A Real-Time Forecast of VOC Emissions, O_3 Concentration, and CO_2 Flux from Vegetation with MM5 and CMAQ using the Upgraded Korean Landuse

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1. INTRODUCTION

Until recently, air quality (AQ) forecasts were based upon analysis of forecast meteorological conditions with consideration of pollutant ventilation conditions. Currently, a number of metropolitan areas take the meteorological forecast models such as MM5, WRF and RAMS, and incorporate the "offline" or "online" chemistry use of photochemical Eulerian grid models such as CMAQ, Calgrid, and CHRONOS to predict ozone or PM concentrations (Grell *et al.* 2000; U.S. EPA 1999, www.epa.gov/airnow/; www.AIRPACT.wsu.edu, http://qfx; weather office. ec. qc.ca/chronos/index_e.htm). We have recently made some improvements of landuse types within the Korean Peninsula through the Korean Ministry of Environment, and incorporated these instead of the USGS landuse types within MM5 and CMAQ models.

In this study, we are to introduce some results of a real-time forecast of VOC emissions, O_3 concentration, and CO_2 flux from vegetation with MM5 and CMAQ using the upgraded Korean landuse.

2. MODEL SETUP

For meteorological processing of the MM5 (version3.6) and MCIP within CMAQ, we ran 3 one-way nested domains starting at a resolution of 27km over the Korean peninsula to 3km for the Seoul metropolitan area. The model was initialized with 2.5 NCEP GDAS datasets. We selected one winter and one summer case starting at January 4, 2004 and August 10, 2004 respectively. For each of these cases the MM5 model is integrated for 48 hrs initialized for 18Z, which is 2am local time in Seoul, Korea. The MCIP process utilizes a sequence of 25 hours beginning at 12Z of that forecast. The MM5 code uses a Lambert Conic Conformal projection centered at (37.5N, 127.0E) with true latitudes fixed at 30.0N and 60.0N. MCIP is used similarly to extract an 18 by 18 3-km grid of meteorology from the MM5 forecast.

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CMAQ requires emissions for the Korean peninsula region in appropriate format, spatial and temporal granularity and extent, and expressed in the chemical scheme that is implemented in the photochemical model being used. CMAQ uses the CBM IV chemistry mechanism. Area emissions that are due to vegetative or soil microbial activity are typically termed biogenic emissions. In CMAQ, a combination of SMOKE and custom-written codes are used to 1) establish a standardized, gridded biogenic emissions dataset for domain landscape for standard levels of light (1000 μ-einsteins) and a standard temperature (30C). Typically SMOKE is used in conjunction with a biogenics estimation package such as BEIS2 (or GLOBEIS) to establish the standardized, gridded biogenic emissions dataset for a domain.

Sources and sinks (NEE) of CO_2 flux by ecosystem are given by the following equations

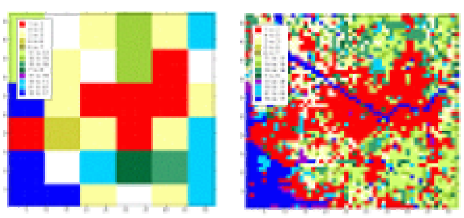
$$NEE = \frac{bI}{1+aI} - R, \quad R = R_1 Q^{\frac{T-T_{10}}{10}}$$

where I is APAR, which is assumed to be equal to the solar insolation obtained from MM5, R_1=0.102[mgCO_2 $m^{-2}s^{-1}$], Q=2.5, and T_{10}=10°C. a and b are constants

3. RESULTS and CONCLUSIONS

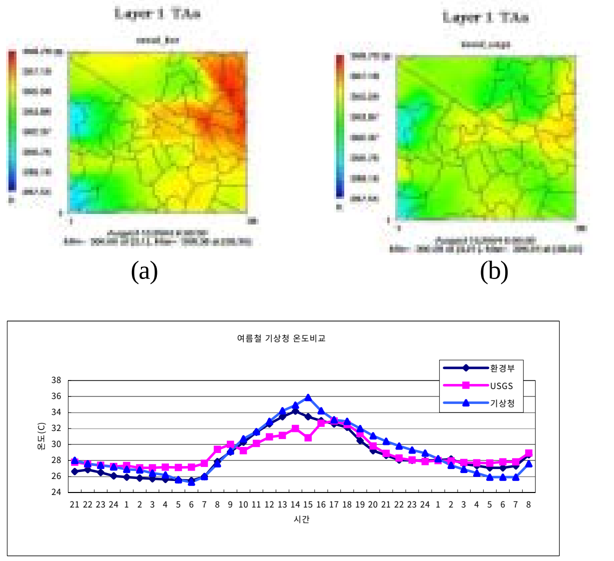
The spatial distribution of the air temperature and the wind was simulated by substituting the sort of the middle of land cover data for the USGS land-use data within the Meteorological Mesoscale Model Version 5(MM5).

