

A21A-0058 0830h POSTER

Measurement of Organic and Inorganic Chemical Tracers for Source Apportionment of Tropospheric Aerosols Collected During the ACE-Asia Experiment

James J Schauer¹ (608-262-4495; jschauer@engr.wisc.edu); June-Soo Park¹ (608-262-7570; junesoopark@facstaff.wisc.edu); Rachele Duvall¹ (608-262-4322; rmduvall@students.wisc.edu); Min-Suk Bae¹ (608-262-7570; minbae@hotmail.com); Martin M Shafer¹ (608-262-0140; mmshafer@facstaff.wisc.edu); Patrick Chuang^{1,2} (831-249-1501; pchuang@earthsci.ucsc.edu); Young Joon Kim³ (82-62-970-2439; yjkim@env.kjst.ac.kr)

¹Environmental Chemistry and Technology Program University of Wisconsin-Madison, 660 N. Park St., Madison, WI 53706, United States

²Earth Science Department University of California Santa Cruz, 1156 High St., Santa Cruz, CA 95064, United States

³Environmental Science and Engineering Kwangju Institute of Science and Technology, 1 Oryong-dong Puk-gu, Kwangju 500-712, Korea, Republic of

Naturally occurring dust and anthropogenic air pollutants are important contributors to tropospheric aerosols and impact air quality and the radiative balance of the Earth's atmosphere. In order to better understand the relationship between the origin, chemical composition and ultimate impact of Asian aerosols on climate forcing, aerosol samples were collected as part of the ACE-Asia experiment for detailed chemical analysis. Atmospheric particulate matter samples were collected from March 27, 2001 through May 6, 2001 at the ACE-Asia ground station located on Cheju Island, Korea. During this period, this region is impacted by anthropogenic air pollution emissions from highly urbanized region of Asia and by desert dust originating from northeastern Asia. As part of the experiment, atmospheric particulate matter samplers were also collected in urban and desert locations in Asia that represent regional sources of particulate matter in Asia. Size resolved aerosol samples were analyzed for trace metals by using microwave assisted-acid digestion and ICP-MS analysis, speciated organic compounds using solvent extraction and GC-MS analysis, as well as soluble ions and elemental and organic carbon (ECOC). These measurements provide fingerprints for source apportionment of the atmospheric particulate matter samples collected at the Cheju Island sampling site. The use of these chemical tracers for apportionment of wind-driven long range transported desert dust, local crustal derived dust, biogenically and anthropogenically derived sulfate, specific urban combustion source, and fossil fuel combustion will be presented.

A21A-0059 0830h POSTER

Analysis of the Spatial Variability of Tropospheric Aerosol as Observed by Space Lidar

David M Winker (757 864 6747; d.m.winker@larc.nasa.gov)

Atmospheric Sciences Atmospheric Sciences, NASA Langley Research Center MS/475, Hampton, VA 23681, United States

Global models are currently our primary means of estimating the direct and indirect forcing of the Earth's climate by aerosols. However, there are large uncertainties in the representations of aerosols in these models. One area of uncertainty is the spatial variability of the aerosol distribution predicted by the model. This has a bearing on the spatial and temporal resolution required to appropriately capture the pattern of aerosol concentration and column burden. Further, statistics of the distribution such as the spatial autocorrelation function provide a means of testing the representativeness of the aerosol transport and removal processes incorporated in the model. An understanding of aerosol variability is also necessary to devise optimum sampling strategies for combining satellite observations with in situ measurements for the purpose of validation.

The Lidar In-space Technology Experiment (LITE) is a backscatter lidar built by NASA Langley Research Center and flown on Space Shuttle Discovery in September 1994. Global observations of clouds and aerosols were made between the latitudes of 57N and 57S during 10 days of the mission. The LITE dataset represents a unique set of observations of tropospheric aerosol on a global scale. Characteristics of the observed aerosol distribution relevant to the above considerations have been analyzed and will be discussed.

A21A-0060 0830h POSTER

Understanding Heterogeneous Chemistry at the Molecular-Level using Broadband Nonlinear Technologies: Application to Atmospheric Aerosol Growth and Chemistry

Heather C. Allen (614-292-4707; allen.697@osu.edu)

The Ohio State University, Department of Chemistry 100 W. 18th Avenue, Columbus, OH 43210, United States

Surface reactions on liquid and solid particles can significantly impact tropospheric chemistry since many reactions that are slow to occur in the gas phase may in fact be favored on these atmospheric particles. Currently, we are investigating the surface structure of a variety of solid and liquid surfaces in order to understand particle growth and chemistry in the troposphere. The structure of a surface is different than the bulk media and consequently, the chemistry occurring at a surface is often unique. Surface vibrational sum frequency generation is the primary tool used in these studies because of its surface and molecular selectivity. New advances in our lab using broadband technology and ultra-fast laser sources for probing reactions taking place on surfaces on short timescales and at atmospheric pressures will be presented. Surface structures and adsorption of gas-phase water at the surface of various organic solutions (e.g. ethylene glycol and methylanthalene) will be discussed.

A21A-0061 0830h POSTER

Automated Measurements of Ambient Aerosol Chemical Composition and its Dry and Wet Size Distributions at Pittsburgh Supersite

Andrey Y Khlystov¹ (andrey@andrew.cmu.edu);

Charles Stanier¹ (cos@andrew.cmu.edu); Wan-Yu Chun¹ (wrchun@andrew.cmu.edu); Dimitris Vayenas¹ (dvayenas@andrew.cmu.edu); Muliya Mandiro¹ (mmandiro@andrew.cmu.edu); Spyros N Pandis¹ (Spyros@andrew.cmu.edu)

¹Carnegie Mellon University, Dept. Chemical Engineering 5000 Forbes ave., Pittsburgh, PA 15213, United States

Ambient aerosol particles change size with changes in ambient relative humidity. The magnitude of the size change depends on the hygroscopic properties of the particles, which is determined by their chemical composition. Hygroscopic properties of particles influence many environmentally important aerosol qualities, such as light scattering and partitioning between the gas and particle phases of semivolatile compounds. Studying the hygroscopic growth of ambient particles is thus of paramount importance.

The hygroscopic growth of ambient particles and their chemical composition are measured continuously within the Pittsburgh Air Quality Study (EPA supersite program). The hygroscopic size changes are measured using an automated system built for this study. The system consists of two Scanning Mobility Particle Sizers (SMPS, TSI Inc.) and an Aerodynamic Particle Sizer (APS, TSI Inc.). The three instruments measure aerosol size distribution between 5 nanometers and 10 micrometers in diameter. The inlets of the instruments and the sheath air lines of the SMPS systems are equipped with computer controlled valves that direct air through Nafion dryers (PermaPure Inc.) or bypass them. The Nafion dryers are drying the air stream below 40% RH at which point ambient particles are expected to lose most or all water and thus be virtually dry. To avoid changes in relative humidity and evaporation of volatile particles due to temperature differences the system is kept at ambient temperature. The system measures alternatively dry (below 40% RH) and wet (actual ambient RH) aerosol size distributions every 6 minutes.

The hygroscopic growth observed with the size-spectrometer system is compared with theoretic predictions based on the chemical composition of aerosol particles. A modified semi-continuous Steam-Jet Aerosol Collector provides the total available budget (particles and gas) of water-soluble species, which is used as an input to the thermodynamic model. The model calculates the aerosol/gas partitioning of semivolatile species including water and thus predicts the hygroscopic growth of particles.

