-998-3992;
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In preparation for the Pacific 2001 field measurement study, a model run for the simulation of pollutants during the Pacific '93 field study period was conducted using the Models-3/CMAQ system. Results were analysed to show the modelled distributions of gas and aerosol species in time and space. Notwithstanding the model limitations and uncertainties, the modelling results were used to help guide the selection of measurement sites for Pacific 2001.

For model evaluation purpose, both the modelling results and the Pacific '93 measurement data were reprocessed in order to generate meaningful comparison results. Various challenges and uncertainties were encountered in the comparison of hourly concentrations of modelled aerosol species based on log-normal distributions with concentrations of measured species at various time intervals and size bins. The comparison showed promising signs of qualitative model performance, and revealed model weakness in various quantitative aspects.

Based on the results of the model evaluation using Pacific '93 data, an effort is underway to improve the model structure and science in preparation for the modelling exercise using Pacific 2001 data. Due to the different weather patterns during the Pacific 2001 period, pollutant levels and distributions may be substantially different from those during the Pacific '93 period. This presents special challenges for the modelling exercise and calls for the development of new modelling strategies.

A71A-0066 0830h INVITED POSTER

The Chemistry of NO₃ During the
Pacific 2001 Field StudyRobert McLaren¹ (416-736-2100 x30675;
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During Pacific 2001, a differential optical absorption spectroscopy (DOAS) system was deployed for the measurement of the nitrate radical, NO₃, close to an elevated site known to be influenced by anthropogenic and biogenic emission sources. The nitrate radical measured on four nights ranged from below detection limit (4-7 pptV) to 48 ppt. Simultaneous measurements of NO₂ and O₃ at the elevated site allow an estimate of night time N₂O₅ levels assuming equilibrium conditions. The interest in this study is the role of NO₃/N₂O₅ in particulate formation. There are several known routes to particle formation that will be explored. The known fast reaction between NO₃ and monoterpenes to form condensable secondary organic products is one route that will be commented on. Simultaneous measurements of a/b-pinene and particulate pinonaldehyde and nopinone will allow some estimates of the importance of this process at the site. Measurements of particle phase pinonaldehyde at this site showed significant diurnal variations with nighttime maximums. The second route of interest is the homogeneous and heterogeneous reactions of N₂O₅ to form gaseous HNO₃ and/or particulate nitrate.

A71A-0067 0830h POSTER

The Pacific 2001 Data Centre The
Making of a Successful Field Study
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Experience from past field studies has shown the importance of careful formatting, archiving, and documentation of field study data in order for data users to effectively integrate and synthesize data from all researchers. The Pacific 2001 Air Quality Study has addressed this need by establishing a series of data management protocols with the following two goals: 1. Facilitation of data exchange among the researchers. 2. Provision of a long-term data archive that is consistently formatted and well documented.

To meet these goals, the Pacific 2001 Air Quality Study Data Centre adopted the NATChem/NARSTO Data Exchange Standard (DES). A template developed around the DES facilitates standardized data formatting and submission to the Data Centre. This template allows input of not only measurement data, but also high-level brief descriptions of metadata, e.g., site characteristics, instrumentation, analysis techniques and other information. The data and high-level metadata are combined in each file to facilitate the exchange of knowledge along with the data.

Supplementing the high-level metadata contained in the DES files, detailed metadata are separately recorded in a standardized Quality Assurance Project Plan (QAPjP). The QAPjP documents the pre-study measurement plans as well as the post-study quality assurance results. It includes descriptions of the instrumentation and analysis methods, detection limits, estimates of accuracy, precision, and representativeness, and other descriptive metadata.

Once data have been quality controlled by the researchers, they are reformatted using the DES template. We demonstrate here the effectiveness of this approach with real-world examples from the study including examples of plots and QA reports based on the DES. The plots and QA reports are tools provided to Principal Investigators to identify potential problems with their data, and to ensure conformity to the data standard. The provision and quick turnaround of these tools during the data submission stage is a key ingredient to producing a successful field study archive.

