Book of Abstracts, IACPES Symposium Day, June 9, 2014

T1: **Quantifying methane sources in oil sands and urban environments**

Sabour Baray, Centre for Atmospheric Chemistry, York University

Sources of methane were investigated in the oil sands via analysis of a dataset collected in the summer of 2013 during the Oil Sands field study led by Environment Canada. Aircraft and ground-site measurements of multiple species, including CO_2, CH_4, CO and H_2O were made by a Picarro cavity ring-down spectrometer (CRDS) instrument to paint a 3 dimensional picture of emissions and to differentiate between various methane sources present. Methane peaks of up to 4.3 parts per million were observed, and analysis is ongoing in order to identify sources, with future research directed towards urban-environment emissions.

T2: **Ozone pollution in Uintah basin: Investigating the role of air-snow chemical interactions of reactive nitrogen oxides**

Angela Hong and Jennifer Murphy, Department of Chemistry, University of Toronto

Photochemical production of ozone depends in a complex manner upon the concentrations of its precursors NO_x (= NO + NO_2) and volatile organic compounds (VOCs), as well as favourable meteorological conditions such as strong actinic radiation and a stagnant atmospheric boundary layer. Recently, ozone pollution events have been observed during the wintertime in the Uintah Basin in Utah, USA, a region of intense oil and gas extraction. The presence of snow was found to be important to establishing the meteorological conditions and type of chemistry that is conducive for wintertime ozone pollution. Observations and model results suggest that gas-phase oxidation chemistry alone cannot entirely explain the ozone production rates observed during high ozone episodes. Additional contributions to the radical budget may involve the air-snow chemical interactions of reactive nitrogen oxides and include a) the heterogeneous conversion of NO_2 into HONO at/in the snow, b) heterogeneous hydrolysis of gas-phase N_2O_5 into HONO or $ClNO_2$ at/in snow, c) the photolysis of snowpack nitrate resulting in gas-phase radical products. During the UBWOS-2014 field campaign, I deployed a 2-channel nitrogen oxide chemiluminescent instrument and ozone analyser to measure NO, NO_2, total reactive nitrogen oxides (NO_y), and O_3 in the interstitial air of the snowpack and at a few heights in the immediately overlying atmosphere. Persistent gradients of NOy and O_3 were observed over the campaign indicating that the snow may be a sink for these species. Case studies of NO and NO_2 concentration gradients will be presented to show evidence of snow-mediated chemistry.

T3: **Modelling the impacts of wind farms in the Great Lakes**

Soudeh Afsharian and Peter Taylor, Department of Earth and Space Science and Engineering, York University

It is very likely that there will soon be wind farms constructed in both US and Canadian sectors of the Great Lakes. Thermal stratification of the lakes is an important factor affecting mixing. Lake Erie in particular has an unusual thermocline structure (deeper in mid-lake than near shorelines) as a result of the wind stress distribution and changes to this could have ecological impacts. We are using a numerical model, COHERENS: Coupled Hydrodynamical-Ecological Model for Regional and Shelf Seas. and have successfully installed the latest version. Working with one of its specific test cases called Pycno (a 1-D test describing the evolution of a wind-driven surface layer without rotation), we are now trying to set switches according to conditions appropriate to our region of study. The research goal is to study airflow over selected Great Lakes with and without wind farms and to investigate the potential impact of wind farm development on circulation, mixing and water quality issues for Lakes Erie and Ontario and the fluxes of atmospheric species to and from the lakes.

T4: **OSIRIS stratospheric aerosol retrieval**

Landon Rieger, University of Saskatchewan

The Optical Spectrograph and InfraRed Imaging System (OSIRIS) on-board the Odin satellite has now taken over a decade of limb scatter measurements, producing global coverage of radiance profiles in the UV/visible range. These measurements are used to produce vertical profiles of 750nm extinction as well as information on aerosol particle size from the upper troposphere to 35km altitudes. This work has been used to monitor volcanic eruptions and subsequent transport of the aerosols throughout the stratosphere, including the indirect injection from the Nabro eruption. More recently the debris left behind in the stratosphere by the Chelyabinsk meteor was detected as well as its subsequent decay to background levels. The OSIRIS aerosol dataset is also currently being merged with the SAGE II aerosol measurements to provide a continuous, 30 year record of stratospheric aerosols.

