

Review – Ambrogio Volonté

Interaction of microphysics and dynamics in a warm conveyor belt simulated with the ICON model

This manuscript contains a very extensive and thorough study that, using a case study, focuses on the effects of (total and individual) diabatic processes on the dynamics of warm conveyor belts. The manuscript is well-written and all the science questions are addressed in detail. My only issue is on the balance between the breadth of analysis included in the manuscript and the necessary synthesis of the results (see General comments). Therefore, I won't have any major problems with the publications of this work once the comments below are addressed.

General Comments:

I don't have any specific major comments on this work. My main concern is more general and relates to the risk of the main results of the analysis being somewhat hidden amongst the description of all the individual behaviours/effects/processes at play. I would suggest the authors go through the whole manuscript and see where and how the descriptions of the various figures can be slimmed down and the key results be better highlighted.

I think this is also true in the abstract and conclusions, both fairly long and detailed (too much?). I would like to see more emphasis on the motivation for this work, highlighting its novelty more clearly, and a more concise description of the results.

I must clarify that I see great value in being able to isolate the effects of individual diabatic processes in the thermodynamics and dynamics of WCBs and I really like the use of this combined Eulerian – Lagrangian framework. This is a great study. However, to avoid the risk of readers getting the impression that it is mainly “incremental” research, can you better highlight what is novel in its purpose, methodology and results? For example, could a final schematic help in highlighting that fast-ascending WCBs are also more diabatically heated and start with higher RH and relate this to implications for future WCBs? Or concisely point at the key modelling developments this study is suggesting?

The specific comments below are mostly very minor and/or typographic.

Specific comments, line-by-line:

Line 30: Most readers would probably know it already, but I suggest adding “warm-sector” before “cloud band”.

Line 64: “in the dynamics of ...”

Line 86: what does “The latter” refer to here?

Line 88: “major contribution to the PV modification” is this referred to both positive and negative changes or do we have different contributions to different parts of the heating pattern and subsequent PV dipole structure?

Lines 96-98: this is a fairly key point in providing motivation to this study. You could highlight it a bit more, and possibly include a shorter version of it in the abstract

Line 99: I suggest starting the sentence with: “Building upon previous research, in this study we provide...”

Line 100: “two-moment microphysics scheme”: is this part of the novelty?

Line 126: Can you provide some background motivation as to why you are using a real case study (as opposed to idealised or free-running simulations) and why this case in particular? (I’m not at all against it and I know there are several good reasons, but would just like to see the argument made more explicitly) In particular, could you expand on why it is a good case even if, if I understand correctly, it’s not a very convective one?

Lines 275-281: This is a very minor point, but I wouldn’t use ω for relative vorticity in (3) and (4) when the very similar “*w* in italics” is used for vertical velocity at line 281.

Lines 309: What does “A” stand for in “ADH” and “APV”? If it’s “accumulated”, please say so.

Line 346: Use “60W”, as the minus sign can easily be missed.

Line 365: “providing a high resolution in the WCB”: word missing here? Also could you rephrase the following sentence? I think I got what you mean but it would definitely be clearer if you were to mention the two times and the associated in/out budgets separately.

Line 374: Do the composites include trajectories starting their ascent at different times? If so, did you consider focusing on a single time to reduce the smoothing effect of compositing? Please specify this in the text (linking it with the concluding sentence of the section)

Line 398: “considerably”

Lines 400-401: Any ideas on why there seems to be a “double path” for the slowest ascent, with either small (~15K) or large (25+ K) latent heating? (see Fig 7a) What is the setting leading to very slow but “very diabatic” ascent? How do you reconcile it with the statement at line 407 (and in the analysis following on)?

Line 621: “...the PV rates of the second...”

Lines 733-735: “yet open”. It doesn’t sound grammatically correct to me. I would replace it with “still not clear” or similar.

Fig 1: Dark green crosses are not easy to spot

Fig 2b: The caption reads “CCN activation”, while it’s “CCN concentration” on the x-axis. I suggest making them consistent with each other.

Fig 3: It is rather difficult to see the green contours in panels a-c. Given that they are repeated in panels d-f, where they are far easier to see, I would consider removing them (or just keeping the outer one) from the earlier panels.

Fig 5: in caption (a), replace “isentropes” with “potential temperature” (or alternatively replace “temperature” with “isotherms”, but I would prefer seeing the name of the physical variables rather than of the contours). In (c), could you add a small letter next to each of the species contours (e.g., ‘r’ for rain, ‘c’ for cloud, ‘s’ for snow) or in a legend box, to help the readers visually making sense of it? Thanks!

Fig 10b: tropopause (red contour) missing from the caption.

Fig 11f: coloured PV contours missing from the caption.