A Simulation of the Nighttime Ozone Episode occurred in Central Region of Korean Peninsula

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1. Introduction

The diurnal variation of ozone in urban area shows generally high concentration in daytime and low concentration in nighttime. However ozone sometimes showed high ozone episode in nighttime. At several sites of air pollution monitoring network in central region of Korean peninsula ozone concentration exceed 120ppb in the nighttime of June 1st 2009. The purpose of the study is to understand the mechanism of high ozone episode in nighttime using CMAQ.

2. Methodology

The domain of CMAQ in this study consists of 132 grid cells in east-west direction and 114 grid cells in south-north direction, with 30km x 30km horizontal resolution covering the China, Korea and Japan as shown in Fig. 1. Number of vertical layer is 15 layers and the height of lowest layer is about 80m. For higher resolution, 10km grid nested domain was used for Korean Peninsula. Number of vertical layer is 17 layers and the height of lowest layer is about 24m. The meteorological data for CMAQ simulation were obtained using the MM5. The emission inventory made for Intex-B project(2006) and CAPSS(Clean Air Policy Support System;2006) were used. The CMAQ simulation was performed during period from 29 May to 3 June, 2009.

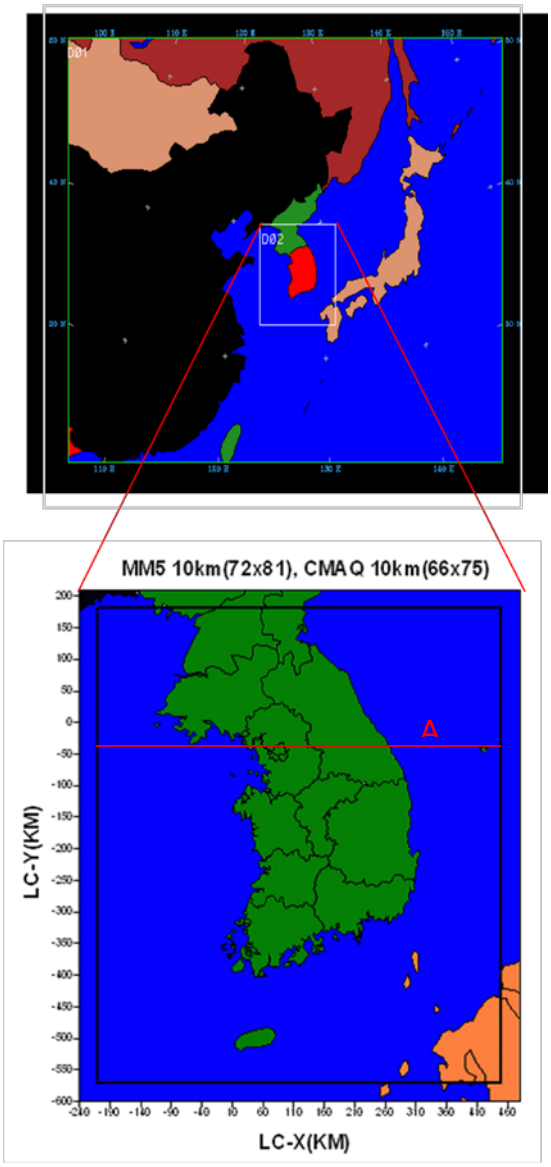

Fig. 1. Modeling domain of MM5(outer box) and CMAQ(inner dotted box). Grid size is 30km and 10km.

3. Results and Discussion

Fig. 2. shows the ozone concentration on June 1st was higher in the nighttime than the daytime at the central region of Korean Peninsula.

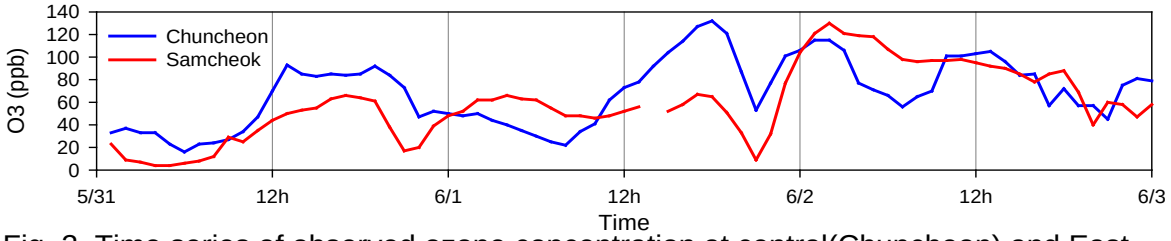

Fig. 2. Time series of observed ozone concentration at central(Chuncheon) and East coast(Samcheon) of Kangwon prvince n May ,31 - June 1,2009.

Fig. 3. Shows the synoptic weather maps of June 1st 2009. The result of Weather map

As is shown on Figure 5 the south-west wind blew from the China to Korean peninsula.