T5: **Measurement of total alkyl nitrates using thermal dissociation cavity ring-down spectroscopy**

Youssef M. Taha (ymtaha@ucalgary.ca) and Hans D. Osthoff (hosthoff@ucalgary.ca), Department of Chemistry, University of Calgary

Alkyl nitrates ($RONO_2$) are present in the atmosphere as a result of both direct emissions and photochemical production. The latter acts to sequester $NO_x = (NO+NO_2)$, changing the rates of local ozone production and facilitating long range transport of NO_x. Accurate measurements of alkyl nitrates are needed to gain a more complete understanding of nitrogen oxide budgets in the troposphere. Thermal dissociation cavity ring-down spectroscopy (CRDS) provides a fast measurement of the sum of alkyl nitrates (ΣAN). CRDS ΣAN detection limits are, however, too large in practice to allow for the measurement of total alkyl nitrates in typical ambient abundance. In addition, the measurement relies on the subtraction of a small ΣAN mixing ratio from a much larger sum of the mixing ratios of NO_2 and total peroxyacyl nitrates (ΣPN); this subtraction is prone to matrix effects. To address this issue, a Tenax preconcentration trap was developed. The preconcentration trap does not require cooling to below ambient temperatures and flash heating to 150 °C is adequate for complete desorption from the trap on top of a zero air matrix.

T6: **Limb imaging aerosol distributions from stratospheric balloon**

Brenden Elash and Adam Bourassa, University of Saskatchewan

Space-based measurement of limb-scattered sunlight has been successfully used in recent years for trace gas and aerosol retrievals from the upper troposphere to the mesosphere. A distinct advantage of this technique is that the measurement is highly sensitive to thin and localized aerosol layers in the stratosphere. Recent work has shown that high quality and cloud information can indeed be obtained from scattered sunlight; however, the vertical, horizontal, and spectral range that are capable from the current generation of satellite instruments are not sufficient to understand the detailed dynamical processes and aerosol composition measurements required by weather and climate models. The work presented here entails the design and development of a new optical imager, to specifically address the required resolutions and spectral range for upper tropospheric and stratospheric aerosol measurements. A prototype version of this image is under development and a test flight from a stratospheric balloon platform is planned from the Canadian Space Agency launch site in Timmins, Ontario, in 2014. In this work, the application of an acousto-optical tunable filter (AOTF) operating at visible and near infrared wavelength is used to allow for two-dimensional spatial imaging at rapidly tunable wavelengths providing greatly improved spatial resolution. Design and characterization of the AOTF imager will be presented, along with the proposed flight plan and customized retrieval algorithms.

T7: **Quantification of monoterpenes and BTEX-type compounds by gas chromatography - ion trap mass spectrometry at a ground site near Fort McKay, AB**

T. W. Tokarek and H. D. Osthoff, Department of Chemistry, University of Calgary,

In late summer 2013, an intensive air quality measurement campaign was conducted at the AMS13 ground site near Fort McKay, AB, to identify and quantify emissions from the AB oil sands and their transformations. Of particular interest were the abundances of volatile organic compounds (VOCs), which were quantified by several commercial instruments.

In this presentation, we describe operation and performance of the University of Calgary's Griffin 450 gas chromatograph with ion trap mass spectrometric detection and Tenax preconcentration (GC ITMS), which was deployed for the first time for ambient air measurements, and present selected data collected. The combination of retention information and electron impact mass spectral data allowed unambiguous identification and quantification of major biogenic monoterpenes, e.g., α and β-pinene, limonene, camphene, and 3Δ-carene, and of many anthropogenic hydrocarbons, e.g., the monoaromatic compounds benzene, toluene, ethyl benzene, o-, p-, and m-xylene (collectively known as BTEX). Mixing ratios of biogenic hydrocarbons varied with time of day, temperature, and solar radiation, whereas mixing ratios of anthropogenic VOCs strongly depended on meteorological conditions. During episodes with high BTEX abundance, many additional hydrocarbons were observed, including high molecular weight hydrocarbons, likely polycyclic aromatic hydrocarbons (PAHs), which were not resolved on the chromatographic column.

T8: **High resolution radiative transfer modelling for use in tomographic retrievals**

Daniel Zawada, Department of Physics and Engineering Physics, University of Saskatchewan

For the past decade the SASKTRAN radiative transfer model has been used, along with OSIRIS measurements of spectrally dispersed limb scattered sunlight, to retrieve vertical profiles of atmospheric constituents such as ozone, nitrogen dioxide and stratospheric aerosol. SASKTRAN is a spherical geometry, multiple scatter model that uses a successive orders approach. Until recently SASKTRAN has relied on horizontal homogeneity of the atmospheric constituents for its simulations. This talk details recent advances to the SASKTRAN model that now allow it to accurately and quickly calculate the diffuse radiance field in the presence of two and three dimensional structure within the atmospheric state. Included is a description of the modifications along with an analysis of the similarities and differences between the original model and the new version in the presence of structures that are found near realistic ozone hole conditions. These results demonstrate the utility of the SASKTRAN model for use in the retrievals associated with the Canadian Atmospheric Tomography System (CATS), an OSIRIS follow-on instrument, that is currently funded under the auspices of the Canadian Space Agency.

