

Three years of UV-visible measurements at PEARL: Variability of ozone and NO₂ during the International Polar Year, the August 2008 solar eclipse, and BrO satellite comparisons

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Two ground-based UV-visible spectrometers take measurements at the Polar Environment Atmospheric Research Laboratory (PEARL) in Eureka, Nunavut, Canada (80°N, 86°W). One of these instruments, the UT-GBS (University of Toronto Ground-Based Spectrometer) has been deployed at Eureka eight times during polar sunrise between 1999 and 2007. The other instrument, the PEARL-GBS (PEARL Ground-Based Spectrometer) was installed permanently in Eureka in August 2006 for year-round operation. Both of these instruments measure vertical column densities of ozone and NO₂, as well as slant column densities of BrO and OCIO when possible.

We will discuss a selection of studies using data from the two GBS instruments. We will present year-round ozone and NO₂ vertical column densities from 2006-2009. We will discuss the seasonal and diurnal variations of these species, with a focus on spring-time data and its relationship to dynamics. Furthermore, we will present ozone and NO₂ measurements and model results for the August 1, 2008 solar eclipse.

BrO measurements from spring 2008 will also be presented. The concentration of stratospheric bromine is a large uncertainty in chemical ozone depletion: although bromine-containing species are low in concentration, they are very reactive with ozone and cause up to half of spring-time chemical ozone depletion. We will discuss the challenges in measuring BrO, show spring-time BrO vertical column densities, and compare these results with the OMI satellite.

Starphotometer at Eureka: recent activities and progress

Konstantin Baibakov, N.T. O'Neill, Y. Blanchard and D. Daou

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The spring-time Arctic stratosphere during IPY - a study using measurements, models and dynamical analyses

Rebecca Batchelor, with contributions from K.Strong, R. Lindenmaier, A. Manson, C. Meek, S. Polavarapu, M. Reszka, G. Manney, W. Daffer, and the NDACC IRWG Arctic Station teams

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Understanding changes occurring in the Arctic polar atmosphere resulting from ozone depletion and climate change is complicated by the dynamical processes and high year-to-year variability that characterize the spring-time Arctic stratosphere. As such, an understanding of both the chemistry and the dynamics of the atmosphere is required.

In this talk, measurements from six Fourier transform infrared (FTIR) spectrometers located north of 60, including the Bruker 125HR at Eureka, will be combined with dynamical analyses and used to study the conditions experienced in the Arctic atmosphere during the International Polar year spring periods of 2007 and 2008. These measurements will additionally be compared and contrasted with the IPY runs of two meteorologically assimilated global chemistry models, the Canadian Middle Atmosphere Model - Data Assimilated (CMAM-DA), and the Environment Canada Global Environmental Multiscale stratospheric model, run with the BIRA (Belgian Institute for Space Aeronomy) online chemistry package (GEM-BACH).

Retrieving cloud optical depth and ice particle size using Thermal IR radiometry at Eureka : Preliminary results and validation

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Atmospheric Transport of Volcanic Emissions into the High Arctic Region

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Volcanic eruptions release gases (e.g Sulfur dioxide, water vapor, carbon dioxide) and fine silicate particles, usually referred to as volcanic ash that can remain in the atmosphere for days and even months depending on the altitude. Sulfur dioxide (SO₂) in the atmosphere is converted to sulfate that increases the Earth's albedo and in the stratosphere cools the troposphere and influences the atmospheric circulation. On the other hand, volcanic ash endangers jet aircraft by causing engine damage and even failure.

In mid-June 2009, one of the most active stratovolcanoes of the Kuril Islands, Sarychev Peak, recorded a series of explosive eruptions leading to warnings by the Volcanic Ash Advisory Centers (VAAC) (http://ds.data.jma.go.jp/svd/vaac/data/Archives/2009_vaac_list.html). The long-range transport of the ash plumes at flight level led to the grounding and re-routing of international flights across the globe. Even astronauts from the expedition 20 crew at the International Space Station observed the ash plumes with a digital camera during the early part of the eruption (see <http://feww.wordpress.com/2009/06/20/volcanowatch-weekly-18-june-2009/>). Emissions from the volcano were detected as far as PEARL (80°N, 86°W) and by various instruments. This study which is supported by CANDAC uses Lagrangian particle dispersion model (FLEXPART) and satellite data from different platforms (e.g., MODIS, OMI, CALIPSO, MLS) including lidar measurements at PEARL and Halifax to investigate the transport processes of the ash plume. Data from the satellites suggest that the volcanic plume reached altitudes of 10-15 km. The altitude information and the daily amount of SO₂ (2700 tonnes/day) were used to initialize the model. According to FLEXPART, transport of the ash plume occurred in two directions: The plume traveling southeast was split into two parts at the Gulf of Alaska, one part traveled northeast and made a U-turn over the Yukon Territory before arriving at Halifax, Canada during the early part of June 18, the second part traveled northwest through the Bering Sea to the Arctic. The plume advected northwest from the Kuril Islands traveled through the Okhotsk sea, the Chukchi sea and then proceeded eastwards to the North American Arctic where it was observed over PEARL on June 23.

