Analysis of Tropospheric Carbon Monoxide and Ozone Production in East Asia

S. H. Lee1, G. H. Choi1, H. S. Lim1, J. H. Lee1, D.C. Seo1, J. N. Jun1, J. H. Jung1, I. S. Kim1
Satellite Operation & Application Center, Korea Aerospace Research Institute
P.O.Box 113, Yuseong Daejeon 305-333, Korea
sanghee@kari.re.kr

J. Kim2
Global Environment Laboratory, Department of Atmospheric Science, Yonsei University
134 Sinchon-dong Seodaemun-gu, Seoul 120-745, Korea
jkim2@yonsei.ac.kr

Abstract: Atmospheric carbon monoxide (CO) and ozone (O_3) play the important trace gases in tropospheric chemistry, through its concentration in the troposphere directly influences the concentrations of tropospheric hydroxyl (OH). Understanding the impact of CO and O_3 on the global tropospheric chemistry requires measurements of the global atmospheric CO and O_3 distributions. This study focuses on the identification of CO and O3 released in the East Asia between March 2000 and February 2004. During the period, the MOPITT instrument onboard the Earth Observing System (EOS)-Terra platform collected extensive measurement of CO. So we have used MOPITT data at 700hPa to analyze seasonal distribution of CO concentration. And the O3 measurements for this study were Total Ozone Mapping Spectrometer (TOMS) and Dobson spectrometer provided NASA/GSFC and Yonsei University, Korea. During springtime, the CO and O3 concentrations were increased over East Asia for April, May, and June. CO and O3 transport and chemistry in the springtime in East Asia are studied by use of the HYbrid Single Particle Lagrangian Integrated Trajectory (HYSPLIT) model.

Keywords: Carbon Monoxide, Ozone, MOPITT, TOMS, HYSPLIT.

1. Introduction

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 the tropospheric CO (*Wang et al., 1999*).

CO is one of the important trace gases because its concentration in the troposphere directly influences the concentrations of tropospheric hydroxyl (OH) (*Logan et al., 1981*), 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.

Previous studies have identified seasonal distribution of CO between March 2000 and February 2001. The global and regional 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. 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 (*Lee et al., 2004*).

This study focuses on the identification of CO and O3 released in the East Asia between March 2000 and February 2004.

2. Data and Results

1) Data

The basic measurement principle employed MOPITT is infrared radiometry. The instrument measures infrared radiation (IR), with the gas concentrations in the atmosphere inferred from their IR measurements (*Smith, 1999*) The main objectives of MOPITT are the measurements of the CO and CH4 concentrations in the troposphere using a CO thermal channel at 4.7 μm and reflected solar channels for CO at 2.3 μm (*Edwards et al., 1999*). CO mixing ratios from MOPITT at 700 hPa, between March 2000 and February 2004, have been used in this study.

TOMS instrument, is managed by The Goddard Space Flight Center (NASA). *Earth Probe TOMS* is currently the only NASA spacecraft on orbit specializing in ozone retrieval. By making 14 polar orbits each day, this single instrument provides daily maps of ozone covering most of the globe. With just the one instrument circling around and around, the problems of calibration differences between sites are very much reduced. With the abundance of global data, one can calculate statistics on ozone changes that are reliable and robust. As of this writing, there are no TOMS instruments measuring ozone (*NASA/GSFC*).

The HYSPLIT model is the newest version of a complete system for computing simple air parcel trajectories to complex dispersion and deposition simulations. The meteorological input fields used by HYSPLIT are required to be in "ARL packed" format. Without the additional dispersion modules, Hysplit computes the advection of a single pollutant particle, or simply its trajectory.

2) *Global Distribution of CO and O3*

Figure 1 shows the examples of the Global distribution for the CO (monthly average) concentration at 700 hPa. The red pixels indicate relatively high levels (near 250 ppbv) of CO and the blue pixel relatively low values (near 0-20 ppbv).