Preliminary data on the measured hygroscopic growth factors of ambient aerosol and a comparison with the model predictions will be discussed.

A21A-0062 0830h POSTER

Organic and Elemental Carbon (OC & EC) vs Altitude in Asian Outflow During ACE-Asia

Timothy H Bertram¹ (1-808-956-6091; tbertram@soest.hawaii.edu); Steve G Howell¹ (1-808-956-5185; showell@soest.hawaii.edu); Jackie A Heath¹ (1-808-956-6091; jheath@soest.hawaii.edu); Byron W Blomquist¹ (1-808-956-5185; byronb@soest.hawaii.edu); Delbert J Eatough² (1-801-378-3667; DJEATOU@chemdept.byu.edu); Barry J Huebert¹ (1-808-956-6896; huebert@soest.hawaii.edu)

¹University of Hawaii, Dept. of Oceanography, Honolulu, HI 96822, United States

²Brigham Young University, Dept. of Chemistry, Provo, UT 84602, United States

Because airborne sampling legs are usually short relative to typical sampling times for carbonaceous aerosols, the number of published OC and EC altitude profiles is limited. It is only recently that Novakov et al. suggested that there may be as much carbonaceous aerosol as sulfate in the free troposphere, a radical change from the "almost all sulfate" view of many authors. We measured OC and EC during ACE-Asia from the NSF/NCAR C-130 aircraft, using a PC-BOSS sampler developed by Delbert Eatough of BYU. This sampler not only preconcentrated the samples (improving our S/N by about 3-5x for a given sampling time), but it also eliminated or minimized two major OC sampling artifacts: 1) a VOC denuder made of carbon-impregnated-glass (CIG) filter strips minimized the positive artifact due to adsorption of organic vapors on our quartz filters and 2) a CIG filter behind the quartz collected any volatilized OC aerosol that would have caused a negative artifact. Our data show that the positive artifact would often have been many times the actual OC, while the negative artifact would have been between 10 and 50% of the actual OC.

Rarely was our S/N less than 2, in part because of relatively high OC and EC concentrations in Asian outflow and because of the enhancement by the PC-BOSS sampler. OC varied from 0.3 to 34 ug C/m³, with a median of 4 ug C/m³. EC was between 0.1 and 37 ug C/m³, with a median of 1.6 ug C/m³. These concentrations of black carbon will have a significant radiative impact. The median EC/OC ratio was 0.4, with an average of 0.8. The median ratio of OC (as carbon, with no multiplier for other elements) to NSS was 0.6, with an average of 1.6. Clearly organic aerosol concentrations are comparable to those of sulfate in Asian outflow.

URL: <http://saga.pmel.noaa.gov/aceasia/>

A21B MC: Hall D Tuesday 0830h Aerosols, Trace Gases, and Radiation Presiding: S Pope, Scripps Institution of Oceanography

A21B-0063 0830h POSTER

Surface Temperature and Emissivity from Airborne Measurements of IR Radiance Spectra

Daniel K Zhou¹ (1-757-864-5663; d.k.zhou@larc.nasa.gov)

William L Smith¹ (1-757-864-5984; bill.l.smith@larc.nasa.gov)

Allen M. Larar¹ (1-757-864-5328; a.m.larar@larc.nasa.gov)

¹NASA Langley Research Center, 21 Langley Blvd., Hampton, VA 23681, United States

The NPOESS Airborne Sounder Testbed Interferometer (NAST-I) provides high spatial resolution (2.0 km footprint) scanning and high spectral resolution (0.25 cm⁻¹) measurements in the spectral region of 645-2700 cm⁻¹ from the ER-2 or Proteus high-altitude (20 or 16 km, respectively) aircraft. Assuming that the contributions to the observed spectra (upwelling atmospheric emission, the upwelling surface reflected downward atmospheric radiation, and upwelling surface emission) can all be separated, then it is possible to determine the surface temperature and emissivity under the assumption that the surface radiates as either a specular or a diffuse reflector. High spectral resolution permits the separation of these terms and a statistical technique has been developed to retrieve the surface and atmospheric properties contained in the spectral radiance signal. Specifically, for surface temperature and emissivity, we develop regression relations between the amplitudes of eigenvectors of surface emissivity to

the amplitudes of radiance eigenvectors. Similarly, the magnitude of the surface skin temperature, as well as the atmospheric temperature and humidity at various atmospheric levels, is related to the amplitudes of the radiance eigenvectors. The eigenvectors and regression relations are based on a synthetic set of NAST-I radiance spectra for a climatology of atmospheric and surface conditions. A set of laboratory measured emissivity spectra for a wide variety of surface types is used to compute the emissivity eigenvectors and the eigenvector amplitudes used in the statistical training. The surface emissivity spectrum as well as the surface temperature and the atmospheric parameters are then predicted from the radiance eigenvector amplitudes that are derived from actual NAST-I radiance spectra. The retrieved surface emissivity and skin temperature is validated by internal consistency with that derived using the observed NAST-I radiance spectra in a full radiative transfer calculation based on radiosonde or retrieved atmospheric profiles. Retrieval results obtained during various NAST-I field campaigns are presented.

A21B-0064 0830h POSTER

UV (280-325 nm) Temperature Dependent (197-295 K) Absorption Cross-Sections of SO₂

Joshua B. Halpern¹ (202 806-6883; jhalpern@howard.edu)

DaNa Carlis¹ (202 806-6767; dcarlis@hotmail.com)

Thomas J. McGee² (301 614-5980; mcgee@aeolus.gsfc.nasa.gov)

John F. Burris² (burris@aeolus.gsfc.nasa.gov)

¹Department of Chemistry, Howard University, Washington, DC 20059, United States

²Atmospheric Chemistry and Dynamics Branch Laboratory for Atmospheres, Code 916 NASA/Goddard Space Flight Center, Greenbelt, MD 20771, United States

Uniquely, sulfur dioxide is both a signal and an interference for satellite instruments such as TOMS which measure backscattered ultraviolet sunlight. Sulfur dioxide is the major interfering species for ozone measurements, but serendipitously, TOMS can trace volcanic clouds by monitoring SO₂. Obtaining the maximum benefit from these and similar missions such as near UV limb sounders, requires temperature dependent SO₂ absorption cross-sections.

Between 300 and 400 nm, there is only a single published low temperature SO₂ absorption cross-section measurement [McGee and Burris 1987]. That work was done at dry ice temperature between 300 and 320 nm. We report new measurements of low pressure (~1 Torr) SO₂ absorption coefficients between room (295K) and dry ice (197) temperatures. Spectra were scanned between 280 and 325 nm at a resolution of 0.015 nm. Measurements were done at relatively low (1 Torr) pressures, but we plan to investigate the effect of adding nitrogen and oxygen at pressures typical of tropospheric or stratospheric conditions.

McGee, T.J.; Burris, J.F., SO₂ absorption cross sections in the near UV. J. QRSRT 37 (1987) 165.

