

The Soufriere Hills Volcano is located on the southern half of the Caribbean island of Montserrat. Montserrat is situated in the northern part of the Lesser Antilles, which is a volcanic island arc formed along the junction of the Atlantic tectonic plate and the Caribbean plate. An eruption of the Soufriere Hills Volcano began in 1995. Periods of small to moderate sized explosions followed. On July 12, 2003, a lava-dome of the volcano collapsed and led to several days of explosions that rocked the island and injected ash into the atmosphere. The aim of the work presented herein is to elucidate the transport mechanism of the volcanic ash from the island of Montserrat to the south-western coast of Puerto Rico and its impact on regional aerosol distributions.

A43A-06 1330h POSTER

The Role of Aerosols in Drizzle Formation

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In October of 2003 seven research flights were carried out over the North Atlantic as a part of the Surface Ocean Lower Atmosphere Study (SOLAS). Each flight followed a similar pattern: a vertical profile through the cloud, sampling above, within and below a stratocumulus cloud layer, as well as 500 feet above the ocean surface. Aerosol size distributions were measured using a TSI-APS (Aerosol Particle Sizer - 0.3-20 micron diameter), a TSI-SMPS (Scanning Mobility Particle Sampler - 10-300 nm), a PMS-PCASP (Passive Cavity Aerosol Spectrometer Probe - 0.15-3 microns) and a PMS-FSSP (Forward Scattering Spectrometer Probe 2-40 microns). Aerosol chemistry was measured using the Aerodyne Aerosol Mass Spectrometer (AMS) and the Particle In Liquid Sampler (PILS). Cloud and precipitation microphysics quantities were measured with a variety of instruments mounted under the wings of the aircraft, including the FSSP that is also used for measuring the size distribution of the cloud droplets. There were also two cloud radars on board. Initial results indicate that the aerosol mass in the boundary layer air feeding the stratocumulus decks was dominated by sulphate and sea salt. Above the boundary layer, the air was found to be extremely clean. Drizzle was present in almost all of the clouds, despite most being relatively thin. The size spectra of aerosols and cloud droplets will be used in conjunction with the precipitation data and aerosol chemistry data to study the role of sea salt aerosols in drizzle formation.

A43B CC: 220 C-E Thursday 1330h

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

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

A43B-01 1330h POSTER

Global Distributions of Carbon Monoxide Total Column: A Statistical Analysis from MOPITT Data

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Measurements of Pollution In The Troposphere (MOPITT) on board NASA Terra satellite is a sensor developed for measuring carbon monoxide (CO) from space. The CO measurements made by MOPITT have greatly enhanced our understanding of temporal and spatial distributions of CO in the atmosphere and the mechanisms governing the distributions. In this study, the global CO data are statistically analyzed in terms of CO total column variations with time, latitude, longitude, and altitude. This statistics provides a new and comprehensive overview of global CO distributions in a quantitative way. The information is useful not only to atmospheric science community but also to other disciplines and public, owing to the importance of CO as a major pollutant, a precursor of ozone, and its effects on many atmospheric chemical processes. The CO data have illustrated the combined effects of natural and anthropogenic factors on the CO distributions in the atmosphere. The preliminary results from the analysis are highlighted as follows: (1) The mean CO of the northern hemisphere usually reaches its maximum in April-May, mainly because of low atmospheric oxidation capacity at the time. The maximum CO of the southern hemisphere often appears in October-November due to large fire events. As a result, seasonal variation of global mean CO generally shows two peaks at a level up to 2.0 1018 molecules/cm², in April-May and October-November. (2) As land is a source of CO and the fraction of land increases with latitude, global annual mean CO total column increase with latitude from 1.0 1018 molecules/cm² in the south pole to 2.1 1018 molecules/cm² at 0°, then staying around that level up to the north pole. When looking at CO over land only, a peak of 2.3 1018 between -10°S and 10°N and a trough at 34°N can be found. The former results from vegetation fires in the tropics and the latter is due to the Plateau of Tibet. The CO averaged over oceans increases from the south pole to 50°N and then decreases slightly along latitude. The trend of CO with latitude is similar to that for CO₂. (3) Along longitude circles, global annual mean CO fluctuates from 1.6 to 1.9 1018 molecules/cm², a variation smaller than that across latitudes. The fluctuation is larger over land than that over oceans. (4) Considering both latitude and time, the rate of CO increase with latitude is the smallest in June/July (0.006 1018 molecules/cm² per degree between ±60°) and the largest in April/May (one time bigger than that for June/July). The amplitude of seasonal variation of CO is low in the southern hemisphere at 45°S and 5°S (0.4 1018 molecules/cm² per year). In the northern hemisphere, the amplitude is 0.6 1018 molecules/cm² per year with a small change with latitude. (5) CO total column generally decreases with altitude because of the reduction of air mass. In terms of the global annual mean, CO total column declines at a lapse rate of 0.3 1018 molecules/cm² per kilometer. (6) With a series of daily global mean CO from 2000 to 2004, a short-time trend of 0.025 1018 molecules/cm² per year is found. A long-term trend can be established if MOPITT continues on orbit for a longer period and other space-borne instrument shall be available to replace MOPITT when it is not operating.

