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The role of the retention in SO_2 redistribution

Vladan Vučković and Dragana Vujović
University of Belgrade, Faculty of Physics,Department of Meteorology, Belgrade, Serbia (dvujovic@ff.bg.ac.rs)

During riming and freezing of hydrometeors in clouds, occurs partitioning of gases. That means one part remains in the frozen hydrometeor, and the other is ejected to the gas phase (or in liquid phase, if the wet growth of hailstones occurred). The retention governing the partitioning of gases between gas, liquid and ice phase. It is an important process, due to whom even highly soluble gases can reach the upper troposphere if they are released from ice-phase hydrometeors at high altitudes.The chemical composition of the atmosphere changes in this way. Retention coefficient is defined as the ratio of solute mass of the chemical species in the hydrometeor particle after freezing to the mass originally dissolved in the drop. If it is equal to one, this is the complete retention, CR (the entire mass of the gas remains in the ice phase). The partial retention (PR) is when values of this coefficient are in the interval (1,0).
Object of this paper was to research how the retention affects the redistribution of SO_2 in the atmosphere in the conditions of the cumulonimbus cloud development under complex, real terrain. For this purpose, we used the complex 3D cloud-resolving model with coupled chemistry module. A high spatial resolution was applied: 500 m in horizontal and 250 in vertical. We include realistic topography, an advective scheme that conserves the mass of scalar, iterative solving of kinetic mass transfer, several aqueous-phase chemical reactions, and tracking of solute concentrations in different hydrometeors.
The first thing to notice is that retention, along the vertical transport, increases mass of SO_2 in the air, especially at high altitudes. As could be expected, the mass of SO_2 in snow and ice is greater in the CR than in the PR case. Consequently, the mass of S(IV) in rainwater in the entire domain is 14.6% greater in the CR than in the PR case. What might be of interest for climate modelling is highlighted increase of the amount of S(IV) in snow between 12 and 13 km altitude, because this aerosol reflects the short-wave radiation.