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Previous inversion studies indicate that Chinese anthropogenic emissions of CO are underestimated by current reporting. A 1(degree) x 1(degree) nested-grid capability has been implemented in the GEOS-CHEM global 3-D model of atmospheric chemistry and applied to Asia to better resolve the geographic distribution of CO sources. CO observations from (a) the TRACE-P aircraft mission over northwestern Pacific, and (b) two Chinese ground stations (in Hong Kong and Lin An) during spring 2001 are used in conjunction with an optimal estimation inverse model to improve estimates of Asian emissions of CO. A priori emissions are based on a detailed bottom-up inventory for the observation period. Error budgets for the ground-based and aircraft data are quantified separately. The inversion study indicates a 70% increase in anthropogenic CO emissions from eastern China (east of 110E, and south of 40N), distributed heterogeneously with the largest adjustments required in the south. A posteriori estimates of emissions from biomass burning in Southeast Asia are much lower than a priori values, consistent with conclusions reached in other TRACE-P studies. Integrating data from the ground-based stations with the aircraft results allows for better resolution of CO sources from three sub-regions in eastern China.

A52B-0799 1330h POSTER

Integrating MOPITT and Aircraft Observations to Estimate Asian CO Emission Sources

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Satellite and aircraft observations of trace species provide independent top-down constraints on emissions. The integration of these data sets in a formal inverse model framework requires careful characterization of their error covariances. Daily MOPITT satellite observations and CO data from the TRACE-P aircraft mission over the NW Pacific are applied here to the regional estimation of emissions from Asia for the spring of 2001. We use the GEOS-CHEM global 3-D model of atmospheric chemistry as the forward model. A priori estimates of Asian emissions are based on state-of-the-science gridded inventories for the observation period, including daily satellite fire count data to constrain biomass burning emissions. The derived a posteriori emissions are consistent with the observations, a priori constraints and their respective errors. We account for the model transport error using an innovative approach based on paired forecasts as well as differences between observations and forecasts. This method accounts for the daily spatial correlations of the errors. We examine the sensitivity of the a posteriori source estimates to the structure of the error covariance as well as the complementarity of the satellite and aircraft observations towards constraining the detailed structure of Asian CO sources.

A52C MCC: Level 2 Friday 1330h

Chemistry and Composition of the Troposphere II Posters *(joint with B, GC)*

Presiding: **A H Goldstein,** University of California**; P Novelli,** NOAA Climate Modeling and Diagnostics Laboratory

A52C-0800 1330h POSTER

Comparison of Measured and Modeled Ozone Profiles Above McMurdo Station, Antarctica, During August-October, 1992-2000

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Measurements are needed to understand the present state of the atmosphere while models are required to test our quantitative understanding of complex processes and for future predictions. These models must be validated and tested by detailed comparison with observations. Here, we compare more than 9 years of balloon-borne ozonesonde profile observations at 78°S with calculations from the SLIMCAT 3-dimensional chemical transport model (CTM). The CTM is forced by ECMWF meteorological analyses and has a detailed stratospheric chemistry scheme. Here the model is run on 18 isentropic levels with a horizontal resolution of 7.5°. While SLIMCAT performs well in reproducing total column ozone values as well as the general trends of spring-season ozone depletion in both the Northern and Southern hemispheres, a detailed comparison with austral polar measurements has not been completed. Here, at the vertical resolution of SLIMCAT, we compare modeled and measured ozone mixing ratios (OMR) between 12 and 30km (potential temperatures of ∼330-1000K) over McMurdo Station, Antarctica from 1992 to 2000 in the period of late August to late October. A one-to-one comparison of OMR at the SLIMCAT levels covered by the measurements gives a linear relationship where SLIMCAT OMR = 0.82(Measured OMR)+ 0.54 with R^2 = 0.83. A slope <1 and positive y-intercept correspond to an overestimation of OMR by SLIMCAT, especially in the region of most active ozone destruction (∼12-20km). The overestimation by SLIMCAT is more evident after mid-September of each year during the period of high ozone depletion. The percent differences between the model and measurements through the austral spring seasons range from -50 to 450% in the active region, and are between -50 and 50% above this region (∼20-30km). Some of this discrepancy is related to the extent of ClO activation in SLIMCAT. Preliminary analyses suggest that SLIMCAT is underestimating ClO and thereby overestimating ozone at the altitudes of greatest ozone loss.