T9: **Method development for concentration measurements of SVOCs in the atmosphere with a focus on emission from oil sands mining**

Yasamin Hassani and Jochen Rudolph, York University

Semi-volatile organic compounds (SVOCs) are atmospheric pollutants with intermediate vapour pressure (10^{-6} to 10^{-2} Pa) and so they can exist in the atmosphere in both gas phase and in particulate matter. As such, accurate quantification of these pollutants in the atmosphere is quite challenging. Phenols, polycyclic aromatic hydrocarbons (PAHs) and n-alkanes are specific examples of SVOC that are the focus of this project. Despite the well-known harmful impact of these SVOCs on human health and climate, there is a lack of knowledge regarding their atmospheric quantities emitted from Oil Sands related activities. Recently, a new methodology that allows sampling and analysis of the total (gas and particle phases) concentration of SVOCs in the atmosphere has been developed in our research group and was tested on a class of SVOC (nitrophenols). The goal of this project is to modify and test the suitability of this method for measurements of other classes of SVOCs like PAHs and n-alkanes. The newly developed method is based on a sorbent impregnated filter (SIF) technique using conventional high-volume air samplers, extraction and analysis by GC-MS. In this presentation, the results of some preliminary tests where the modified technique was applied for analysis of PAHs and n-alkanes will be discussed. In addition, results of some experiments conducted to gain more insight into the possible reason behind the low ambient yield and the lack of vapour pressure dependence on the phase distribution of nitrophenols, observed in previous studies, will be presented. Future application of the modified method to study ambient samples collected at Alberta’s Oil Sands region (summer of 2013) will also be outlined and discussed.

T10: **Statistical modelling of polarized radiative transfer in a fully spherical geometry**

Seth Dueck, University of Saskatchewan

The SASKTRAN radiative transfer model has evolved in the past few years to be more than just a multiple scatter, spherical geometry model that accurately simulates limb-scattered sunlight signal as seen by the OSIRIS instrument onboard the Odin spacecraft. This paper will detail the algorithm and techniques required to implement a statistical Monte Carlo algorithm within the SASKTRAN framework of optical properties that includes species climatologies and absorption and scattering cross sections. One advantage in having an extremely accurate statistical model that uses the same code infrastructure as a separate model that is designed for speed is that comparison results do not depend on how certain parameters such as optical properties are implemented within the models. I will discuss the results obtained from the model and their comparison with both the original and high-resolution versions of SASKTRAN. I will also discuss the newly implemented pseudo-vectorized (polarized) SASKTRAN successive orders model and its comparison with the fully vectorized MC model.

T11: **Compound specific ambient yields of SOA**

Marina Saccon, Centre for Atmospheric Chemistry, York University

The composition, processing and yields of secondary organic aerosols (SOA) in the atmosphere are poorly understood. Arising from the photooxidation of both biogenic and anthropogenic volatile organic compounds (VOC), SOA have been known to have both adverse climate and health effects. To gain insight into SOA, it has been proposed to combine concentration and isotope ratio measurements of compounds, in this case, nitrophenols, formed specifically from aromatic VOC. Once emitted, VOC will have an isotope ratio that is specific to the source it is emitted from, and due to the kinetic isotope effect, the isotope ratio of the unreacted VOC will become more enriched in ^{13}C with photochemical processing. At the same time, the products of VOC oxidation will be depleted in ^{13}C. While the isotope ratio of all products can be determined from a simple mass balance, the isotope ratio of individual products will depend on details of the reaction rates and the kinetic isotope effects for these reactions. This talk will present and discuss the possibility to derive photochemical ages of SOA from their isotope ratios and their application to determine ambient yields.

T12: **Evaluating the utility of an atmospheric pressure chemical ionization mass spectrometer for detecting organic hydroperoxides during β-pinene ozonolysis smog chamber experiments**

Amanda Jameer, Donald Hastie; Centre for Atmospheric Chemistry, York University

In the atmosphere, organic peroxides form through the oxidation of volatile organic compounds (VOC) by hydroxyl (HO) radicals and ozone (O_3). As reservoirs for HO, perhydroxyl (HO_2), and alkyl peroxy (RO_2) radicals, the presence of these compounds can help determine the lifetime of many anthropogenic or biogenic pollutants such as methane. Although modelling studies suggest that these compounds might be a major component of secondary organic aerosol, their detection in the atmosphere and in smog chamber experiments is problematic due to their thermally labile nature. Moreover, there is a lack of suitable analytical techniques in the scientific literature to assist in organic peroxide identification resulting in a handful of published work on these compounds.

