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Simulation of hurricane response to suppression of warm rain by sub-micron aerosols

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Abstract. The feasibility of hurricane modification was investigated for hurricane Katrina using the Weather Research and Forecasting Model (WRF). The possible impact of seeding of clouds with submicron cloud condensation nuclei (CCN) on hurricane structure and intensity as measured by nearly halving of the area covered by hurricane force winds was simulated by "turning–off" warm rain formation in the clouds at Katrina's periphery (where wind speeds were less than 22 m s^{-1}). This simplification of the simulation of aerosol effects is aimed at evaluating the largest possible response. This resulted in the weakening of the hurricane surface winds compared to the "non-seeded" simulated storm during the first 24 h within the entire tropical cyclone (TC) area compared to a control simulation without warm rain suppression. Later, the seeding-induced evaporative cooling at the TC periphery led to a shrinking of the eye and hence to some increase in the wind within the small central area of the TC. Yet, the overall strength of the hurricane, as defined by the area covered by hurricane force winds, decreased in response to the suppressed warm rain at the periphery, as measured by a 25% reduction in the radius of hurricane force winds. In a simulation with warm rain suppression throughout the hurricane, the radius of the hurricane force winds was reduced by more than 42%, and although the diameter of the eye shrunk even further the maximum winds weakened. This shows that the main mechanism by which suppressing warm rain weakens the TC is the low level evaporative cooling of the un-precipitated cloud drops and the added cooling due to melting of precipitation that falls from above.

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