Optical analysis of synchronous sunphotometry and lidar data acquired at Eureka during the ARCTAS-A campaign of 2008

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We have consistently found strong qualitative correlation between the backscatter coefficient profiles of the AHSRL (employing depolarization ratio as simple classification indicator of aerosol type) and estimates of fine and coarse mode optical depth at Eureka. Recently we have begun to investigate crude algorithms for extracting coarse and fine mode optical depth from the the AHSRL based on depolarization and / or altitude slicing classifications. This approach (applied to a limited ARCTAS-A data set) yields good correlations between lidar indicators of fine and coarse mode optical depth and sunphotometer estimates of fine and coarse mode optical depth (assuming a constant value of extinction to backscatter ratio for both fine and coarse mode particles). Some preliminary results along with a sensitivity study will be presented.

The OSIRIS Sulphate Aerosols

Doug A. Degenstein, A.E. Bourassa and the Odin-OSIRIS Team of Scientists.

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The OSIRIS instrument has been in operation onboard the Odin spacecraft since the autumn of 2001. During this time OSIRIS has made measurements from which information about the stratospheric sulphate aerosol content has been inferred. This presentation will highlight features of the eight year data set including results related to: UTLS dynamics; volcanic activity; the QBO and the variability of the background Junge layer. These results are all taken from the newest version of the data set that will be available late in 2009.

Retrievals and Calibration of Water-vapour and Temperature from the CANDAC Raman Lidar

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The CANDAC Raman Lidar was designed for the measurement of tropospheric temperature and water-vapour. Since commissioning in December 2008, measurements have been concentrated on the calibration of these retrievals. In this presentation the retrieval techniques, calibration, and performances will be discussed. Finally, recent water-vapour and tropospheric temperature retrievals will be presented to illustrate these techniques.

PARIS-IR: Highlights from the Canadian Arctic ACE Validation Campaigns, recent developments and plans for the future

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The Atmospheric Chemistry Experiment (ACE) is a satellite mission on-board the Canadian satellite SCISAT. One of its goals is to understand the chemical and dynamical processes controlling middle atmosphere ozone distribution, particularly in the Arctic. The primary instrument on SCISAT is the ACE-FTS, a high-resolution Fourier Transform Spectrometer. Each spring since 2004, the ground-based version of the ACE-FTS, the Portable Atmospheric Research Interferometric Spectrometer for the Infrared (PARIS-IR) has been deployed at the Polar Environment Atmospheric Research Laboratory (PEARL) in Eureka, Nunavut (80N, 86W) as part of the Canadian Arctic ACE Validation Campaign project. PARIS-IR is one of the ground-based and balloon-borne instruments used in the campaigns. It records double-sided interferograms with the same maximum optical path difference (25 cm) as ACE-FTS, resulting in a resolution of 0.02 cm^{-1} . PARIS-IR is designed to measure the full $750 - 4400 \text{ cm}^{-1}$ spectral range with each six minute measurement. This feature allows total column measurements of a range of atmospheric species to be determined from every spectral measurement, creating a data set with high temporal resolution.

During the 2009 campaign, improvements to the PARIS-IR Command Software were implemented. Since July 2009, PARIS-IR has been operating at the Toronto Atmospheric Observatory (TAO). A retrieval of CH_4 from the PARIS-IR Eureka spectra has been developed recently, which will be applied to the Eureka spring campaign data set in addition to measurements recorded at TAO. Measurements of ozone and related trace gas species (including HCl, HNO_3 and HF) obtained during the 2007, 2008 and 2009 campaigns will be presented in addition to the initial CH_4 results. Plans for validation of other satellite instruments will also be discussed.

