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The influence of submicron sized aerosol scavenging by snow in the Cb cloud

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In this work we have investigated the effect of aerosol particles (APs) scavenging by snow in a cumulonimbus cloud. It was shown that APs in the atmosphere have a major impact on cloud formation, development and its products, climate, environment, public health, etc. The scavenging coefficients for various snow scavenging processes were calculated, analyzed and implemented in a three-dimensional, three-moment microphysical model in which all the number concentrations and the mixing ratios, were explicitly calculated for all hydrometeor categories. Analyzing the AP scavenging coefficients we concluded that Brownian/turbulent diffusion is the dominant process for smaller diameter aerosols, up to a point, where inertial interception overpowers. Impaction scavenging is by far the most dominant process of APs scavenging by snow for particles larger than ~0.5 μm in diameter, therefore it was neglected because most of the APs injected into the cloud are of the diameter <0.2 μm. Scavenging coefficient of snow is comparable to that of raindrops or even cloud droplets, which means that APs scavenging with snow should be included in the model. Two sets of numerical experiments were conducted: (1) APs were scavenged only by cloud and rainwater and (2) APs were scavenged by cloud and rainwater and snow. No ice nucleation processes were included. The results of 3D numerical simulations showed that snow contributes more to mass than the number of AP washouts, as it collects larger particles more efficiently. As snowflakes melt into raindrops, scavenging by snow becomes a significant mechanism for removing APs from the atmosphere. Approximately 29.3% and 7.2% of the total number and mass of APs, respectively, get deposited on the ground through precipitation during a 3-hour simulation when snow does not actively collect APs. When snow collection is included in the model, the total number and mass of APs precipitated on the ground increase by 10.7% and 56.9%, giving a total of 32.4% and 11.3%, respectively.