In this study, a positive-ion atmospheric pressure chemical ionization mass spectrometer ((+) APCI-MS/MS) was used to detect oxidation products formed during β-pinene oxidation with O_3. Organic peroxides were detected by probing for losses of 32, 34 and 62 u during neutral-loss scan analysis. Based on neutral-loss and product-ion mass spectra, six organic peroxide structures were proposed. Furthermore, observed common mass losses were used to develop a "fingerprint" analysis for future oxidation studies with other atmospherically relevant VOC.

T13: **Raman Spectroscopy applied to Mars water cycle studies**

George Nikolakakos, Department of Physics and Astronomy, York University

The Phoenix Mars lander provided crucial new insight into the Martian atmosphere and surface. Foremost among the discoveries was the confirmation that a vast water ice table exists below a shallow layer of soil. Other key Phoenix mission findings included the observation of ice crystals precipitating from clouds, adsorbed water on regolith grains and perhaps most interestingly, the detection of perchlorate, a highly deliquescent salt. The addition of Raman spectroscopy capabilities to the next generation of Mars lander would greatly improve the understanding of these Mars water cycle processes by providing an unambiguous method of detection. In order to assess the feasibility of such an instrument and conduct process studies, both a stand-off Raman system and planetary simulation chamber have been developed and operated at York University. Preliminary measurements involving magnesium perchlorate indicate that liquid brines could exist at Martian temperatures and pressures and that the Raman method is capable of detecting their formation.

T14: **An overview of the airborne study of oil Sands air pollutants under the Joint Canada-Alberta implementation plan on oil sands monitoring**

S-M Li Shao-Meng.Li@ec.gc.ca, K Hayden, SG Cober and J Brook, Environment Canada; M Wolde, National Research Council Canada

A short term airborne study of oil sands air pollutants was carried out in August and September 2013 as part of the 2013 JOSM (Joint Canada-Alberta Implementation Plan on Oil Sands Monitoring) summer intensive field campaign. The study has three objectives: 1) to quantify emissions of criteria air contaminants (CACs) and other air pollutants from individual facilities in the Athabasca oil sands, in order to validate the National Pollution Release Inventory (NPRI) for the oil sands surface mining facilities; 2) to understand the transport and transformation of primary pollutants; and 3) to provide data for model and satellite retrieval validation. The data will be used for the evaluation pollutants and improvement of high –resolution air quality models for eventual application in determining the fates of these pollutants and their deposition to the downwind ecosystems. Various chemical species were measured from the National Research Council of Canada Convair-580 aircraft at high time resolution of 1-10 seconds. A total of 22 flights were made, with 14 flights dedicated to emission validation, 5 flights to transport and transformation of oil sands pollutants, and 5 flight to satellite data validation. At the present time, the measurements form the airborne study are undergoing intensive quality assurance and quality control processes and a time schedule has been set for the public release of the data from the study.

T15: **An algorithm of calculating facility emissions from the aircraft flights conducted during the 2013 JOSM summer intensive field campaign**

M Gordon mark.gordon@ec.gc.ca, S-M Li, R Staebler, A Darlington, J O'Brien and K Hayden, Environment Canada; M Wolde, National Research Council Canada

As part of the 2013 JOSM (Joint Canada-Alberta Implementation Plan on Oil Sands Monitoring) summer intensive field campaign, airborne measurements of various chemical species (e.g. SO_2, NO_x) were collected in the Athabasca oil sands during 22 flights between August 13 and Sept 7, 2014. An algorithm has been developed to determine facility emissions from the aircraft measurements. In this algorithm, the flight path around a facility at multiple heights is mapped to a two-dimensional vertical screen surrounding the facility. The flux across this surface is calculated using aircraft wind measurements, and facility emissions are then calculated based on the divergence theorem. Example calculations of smokestack SO_2 emissions for two separate days will be presented. These calculations show an upset condition of SO_2 emissions on one day and a return to industry-reported average emissions rates on another day, demonstrating the accuracy of this method. Uncertainty estimates in the calculation will be presented, based on non-stationarity of winds and atmospheric buoyancy, estimation of surface winds, variation of the flight path with altitude, estimations of instrument response time, and variation in background concentration.