ERWIN 2: Algorithm Developments, Validation, and Science

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ERWIN-2 (E-Region Wind Interferometer) is a field widened Michelson interferometer that is used to measure winds in the mesopause (~90 km). ERWIN-2 uses Doppler shifts in the hydroxyl, oxygen green-line, and O₂ airglow emissions. The optical system for ERWIN-2 contains a quad mirror which allows for the simultaneous imaging of the five viewing directions. The observation cadence for the three emissions is ~2 minutes making this the fastest wind measuring instrument in the world for the mesopause region. Instrument operation and the algorithms used to calculate winds will be discussed. In addition, results from January 2009, and comparisons with meteor radar, used to validate the ERWIN-2 results, and determine the heights of the three emission layers, will be presented.

Three years of stratospheric trace gas retrievals at PEARL and comparisons with the Atmospheric Chemistry Experiment

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The process of rapid stratospheric ozone loss in the polar regions begins during the polar winter, when dynamical and chemical conditions lead to the formation of reactive chlorine and bromine radicals. Arctic ozone loss varies significantly from year to year because of changing dynamical conditions. Therefore, long-term data sets of Arctic chemical composition measurements are needed to better understand the process of ozone loss, the links between ozone depletion and climate change, and the future evolution of ozone.

One of the key instruments contributing to the CANDAC Arctic Middle Atmosphere Chemistry (AMAC) theme is the Bruker IFS 125HR Fourier transform infrared (FTIR) spectrometer, which completed three years of measurements at PEARL in July 2009. This instrument has been specifically designed for high-spectral-resolution measurements over a broad spectral range. The instrument is being used to measure reactive species, source gases, reservoirs, and dynamical tracers, to determine total columns and the vertical distribution of these species.

The talk will highlight results from three new papers. The first is the Bruker 125HR commissioning paper, which describes the instrument, retrieval technique, and error analysis, and compares the measurements with those made by the Bomem DA8 FTIR instrument (published). The second paper focuses on the evaluation of the ozone microwindows to determine which microwindow is the most suitable for retrievals at Eureka (submitted). The third paper presents a comparison between three FTIR spectrometers that made side-by-side measurements during the 2007 and 2008 Canadian ACE Validation spring campaigns at PEARL (submitted). This paper also presents comparisons between the Bruker 125HR and the ACE-FTS, showing the impact of incorporating stringent coincidence criteria that account for the relative locations of sampled airmasses.

Transport of biomass burning aerosol into the Arctic in April 2008: GEM-AQ simulation and comparison with optical observations

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The early fire season of 2008 in northern Asia (forest fires in eastern Siberia and agricultural burning in Kazakhstan) resulted in a large amount of pyrogenic species being transported into the Arctic atmosphere. Biomass burning plumes were observed at ground stations in the high Arctic. To simulate these events, we used the Global Environmental Multiscale Air Quality model (GEM-AQ), a global, tropospheric chemistry, general circulation model based on the global multiscale model developed by the Meteorological Service of Canada for operational weather forecasting. GEM-AQ includes a size-resolved multi-component aerosol module. Fire emissions with daily temporal resolution were generated from MODIS active fire products. The model output is compared with spectral sunphotometer data acquired over different pan-Arctic stations and with MODIS products over the Arctic.

Gravity wave measurements using the CANDAC-EC DIAL lidar during the 2009 Polar Sunrise Campaign

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During the intensive Polar Sunrise ACE Validation Campaign of February and March 2009 at the Polar Environment Atmosphere Research Laboratory (PEARL) in Eureka, Canada (80°N, 86°W), 20 nights of relative density measurements were made with the CANDAC-Environment Canada DIAL lidar, 15 of which were suitable for gravity wave spectral analysis. The magnitudes of the perturbations due to gravity waves in the middle atmosphere above Eureka were found to be on the order of $\pm 1.5\%$ with variability evident over the course of one night as well as on timescales of several weeks. Gravity wave spectra were calculated between 20 km and 40 km altitude. Preliminary analysis was made using the correlogram technique in preparation for future analysis using Prony's method which has much higher spectral resolution. A major sudden stratospheric warming event was reported one month prior to the measurement period. The available kinetic energy density and potential energy per unit mass in the gravity wave spectra were revealed to be low, compared with the mean values from previous measurement years, with values consistently less than 0.05 J/m^3 and 2 J/kg respectively for the 2009 measurement campaign.

