Assimilation CO_2 concentration data in the Kanto region using AIST-MM model and for the estimation of CO_2 emissions

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Atmospheric carbon dioxide (CO_2) known as greenhouse gas is the most important gas for global warming. For the reason, there have been many researches about CO_2 such as model calculations, satellite observations and direct observations recently. As computer spec get higher, the CO_2 model has been more improved and 3D distributions of CO_2 has been calculated in more detail. In Japan, the satellite observation has been high resolution by satellite, Greenhouse Observing SATellite-2 (GOSAT-2). But in urban area, CO_2 distributions are complicated because of complexed CO_2 emission source and sink around the area. Especially, in the Kanto district mega city, Tokyo is located, CO_2 emissions from power plants and human activities are very huge. Furthermore, around the city there are forests and mountains which strongly affect to CO_2 concentrations in the atmosphere through their respiration and photosynthesis. In case to calculate such the district with high spatial resolutions, the models are required to be able to represent the temporal and spatial variations of the respiration and photosynthesis of the plants precisely. It has been also pointed out that representativeness of the vertical transport of CO_2 in the models is a key subject. About satellite observations, it is not always possible to observe CO2 distributions because of to be influenced by the weather and the frequencies of them are limited, and what ca be observed are not 3 dimensional but 2 dimensional namely vertical column densities of CO_2. On the other hand, the accuracy of the in-situ observations, is best, but there are very limited observation points. These are obstacles to grasping the detailed behavior of CO_2 concentration.

In this study, a regional transport model, AIST-MM has been used to investigate the behavior of CO_2 concentrations in Kanto district (Kondo et al., 2001). Firstly, AIST-MM computes CO_2 concentrations in the outer area (630 km×550 km), and then calculates CO_2 concentrations in the inner area (216 km×216 km) using the results from the former.
Firstly, the model was improved to be able to calculate the CO_2 seasonal variations through a year in order to estimate CO_2 emission source which contained large error. It was found that AIST-MM had uncertainty in the part of plant activities especially respiration in summer. As the calculation of plant respiration strongly depends on the temperature, when the temperature becomes high, the respiration of plants unrealistically increases. So the plant respiration parameter was tuned.
In order to compensate for the CO_2 influx from outside of the calculation region, the result of a global model, NICAM-TM (GL5) were used as the boundary conditions when calculating outer region. This modification led to improve the calculation of the vertical transport.
Furthermore, constant sea surface temperature was replaced with the satellite observation data derived from AVHRR-AMSR. In order to improve the simulating performance, we adjusted many detailed emission information by distinguishing between holidays and weekdays.
Secondly, Local Ensemble Transform Kalman Filter (LETKF) which is one of data assimilation methods is adapted to the adjusted AIST-MM and try to calculate CO_2 concentrations using in-situ observations, satellite observations, and ground remote sensing observations. In the near future, the CO_2 emissions will be estimated using Kalman smoother method.

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