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Cloud aerosol interaction - Propagation of aerosol effects from cloud microphysics to dynamics

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Aerosol particles serve as cloud condensation nuclei (CCN), thus clouds developed in a polluted environment have more numerous smaller cloud droplets that increases the cloud brightness and lifetime. Such changes in the droplet properties may induce changes in larger scales. The rain suppression, or delay, due to the change in droplet distribution will allow a development of stronger updrafts. Smaller droplets driven by stronger updrafts may freeze on lower temperatures releasing the freezing latent heat higher in the atmosphere, hence further enhancing the convection. Stronger convection will create higher clouds, larger ice anvils and different rain patterns. We have shown these effects by using large statistics of 1km resolution MODIS data over the Atlantic. The aerosol effects were separated from the meteorology by several tests and the orthogonal component was isolated by regression. The average convective cloud top height increased by 500m and the average cloud fraction increased by 12% when comparing clean to average aerosol loaded atmosphere. The resulting daily radiative forcing is cooling of -8+-1 W/m2 at the top of the atmosphere and -10+-1 W/m2 at the surface, but the impacts on the type and distribution of precipitation, energy and moisture are expected to be even more important.