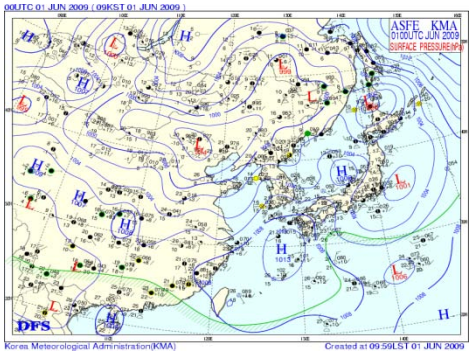

Fig. 3. Synoptic weather map for June 1, 2009.

The high concentration was measured in the east coast of Kangwon province. This happened on June 2nd this year, when the high nighttime ozone appeared in whole central region of the korean peninsula, especially in the east coastal area, while the concentrations of ozone in east regions was low in Fig. 4.

The simulated ozone concentrations and horizontal wind on fields on 1 June 2009 is showed in Fig. 5. Horizontal distribution of ozone concentration was similar with the observation. The wind fields would be expected to affect the horizontal transport of air pollutants and their products from the Shanghai to the Korean peninsula.

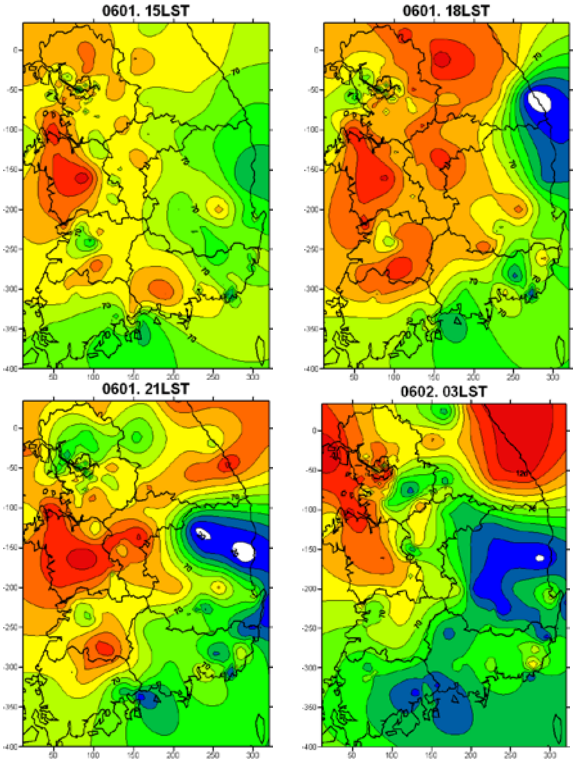

Fig. 4. Horizontal distributions of observed ozone concentration on June 1-2,2009.

The 10km model shows how the high concentration ozone moves from the west coastal areas from 15LST to the east and on June 2nd 03LST appears in the east coastal areas.

The result of model shows high concentration of ozone in North Korea as well. However, it is impossible to compare the model result with observation data from North Korea because they are not available.

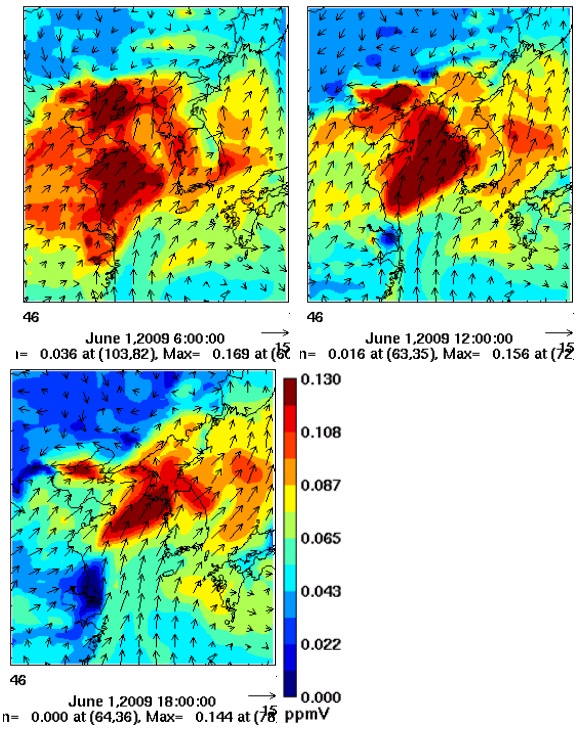

Fig. 5. Horizontal distribution of ozone concentration calculated by CMAQ model on June 1, 2009.

The downdraft occurred in Taebaek mountains located near East coastal area. High concentration ozone moves from the upper layer to the lower(Fig. 6). By the vertical cross section of wind profile I figure out that the occurrence of the nighttime high ozone concentration in east coastal area were caused by the downdraft from the upper layers. The results showed that ozone and the precursors of ozone emitted in Shanghai, China area were transported to Korean Peninsula.