A52C-0801 1330h POSTER

NAO signature in tropospheric ozone: data and model analysis

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This study focuses on the NAO signature in the interannual variability of tropospheric ozone, with an emphasis on spring ozone in the northern latitudes of the American and European continents. The analysis is performed on ozonesonde data. It is shown that the variability in NAO significantly modulates the tropospheric ozone with a correlation of ?0.57 in the lower troposphere over North America. Finally, using model results, it is shown that the NAO signal is global in nature.

A52C-0802 1330h POSTER

The Solar Cycle Variation of Ozone and Other Chemical Species in the Stratosphere Simulated With a 3-D Chemistry-Climate Model

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Photochemical reactions in the atmosphere are induced by ultraviolet (UV) radiation from the sun. Radiation from the sun shows an 11-year oscillation, in which total irradiance changes are relatively small. But more than 10 % irradiance changes occur in ultraviolet (UV) radiation. The photochemical reactions, therefore, are influenced by the solar cycle variation. The response of the stratospheric ozone particularly could have an impact on Earth's climate. We have analyzed the results of a three-dimensional chemistry-climate model of the Meteorological Research Institute (MRI) in order to evaluate the sensitivity of ozone and other chemical species in the stratosphere to the solar cycle variation. The dynamical module of the model is based on an atmospheric general circulation model (AGCM), which is developed by MRI and the Japan Meteorological Agency (JMA). The chemical module includes 49 chemical species, 34 photolysis reactions, 79 gas phase reactions, 5 heterogeneous reactions on polar stratospheric clouds (PSCs), and 2 heterogeneous reactions on sulfate aerosols. Chemical species are transported with semi-Lagrangian scheme.

A52C-0803 1330h POSTER

Effect of the Horizontal Resolution of General Circulation Model on the Ozone Distribution Simulated by Chemical Transport Model

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Effect of the horizontal resolution of winds and temperature used in the transport of chemical species are investigated with a 3-D chemical transport model of Meteorological Research Institute, MJ98-CTM. The vertical resolution is fixed to be 45 layers extending from the surface to 0.01 hPa (about 80 km), while the horizontal resolution of GCM module is varied. Control run uses T21 resolution both for GCM and CTM modules, and experiment run uses T42 resolution for GCM module. T21 and T42 resolutions correspond to 300 km and 600 km grid sizes, respectively. GCM module is a full primitive spectral model, which includes major physical processes. CTM module treats 34 long-lived species including 7 families, and 15 short-lived species with 79 gas phase reactions, 34 photochemical reactions and 9 heterogeneous reactions on polar stratospheric clouds and sulfate aerosols. Transport scheme is a flux form semi-Lagrangian type in the vertical and, at once, a simple semi-Lagrangian type in the horizontal with cubic interpolation. Greenhouse gases are not treated interactively, i.e., CTM-simulated ozone, methane and nitrous oxide are not used in the radiation scheme in GCM module. Climatological values of sea surface temperature and greenhouse gases for GCM module are used and so do those of tropospheric-origin species for CTM module. Time integration is made for five years and the control run of T21-GCM coupled with T21-CTM (T21-T21) and the experiment run (T42-T21) are compared for the simulated fields of chemical species, focusing on ozone. Since the increase in GCM horizontal resolution does not necessarily improve simulated fields of winds and temperature, similar experiment is also made with the nudging force toward observed winds and temperature.

A52C-0804 1330h POSTER

Trajectory Assisted Analysis of Long-Term Ozonesonde Data Over N. America: A Comparison With Europe and East Asia