A21B-0065 0830h POSTER

Error Evaluation for the Broadband Interferometry

TAKESHI MORIMOTO¹ (+81 6 6878 7134; morimoto@comf5.comm.eng.osaka-u.ac.jp)

Zen KAWASAKI¹ (+81 6 6879 7690; zen@comm.eng.osaka-u.ac.jp)

Redy MARDIANA¹ (+81 6 6879 7691; redy@pels.pwr.eng.osaka-u.ac.jp)

¹Osaka University, Graduate School of Engineering, Department of Communication Engineering, Yamada-Oka 2-1, Suita, Osaka 565 0871, Japan

Two-dimensional and three-dimensional VHF source mapping emitted by lightning discharge progression have been established by a unique technique based on the broadband interferometry. Though the functions and potential capabilities of the broadband interferometry have been shown widely, the discussion on their accuracy have not been discussed sufficiently yet. Then the objective of this paper is presenting the quantitative discussion and evidence of the superiority of the broadband Interferometer. The main attention is paid on the two-dimensional source localization for VHF impulses. One unit of interferometer consists of three antennas, and azimuth and elevation of VHF sources against the site of the interferometer can be derived. Since the background noise components are superimposed on the VHF pulse signals intrinsically, the calculated azimuth and elevation include location error. The broadband interferometry is based on the phase estimation for more than a hundred Fourier components. Since the Fourier component is linearly independent each other, we can estimate the azimuth and elevation for all Fourier components. If there is no noise, and if

there is no dispersions during VHF pulse propagation, the azimuth and elevation for all Fourier components should be the same. In the real observations it does not happen, and estimated azimuth and elevation vary depending on the frequency. The variation of azimuth and elevation depends on the original VHF pulse, and in some cases there is less variation and other cases the variation are large. In any cases we normally adopt the arithmetic averaging or weighted averaging to finalize the azimuth and elevation for VHF pulse source. If we think about this situation seriously, we can notice the existence of the redundancy in terms of the Fourier spectra. This means that we can reach an idea to use this for the discussion of location error or ambiguity of the broadband interferometry.

One additional idea is the application of broadcast signals. The frequency bandwidth of the broadband interferometry is ranging from 25 MHz to 250MHz, and this frequency band includes FM radio and VHF TV services. Since the relative positions of broadcasts against the VHF broadband interferometer are constant, and the azimuth of Fourier frequency component corresponding to the broadcast is known. It is able for us to use this to calibrate the broadband system, and it can be done on site exactly on real time.

A21B-0066 0830h POSTER

Retrieval of Trace gas and Aerosol Densities From Limb Scatter Measurements by OSIRIS on Odin Using a Modified Onion Peeling Method

Harri Auvinen¹ (+358 9 1929 4659; harri.auvinen@cc.helsinki.fi)

Liisa Oikarinen² (+358 9 1929 4650; liisa.oikarinen@fmi.fi)

Erkki Kyrölä² (+358 9 1929 4640; erkki.kyrola@fmi.fi)

Odin team³

¹University of Helsinki, Department of Mathematics, Yliopistonkatu 5 P.O.Box 4, Helsinki 00014, Finland

²Finnish Meteorological Institute, Vuorikatu 15 P.O.Box 503, Helsinki 00101, Finland

³The Odin team, <http://www.snsb.se/Odin/Odin.html>

The Odin satellite, which carries two instruments, OSIRIS and SMR, was launched to a heliosynchronous orbit in February 2001. The observation time is divided between aeronomical and astronomical measurements. In aeronomy mode OSIRIS and SMR will scan the limb either in a continuous or in a stepwise manner from tangent altitudes of 60 (alternatively 120 km) to 7 km. OSIRIS includes an UV-visible spectrometer and an infrared imager. SMR is a sub-millimeter radiometer, which is used for both aeronomy and astronomy measurements.

In this paper we present a Modified Onion Peeling (MOP) method to retrieve minor species densities from limb scatter measurements by OSIRIS. The goal is to retrieve vertical profiles of ozone, NO₂, OClO and BrO density, and also aerosol and Rayleigh extinction. The need for absolute calibration of the radiance measurement is circumvented by dividing the data with a reference measurement made at a high tangent altitude by the same instrument. We approximate the atmosphere to be, at least in the first order, locally spherically symmetric. This leads to a non-linear inversion problem. Multiple scattering is taken into account by pre-calculated total to single scattering radiance ratios tabulated as a function of wavelength, tangent altitude, and several other relevant parameters. The inversion uses the whole UV-visible spectral range of OSIRIS. Several constituents are inverted simultaneously. We show preliminary retrieval results from selected OSIRIS measurements.

Odin is a Swedish-led satellite project funded jointly by Sweden (SNSB), Canada (CSA), Finland (Tekes) and France (CNES).

A21B-0067 0830h POSTER

Comparison of Radiative Transfer Models for Limb-Viewing Scattered Sunlight Measurements

Liisa Oikarinen¹ (liisa.oikarinen@fmi.fi)

Erik Griffioen² (erik@nimbus.yorku.ca)

Robert Loughman³ (loughman@wrrabbit.gsfc.nasa.gov)

Oleg Postyljakov⁴ (ovp@omega.ifaran.ru)

Alexei Rozanov⁵ (alex@game5.physik.uni-bremen.de)

¹Geophysical Research Division, Finnish Meteorological Institute, Helsinki, Finland

²Earth and Atmospheric Science, York University, Toronto, Canada

³Cooperative Center for Atmospheric Science and Technology, University of Arizona, Tucson, Arizona

⁴Institute of Atmospheric Physics, Russian Academy of Sciences, Moscow, Russia

⁵Institute of Remote Sensing, University of Bremen, Bremen, Germany

The intensity of solar ultraviolet, visible, or near-infrared radiation back scattered from the Earth's atmosphere carries information on several trace gases and aerosol. A number of new satellite instruments will measure atmospheric constituents by looking at scattered radiation in limb-viewing geometry. The OSIRIS instrument flying on the Odin satellite since Feb. 2001 and the SOLSE and LORE instruments flown on the Shuttle flight STS-87 use this technique. SCIAMACHY and GOMOS on Envisat and SAGE III on Meteor-3M will carry out limb scatter measurements in addition to nadir-viewing measurements of scattered sunlight and limb-viewing occultation measurements.

Inversion methods for retrieving constituent profiles from limb intensity measurements are under active development. A central part of data inversion is a radiative transfer model. Accurate radiative transfer modeling for limb-viewing measurements is complicated, because the spherical shape of the atmosphere has to be taken into account. Multiple scatterings in the atmosphere as well as light reflected from Earth's surface significantly contribute to the intensity.

We have compared limb intensities from six different models, which use different numerical methods to solve the radiative transfer problem. The objective is to validate the models against each other and to get an idea on their computational efficiency. Four of the models take fully into account the sphericity of the atmosphere: a model which uses a Gauss-Seidel iteration scheme (GSS), a model called "Combining Differential-Integral approach involving the Picard Iterative approximation" (CDIPI), and two Monte Carlo models (a model called "Siro" and a model developed at the Russian Academy of Sciences). The two other models, a model based on the Combined Differential-Integral approach (CDI) and a model called "LIMBTRAN", involve some approximation in spherical geometry but are computationally much faster than the fully spherical models. In the first comparisons of limb intensity from a realistic atmosphere the fully spherical models differed at most by 5%, often less. The difference between fully spherical models and CDI and LIMBTRAN increased with tangent altitude, in the first comparisons differences were at most 8%.

