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INFLUENCE OF NEWLY FORMED PARTICLES ON CLOUD FORMATION – A PARAMETRIC SENSITIVITY STUDY

T. Anttila, and V.-M. Kerminen

Finnish Meteorological Institute/Research and Development/Climate and Global Change

tatu.anttila@fmi.fi / Fax: +358 (0)9 179 581 / Phone +358 (0)9 1929 5526

Measurements conducted during the last two decades show that formation of new nanometer-sized particles takes place regularly in various tropospheric conditions and that these secondary particles may also act as seeds for cloud droplets. The associated climatic effects can be quantified using large-scale atmospheric models. Due to the various spatial scales involved, however, relevant microphysical processes have to be described in a computationally efficient way in such models. In order to make an optimal compromise between computational efficiency and accuracy, our aim is to give an answer to the following question: "which physico-chemical properties of secondary particles are most important regarding their contribution to cloud droplet number concentrations?". We approach the problem using the sensitivity analysis method proposed by Tatang et al. (1997).

The applied method is based treating uncertain model variables as random variables and approximating model output with a polynomial, the terms of which are a function of the random variables. The terms are chosen so that the contribution of each uncertain variable to the total variance of model output can be readily calculated, and that an optimal agreement between model predictions and approximation is obtained.

We used an adiabatic air parcel model to calculate the number of cloud droplets formed around secondary particles which is the approximated model output. The chosen random variables are the model parameters describing modal and chemical properties of secondary particles, including their total number concentration, size and water solubility of their chemical constituents. The values of other model parameters were kept

constant, reflecting conditions typical for the investigated atmospheric environment.

We have verified the validity of our approach and made a preliminary analysis of the results, which shows the following: 1) the modal properties of newly-formed particles, in particular the number concentration, are generally more important than their chemical properties, 2) the importance of the chemistry increases with decreasing maximum supersaturation reached during an air updraft, and 3) the shape of the secondary particle mode can be as important as the particle mean size at low updraft velocities.

References

Tatang, M. A., et al. (1997). An efficient method for parametric uncertainty analysis of numerical geophysical models. J. Geophys. Res., 102, 21 925–21 932.