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A New Model of Wet Growth and its Role in the Aerosol-Cloud-Lightning Interaction

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Wet growth of rimed precipitation occurs when supercooled cloud-liquid is accreted faster than it can freeze on impact. Wet growth displays a strong threshold behaviour with respect to particle size and liquid content. These are aerosol-sensitive quantities.

A new theory of wet growth of hail is proposed to treat inhomogeneities of surface temperature and coverage with liquid of the surface of the particle. The new theory can parameterise the effects from the typically spheroidal shape of real hail. The parameterization is implemented in two cloud models with bin microphysics.

An impact from soluble aerosol pollution on the penetration of wet growth to colder temperatures in hail-shafts of vigorous continental convection is shown with simulations. A similar type of impact is predicted for the occurrence of raindrop-freezing, a common source of hail, with an associated aerosol-sensitivity of radar ZDR-columns from supercooled drops predicted. Such columns disappear at low soluble aerosol loadings.

Lightning is created by charge-separation in rebounding collisions between ice and large ice precipitation in convective clouds. Yet ice crystals hitting a wet surface will stick to it. Hence, wet growth is important for limiting the charging of a thunderstorm. By invigorating raindrop-freezing, hail formation and riming aloft extra aerosols can augment the ice precipitation and charge separation in a thunderstorm. The simultaneous boosting of wet growth by extra aerosols partially counteracts this sensitivity. Wet growth is important to include in models of the aerosol-cloud-lightning interaction.