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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Investigations of aerosol impacts on hurricanes: virtual seeding flights" *by* G. G. Carrió and W. R. Cotton

Anonymous Referee #2

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General comments

This paper introduces an interesting method of studying the effects of cloud seeding in a numerical model by using virtual seeding flights. It is remarkable that the effects of the virtual seeding flights on the strongest winds are quite large (figures 13 and 14).

My main concern is the assumption that inreasing the number of CCN affects through cold pools only. It has been shown in many studies that there are other effects of convection in the outer rainbands than just that due to the cold pools (e.g. references of Anonymous referee 1). For the other mechanisms of how convection in the outer rainbands may cause weakening of the storm, see Bister (2001, Journal of the Atmospheric Sciences, 58), p. 3470. In that study, prevention of sea surface fluxes of latent and sensible heat in the outer region resulted in a faster development of the storm.

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The balanced response to outer convection, at least temporarily, dominated the effect of weaker surface fluxes.

The effect of cold pools was quite strong in Riemer et al. Compared to their no shear case, the "significant thetae depression was associated with a 4-5 g/kg depression in the water vapor mixing ratio and a 2-3 K depression in theta relative to the no shear case (p. 3171)". In the present study, the cold pools do not seem to be much colder than in the control case.

The authors should show evidence for their statement that the intensity changes are related to the cold pool effects (and not balanced effects associated with increased latent heating in the outer rainbands), especially since the mechanism they suggest relies on increased intensity of convection in the outer rainbands.

It would also be interesting to see whether the net latent heating in the outer rainbands in 16000cm-3 case has changed from that in 12 0000cm-3 and 8000cm-3 cases? Also re-evaporation of ice should be taken into account in such a calculation.

Specific comments

1. p. 22443 line 12. Is the TC in a steady state during 36-42 hr?

2. The figure captions as well as the table captions should contain more information. E.g., specify which experiment, time/time interval, averaging region/time etc. Also how was deltaT__pool calculated? Is it an average over all cold pools? Please define all quantities carefully.

3. p. 22444 l.2 What is the "latter experiment"?

4. p. 22444 l.21-24. Integral volume of precipitation during four hours increased by 15 %. How much did it decrease during the 29 hours from 43 to 72 hr? Even if it decreased much less than 15%, the longer time interval (29 hr compared to 4 hr) can make the net effect large. An artificial increase of precipitation may lead to a decrease in precipitation when the forcing ends.

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5. p 22445 l. 6. Shading is missing from the table.

6. What might be the reason for the last experiment in Table 1 to be so close to the control experiment?

7. Section 4.2 Why not consider theta_e instead of temperature? Theta_e is important for convection. And this would also help the comparison with the results of Riemer et al.

8. p. 22445 l. 17 What is the last 24 hr of the simulation? How long did the simulation last?

9. 22445 l. 20. The difference in temperature might not be so much the cause of the weakening as the difference in Theta_e. And as said above, there is no evidence in the paper now showing that temperature and wind changes (and their effects on the eyewall convection) associated with the increased precipitation in the outer rainbands would not be the cause for the weakening of the storm, at least partially.

10. p. 22446 l.2 An extra zero.

11. p 22446 l. 6. How was this downward mass flux calculated, where and when and what kind of an average?

12. The use of word "respectively" is not right in some figures, e.g. fig. 7.

13. p. 22446 l. 14-19 There seems to be a contradiction in "larger areas covered by them" and later "downdraft areal coverage lower"

14. p. 22446 l. 20 What are the "three cold pools"? Are these three cold pools discussed later?

15. Section 4.4. In all categories, frequencies have decreased. This is somewhat surprising especially since there is an increase of precipitation in the outer rainbands, which should increase the tangential wind there. You could include a plot to show the effect of seeding on tangential wind speed as a function of radius from the center. Such

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a plot for a few experiments would be very informative. It would also be interesting to see this kind of a plot for a later time after the seeding. What is the time interval used in figures 13 and 14?

16. p. 22448 l.10 Where in Riemer et al is it said that the overall (azimuthally averaged) convective activity in the outer rainbands is invigorated when shear is added? Is this a conclusion from their figure 7?

17. p. 22448 l. 19. What is this downward flux? How is it defined?

Interactive comment on Atmos. Chem. Phys. Discuss., 10, 22437, 2010.