URL: <http://www.msc.ec.gc.ca/pacific2001>

A71A-0068 0830h POSTER

Detailed Characteristics of a Ship Plume
Observed in Land During Pacific 2001Gang Lu¹ (416 739 4736; gang.lu@ec.gc.ca); JefferyR Brook¹ (416 739 4916; jeff.brook@ec.gc.ca);Kurt Anlauf¹ (416 739 4840);M. Rami Alfara² (161 200 3946; m.alfara@student.umist.ac.uk); JamesAllan² (161 236 3311 x 2490);j.allan-2@student.umist.ac.uk); Richard Leitch¹

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During Pacific 2001 one of main surface sites, Slocan Park, was located in Vancouver proper in order to obtain measurements closer to one of the suspected source regions for the entire Lower Fraser Valley. Local motor vehicle and industrial emissions were expected to major contributors to fine particles (PM_{2.5}) and their precursors (NO_x, VOCs, SO₂). However, the measurements also indicated that marine emissions are potentially an important and perhaps under-appreciated source. A distinct plume, indicated by a twenty-fold increase in NO concentration, clearly indicating fresh emissions, and more than an order of magnitude increase in SO₂, was tracked from a routine monitoring site near the coast to Slocan Park, which is 8.5 km inland. The detailed measurements at Slocan Park indicate that this plume of marine origin was also characterized by large rises in black carbon, total particle counts, VOCs, as well as a four-fold increase in fine particle mass and sulphate. By the time the plume reached Slocan Park the peak SO₂, NO, BC, PM_{2.5} and particles counts were, 10 ppb, 55 ppb, 1.5 ug per m³, 12 ug/m³ and 6000 per cm³, respectively. The goal of this poster is to provide detailed chemical characteristics of this "ship plume" including time and size resolved particle composition measured with an Aerosol Mass Spectrometer (AMS), to contrast these characteristics with measurements during other periods of the study and to provide information on the relative frequency with which "ship plumes" impact upon the population of Vancouver.

A71A-0069 0830h POSTER

Gaseous Chemical Characterization of
the Lower Fraser Valley Airshed
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During the Pacific 2001 field campaign, measurements of a number of gaseous chemical compounds were made at three different locations: Langley (agricultural), Sumas Mtn (forested, 300 m elev.) and Slocan (urban Vancouver). NO_x was the dominant component of NO_y and limited conversion to its oxidation products of HNO₃ and PAN resulted in low O₃ production efficiencies. The sum of the individual measured species (NO_y) show that approximately 17 and 6 percent of the NO_y is unaccounted for at Langley and Sumas respectively. Using species indicator ratios, conditions were NO_x-limited at Langley and Sumas, whereas, at Slocan, VOC-limited chemistry characteristic of urban environments existed. A secondary nighttime peak in HNO₃ at Sumas was, at times, coincident with peaks in HONO, particle nitrate (MOUDI impactor), O₃, HCHO and PAN. This behaviour is attributed to return valley flow, but evidence suggests that the formation of HNO₃ at night through N₂O₅ hydrolysis may also be significant.

A71A-0070 0830h POSTER

Application of Lidar Data in the
Assessment of Observed and Model
Output Temperature Soundings
During the Pacific 2001 Field Study.Kevin B. Strawbridge¹ (1-705-458-3314;
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Surface and airborne lidar, along with upper air soundings and model derived soundings were examined over the course of the Pacific 2001 Air Quality Field Study. The general region of interest in this report is the Georgia Basin with a focus on the Lower Fraser Valley of British Columbia.

Data included the following: RASCAL (Rapid Acquisition Scanning Aerosol Lidar), a surface-based scanning lidar facility at the Langley Lochiel site, operating close to 16 hours each day; AERIAL (AEROSOL Imaging Airborne Lidar), a simultaneous upward/downward airborne lidar system providing 9 flights during the field study; radiosondes, released 4 times daily from the Langley Poppy site; and once-daily 3.3 km resolution MC2 (Mesoscale Compressible Community weather prediction) model output.

Methods of diagnosing mixing heights amongst the various datasets are outlined. The higher resolution lidar data provides a means of calibrating mixing heights from radiosondes and also allows a means of evaluating model derived soundings. Results show that in most cases there is good agreement amongst the various sources of data. This data is then used to demonstrate the variation of mixing height with sea breeze activity over the Lower Fraser Valley.

A71A-0071 0830h POSTER

Carbon Isotope Measurements of Different Carbon Species (OC and EC) in Aerosols: Method Development, Application to Pacific 2001 Campaign Samples and its Implications

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Carbonaceous aerosols play an important role in air quality related issues in the LOWER FRASER VALLEY. It is known that those aerosols are formed from different emission sources (e.g., fossil fuel or biomass) through different formation processes (e.g., primary emission: high temperature combustion and secondary formation: low temperature photochemical oxidation). We have developed a method to measure carbon isotopic compositions of bulk carbon fractions in aerosols, released at different temperature ranges and different redox conditions, including OC (organic carbon), CC (carbonate carbon) and EC (elemental carbon). The distribution of carbon isotopic compositions (δC^{13}) obtained from different temperature ranges may provide information about source and formation processes. The method uses a step-wise heating thermal desorption/combustion OC/EC analyzer coupled with GC-IRMS (gas chromatography separation, followed by isotopic ratio mass spectrometer analysis) through a Pre-Con system. The overall precision of the whole method is about 0.3, the average difference between on-line and off-line results is 0.1. For further study the isotopic compositions of some OC components, the method of compound-specific isotope analysis has been developed and the results will be compared with those from the bulk analysis.