T16: **Deriving long-term spatially averaged surface NO_2 concentrations across multiple satellite instruments**

Jeffrey Geddes and Randall Martin, Department of Physics and Atmospheric Science, Dalhousie University

Although air pollution in Canada has been roughly estimated to cost billions of dollars every year in health care and lost productivity, spatial gaps in ground-based monitoring networks inhibit comprehensive air quality assessments. Nitrogen dioxide (NO_2) is a criteria air contaminant that has been strongly associated with acute health effects and is included in the

Canadian Air Quality Health Index. Satellite remote sensing observations of NO_2 offer global information at up to daily resolution that can be used to supplement sparse ground-based monitoring networks. Here, observations from GOME (1995-2003), SCIAMACHY (2002-2012), and GOME-2 (2006 -) were combined with output from a global chemical transport model to infer a two-decade time series of ground-level NO_2 concentrations across all of North America. Issues of acceptable statistical coverage and changing instrument characteristics were addressed, and the dataset was compared with ground-based in-situ data where available. The correlation between in-situ and the derived satellite data is consistent across the three instruments, and relative inter-annual variability and rates of change are reproduced well at urban spatial scales. The rate of decline in NO_2 across North America is spatially and temporally variable. Future applications of the dataset will be discussed.

T17: The siding spring cometary encounter with Mars: A Natural experiment for the Martian atmosphere

J.E. Moores (York), T.H. McConnochie (Maryland), D.W. Ming (JSC), P.D. Archer, Jr. (JSC) and A.C. Schuerger (Florida)

On October 19, 2014 comet C/2013 A1 will encounter Mars. The planet is anticipated to pass through the coma resulting in a greater than four order-of-magnitude increase in the accretion of dust with 430 tonnes of dust with diameters between 1 μm to 12.4 mm surviving atmospheric passage. At high altitude, the dust would impact temperature, and may affect limb dust extinction and cloud formation. The UV-photolysis of the organic carbon content of the dust, 1.9 to 4.6 tonnes, would have a negligible effect on atmospheric methane. Should C/2013 A1 brighten, increases in upper atmospheric accretion of coma particles will exceed the background dust and the population of small coma particles may be constrained from orbital measurements. For $M_1 < -1.3$, methane produced might be measurable by the Sample Analysis at Mars Tunable Laser Spectrometer instrument onboard Curiosity.

T18: Estimation of Obukhov length from wind speed and delta-T measurements

Daniel Laroche[1] and Peter Taylor, Earth and Space Science and Engineering, York University

York University have a campus weather station in a grass covered traffic circle N of the Tait McKenzie gym. It is used to provide local data in atmospheric science courses and background information for atmospheric chemistry studies. Measurements include temperature differences (ΔT from 9m to 1m) and wind speed at 10 m (U_{10}), and these two parameters have been used to characterize stability. An alternative single quantity would be the Obukhov length (L). This talk describes our methodology for determining L. A particular motivation was provided by a recent PhD thesis by Patryk Wojtal (2013). The station generates data on wind speed, wind direction, temperature and humidity, temperature difference (ΔT), 4 radiation components, precipitation amounts and soil temperature. The grass is generally snow covered in winter.

The Obukhov length is defined in terms of friction velocity and heat flux, neither of which are measured directly, but with assumed forms for velocity and temperature profiles we can set up non-linear equations to allow us to determine L from U10 and ΔT measurements provided certain conditions are satisfied. Solving these equations and investigating sensitivity to assumed roughness lengths has led to a procedure to determine L. This has been tested against comparable data from a mast at Cabouw in Holland where direct measurements of fluxes were also available.

[1] Co-op student, Chemical Engineering, University of Waterloo.

T19: **A mechanistic and kinetic investigation of levoglucosan photooxidation in the aqueous phase – the power of high resolution chemical ionization mass spectrometry**

Ran Zhao, Emma Mungall, Alex Lee and Jonathan Abbatt, Department of Chemistry, University of Toronto

Although levoglucosan has been widely used as a tracer for biomass burning and has been assumed to be stable in most of the atmospheric models, recently studies have shown that levoglucosan can be photooxidized rapidly in the atmospheric aqueous phase. To achieve an accurate source apportionment for biomass burning, a complete understanding of the kinetics and mechanism of levoglucosan photooxidation is needed. However, there are only a few kinetic studies to date, and little is known about the mechanisms of this reaction. In the current study, a high resolution time of flight chemical ionization mass spectrometer (HR-ToF-CIMS) was employed in a detailed mechanistic and kinetic investigation of the aqueous-phase oxidation of levoglucosan (LG) by OH radicals. The strength of HR-ToF-CIMS lies in its fast time-response, excellent sensitivity and the ability to determine exact chemical formula due to its high mass resolution. We applied this powerful instrument to monitor aqueous-phase chemistry by atomizing the aqueous solution and volatilizing organic compounds in a heated flow line (i.e. the Aerosol-CIMS setup). Using a reference kinetic method, we confirmed that LG indeed oxidized rapidly by OH radicals. To further take full advantage of the high resolution nature of the instrument, we analyzed the reaction mechanism using two novel approaches. The first approach is a mass defect plot which clearly displays trends of product formation. The second approach utilizes molecular oxidation state and double bond equivalence to offer functional group information which is often lacking from mass spectrometry data. These approaches revealed fundamental aspects of aqueous phase chemistry and also showed potential applicability for other high mass resolution mass spectrometry data.

