IMPACT OF OPEN CROP RESIDUAL BURNING FOR AIR QUALITY OF CENTRAL EAST CHINA IN 2006

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1. INTRODUCTION

Historically crop residue has been a major energy source at rural area in China, but rapid economic development has increased rural access to commercial energy and decreased the use of biofuel. As the result, crop residue increasingly is being burned in the field. On the Mount Tai Experiment 2006(MTX 2006), an observation campaign at the summit of Mount Tai placed on the North China Plain (NCP), heavy atmospheric pollutions were observed on June, and that was pointed out caused by crop residues burning in the field over NCP (Kanaya et al., 2008; Li et al., 2008). For example, Li et al. (2007) and He et al. (2008) indicated that monthly averaged O_3 peaks usually appeared in June with more than 60 ppbv, and the maximum hourly O_3 reached 150 ppbv in each year of 2004-2006. On the other hand, several regional modeling studies (Li et al., 2007; He et al., 2008; Yamaji et al., 2008) captured this seasonal cycle having a peak in early summer, June-July, but systematically failed to simulate such high concentrations. These underestimates seemed to be caused by rapid increases in anthropogenic emissions after 2000, the uncertainty of the temporal and spatial distributions of agricultural waste burning, and an insufficient grid resolution to reproduce meteorological fields at an isolated mountain surrounded by high emission sources (Yamaji et al., 2008).

In this study, we developed updated anthropogenic and open burning emission inventories and tried to simulate atmospheric pollutants over Central East China (CEC) using these inventories.

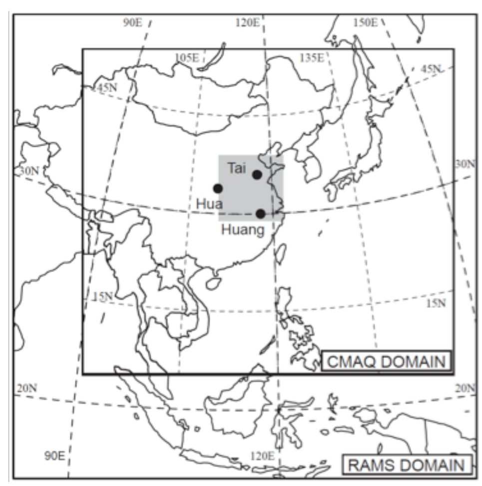

Figure 1 Model Domain

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2. MODEL

The modeling system employed in this study is CMAQ version 4.4 (Byun and Ching, 1999) driven by the meteorological fields calculated by the Regional Atmospheric Modeling System (RAMS) Version 4.4 (Pielke et al., 1992; Cotton et al., 2003). This RAMS simulation used the NCEP Global Tropospheric Analyses with a 1.0 degree × 1.0 degree at 6–hour intervals for the year 2006 data set. The off–line processor for combining CMAQ with RAMS has been developed by Uno et al. (2007). Spatial domains for CMAQ and RAMS shown in Figure 1 are 6240 × 5440 km^2 (inside domain in Figure 1) and 8000 × 5600 km^2 (outside domain in Figure 1) centered at 25 ˚N and 115 ˚E, respectively, with an 80 × 80 km^2 resolution. For the vertical resolution, both model systems have the same model height of 23 km and employ a hybrid sigma-pressure coordinate. CMAQ has 14 vertical layers, with about 7 layers below 2 km. RAMS has 23 vertical layers, and about 7 layers within 2 km. The boundary conditions of O_3 and its precursors were obtained from daily averaged concentrations by the CHemical AGCM for Study of Atmospheric Environment and Radiative forcing, CHASER (Sudo et al., 2002). As for the gas–phase atmospheric chemical mechanism, the Statewide Air Pollution Research Center (SAPRC)–99 (Carter, 2000) was employed with the mechanism–specific Euler Backward Iterative (EBI) solver. We also used the 3rd generation CMAQ aerosol module (AERO3). This model simulation started from 1 May 2006. The first 1–month simulation is regarded as the spin–up and the following 1-month simulation is used for this analysis. The chemical concentrations used in this study are the instant CCTM outputs obtained every three hours starting at 00:00 UTC.