The carbon isotopic compositions of OC and EC in different samples collected at three PACIFIC 2001 sites (Golden Ears Park, which is dominated by biogenic sources; Cassiar Tunnel, which is dominated by motor vehicle emissions; Slocan Park, which is an urban area and should reflect the influence from multiple sources) have been measured and the corresponding standardizing thermographs have been obtained. According to the results, there is an obvious difference between the biogenic component (Golden Ears Park samples) and the fuel combustion component (tunnel samples), in terms of the distribution of isotopic compositions and corresponding standardizing thermographs. In tunnel samples, the δC^{13} value of EC tends to be very close to the value of OC, indicating no or very small isotopic fractionation between different components during a high temperature process, whereas in the forest samples, although the fraction of EC is small, the δC^{13} value of EC is obviously different from that of OC. The former is more positive than the latter. The isotopic composition of the forest EC may reflect the isotopic composition of the EC in the background air. These results suggest that the combination of the isotopic compositions of different carbon components (i.e. the difference of δC^{13} between OC and EC) and the corresponding relative ratios of those components may be a powerful tool to constrain source apportionment for carbonaceous ambient aerosols.

A71A-0072 0830h POSTER

Optical Coherency of Dual-station Sunphotometry, Ground-based Multi-angle Lidar and Airborne Lidar During the Pacific 2001 Experiment.

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An intensive aerosol sampling and optical field campaign was carried out during the 2nd and 3rd weeks of August 2001 in and near the lower Fraser Valley, British Columbia (B.C.). This region is known for its

mix of urban, marine and rural aerosols. CIMEL sunphotometer / sky scanning radiometers were located near the city of Vancouver (the Lochiel site in Langley B.C.) and on Saturna Island, about 80 km southeast of the Lochiel site in the Straits of Georgia. A multi-angle scanning lidar, co-located at the Lochiel site, acquired 3D backscatter profiles synchronously with the sunphotometer measurements. An airborne upward and downward looking lidar was also employed to acquire 3D backscatter slices along flight lines in the Georgia Strait. These optical measurements were complemented by a variety of micro-physical and chemical measurements made at a number of stations in the Vancouver area and from airborne platforms. The timing for this two week period was fortunate since a significant pollution event was detected by virtually all optical and micro-physical sensors. This communication focuses on the sunphotometer measurements and the optical coherency of these measurements relative to the lidar profiles as well as available microphysical data. In particular we will present derived data related to the concentration, size distribution and single scattering albedo and how this data complements or supports the other types of data.

URL: http://www.msc-smc.ec.gc.ca/projects/pacific2001/index_e.html

A71A-0073 0830h POSTER

Impact of Local Pollution and Biomass Burning on Air Quality in the Pacific Northwest During the PNW2001 August Intensive

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From 1974 to 2000, Enumclaw, WA, has exceeded the 8-hour, 80 ppbv O₃ limit 31 times. As the National Ambient Air Quality O₃ Standard moves to this lower level and the population in the Pacific Northwest continues to increase, understanding and forecasting potentially harmful air quality days will become more important. Three research flights were conducted as part of the PNW2001 field study in the Puget Sound region to examine the spatial distribution of O₃ and aerosol loadings during August 2001. Comparisons to and validations of forecast model CALGRID O₃ model results were also made. A local pollution episode was measured on August 10 with elevated O₃ (~80 ppbv) and aerosol scattering coefficients (~35 Mm⁻¹) measured downwind of Seattle and Tacoma. These findings are consistent with previous studies but differ in the location of the pollution plumes compared to the forecast model CALGRID model results. Biomass burning emissions were also encountered in a broad layer above a well-defined temperature inversion on August 16. Meteorological analysis and satellite imagery suggest the elevated O₃ (~60 ppbv) and very high aerosol scattering coefficients (~80 Mm⁻¹) were due to emissions from fires burning in Washington, Oregon, and Northern California. These results provide evidence of enhanced O₃ and aerosol scattering, extending to 4 km over Puget Sound, from varying sources. They further demonstrate the capabilities of the CALGRID O₃ forecast model and the need to include biomass burning emissions in this model.

