the mean oxygen-isotope composition of the ocean, the ice-sheet model is coupled to an ocean box model. The only forcing is high-latitude northern hemisphere summer insolation. Experiments are performed for (1) an isothermal ice sheet and (2) varying ice temperature. The snow-δ^{18}O parameterization considers the depletion in ^{18}O of precipitation with altitude. Snapshots of the modeled δ^{18}O distribution in the ice sheet at different moments during the last glacial-interglacial cycle are presented. Furthermore the model output is compared to sea-level reconstructions from corals as well as to foraminiferal δ^{18}O. Upon glacial inception, the simulated mean ocean δ^{18}O changes faster than ice volume, but then the ice volume is found to lead the mean ocean δ^{18}O throughout the rest of the glacial cycle (including the termination) by up to 6 kyr. The significance of this result is discussed with respect to the phase relationships between ice volume inferred from foraminiferal δ^{18}O, insolation and the atmospheric carbon dioxide concentration.

A41C CC: 520 D Thursday 0830h

Tropospheric Chemistry and Dynamics Using Data From Measurement of Pollution in the Troposphere (MOPITT) Experiment I

Presiding: **J R Drummond,** University of Toronto**; J C Gille,** National Center for Atmospheric Research

A41C-01 0830h

Measurements Of Pollution In The Troposphere (MOPITT): Past, Present and Future

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The MOPITT instrument has now been in orbit for over four years. A nearly continuous dataset has been accumulated from the instrument over that time. The first part of this talk will quickly review the history and status of this dataset and highlight some of the strengths and weaknesses. The applications of these data are similarly diverse and some examples will be highlighted although other papers in the session will provide more details. As the MOPITT measurements become more mature and experience in using them grows, the range of science applications also grows. This not only points to an increase in the potential science, but also permits a more detailed analysis of the potential for future missions. A successor instrument is being studied and a number of scientific and instrumental improvements are being considered. These instrumental include (among others) changes in the spectral passbands, the spatial resolution, and the revisit time. These in turn change the potential science. The second part of this talk will discuss the possibilities for such an instrument and how this might expand the range of scientific applications.

A41C-02 0845h INVITED

Observations of Carbon Monoxide and Aerosol From the Terra Satellite: Northern Hemisphere Variability

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Measurements from the Terra satellite launched in December of 1999 now provide a global record of the recent inter-annual variability of tropospheric air quality: carbon monoxide (CO) from the Measurement Of Pollution In The Troposphere (MOPITT) instrument, and of aerosol optical depth (AOD) from the Moderate-resolution Imaging Spectroradiometer (MODIS). This paper compares and contrasts these data sets with a view to understanding the general features of the overall pollutant loading of the Northern Hemisphere (NH). We present a detailed examination of the seasonal and recent inter-annual variability of the fine mode AOD and CO column, first considering the variation of the global zonal average for both quantities, and then concentrating on several geographical regions with the aim of isolating different emissions. This is accompanied by a discussion of the various sources and sinks of CO and of the aerosol types that contribute to the fine mode AOD. In a zonal sense, the principal NH sources are related to anthropogenic urban and industrial activity. We show that both the CO loading and the AOD zonal seasonal variations reflect the atmospheric oxidant loading which determines the primary sink of CO and the production of sulfate aerosol. As a consequence, the seasonal cycles are several months out of phase, with perturbations resulting from wildfire or biomass burning emissions. In these cases, carbonaceous particles define the AOD, and this results in the best correlation with the CO column. The MODIS AOD measurement is more sensitive to the boundary layer than the MOPITT CO measurement, thus making it the more reliable indicator of wildfire and biomass burning locations. Conversely, the MOPITT CO measurement is more useful for tracing long-range transport of fire emissions. The two measurements are therefore complimentary in building up the overall picture of plume evolution. Of the four years of data available from the Terra satellite, the Winter and Spring of 2002/2003 showed anomalously high NH pollutant loadings compared to the previous years. This was a result of fires in western Russia in the late Summer and Fall of 2002, and intense fires in the southeast of Russia in the Spring of 2003. We examine these events using fire counts from MODIS to indicate the burning regions, and investigate how the timing of the fires in relation to atmospheric oxidant concentrations affects the resultant seasonal pollutant loadings. Finally, we trace the emissions from these fires to indicate how intense local pollution sources can impact continental and global scale air quality.