A21B-0068 0830h POSTER

Study on Long-range transported aerosol characteristics from China at Korean urban and rural area in spring

Joo wan Cha¹ (jwcha@kma.go.kr)

jae-cheon Choi (jchoi@kma.go.kr)

So Young Bang (sybang@kma.go.kr)

Jeong-Sik Kim (kimjs@kma.go.kr)

Yong-Hoon Yoon (yhyoun@kma.go.kr)

¹Korea Global Atmosphere Watch Observatory, 1764-6, Seungun-ri, Anmyon-up, Taean-Gun, Chung Nam 357-961, Korea, Republic of

A lot of aerosol particles occur in Asian continent in spring. The aerosol particles are called Asian dust. The Asian dust is transferred from Asian continent to North-East Asia. The long-range transported aerosol particles from Asian continent generally affect in Korea during Asian dust event. Also, the aerosol particles characteristics change while the aerosol particles go through Korean peninsula. Especially, the aerosol particles react with air pollutant in urban area. This study selects two observational sites. The one is Anmyon island where is located in west coast of Korea, the other is Kwang-Ju city where is located in southwest area of Korea. The Anmyon island is first observational site when the Asian dust reaches the Korean peninsula and is Korean Global Atmosphere watch observatory. So, the many instruments are installed for aerosol observation. The Kwang-ju city site is urban area where is one of large city in Korea. The KJIST (Kwang-Ju Institute of Science Technique) is located in Kwang-Ju city. The KJIST have many instruments for the aerosol particles. So, the Anmyon island and Kwang-Ju city sites are important sites in Korea for monitoring about the long-range transported aerosol particles from China. The aerosol particles are measured continually using aethalometer and nephelometer were used extensively for measurement of the aerosol particles scattering (ssp) and absorption (sap). Aerosol particles scattering is measured at 450nm, 550nm, and 700 nm by nephelometer that is a high-sensitivity device capable of detecting the scattering properties of aerosol particles. For calculation the single scattering albedo(w), defined by w=(ssp)/(ssp+ sap), estimated from atmospheric black carbon aerosol (BC) concentration of aethalometer and the data of nephelometer measurement at 550nm. Especially, BC(ng/m3) is converted into

10-8 (/m) by using Bodhaines method for aerosol absorption. Aerosol Optical Depth (AOD) is measured by sunphotometer. The g parameter is calculated by using the AOD. Airborne particle counter is used for aerosol size distribution. The aerosol particles are collected by PM-10 High Volume Air sampler (HVAS) and analyzed the chemical components of the particles by Ion Chromatography.

URL: <http://www.metri.re.kr/kgawo>

A21B-0069 0830h POSTER

A Coupled Atmosphere-Snow Radiative Transfer Model

Julia M Lee-Taylor¹ (303-497-1489; julial@ucar.edu)

Sasha Madronich¹

¹National Center for Atmospheric Research, 1850 Table Mesa Drive, Boulder, CO 80303, United States

The TUV one-dimensional atmospheric radiative transfer model has been adapted for use within snowpack by addition of a multi-level snow layer. We use the model with previous observations of snow albedo and attenuation depth to derive a range of scattering coefficients applicable to natural snow. The behavior of actinic flux within model snowpack is compared to that of irradiance. The two quantities differ substantially at the snow surface, but decrease at constant ratio within the bulk of the snowpack. Below the surface, spectral total actinic flux may be approximated by 4 x downwelling spectral irradiance. We simulate in-snow nitrate photolysis for a variety of environmental conditions. Resultant NO_x production estimates reproduce observations well. Boundary-layer enhancements of up to 40 pptv NO_x per day due to fluxes from the snow are shown to be quite realistic for mid-April at Alert.

A21B-0070 0830h POSTER

Temperature Retrievals From Non-oxygen Bands Measured by the Submillimeter Radiometer Onboard the Odin Satellite.

Philippe Baron¹ (baron@misu.su.se); Frank

Merino¹; George Witt¹; Joachim Urban²; Nicolas Lautie²; Eric Le Flochmoen²; Philippe Richaud²; Jerome de la Noe²; Donal Murtagh³; Patrick Eriksson³; Carlos Jimenez³; The Odin Team⁴

¹MISU, Stockholm University, Stockholm SE-10691, Sweden

²Bordeaux Observatory, Floirac, France

³Chalmers University of Technology, Gothenburg, Sweden

⁴Odin web page, <http://www.snsb.se/Odin/Odin.html>

The Odin satellite carrying a sub-mm radiometer (SMR) and the Optical Spectrograph and Infra Red Imaging System (OSIRIS) was launched in February 2001. The two instruments will provide vertical profiles on a global basis of various atmospheric constituents such as O₃, ClO, HNO₃, N₂O, H₂O and its isotopes H₂¹⁸O, HDO and H₂¹⁷O, as well as temperature. The aim of this poster is to present the capabilities of the SMR radiometer for the retrieval of temperature from non-oxygen bands in the stratosphere and the mesosphere. Some first results will be presented.

Odin is a Swedish-led satellite project funded jointly by Sweden (SNSB), Canada (CSA), Finland (Tekes) and France (CNES).

A21B-0071 0830h POSTER

A Model Study of New Sulfate Aerosol Formation and Transport in Deep Convective Storms

Chieko Kittaka¹ (608-262-0794; chieko@windy.meteor.wisc.edu)

Pao K Wang¹ (608-263-6479; pao@windy.meteor.wisc.edu)

¹Department of Atmospheric and Oceanic Sciences, University of Wisconsin-Madison 1225 W. Dayton Street, Madison, WI 53706, United States

Convective storms play a significant role in the transport of trace chemical species in the atmosphere. They not only transport these chemicals by their circulation, but also produce new chemical species via chemical reactions (both homogeneous and heterogeneous) between trace chemicals and water substance in the cloud. In this paper, we will report a numerical model simulation study utilizing a 3-D nonhydrostatic, quasi-compressible cloud model with detailed cloud microphysics and chemistry to simulate the formation of

sulfate particles in the storm. A typical concentration profile of sulfur dioxide gas is assumed to exist in the beginning of the simulation. The sounding of a 1981 storm occurred in Montana is used as the initial condition for the storm development. The chemical reactions include the initial hydration of SO₂, two ionization steps of the hydrated species that produces SO₃ ions, and the oxidation of SO₃ to SO₄ ions by hydrogen peroxides. The above reactions are assumed to occur mainly in the liquid phase, but the sulfur contaminated liquid drops may be taken up by ice particles in the cloud via the riming process. Thus, the cloud process not only re-distributes the original sulfur dioxide gas, but also produces new sulfate particles and transports these new aerosol particles by the storm circulation. There are observational confirmation of such new aerosol formation and re-distribution.

A21B-0072 0830h POSTER

Retrieving Aerosol Size Distributions and Integral Properties From Simulated Satellite Extinction Measurements

Glenn K Yue (757-864-2678; g.k.yue@larc.nasa.gov)

NASA Langley Research Center, 100 NASA Road, Hampton, VA 23681, United States

A new method to retrieve aerosol size distribution and integral properties from the Polar Ozone and Aerosol Measurement (POAM) II and III is proposed. This method assumes that the aerosol number density in each size bin, the surface area and volume densities can be expressed as a linear combination of the measured extinctions. The coefficients in the expressions are obtained by minimizing the retrieval errors averaged over a set of testing size distributions.

It is found that not all six aerosol extinctions measured by POAM are required to retrieve aerosol properties. The derived expressions for retrieving aerosol properties are presented. The retrieval uncertainties for different aerosol properties and different satellite systems including SAGE II and III are compared and discussed. It is found that in general, the aerosol properties can be retrieved with reasonable accuracy from satellite measurements of aerosol extinctions. However, the retrieval of POAM II and III is not as accurate as SAGE II and III.