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Changes in tropospheric ozone over one continent are controlled by photochemistry and meteorology within that continent and also by long-range transport from other continents. Knowledge of background ozone concentration over individual continent plays an important role in such studies. Therefore it is important to establish a suitable and versatile methodology, which could estimate the changes in background ozone at one continent and also estimate the contribution of regional pollutions from other continents. In this direction, we had successfully analyzed long-term ozonesonde data from Europe (Hohenpeissenberg, and Payerne) and Japan (Sapporo, Tateno, Kagoshima, and Naha) using residence time and sectoral classification, which were deduced from backward isentropic trajectories. Here, we present recently analyzed ozonesonde data from Boulder (40.0N, 105.0W, 1689m), Wallops (38.0N, 75.5W, 13m) and Hilo (19.7N, 155.1E, 11m) for the boundary layer (BL) and lower troposphere (LT). We have classified two types of ozone namely, regionally polluted ozone and background ozone. Regionally polluted ozone shows similar seasonal variation over Wallops and Boulder with maximum ozone in late spring and early summer. Background ozone levels in USA boundary layer are estimated to be lesser (by 10 ppbv), when compared with regionally polluted ozone levels over USA. Surprisingly, background (pacific air-mass) ozone levels over Hilo, USA are higher than the ozone levels for similar type of air-masses over Japanese sites. Unlike over Europe, ozone levels over USA do not show very significant correlation with residence time of air-masses. Long-term changes in regionally polluted ozone over Wallops and Boulder are nearly similar and appear to show some consistency with NOx emissions over USA. More results will be discussed during presentation.

A52C-0805 1330h POSTER

EFFECT OF THE ANTARCTIC OZONE HOLE ON SOUTHERN HEMISPHERE MIDLATITUDES.

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A three-dimensional chemical transport model driven by assimilated winds is used to isolate the effects of the Antarctic ozone hole (AOH) on southern hemisphere midlatitudes. The model incorporates chemistry using parameterized production and loss rates as obtained from a two-dimensional photochemical model. Simulations with and without polar stratospheric cloud (PSC) chemistry, one of the processes responsible for the AOH, are performed for the years 1997-2000. Specific low ozone events in the midlatitudes are analyzed to determine the contribution of PSC chemistry. The effect of Antarctic ozone depletion on midlatitude ozone trends is also examined along with a discussion of the role of interannual variability.

A52C-0806 1330h POSTER

HISTORICAL ANALYSIS AND CHARATERIZATION OF GROUND LEVEL OZONE FOR CANADA AND UNITED STATE

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Ground-level ozone has long been recognized as an important health and ecosystem-related air quality concern in Canada and the United States. In this work we seek to understand the characteristics of ground level ozone conditions for Canada and United States to support the Ozone Annex under the Canada-U.S. Air Quality Agreement. Our analyses are based upon the data collected by Canadian National Air Pollution Surveillance (NAPS, the NAPS database has also been expanded to include U.S. EPA ground level ozone data) network. Historical ozone data from 1974 to 2002 at a total of 538 stations (253 Canadian stations and 285 U.S. stations) were statistically analyzed using several methodologies including the Canada Wide Standard (CWS). A more detailed analysis including hourly, daily, monthly, seasonally and yearly ozone concentration distributions and trends was undertaken for 54 stations.

A52C-0807 1330h POSTER

Evaluation of WRF Model Against Satellite and Field Measurements During ARM March 2000 IOP

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Meso-scale WRF model is employed to simulate the organization of clouds related with the cyclogenesis occurred during March 1-4, 2000 over ARM SGP CART site. Qualitative comparisons of simulated clouds with GOES8 satellite images show that the WRF model can capture the main features of clouds related with the cyclogenesis. The simulated precipitation patterns also match the Radar reflectivity images well. Further evaluation of the simulated features on GCM grid-scale is conducted against ARM field measurements. The evaluation shows that the evolutions of the simulated state fields such as temperature and moisture, the simulated wind fields and the derived large-scale temperature and moisture tendencies closely follow the observed patterns. These results encourages us to use meso-scale WRF model as a tool to verify the performance of GCMs in simulating cloud feedback processes related with the frontal clouds such that we can test and validate the current cloud parameterizations in climate models, and make possible improvements to different components of current cloud parameterizations in GCMs.

A52C-0808 1330h POSTER

A Comparison of the Forecast Skills among Three Numerical Models

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Three numerical weather forecast models, MM5, COAMPS and WRF, operating with a joint effort of NOAA HU-NCAS and Jackson State University (JSU) during summer 2003 have been chosen to study their forecast skills against observations. The models forecast over the same region with the same initialization, boundary condition, forecast length and spatial resolution. AVN global dataset have been ingested as initial conditions. Grib resolution of 27 km is chosen to represent the current mesoscale model. The forecasts with the length of 36h are performed to output the result with 12h interval. The key parameters used to evaluate the forecast skill include 12h accumulated precipitation, sea level pressure, wind, surface temperature and dew point. Precipitation is evaluated statistically using conventional skill scores, Threat Score (TS) and Bias Score (BS), for different threshold values based on 12h rainfall observations whereas other statistical methods such as Mean Error (ME), Mean Absolute Error(MAE) and Root Mean Square Error (RMSE) are applied to other forecast parameters.