A41C-03 0900h INVITED

CO as a Precursor of Ozone and a Tracer of Transport: Evidence from MOPITT Data

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Carbon Monoxide(CO) retrievals from MOPITT are used to explore two facets of CO in the troposphere, namely its role as a precursor of ozone in the biomass burning areas of the southern tropics and as a tracer of transport phenomena. The correlation with ozone is studied at 6 ozonesonde stations: Reunion, Irene, Natal, Ascension, San Cristobal and Paramaribo. Three year climatologies (March 2000-March 2003) of CO indicate distinct seasonal patterns at each station. All stations show enhanced CO levels during September-November period reflecting the austral burning with additional signatures of burning in Northern Africa and Northern Amazonia at some stations. The aerosol optical depths retrieved contemporaneously from MODIS show generally similar variations as CO with some notable anomalies. Tropospheric ozone from the sondes shows a generally good correlation with CO at most stations, but shows several instances of ozone enhancements uncorrelated to CO. This might help delineate the reasons for ozone variations in the southern tropics. At San Cristobal strong CO enhancements during March-April are not accompanied by any significant change in ozone. The potential of MOPITT CO measurements as tracers of convection and stratosphere-troposphere exchange (STE) events is also examined. The problem of limited vertical resolution of MOPITT retrievals is alleviated to a certain extent by the large number of profiles at any place. Case studies showing signatures of convection and STE in the MOPITT CO data will be presented.

A41C-04 0915h

Trans-Pacific Transport of CO Derived From MOPITT Observations and Data Assimilation

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The Measurements Of Pollution In The Troposphere (MOPITT) instrument on the EOS Terra Spacecraft has obtained data from which the vertical distribution and total columns of CO have been obtained on a global basis since March 2000. These data have been assimilated using the MOZART model, combined with the source strengths inferred by Petrone et al. This results in daily, global data from which studies of transport can be made. Here we present results detailing the transports from January-May, the months of maximum transport from Asia across the Pacific toward North America. The agreement between original measurements and the assimilation results shows that the original accuracy is retained, but missing areas are filled in to provide a more complete picture. The mix of sources from biomass burning in SE Asia and industrial regions in China and elsewhere is displayed. The magnitude of the derived transports are shown as cross-sections at several longitudes, indicating the expected movement toward higher latitude and altitude as the air moves eastward. These are compared with trajectory analyses, which show the fates of some of the plumes. Comparing 3 years of data gives an idea of the size of inter-annual variations.

A41C-05 0930h

Tracking of Pollution Plumes Using MOPITT Measurements

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The measurements performed by the MOPITT remote sensor onboard TERRA provide global scale information on the CO distribution for a period of 4 years. When studying the CO budget over a specific geographic area, one has to take into account different sources, including biomass burning and industrial emissions, to understand the CO concentration as measured by the instrument. This work investigates the possibility of detecting pollution plumes directly emitted above major cities using the MOPITT data. A selection of the more qualitatively reliable retrieved L2 data was performed. We have chosen several locations, both over polluted cities (e.g. LA, Mexico City, Beijing) and over remote areas (Jungfraujoch Alpine station), to analyse the time-evolving CO concentrations as measured by MOPITT and to compare these data with local measurements, and with regional CTM model simulations.

A41C-06 0945h

Using MOPITT Data to Improve Temporal Profiles of Boreal Forest Fire Emissions

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Broad-scale modeling of how terrestrial sources affect the atmospheric trace gas composition has largely been limited to coarse-resolution analyses of background air. In the case of boreal forest fires, emissions are extremely localized in space and time, and aggregating to coarse spatial resolutions and monthly time scales results in a great loss of information for atmospheric studies. Emissions estimates in the literature have largely relied on three different methods for estimating temporal profiles of fire activity: reported data from fire management agencies, satellite detections of thermal hot spots, and satellite measurements of aerosol optical depth. We used MOPITT data together with a highly resolved emissions model and the Goddard/UM CTM to compare these methods. We found that while the biases of using reported data are more or less as expected due to delays in reporting, the inaccuracies of the other methods are more complex, and more difficult to account for. We found that while hot spot based methods generally perform better than aerosol-based methods at fine temporal scales, these methods are can be complementary in certain cases.

A42A CC: 520 D Thursday 1030h

Tropospheric Chemistry and Dynamics Using Data From Measurement of Pollution in the Troposphere (MOPITT) Experiment II

Presiding: **J R Drummond,** University of Toronto**; J C Gille,** National Center for Atmospheric Research

A42A-01 1030h INVITED

Simulating CO Concentrations over Europe: Evaluation and Budget Study

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CO in an indicator for the transport of pollutants in the troposphere on a global and regional scale. The first global and vertically resolved measurements of atmospheric CO have been provided by the Measurements Of Pollution In The Troposphere (MOPITT) remote-sensing instrument on board the Terra satellite. MOPITT CO data from the first year of operation (March 2000 to March 2001) have been employed in an inversion scheme to optimize the CO surface emissions in the global chemistry transport model MOZART-2. For evaluating the simulations we compare the modeled CO fields with MOPITT data, and also with independent aircraft and ground-based in-situ measurements of CO. The comparison indicates that (1) the agreement typically improves by using the optimized emissions, and (2) the model concentrations represent the background conditions and large scale transport over Europe relatively well, and, therefore, are suited for the budget studies we conducted. To diagnose the contributions of different processes and source regions on the CO load over Europe we tagged the CO molecules in the model according to the emission type and the source region. The results of this analysis indicate to which extent expected source changes might impact the European CO field.

