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Aerosol particle scavenging during precipitation: Model results and estimations from field measurements

C. Andronache (1), L. Laakso (2), T. Gronholm (2), V. Phillips (3)

(1) Boston College, Chestnut Hill, MA, 02467 USA (andronac@bc.edu/1-617-552-2836), (2) Department of Physical Sciences, P.B. 64, FIN-00014, Helsinki, Finland (lauri.laakso@helsinki.fi; Tiia.Gronholm@helsinki.fi), (3) Princeton University, Atmospheric and Oceanic Sciences Program, Princeton, NJ 08540, USA (Vaughan.Phillips@noaa.gov)

Removal of airborne particles from atmosphere during precipitation events represents a major sink of aerosol. The process involves several possible scenarios that eventually determine the fate of a given aerosol particle (AP): 1) the AP can become cloud droplet by nucleation scavenging and subsequently can grow as raindrop and fall through cloud. It can collect other cloud droplets and interstitial aerosol in cloud, and this leads to in-cloud (IC) scavenging; 2) the AP present in the boundary layer (BL), below-cloud (BC), can be collected by falling raindrops, and this leads to BC scavenging. Ultimately, the AP scavenging rate is largely controlled by aerosol size, rainfall intensity and precipitation type. Other factors such as aerosol chemical composition, electric charge on aerosol and hydrometeors might play a role as well. Models show that BC scavenging rate is sensitive to aerosol size, and this rate can be enhanced by electric and phoretic forces. The IC scavenging rate is less sensitive to aerosol size and is higher than the BC scavenging rate.

Measurements of ultra fine particles (UFP) size distribution in the range 3-500 nm at a boreal forest site in southern Finland during 1996-2001 provided the data set used to infer a scavenging rate directly from observations and to compare with model results for selected cases. Generally, the scavenging rate determined from observations has little dependence on aerosol size and tends to be higher than the model BC scavenging rate. Sensitivity calculations show that electric charge and phoretic effects can reduce the differences between model and observations. In addition, the role of vertical mixing between BL and in-cloud domain and possible IC scavenging are also discussed and illustrated for selected precipitation events. The study underlines the

complex aerosol-hydrometeor interactions and the role of vertical mixing in the overall aerosol scavenging effect observed in the BL.