A52C-0809 1330h POSTER

A numerical expariment of a topographic effect to Arctic oscillation by using barotropic global circulation model

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We have developed a barotropic global circulation model to investigate physical and dynamical features of Arctic Oscillation (AO). We first tried to reproduce the observed AO pattern using this model. External forcing of the model is calcurated from the matrix obtained from the past 50-year observation data by using a liner regression. So the model is referred to as "Barotropic S-Model". After running this model for 50 years under the perpetual January condition, we applied the empirical orthogonal function analysis to examine the dominant modes in the model atmosphere. As a result, we obtained an AO-like variaton in terms of both spatial pattern and time spectrum. We examined how the external forcing in our model redistributed the energy of each zonal wavenumber. It is found that a part of the steady compornent of the statistical forcing transports the energy of zonal flow to planatary waves. We considered this compornent as topographical effects. Then, to clearfy the topographical effct upon the AO, we conducted numerical experiments in which the topographical compornents are gradually reduced. According to the result, the AO-like annular structure is modified to a di-pole structure with zonal wavenumber 1 as the topographic effect decreases. When the topographic effect is further decleased, the most dominant mode becomes an annular structure again. It seems that the axisymmetric annular structure with the weak topographic effect is different from the AO in the control run. The result suggests that the AO in the Arctic and Antarctic Osciillation (AAO) in the Antarctic can be dynamically different modes.

A52C-0810 1330h POSTER

Regional Numerical Modeling Study of the East Asia Dust Storms

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An on-line PRM-Dust model has developed to study the dust storms in the East Asia region by incorporating a dust module with a prognostic mesoscale meteorological model, the Purdue Regional Model (PRM). The dust module consists of emissions, dry and wet deposition, and optical depth calculation. The dust emission model applied herein is based on the dust emission source function proposed by Ginoux (2001). This coupled atmosphere-dust model calculates meteorological processes, dust emission, and dust transport simultaneously. Furthermore, the resultant optical depths due to these mineral dusts are included in the radiation module such that their radiative effects on the regional weather can be considered. The PRM-Dust has been implemented to simulated April 8-24,1998 East Asia dust storms. The meteorological fields generated form the PRM control run has shown great consistency with ECMWF reanalysis data, especially the wind fields. It has shown that the PRM successfully simulates the transport patterns and mineral dust source regions of April 1998 East Asia dust storms as those have shown from satellite observations. This research demonstrated the attempt to utilize the Purdue Regional Model (PRM) to integrate with the dust emission module to perform on-line dust storm simulations, as well as to consider the radiative feedback and climate impacts on the regional scale.

A52C-0811 1330h POSTER

The Sensitivity of Atmospheric Trajectory Cluster Analysis Results to Clustering Methods Using Trajectories to the PICO-NARE Station

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The use of cluster analysis to group atmospheric trajectories according to similar flow paths has become a common tool in atmospheric studies. Many methods are available to conduct a cluster analysis. However, the dependence of the resulting clusters upon the specific clustering method chosen has not been fully characterized. Specifically, the use of hierarchical versus non-hierarchical clustering algorithms has received little focus. This study presents the results of two cluster analyses: one using the hierarchical clustering algorithm average linkage, and one using the non-hierarchical clustering algorithm k-means. These results demonstrate the sensitivity of this cluster analysis to the use of a hierarchical method versus a non-hierarchical method. In addition, this study analyzes methods for dealing with the vertical component of trajectories during the clustering process. The analyses were performed using a 40-year set of trajectories to the PICO-NARE station, located atop Pico Mountain in the Azores Islands in the central North Atlantic.

A52C-0812 1330h POSTER

Operational regional air quality forecast over the U.S.