3. EMISSION

Annual atmospheric pollutants emissions from anthropogenic sources excluding biomass combustion in the field based on the Regional Emission inventory in ASia (REAS) (Ohara et al., 2007). For this model study, therefore, the emissions data in the year 2006 were obtained by simple interpolation using those amounts in 2003 and 2010 (PFC). Biogenic NMVOC emissions, isoprene and terpene were obtained from the Global Emission Inventory Activity (GEIA) 1 degree × 1 degree monthly global inventory (Guenther et al., 1995). For open burning emissions in China for the year 2006, we developed daily emissions based on a bottom-up methodology by Yan et al. (2006) and hotspots information detected by Aqua/Terra MODIS (MOerate resolution Imaging Spectroradiometer, http://webmodis.iis.u-tokyo.ac.jp/). Figure 2 shows daily NOx and CO emissions on 7 and 28 June 2006.

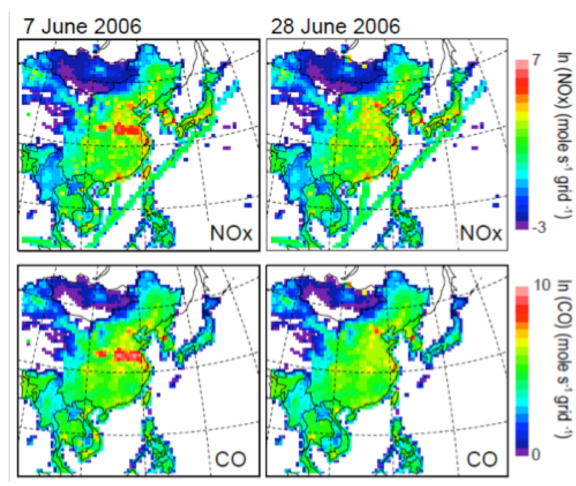

Figure 2 Daily NOx and CO emissions on 7 and 28 June 2006

4. RESULTS

An observed polluted peak in 7 June were controlled by the northward and northeastward transport toward a strong low pressure locating at northeastern China, particularly in and around CEC (Figure 3). Therefore the observed high-polluted episode (Kanaya et al., 2008; Li et al., 2008) at the summit of Mount Tai were affected from south of CEC. In particular for 7 June, this model could capture the polluted episode, and that was affected by higher atmospheric pollutants and their precursors emissions over south of CEC shown in Figure 2, which were associated with hotspots due to open crop residual burning. The daily contributions from open crop residual burning on emissions were 44–69 % in 7 June much higher than monthly averages, 17-45 %. O_3 and CO took large impact from open crop residual burning, more than 20% (O_3) and 50%(CO) near Mount Tai (Figure 3). On the spatial distribution, polluted air mass caused by open crop residual burning, whose contributions were 20-30 % for O_3, 50-80 % for CO, 60-80 % for BC and OC, covered over Shandong province as shown in Figure 3.

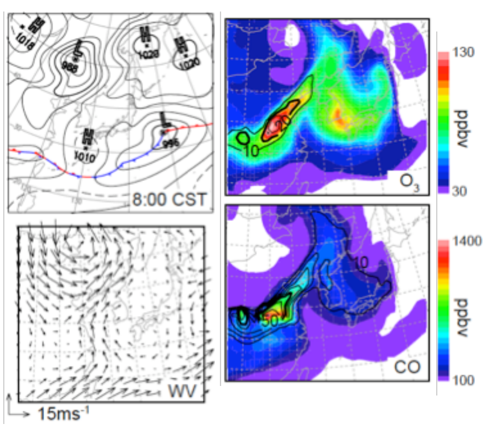

Figure 3 Spatial distributions of surface meteorological fields and simulated O_3 and CO concentrations on 7 June 2006

5. SUMMARY

Impact of open crop residual burning on atmospheric pollutants CEC for MTX2006 was simulated using CMAQ and daily emissions for open biomass burning. An observed polluted peak in 7 June was largely affected by Chinese crop residual burning.

6. REFERRENCES

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