Review of Microphysics and dynamics of snowfall associated to a warmconveyor belt over Korea", by Josué Gehring, Annika Oertel, Étienne Vignon, Nicolas Jullien, Nikola Besic, and Alexis Berne, https://doi.org/10.5194/acp-2019-1173

Overview

This very interesting and well written article discusses their interpretation of the microphysics associated with snowfall associated with a warm conveyor belt that occurred over Korea on 28 February 2018. Their interpretations are based on air trajectories using the Integrated Forecast System Model, scanning X-band Doppler dual-polarization radar, vertically pointing W-band Doppler radar combined with an integrated 89 GHz radiometer, and the multi-angle snowflake camera located at the ground.

General Comments

The interpretations of the microphysics of ice particle growth in this storm system are based on air trajectories, scanning polarization radar data and vertically pointing cloud radar data, and the MASC instrument. At first, I thought that it would be difficult to interpret the microphysics (habits, etc), nucleation (secondary ice production) and growth processes within this storm system without the use of in-situ (aircraft or some type of balloon-borne device). I was unexpectedly surprised to find that indeed they were able to conduct this type of analysis and justify their analysis. I therefore strongly support the conclusions reached in their study.

We gratefully thank you for your review of our paper. We answer your line by line comments here below.

Specific Comments

Page 3, line 9: IFS model: A reference(s) is needed, and a brief description is desirable
Thank you for the suggestion, we added a reference on page 3, line 24:
"We also make use of the Integrated Forecast System (IFS, ECMWF (2017)) model from the European Center for Medium-Range WeatherForecast to identify WCB trajectories associated with this event."
and a reference of the model version and microphysics scheme used on page 5, line18:

"[..] on the 1-hourly 3D wind field of the hydrostatic model IFS (model version Cy43r3 operational from July 2017 to June 2018, ECMWF 2017), The details of the microphysics scheme can be found in Forbes et al. (2011)"

Page 6, line 20: 5 cm/s seems too low to maintain 100% RH in the presence of both ice and snow.
Thank you for pointing this. We did the computation of the critical vertical velocity to maintain supercooled liquid water in the presence of both ice and snow this time, taking again the relation of Korolev and Mazin 2003 (Fig. 10). We found that a critical velocity of 10 cm/s would be enough to maintain liquid water with the concentrations and size distributions provided by the IFS data at 09 UTC in this event. Considering that the ascent rate of the WCB is 20 cm/s, we conclude that it is enough to maintain supercooled liquid water. We added the details of the calculation in an appendix of the paper, which can be found as a second answer to your post in the discussion. We modified this part in the manuscript consequently, Page 6, line 33:
"To show that the ascent rate of the WCB is large enough to produce SLW, we estimated wc from Fig. 10 in Korolev and Mazin (2003) using the radio-sounding and IFS data at 09:00 UTC at 4000 m asl. We found that in this event a vertical velocity greater than 0.1 m s^{-1} would form supercooled droplets in the presence of both ice and snow particles. The ascent rate of the WCB can be

estimated from Fig. 4 to 0.2 m s^{-1}. We conclude that the simulated SLW is a consequence of the strong large-scale ascent in the WCB. "

Page 7, line 15: Figure 6 is terrific. It would be just great to use a V D =Z e relationship for snow to get a rough estimate of the air vertical velocity. If you want suggestions as to how to best do this, you can contact this reviewer (identified at the end of this review).
Thank you for this suggestion. According to our discussion, we decided to investigate the estimation of the air vertical velocity in future studies.

Page 7, 25: KH waves need a stable lapse rate. You mention later that the lapse rate supports KH waves, but you could mention it here. A suggestion would be to discuss the stability of the lapse rate from the sounding through the vertical column of the cloud.
Thank you for this suggestion. We looked at the vertical profiles of the gradient Richardson number (*Ri*) to investigate the conditions for KH instability. It is likely that between 3000 and 5000 m the observed updrafts can be generated by KH instability, since *Ri* is smaller than one and often smaller than 0.25. We added this sentence Page 8, line 6:
"Except for a moist neutral layer around 4000 m at 06:00 UTC, the profiles at 06:00 and 09:00 have a stable lapse rate, which together with a strong wind shear provide favourable conditions for Kelvin-Helmholtz instabilities."

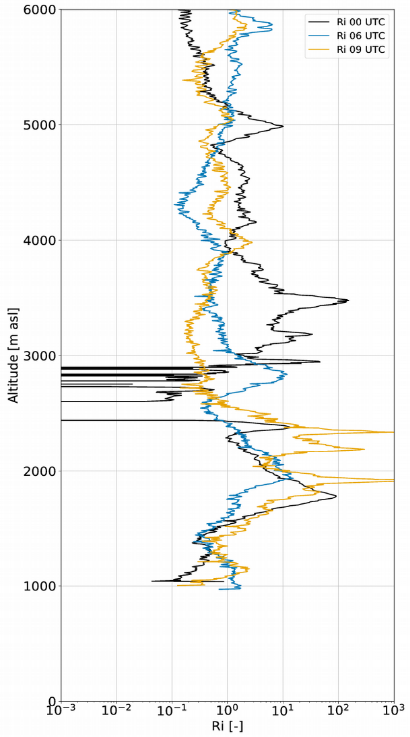

Figure 1: Gradient Richardson number computed from the radiosoundings

General Comment: I feel that you are placing too much accuracy on the measurements of the RH and thus RHi-see for example Page 9, lines 9-11.
We changed the indications of saturation to qualitative terms (e.g. well/slightly above saturation) instead of percentages.

Page 8, line 26, Fig 8: What was the collection temperature?
The average temperature of collection during the period 03:00 to 04:00 UTC was 1.5°C (see Fig. 6a). It is a good point, so we added the average temperature at the site during the collection periods in the MASC figures captions (Fig. 8, 11, 14) and we also mentioned it in the text when this information is relevant.

Technical Corrections

Page 4, line 2: national>National
Corrected
Page 6, line 7: probably should number this figure (6) as (5).
Page 6, line 29: Fig. 5>Fig. 6
We inverted the order of these figures.
Page 7, 11: Micvrophysial>Microphysical
This typo was corrected in the discussion paper published on 04 February 2020.
Page 8, line 31: "support" to "supports"
Corrected

Andy Heymsfield, NCAR