We thank Roger Smith for his careful reading of our manuscript and his detailed comments and suggestions for further improvement. For convenience, his comments are here repeated in blue, our respective responses are given in black.

#### **Minor comments**

P6990, L9: I suggest: "We survey here ..." Changed to "..., we survey and diagnose here ..."

## **P6990, L16:** What, precisely is meant by "a higher downdraft activity". How is such activity quantified?

In Sec. 3.7, a "higher downdraft activity" is implicitly defined as a broadening of the frequency distribution of downdraft magnitude, i.e. as a more frequent occurrence of strong downdrafts. We do not introduce a threshold value for "strong downdrafts". Our notion of relatively strong downdrafts is based on visual inspection of contour frequency by altitude diagrams (CFADs). A more thorough quantification of "downdraft activity" is not intended in this study. We believe that the notion of increased downdraft activity is sufficiently clear from the visual inspection of the CFADs.

In the context of the abstract, the following phrasing should be clearer to the reader (changes are given in bold):

"Tropical cyclones in which strong downdrafts occur more frequently exhibit a more pronounced depression of inflow layer  $\theta_e$  outside of the eyewall."

We have deleted "in our experiments" at the end of the sentence because it is already very clear in this paragraph of the abstract that we present results from our experiments.

P6991, L16: I suggest inserting a comma after "Carnot cycle". Should Carnot cycle be hyphenated?

We follow this suggestion and this part now reads: "... idealised Carnot cycle, a decrease ..."

# P6991, L21: Is it really necessary to introduce the non-standard acronym "SBC"? My suggestion would be to get rid of it!

We believe that the introduction of this acronym is not overly confusing to the reader. We are neither aware of a conflicting definition for SBC nor of a standard acronym for the 'stationary band complex" or, more generally, for "rain bands".

P6992, Footnote 2: "has been" should be "was". Corrected

P6993, L8: I suggest: "We survey here ... " Changed to "..., we survey and diagnose here ..."

P6993, L16: I suggest placing "employed" after "scheme". Done, and expanded to "employed in this study".

**P6993, L24-25:** I would have thought one could give a pretty good explanation for how these differences arise in terms of the conventional (balance) model of spin up, noting that the inclusion of ice microphysics will substantially modify the diabatic

heating rate etc. etc.

We agree that the explanation outlined by Roger Smith is a promising avenue to better understand differences in the radial structure between experiments employing different microphysics schemes (and thus exhibit differences in the diabatic heating profiles). However, we are not aware of published studies that elaborate on these ideas. We have added the following footnote to communicate this potential explanation:

"In his review of this study, Roger Smith proposes that a first-order explanation of how these differences arise could be given in terms of the conventional (balanced) model of vortex spin-up, noting that the inclusion of ice microphysics substantially modifies the diabatic heating rate. We are not aware, however, of published studies that elaborate on this idea."

P6994, L19-21: I don't fully understand the arguments here. Doesn't the "replenishment time" for  $q_e$  depend on the total wind speed and not just the strength of the inflow? How do you quantify "more complete"?

Our use of the term "replenishment time" in this context may not be sufficiently clear. We have clarified our argument as follows (new wording is given in bold):

"Smaller values of  $C_D$  may lead to less radial inflow and thus to an *increase* of the time that the air parcels spend under the influence of surface fluxes while spiralling inwards. Assuming that  $C_K$  is not changed, and that the wind dependence of the fluxes is dominated by the tangential wind speed, the replenishment of depressed inflow layer  $\theta_e$  values is then more complete than for larger values of  $C_D$ ."

P6996, L16: I suggest replacing "the scheme" by "that". Done

P6996, L19: I suggest replacing "wind" by "flow". Wind usually refers to the horizontal component of the flow. Done

P6997, L4: I suggest removing "also" and inserting "further" after "grow". Done

P6999, L2: I suggest replacing "and" by "together with". Done

#### P6999, L8: What is the significance of the acronym RMN?

The following phrasing should clarify the significance of this acronym (new wording is given in bold):

We refer to experiments that employ the same parameterisations as in RMN10, i.e. warm rain and Deacon's formula for the exchange coefficients (with  $C_K / C_D = 1$ ), as RMN.

#### P6999, L22: Is "mps" defined in RMN10?

Yes, "15mps" is the name given to one of the experiments in RMN10. We now use quotation marks to emphasize this fact.

P6999, Sec. 2.4: It might be helpful to the reader to say briefly what the purposes of

the new experiments are and not just specify them?