T20: **Stable carbon isotope composition of ambient VOC**

Anna Kornilova, Centre for Atmospheric Chemistry, York University

Volatile Organic Compounds (VOC) are the substances with vapor pressure greater than 10 Pa (at 25◦C), a boiling point up to 260 ◦C at atmospheric pressure, and containing less than 15 carbon atoms. These compounds are emitted from anthropogenic and biogenic sources. The main source of anthropogenic VOC is fossil fuel use, followed by a contribution from industrial processes. Aromatic VOC are one of the main classes of anthropogenic VOC with toluene being the most abundant. These compounds are major precursors of many important semi- and non-volatile pollutants that are formed during oxidation processes. Stable carbon isotope ratio (δ13C) has proven to be one of the valuable tools used for providing insight into the chemical and physical processing of VOC in atmosphere. It can be used to differentiate physical processes such as dilution and mixing from photochemical ageing, to identify emission sources and to determine the photochemical age of individual compounds.

In this presentation use of stable carbon isotope composition in qualitative and quantitative analysis will be discussed and its application would be shown using ambient samples collected from Egbert and Toronto sampling locations. It will be shown that local sources have a large impact on the air quality of these locations, and freshly emitted VOC predominate their air masses. It will be also demonstrated that different VOC in photochemically processed air masses differ in their stable carbon isotope composition depending on their reactivity. At the end, future plans and possible applications will be outlined and discussed.

POSTERS

P1: **Measurements of nitrogen oxides in the AB oil sands by cavity ring-down spectroscopy**

C.A. Odame-Ankrah and H.D. Osthoff***,** Department of Chemistry, University of Calgary

Nitrogen oxides ($NO_x = NO + NO_2$) are emitted in large quantities in the AB oil sands region, but their chemical transformations (including formation of acids) and impacts on oxidant levels, ozone production and atmospheric visibility remain unclear because of a lack of suitable measurements. While measurements of nitric oxide (NO) and "total odd nitrogen" (NO_y) have become routine, measurements of the abundances of the various components of NO_y have proven more challenging. Recently, accurate, sensitive, and real-time measurements of nitrogen dioxide (NO_2), the nitrate radical (NO_3), dinitrogen pentoxide (N_2O_5), and total peroxyacyl nitrate (□PN) abundances have become possible using cavity ring-down spectroscopy (CRDS).

Here, measurements using a multichannel instrument for simultaneous monitoring of NO, NO_2, N_2O_5, and □PN abundances at the AMS 13 ground site near Ft. McKay, AB, from the period of August 10 to September 6, 2013, are presented. The instrument uses a blue diode laser to quantify NO, NO_2, and □PN and a red diode laser to quantify N_2O_5 in a similar fashion as described earlier in standalone instruments.[1-3] The performance of the new instrument and its calibration via NO-O_3 gas-phase titration are discussed.

1 D. Paul and H.D. Osthoff *Anal. Chem*. **82**, 6695 (2010). 2 C.A. Odame-Ankrah and H.D. Osthoff *Appl. Spectrosc*. **65**, 1260 (2011). 3 Fuchs et al. *Environm. Sci. Technol.* **43**, 7831 (2009).

P2: **Airborne component of the summer intensive air monitoring campaign 2013**

Katherine Hayden, Environment Canada Aircraft Team

Eighteen months of planning and preparation culminated in the successful implementation of the summer 2013 airborne campaign in the Athabasca oil sands region. State-of-the-art fast instruments that measure gas and particulate matter were operated from the National Research Council of Canada’s Convair 580. 22 flights for a total of 90 hours were flown to quantify emissions, transport and transformation of pollutants, and provide data for satellite retrieval validation and air quality models. Measurements were obtained around several facilities including Suncrude, Suncor, Aurora, Shell, CNRL, Imperial Kearl Lake, and Firebag in-situ. An overview of the measurements is presented.

