

Assimilation CO₂ concentration data in the Kanto region using AIST-MM model and for the estimation of CO₂ emissions

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Atmospheric carbon dioxide (CO₂) known as greenhouse gas is the most important gas for global warming. For the reason, there have been many researches about CO₂ such as model calculations, satellite observations and direct observations recently. As computer spec get higher, the CO₂ model has been more improved and 3D distributions of CO₂ 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, CO₂ distributions are complicated because of complexed CO₂ emission source and sink around the area. Especially, in the Kanto district mega city, Tokyo is located, CO₂ emissions from power plants and human activities are very huge. Furthermore, around the city there are forests and mountains which strongly affect to CO₂ 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 CO₂ 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 can be observed are not 3 dimensional but 2 dimensional namely vertical column densities of CO₂. 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 CO₂ concentration.

In this study, a regional transport model, AIST-MM has been used to investigate the behavior of CO₂ concentrations in Kanto district (Kondo et al., 2001). Firstly, AIST-MM computes CO₂ concentrations in the outer area (630 km×550 km), and then calculates CO₂ 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 CO₂ seasonal variations through a year in order to estimate CO₂ 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 CO₂ 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 CO₂ concentrations using in-situ observations, satellite observations, and ground remote sensing observations. In the near future, the CO₂ emissions will be estimated using Kalman smoother method.

Keywords: regional CO2 transport model, plant respiration, data assimilation, Local Ensemble Transform Kalman Filter, Kanto region