The purpose of our new experiments may not have been communicated sufficiently clearly in the manuscript. In the introduction, at the beginning of Sec. 1.2, we now emphasize that one goal of this study is to assess the robustness of RMN10's results in a more realistic and representative experimental setup. In response to comments by Reviewer 3, we further note that the purpose of this study is **not** to investigate the impact of environmental factors such as the vertical profiles of moisture and temperature, and the environmental winds. The beginning of Sec. 1.2. now reads:

"The experimental setup in RMN10 features a simplified cloud microphysics scheme, a likely overestimation of the surface exchange coefficients of momentum and enthalpy at high wind speed, and a very high TC intensity at the time when shear is imposed, representative for a minority of TCs in the real atmosphere only. The particular relevance of these points for RMN10's framework is discussed in more detail below. One goal of this study is to assess the robustness of RMN10's results in a more realistic and representative experimental setup.

Several environmental factors likely play a role for the evolution of TCs in vertical wind shear also. Besides the obvious importance of the shear magnitude, such factors include the vertical profiles of environmental wind speed and direction (Zeng et al., 2010, Wang 2012), and the environmental moisture and temperature profiles (cf. discussion in RM11).

Careful examination of the importance of these environmental profiles is beyond the scope of this study but constitutes an important topic for future research."

The following footnote is added at the end of the above paragraphs: "A brief discussion of the potential consequences of the environmental wind profile can be found in the authors' response to the anonymous reviewer (item 1 and 2) on the ACPD webpage."

Furthermore, the title of subsection 1.2 has been changed to "Purpose of additional experiments".

P7000, L10: I suggest replacing "consistent" by "common". Done

P7000, L15: I suggest inserting a comma before "but" and writing "due also" so as not to split the verb. Done

P7000, L24: I suggest replacing "of" by "between". Done

P7002, L6: I suggest inserting a comma after "gradient". Done

P7004, L1: I suggest moving "in contrast" before "In CBLAST". Done

**P7004, L13-15:** I find this sentence unclear and the appearance of "based on the" twice in one sentence is clumsy. Why can one expect a more pronounced intensity decrease in ICE<sub>68</sub>?

Wong and Chan (2004) found that, in their set of experiments, TCs with smaller

radial scale are more susceptible to the detrimental impact of shear than TCs with a broader radial scale. Their results are briefly summarized at the end of Sec. 3.1.1 on P7002. In our set of experiments, the TC in ICE<sub>68</sub> has a smaller radial scale than in the RMN<sub>68</sub> and CBLAST<sub>68</sub> experiments. Thus, one may expect a more pronounced weakening in ICE68 due to the smaller radial scale alone.

We do not believe that it is necessary to repeat Wong and Chan's results relevant to the current study in this paragraph. We now remind the reader that the results are discussed earlier in the manuscript and slightly reword the sentence:

"Furthermore, based on the results of Wong and Chan (2004) **summarized at the end** of Sec. 3.1.1, a more pronounced intensity decrease in ICE68 can be expected due to the smaller radial scale of the vortex alone."

P7005, L8: I suggest replacing "to" by "from". Done

P7005, L28: Insert "a" before "quiescent". Done (in L25)

**P7006, L14-17:** It would be worth saying what the reduced mass flux would do, rather than simply writing "due to".

The impact of the reduced mass flux is discussed in more detail in Sec. 4.2. A reference to the associated divergence above the inflow layer is now included in this sentence also (added text given in bold):

"... this rapid weakening is consistent with the frictional spindown of an axisymmetric vortex due to **divergence above the inflow layer associated with** a significant reduction of the inner-core convective mass flux."

We have made the same modification to the sentence just before the beginning of Sec. 4.1 on page 7017 also.

P7008, L15: I suggest inserting "The quantity" before DFX. Done

P7009, L4: Is a "helical updraft" the same as a "rotating updraft"?

The helical updrafts referred to here are distinct from, say, rotating updrafts in vortical hot towers. No reference, however, is made in this manuscript to types of rotating updrafts other than the following:

The updrafts in the stationary band complex are helical because the updrafts occur in the strong swirling winds of the TC. Air parcels experience considerable azimuthal displacement while rising in these updrafts. Due to this azimuthal displacement, precipitation from these updrafts may fall into unsaturated air below. The importance of this process is emphasized in the introduction (Sec. 1.1). At the current point in the manuscript, we intend to emphasize the helical path that individual air parcels take without reiterating the process that leads to the distinguished downdraft pattern due to evaporation of precipitation in unsaturated air below the helical updrafts.