A43B-02 1330h POSTER

MOPITT Observation of Large Horizontal Gradients of CO at the Synoptic Scale

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Carbon monoxide (CO) generated from incomplete combustion of fossil fuel is one of the major pollutants in the atmosphere. The MOPITT (Measurements Of Pollution In The Troposphere) instrument, on board the Terra satellite is now measuring this atmospheric gas from space for the first time. With the MOPITT CO data, a phenomenon of large horizontal gradients of CO at the synoptic scale was observed. The horizontal concentration of CO varied rapidly by 50-100% in 100 km across a noticeable boundary. This phenomenon lasted one to several days and spanned horizontally 500 -1000 km, appearing at almost all heights of CO retrievals from 850 mb to 250 mb. In comparison with

the corresponding NCEP/NCAR Reanalysis meteorological data, we found that over land this phenomenon often correlates with a shift in the vertical wind direction on the two sides of the boundary. The boundary is mostly aligned with the transition between downward and upward airflows, with ascending air motion correlating with high CO on one side and descending motion with low CO on the other side. The shift in the vertical wind direction is usually associated with synoptic weather processes, such as frontal systems. Over oceans, the phenomenon appears to be related to horizontal wind shear. In addition to case studies, we will also discuss the significance of these new findings in understanding the mechanisms of air pollutant transport and modeling of their spatial distribution patterns.

A43B-03 1330h POSTER

MOPITT Data and Tools Available from the Atmospheric Sciences Data Center

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The Measurements Of Pollution In The Troposphere (MOPITT) data products are archived and distributed by the Atmospheric Sciences Data Center (ASDC) at NASA's Langley Research Center. Available MOPITT data products include Level 1 radiances and Level 2 derived carbon monoxide. The ASDC also provides access to tools that aid in the visualization and analysis of the MOPITT Level 2 data products. The MOPITT L2 Viewer software package plots images from the MOPITT Level 2 data files. Sample read software extracts data from a MOPITT Level 2 HDF-EOS formatted file and outputs the data in ASCII. The software also allows subsetting by latitude and longitude. Detailed information about the MOPITT data products, tools and documentation are available from the ASDC web site, <http://eosweb.larc.nasa.gov>.

URL: <http://eosweb.larc.nasa.gov>

A43B-04 1330h POSTER

Airborne Measurements of CO by MOPITT-A

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MOPITT (Measurements of Pollution In The Troposphere) is a carbon monoxide and methane remote sounder launched in 1999 on the Terra spacecraft. An aircraft version of MOPITT (MOPITT-A) has been developed at the University of Toronto to perform validation of MOPITT radiances as well as small scale pollution studies. MOPITT-A is based on the engineering model of MOPITT, modified for flight in NASA's ER-2 research aircraft. In August and September 2000, it participated in the SAFARI 2000 field campaign in South Africa, monitoring CO emissions from biomass burning. This talk will describe the method used to retrieve carbon monoxide concentrations from longwave channel radiances. Special attention will be paid to the September 7th 2000 mission, the highlight of which was the overflight of a large prescribed fire in the vicinity of the Kruger National Park. MOPITT-A is financed by the Canadian Space Agency and the Natural Sciences and Engineering Research Council.