A71A-0074 0830h POSTER

Determination of external and internal mixing of organic and inorganic aerosol components from equilibrium water uptake by sub-micrometer particles.

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The ability of a particle to gain and lose water with changes in relative humidity is fundamental to particle's effectiveness as a cloud condensation nucleus,

chemical reactivity, atmospheric residence time and influence on global radiation balance. We describe a method developed to measure particle hygroscopicity over a range of relative humidities (RH) from 50% to 85%. Ambient aerosol particles were dried, monodisperse particles with diameters of usually 50 and 114 nm were selected, and their size distribution following humidification was measured. We measured particle hygroscopicity at Golden Ears Provincial Park and Eagle Ridge Mountain as part of the Pacific 2001 field study in the lower Fraser Valley in August of 2001.

The humidified size distributions were sometimes monomodal and sometimes bimodal distribution with less and more hygroscopic peaks. The hygroscopicity of the monomodal particles varied between that of the less and more hygroscopic particles. The less hygroscopic particles were probably almost entirely organic in composition; they had consistent growth curves with wet/dry diameter ratios that increased from 1.04 at 50% relative humidity to 1.09 at 80% RH. These less hygroscopic particles constituted almost all the sampled aerosol at the forested site in Golden Ears Park and during the rainy periods at Eagle Ridge. At other times there were more hygroscopic particles, either as a single mixed mode or as a distinct mode in addition to the less hygroscopic particles. These showed little growth below 70% RH and pronounced growth above 70%. The increased water sorption above 70% RH is likely due to the particles containing (NH₄)₃H(SO₄)₂ or (NH₄)₂(SO₄), as these salts deliquesce at 70% and 80% RH, respectively. Since the growth of these particles was less than expected for the pure salts, we conclude that these particles consisted of a mixture of the organic and inorganic components. An estimate of the relative organic fraction was made using the observed growth factors for mixed and organic particles and calculated growth factors for pure inorganic particles. The results indicate that the sampled particles contained a significant organic fraction. 50% of the more hygroscopic particles had organic fractions higher than 0.63, this value was 0.84 for monomodal particles.

Bimodal distributions of the humidified particles clearly demonstrated external mixing of the aerosol. In addition, the width of the humidified distribution (spread factor) was also used as an indicator of varying composition. The most common result following humidification of particles was a single mode which frequently exhibited significant spread when humidified above 70% RH. The least amount of spread was observed for particles measured at Golden Ears Forest. At Eagle Ridge, lower spread factors were observed for particles with growth factors at the high or low end of the values observed. The highest spread factors were observed for particles with mid-range growth factors. These results indicate that while particles at Golden Ears Forest were largely single component particles, at Eagle Ridge particle had two sources whose hygroscopicity was approximated by the upper and lower growth factor values observed for the site.

A71A-0075 0830h POSTER

VOC Measurements in the Lower Fraser Valley, British Columbia, Canada

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We report VOC measurements made with an onsite GC/FID/MS system in the lower Fraser Valley, BC, Canada during 2000 and 2001. The focus of these measurements was on several target classes of compounds: benzene/toluene/ethylbenzene/xylene (BTEX) representing anthropogenic pollution impact, isoprene and monoterpenes as markers for biogenic hydrocarbons, and C2-C4 alcohols and carbonyls. Data were collected at two forested areas (Seymour Dam and Golden Ears Provincial Park) on the edge of the valley as well as at a rural location in the center of the valley (Langley). All these sites might be expected to be occasionally downwind of the city of Vancouver. In addition, we collected whole air samples in stainless steel canisters from a small aircraft to obtain further insight into the distribution of the NMHCs.

As expected, large quantities of isoprene and terpenes were observed in the forested locations, and these were highly variable due to meteorological conditions. Terpenes were mostly below detection limits at Langley. BTEX was observed at all locations especially in the afternoons, indicating that urban polluted air was moving to these sites. As for the oxygenates, alcohol levels were also substantially different between the forested locations and Langley, but acetone was abundant at all locations implying that its source can be

both anthropogenic and biogenic. The airborne samples showed much lower abundances of the hydrocarbons above the boundary layer, but over Langley there was an indication of a plume coming from the South-west rather than the North (the location of the forested sites), in agreement with prevailing air flow patterns in the region.

We use the data to explore the role that anthropogenic and biogenic hydrocarbons play in the oxidant chemistry, and their contribution to the formation of the organic carbon fraction of the particle load in the region.