Summary of the summer 2009 laser upgrade to the CANDAC-EC DIAL lidar at PEARL

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During July and August 2009 the CANDAC-EC DIAL lidar's EX-600 XeCl excimer laser was successfully replaced with a model IPEX-800 XeCl excimer laser. An overview of the installation will be presented, and the capabilities of the upgraded system will be the focus of the remaining discussion.

Non-tidal, short period (< 1d) variance in Eureka/PEARL SKiYMET meteor radar winds

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Various methods of extracting short period variance (presumably due to gravity waves) from meteor winds are attempted, but hampered by non-uniformity of echo locations. These methods include examination of the radial velocity differences between fitted wind vector and individual echoes; high pass filter of hourly values (hourly value minus centred 24hr mean + 24,12 tide fit shifted by 1 hour), and an hourly difference filter.

The Sudden Stratospheric Warming [SSW] of 2008/9 winter: data from three GCMs with Data Assimilation [UKMO, CMAM-DAS, ECMWF], and observations from Aura MLS and the CANDAC-PEARL VHF Meteor Radar

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The SSW arrived in the middle of January, near the 20th, which was an inopportune time for some instruments and for heterogeneous chemical destruction of ozone at PEARL [80N 86W]. Polar plots of the streamlines and the Vortex Edge [Q-diagnostic] using UKMO [UK Met Office], ECMWF [European Centre for Mid-Range Weather Forecasting] and CMAM-DAS [Canadian Middle Atmosphere Model] are shown for selected days from early January to mid-February.

For the interval from Jan 25 to Feb 8 the vortex was split into two cyclonic centres over Scandinavia-Russia and Canada, with Eureka initially near the northern Edge; and a large and strong anticyclone resided over the pole, into which system Eureka was present from Feb 1. Matching polar plots of wind, Z[gpm] and temperature T are provided.

Temperature T [MLS] contours in height-time plots show the apparent downward progression of warm and cold atmospheric regions [mesosphere and stratosphere] over Eureka and selected locations. These progressions are due to the motions of the Edges across Eureka, as cyclonic or anticyclonic systems alternately dominate. The contour plots from SABER and CMAM-DAS are in excellent agreement with MLS. Height-latitude T-plots stress this and also the anticipated changes in thermal winds.

The mesosphere-lower thermosphere [MLT] winds and tides from the SKiYMET radar show strong variability, consistent with the thermal middle atmospheric structures. These are compared with the modelled winds. Relatively few occasions exist when heterogeneous chemical destruction of ozone [MLS] is possible over Eureka, as the early warming precludes solar radiation. However ozone changes over Eureka associated with the vortex structure and position are strong, as ozone-rich air flows over the Laboratory and North Pole due to anticyclonic dominance early in February.

Eureka Water Vapour Lidar: The first three years

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Water vapor is an important part of the atmosphere due to its roles in the hydrological cycle, greenhouse heating and ozone chemistry. The stratospheric ozone lidar located at the Polar Environment Atmospheric Research Laboratory (PEARL) in Eureka, Nunavut (80.2° N, 86.4° W) is jointly operated by the Canadian Network for Detection of Atmospheric Change (CANDAC) and Environment Canada. It has recently been upgraded to measure water vapor at 150 m vertical resolution in the polar troposphere up to about six kilometers, with measurements extending above this at lower vertical resolution. Successful calibration of these measurements allows for scientific studies to begin with the coincident measurements from the lidar and suite of CANDAC instruments at PEARL. In concert with the lidar's well-established ozone and temperature profiles these new water vapor measurements will allow incidents of stratosphere-troposphere exchange to be monitored as well as, when combined with other measurements from PEARL instrumentation, detailed studies of ozone chemistry to be performed. A calibration has been completed using 11 nights of measurements from the 2008 Canadian Arctic ACE Validation Campaign through a careful comparison with regular radiosonde launches at the Eureka Weather Station. Water vapor measurements have been analyzed for eleven nights during the 2008 campaign, as well as eight nights in 2007 and nineteen in 2009. Calibrated lidar measurements are currently being compared to water vapour measurements from overpasses by the Atmospheric Chemistry Experiment (ACE) satellite.

