This article by Lukas Pfitzenmaier et al. presents the development and demonstration of an open-access simulator tailored for the CPR measurements of EarthCARE. The paper provides a novel way of comparing model results with observational satellite data, hence falls within the objectives of the GMD. The work is complete, scientifically accurate, and significant, and the manuscript is well-written and well-structured. Overall the study is suitable for publication. Certain sections could benefit from some additional clarifications, described herein.

Thanks, Eleni Marinou, for reviewing the article and the suggestions and comments given.

L. 5-6: "We demonstrate Orbital-Radar's ability to provide realistic CPR views of typical cloud and precipitation scenes." It would benefit the reader If you include in the abstract some additional information of the demonstration of the realistic CPR views provided in this work. Maybe through mentioning the applications presented in the paper? Also, you could consider including in the conclusion the need of additional evaluation of the performance of the tool with CPR measurements.

Thanks for the comments. The Abstract is edited and some more information included. See the edited text below or in the updated manuscript.

"… . The presented case studies show small-scale convection, marine stratus clouds and arctic mixed-phase cloud cases. These results provide valuable insights into the capabilities and challenges of the EarthCARE CPR mission and its advantages over the CloudSat CPR. Finally,
Orbital-Radar allows for evaluating kilometre-scale numerical weather prediction models with EarthCARE CPR observations. So, orbital-radar can generate Cal/Val data sets already pre-launched. Nevertheless, an evaluation of synthetic CPR output data to accurate EarthCARE CPR data is missing. …"

Lines 74-75: "If the input radar data are from a 35 GHz radar system, then, the technique described in Protat et al. (2010) is used to convert them to 94 GHz and the same dielectric constant (k = 0.75) is used to estimate radar reflectivity (Ze)." The dielectric constant |K2| may vary in different conditions of temperature/ or different wavelengths of electromagnetic radiation (see Table 1 from Lhermitte 1989).
Do you expect that using the same dielectric constant may have an impact on the results of the simulator? Also, please elaborate on the k=0.75, given that the dielectric factor used in radar meteorology is usually denoted as K2.

The code uses the transformation of the dielectric constant to calculate all data based on it. Both constants are used for w-band systems, and the values usually do not change during the radar system's operation. So, the temperature or aggregate dependency of the hydrometeors and their surrounding gases is not used to calculate their equivalent reflectivity values.

See changes mad in the manuscript:
"… . The assumption of the transformation relies on an assumption about the mass–diameter relationship of ice particles used in the Mie scattering computations. the disparity in radar reflectivity between 35 GHz and 94 GHz begins to exceed 1 dB when the 35 GHz reflectivity reaches approximately 0 dBZ. In most cases the 35 GHz radar ice reflectivities fall below 0

dBZ. Therefore, any uncertainty arising from this approximation is deemed insignificant (Protat et al., 2010; Kollias et al., 2019). Also the the same dielectric constant (|k|2 = 0.75) is used to estimate radar reflectivity (Ze). This step is done to match the the Satellite configuration. This is mainly used for the ACTRIS data sets and will be applied during the data preparation of orbital radar. …"

L. 82: "The gaseous attenuation is straightforward and requires only knowledge of the vertical profile of water vapour that can be retrieved from an atmospheric sounding (Liebe and Layton, 1987). Knowledge of the hydrometeor phase, mass, density, and number concentration is needed for the estimation of the hydrometeors attenuation. These microphysical parameters are not available from ground-based radar observations". Can you provide additional comment on indicative cases with strongly attenuating conditions of clouds or rain where the tool phases limitations to simulate the CPR data?

The other reviewers commented that these parts needed more information. Generally speaking, comparing ground-based and satellite CPR measurements is challenging in the presence of liquid water in the ground-based measurements. Therefore, these data are statistically compared using ice cloud data only (Protat et al., 2010; Kollias et al., 2019). This is because the attenuation correction for liquid requires additional data and information that might only be present for some of the sites and data sets. Hence, such preprocessing of the synthetic CPR data strongly depends on the additional data sets available, and no general flagging was calculated. This, on the one hand, makes the use of the synthetic data less intuitive; on the other hand, it increases the number of possible input data sets with which the tool can be used!

L. 89: "The core components of Orbital-Radar have been separately described." Can you clarify in the text if all these core components are used in the simulator?