A71A-0076 0830h POSTER

Atmospheric Aerosol Size Distribution at Sumas Mountain, Vancouver, BC.

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Atmospheric size distributions provide fundamental information for studying atmospheric particle physics. To study and monitor the air quality in the Lower Fraser Valley, Vancouver, BC, Pacific 2001 field study was held in Vancouver during August 13th to September 1st 2001. As part of the Pacific 2001 study, aerosol size distributions were measured at Eagle Ridge, just east of Abbotsford, BC. Atmospheric particles were sampled from a 3/8-inch stainless steel tubing with an inverted U-shape inlet. The sample line located at 2 meters above the top of a trailer that has an elevation of 300 meters above sea level. Particles coming from the sample line were sized using a TSI 3071 Differential Mobility Analysis (DMA) and then counted by a TSI 3010 Condensation Nucleus Counter (CNC). The system measured atmospheric particles with diameters from 9.3 to 604 nm. Each five-minute scan consisted of 30 size bins increasing exponentially in size. All the data was corrected for CNC counting efficiency and multiple charging effects to represent a more realistic description of the size distribution.

During the field study, 19 days of data for both sunny and rainy days were obtained. By comparing the measured total concentration from 10 nm and 6 nm on-wards, identified local nucleation event was observed in 4 days. Clear observation of particle transport from other remote places to the monitoring site was observed in 13 days during the study.

Nucleation mode particles were usually observed between 10 a.m. to noon in all sunny days. These nucleation mode particles are thought to be due to nocturnal inversion. As that happen, pollutants that were accumulated overnight in the valley were transported up to the site, with the combination of the sunlight, trigger the formation of new particles. The formation of these nucleation mode particles was usually followed by a short particle growth period, which may last from two to five hours, except for one day, which this growth period extends to midnight. Owing to the high variability of the size distribution, to fit these data using multi-LogNormal distributions may result instability problem. To accomplish this, we have explored a new method to analyse the data. Applying the Principal Component Analysis (PCA) to the data may provide more stable distribution for describing the data. Furthermore, the PCA also provide a mean for reducing a massive data set to a manageable data set.

A71A-0077 0830h POSTER

Chemical and Size Characteristics of Particles in the Lower Fraser Valley: Pacific 2001 Field Study.

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During August 2001, the Pacific 2001 field study was conducted in the Lower Fraser Valley of British Columbia, Canada. Extensive particle and gas measurements were made simultaneously at 3 locations: (1) Vancouver (an urban park site about 8.5-12 km inland from Georgia Strait), (2) Langley (rural, relatively flat terrain, about 12 km inland), and (3) Sumas mountain (a partly forested higher altitude site, about 300 m asl and 40 km inland). This paper will present details on the particle size distributions, as measured by an impactor device, and their chemical ionic characteristics. Briefly, the size distributions exhibited a fine particle maximum in the size range 0.3-0.55 μm (with an indication of a smaller maximum in the 0.1-0.17 μm

range) and another maximum of coarser particles at 3.1-6.2 μm . This latter coarse mode was dominated by sodium, indicative of marine origin, but was depleted of chloride and augmented by nitrate, indicating nitric acid reaction on sea salt particles. The fine mode was characterized by SO_4^{2-} and NO_3^- , ionically balanced by NH_4^+ . At both the urban and Sumas mtn. sites there were instances of nighttime formation of nitrate particles in the fine mode, as there was sufficient NO_x and ozone on these occasions; the Langley site was subject to coastal breezes and generally showed less photochemical activity and particle nitrate formation.

A71A-0078 0830h POSTER

A non-derivatization Analysis of Fatty Acids from C6 to C20 in PM 2.5 Aerosols using GC/FID and GC/MSD

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Fatty acids make large contributions to aerosol mass. In particular, palmitic acid (C_{16}) and stearic acid (C_{18}) are dominant in atmosphere and in many sources of aerosols. Their analysis after sampling is usually based on methylation or silylation into methyl esters or silanes for analysis on GC/FID or GC/MSE. In this paper, a non-derivatization analysis method of fatty acids ranged from C_6 to C_{20} in $\text{PM}_{2.5}$ aerosols is discussed. The entire analysis method includes the processes of extraction using Accelerated Solvent Extraction (ASE), cleanup using silica gel column chromatography, concentration by blow down, and GC/FID and GC/MSD analysis/identification with the DB-FFAP capillary column.