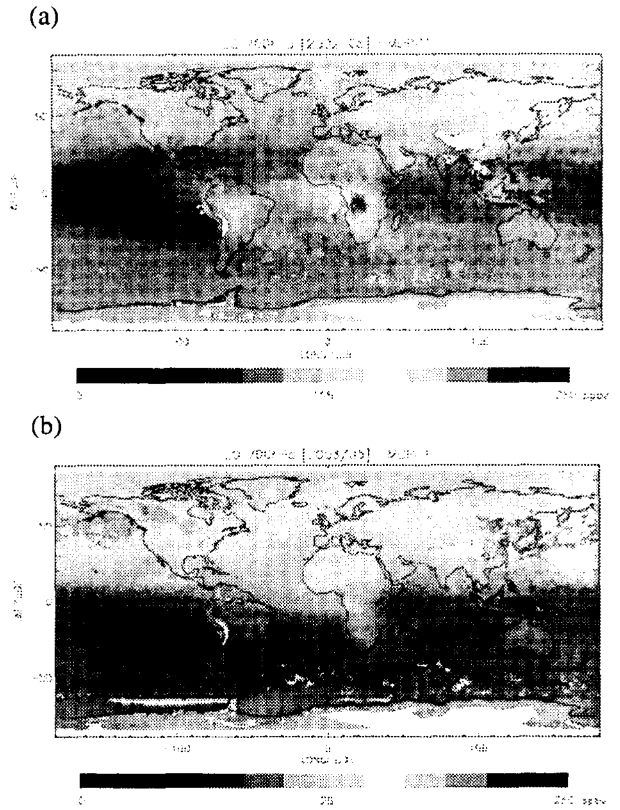

Fig. 1. Global distribution of carbon monoxide concentration using MOPITT data (at 700 hPa) (a) in August, 2002, (b) in May, 2003.

Of the ozone precursors, CO is an important trace gas, which controls the oxidizing capacity of the atmosphere, by reacting with OH radicals (*Logan et al., 1981; Novelli, 1997*). Due to its relatively long atmospheric lifetime, in the order 1-3 months, CO can also serve as an almost inert tracer of the anthropogenic activity on a regional scale (*Parrish et al., 1991; Jaffe et al., 1997*). Thus, the correlation between CO and O3 is often used to evaluate the photochemical production of O3 (*Parrish et al., 1993*), as their CO seasonal cycles are similar.

Figure 2 shows the Global distribution for the O3 (monthly average) concentration. The red pixels indicate high levels (near 450 DU) of O3 and the blue pixel relatively low values (near 150-200 DU).

Through this study, the regional morphology of CO and O3 distributions has been generated, and will be continued.

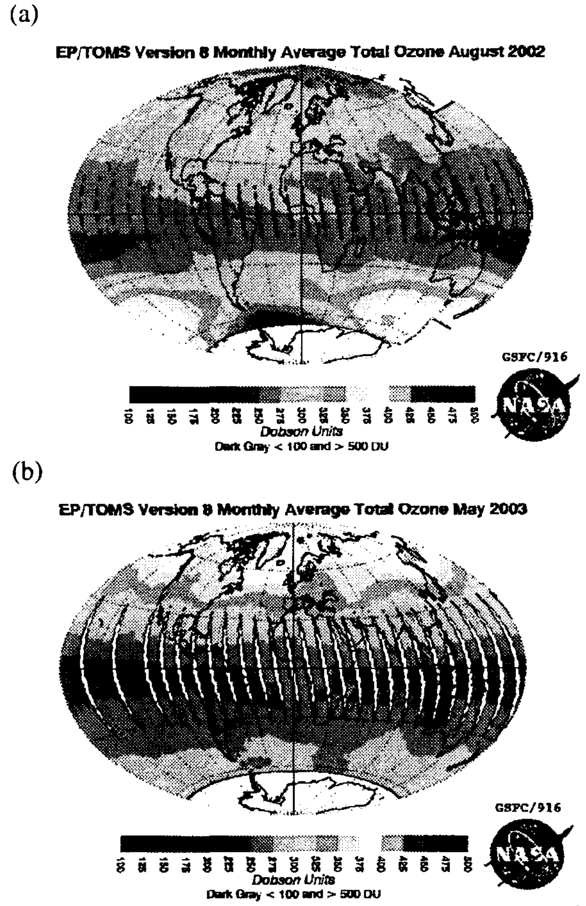

Fig. 2. Global distribution of ozone concentration using TMOS data (total column) (a) in August, 2002, (b) in May, 2003 [provided NASA/GSFC].

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