P7009, L10: I suggest placing "thus" at the beginning of the sentence. Done

P7009, L13: I suggest writing " ... the correlation of the location of formation of the stationary band complex with the tilt ... "

Changed to: "The correlation of the location of SBC formation with the tilt ... "

P7009, L25: I suggest placing "therefore" at the beginning of the sentence. Done

P7009, L26: I suggest placing "however" at the beginning of the sentence. Done

P7010, L4-5: Too many "and"s in this sentence. Thank you. We have deleted the first "and" and added commas.

P7012, L25: I suggest adding a comma after "cycle" and deleting (or moving) "thus". Comma added and "thus" deleted.

P7013, L6: I suggest replacing the first "in" by "into". Done

P7013, L7: I suggest adding a comma after "cases". Done

P7013, L20: I suggest placing "however" at the beginning of the sentence. Done

P7013, L22: I suggest placing "therefore" at the beginning of the sentence. Done

P7014, L4: I suggest adding a comma after "semicircle". Done

P7014, L8: I suggest placing "In contrast" at the beginning of the sentence for more emphasis. Also, to what does "it" refer?

For emphasis and clarification, the sentence is rephrased as follows:

"In contrast, in RMN<sub>54</sub> and ICE<sub>68</sub>, an additional, much more direct pathway for low- $\theta_e$  air from the downshear quadrant to enter the eyewall updrafts in the downshear to downshear-left quadrant is indicated (Fig. 8c,e)."

P7014, L19: I suggest placing "here" at the beginning of the sentence. Done

P7014, L25: I suggest placing "therefore" at the beginning of the sentence. Done

P7014, L27: I suggest adding a comma after "(Fig. 9a,b)". Done

P7015, L2: I think you don't need the comma after "both". Deleted

P7015, L10: I suggest replacing "as" with "to those". Done

#### P7015, L26: Why i.e.? I don't follow the argument.

We meant to give a brief definition of the wet-bulb process. Now, we have dropped the term wet-bulb process and the sentence simply reads:

"First, evaporation of precipitation cools an air parcel isobarically until saturation is reached."

#### P7016, L4-6: I don't understand this sentence. "respectively" doesn't fit!

Examining DCAPE in the different regions, we could not find any clear relationship between the DCAPE values and "downdraft activity", or between the DCAPE values and the downward flux of low- $\theta_e$  air into the inflow layer. Rephrasing the sentence as follows, we hope to clarify the statement:

"For none of these regions, we could find a clear relationship between the DCAPE values and the downdraft activity, or between the DCPAE values and the downward flux of low- $\theta_e$  air into the inflow layer."

#### P7016, L29: I would put "also" before "the associated" on the previous line.

We have moved "also" to the end of the sentence. The idea here is that similar differences between CBLAST and RMN are found in the no-shear experiments also, not only in the shear experiments.

P7017, L11: I suggest placing "nevertheless" at the beginning of the sentence.

Done, The sentence now starts with: "Nevertheless, it has been shown in the previous section that ..."

P7018, L4: I suggest writing "We consider now ... " and inserting a comma after "short-lived". Done

P7018, L23: I suggest inserting a comma after "ICE68". Done

P7018, L24: I suggest inserting a comma before "but". Done

P7018, L27: Would "preferentially" be better than "preferably". Yes, thanks.

P7020, L13: I suggest writing "examines further". Done

P7020, L14: I suggest replacing "based on" by "on the basis of". Done

**P7021**, L3-4: This sentence is unclear. What is "interacting" with the shear?

The TCs are interacting with the shear. Upon reflection, however, it seems superfluous to mention this explicitly at this point. We have simplified the sentence as follows:

"Some differences in this radial structure arise in the individual experiments before vertical wind shear is imposed."

P7021, L9: The construction "to, e.g.," is a little clumsy! We have deleted "e.g.".

P7021, L22: I suggest placing "However" at the beginning of the sentence. Done

P7022, L12: I suggest replacing "as" by "to those". Done

P7022, L14: I suggest replacing "are all the most" by "more".

We have rephrased the sentence as follows:

"In our suite of experiments, the general downdraft activity, ... are most pronounced in the ice experiment."

P7022, L16: I suggest replacing "than" by "as that". Done

### **References:**

Wang, Y.: Does the vertical wind shear profile matter to tropical cyclone intensity change?, 30th Conf. on Hurr. and Trop. Met., Ponte Verde, Fl, 2012, https://ams.confex.com/ams/30Hurricane/flvgateway.cgi/id/20692?recordingid=2069 2.

Zeng, Z., Wang, Y., and Chen L.: A statistical analysis of vertical shear effect on tropical cyclone intensity change in the North Atlantic, Geophys. Res. Lett., 37, 2010.