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A regional chemistry and transport modeling system is used to provide 48-hour forecast of the concentrations of ozone and its precursors over the United States. Meteorological forecast is conducted using the NCAR/Penn State MM5 model. The regional chemistry and transport model simulates the sources, transport, chemistry, and deposition of 24 chemical tracers. The lateral and upper boundary conditions of trace gas concentrations are specified using the monthly mean output from the global GEOS-CHEM model. The daily forecasting products are available online at http://apollo.eas.gatech.edu/forecast.html. Interesting episodes during the fall-winter transition of 2003 will be discussed.

URL: http://apollo.eas.gatech.edu/forecast.html

A52C-0813 1330h POSTER

Atmospheric CO2 Trapped In Siple Dome Ice Cores Over The Last 40 Thousand Years

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We have measured the CO2 content of air occluded in the Siple Dome ice core, Antarctica, formed over the last 40 thousand years. The general time series of Siple Dome CO2 follow temperature and support the other Antarctic ice CO2 records including the recent EPICA Dome C record of the last Termination. However, the Siple Dome CO2 concentrations of the last Termination and the Holocene are at certain times higher than in other Antarctic ice cores by up to 20 ppm. The processes for the excess CO2 of Siple Dome are not clear.

A52C-0814 1330h POSTER

Robust$CO2$ Flux and $CO2$ Concentration Measurements in a Mid-Latitude Wetlands Environment

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Wetlands (both coastal and inland) have been identified as significant sinks of carbon and are estimated to store as much as 40 % of the global terrestrial carbon, although they cover only about 3-4 % of the world's land area. Thus they play an important role in the global carbon cycle and are sensitive indicators of climate change. While the sequestration and release of carbon from wetland areas to the atmosphere are controlled by complicated biogeochemical processes, the measurement of CO2 fluxes in wetland environments can provide valuable information on global carbon dynamics. The development of instrument systems capable of accurately measuring the biosphere/atmosphere exchange of CO2 is very important to achieving an understanding of this process. Laboratory experiments have been conducted to evaluate the overall performance of the LICOR- 7000 IRGA for flux measurements and to improve the resulting flux system signal-to-noise ratio. Since perturbations in relative humidity can affect the infrared absorption of CO2, the effect of water vapor mixing ratios ranging from 100 to 30,000 ppmv on predetermined CO2 concentrations were tested. The differences of measured CO2 concentration with a predetermined CO2 concentration between lowest and highest water vapor mixing ratios in the sample flow after it passed the dryer were less than 0.1 ppmv. The CO2 instrumentation and supporting meteorological equipment was subsequently mounted on a tower situated in a local marsh to initiate flux measurements and the results of these observations will be presented. The resulting simultaneous, high precision, fast-response CO2 flux and concentration measurement capability will contribute to elucidating the effects of recent global environmental change on wetland ecosystems and to reducing the uncertainty in our understanding of global carbon cycle.

A52C-0815 1330h POSTER

Measurements of CO2 Mixing Ratio in and above PBL over the Forest Area in Western Siberia

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To understand the difference in CO2 variation between planetary boundary layer (PBL) and free troposphere (FT) quantitatively, we conducted CO2 measurements in high frequency using a small aircraft and a tower at the forest area in western Siberia. Continuous CO2 measurement system was installed near the radio communication tower (90 m height) located in Berezorechka village (56N, 84E) in October 2001. Small CO2 measurement device based on single-cell NDIR (LI-COR, LI-800) equipped with pressure regulation system was developed and installed in a small aircraft, An-2. Two standard gases are introduced into NDIR every 5 minutes. The aircraft ascend to 2 km above Berezorechka tower and then descend to 0.15 km to get the vertical profile of CO2. The aircraft measurement has been conducted every 1-3 weeks since February 2002. 34 vertical CO2 profiles were obtained in 2002. The height of afternoon PBL was 0.2-0.9 km in winter and 0.5-2 km in summer. The CO2 mixing ratio in PBL was 10 ppm lower in summer and 2-3 ppm higher in winter compared to that in FT aloft. The peak-to-peak amplitude of seasonal CO2 variation in PBL was 35 ppm and that in FT was 19ppm. The phase in seasonal variation is slightly earlier in PBL. The lowermost aircraft data are compared with tower data obtained in the afternoon. Both data agree well in winter. In summer lower CO2 values in the scatter of tower measurements are similar to aircraft data.