P3: **Summer intensive air monitoring campaign 2013: Transport and transformation of emissions in the oil sands region**

Katherine Hayden, Environment Canada Air Quality Research Team

Ground-based monitoring sites, mobile platforms, aircraft, satellite remote sensing and prediction model output were used to address the Joint Canada/Alberta Implementation Plan for Oil Sands Monitoring (JOSM) objectives. Approximately 90 participants from Environment Canada, universities and the National Research Council of Canada conducted measurements between Aug 13 and September 13, 2013. A full complement of pollutants were measured to high levels of accuracy using high levels of standardization methods resulting in the collection of a very detailed, unique, comprehensive dataset. An overview of the summer field campaign is provided.

P4: **Wintertime measurements of nitrogen containing pollutants in Calgary, Alberta**

Y.M. Taha, R. Woodward-Massey, and H.D. Osthoff, Department of Chemistry, University of Calgary

The combustion byproduct isocyanic acid (HNCO) has been found in forest fire plumes and Diesel exhaust and has been implicated in initiating the inflammatory response that is characteristic of smoke-related health effects. However, its concentration in ambient air is currently poorly constrained by measurements. In this work, measurements of several nitrogen containing pollutants including HNCO, NO, NO_2, total odd nitrogen (NO_y), and nitryl chloride ($ClNO_2$) on the rooftop of the Science B building at the University of Calgary February 3rd-7th, 2014 are presented. Chemical ionization mass spectrometry (CIMS) with iodide reagent ion was used for the first time to quantify HNCO in ambient air with a detection limit of 12 pptv (parts per trillion by volume) and 40 s integration time (S/N = 3). Median HNCO and $ClNO_2$ mixing ratios of 34 pptv (maximum 94 pptv) and 63 pptv (maximum 202 pptv) were observed, respectively. These abundances are inline with mixing ratios observed at other locations and seasons and are not cause for immediate health concern. The HNCO to NO_x emission ratio was 6×10^{-4} and larger than literature emission factors from Diesel engines, which indicates the presence of additional and/or underestimated HNCO sources in Calgary.

P5: Aging of secondary organic aerosol from β-pinene

Mehrnaz Sarrafzadeh and Donald R. Hastie, Centre for Atmospheric Chemistry, York University

P6: Quantification of monoterpenes and BTEX-type compounds by gas chromatography - ion trap mass spectrometry at a ground site near Fort McKay, AB

T. W. Tokarek and H. D. Osthoff, Department of Chemistry, University of Calgary

P7: Small reconnaissance of atmospheres (SMARA) mission platform concept: a swarm of scientific microprobes to the clouds of Jupiter in 2030

J.E. Moores, K.A. Carroll, I. DeSouza, K. Sathiyanathan, B. Stoute, J. Shan, R.S. Lee and B. Quine

A mission concept is presented for several small atmospheric entry vehicles at Jupiter. By relaxing the requirement for substantial penetration into the Jovian atmosphere, the size of the Atmospheric Entry Probes shrinks dramatically. Such Atmospheric Entry Probes would experience much less heating than previous concepts of much larger (~300kg) spacecraft presented as minimum concepts and no parachutes are necessary. This reduces complexity while still permitting over 15 minutes of useable science under free-fall from above the 0.45 Bar level to near the 10-Bar level of the Jovian Atmosphere during which up to 20 Mbits of data could be returned per probe. By dividing the payload, the risk to the mission is substantially mitigated and ground truth from a large part of the entire planetary atmosphere using a single launch.

P8: Low dust, low ice conditions at Gale Crater, Mars as observed during the first 360 sols of atmospheric monitoring movies from the curiosity rover

J.E. Moores et al. (25 co-authors)

We report on the first 360 sols (L_S 150º to 5º), representing just over half a Martian year, of atmospheric monitoring movies acquired using the NavCam imager from the Mars Science Laboratory Rover. Such movies reveal blowing dust, faint clouds and a single faint dust devil that are difficult to discern in single images. The data set from MSL is compared to similar observations made by the Surface Stereo Imager onboard the Phoenix Lander (at 68.2ºN) and suggests a much drier environment at Gale Crater (4.6ºS) during this season as would be expected based on latitude and the global water cycle. Examinations of dust devil frequency and line of sight optical depth suggest that most dust devils in Gale Crater are dustless, consistent with the shallow boundary layers predicted by models, and that dust extinction is reduced below the crater rim compared to the bulk column optical depth by a factor of two, typically. This lack of dust lifting and low dust mixing in the lower atmosphere suggests that the portion of Gale to the north of the rover may be a sink of dust in the current era, a finding supported by atmospheric modeling of the crater circulation.

