**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.

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General Comments:

It's a very original idea, to seed hurricanes. However, a possible criticism of this work is that the convection in hurricanes is typically very deep. Consequently, a very high number concentration of droplets is needed to shut down the precipitation production. So, any seeding of clouds in the hurricane would probably need to produce CCN concentrations of a similar order of magnitude to those of a biomass-burning or pollution plume. Such a seeding operation would be a major task. Is it really feasible ? Even if this question cannot be definitively answered by the paper, it is very worthwhile to start debate on this topic.

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There is an apparently false statement in the interpretation of the results (see below) about potential temperature being unchanged by evaporation but this can be easily corrected. It is a trivial error.

I recommend that the paper be published, subject to minor revisions being made to it.

Specific Comments:

Abstract

It is not clear from what is written here why the low-level cooling weakens the TC circulation. Does it reduce the conditional instability within the TC ?

1. Introduction

This all seems very good.

2.Design of the numerical experiments

Page 5652, Line 8: A bulk microphysics scheme cannot be "explicit". An explicit microphysics scheme refers to a size-resolving (spectral) scheme, not a bulk scheme.

Page 5652, Line 16: Can evidence be cited in favour of 27 degC being a realistic prescription of the sea surface temperature over the Gulf of Mexico ?

Page 5652, Line 27: What observed concentrations of sea-salt CCN are possible ? Spracklen et al. (2005, ACPD) have done a modeling study of sea-salt CCN concentrations and find concentrations are generally very low. More evidence would be good on this point. The reason I have doubts about the role that sea-salt giant CCN can have is that Feingold et al. (1999, JAS) have shown that giant CCN > 1 micron only initiate rain in clouds that are close to the threshold anyway for precipitation. Clouds engulfed in smoke or intensively seeded would seem to be far from such a threshold. Physically, just after such giant CCN activate (e.g. at cloud-base), surely their size will converge to that of the other droplets formed on smaller CCN (e.g. Rogers and Yau 1991) ? Maybe not if their initial size is very large.

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3.Results

Page 5655, Line 12: It could be mentioned that the extra cloud-droplets are there at the TC periphery in the NWRP run because of the lack of accretion of cloud-liquid by precipitation.

I wonder why the simulations must be referred to with mnemonics. Discussion about "NWR" and "NWRP" all seems unnecessarily cryptic. Could they simply just be described as "zero-warm rain" or "zero-peripheral warm rain" simulations ? It is confusing to refer to the control run as "WR", which seems to connote yet another perturbation run. Why not call the control run "the control run"?

Page 5655, Lines 19-22: It is unclear which simulations are being compared.

4.Interpretation of the results

Page 5656, Lines 1-5: The sensitivity of the latent heating may be viewed as arising from the fact that ordinarily, the warm rain process provides a major sink for cloud-liquid because of accretion. So, when warm rain is absent, there is much more cloud-liquid to freeze aloft. Maybe a mass budget for cloud-liquid would make this point clearly.

Page 5656, Line14: It is true that evaporative cooling can cause lower tropospheric air to be less buoyant.

Page 5656, Line15: It is not true in general that the potential temperature must remain unchanged during evaporation. In fact, it can be changed by either condensation or evaporation, which is why latent heat release from condensation contributes to the positive buoyancy of cloudy parcels inside convective clouds. It is the equivalent potential temperature that is unchanged by evaporation.

Page 5656, Line16: Because the air is cooler (i.e. its potential temperature is reduced), its buoyancy is also reduced (proportional to the fractional excess of the potential temperature over the environmental value). This is why the evaporative cooling at low levels in the NWR and NWRP cases reduces the deep convective ascent, causing the

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eye to be more compact.

Page 5657, Line 27: the statement that low-level evaporative cooling "might explain" the reduction in TC intensity in simulations by Cotton et al. 2007 seems unnecessarily vague. The whole point of using models is that one can be sure of the internal functioning of the model, even if there is uncertainty about how realistic the model is. So, it ought to be possible to analyse the paper by Cotton et al. (2007) more carefully and say with certainty whether or not evaporative cooling is important. At least, some more details here could be provided in support of this argument.

5.Discussion

Another schematic diagram of the hurricane track would be good (e.g. a plan view from above). It could illustrate the organisational and early stages of the cyclone's life-cycle, and the spatial extent of the seeding window over which the storm is sensitive to seeding.

Clarification is required about how the present simulations demonstrate the existence of a "seeding window". How is this inferred from your results ?

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

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