A52C-0816 1330h POSTER

Diurnal Variation in CO2 Profile in the Lower Troposphere above a West Siberian Forest

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Diurnal variation of atmospheric carbon dioxide (CO2) concentration in lower troposphere (from 150 to 2000 m) was measured above Berezorechka village in west Siberia (56°;N, 85°E) over considerably homogeneous and flat forest area using aircraft. Measurements were performed every two hours from 6:00 to 20:00 on July 18, 19, 23 and 26, 2002. In the morning, nocturnal boundary layer (NBL) height was approximately 200 m and higher CO2 was observed in this layer. On July 18, convective boundary layer (CBL) height had been kept almost constant during the day around 1700 m. On July 19, the CBL height decreased from 1200 m in the morning to 800 m in the evening due to warm front passing through this region. On July 23, CBL was developed from the morning and grew to a height of 1300 m in late afternoon. On July 26, CBL was difficult to determine because CO2 within the measurement layer was largely scattered caused by advection of different air mass. In general, CO2 within the CBL was homogeneous and decreased during the daytime, which implied that CO2 uptake existed at the surface. This was clearly shown in July 23. On the contrary, increasing of CO2 was observed on July 19 and 26, due to the advection of higher CO2 air mass. CO2 within the CBL also correlated with the CO2 above the CBL through entrainment exchange. The result of 5 days back trajectory analysis showed that the higher CO2 air mass generally came from the higher altitude. The lower CO2 air mass was traced the lower altitude, which indicated that the air mass was much affected by surface CO2 uptake.

A52C-0817 1330h POSTER

Seasonal Change Of CO2 Flux At Tundra Vegetation In Interior Alaska

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CO2 flux and micrometeorology have been measured to reveal the responses of forest at permafrost to climate change since October in 2002. The vegetation was black spruce and tussock tundra located in the campus (147°51'W, 64°51N) of the University of Alaska Fairbanks, Alaska. There have been significant gaps of flux measurements in the interior Alaska where it is generally warmer in summer and has different climate conditions. CO2 uptake started in March when the tussock tundra was still under snow cover. CO2 uptake increased after spring thaw in mid April that ranged -0.3mg/m2/s and increased gradually until early May (DOY135). After that, daily maximum CO2 uptake kept almost upper-limit level of -1mg/m2/s during summer (June and July). Day-length was longer at the site so the nighttime CO2 respiration was defined as CO2 efflux when PAR was less than 10 mol/m2/s. Averages of CO2 respiration were 0.042mg/m2/s in mid April (DOY100-109), 0.021mg/m2/s in mid May (DOY130-139), 0.15mg/m2/s in mid June (DOY160-169), and 0.15mg/m2/s in mid July (DOY190-199), respectively. Air temperature in mid summer did not changed remarkably and daily average temperature in June and July were almost the same as between 10 and 20. These were caused by lower solar radiation and higher level of precipitation in 2003 summer than the normal year. Observed CO2 flux was limited period and the CO2 budget over tussock tundra in interior Alaska was a source from spring to summer in 2003. Long term CO2 budget study is demanded to reveal whether anthropogenic or natural variation is major effect on climate change, thus it is important to continue the flux measurements and to reveal the relationships between the atmosphere and the vegetation.

A52C-0818 1330h POSTER

On the Relation Between Atmospheric Carbonyl Sulfide and Carbon Dioxide

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Measurements of carbonyl sulfide (COS) at ground-based sampling stations show large seasonal variations that are strongly related to those observed for carbon dioxide. Specifically, the relative magnitude of seasonal decreases observed for COS during spring and early summer at seven Northern Hemispheric (NH) sites are strongly correlated (r^2=0.97) to those observed for CO_2. The seven sites at which COS measurements were made since 2000 include coastal sites in the arctic (Barrow, 71N, and Alert, 82N), mid-latitudes (Trinidad Head, 41N), and on Hawaii (Kumukahi, 20N), continental U.S. sites (Wisconsin, 46N, and Harvard Forest, 43N), and high altitude sites (Mauna Loa, 20N, and Niwot Ridge 40N). This correlation most likely arises because a major loss process for both CO_2 and COS is reaction with carbonic anhydrase in photosynthesizing plants. But whereas CO_2 is respired by vegetation and other organisms, COS is not similarly produced. This important point may help explain why the spring-summer relative drawn-down observed for COS is about eight times larger than that for CO_2 at these NH sites. Given our understanding of interactions between trace gases and vegetation, the observations suggest that COS measurements could provide constraints on our understanding of CO_2 uptake by plants independent of the influence of respiration. Sources and non-vegetative sinks of COS are also considered; constraints to their influence on COS seasonality in the Northern Hemisphere may possibly be derived, for example, from measurements at Southern Hemispheric sites.