Measurement Overview of the CANDAC Raman Lidar

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With a winter-time campaign approaching, the measurement capabilities of the Rayleigh-Mie-Raman lidar at ØPAL will be reviewed. Characterisation of the lidar has been ongoing and system optimisation will be discussed in relation to key performance criteria. Results to date will be shown to illustrate the lidar's capabilities.

Pan-Arctic sunphotometry during the ARCTAS-A spring campaign of 2008

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The ARCTAS-A (Arctic Research of the Composition of the Troposphere from Aircraft and Satellites) campaign during the spring of 2008 provided a unique opportunity to compare and interpret a variety of airborne, ground-based and satellite aerosol measurements. In this communication we present an Arctic-wide interpretation of sunphotometry measurements acquired at a variety of Arctic and sub-Arctic sites and their link with available lidar, satellite data and airborne data. The presentation will focus on sites in Barrow, Alaska (NOAA Earth System Research Laboratory), the PEARL (Polar Environment Atmospheric Research Laboratory) Arctic observatory in Eureka, Nunavut (Canada), Spitzbergen (Ny Alesund and Hornsund) and subArctic AEROCAN / AERONET sites in Resolute Bay, Nunavut, Yellowknife, Northwest Territories (Canada), and Iquluit, Nunavut.

A New Radiometric Instrument for PEARL

Niall Ryan and K.A. Walker

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This talk will outline the development of a new ground based millimeter wave radiometer to be deployed at PEARL. The millimetre wave remote sounding studies are to focus on ozone depletion chemistry in the Arctic stratosphere via measurements of ozone (O_3), chlorine monoxide (ClO) and nitric acid (HNO_3). There are no instruments of this kind currently in operation in Canada and it will provide a capability for year-round observations of stratospheric ClO. These results will give a better understanding of stratospheric chemical processes and will complement observations made by instruments currently housed at PEARL. In this talk I will discuss the measurements to be provided by the instrument as well as development plans.

DIAL ozone measurement and Eureka update

Jeff Seabrook, Jim Whiteway and Leonce Komguem

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A study of temperature and meridional wind relationship at high northern latitudes

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Mesosphere Lower Thermosphere temperatures have been measured using groundbased airglow instruments at high latitudes during wintertime. Warmer temperatures in winter are known to result from the largescale mesospheric circulation from pole to pole. There is thus a convergence and downwelling of this flow in the polar regions as a result of this largescale circulation, with the temperature enhancement resulting from adiabatic heating. Because of this there a correlation between the meridional winds and the temperature in the MLT region is expected. OH airglow temperatures from the SATI (Spectral Airglow Temperature Imager) at Resolute Bay (75°N, 95°W) and a Fourier Transform Spectrometer (Michelson interferometer) at Kiruna (68°N, 21° E) are compared with radar wind measurements by radar at these two locations. The temperature and meridional wind do have a positive relationship, confirming the interpretation as a result of the largescale circulation. The differences between the observations at the two stations, at two different latitudes, are described and discussed.

Airglow and Temperature Response during the January 2009 Major Stratospheric Warming

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The airglow is a photochemical glow in the upper atmosphere that occurs in thin layers corresponding to different chemical processes. The O₂ atmospheric airglow layer exists at about 94 km altitude and the hydroxyl layer - at about 87 km. The intensity of the light gives information about the concentration of atomic oxygen there, while the rotational distribution of the spectrum gives accurate values of the temperature. In this investigation these are measured using an instrument called SATI (Spectral Airglow Temperature Imager). In the fall of 2007 a SATI instrument was installed at the Polar Environment Atmospheric Research Laboratory (PEARL) at Eureka (80°N, 86°W) as part of the Canadian Network for the Detection of Atmospheric Change (CANDAC). The 2008/2009 winter season was marked by a very dramatic major stratospheric warming event (SSW), observed in the second half of January 2009. The study examines the response of the MLT region (mesosphere/lower thermosphere) to this SSW, as seen in the OH and O₂ airglow observations by SATI at 87 km and 94 km, respectively. At the time of the event both the temperature and airglow emission rates appear decreased and depleted, followed by an enhancement of the airglow emission rates during the restoration phase of the SSW, while the temperature returned to its pre-event state. From the SATI observations and correlative SABER temperature and OH emission observation the peak altitude of the OH airglow layer is inferred and [O] mixing ratio, corresponding to the observed emission rates is modeled. The results obtained are interpreted in terms of temperature and [O] mixing ratio variability in the upper mesosphere and their response to the major SSW event.

