General comment by the authors to the Reviewer #3:

We thank the reviewer for the time and effort in reading the manuscript and for the constructive comments and suggestion which we address in the following point by point (our answers are marked with blue font color and the modified text are in italic blue).

Reviewer #3

The paper describes a dataset composed of radar observations collected at vertical incidence at three different frequencies (at X, Ka, and W band). The “level 2” data are available through the ZENODO platform in netcdf format, while original data should be obtained through the corresponding author. Many studies on multiple wavelength radar techniques have been published in the recent years to show the potential of such techniques for improving retrievals of clouds and snow properties. Since collocated measurements at multiple frequencies are not common, the publication of the dataset is welcome. Examples presented in section 4 highlight the potential of this dataset. Therefore, I recommend that the manuscript should be accepted after minor but mandatory revision. The language of the manuscript is quite poor, but I am confident that after a thorough revision by the author, it can be improved. In the following there is a list of comments/recommendations:

1) The manuscript presents a two-month dataset that authors (in the conclusion) consider a “long-term” one. I am not sure whether “long-term” is appropriate or not. However, it is relevant to add a description of what is in the two-month dataset (how many rain events, snow, a description of main events

A: A table describing all events was also suggested by reviewer #1 (see reviewer #1 comment 1). We added this table in section 4. Regarding the statement of a "long-term" data set, we replaced it by “two-month long dataset“.

2) KiXPol: the X-band radar implements the STAR-mode and LDR measurements are not possible. However, other measurements, such are the copolar correlation coefficients are useful at vertical incidence. Moreover, since the antenna is rotating, also second order moment of dual polarization measurements can be used. I think that, to be

considered as completed, KiXPol data set should include reflectivity, dual-pol, and Doppler measurements (of course, if collected during the experiment). The manuscript reports “Using a pulse duration of 0.3µs, we set the radial resolution down to 30 m which is close to the resolution of the other radars”. Actually, the radial resolution corresponding to 0.3µs is 45 meters

A: We follow the reviewer’s suggestion to include polarimetric variables measured by the X Band radar. As the Doppler velocity is already included, the new polarimetric variables added to the dataset are Z_dr, Rho_hv, Phi_dp and K_dp. These variables are included as they are, and no filtering or quality control has been applied to them. It is true that 0.3µs implies a radial resolution of 45 meters. The explanation of this discrepancy is that the radar software applies an oversampling in order to match the range resolution of 30m of the other radars. We have added a short description of the new variables included in the dataset to the text.

3) JOYRAD-35: As I understood, all the radars are calibrated by the manufacturer. The 35GHz radar, maybe the most popular instrument of this class, comes with a 2dB bias due to receiver losses (as per communication from the manufacturer). Then the verification of the calibration with a disdrometer shows a further 4 dB underestimation. One can preliminarily use as bias determined by the comparison with disdrometer to analyze data, but, after all, the radar should be inspected. Moreover, the sensitivity declared in Table 1 is not the same resulting from Figure 6.

A: We agree with the reviewer that the offsets found are quite large and unsatisfactory, but they are not at all unusual. The literature shows calibration offset even larger than found for our system (for example see Protat, A., D. Bouniol, E.J. O’Connor, H. Klein Baltink, J. Verlinde, and K. Widener, 2011: CloudSat as a Global Radar Calibrator. *J. Atmos. Oceanic Technol.,* 28, 445–452, https://doi.org/10.1175/2010JTECHA1443.1). During more recent times, we applied different techniques to several radars at JOYCE from different manufacturers and found calibration biases for each radar in the order of 2-5 dB even though some instruments came directly from inspection or were brand new. One problem is that manufacturers usually only calibrate the internal components of the radar (receiver, transmitter, waveguides). Issues resulting e.g. from imperfect antenna shape, radome attenuation etc. are usually not directly measured because in order to do so, an external target is needed. Very recently, the use of natural volume filling targets are intensively investigated as important monitoring tool for the calibration quality: Maahn et al, AMTD, 2019:

https://www.atmos-meas-tech-discuss.net/amt-2019-20/). Regarding the sensitivity, the values from the table were indeed slightly different from the figure 6. They have been corrected.

4) JOYRAD-94: note not all the FMCW radars have variable range resolution.

A: The reviewer #1 pointed out the same issue. We reworded the sentence.

The FMCW system allows the user to set different range resolutions for different altitude by acting on the frequency modulation settings (chirp sequence).

5) “Inter radar calibration”: What is presented is not a radar calibration, but it is a method to normalize data from different radar to make them comparable in the ice part of the cloud. Therefore, the title of the section is misleading. Actually, JOYRAD-35 was the only system that underwent a calibration and a calibration problem was highlighted. What about the other systems? I think that working with three different systems, calibrating accurately each of them before a campaign is mandatory.

A: All the three radar were calibrated by the manufactures before the campaign. Our calibration methods using rainfall to simulate the according reflectivities is applied to verify the quality of the initial calibration of the Ka band radar. The additional calibration of the other two radars is required because the manufacturers usually only calibrate the internal components of the radar (receiver, transmitter, waveguides). Issues resulting e.g. from imperfect antenna shape, radome attenuation etc. are usually not directly measured because in order to do so, an external target (caliber) is needed. We have decided to change our discussion in this point to avoid confusion about the term “radar calibration”. The new section title, “DWR calibration”, and the text that follows emphasize the fact that we are not calibrating the radar systems themselves (Ze is indeed underestimated), but we adjust the reflectivity measurements of X band and W band in order to get DWR values that are calibrated with respect to the known Rayleigh regime in the upper part of the cloud.