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Interactive comment on "On the Freezing Time of Supercooled Drops in Developing Convective Clouds" *by* Jing Yang et al.

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In my opinion, this paper misrepresents the measurements and does not offer any new information. One of the premises stated in the paper is that (e.g. lines 236 – 237): "The ice PSD measured by the Learjet indicates that large frozen drops were observed at colder temperatures than small ice", contradicts the ICE-T measurements shown in Lawson et al. (2015). In the example in Lawson et al. (2015) Fig. 2, there is a clear progression showing that large supercooled drops freeze prior to small drops in the updraft, and the ice PSD shows much higher concentrations of small ice than large frozen drops at the coldest temperatures. These measurements are supported in the mean PSDs shown in Figs. 5 and 9, which are based on all of the cloud penetrations shown in Table 1.

The paper also contains several statements that display a lack of understanding of the

literature and the physics of convective clouds.

For example, lines 30 – 31 state: "Observations suggest that ice initiation in convective clouds is strongly related to the freezing of supercooled drops (Rangno and Hobbs, 2005; Lawson et al., 2015). While the statement has validity as written, the main conclusion of both of these studies is that ice initiation and ice production are strongly related to the size of supercooled drops.

Lines 34 - 35 state: "…during airborne measurements, freezing drops cannot be observed until they have experienced obvious deformation. This generalized statement does not apply in all situations, and perhaps does not apply in most situations. Large drops tend to deform when they freeze so that frozen drops larger than about 300 microns, which are 30 pixels across when viewed with the 2D-S, are most often discernable from supercooled drops of the same size. Smaller drops are readily discernable with the CPI, which has a much smaller sample volume and has poor sampling statistics for drops larger than about 300 microns. That said, there are certainly frozen drops that can be mistaken for supercooled drops, but laboratory experiments and comparisons with other in situ instruments (e.g., LWC and TWC devices), suggest these instances are in the minority.

Lines 39 – 40 state: "the recalescence stage [of the freezing process of a supercooled drop], during which rapid kinetic ice nucleation occurs, which results in a rapid drop in temperature that is terminated when the drop temperature reaches 0 °C." The temperature of a supercooled drop doesn't fall during the freezing process, it rises.

Line 45: Stating the (long) freezing time of a drop in still air ("typical air conditions") is of no value and misleading, because as stated later in the paper, drop cooling and freezing time is largely a function of the convective heat transfer term, which is a nonlinear function of drop size.

Lines 77 – 78: First ice in cumulus may, or may not be small. First ice can only be reliably identified using high resolution imagery from the CPI or similar instruments, and the CPI and other similar instruments have relatively small sample volumes. This limits the ability to detect first ice, whether it is small or large. There are no conclusive measurements of the size and type of "first ice" in convective updrafts. In my opinion this is not well clarified in Lawson et al. (2015).

Line 94: The paper states that coalescence is neglected in the model. Yet, there can be no argument that this is the process that generates the large supercooled drops in tropical convective updrafts. This is a blatant oversight. This alone is grounds for rejection of the paper, unless the authors can definitively show that neglecting coalescence does not affect their results, and explain why this is so.

Lines 107 – 108: "The primary goal of the Learjet was to make repeated penetrations in fresh developing convective updrafts near the cloud top." This is incorrect. The primary objective of the Learjet was to make rapid, repeated penetrations of the updrafts of growing turrets at different altitudes. The C-130 was not capable of making rapid, repeated penetrations of growing convective turrets, and was certainly not capable of climbing with the updraft, which is what the Learjet did whenever possible.

Line 197: As stated in the paper: "The latent heat released due to freezing leads to a sudden drop in temperature from -8 °C to 0 °C." Again, this is incorrect, either a careless mistake or a fundamental misunderstanding. Going from -8 °C to 0 °C is obviously a rise in temperature.

Section 3.3 Discussion: The whole introduction of Hallett-Mossop ice multiplication is off topic and incorrect. H-M did not occur in strong ICE-T updrafts.

The only correct result from this paper that I can find is that large supercooled drops take longer to freeze than small drops. But, this has been known for hundreds of years.

I don't see how this paper can be salvaged in its present form. The work needs to be redone and the paper resubmitted.

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