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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Simulation of hurricane response to suppression of warm rain by sub-micron aerosols" *by* D. Rosenfeld et al.

D. Rosenfeld et al.

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The authors thank Referee 1 for the constructive and helpful comments. Following are our responses to the comments of Referee 1, which are replicated here in *italic text.*

Comment: *Concerning the choice of hurricane Katrina.*

Response: The choice of Katrina was due to its high visibility. We did not attempt explaining the observed variability of real Katrina intensity by aerosol effects, but rather use Katrina for our sensitivity study to the potential aerosol effects. We agree that other tropical storms should be simulated as well. Katrina was not the kind of storm that is expected to show the greatest response to aerosols, because it was a too concentrated

tropical cyclone (TC), which had too small cloudy area for seeding. We agree that there is no a general correlation between hurricane intensity and the size of eyes.

However, when evolution of particular TCs is considered, an increase in intensity is usually accompanied by the decrease in the eye size. In the paper we consider effects of seeding of clouds at TC periphery on both TC intensity (maximum wind, minimal pressure) and hurricane strength (the overall strength of the TC as the area covered by hurricane force winds). It is shown that during the first 12 h seeding decreases both the intensity and the strength. Later on, a small increase in the TC intensity was found to be accompanied by the decrease in the TC strength.

Comment: 5650, lines 19-25: What prev. studies in hurricanes show that a significant fraction of raindrops freezes above the -10°C isotherm? Don't some recent studies show that in continental clouds, there can be significant amounts of supercooled water down to -38°C or colder?

Response: The probability of drop freezing (by collisions with ice or heterogeneous freezing) dramatically depends on drop size. In a clean atmosphere cloud droplets grow rapidly and collide producing raindrops. Most of these drops fall as warm rain, and the remaining drops freeze. In continental clouds droplets are smaller, so that they can reach higher levels before freezing. This process was observed by Rosenfeld and Woodley (2000) and numerically investigated in detail by Khain et al (2001).

Comment: *Page 5650, lines 24-26: The statement that "clouds developing in a polluted atmosphere turn out to be more intense and reach higher levels than clouds developing in a less polluted air mass" seems to contradict earlier studies by these same authors on continental clouds! Please explain.*

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Response: The results of earlier studies are related to clouds of the other type (continental cumulus clouds). As concerns the maritime clouds, the aerosol induced invigoration of convection was reported by the authors in a several earlier studies (e.g. Khain et al 2004; 2005; Koren et al 2005).

Comment: 5652, lines 4-7: Which version of the WRF was used?

Response: The ARW (NCAR) version was used.

Comment: *Comment concerning the value of SST.*

Response: This is an obvious error in the text. The SST field was taken over the computational area from the reanalysis and was spatially inhomogeneous. The SST=27°C was at the point of the initial location of the TC. The SST over the Gulf of Mexico was obviously higher. Otherwise we would not get the intense hurricane. The text now reads: "The sea surface temperatures were obtained from the Global Forecast System analysis data file for 00 UT 27 August."

Comment: *Page 5652, Lines 24-29: What observational studies support the assertion in hurricanes that "wind driven sea spray particles serve as giant CCN that initiate early rain even when large concentrations of small CCN exist"? Neither of the two references cited provide such direct evidence.*

Response: The following text was added: Woodcock (1953) measured, just below cloud base in a tropical cyclone near Florida, 10 micrometer diameter wet sea spray particles at a concentration of $1cm^{-3}$ under hurricane force wind ($32ms^{-1}$). The

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concentration of 22 micrometer sea spray particles was $0.3cm^{-3}$, and 47 micrometer particles at $0.1cm^{-3}$. Such concentration of ultra-giant CCN should overwhelm the rain suppression seeding effect even in clouds with very small drops.

Comment: *Some of the figures are so small as to be nearly llegible!*

Response: The online PDF images contain all the fine details, which can be viewed clearly when using higher magnification on the screen.

Interactive comment on Atmos. Chem. Phys. Discuss., 7, 5647, 2007.