Characterizing aerosol transport into the Canadian High Arctic using aerosol mass spectrometry and Lagrangian modelling

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An aerosol mass spectrometer (AMS) from Aerodyne Research Inc. was installed in the Polar Environment Atmospheric Research Laboratory (PEARL) in summer 2006. PEARL is well suited as a receptor site to study tropospheric transport of pollutants into the Arctic because it is in the free troposphere most of the time. Selected results of AMS measurements of aerosol mass concentration, size, and chemical composition will be reported. Sulfate was at most times the predominant aerosol component with on average 0.115 μg/m³. The second most abundant component was organic aerosol, with on average 0.111 μg/m³. The nitrate component, which averaged 0.0066 μg/m³, was above its detection limit, whereas ammonium ion had an apparent average concentration of 0.015 μg/m³, which was below the specified AMS detection limit. A few episodes having increased mass concentrations and lasting from several hours to several days are apparent in the data. These were investigated using statistical analysis to identify common characteristics. There were high correlations among some of the components arriving during the short term episodes, which suggests common sources. These were analysed further using Lagrangian modelling methods to identify their source regions. Sources for some episodes were located in North America, while others originated in central and eastern Asia. The source identification and atmospheric transport of the sulfate aerosols will be discussed.

To be submitted

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Canadian Arctic Atmospheric Chemistry Experiment Validation Campaigns at PEARL: Polar Sunrise 2009

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Six springtime validation campaigns have been conducted in the Canadian high Arctic to provide correlative measurements for the Atmospheric Chemistry Experiment (ACE) satellite mission. There are two instruments on-board the satellite: a high-resolution (0.02 cm^{-1}) infrared Fourier Transform Spectrometer (ACE-FTS) and a dual UV-visible-NIR spectrophotometer called MAESTRO (Measurements of Aerosol Extinction in the Stratosphere and Troposphere Retrieved by Occultation). The ACE mission has been in orbit on board the SCISAT satellite since August 2003 and the instruments have been taking routine measurements since late February 2004.

The validation campaigns took place at the Polar Environment Atmospheric Research Laboratory (PEARL) in Eureka, Nunavut (80 N, 86 W) during spring (February - April in 2004 - 2008). This period coincides with the most chemically active time of year in the Arctic and a significant number of satellite overpasses. Eleven ground-based instruments were operated: a ground-based version of the ACE-FTS (PARIS - Portable Atmospheric Research Interferometric Spectrometer for the Infrared), a terrestrial version of the ACE-MAESTRO, a SunPhotoSpectrometer, a zenith-viewing UV-visible grating spectrometer, a Bomem DA8 Fourier transform spectrometer, a Differential Absorption Lidar, two Brewer spectrophotometers, a Systeme d'Analyse par Observations Zenithales (SAOZ) instrument, a Bruker 125HR Fourier transform spectrometer and a second UV-visible grating spectrometer. Also, balloon-borne ozonesonde and radiosonde sensors were flown frequently during the campaign.

An overview of the campaign project and its role in the ACE Validation Program will be presented.

Satellite Observations of Temperature and Ozone between 2004 and 2009 at Eureka

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MIPAS/ENVISAT and MLS/AURA measure the stratospheric and mesospheric temperature and ozone distributions with nearly pole-to-pole coverage by using limb-viewing infrared emissions and microwaves, respectively. The two satellite instruments are launched on 1 March 2002 and 15 July 2004, in the same sun-synchronous orbit plane (98° inclinations) with a 10:00 AM and 1:45 PM equator crossing time, respectively. Climatology of monthly mean temperatures and ozone mixing ratios at Eureka are derived from the satellite data taken between 2004 and 2009. The satellite-measured temperatures are compared with those of the CMAM and other models and ground-based measurements collected from the CANDAC project. In particular, studies of the atmospheric tides at the high latitude are stressed, since the two data sets combined together provide a daily coverage of four local times for given latitude and can be used to derive tidal signatures better than those from the measurements of a single satellite.

The PEARL All Sky Imager

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The PEARL All Sky Imager was installed in the late fall of 2007 and has now completed two years of winter observations. Some operational issues have arisen associated with frosting and are being worked out. Analysis tools for this instrument have been developed and used for scientific analyses and support of other instruments. Several gravity wave events have been identified and analysed. During the major warming this past January, interesting airglow variations, including significant depletions and enhancements were observed. Time series of integrated emission rate, keograms, movies and cloud cover determinations are among the basic tools through which this instrument provides information for the site. Special filters have been ordered to allow observations during the summer to be made. These will be installed in the spring of 2010.

