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Explicit Simulation of Cloud Processing of Aerosol Using the MC2 Model

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Cloud processing of aerosol may substantially affect the post-cloud aerosol spectrum due to in-cloud oxidation. We hypothesize that the in-cloud oxidation increases the sulfate mass concentration of the post-cloud aerosol particles that were activated in the cloud. To test this hypothesis we explicitly simulate the cloud processing of aerosol in a continental stratocumulus cloud, which occurred downwind of Lake Erie at 1800 UTC on 11 July 2001.

The Canadian Mesoscale Compressible Community (MC2) model was run at high resolution with an explicit aerosol activation scheme, an explicit double-moment bulk cloud microphysical scheme, and a bulk in-cloud oxidation scheme. The following categories of gas-phase, aerosol and cloud species were considered: three gas-phase species, SO_2 and two oxidants (H_2O_2 and O_3); three aerosol species, interstitial sulfate aerosol and aerosol scavenged in cloud and in rain; and two hydrometeor categories, cloud droplets and rain drops. The interstitial aerosol was assumed to follow a lognormal distribution and the cloud droplets and raindrops were assumed to follow a generalized gamma distribution. Prognostic equations for the gas-phase species and the mass and the number concentration of aerosol were added to the model equations with only aqueous-phase sources and sinks considered.

The pre-cloud and the post-cloud aerosol will be compared and the relative contribution to the post-cloud aerosol spectrum of each of the cloud processes, in-cloud aerosol scavenging, in-cloud sulfur oxidation, and cloud droplet interactions, will be discussed.