Review of "Continuous secondary ice production initiated by updrafts through the melting layer in mountainous regions", by Lauber et al., acp-2020-986.

This is an interesting article that uses a gondola with a holographic camera (HOLIMO) to sample a cloud on a mountain slope just above the melting layer at temperatures warmer than -3 °C. Small hexagonal plate crystals were sampled, and given that the vertical motion was estimated to be about 0.6 m/s, this would imply that 1) secondary ice particles were produced in the temperature range 0 to -3C, and 2) that small drops (>40 microns) that shatter when freezing are thought to be responsible for the production of the ice crystals. Nine uphill sampling penetrations were made on 22 February 2019. Calculations based on laboratory measurements and ice crystal growth equations are used to support their conclusions.

Here are my primary concerns.

1) This is obvious but several cases that support your conclusions would have been desirable.

2) Many studies based on in-situ aircraft observations, especially those in tropical regions, have sampled updraft regions (some of them with weak vertical motions) with comparable size drops that have not identified secondary ice particles (SIP) from particle probes, including holographic imagers and the cloud particle imager (CPI) in this temperature range.

3) It seems entirely possible that snow that could fall through the updraft into the melting layer partially melted and created fragments that would have been carried up into the 0 to -3C temperature range and been incorrectly identified as SIP.

4) Given my comments below about ice crystal growth rates and terminal velocity, it seems unlikely that the droplets and SIP plates would have resided in this temperature range long enough to have grown to 60 microns and larger.

5) Although obvious, how applicable are the laboratory experiments of fragmentation applicable to natural clouds?

My more detailed comments appear below.

Page 10, 11. Is it possible that the small plates are a result of partially melted ice that fell through the melting layer and then partially melted ice fragments were carried up brought the melting layer by the 0.6 m/s updraft?

1, line 7: small plates at -3C? According to Fukuta and Takayashi (1999), the basic crystal habit is thick plates (>–4.0°C). I recommend providing that reference at this point in the article.

1, line 11: high temperatures > slightly sub-0C temperatures.

2, 5: "water vapor pressure" to "relative humidity?

2, 12: "exist" to "can exist".

2, 13: I don't think its necessarily the primary ice that causes SIP.

11, line 6. You've calculated how long it takes to grow plates of up to 93 microns diameter at temperatures 0 to -3C. The linear growth rate is extremely slow, because the plates are "thick". The Mitchell et al. (1990) mass dimensional relationship for plates is therefore not applicable. What would the growth rate be if the ratio of the diameter to thickness is 1.0?. Please refer to Figure 10 of Fukuta and Takahashi, who give the appropriate axial dimensions. And their terminal velocity, which will govern how long they stay in the 0 to -3C temperature range before being lofted to higher altitudes and lower temperatures.

My comment above will obviously affect your calculated rate of SIP.

13, 20: The ice number concentration at temperatures below -12C or so are not too much higher than the IN concentration. Also, one does not see evidence from in-situ measurements that there are copious numbers of small plate-like ice crystals at temperatures below -12C that would suggest a vibrant SIP process.

15, 13: "larger" to "higher"

16, 5-6. Terminal velocity can be readily calculated for all ice crystal sizes, based on their shape from the holographic images.

16, 25: Is it even reasonable to assume that 40 micron droplets all freeze and produce splinters? There's no evidence for this from in-situ aircraft measurements.

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