The CANDAC January 2009 Campaign

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A campaign for the Waves and Coupling Processes Theme instrumentation was planned and took place during the new moon period of January/February 2009. The original purpose of this campaign was to provide an opportunity for the coordination of the various instruments to take place so that the observations could be compared and validated with each other. While the desired observations did take place, the original purpose of the campaign was high-jacked by the occurrence of one of the largest sudden stratospheric warmings on record. As a result, significant effort has been directed toward diagnosing the development of the warming as seen with the Eureka instruments and interpreting these results in terms of the developing understanding of the what went on during the warming. The Eureka data provide a unique observation set of what happens in the mesopause region during a warming and the extent to which coupling throughout the atmosphere occurs. This talk provides a short overview of the Waves and Coupling Processes observations during this period and with an emphasis on the All Sky Imager observations. Other talks will provide details of the other instrument observations and analysis which has taken place.

One Year of E-AERI Infrared Emission Measurements at PEARL

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The Extended-range Atmospheric Emitted Radiance Interferometer (E-AERI) is a moderate-resolution (1 cm^{-1}) Fourier Transform Infrared Interferometer (FTIR) for measuring the absolute downwelling infrared spectral radiance. This instrument was installed at PEARL in October 2008 and has just completed its first year of measurements. Infrared radiance spectra of the sky and two calibrated blackbodies are collected continuously every ten minutes during light and dark periods, including both clear-sky and cloud-covered conditions. An automated hatch protects the optics and electronics of the instrument when a precipitation sensor senses rain or snow.

Data from the E-AERI is being used to address three primary objectives:

1. To retrieve temperature and humidity profiles of the planetary boundary layer, allowing for high-temporal-resolution records and analyses of temperature and water vapor changes due to mesoscale meteorological features.
2. To use the extended spectral coverage of the E-AERI ($400\text{-}3000 \text{ cm}^{-1}$ or $3\text{-}25 \text{ micron}$) to investigate the so-called dirty window (the 20-micron region) which dominates the current Arctic radiative transfer. This may change in the near future as a consequence of climate change; these changes will be quantified with the E-AERI radiance measurements.
3. To retrieve total columns of various trace gases using emission features within the measured wavelength range, e.g., HNO_3 , CH_4 , CO , O_3 , N_2O . In contrast to solar absorption measurements of atmospheric trace gases, which depend on sunlit clear-sky conditions, the use of emission spectra allows measurements essentially year-round (except during precipitation). This capability allows the E-AERI to extend the data series of the PEARL solar absorption FTIR throughout the polar night.

This paper will describe the E-AERI and its capabilities, and show some initial results. An overview of the retrieval methods will be given, along with a discussion of future plans.

On the semidiurnal tide during 2006/7: Results from the CMAM-DAS hourly data compared with published studies

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This work presents the semidiurnal (SD) tides for 2006/7 obtained from the CMAM-DAS (Canadian Middle Atmosphere Model with Data Assimilation System) hourly data. Consistent with existing observations, the main features of the SD tide are well captured by the CMAM-DAS. The simulations show clear late-summer/early-fall (LSEF, August-September) maxima in the SD wind tidal amplitudes at northern mid- and high-latitudes, in agreement with the radar observations. At northern mid-latitudes, a non-migrating $s=-2$ SD tide is evident for summer, consistent with the HRDI-UARS winds analysis. For the LSEF maximum, the migrating SD tide ($s=2$) dominates, as compared to the percentage-power of the migrating tide, with values very close to 100%, derived from two polar radars (Eureka 80N, 86W and Svalbard 78N, 16E) and two high mid-latitude radars (Saskatoon 52N, 105W and Collm 51N, 15E). Consistent with earlier studies, a non-migrating $s=1$ SD wind tide is identified in the summer mesosphere in high/polar southern latitudes. The stationary planetary wave in the Northern Hemisphere stratosphere is most likely a source for the occurrence of the $s=1$ SD wind tide in the opposite hemisphere since a good correlation is found between them, indicating an inter-hemispheric linkage in the stratosphere-mesosphere. The SD tidal vertical wavelength exhibits seasonal and vertical variations. A Hough mode decomposition provides a consistent explanation for these variations.