【Grant-in-Aid for Scientific Research(S)】
Integrated Science and Innovative Science (New multidisciplinary fields)

Title of Project : Integrated studies of aerosol-cloud-precipitation system in Asia based on measurements and model calculations

Yutaka Kondo
(The University of Tokyo, Graduate School of Science, Professor)

Research Area : Environmental science, Environmental dynamic analysis
Keyword : Environmental change

【Purpose and Background of the Research】

The effects of aerosols on clouds and precipitation (aerosol indirect effect) are one of the most uncertain factors in predicting the future global climate change. The key parameters required for understanding the role of aerosols in cloud and precipitation processes are the number concentrations and their size distributions of aerosols. Conventional mass-based studies do not take into account them properly.

To reduce the uncertainty in aerosol indirect effect, we make studies to greatly improve our understanding of the aerosol and cloud interaction by the greatly updated measurements and modeling of key parameters and processes of aerosols and clouds. We also evaluate the heating effects of aerosols (aerosol semi-direct effect) accurately by the combination of measurements and model calculations.

【Research Methods】

Measurements: We develop advanced measurement techniques and deploy them for field measurements. Surface (3 sites) and aircraft measurements (2 seasons) will be conducted in East Asia to study the impacts of aerosol emitted from anthropogenic activities. We will measure the size distribution, chemical composition, and mixing states of aerosols, size distribution and liquid water content of cloud and rain droplets, and meteorological components, including radiative parameters.

Numerical models: We plan to develop a new radiative transfer model to efficiently calculate aerosol radiative effects with improved accuracy. The calculations are validated by comparison with the measurements of radiation at surface. The validated radiative transfer model is integrated into regional scale 3-D models to calculate aerosol impacts on regional scale circulation. We also develop a new generation regional three-dimensional model, which considers aerosol-cloud interactions explicitly based on particle number concentrations and their size distributions. We will validate this model by comparison with the observations for each step of aerosol-cloud process. Using the validated models, we will evaluate aerosol indirect effects and their uncertainties in Asia.

【Expected Research Achievements and Scientific Significance】

There are strong needs to improve the accuracy of the predictions of climate change by greatly reducing the uncertainties of the effects of aerosols. Conventionally, global models have been used to assess the indirect and semi-direct effects of aerosols. However, the detailed processes of aerosol generation, transformation, and its uptake by clouds are not fully expressed by these models because they are mass-based models. In order to overcome these difficulties essentially, we make a completely new scheme to express number concentrations and their size distributions of particles. This scheme will greatly improve the calculation of aerosol and cloud processes in a self-consistent way. This study will greatly contribute to the improvement of climate predictions.

【Publications Relevant to the Project】

- Y. Kondo, H. Matsui, N. Moteki, L. Sahu, N. Takegawa et al., Emissions of black carbon, organic, and inorganic aerosols from biomass burning in North America and Asia in 2008, J. Geophys. Res., 116, D08204, doi:10.1029/2010JD015152, 2011.
- Kondo, Y., N. Takegawa, H. Matsui, T. Miyakawa, M. Koike et al, Formation and transport of aerosols in Tokyo in relation to their physical and chemical properties -A review-, J. Metorol. Soc. Japan, 88, 597-624, 2010.

【Term of Project】 FY2011-2014

【Budget Allocation】 165,500 Thousand Yen

【Homepage Address and Other Contact Information】

http://www-sys.eps.s.u-tokyo.ac.jp/~kondo/