A52C-0819 1330h POSTER

Use of Sulphur and Boron Isotopes to Identify Natural Gas Processing Emissions Sources

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Natural gas processing results in the emission of large amounts of gaseous pollutants as a result of planned and / or emergency flaring, sulphur incineration, and in the course of normal operation. Since many gas plants often contribute to the same air shed, it is not possible to conclusively determine the sources, amounts, and characteristics of pollution from a particular processing facility using traditional methods. However, sulphur isotopes have proven useful in the apportionment of sources of atmospheric sulphate (Norman et al., 1999), and boron isotopes have been shown to be of use in tracing coal contamination through groundwater (Davidson and Bassett, 1993). In this study, both sulphur and boron isotopes have been measured at source, receptor, and control sites, and, if emissions prove to be sufficiently distinct isotopically, they will be used to identify and apportion emissions downwind. Sulphur is present in natural gas as hydrogen sulphide (H_2S), which is combusted to sulphur dioxide (SO_2) prior to its release to the atmosphere, while boron is present both in hydrocarbon deposits as well as in any water used in the process. Little is known about the isotopic abundance variations of boron in hydrocarbon reservoirs, but Krouse (1991) has shown that the sulphur isotope composition of H_2S in reservoirs varies according to both the concentration and the method of formation of H_2S. As a result, gas plants processing gas from different reservoirs are expected to produce emissions with unique isotopic compositions. Samples were collected using a high-volume air sampler placed directly downwind of several gas plants, as well as at a receptor site and a control site. Aerosol sulphate and boron were collected on quartz fibre filters, while SO_2 was collected on potassium hydroxide-impregnated cellulose filters. Solid sulphur samples were taken from those plants that process sulphur in order to compare the isotopic composition with atmospheric measurements. A method was developed to extract and concentrate boron for isotope analysis. Isotopic composition and concentrations of both sulphur and boron were measured in order to determine whether emissions have distinct sulphur and/or boron isotopic compositions. Preliminary results of SO_2 and solid sulphur analysis show values that range from +3 to +30 $^o/_{oo}$.

A52C-0820 1330h POSTER

Seasonal Variability of 34S in Precipitation from two Urban Sites of Korea

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We measured the seasonal variations of 34S, together with major ions and naturally occurring 210Pb, 210Po, and 7Be in snow and rainwater samples from urban areas. Precipitation samples were collected from metropolitan city, Seoul and large port city, Busan, Korea, for one year from June 2002 to June 2003. The δ34S values of sulfate in precipitation ranged from -4.3$^o/_{oo}$ to +6.6$^o/_{oo}$ (mean: 3.72$^o/_{oo}$) and +1.0$^o/_{oo}$ to +18.6$^o/_{oo}$ (mean: 5.55$^o/_{oo}$) in Seoul and Busan, respectively. These δ34S values suggest that sulfate in Seoul precipitation originates more from anthropogenic sources relative to that in Busan. The elevated anthropogenic sources in Seoul might be influenced by industrial activities from surrounding industrial cities, while the scatter of δ34S values in Busan may be influenced by marine air. As such, Seoul and Busan showed significant differences in chemical compositions and naturally occurring radionuclides, such as 210Pb, 210Bi, and 7Be. In both areas, δ34S values are high in fall and low in spring, which indicates that δ34S values of spring time are affected by biogenic sources compared to those of other seasons.