Fig.1 shows intercomparison of USGS with upgraded landuse data in the Seoul metropolitan area, and Figs. 2 and 3 present their results using MM5.



(a) (b)

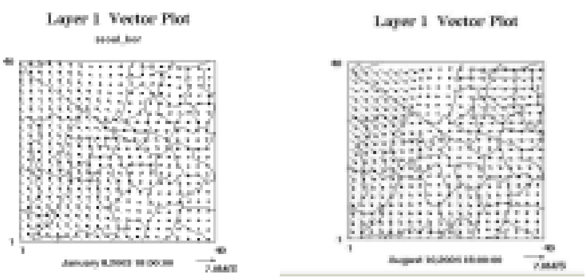
Fig.1. Intercomparison of (a) USGS with (b) upgraded landuse data.



(a) (b)

(c)

Fig. 2. Spatial distribution of the 10-meter air temperature between (a) USGS and (b) upgraded landuse data, and (c) their time series.



(a) (b)

Fig. 3. Same as Fig. 2 except for wind vector

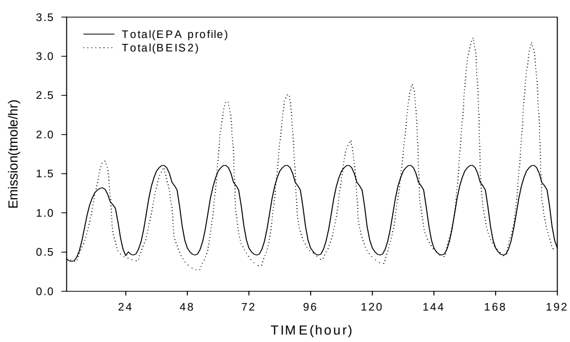
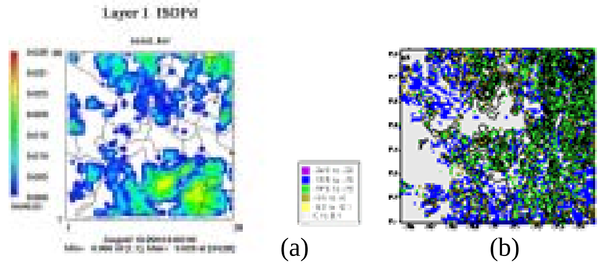


Fig. 4. Hourly time series of total VOC emissions between EPA temporal profiles and custom-written codes.using BEIS2.



(a) (b)

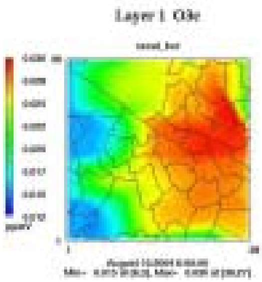


Fig. 5. Spatial distribution of VOC emissions(a), CO_2 flux (b) and O_3 concentration (c) from vegetation with MM5 and CMAQ using the upgraded Korean landuse at August 10, 2004.

(c)

The difference of the air temperature of both data was shown in the range of -2°C to 2.9°C, and those of wind vectors were seen in increase or decrease in daytime and nighttime. The hourly time series of Volatile Organic Components (VOCs) was calculated by using Biosphere Emission and Interaction System Version 2(BEIS2). It was possible to calculate the maximum concentration of ozone due to the biosphere emission of VOCs in the daytime (Figa. 4 and 5a). It was shown in about 30 ppb as the modeling result of the Community Multi-scale Air Quality (CMAQ) system in summertime (Fig. 5b). The CO_2 flux due to the sort of the middle of the land cover data was calculated by the parameterization model, which was composed of the function of the solar radiation and the air temperature (Fig. 5c). The net flux was seen in -19 ton/km^2 by the photosynthesis during daytime, and in 2 ton/km^2 by the respiration during nighttime.

Acknowledgements

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