Analysis of Tropospheric Carbon Monoxide over East Asia

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Abstract: Carbon monoxide (CO) is one of the important trace gases because its concentration in the troposphere directly influences the concentrations of tropospheric hydroxyl (OH), which controls the lifetimes of tropospheric trace gases. CO traces the transport of global and regional pollutants from industrial activities and large scale biomass burning. The distributions of CO were analyzed using the MOPITT data for East Asia, which were compared with the ozone distributions. In general, seasonal CO variations are characterized by a peak in the spring, which decrease in the summer. The monthly average for CO shows a similar profile to that for O_3. This fact clearly indicates that the high concentration of CO in the spring is possibly due to one of two causes: the photochemical production of CO in the troposphere, or the transport of the CO into East Asia. The seasonal cycles for CO and O_3 in East Asia are extensively influenced by the seasonal exchanges of different air mass types due to the Asian monsoon. The continental air masses contain high concentrations of O_3 and CO, due to the higher continental background concentrations, and sometimes to the contribution from regional pollution. In summer this transport pattern is reversed, where the Pacific marine air masses that prevail over Korea bring low concentrations of CO and O_3, which tend to give the apparent summer minimums.

Keywords: Carbon Monoxide, Ozone, MOPITT, MODIS, Russian Fires, East Asia.

1. Introduction

Carbon monoxide (CO) is a colorless, odorless, poisonous gas. It is produced by the incomplete burning of solid, liquid, and gaseous fuels. Appliances fueled with natural gas, liquefied petroleum (LP gas), oil, kerosene, coal, or wood may produce CO.

The troposphere is a region of great chemical diversity and activity, which contains many important trace gases that are produced by natural and anthropogenic processes at the troposphere. Atmospheric CO is one of the important trace gases because its concentration in the troposphere directly influences the tropospheric hydroxyl radicals (OH) (Logan *et al*., 1981). These trace gases affect the chemistry of the entire atmosphere, and directly impact on the quality of the air we breathe, while also playing important roles in the greenhouse effect and climate changes (Wang *et al*., 1998). CO traces the transport of pollutants from industrial activities and large scale biomass burning. Large amounts of trace gases and aerosol particles are emitted from fires (Crutzen and Andeae, 1990; Houghton *et al*., 1990).

Understanding the impact of CO on the tropospheric chemistry requires measurements of the CO distributions.

2. Data

the datasets used for this study consist of MOPITT data, MODIS data, NOAA reanalysis data, TOMS ozone data, and ozonesonde data.

The Measurements of Pollution in the Troposphere (MOPITT) instrument (Drummond, 1992) is an eight-channel gas correlation radiometer, which was designed to measure the concentrations of tropospheric CO and methane. The instrument was launched on the Earth Observing System (EOS) Terra satellite in 1999, with the purpose of measuring the global distributions of tropospheric CO at a horizontal resolution of 22km.

Moderate Resolution Imaging Spectroradiometer (MODIS) is a instrument aboard the Terra (EOS AM) and Aqua (EOS PM) satellites.

Total Ozone Mapping Spectrometer (TOMS) on board a sun-synchronous satellite measures UV radiances backscattered by the underlying atmosphere and Earth's surface or clouds (McPeters *et al*., 1996).

The ozone measurements for this study were obtained from a balloon-borne ozonesondes, consisting of an ozone sensor, which will be referred to as the electrochemical concentration cell (ECC). The ECC ozonesondes were regularly launched about once a week.

3. Results

During spring, the CO concentrations are at maximums in both hemispheres. Fig. 1. shows (not shown) increased CO concentrations over East Asia for April, May and June. This effect was influenced by biomass burning, causing the increased concentrations of CO over East Asia.

1) Russian Fire Episode : May 20, 2003

In this work, we present a more detailed examination of the CO and O_3 from Russia by MODIS data. Fig. 2. shows MODIS images over East Asia. Left is RGB image and Right is Infrared image on May 20, 2003. In the wake of the fires, the 700hPa MOPITT retrieved CO concentrations reach up to 250ppbv, indicating at least a doubling of the local concentrations from the fires (Lamarque *et al*., 2003). Fig. 2. shows that the transport of the CO from Russian Fires can be studied by the combination of satellite data (MODIS fire location and MOPITT CO).