A21B-0073 0830h POSTER

Absolute Brewer Zenith-sky Radiance and Polarization Measurements with Application to the Retrieval of Aerosol Properties

Chris A McLinden¹ (416-739-4594; chris.mclinden@ec.gc.ca)

C Thomas McElroy¹

Vladimir Savastouk¹

Jim B Kerr¹

David I Wardle¹

¹Meteorological Service of Canada, 4905 Dufferin Street, Toronto, ON M3H 5T4, Canada

A Brewer spectrophotometer operating in zenith-sky mode has been absolutely calibrated and equipped with a polarizing filter to enable measurements of the absolute radiance in two planes. (The zenith-solar plane and the plane perpendicular to it). In this new configuration, two months of data were collected at Fairbanks, Alaska (65°N, 148°W) as part of the TOMS³-F campaign. An extended (305–360 nm) wavelength scan was used for these measurements. Comparisons between these data and a vector radiative transfer model indicate good agreement. In addition, an investigation into the feasibility of using these absolute radiance and linear polarization measurements for purposes of retrieving aerosol optical depth, effective radius, and refractive index has been conducted. Brewer data, model comparisons, and the results of the feasibility study will be presented.

A21B-0074 0830h POSTER

Modeling of Atmospheric Radiative Transfer with Polarization and Its Application to the Remote Sensing of Tropospheric Ozone

Yibo Jiang¹ (ybj@mils.jpl.nasa.gov)

Yuk L Yung² (yly@mercul1.gps.caltech.edu)

Stan P Sander¹ (stan.p.sander@jpl.nasa.gov)

Larry D Travis³ (pdltd@nasagiss.giss.nasa.gov)

¹JPL, 183-701, JPL 4800 Oak Grove Drive, Pasadena, CA 91109

²Caltech, Caltech, 170-25, Pasadena, CA 91125

³NASA Goddard Institute for Space Studies, 2880 Broadway, New York, CA 10025

Light reflected or transmitted by a planetary atmosphere contains information about particles and molecules in the atmosphere. Therefore, accurate modeling of the radiation field may be used to retrieve information on atmospheric composition. In this paper, a multi-layer model for a vertically inhomogeneous atmosphere is implemented by using the doubling-adding method for a plane-parallel atmosphere. By studying the degree of polarization of the transmitted and reflected solar light in the Huggins bands, we show that the behavior of tropospheric ozone and stratospheric ozone, and the lower tropospheric and upper tropospheric ozone are significantly different. This result provides the theoretical basis for the retrieval of tropospheric ozone from the measurement of the degree of polarization of the scattered sunlight both from the ground and from the space.

A21B-0075 0830h POSTER

Atmospheric Absorption in ARES II: Observations and Models

Shelly K Pope¹ (858-534-9619; spope@ucsd.edu)

Francisco P.J. Valero¹ (858-534-2701; fvalero@ucsd.edu)

Brett C. Bush¹ (858-822-0514; bcbush@ucsd.edu)

David C. Marsden¹ (858-534-9621; dmarsden@ucsd.edu)

Quy T. Nguyen¹ (858-822-5040; qtnghuyen@ucsd.edu)

¹Scripps Institution of Oceanography, University of California San Diego, 9500 Gilman Dr., Dept. 0242, La Jolla, CA 92093, United States

Observations of the absorption of solar radiation by the atmosphere in clear and cloudy skies are compared to several calculations performed with different radiative transfer models. It is found that the calculated absorption differs from the observed value by a significant amount in cloudy conditions, with models under-predicting the absorption. Most interestingly it is also found that the models, all using identical input, differ among themselves significantly, e.g. yielding absorption estimates ranging from 15% to 19% for the column of atmosphere from the surface up to 7 km. Models predict clear sky absorptance in agreement with the observations within experimental uncertainties.

These results are from ARES II; a comparison with ARES I results shows agreement within observational uncertainties. As in ARES I, visible absorptance is present on some days at levels of up to 2.5%, which can be attributed to the presence of aerosols.

A21B-0076 0830h POSTER

Light Scattering by Aerosols Over the Remote Ocean: Clear-Sky Point and Column Radiative Closure Studies

Ann M. Fridlind¹ (1-650-723-1825; fridlind@stanford.edu)

Mark Z. Jacobson¹ (1-650-723-6836; jacobson@ce.stanford.edu)

¹Stanford University, Department of Civil and Environmental Engineering, Stanford, CA 94305-4020, United States

Field data gathered by ship and aircraft during leg 2 of the First Aerosol Characterization Experiment (ACE 1) were used to study clear-sky radiative closure over the remote Southern Ocean. Closure was evaluated by comparing observations with modeled values of: (i) aerosol light scattering coefficients in the marine boundary layer and free troposphere, (ii) total aerosol optical depth, and (iii) total solar radiation at the ocean surface. Point modeling using the ship data benefited from an existing study of closure on the ship, expanding the number of data points considered in that study from 22 to 887. Point and column modeling using the aircraft data provide the first such studies to date.

Aerosol light scattering coefficients were calculated from size-distributed measurements of aerosol chemical composition and number concentration, and were compared with observations at three wavelengths (450, 550, and 700 nm) on both ship and aircraft. Point closure on the ship could be achieved at all wavelengths for both total and hemispheric backscattering coefficients if the model accounted for experimental uncertainties in aerosol chemistry, nephelometer nonidealities, and the likely nonsphericity of dried sea salt aerosols. Point closure on the aircraft could be achieved at most wavelengths for total scattering coefficients, but could not be achieved at any wavelengths for hemispheric backscattering coefficients. Deviations between

predicted and observed backscattering coefficients on the aircraft were widely scattered rather than biased, indicating that a low signal to noise ratio in observed backscattering coefficients was the likely cause for lack of closure.

Aerosol optical depth and solar radiation at the ocean surface were calculated for the two days with clear-sky periods when the aircraft measured aerosol profiles near the ship. Input gas and meteorological data were the observed profiles of ozone, water vapor, temperature, and pressure from the surface to approximately 35 km, as well as total column ozone. Input aerosol data were the observed profiles of boundary layer and tropospheric aerosols from the surface to approximately 6 km, as well as stratospheric aerosol profiles estimated from observations made during the Stratospheric Aerosol and Gas Experiment (SAGE). Aerosol optical depths were very low (<0.1) on both days, resulting in large experimental uncertainties in observed depths and minimal impact of aerosols on total solar radiation at the surface. Column closure for aerosol optical depths could be achieved at all wavelengths (500, 778, and 862 nm) on both days when the model accounted for the spectrally-dependent contributions of stratospheric and free tropospheric aerosols. Uncertainty in modeled solar radiation at the ocean surface was dominated by the experimental uncertainty in column water vapor.