P9: **Ground site measurements of NO_2, SO_2 and HONO by active-DOAS in the oil sands region of Alberta**

A. Lobo, Z. Davis, K. Nikelski and R. McLaren, Centre for Atmospheric Chemistry, York University

Nitrogen and sulfur oxides are among the most abundant air pollutant emissions in urban areas as well as industrial resource extraction regions. Quantifying their real world emissions through top-down measurement methods is an important exercise in order to test the validity of estimates made via bottom-up emission inventory methods. During the summer of 2013, we deployed an active-DOAS instrument to a ground site in the oil sands region of Alberta. Our focus was on measuring SO2, NO2 and HONO, the latter being a major nocturnal reservoir of the hydroxyl radical. The ground site was frequently impacted during the day by elevated plumes from major oil sands facilities in the region that fumigated SO2 and NO2 to the surface. Such fumigation events were not observed at night due to stable atmospheric conditions, largely indicated by the low levels of SO2 (< 1 ppb) observed at night. In contrast, NO2 was elevated almost every night, likely indicative of the myriad of surface sources of NOx in the region, in contrast to SO2. We also report initial measurements of HONO, that is elevated at night due to its heterogeneous formation on surfaces from reaction of NO2 with water.

P10: **MAX-DOAS and Active-DOAS observations of pollutant gases in the Alberta Oil Sands**

Z. Davis, **K. Nikelski**, A. Lobo and R. McLaren, Centre for Atmospheric Chemistry, York University

Our understanding of the levels of gas pollutants emitted by Alberta oil sands industry is essential to making quality environmental management decisions and requires top-down real world studies to quantify the emission of these gases. In August 2013 a mini-Multi Axis Differential Optical Absorption Spectroscopy (MAX-DOAS) instrument was used to measure Slant Column Densities of NO_2 and SO_2 at a ground site north of Fort McMurray in the Oil

Sands region of Alberta. An active DOAS instrument was also deployed at the site to measure surface level concentrations of these gases averaged over a 1.2 km path (2.4 km return), approximately 20 km from major industrial sources. Research objectives of the study include the determination of tropospheric vertical column densities (VCDs) of NO_2 and SO_2 in the oil sands region, validation of the accuracy of equivalent satellite retrievals of VCDs, independent estimations of NOx and SO_2 emissions from oil sands facilities to compare with bottom-up emission inventories and more generally to learn about the chemical transformation of pollutant emissions. Preliminary analyses indicate maximum NO_2 VCDs of 4.3x1016 molec cm-2, and maximum SO_2 VCDs of 8 x1016 molec cm-2. Maximum SO_2 surface mixing ratios of ~ 80ppb were observed during an industrial plume impact event. We are analyzing such events with a view to calculating total emissions flux from the source facilities, as well as the determination of relevant emission factors.

P11: **The Application of Source Apportionment Models to Identify Potential Sources of Ambient VOCs in Windsor**

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Chemical Mass Balance (CMB), Principal Component Analysis (PCA), and Positive Matrix Factorization (PMF) were applied to investigate the major sources of Windsor ambient Volatile Organic Compounds (VOCs). The 24-h air samples were collected by 6-L SUMMA canisters set up in the back yards of 51 and 49 Windsor residents in winter and summer of 2005 and 2006, respectively. Among the 188 VOC species analyzed, 112 non-methane hydrocarbon (NMHC) were used for source apportionment. The annual average total (NMHC) VOC concentrations declined from 46.1 $\mu g/m^3$ (range: 0.03 to 6 $\mu g/m^3$) in 2005 to 35.8 $\mu g/m^3$ (0.04 to 4 $\mu g/m^3$) in 2006. Summer concentrations were higher than winter, 48.2 $\mu g/m^3$ vs. 44 $\mu g/m^3$ in 2005 and 41.2 $\mu g/m^3$ vs. 30.5 $\mu g/m^3$ in 2006. CMB results indicated that vehicle-related sources were the major contributors in both winter (18.1 $\mu g/m^3$ in 2005; 12.7$\mu g/m^3$ in 2006) and summer (26.5 $\mu g/m^3$ and 23.5 $\mu g/m^3$). Other major sources included Commercial Natural Gas (2005: 10.3 $\mu g/m^3$; 2006: 5.4 $\mu g/m^3$), and Industrial Refinery (7.4 $\mu g/m^3$; 5.4 $\mu g/m^3$) for winter; Architectural Coatings (7.7 $\mu g/m^3$; 5.5 $\mu g/m^3$) for summer. The different approaches produced similar source profiles including Gasoline Vapour, Commercial Natural Gas, Liquefied Petroleum Gas, Industrial Refinery, and Coatings with PCA identifying additional emitters including “Adhesive and Sealant Coating” and “Chemical Industry” and PMF identifying “Adhesive and Sealant Coating” and “Wood Combustion”.

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