First Year Progress Report
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Linking Urban Air Pollution to Global Tropospheric Chemistry and Climate

NASA-NNG04GP30G

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PROPOSED MAJOR TASKS:

The two major tasks of this project are to study: (a) the impact of urban nonlinear chemistry on chemical budgets of key pollutants in non-urban areas; and (b) the influence of air pollution control strategies in selected metropolitan areas, particularly of emerging economies in East and South Asia, on tropospheric chemistry and hence on regional and global climate.

YEAR 1 REPORT

The major task for the first year as proposed is to develop the three-dimensional climate-tropospheric chemistry model based on: 1) NCAR CCSM/CAM, and 2) MIT tropospheric chemistry model with urban parameterization.

1. Research progresses

In the first year, research efforts are primarily focused on the model development. Three sub-projects have been carried out: 1) the improvement of the parameterization of urban fast chemistry in the current MIT IGSM model; 2) the preparation of policy-related emissions based on MIT EPPA model and its postprocessor; and 3) coding the tropospheric chemistry package along with the urban parameterization module into NCAR CCSM/CAM,

The revision of the current urban parameterization scheme concentrated on the predicted CO and O3 urban peak values along with their exports to the suburban have been carried out. The revised scheme has been tested using the MIT IGSM and the results have been much improved. This newly revised scheme will be incorporated in the climate-chemistry model soon.

Several sets of emissions data are derived based on the results of a set of 1000 runs using the MIT IGSM (zonal-mean model; results are published under separate support). Specifically, we have revised the MIT EPPA postprocessor to produce an emission data set for a 1x1 degree (longitude by latitude) grid system rather than the zonal-mean and low-resolution grid for IGSM. This new emission data set is then mapped into a 2.5x2 degree grid to be used in this project. Emissions data for "policy" runs have been prepared based on the above-described 1000-run results.

We started our work in the development of the climate-chemistry model from coding various aerosols into the climate model first. The aerosol module is then tested using NCAR sulfur chemistry model and the results suggest a reasonable consistency between our model and the original NCAR model (difference is also seen due to the new features in our model). The current efforts are mainly on coding the MIT tropospheric chemistry model into the NCAR CCSM/CAM. At this moment, all transported chemical species (~30 plus BC, OC, internal mixed, and several sulfate aerosols – both number concentration and mass) have been introduced into the model. Initial test of the transport of these species driven by above-described emissions data suggest a good feature of the modeled data. This allows us to continue our work for the next stage to code photochemical reactions and aqueous chemistry as well as the urban parameterization into the model.

All first-year targets except for the coding of photochemical package are accomplished on time.

2. Major publications and presentations:
Because the major work in the first year as proposed is the model development, we have not been able to produce any publication. Chien Wang has given several presentations related to this project including the ones in the NCAR CCSM AMWG meeting, and a workshop on BC emissions and climate change by USEPA, EMA, NREL, and API (invited).

We do expect reporting the major results in the second year and producing publications in quantity in the third year.

3. Personnel changes
Dr. Dongchul Kim joined the team from February 2005 and he is currently covered in half-time by this project to carry out the major tasks in model development.

A graduate student is expected to join the team after September.

5. Expected accomplishment in coming year
We will first to accomplish the coding of the whole chemistry model in the first part of the second year. Then, we expect to carry out model runs driven by derived reference emissions. These model simulations will exclude the feedback of chemistry to climate. We will compare the results with observations and other model results. In addition, we will develop a method to use satellite data to examine the modeled outflow of urban air pollution. The impact of urban export in tropospheric chemistry will be analyzed.

All these works in the second year will lay a solid ground for the chemistry-climate interactive simulations and policy-related simulations in the third year.