

Interactive comment on “Small-scale mixing processes enhancing troposphere-to-stratosphere transport by pyro-cumulonimbus storms” by G. Luderer et al.

G. Luderer et al.

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[This paper shows the importance of small-scale mixing processes occurring at the top of a fire-induced storm (pyroCb) via comparing the features of satellite visible and IR images and cloud top temperature structure extracted from a cloud resolving model simulation results of the Chisholm fire on 28 May 2001. Such mixing processes, especially those associated with the gravity wave processes, are important to the transport of trace species from the troposphere to the stratosphere and the paper sheds lights on the role played by pyroCbs in the cross-tropopause transport via these processes. The paper is clearly written and the analysis appears to be sound. Hence I support the acceptance of this paper for publication.]

We would like to thank Pao Wang for his review and the constructive comments. Replies to the three comments are given below.

[(1) In the middle of P. 10382, the authors mentioned that "the occurrence of the cold U/Warm center structure must have been due to dynamic effects at the cloud top rather than radiative effects". This is exactly the same conclusion reached by Wang et al. (2002a, b) who used another cloud resolving model to simulate a regular severe US Midwest thunderstorm (but not a pyroCb). Thus the present paper enhances the plausibility further that the dynamic effect probably plays the dominant role in shaping the satellite observed IR features atop deep convective storms whether they were fire-induced or not. I think this point deserves some note in the paper.]

The result that dynamic rather than radiative effects are responsible for the cold U/warm center structure is indeed the same as the conclusion reached by Wang et al. (2002a, b). We have not been aware of these studies before. The discussion of the role of dynamic vs. radiative effects was extended in the Sections 4.1 and 5.

[(2) While recognizing that the gravity waves may be largely responsible for the main features of the storm top thermal structure, it is also possible that storm top cirrus plumes, if thick enough, may also contribute to shaping the appearance of the cold-U structure as viewed from satellites, as pointed out in Setvak et al. (2007). For example, it may make the cold-U to look more like cold-V since the plume may cover part of the apex of the "U" and make the apex looked sharper. There are also mean flow-storm interactions that may contribute to the appearance. I understand that the authors have indicated that their conclusions are specific to this case. Nevertheless, it is worthwhile to point out that other processes may also contribute to the overall appearance.]

The observed optical thickness of the Chisholm cloud top and our modeling suggest that the mechanism described by Setvak et al. (2007) is not relevant for this specific case. An additional sentence has been added to Section 4.1 to point this out more clearly. In Section 5, a discussion of processes other than those relevant in our case

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study and their contribution to the overall appearance of the cold U/warm center structure was added.

[(3) Finally, about the term "cold-U (or V)". In US it is now more customary to call it "enhanced-U (or V)". Some readers may wonder whether the two are the same thing or not (they really are). I myself have not particular preference. Either the authors are willing to use the term "enhanced-U" or at least make a note that there is also another term in use that refers to the same phenomenon.]

We decided to stick with the term cold-U/warm center, which seems to be also quite common in the literature (e.g. Setvak et al., 2007). A reference to the alternative term "enhanced-U" was made in the introduction.

Interactive comment on Atmos. Chem. Phys. Discuss., 7, 10371, 2007.

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