Impact of air pollution (aerosols) on precipitation

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Spectral (bin) microphysics (SBM) was coupled to the Weather Research Forecast (WRF) model to investigate the effect of aerosol concentration (i.e., air pollution) on simulated precipitation in mountain induced (shallow) precipitation, squall-lines, and super-cell circulations. Two-dimensional (2-d) and three-dimensional (3-d) simulations were produced to simulate both liquid and ice processes using either maritime ("clear-air") or continental ("dirty-air") aerosols. Over the mountain slopes, 2-d simulations with clean air produced more precipitation on the lower and middle mountain slope than simulations with continental aerosols. In the squall line 2-d simulations, dirty clouds produced higher cloud tops, but less precipitation. In the super cell 3-d simulations, dirty clouds produced more intense circulations and higher rain amounts. Sensitivity tests demonstrated the importance of relative humidity and vertical velocity on droplet spectrum broadening and precipitation amounts, and showed that ice processes lead to greater sensitivity of precipitation to aerosol concentration.