The calibration curves of the fatty acids on the GC/FID basically go through the origin and have highly linear response (r^2 from 0.99862 to 0.99979) for the concentrations ranged from 0.6 to 128 $\text{ng}/\mu\text{l}$. Detection limits of fatty acids on the GC/FID are from 0.2 to 0.6 $\text{ng}/\mu\text{l}$ depending on the compounds. The linear response of the calibration curves on the GC/FID is from 0.92 to 0.99. The detect limits on the GC/MSD are around 0.8 $\text{ng}/\mu\text{l}$. The relative standard deviations (RSD) of quantitation on the GC/FID are smaller than on the GC/MSD.

Using the GC/FID, the recoveries of fatty acids using the entire method with spiked internal standards (surrogates) are between 80 and 104% with the RSD <8% except C_6 and C_7 . The recoveries of fatty acids using the entire method without the surrogates are 50 to 61% for C_{10} to C_{20} , and are lower than 40% for C_6 to C_9 , with the RSD <8% for all compounds. The temperature is a key factor for the stability of the compounds on the ASE performance. The compounds through the ASE at 40°C are very stable for at least 3 months and very less contamination. However, when extracted at 80°C later on the ASE the compounds were not stable and later turned into their methyl esters within one month, as well as creating some contamination peaks that rendered the quantitative analysis useless.

URL: <http://www.msc.ec.gc.ca/pacific2001>

A71A-0079 0830h POSTER

Particulate-Phase Carbonyls: Laboratory and Pacific 2001 Field Measurements

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Atmospheric aldehydes and ketones are important constituents of the gas phase. They are emitted from anthropogenic and biogenic sources directly, but are also formed as secondary oxidation products of a variety of saturated and unsaturated hydrocarbons. Although their gas phase occurrence and chemistry is well known, the presence of these compounds in the particulate phase is not completely understood. A method has been developed to measure particulate phase carbonyls. Analysis was performed by a simultaneous extraction and derivatization of carbonyls by 2,4-dinitrophenylhydrazine. The subsequent derivatives are pre-concentrated and injected onto an HPLC and detected by UV absorption. Laboratory studies of the extraction kinetics, suggest that partitioning of even highly volatile carbonyls may be possible. Also, experiments performed to determine the extent of positive artifacts on Teflon coated filters, indicate that measurements of these volatile carbonyls are likely not a result of gas-phase adsorption to the filter. These studies also indicate that sampling on

quartz fiber filters may introduce significantly more uncertainty with respect to positive artifacts. The analytical method was used to analyze filters sampled during the Pacific 2001 field campaign. Particulate samples were collected on Teflon coated glass-fiber filters. Samples were collected at an urban site (Slocan Park, Vancouver), a rural site (Langley) and an elevated rural mountain site (Eagle Ridge, Sumas). Preliminary results show several carbonyls present in aerosols, at pg/m^3 to ng/m^3 levels. Detected carbonyls of possible anthropogenic origin include formaldehyde, acetaldehyde, acetone, propanal, glyoxal and methylglyoxal. Detected carbonyls of biogenic origin include pinonaldehyde and nopinone, known oxidation products of the biogenically emitted α -pinene and β -pinene. Possible mechanisms for carbonyl partitioning and implications for their contribution to aerosols in the Lower Fraser Valley will be presented.

A71A-0080 0830h POSTER

Analysis of Phytosterols and N-Alkanols in Atmospheric Organic Particulate Matter Collected in Vancouver During the Pacific 2001 Air Quality Study

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As part of Pacific 2001, HiVol samples were collected from 5 sites in the Vancouver area. The samples were extracted by accelerated solvent extraction (ACE), concentrated with nitrogen blow down, and separated into fractions by silica gel chromatography. For this portion of the study, an aliquot of one of the polar fraction was derivatized with BSTFA and analyzed by GC-FID and GC-MS. The results for n-alkanols and phytosterols will be reported and discussed. Previous studies have shown that the biogenic components of particulate matter are major constituents of the total organic material in atmospheric samples. Phytosterols are present in wood smoke, epicuticular waxes of many plants and microbial sources. In addition, cholesterol has been proposed as a potential tracer for emissions from cooking. The most abundant phytosterols are cholesterol, campesterol, stigmasterol and beta-sitosterol. It has been hypothesized that the phytosterol signature may be useful in identifying particulate matter from different source areas. The phytosterol signature for these samples will be reported and compared. The n-alkanol CPI and C_{max} will also be reported. N-alkanols in atmospheric samples generally show a strong even to odd predominance indicating that their main source in particulate matter is biogenic. The n-alkanol signature for each sampling site will be compared.

