The Transformation of Black Carbon Aerosols from Hydrophobic to Hydrophilic and the Global Distribution

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Abstract

The transformation for black carbon (BC) aerosols from hydrophobic to hydrophilic is more than 10 times faster in polluted than in remote areas. Condensation of H_2SO_4 vapor is found to be the most important mechanism in the transformation processes. The representative transformation time for this mechanism ranges from ~10 hours in polluted areas to ~100 hours in remote areas. The transformation in remote polar areas is longer than 100hr. The homogeneous nucleation of H_2SO_4 vapor and water vapor reduces the aging time in polluted areas in different degrees, depending on the concentration of H_2SO_4 vapor. The coagulation of hydrophobic BC aerosols with pre-existing water-soluble aerosols is important only in polluted areas, while the coagulation with cloud droplets is relatively more important in remote areas. Sensitivity tests on several important microphysical parameters, such as the accommodation coefficient and the nucleation factor in the condensation and nucleation of H_2SO_4 vapor show that the transformation time is affected very weakly by variations of these parameters.

Since the condensation of H_2SO_4 vapor plays a critical role in the transformation process, one would expect that BC aerosol modeling be improved significantly if simulated together with sulfate chemistry. A global chemistry model, MOZART II, is applied in this purpose. There are ozone, sulfate, ammonia, and nitrate chemistry in the version of MOZART II for this study. The results are compared with simulations by using a global uniform transformation time (control run). It is found that BC aerosol concentration is reduced in polluted areas, and is increased in remote areas by using a parameterized transformation time (parameterized run). The increase is especially prominent in south Africa and South America (the major biomass burning areas), Antarctic areas, and higher atmospheric levels. A preliminary comparison of the control run with observations indicates that the variation trend in the parameterized run is good.