URL: <http://www.atmos.physics.utoronto.ca>

A43B-05 1330h POSTER

Estimate of Global Carbon Monoxide Budget Derived From MOPITT Data

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Carbon monoxide influences the oxidizing capacity of the troposphere as the major sink of OH radicals. Thus it is very important to have an accurate estimate of the CO budget of the atmosphere. CO is measured from a variety of platforms. Surface concentrations are measured on a regular basis at a number of stations worldwide and other measurements are made by commercial aircraft, and satellites. On the basis of these measurements the general features of global CO distribution have been established and it is well known, that CO concentrations are higher in the northern hemisphere than in the southern hemisphere. However, another important source of CO is biomass burning, much of which takes place in the southern tropics. In particular the seasonal biomass burning in Africa and South America injects large plumes of CO into the atmosphere which in turn affect tropospheric ozone concentrations. Another very significant emission source is Indonesia, where land-use conversion projects among other reasons have resulted in large biomass burning in recent years. In this work, we used total atmospheric column measurements of carbon monoxide (CO) from the MOPITT (Measurement of Pollution in the Troposphere) instrument to study the CO burden of the atmosphere. The global budget of CO has been estimated from the satellite measurements for the first time. The total emission of CO is estimated to be 1900-2230 Tg/year which is near the lower end of the previous estimates from models and climate change assessment reports. We assumed the reaction with OH to be the primary sink of CO and neglected all others including surface deposition. This sink is estimated to be 1890-2185 Tg, which is also within the range estimated previously. In addition we calculated CO emissions from a biomass burning event in August-November, 2002 in Indonesia. The emitted CO amount was estimated to be about 66 Tg, which is about half of the estimated emission from the 1997 Indonesian fires.

A43B-06 1330h POSTER

Validation of Four Years of MOPITT CO Retrievals with Independent Measurements

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Validation of the MOPITT retrievals of carbon monoxide (CO) has been performed with a varied set of correlative data. These include in situ observations from a regular program of aircraft observations at five sites ranging from the Arctic to the tropical South Pacific Ocean. These correlative measurements are a crucial component of the validation of the retrieved CO

profiles and columns from MOPITT. The current validation results indicate good quantitative agreement between MOPITT and in situ profiles, with an average bias less than 20 ppbv at all levels. The temporal stability of the validation results will be shown using comparisons with the aircraft in situ samples, as well as surface measurements and ground-based spectroscopic measurements.

A43B-07 1330h POSTER

Total Columns and Vertical Profiles of Carbon Monoxide Measured Over Toronto Using a Ground-Based Fourier Transform InfraRed (FTIR) Spectrometer: Comparisons With Measurements of Pollution in the Troposphere (MOPITT) Data (Jan 2002 - Sep 2003)

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A high-resolution Fourier Transform InfraRed (FTIR) spectrometer is the primary instrument at the University of Toronto Atmospheric Observatory (TAO), established in 2001. Continuous measurements of solar absorption spectra using narrow band optical filters began in October 2001 for the purpose of building a long-term data set of key species related to climate change and mid-latitude atmospheric chemistry, and for the validation of satellite instruments. Measurements have greater temporal coverage in the summer and fall months due to favourable weather conditions. Total columns and low-resolution vertical profiles of carbon monoxide have been derived from the high-resolution (0.004 cm^{-1}) solar absorption spectra recorded at TAO using lines in the (1-0) transition region near $4.7 \mu\text{m}$. Microwindows were chosen to approximately match Measurements of Pollution in the Troposphere (MOPITT) averaging kernels and spectra were analyzed using the SPIT-2 optimal estimation method retrieval algorithm (developed at NASA Langley Research Centre, USA, and National Institute for Water and Atmospheric Research (NIWA), New Zealand.) Monochromatic transmittances were calculated in the forward model assuming a Voigt line shape and using the HITRAN 2000+ spectral database, NCEP temperature and pressure profiles as well as volume mixing ratio a priori information for CO and interfering species. The averaging kernels of both observation platforms have been considered in the analysis. Comparisons between ground-based solar absorption FTIR and MOPITT total columns and vertical profiles will be presented.

