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The effect of aerosol on radiation fog life-cycle

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Radiation fog is formed during the night under clear skies when emission of long wave radiation cools the surface and air above it. After formation, the development of fog is further influenced by longwave cooling and turbulence entrainment-detrainment at the top of the fog layer, and microphysical processes through droplet activation and sedimentation. After sunrise, the fog is dissipated due heating of the surface and the air above it. Like in the case of clouds, atmospheric aerosol particles also affect the properties of fog and together with meteorological conditions determine their life cycle from formation to dissipation.

To explore how aerosols are affecting radiation fog properties and lifetime, we have used a Large Eddy Model with explicit representation of aerosol particles and aerosol-fog droplet interactions. Our results show that the fog droplet concentration increases with increasing aerosol concentration. In the early stages of fog formation the radiative cooling at the top of the fog controls the maximum water supersaturation and droplet formation in a similar manner than the updraft velocity does at the base of a cloud. The liquid water content in the fog is mainly determined by the droplet concentration as large droplets are efficiently removed through sedimentation. Thus, with increasing aerosol particle concentration, the more numerous, but smaller fog droplets increase the fog's optical depth and thereby delay the fog dissipation after sunrise, because the surface warms more slowly. This effect is further enhanced if turbulence inside the fog leads to secondary activation of droplets. Overall, the radiation fog dissipation in polluted conditions can be delayed up to hours when compared to clean conditions.