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Scavenging of black carbon in mixed phase clouds at the high alpine site Jungfraujoch

J. Cozic[1], B. Verheggen[1,*], S. Mertes[2], P. Connolly[3], K. Bower[3], A. Petzold[4], U. Baltensperger[1], and E. Weingartner[1]

[1]Laboratory of Atmospheric Chemistry, Paul Scherrer Institut, 5232 Villigen PSI, Switzerland

[2]Leibniz-Institute for Tropospheric Research, 04318 Leipzig, Germany

[3]School of Earth, Atmospheric and Environmental Sciences, University of Manchester, M60 1QD, UK

[4]Institute for Atmospheric Physics, German Aerospace Centre, 82234 Wessling, Germany

[*]now at: the Institute of Atmospheric and Climate Sciences, ETH Zürich, 8092, Switzerland

Abstract. The scavenging of black carbon (BC) in liquid and mixed phase clouds was investigated during intensive experiments in winter 2004, summer 2004 and winter 2005 at the high alpine research station Jungfraujoch (3580 m a.s.l., Switzerland). Aerosol residuals were sampled behind two well characterized inlets; a total inlet which collected cloud particles (droplets and ice particles) as well as interstitial (unactivated) aerosol particles; an interstitial inlet which collected only interstitial aerosol particles. BC concentrations were measured behind each of these inlets along with the submicrometer aerosol number size distribution, from which a volume concentration was derived. These measurements were complemented by in-situ measurements of cloud microphysical parameters. BC was found to be scavenged into the condensed phase to the same extent as the bulk aerosol, which suggests that BC was covered with soluble material through aging processes, rendering it more hygroscopic. The scavenged fraction of BC ($F_{Scav,BC}$), defined as the fraction of BC that is incorporated into cloud droplets and ice crystals, decreases with increasing cloud ice mass fraction (IMF) from $F_{Scav,BC}$=60% in liquid phase clouds to $F_{Scav,BC}$~5–10% in mixed-phase clouds with IMF>0.2. This can be explained by the evaporation of liquid droplets in the presence of ice crystals (Wegener-Bergeron-Findeisen process), releasing BC containing cloud condensation nuclei back into the interstitial phase. In liquid clouds, the scavenged BC fraction is found to decrease with decreasing cloud liquid water content. The scavenged BC fraction is also found to decrease with increasing BC mass concentration since there is an increased competition for the available water vapour.

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