URL: <http://www.msc.ec.gc.ca/pacific2001>

A71A-0081 0830h POSTER

Assessing Spatial and Temporal Variability and Source Attribution of Ammonia during Pacific 2001

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We present ammonia concentrations in the Fraser Valley during Pacific2001. The observations were obtained using time integrating active diffusion denuders (ADD) and two continuous techniques; Wet Effluent Diffusion Denuders (WEDD) and a Tunable Diode Laser Spectrometer (TDLAS). The former were operated at three sites; an urban location, an agricultural/sub-urban location and from a high altitude site, the latter was operated only at the agricultural/sub-urban location. In this presentation we focus on four aspects of the data: (i) Detailed

comparison of measurements derived using independent instrumentation. (ii) Quantitative assessment of the representativeness of the measurement sites with respect to the ammonia observations. (iii) Assessment of the high frequency (sub-hourly) temporal variability of ammonia concentrations. (iv) Use of a simple three end member model and ratioing techniques to provide source attribution of the observed ammonia concentrations relative to a spatially resolved ammonia emission inventory. Preliminary results of the inter-comparison of the WEDD and ADD systems indicate a high degree of correspondence with virtual zero bias and low systematic error. The measurement sites in the urban and sub-urban locations indicate the sites are representative of the respective land use types and locations, but the high elevation site, as expected, shows a high degree of variability associated with coupling and decoupling of the site with the valley below. Initial results of the sub-hourly variability of ammonia concentrations indicate that at the sub-urban site, the relative variability is lower than that of nitrogen dioxide and of the same order as carbon monoxide indicating a relatively high degree of homogeneity of ammonia concentrations. The source attribution work is still underway but provisional results for the sub-urban site indicate a substantial contribution from the mobile sector.

A71A-0082 0830h POSTER

Differentiation of Natural and Anthropogenic Organic Compounds on Atmospheric Particles by Molecular and Stable Isotope Composition - Pacific 2001, Lower Fraser Valley Air Shed Study

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This component of the CFCAS Pacific 2001 study examined the character of specific non-volatile organic compounds (nVOCs) extracted from filtered total suspended particulates at the Pacific 2001 sites in the Lower Fraser Valley (LFV), Vancouver, BC region. The objective is to identify or fingerprint spatial and temporal variations in both molecular and stable isotope composition of these organic compounds with the goal of understanding their sources or to provide insights into transport and/or atmospheric chemistry processes. This will provide critical information to help assess the potential type and magnitude of exposure that humans receive from nVOCs in such urban settings, and the associated health risks.

Aerosol samples were collected over 24hr to 7-day period on HiVol filters in the LFV at Slocan Park, Golden Ears Park, Langley HS, Sumas Mt., and Casiar Tunnel (2hr). nVOCs were solvent-extracted from filters, then separated into different compound classes by silica-gel chromatography. Selected fractions are analysed for their individual compound molecular compositions by Gas Chromatography-Mass Spectrometry (GC/MS) and by Continuous Flow-Isotope Ratio Mass Spectrometry (CF-IRMS) for their stable carbon ratio.

Significant variations in nVOC composition are observed for the 5 LFV sites. These are related to a combination of natural and anthropogenic urban activities. The most striking discovery is the strong odd-even carbon number predominance (OEP) observed for BOTH molecular and carbon isotope data. Recent natural release of hydrocarbons from plants have a clear predominance for the odd-carbon numbered n-alkanes. These C23 - C31 compounds are also systematically depleted in 13-C. The carbon isotope range between the odd and even compounds is up to 10 permil for the plant signatures. Anthropogenic and aged hydrocarbons have substantially lower molecular and isotope OEPs.

This novel biogeochemical approach has good potential for estimating broad source apportionment and process control of nVOCs in rural and urban air masses. URL: http://www.msc.ec.gc.ca/projects/pacific2001/index_e.html

A71A-0083 0830h POSTER

Detection of Air Pollutants in the Lower Fraser Valley by Fourier Transform Infrared Spectroscopy