A21B-0077 0830h POSTER

Scattering characteristics of highly elongated particles

Hans A Eide¹ (heide@stevens-tech.edu)

Knut Stamnes¹ (kstamnes@stevens-tech.edu)

¹Stevens Institute of Technology, Department of Physics and Engineering Physics, Castle Point on Hudson, Hoboken, NJ 07030, United States

In studies involving radiative transfer in the atmosphere-ocean system one often encounters the difficult task of modeling the optical properties of ensembles of randomly oriented nonspherical particles. In many cases these particles have shapes that deviate significantly from that of a sphere, such as ice-crystals. If the particles are large compared to the wavelength of light one can use geometric optics, or ray-tracing techniques, for this purpose. Similarly, if the size of the particles are smaller than, or comparable to, the wavelength of the incident light other methods exist that can accurately model the single scattering properties of highly elongated particles. For particles with sizes comparable to the wavelength of the incident light few good methods are available for computing the optical properties of ensembles of randomly oriented particles. Still fewer methods exist for ensembles of particles with highly aspherical, or elongated shapes. Here we show results for the optical properties of such ensembles of highly elongated particles obtained using a rigorous approach to the single scattering problem for spheroidal particles. We use the Separation of variables Method (SVM) and exploit the fact that expansion of the eigenfunctions of the boundary value problem in the spheroidal coordinate system yields a numerically stable solution for spheroids with large aspect ratios. Ensemble averages are obtained through the traditional T-matrix which we obtain after a transformation of the solution as expressed in the spheroidal coordinate system to one expressed in the spherical system. We compare the optical properties of ensembles of highly elongated particles with those obtained for ensembles of spheres with an equal volume to surface area (V/A) ratio. This allows us to explore the usefulness of this approximate representation especially for the purpose of modeling energy transfer.

A21B-0078 0830h POSTER

Trace Gases and Aerosol Optical Properties Over the US Mid-Atlantic During Summer 2001

Bruce G Doddridge¹ (301-405-7628; bruce@atmos.umd.edu)

Charles A Piety¹ (301-405-7668; charles@atmos.umd.edu)

¹Department of Meteorology, University of Maryland, College Park, MD 20742, United States

Anthropogenic emissions from rapid urban sprawl, commuter/commercial traffic and industrialization along the East Coast of the United States have a profound effect on urban and regional air quality. During summer 2001 we used a light aircraft research platform operated from North Carolina northward through Pennsylvania measuring meteorological scalars, selected trace gases and aerosol optical properties on selected pollution episode days. The goal of this research is to gain an improved understanding of the sources, sinks, transport and photochemical transformations controlling the observed abundance of photochemical oxidants and fine particulate haze over the

U.S. Mid-Atlantic region. The aircraft research capabilities will be described, over 60 research flights totaling in excess of 160 flight hours summarized, and key findings presented. Although westerly transport of remnant ozone and haze along with precursors can make substantial contributions to observed urban corridor air quality aloft, significant production downwind of the urban center often can occur within the planetary boundary layer during the afternoon hours.

A21B-0079 0830h POSTER

Gas measurements on Western Pacific in Mirai MR01-K02 cruise

Shungo KATO¹ (81-3-5452-5144; shungo@atmchem.rcast.u-tokyo.ac.jp)

Jun Matsumoto¹ (81-3-5452-5144; mjun@atmchem.rcast.u-tokyo.ac.jp)

Yoshizumi Kajii¹ (81-3-5452-5141; kajii@atmchem.rcast.u-tokyo.ac.jp)

¹RCAST, The University of Tokyo, Komaba 4-6-1, Meguro-ku, Tokyo 1538904, Japan

The Japanese investigation ship, Mirai, cruised in the Western Pacific in May 2001. The cruise is a part of ACE-ASIA project. During the cruise, we measured atmospheric gas components on the ship. CO, O₃, NO, NO_x, SO₂ were measured continuously by commercial instruments, and 40 canisters were sampled for hydrocarbon measurements and were analyzed by GC-FID and GC-MS in the laboratory in Tokyo. Since the shipped area is located in the east of Japan main island, most of the air masses would be affected by the pollutants emitted in Japan. In May, the wind is mostly coming from the west, and long range transport of polluted air and aerosol would be observed.

After leaving the port near Tokyo, the concentrations of CO, O₃, SO₂, NO and NO_x decreased gradually as expected. NO and NO_x are sensitive to the influence of the exhaust emitted from the ship itself. SO₂ is also sensitive to the exhaust from the ship, but there are some small, and broad peaks which are not corresponding to the NO and NO_x peaks. The concentration of O₃ and hydrocarbons decreased drastically after the front passage. Westerly wind polluted in Japan was dominant in most case, but the clean maritime air came from east or south when low pressure passed. The backward trajectories explain the concentration changes of hydrocarbons well. When the air came quickly from Japan, high concentrations were observed. There are good correlation between O₃ and hydrocarbons.

A21B-0080 0830h POSTER

Twentieth Century Increase of Atmospheric Ammonia Recorded in Mt. Everest Ice Core

Shichang Kang¹ (207-581-2840; shichang.kang@maine.edu)

Paul A Mayewski¹ (paul.mayewski@maine.edu)

Yuping Yan¹ (yyan@maine.edu)

Dahe Qin²

¹Institute for Quaternary and Climate Studies, University of Maine, 303 Bryant Global Science Center, Orono, ME 04469, United States

²Cold and Arid Regions Environment and Engineering Research Institute, Chinese Academy of Sciences, 260 Donggang West Road, Lanzhou, GS 730000, China

An NH₄⁺ record covering the period AD1846-1997 was reconstructed using an 80.4 m ice core from East Rongbuk Glacier on Mt. Everest. Variations in NH₄⁺ are characterized by a dramatic increase since the 1950s. The highest NH₄⁺ concentrations occur in the 1980s. They are about two-fold more than those in the first half of 20th century. EOF analysis on the major ions series from this core indicate that NH₄⁺ has a unique source and/or transport pathway that differs with those of crustal species. Instrumental sea level pressure (SLP) and regional temperatures are used to explore the relationships between NH₄⁺ variations and atmospheric circulation and source strength over Asia. Higher NH₄⁺ concentrations are associated with an enhanced winter Mongolian High and a deepened summer Mongolian Low. A positive relationship exists between NH₄⁺ concentrations and regional temperature of the GIS Box 36 indicating that an increase in temperature may contribute to the strengthening of natural ammonia emissions (e.g. plants and soil). None of these variations of atmospheric circulation and natural sources can result the dramatic increase in NH₄⁺ concentrations since the 1950s. This increase should reflect to substantially strengthening of agricultural activities over Asia during the last few decades.

A21B-0081 0830h POSTER

Atmospheric Trace Species at Grand Canyon and Canyonlands National Parks: Preliminary Field Measurements From the Western States Visibility Assessment Program, July/August 2001

Randal S Martin¹ (435-797-1585; rmartin@cc.usu.edu)

Carl J Popp² (505-835-5159; flyfish@nmt.edu)

Oliver Wingenter² (505-835-6006; oliver@nmt.edu)

Suilou Huang³ (505-835-5993; suilou@nmt.edu)

¹Utah State University Department of Civil Environmental Engineering, Utah Water Research Laboratory 8200 Old Main Hill, Logan, UT 84322-8200, United States

²New Mexico Tech Dept. of Chemistry, 801 Leroy Place, Socorro, NM 87801, United States

³New Mexico Tech Dept. of Physics, 801 Leroy Place, Socorro, NM 87801, United States

In the western United States there is a growing concern about the increasing impairment of visibility in and around National Parks, National Monuments, wilderness areas, and other scenic attractions. Quantifying trace species associated with energy production and consumption is critical in understanding regional visibility impairment and modeling how present and future energy use patterns may influence visibility. The Western States Visibility Assessment Program (WSVAP) of the New Mexico Institute of Mining and Technology (NMT) was established to provide visibility assessment and associated trace species data to regional, state, and local policy makers, industry representatives, and other interested parties. The program's origins are found in prior DOE-sponsored research implemented by the Center for Applied Research in connection with the Grand Canyon Visibility Commission.