The high concentration of CO over East Asia is clearly a combination of a variety of sources, but Russian wildfires must be a strong component in May 2003.

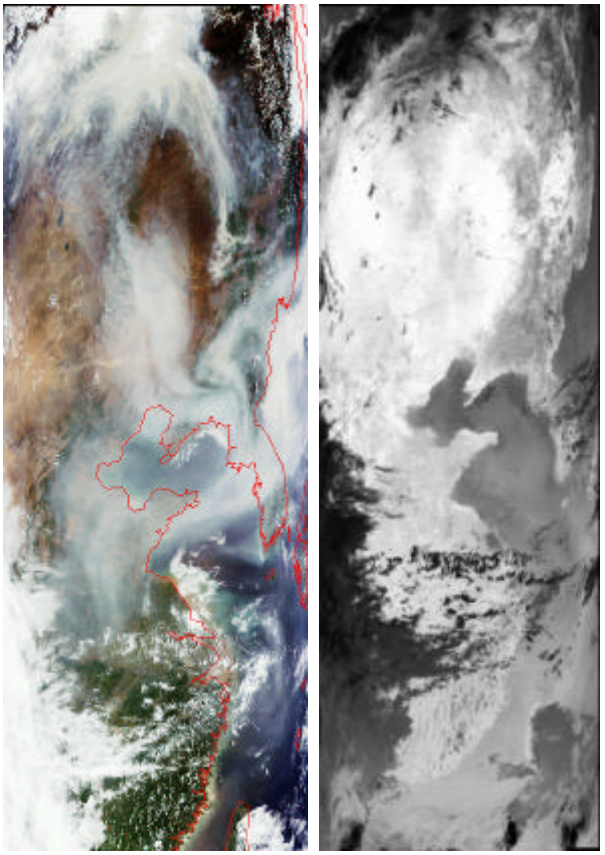

Fig. 2. MODIS images over East Asia. Left is RGB image and right is Infrared image (11 μm) on May 20, 2003.

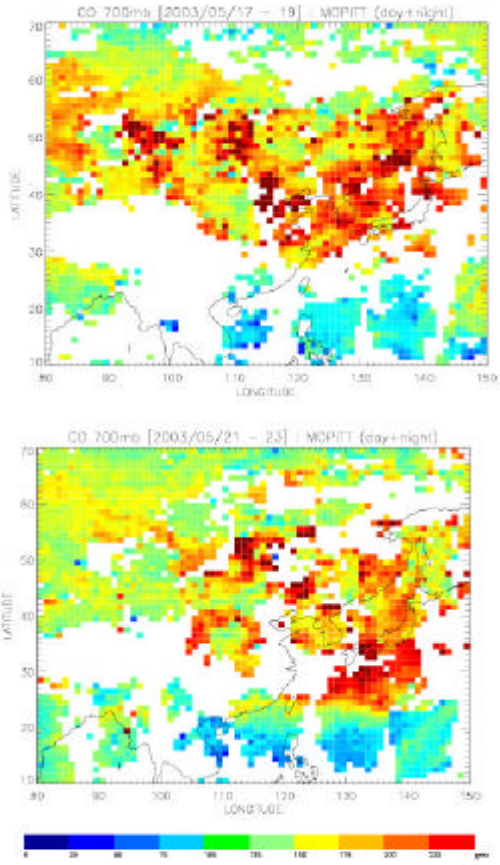

Fig. 3. The distribution of carbon monoxide concentration from MOPITT data in May 2003 (at 700hPa).

4. Conclusions

Through this study, the regional morphology of carbon monoxide distributions has been generated. The seasonal variations in the tropospheric carbon monoxide and ozone concentrations show a primary peak during the spring. This suggests that the spring maximum may be caused by biomass burning and anthropogenic pollutants.

The influence of synoptic weather systems of the distribution of CO and O_3 has been examined over Korea for the Russian Fires. For May 20 of 2003, CO values rapidly increase about 250ppbv throughout the troposphere.

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