Fig. 7. shows the result of Process Analysis (PA) on 1st June 2009. We noticed that nighttime ozone were increased up to 70ppb due to the horizontal transport (ADV2; middle) in the east coastal area. Also ozone were increased up to 30ppb due to the vertical transport(VDIF; left) in the Taebaek mountains.

The ozone concentrations in Metropolitan area decreased due to chemical reaction.

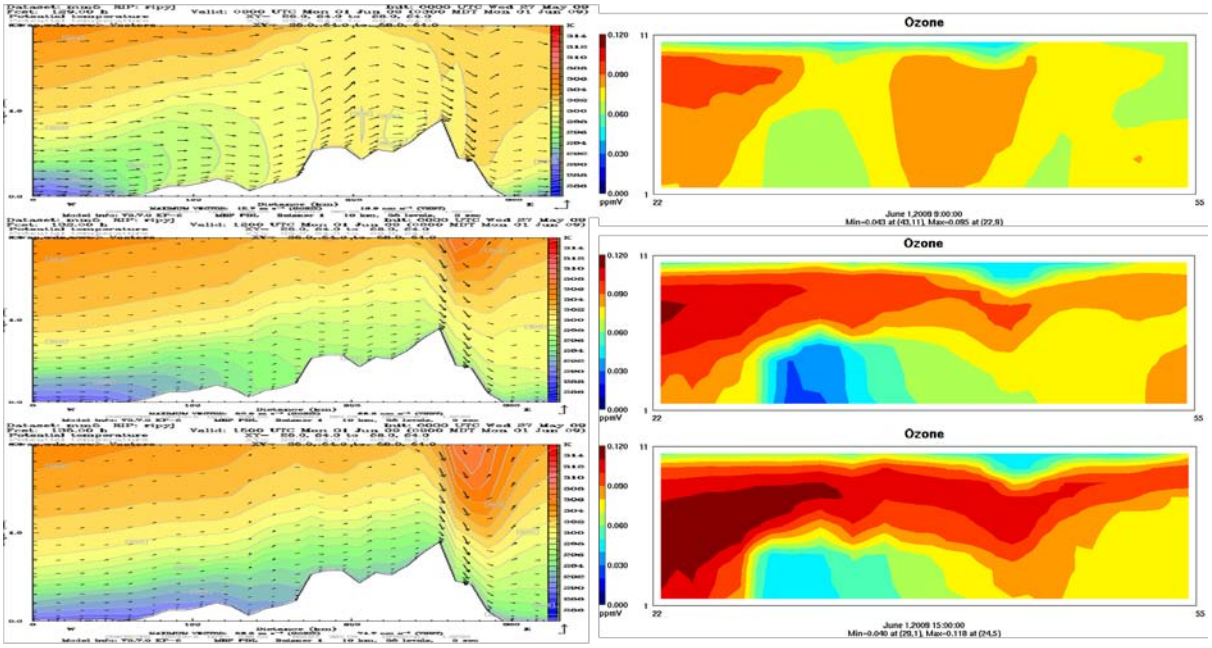

Fig. 6. Vertical cross section of wind profile and temperature(left) and simulated ozone concentrations (right) along the line A in Fig. 2.

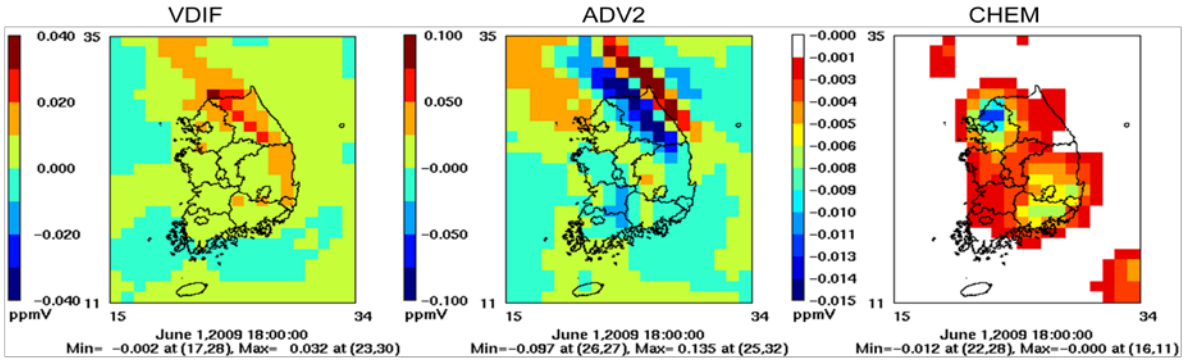

Fig. 7. Mass balance of process contribution to ozone concentration on June 1, 2009.