

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, Raphaëlle 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

an international ice core research. The broad elevational extent of snow accumulation zones in this region (ranging from 2500 to 5300 m asl) allows for the detailed investigation of environmental change extending from the planetary boundary layer through to the free troposphere via the collection and analysis of ice cores from different elevations. Multi-parameter, high resolution glaciochemical records are currently available from the Northwest Col on Mt. Logan (5340 m asl, 103 m deep; 270 year record;) and from three cores recovered from the Eclipse Icefield (3107 m asl) in 1996 (160 m deep; 100 year record) and in 2002 (345 m and 140 m deep). Snow accumulation rates at Eclipse are about 5 times larger than the summit average of 0.30 m water equivalent. Despite their close proximity, the climate signals recorded on the summit of Mt. Logan also differ from those at Eclipse. For example, while the Mt. Logan record shows no increase in sulfate or nitrate deposition over the past 100 years, all three Eclipse cores shows a clear increase in nitrate and sulfate deposition beginning in the late 1940s due to an increase in anthropogenic emissions in Eurasia during this time period. Over the last century, the sulfate time-series from Eclipse records from 32 discrete volcanic events, primarily from Alaskan, Aleutian, or Kamchatkan eruptions, while the summit site only records 8 volcanic events. The Eclipse summer $\delta^{18}O$ record displays a significant positive relationship with summer temperatures at both coastal and interior Alaskan sites, while the Mt. Logan $\delta^{18}O$ time-series does not correlate well with instrumental temperature records or most circum-Arctic paleoclimate records. Conversely, the summit ice core accumulation time-series strongly correlates with instrumental precipitation records from Japan and with indices of the El Niño-Southern Oscillation on both interannual and interdecadal time scales suggesting the summit records are uniquely situated for studies of global teleconnection patterns. Our results to date indicate that the two sites sample different air masses and that boundary layer dynamics play an important role in the glaciochemical signals preserved at each location. The Northwest Col and Eclipse records, in conjunction with analysis of new ice cores already recovered from Prospector-Russell Col (5300 m; 187 m; circa 35,000 years) by the Geological Survey of Canada and King Col (4135 m asl; 220 m deep; circa 2,000 year record) on the Logan Massif by the National Institute for Polar Research (Japan) offers an unprecedented opportunity for paleoclimate reconstruction along a vertical transect in the St. Elias Mountains and should provide a rich and multi-layered contribution to our understanding boundary layer dynamics and Holocene environmental change in the region.

A43C-03 1400h

The Relationship Between Snow Accumulation at Mt. Logan, Yukon, and Climate Variability in the North Pacific

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An ice core from Mt. Logan, Yukon, presents an opportunity to evaluate the degree to which ice core accumulation records can be interpreted as meaningful measures of interannual climate variability. Statistical analyses and comparisons with synoptic station data are used to identify the physical relationships between Mt. Logan ice core accumulation data and large scale atmospheric circulation. These analyses demonstrate that only the winters of high accumulation years have a robust connection with atmospheric circulation. There are no consistent relationships during anomalously low and average accumulation years. The wintertime of high accumulation years is associated with an enhanced trough-ridge structure at 500 hPa and in sea level pressure over the Northeast Pacific and Western Canada, consistent with increased southerly flow bringing in warmer, moister air to the region. While both storm (i.e. 2-6 days) and blocking (i.e. 15-20 days) events project onto the same climate pattern, only the big storm events give rise to the dynamical moisture convergence necessary for anomalously high accumulation. Taken together these results suggest that while the Mt. Logan accumulation record is not a simple record of Pacific climate variability, anomalously high accumulation years are a reliable indicator of wintertime circulation and, in particular, of Northeast Pacific storms.

A43C-04 1415h

North Pacific Volcanism in Three Ice Cores from Eclipse Icefield, Yukon Territory, Canada

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Prior work has demonstrated that a record of regionally significant volcanic eruptions in the North Pacific is available from Eclipse Icefield, Yukon Territory, Canada. The acquisition of two new cores from Eclipse Icefield during the 2002 field season allows us to extend the record of volcanism by at least five hundred years and assess the variability in volcanic signal preservation using the three ice core records now available from Eclipse Icefield. Non-sea-salt sulfate residuals above a robust spline and empirical orthogonal function (EOF) analysis were used to identify volcanic sulfate signatures. These signals were then matched to the historical record of volcanism to identify eruptions in the Eclipse ice core. At least ten of these identifications have been independently verified by means of tephrochronology, including, for the first time, recovery of tephra from the unknown 1809 eruption seen in both Greenland and Antarctic ice core records. The largest eruptions, such as Katmai 1912 (VEI 6) and Ksudach 1907 (VEI 5), as well as some moderate-sized eruptions (i.e., Redoubt 1989; VEI 3), are consistently recorded in each of the available cores. Meanwhile, other moderate to large eruptions, such as Bezymanny 1956 (VEI 5), are not recorded in any of the cores. Anthropogenic sulfate deposition at Eclipse since about 1950 appears to mask signals from large tropical eruptions such as Pinatubo (1991) and El Chichon (1982), while older tropical eruptions prior to the period of anthropogenic sulfate deposition such as Krakatau (1883), Tambora (1815), and the unknown 1809 eruption are clearly recorded at Eclipse Icefield.

A43C-05 1430h

EPICA DOME C : A 800 ky DEUTERIUM TEMPERATURE RECORD

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The two cores drilled at the Dome C site in East Antarctica (elevation 3233 m, mean annual temperature, -54.5°C) in the frame of the European Program for Ice Coring in Antarctica, now provide a continuous deuterium profile covering the last 800 ky back to marine stage. Measurements have been performed on 55 cm samples with a precision of either ± 0.5 or ± 1.5 per mill depending of the part of the record considered. We will focus on describing the characteristics of this record, dated by inverse modelling, both in the time and frequency domains. Specific time periods such as termination V and the very bottom part of the core as well as comparison with marine and continental records covering the same time span, will be discussed.

A43C-06 1445h INVITED

Deuterium Excess in ice Cores: a Tricky Tracer of Past Global Environmental Changes

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Several deuterium excess histories from ice cores at different locations and timescales are shown in this presentation. We point out that deuterium excess is an integrated isotopic parameter, so a wealth of climate information, but in return difficult to interpret. First, at glacial-interglacial timescale, we compare Vostok deuterium excess history with the new Dome Fuji record. We discuss the possibility to reconstruct past changes both in site and source locations with the combination of deuterium excess and deuterium. In this framework, we discuss the recent comparisons done between source temperature (or deuterium excess) and a single-site SST and give some important caveats against such a comparison. Second, we compare different deuterium excess histories over the last glacial period both in Antarctica and Greenland. We point out similarities and differences, some of them remaining unexplained. Finally, we briefly show deuterium excess from tropical ice cores focusing on our poor understanding of the controls on deuterium excess at tropical low latitudes.

A44A CC: 520 D Thursday 1530h

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

Presiding: D Fisher, Geological Survey of Canada; J Jouzel, Laboratoire des Sciences du Climat et de l'Environnement

A44A-01 1530h INVITED

Wonders From a new 3085m Deep ice Core From NorthGRIP on the Greenland ice Sheet.

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