For this comment, we edited the text. So please see the manuscript.

"… 3. Spaceborne CPR forward simulator

The core components of Orbital-Radar have been separately described in Tanelli et al. (2002); Kollias et al. (2014b); Lamer et al. (2020); Kollias et al. (2022) and used in the code. These are i) the introduction of the Earth's surface radar reflectivity and the response of point target into the range gates above and below the surface (effect of the oversampling of the CPR), ii) the application of the CPR antenna pattern weighting function, iii) the application of the CPR range weighting function considering the details of the transmitter pulse characteristics and the CPR receiver characteristics, iv) the along-track integration, v) the estimation of the Doppler velocity errors, vi) the estimation of the non-uniform beam filling (N U BF) effect on the CPR radar reflectivity and Doppler velocity, and vii) the estimation of the CPR signal-to-noise ratio (SN R), which determines the random error in the CPR radar observables along with the along-track integration. The following sections describe the transformations and assumptions in Orbital-Radar. Following the flowchart (figure 1) we describe how they are implemented and treated within the orbital-radar tool. …"

Equation 1: Do you assume a uniform linear motion? I would suggest to elaborate a little on that.

Yes, a mean wind speed throughout the whole atmosphere is assumed. We know it is a really easy way to transform time into distance along a track. Nevertheless, the parametrization is an easy one; the results are robust and give stable results with a minimum of data input. See changes below or in the manuscript.

"… - Data preparation, coordinate conversion: Ground-based observations are typically recorded as a function of time and range, i.e., height above ground. Orbital-radar converts time (t) to along-track distance (d) by assuming a constant horizontal wind speed (vh) throughout the whole atmosphere: …"

L. 93: Please indicate that NUBF is the non-uniform beam filling. It is mentioned only in Fig 1 caption.

For this comment, we edited the text.
L. 131: typo W(x).

The typo was changed - please see the manuscript.

Lines 126-144: The authors could consider including a brief description of the concept of a weighting function, (e.g. a mathematical example like the Gaussian form e^{-2x2/(2σ2)}). This would help readers not very familiar with technical details, understand how the antenna gain and range weighting functions behave.

Thanks for the comment. We hope that the editing and the additional citation now available in the manuscript help readers understand the concept of weighting functions.

– Along track convolution (spatial filtering): The three-dimensional pattern of the CPR pulse is described by the antenna gain weighting function Want(x, y) where x and y represent the distance from the line of sight in the cross-radial direction and the range weighting function Wrange(r) where r is the distance from the center of the CPR pulse along the radial direction (Kollias et al., 2014b; Tanelli et al., 2002) **(Donovan et al. (2023) provide an overview of the antenna pattern and the along track weighting functions to represent them in simulation).** Cross-track effects are not represented in Orbital-Radar since the ground-based and airborne radar datasets are two-dimensional (time and height). Therefore, Orbital-Radar assumes cross-track homogeneity for all inputs. The Wx(x) for CloudSat is given by:
Wx(x) = exp{−2 · ln(2)(x0.5 · IF OV)2} , (2)
where x is the along-track distance between suborbital observation and CPR line of sight, and IF OV is the CPR instantaneous field of view (Table 1).
– Along range convolution: The range weighting function Wr (r) depends on the transmitted waveform. The EarthCARE and CloudSat CPRs transmit a 3.3 µs unmodulated pulse and Wrange(r) is given by:
Wr (r) = exp{−Cwr · r2} , (3)
where r is the distance between suborbital observation and CPR pulse centre, and Cwr is the range weighting constant (Table 1). However, the transmitted pulse shape and frequency

modulation are not the only parameters determining the detailed shape of the Wrange(r). The EarthCARE CPR uses a receiver filter that generates a sharp cut of the range side-lobes in heights above Earth's surface (Lamer et al., 2020). Therefore, the range weighting function for the EarthCARE CPR is imported from a text file. **Lamer et al. (2020) contains a detailed description of the effect of the range weighting function and provided us the range weighting function used in the tool.** The Wr (r) and Wx(x) describe the instantaneous spatial filter of the CPR and are used to estimate the CPR reflectivity ZeEC and Doppler velocity VEC using the methodology described in Kollias et al. (2023a); Donovan et al. (2023)