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Interactive comment on "Idealised simulations of cyclones with robust symmetrically-unstable sting jets" *by* Ambrogio Volonté et al.

Anonymous Referee #2

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General

The paper presents an important investigation of sting jets (SJs) based on idealized simulations of Shapiro-Keyser cyclones that develop a SJ with the MetUM model. Compared to previous idealized studies, a more realistic representation of a SJ is obtained thanks to improvements of the model initialization. A range of sensitivity experiments is used to explore the environmental control of SJs, such as initial jet velocity, humidity and temperature profiles, and further study the relationship between dry mesoscale instabilities and SJ characteristics. This approach is crucial for understanding what generates the strongest winds, especially given the complexity and high case-to-case variability of previous real case studies. Indeed, SI volume is shown to be consistent with SJ descent through the parameter choices. The paper is overall well-written but

the presentation can be made clearer. The introduction in its present form does not set the scene with a clear story line for the current study, and lacks a clear motivation for specific choices made. These issues should be addressed, and I suggest in the following some ways to improve the clarity of the presentation.

Major comments

1. The background description starts with the cold bias of previous idealized studies. The continuation of Sections 2.1.2 and 2.1.3 drowns in details that divert the attention to configurations of the MetUM and the new thermal wind balance for deep flows, without keeping a line of thought of how this helps to solve the bias and different from the previous idealized simulations. The introduction already becomes very long before the mesoscale instabilities are introduced (which are the focus of this study), and is in many places tough to read, with long sentences and many equations that are not essential for understanding the dynamics in the Results. This part of the introduction should be rewritten and I suggest - to move substantial parts to an appendix and leave only concise information in the main text - especially the information that relates to correcting the temperature bias. - add the humidity profile to Fig. 1, Additionally it would be good to visualize the profiles of the present control to previous simulations and those in the sensitivity experiments. The figure(s) can replace some of the text or analytical expressions. - Break down long sentences (e.g., L51-54, L70-73).

2. It is not fully clear why you state that you focus on dry instabilities. Please clarify what you mean by dry instabilities on lines 75 and 276, which is currently confusing as you discuss also CI and CSI in the same paragraphs, and essentially through most of the results until the synthesis in Fig. 11. The results in Fig. 11 then raise the question of how CSI release in the ascent phase is related to the SJ characteristics. I therefore suggest to either justify the focus on the dry instabilities, or expand the analysis to encompass moist instabilities among the sensitivity experiments.

3. L. 278 and Section 2.3: Please explain the rationale behind attributing the insta-

bilities to slantwise trajectories of the SJ. This is non trivial and especially confusing, considering that CI is defined by theoretical purely-vertical motion of an air parcel.

Minor comments

- You find a coherent saturated ascent - adiabatic descent pattern of SJ trajectories. Related to major comment 2, the reader is left wondering about the role of the initial ascent and its variability among the experiments, and how they relate to other SJ characteristics. Please elaborate on this.

- L4: “and different” is unclear and can be deleted.

- L 82: replace ‘the’ by ‘be’.

- L103: replace “former study” by the reference, to avoid confusion.

- L141: why do you choose the reduction to m_v? how is this consistent with RH wrt ice that is used?

- L194, L198-199: these sentences are unclear. A figure (major comment 1) can help to clarify.

- L249: add ‘d’ to ‘achieve’.

- L267: replace ‘significant’ by ‘significance’.

- L310: reword to “. . . and with accordingly coarser vertical resolution (as shown. . .”

- Fig. 2: Mark the frontal fracture region onto the figure.

- Fig. 3: Mark ‘SJ’ on the wind maximum in 3c.

- L396: delete ‘and see the list of other studies’.

- L401: add ‘h’ after 94.

- L427: replace ‘magnitude’ by ‘rate’.

- L475: delete ‘the’ after ‘until’.

- L501-502: This is not clear. The slope is directed across the slantwise descending flow. Please clarify.

- Fig. 8 caption: replace ‘5a’ by ‘6a’.

- L505-508: These arguments are hard to follow. I suggest to add the vertical velocity onto the CD profiles.

- L569: replace 25 by 45.

- Fig. 11: The legend should have no lines. In caption to (a), note that the 04deg and 025deg overlap at (0,0).

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