As a part of this program, a three-week field campaign was initiated in July and August of 2001 to monitor a suite of atmospheric trace species at the Hance site within Grand Canyon National Park in north-central Arizona and at the Island in the Sky District within Canyonlands National Park in southeast Utah. Gaseous trace species monitored at each site included oxides of nitrogen, carbon monoxide, sulfur dioxide, non-methane hydrocarbons, and low molecular weight aldehydes, ketones and organic acids. Additionally, total suspended particulate and PM_{2.5} samples were also collected, both of which are to be subsequently analyzed for speciated composition. Corresponding data simultaneously collected at or near the sampling sites by Park Service and other personnel included visibility quantification, ozone, meteorological parameters, separate speciated PM_{2.5} data (IMPROVE), and acidic species deposition (CASNET). The presentation will include initial analysis of the collected data and a brief discussion of future measurements, as well as planned modeling exercises.

A21B-0082 0830h POSTER

Trace Gas Measurements Along the Trans-Siberian Railroad: the TROICA Expeditions, 1995 - 2001

Eva Oberlander¹ (+49-6131-305452;

eao@mpch-mainz.mpg.de); Carl Brenninkmeijer¹ (+49-6131-305453; carlb@mpch-mainz.mpg.de);

Paul Crutzen¹ (+49-6131-305333;

air@mpch-mainz.mpg.de); Rolf Hofmann¹ (+49-6131-305429; rolfh@mpch-mainz.mpg.de);

Rupert Holzinger¹ (+49-6131-305464;

holzinger@mpch-mainz.mpg.de); Dieter Scharffe¹ (+49-6131-305423; scharffe@mpch-mainz.mpg.de);

Igor Belikov² (+7-095-9515387; sibb@transtrs.ru);

Nikolai Elansky² (+7-095-9533695;

Nikolai@Elansky.home.bio.msu.ru); George

Golitsyn² (+7-095-9511347;

golitsyn@atm.phys.msu.su); Dale Hurst³

(+1-303-4977003; Dale.Hurst@noaa.gov); Pavel

Romashkin³ (+1-303-4977003;

promashkin@cmdl.noaa.gov); James Elkins³

(+1-303-4976224; jelkins@cmdl.noaa.gov)

¹Max Planck Institute for Chemistry Max Planck Institute for Chemistry, P.O.Box 3060, Mainz 55020, Germany

²Institute of Atmospheric Physics, Pyzhevsky per. 3, Moscow 109017, Russian Federation

³NOAA/CMDL, 325 Broadway, Mail Stop R/CMDL1, Boulder, CO 80305-3328, United States

Observations of CH₄, CO, CO₂, O₃, NO_x, NMHC, 222Rn and standard meteorological parameters have been made along the Trans-Siberian railroad (48.5-58.5°N; 37.7-135.0°E), Russia. Over the period 1995 - 2001 seven expeditions during different seasons were

carried out, and boundary layer air data covering almost 113 000 km were obtained without significant contamination from the train. A secondary CH₄ maximum occurs in the annual cycle in summer: highly elevated levels of CH₄ were observed in late June - August over the West Siberian lowlands which generally decreased towards East Siberia, except for the far eastern region, where frequent biomass burning events were registered. The isotopic signatures of sampled CH₄ point to the wetlands as the dominant source of methane emissions, with some indications of natural gas release. Diurnal variations of ²²²Rn, CO₂ and CH₄ due to both micrometeorological conditions and varying soil and vegetation types, were used to estimate ecosystem fluxes of CO₂ and CH₄. Whilst background CO levels over the west Siberian wetlands were close to background values at mid-to-high northern latitudes, high CO concentrations, exceeding 1000 nmol/mol, were registered east of Chita, as a consequence of forest and other vegetation fires, which significantly affect the chemical composition of the air over Russia. O₃ also showed increases in East Siberia and the far eastern region: high night-time O₃ values during spring and summer coincided with CO concentration increases. Back-trajectory analyses suggest that boreal forest fires in far eastern Siberia had a significant impact on the observed CO and O₃ mixing ratios.

URL: <http://www.mpch-mainz.mpg.de/~dunker/Troica/index.htm>

A21C MC: 133 Tuesday 0830h

The Arctic Oscillation and the North Atlantic Oscillation: Definitions and Mechanisms (*joint with OS*)

Presiding: N Gillett, University of Oxford; J Perlwitz, NASA Goddard Institute for Space Studies

A21C-01 0840h

The Pacific Center of Action of the Northern Hemisphere Annular Mode: Real or Artifact?

John M. Wallace¹ ((206) 543-7390; wallace@atmos.washington.edu)

David W. J. Thompson² ((970) 491-3338; davet@horizon.atmos.colostate.edu)

¹Department of Atmospheric Sciences, University of Washington, University of Washington, Box 354235, Seattle, WA 98195

²Department of Atmospheric Science, Colorado State University, Colorado State University, Fort Collins, CO 80523

The leading empirical orthogonal function (EOF) of the sea-level pressure field, referred to as the Arctic Oscillation (AO) or Northern Hemisphere annular mode (NAM), consists of a dipole between the polar cap region and the surrounding zonal ring centered along 45°N. Embedded within the outer ring are centers of action over the Euro-Atlantic and Pacific sectors in which pressure fluctuates in phase. That the observed pressure fluctuations at these two centers of action are virtually uncorrelated in the observations raises the question of whether the Pacific center in the annular mode could be an artifact of EOF analysis. It is argued that sea-level pressure fluctuations at the Pacific and Euro-Atlantic centers of action of the AO/NAM would be more strongly correlated were it not for the coexistence of a second hemispheric mode in which geopotential height fluctuations over the North Atlantic and North Pacific vary out of phase. Evidence of the coexistence of such a pattern, whose signature in the 500-mb height field resembles an augmented of the Pacific/North American pattern, with a wave-train over the Euro-Atlantic sector is presented. The inter-sectoral linkages in the outer ring of the Southern Hemisphere annular mode are obscured by coexisting modes of variability in a similar manner, but to a lesser extent.

A21C-02 0900h

Significance of the Interannual Seesaw Between the Aleutian and Icelandic Lows in the Interannual Variability Over the Wintertime Northern Hemisphere

Meiji Honda¹ (81-45-778-5514; meiji@jamstec.go.jp)

Hisashi Nakamura^{1,2} (81-3-5841-4664; hisashi@eps.s.u-tokyo.ac.jp)

¹IGCR, Frontier Research System for Global Change, 3173-25 Showa-machi, Kanazawa-Ku, Yokohama 236-0001, Japan

²Dept. Earth and Planetary Science, University of Tokyo, 7-3-1 Hongo, Bunkyo-Ku, Tokyo 113-0033, Japan

The late-winter formation of an interannual seesaw between the surface Aleutian and Icelandic lows (AL and IL, respectively) is shown to significantly impact the covariance structure of the leading mode of the interannual variability in the geopotential height field over the extratropical Northern Hemisphere. The tropospheric leading mode for early winter (November-January) is characterized by a polar-midlatitude dipole over the Euro-Atlantic sector with a high degree of the annularity, coupled with the anomalous lower-stratospheric polar vortex. Over the North Pacific, no significant anomalies are associated with this mode. After the formation of the AL-IL seesaw, however, the dipole no longer dominates in the upper-tropospheric variability. The dipole signature is masked in late winter (February-April) by the predominant combined signature of the so-called Pacific/North American pattern and a meridional dipole over the Northwestern Atlantic as an upper-level manifestation of the seesaw. Though somewhat less pronounced, the leading mode of the near-surface variability is modified accordingly in late winter by the superposition of the distinct signature of the AL-IL seesaw. The annularity of the leading mode of the tropospheric variability is thus reduced in late winter particularly at the upper levels. Nevertheless, because of the particular geographical alignment between the anomalous AL and IL, their seesaw changes the zonal wind coherently between the two ocean basins, yielding a strong projection on the meridional plane whose latitudinal profile is almost indistinguishable from the counterpart of the Arctic-midlatitude dipole.