A42A-02 1045h

Seasonal and Geographic Trends in Performance of MOPITT CO Profile Retrievals

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Retrievals of carbon monoxide (CO) tropospheric profiles by the MOPITT (Measurements of Pollution in the Troposphere) satellite instrument rely primarily on measurements of thermal infrared radiation in a band near 4.7 microns. With respect to information content (and vertical resolution), the performance of the MOPITT CO retrieval algorithm depends on the surface temperature and atmospheric temperature profile. Seasonal and geographical variability of these geophysical parameters imposes corresponding variability on the performance of the MOPITT retrieval algorithm. For example, weak thermal contrast in polar regions (associated with low surface temperatures and weak thermal gradients in the troposphere) produces retrievals which are typically weighted by a priori information more heavily than in tropical regions. In this study, retrieval information content is quantified by Degrees of Freedom for Signal (DFS), which is calculable from the retrieval averaging kernel matrix. Both seasonal and geographic trends in DFS will be presented.

A42A-03 1100h

Measurements of CO Tropospheric Burden From the Ground and From a Satellite: Error Analysis

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Spectroscopic measurements in 2002 and 2003 at Zvenigorod (located in 60 km from Moscow, Russia) reveal abnormally high CO total column amounts comparing to other years. Especially high, even record, CO column amounts were observed in September 2002. A comparison to other sites in the northern hemisphere allows one to treat this event as a regional pollution connected with strong peat fires around Moscow. CO surface layer concentrations measured in Moscow city were also unusually high. Increased CO column amounts at the same region were detected by the MOPITT/Terra instrument as well; however, the absolute values were much less, then those measured by the ground-based spectrometer. CO anomalies (i.e., the deviations from the "normal" monthly means, determined as averages over 2000- 2001) were also different for the MOPITT and for the spectrometer. An underestimation of the CO boundary layer contribution in the total column that is inherent to the MOPITT methodology may explain this difference. The ground-based network of the spectroscopic stations is free of this error, but it is very sparse and almost lacking in the source regions. The report focuses on estimating an error in the hemispheric CO burden (total CO mass in the troposphere) measured using the existing ground-based and satellite-based instruments.

A42A-04 1115h

Assimilation of MOPITT observations using GEM-AQ

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The Meteorological Service of Canada is developing a Chemical Weather Prediction and Monitoring system based on the operational meteorological model GEM coupled online with a tropospheric chemical model used for air quality prediction ; GEM-AQ. The assimilation is conducting using a 3D Var scheme with the addition a bias correction scheme to estimate systematic errors due to misspecifications of the chemical sources. The bias correction scheme is at variance with the proposed scheme by Dee and daSilva (1998) as it contains explicit cross-covariance error statistics. Issues about observability of chemical sources and the use of innovation error covariance statistics to adjust covariance parameters will be discussed in detail.

A42A-05 1130h

Implications of Spatial and Temporal Sampling on CO and Aerosol Fields Retrieved From Satellite-Borne Sensors

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Carbon monoxide, mineral dust and carbonaceous aerosols are central to many problems in the atmospheric sciences, ranging from atmospheric chemistry and air pollution to climate change. It is critical to understand the sources and transport of CO and aerosols if their diverse impacts are to be reliably predicted. Satellite remote sensing offers a unique tool to address these issues, by providing information on the spatial and temporal distribution of CO and aerosols on regional and global scales. This study presents the results of our ongoing work towards finding and exploiting synergy between CO and aerosols retrieved from multi-satellite, multi-sensor data. The goals have been to 1) investigate whether the collocated CO and aerosol optical depth fields retrieved from satellites can provide additional constraints on sources, lifetime and transport routes of these species, and 2) to determine how the correlation between retrieved CO and aerosol fields are influenced by the spatial and temporal sampling, and the inherent spatial averaging that occurs, as provided by satellite remote sensing instruments. Collocated fields of CO derived from MOPITT measurements and aerosol optical depth (from MODIS and TOMS), were analyzed for several recent biomass burning events and Asian and Saharan dust outbreaks. The results of correlation analysis will be presented and implications for data assimilation by chemical transport model will be addressed.