A43B-08 1330h POSTER

Estimates of Time-dependent CO Sources Inferred From Global MOPITT CO Measurements

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Global measurements of CO from MOPITT offer an opportunity to greatly enhance our present knowledge of tropospheric chemistry, particularly in terms of better constraining the temporal and spatial variability of CO sources. We will present here results derived from time-dependent synthesis inversions of regional and sectoral sources of CO using MOPITT CO measurements. Estimates of monthly CO emissions for the first year of operation of MOPITT will be shown. We highlight in particular the differences between recent top-down and bottom-up estimates of Asian sources as well as variations in the seasonal distribution of large-scale biomass burning sources. In addition, we compare time-dependent and time-independent inversion estimates of CO sources.

A43C CC: 520 D Thursday 1330h

Ice Cores: Contributions to Climate Variability and Dynamics II (joint with B, OS, C, GC, PP)

Presiding: E J Steig, University of Washington; J W White, University of Colorado

A43C-01 1330h

The Mount Logan (Yukon) Ice Cores: Preliminary Results

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Three ice cores were taken at different elevations on or near My Logan in the years 2001 and 2002. The summit core (PRCol) comes from the summit plateau (5340 masl, length 187 m to bedrock, mean temperature -29 C) and was done by the Geological Survey of Canada. The NIPR core cored 210m on the flanks of the mountain at King Col (4200 masl mean temperature -16C) and the UNH group cored 20 km from the mountain at Eclipse "Dome" (3015 masl, length 345 m mean temperature -5C). The three cores were done cooperatively by GSC, NIPR and UNH and cover nominally 30 ka, 1 ka and 2ka respectively. Located very close to the Gulf of Alaska these core records are thought to reflect the climate history of the Pacific Ocean and having three widely spaced elevations, the sites "see" different distances to different sources. The lowest site (Eclipse) has excellent seasonals but a very muted $\delta^{18}\text{O}$ history with no obvious little ice age, whereas the most recent 1ka of the PRCol summit sites contains two very large and sudden $\delta^{18}\text{O}$ and d (deuterium excess) shifts at 1850 AD and 800 AD. The $\delta^{18}\text{O}$ shifts which happen from one year to the next are about 4 o/oo. The summit site (PRCol) $\delta^{18}\text{O}$ response is "backwards", i.e. the Little Ice Age $\delta^{18}\text{O}$ values are 4 o/oo more positive than recent ones. The PRCol $\delta^{18}\text{O}$ and d suggest that the source water can either be local (Gulf of Alaska) or very distant (tropics). The Eclipse site seems only to get the local water. A massive dust storm originating in central Asia (Gobi) in April 2001 dumped a visible layer all over the St Elias Mountains and this layer was sampled, to provide a calibration "Asian dust event". The satellite and isotopic signatures both agreed that Gobi was the source. The PRCol record covers the Holocene and well back into the ice age. The transition is defined by a sudden ECM shift on the flanks of a more gradual O18 shift. Acknowledgements. Logan consortium consists of: Geological Survey of Canada: Jocelyne Bourgeois, Mike Demuth, David Fisher, Roy Koerner, Chris Zdanowicz, James Zheng. University of Ottawa: Ian Clarke, Raphaelle Cardyn. National Institute of Polar Research (Japan): Kumiko Goto-Azuma. University of New Hampshire: Cam Wake, Kaplan Yalcin. University of Maine: Karl Kreutz, Paul Mayewski, Erich Osterberg. Arctic Institute of North America: Gerald Holdsworth. University of Washington: Eric J. Steig, Summer B. Rupper. University of Copenhagen: Dorte Dahl-Jensen. David Fisher is the presenter but many contributed to what is a joint preliminary offering.

A43C-02 1345h INVITED

Why Drill More than One Ice Core? Paleoclimate Reconstruction along a Vertical Transect in the Saint Elias Mountains

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The Arctic represents one of the key regions on Earth in our efforts to document and understand global change. The St. Elias mountain range in the southwestern Yukon Territory has recently been the focus of