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Multifaceted Aerosol Effects on Precipitation

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A wide range of aerosol effects on precipitation have been proposed, from the scale of individual clouds to that of the globe.

This presentation, based on the findings of an expert workshop under the umbrella of the GEWEX Aerosol Precipitation initiative, reviews the evidence and scientific consensus behind these effects and the underlying set of physical mechanisms, categorised into i) radiative effects via modification of radiative fluxes and the energy balance and ii) microphysical effects via modification of cloud droplets and ice crystals.

There exists broad consensus and strong theoretical evidence that, because global mean precipitation is constrained by energetics and surface evaporation, aerosol radiative effects (aerosol-radiation interactions and aerosol-cloud interactions) act as drivers of precipitation changes. Likewise, aerosol radiative effects cause well-documented shifts of large-scale precipitation patterns, such as the Inter-Tropical Convergence Zone (ITCZ). The extent to which aerosol effects on precipitation are applicable at smaller scales and driven or buffered by compensating microphysical and dynamical mechanisms and budgetary constraints is less clear. Although there exists broad consensus and strong evidence that suitable aerosol perturbations increase cloud droplet numbers, reducing the efficiency of warm rain formation across cloud regimes, the overall aerosol effect on cloud microphysics and dynamics as well as the subsequent impact on local, regional and global precipitation is less constrained.

This presentation provides a review of the physical mechanisms of aerosol effects on precipitation backed up by evidence from recent cloud-resolving and global modelling simulations as well as from satellite observations.

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