A52C-0821 1330h POSTER

Measurement of Atmospheric Carbon Dioxide on Tower in Berezorechka, West Siberian Forest Region

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Atmospheric CO2 concentration is observed in the lower troposphere over the west Siberian forest region around Berezorechka village (56.17N, 84.33E) since October 2001 to reveal CO2 variation in and over planetary boundary layer (PBL). Ground based measurement is conducted using a tower with its height about 90m, and lower tropospheric observation is done between 100-2000m height every 1-3 weeks using aircraft. The tall tower stood in forest with its canopy height of 10-15m and four air intakes are attached at about 80, 40, 20 and 5 m height of the tower. The pressurized air by a diaphragm pump is dehumidified and introduced into analyzer (Li-Cor : LI-7000) at constant flow rate (35 ml min-1). Sample air at each height is introduced into analyzer for six minutes and last one minute signal is used for calculation. The CO2 concentration is determined against three CO2-in-air standard gases based on the National Institute for Environmental Studies (NIES) standard gas scale. The feature of this system is to employ on-site compressed air as both reference gas for analyzer and sub-standard gas. Ambient air compressed into 48L cylinder up to about 0.5MPa is kept for about ten days and then used for the reference and sub-standard gas. Analysis of all four heights sample air and sub-standard gas is done every 30 minutes except twice a day when three standard gases are analyzed. Total precision is estimated to be 0.3ppm. The observed CO2 concentration generally shows diurnal variation with low value in daytime, increase from evening till early morning and decrease till evening. The amplitude of diurnal variation is large in summer and small in late winter. The CO2 diurnal variation is different day by day even in a same season and well correlated with temperature profile variation. Clear inversion layer is observed in calm and/or clear sky night, and the concentration increases from ground surface to higher height accompanied with inversion layer growth. Larger vertical CO2 difference in July than in February at night suggests that CO2 release from land biosphere is also larger in July than in February. On a day when inversion layer is not observed, CO2 variation at each height is similar to each other, and its difference is in 5ppmv. These CO2 temporal and vertical variations are resulted from covariance of biospheric activity, photosynthesis and variation of inversion layer.

A52D MCC: 3018 Friday 1340h

Ocean/Atmosphere Modeling II *(joint with OS, NG)*

Presiding: **A Wallcraft,** Naval Research Laboratory**; L P Davis,** DOD High Performance Computing Modernization Program

A52D-01 1340h INVITED

High-Resolution Global Ocean and Ocean/Ice Models for Synoptic and Climate Prediction

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Realistic high-resolution ocean and ice components of a future global coupled air/ocean/ice model are being developed, tested, run, and evaluated for use in future synoptic and climate prediction systems. The ocean model is the Parallel Ocean Program (POP); it is configured on a displaced North Pole grid to allow the inclusion of the Arctic, it has a horizontal spacing of 0.1^o at the equator and 40 vertical levels, and has an active mixed layer. It is forced with synoptic surface forcing whenever possible. Quantitative evaluations of the two-decade simulation will be presented with particular focus on the mean characteristics of the general circulation and comparisons of the surface variability from data sets with global or near-global coverage such as satellite altimeters and surface drifting buoys. Model biases will be addressed along with efforts to improve unrealistic aspects of the simulation. The inclusion of a dynamic/thermodynamic ice model, such as the Los Alamos National Laboratory CICE model, will improve the realism of the ocean model. Towards this end we are testing a global coupled POP/CICE model at eddy-permitting resolution in the first instance. CICE fields will be compared with satellite data and available observations.

URL: http://www.oc.nps.navy.mil/navypop

A52D-02 1410h

Predictability Experiments With the Navy Operational Global Atmospheric Prediction System

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There are several areas of research in numerical weather prediction and atmospheric predictability, such as targeted observations and ensemble perturbation generation, where it is desirable to combine information about the uncertainty of the initial state with information about potential rapid perturbation growth. Singular vectors (SVs) provide a framework to accomplish this task in a mathematically rigorous and computationally feasible manner. In this study, SVs are calculated using the tangent and adjoint models of the Navy Operational Global Atmospheric Prediction System (NOGAPS). The analysis error variance information produced by the NRL Atmospheric Variational Data Assimilation System is used as the initial-time SV norm. These VAR SVs are compared to SVs for which total energy is both the initial and final time norms (TE SVs). The incorporation of analysis error variance information has a significant impact on the structure and location of the SVs. This in turn has a significant impact on targeted observing applications. The utility and implications of such experiments in assessing the analysis error variance estimates will be explored. Computing support has been provided by the Department of Defense High Performance Computing Center