It is argued that what is called the Arctic Oscillation in some recent literature, defined as the leading mode of the sea-level pressure variability for the entire cold season, may be interpreted as a superposition of the AL-IL seesaw upon a dominant signal of the Arctic-midlatitude dipole. The corresponding leading mode for the upper troposphere primarily represents the variability associated with the seesaw. It is also argued that the late-winter tropospheric variability over the North Atlantic may not necessarily be associated with the Arctic-midlatitude dipole. The remote influence of the North Pacific variability accounts for as much as 30% to 50% of the variance in the vicinity of the IL for the data period considered.

A21C-03 0915h

Is the NAO Inseparable From the Arctic Oscillation?

Jeffrey C. Rogers (1-614-292-0148; rogers.21@osu.edu)

Ohio State University, Department of Geography 1036 Derby Hall, Columbus, OH 43210-1361, United States

A rotated principal component analysis (RPCA) is performed on cosine adjusted monthly gridded hemispheric sea level pressure anomalies over latitudes 40°N to 85°N and period 1946-1998. The monthly data are grouped into traditional seasons (DJF, MAM, JJA, SON) and a 12-month-averaged annual analysis is performed. The number of components retained for rotation never exceeds ten, the limit often used in similar analyses published using lower latitude datasets (e.g., Barnston and Livezey, 1987; Rogers, 1990). The methodology here contrasts that of the unrotated EOF analysis used in the original discovery of the AO. In each non-winter season the RPCA reveals the NAO to be the first component. The second component is centered only over the Arctic Ocean basin, and is here called the AO. This result is achieved in non-winter seasons with only 5-7 EOFs retained for rotation. In winter, rotation of as many as 10 components fails to separate the NAO from the AO, a result also obtained for an annually-stratified run. It will be suggested that the winter inseparability may be due to a shared storm track between the northern Atlantic and the Arctic, extending over the region between Iceland and the Barents Sea and eastward. Finally, Summer cyclonic activity over the Arctic Ocean basin is largely independent of the northern Atlantic, and a highly significant relationship is found between the AO phase and the direction of rotation (cyclonic, anticyclonic) of the Arctic Ocean.

A21C-04 0930h

Correlation between North Atlantic Oscillation and North Pacific Oscillation: Evidence for a Combined Mode

Benjamin F. Chao¹ (301-614-6104; chao@bowie.gsfc.nasa.gov)

Andrew Y. Au² (301-614-6114)

¹NASA Goddard Space Flight Center, Space Geodesy Branch, Greenbelt, MD 20771, United States

²Raytheon ITSS, and NASA Goddard Space Flight Center, Space Geodesy Branch, Greenbelt, MD 20771, United States

The geographical disparate NAO and NPO are found to be highly correlated in time: A temporal correlation coefficient of 0.43 is found between them with extremely high statistical significance. The NAO and NPO are here identified as the non-seasonal leading EOF/PC mode derived from the monthly surface pressure data provided by NCEP for 1958-2000. This overall correlation is analyzed in both time and frequency domains to reveal interesting behavior of the oscillations. The leading EOF/PC mode for the Northern Hemisphere (NH), identified as the NH Annular Mode (NAM), is also obtained. It bears strong resemblance to the amalgamation of NAO + NPO in the EOF pattern, and not surprisingly also highly correlated with both NAO (0.88) and NPO (0.76) in time. In particular, the decadal behavior of NAO and NPO closely follow each other, and with that of NAM, showing a long-term trend which had an abrupt change since around 1988. Based on the temporal correlations and the fact that NAM encompasses NAO and NPO geographically, we conclude that NAO and NPO are major partners constituting NAM. This strongly corroborates the notion put forth by Thompson and Wallace [1998; 2000].

Thompson, W.J., and J.M. Wallace, The Arctic Oscillation signature in the wintertime geopotential height and temperature fields, *Geophys. Res. Lett.*, 25, 1297-1300, 1998.

Thompson, W.J., and J.M. Wallace, Annular Modes in the Extratropical Circulation. Part I: Month-to-Month Variability, *J. Climate*, 13, 1000-1016, 2000.

A21C-05 0945h

The Cyclic Climate Regime of the Recent Past

Lionel Pandolfo¹ (604-822-1814; lionel@eos.ubc.ca)

Perry Sih² (perrysih@physics.ubc.ca)

¹Department of Earth and Ocean Sciences, University of British Columbia, 6270 University Blvd, Vancouver, BC V6T 1Z4, Canada

²Department of Physics and Astronomy, University of British Columbia, 6224 Agricultural Road, Vancouver, BC V6T 1Z1, Canada

We apply a variant of Non-linear Principal Component Analysis to atmospheric observations and simulations from a Global Climate Model. Analysis of tropospheric geopotential height fields for the Northern Hemisphere shows that climate variability in the extratropics during the second half of the twentieth century is due to the existence of 3 main weather regimes. These regimes are similar to those identified recently by various groups. We show that by introducing a fourth weather regime, it is possible to build a climate cycle for the recent past. We will describe this cyclic climate regime, its relation to stratospheric variability and its link to the Arctic Oscillation. We will also describe the structure of the cyclic regime present in climate simulations conducted with a Global Climate Model.

A21C-06 1000h

Calculating the Fastest Growing Modes of the Atmosphere by Empirical Means.

hugo m van den dool (301 763 8000 X7570; huug.vandendool@noaa.gov)

Climate Prediction Center, 5200 Auth Rd, Camp Springs, MD 20746

The study of instability and unstable modes has been instrumental in developing many parts of physics. In meteorology for instance, the theory of baroclinic instability is considered seminal. Usually instability calculations are based on manipulating the basic equations, such as they are known to us. Still many modes, such as the NAO, can not be readily related to theory. Here we follow an unbeaten track. We use a large data set (Reanalysis) of NH 500 mb daily data. We then breed growing modes by repeated application of the constructed analogue (CA) operator to an arbitrary (non-zero) initial state, while normalizing the resulting fields to avoid e-folding to either zero or infinity. It will be shown that CA converges to complex growing time varying modes with calculable e-folding time and period. The 1st mode consists of 2 space patterns (orthogonal); their associated time-series (a deformed sine - cosine pair) are orthogonal too. The interpretation of these modes for the real world may not be entirely straightforward, but we do note that a zero frequency NAO like feature appears as the 2nd mode. Given slow growth, should these modes play a big role? Do these modes explain appreciable variance in the observations? Among the technical issues: how to calculate mode n from the data set, given that n-1 modes are already known. How does the definition of the areal extent (US) impact these modes.