Models-3/CMAQ validation of March 2002 case for East Asia

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1. Background

Chemical Transport Models (CTMs) are playing increasingly important roles in the design, execution, and analysis of Large-scale atmospheric chemistry field studies (Carmichael et al, 2003). But, model verification should be done first, to evaluate what a extent it represent the regional characteristics, emission inventory, and if it correctly represent the real process, then process analysis and sensitivity test can be applied to explore the relative importance for each process, or scenario analysis could be done to check the effect of pollution control strategy.

Model validation is a hard task, because the site selected for comparison must stand for a region characteristic, which it is difficult for getting, especially for inland area of China. A variety of dataset was available for Mar. 2002, including clean sites of **EANET (**Acid Deposition Monitoring Network in East Asia) at Japan, intensive monitoring at 3 remote sites at east China coast, 5 remote sites for long term monitoring at inland China from IMPACTS (Integrated Monitoring Program on Acidification of Chinese Terrestrial Systems), and 2 flight measurement (one made between Liaodong peninsula and Shandong peninsula, another made on Yellow sea), which comprise a good chance for Model validation. Models-3/CMAQ framework was setup for Mar. 2002 case to make comparison with these dataset, and some implication could be obtained on model behavior, emssion inventory, model process improvement, site selection for model comparison and etc.

2. Result

We have setup a Models-3/CMAQ modeling system, and done a full month simulation for whole East Asia. Monitoring dataset from a variety channels, e.g., EANET, IMPACT, intensive monitoring and flight measurement, was used for model validation.

The model has good performance on SO_2 for both clean sites over the sea and inland sites at mainland China, indicating that SO_2 emission was well prepared and CMAQ could correctly treat sulfur related process. NOx and O_3 were not simulated as good as SO_2, which maybe attributed to the uncertainty of NOx and VOC emission inventory, the complex processes of diffusion, transportation, gaseous chemistry, deposition and etc. For aerosol component, sulfate and nitrate monthly mean could be reproduced well at inland sites of China, which means that model could present sulfate and nitrate well at a region level.

From monitoring and model data analysis, we found that NH_3 emission may be overestimated for large area in the domain. Since no Ca^{2+} considered in thermodynamic equilibrium module, NH_3

took the role of Ca^{2+} in aerosol chemistry to neutralize sulfate and nitrate, making overestimated ammonium in model result. As shown in model result comparison and aerosol data analysis, Ca^{2+} played an important role in aerosol chemistry, which is a different case from America and Europe, and should be included in thermodynamic equilibrium calculation.

Model presented flight measurement well with SO_2. NOx was much underpredicted by both flight measurement, there is a need to reconsider the NOx emission inventory. Since model take most part of emission as area source, the effect of high stack sources maybe underestimated, or, some high stack emission was missed in the inventory. Backward trajectory analysis indicated the potential influence of Shandong peninsula emission on flight measurement over Yellow sea.

Models-3/CMAQ achieved a good performance on a regional basis for Mar 2002 case. But, March was usually not a typical time for high O_3 build up. A July case should be included for model validation on its application in east Asia to check its performance under high oxidation condition, before it can be used in sensitivity test on process contribution or pollution control strategy analysis, and NOx and O_3 can be further checked then. So, more monitoring data especially for a July case are highly needed for future model validation.

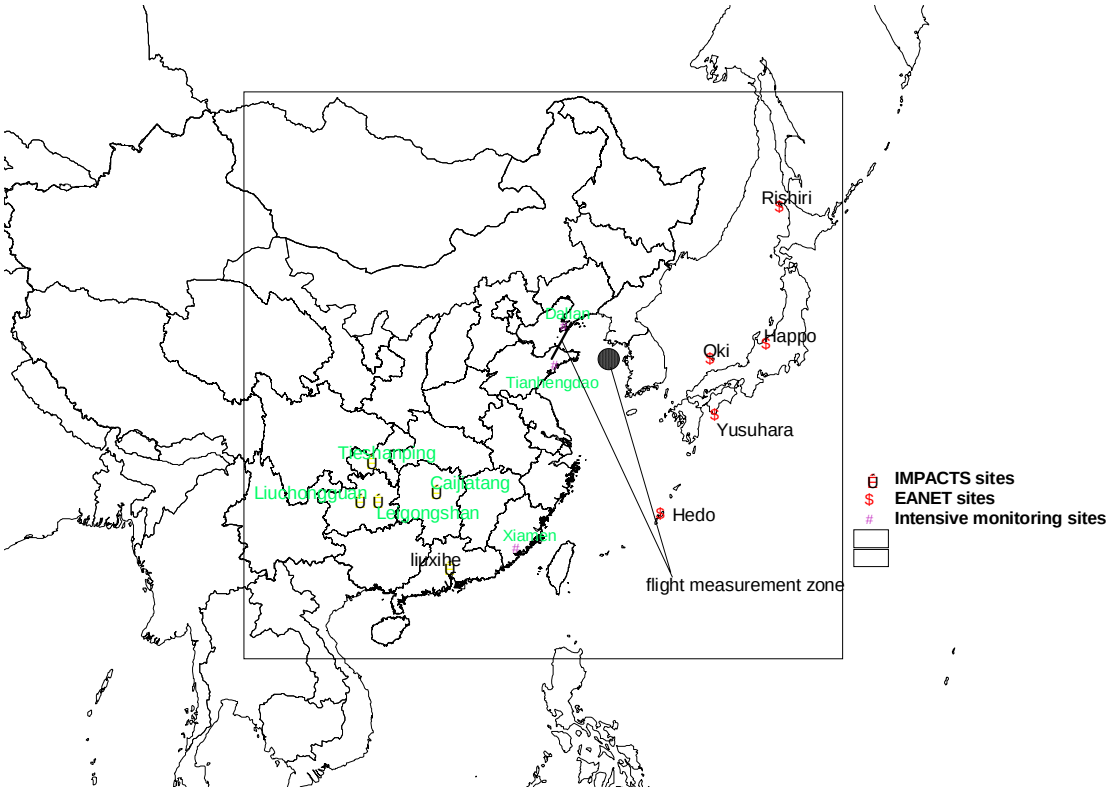

Fig.1 Model domain with monitoring sites and flight measurement zone for model validation