1B3) RAQMS-CMAQ linkage를 이용한 광화학 대기질 모델링

Atmospheric Chemistry Model Data for Summer 2006 Utilizing the RAQMS-CMAQ Linkage

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1. 서 론

The Community Multiscale Air Quality (CMAQ) model (Byun and Ching, 1999) is a state-of-the-art science atmospheric chemistry model which has been widely used to study and simulate multi-scale air quality issues. The CMAQ model is capable of providing high quality atmospheric chemistry profiles through the utilization of high resolution inputs relating meteorology and emissions with chemical reactions. However, it cannot simulate air quality accurately if input data are not appropriate and reliable. One of the most important inputs required by CMAQ is lateral boundary conditions (LBCs), which continue to affect model predictions throughout the simulations. Although a nesting technique may be used to reduce uncertainties of boundary conditions in the urban-scale domain, this technique is not applicable for the regional-scale domain or in the case when the in-flux mass of pollutants is not negligible. Since the current CMAQ model uses a set of constant lateral background condition profiles of the pollutant species, without reflecting temporal and spatial variations at the boundaries, it is critical to generate proper model-ready boundary data for model inputs. The key hypothesis of this study is that such limitations can be improved by the utilization of the NASA's substantial archives of earth science remote sensing and modeling data products. The NASA LaRC-University of Wisconsin Realtime Air Quality Modeling System (RAQMS) (Pierce et al., 2003) model with satellite observations assimilated using a statistical digital filter can provide such dynamic lateral boundary conditions for CMAQ. The objective of this study is to improve predictability of CMAQ modeling by means of the lateral boundary conditions generated from RAQMS results. Based on the previous research (Song et al., 2008), we updated the RAQMS-CMAQ linking tool by adding the CMAQ aerosol modules (AERO3 and AERO4) as well as additional gas phase species available from RAQMS. We investigated the boundary condition impacts on CMAQ simulation, and verified and characterized the model results by comparing with various measurement data available in this study.

2. 연구 방법

RAQMS-CMAQ converter was updated from the previous version for this study. In the previous version (Ver. 1) (Song et al., 2008), only CB4 gaseous species are taken into account to generate CMAQ-ready boundary conditions from RAQMS outputs. In the new version (Ver. 2), CMAQ aerosol modules (AERO3 and AERO4) are incorporated into the converter as well as additional gas phase species available from RAQMS. Nearest grid points between the two models are used for the horizontal grid point matching and the two model's 3-D pressure fields are utilized for the vertical interpolation of gas phase and aerosol species concentration. Some species with the same chemical definitions in RAQMS and CMAQ are converted directly, but others were mapped by partitioning and/or regrouping species. Dusts in the RAQMS are separated by their size distribution and are redistributed by the CMAQ size definition. Sea salts in RAQMS are also separated by their size distribution and speciated into Na and Cl with a typical ratio of sea salt composition (Seinfeld and Pandis, 2006). Species of the same name in both models are converted directly.

3. 결과 및 고찰

Figure 1 shows the two CMAQ results with predefined and RAQMS LBCs on August 30 2006 20:00 UTC, overlaid with 13 ozonesondes found within 17:00~23:00 UTC at different CMAQ layers (22nd, 18th and 14th layer). At the 22nd layer (13~17 km), observed ozone values range from 120 ppb to 400 ppb and CMAQ results are distinctively different, although the areas of high ozone concentration at the northern and central part of the domain are similar, indicating that this layer is highly influenced by lateral boundary conditions. Maximum values from CMAQ with predefined LBCs is 76 ppb, which is much lower than observations, suggesting these LBCs are not capable of providing sufficient ozone at this layer. CMAQ with RAQMS LBCs well simulated high ozone concentrations at this layer, except for some areas of under-prediction. At the 18th layer (4.5~6 km), the two CMAQ results are not distinguishably but still quite different, indicating that this layer is moderately influenced by lateral boundary conditions. Ozone concentration ranges of nearby observation sites for CMAQ with predefined and RAQMS LBCs are 38~76 ppb and 38~88 ppb, respectively, while that of observation is 40~76 ppb. CMAQ with predefined LBCs have widespread areas of elevated ozone in the domain and CMAQ with RAQMS LBCs show some well defined areas with maximum ozone values in the northwestern, central, and northeastern part of domain. At the 14th layer (1.4~1.9 km), the two CMAQ results are very similar, indicating that this layer is slightly influenced by lateral boundary conditions. Both CMAQ simulated ozone concentration ranges are 20~70 ppb with slightly different spatial distribution, while the observation range is 26~66 ppb. Theses results show that CMAQ ozone predictions are influenced by LBCs, significantly at upper

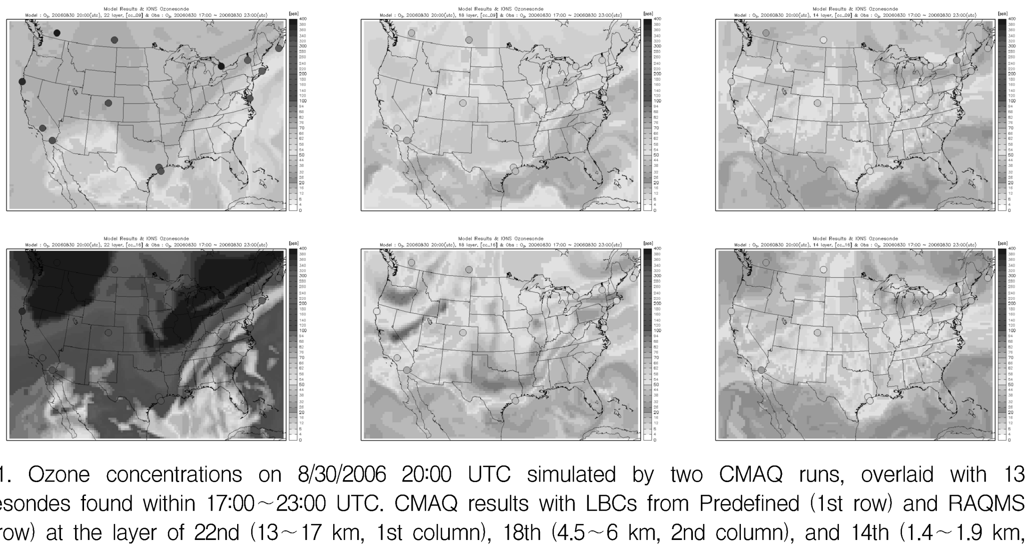

Fig. 1. Ozone concentrations on 8/30/2006 20:00 UTC simulated by two CMAQ runs, overlaid with 13 ozonesondes found within 17:00~23:00 UTC. CMAQ results with LBCs from Predefined (1st row) and RAQMS (2nd row) at the layer of 22nd (13~17 km, 1st column), 18th (4.5~6 km, 2nd column), and 14th (1.4~1.9 km, 3rd column).

troposphere and lower stratosphere, moderately at middle troposphere, and non-negligibly at lower troposphere. It should be also noted that general vertical ozone structure can be properly reproduced by using RAQMS LBCs.

참 고 문 헌

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