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The Trent experiment was part of Environment Canada's Pacific 2001 Air Quality Study which took place in August 2001. The Lower Fraser Valley area is of particular interest to study as it experiences emissions from urban, suburban, marine and agricultural sources, thereby making it one of Canada's smog corridors. The population of the Lower Fraser Valley is predicted to increase and therefore the emissions of pollutants are expected to increase as well. The purpose of the Pacific 2001 study was to investigate the changes in size and composition of aerosols and gases in the smog. During the study, air and ground measurements were taken at 5 locations in the greater Vancouver area. The purpose of the Trent experiment was to use Fourier Transform spectroscopy to measure the concentrations of O₃, CO, CO₂, N₂O and CH₄ along an open path at ground with a BOMEM DA-8 FTS. The measurements for this experiment were taken at the Langley School site from August 14, 2001 until September 1, 2001; approximately 5 long path measurements were taken daily. The concentrations of CO, CO₂, N₂O and CH₄ varied throughout the study in August. The concentration of CO varies strongly because CO has a short lifetime and the concentration can increase rapidly due to large anthropogenic pollution sources, such as automobile use. The other three species, CO₂, N₂O and CH₄, have much longer lifetimes and thus are more stable in the troposphere; the concentrations of these species did not vary greatly throughout the study. Ozone and ammonia concentrations were also measured. A second FTS was flown on the Convair 580 aircraft viewing in the nadir direction to determine column amounts of ozone and CO.

A71A-0084 0830h POSTER

Chemical and Physical Characterization of Ambient Particulate Matter by Raman Spectroscopy

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We report Raman spectroscopic measurements of particulate matter samples collected during the Pacific 2001 field campaign in the vicinity of Vancouver BC. The samples were collected by drawing 2.5 SLPM of ambient air through two metal filters having pore sizes of 3.0 and 0.2 µm, which were mounted in tandem. Four samples were collected per day in each of the Slocan Park and Langley sites on the schedule: 8 10 AM; 12 2 PM; 4 6 PM; 7 PM 7 AM. The filters were analyzed in the laboratory using a Raman spectrometer that recorded Raman shifts from 500 cm⁻¹ to 3500 cm⁻¹. The most intense Raman spectrum detected in the samples was that of Elemental Carbon (EC), which exhibited band shapes characteristic of soot. In addition to the EC bands, most samples gave strong fluorescence signals, the bands of which could be categorized into a small number of characteristic shapes. Many samples also had bands characteristic of sulfate, nitrate and other inorganic components. In this presentation, we will report the quantification of the relative intensities of these bands and the implications of these results for the composition of the particles. We will also provide estimates of the microphysical properties of the particles based on a model we have previously developed.

A71A-0085 0830h POSTER

Pacific 2001 Golden Ears Micro Field Study

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Prior to Pacific 2001, a weeklong study was conducted at Golden Ears Provincial Park, near Maple Ridge, B.C. The objective of the study was to increase our understanding of the potential contribution to the regional aerosol from the oxidation of monoterpenes. During one particular overnight period, the aerosol mass increased in the presence of higher monoterpene levels with relatively low concentrations of inorganic ions. The particle size distributions began with higher concentrations of smaller particles and ended with lower concentrations of larger particles, indicating evolution due to coagulation and condensation of the terpene oxidation products. The hygroscopic growth factors for these particles, determined from an hTDM, were relatively small. The growth of water droplets on the particles, in a CCN chamber, showed an initial delay in the growth of the particles, relative to that on particles of sulfate. These two results indicate that these particles were relatively ineffective at taking up water and have consequences for the impact of these particles on visibility in the area as well as the ability to nucleate cloud droplets.

A71A-0086 0830h POSTER

Real Time Chemical and Physical Characterization of Aerosols in Urban and Semi-rural Area During Pacific 2001

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Two Aerodyne Aerosol Mass Spectrometer (AMS) were used to measure in real time the size resolved mass distribution and total mass loading of organic and inorganic species present on sub micron particles during PACIFIC 2001 at Vancouver, British Columbia, Canada from August 13 to September 01, 2001.

The AMSs were deployed in three sites during this study. One site was located in Vancouver and the other two in semi-rural areas, northeast and southeast of Vancouver allowing to study the source and origin of aerosols formation at Lower Fraser valley at Vancouver responsible for very hazy conditions and low visibility observed systematically in late summer. Temporal variation of total mass loading of sulphates, nitrates and organics measured at the different sites will be presented. The size distribution of sulphate, nitrate and some organic species will be also presented.

Data analysis of aerosols mass loading shows that, in most cases, organic carbon represents the most dominant fraction of species present on aerosols. Many aerosol events were observed during this experiment, including nighttime organic plumes and diurnal variation in some organic and inorganic groups. Detailed analyses of these observations using back-trajectories will be presented, with the goal resolving the processes controlling aerosol loading, including transport, physical and chemical transformations.

A71A-0087 0830h POSTER

The Variability of Aerosol Composition in the Lower Fraser Valley During PACIFIC 2001 Measured by Two Aerodyne Aerosol Mass Spectrometers

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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. Slokan 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 Slokan 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 studied 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,
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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 (keranic 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 reveal 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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