**General comment:**
The topic is of great interest and relevance. The direct assimilation of radar data, and in particular polarimetric variables, represents a challenge in data assimilation.

The article refers to various types of radar data assimilation (variational and LEFTK), but does not describe in detail the different methodologies used for the assimilation of such data. For example, with regard to LEFTK, the EMOVRADO operator was developed within the ICON limited area modelling framework, which also has a specific component for “polarimetric data assimilation”.

The introductory part of the article should provide an in-depth overview of this, following a logical path from the definition of the observables to be assimilated, the methodologies already in use, the limitations and strengths of the methodologies. In this context, it is unclear what added value the proposed methodology offers over current methods, considering the results obtained.

We sincerely appreciate the reviewer’s considerate comments regarding the insufficiency of the Introduction, and we have revised this section to substantially improve its completeness. As the primary objective of this research is to validate and point out the unavoidable biases associated with two types of observation operators, the revised Introduction now focuses more explicitly on studies related to dual-polarization radar observation operators. In addition, key references on the LETKF framework, including comparisons between LETKF and other EnKF-based systems, are now briefly introduced for context. Since the biases of simulated observed variables in the background leads to unreasonable error covariance degrading data assimilation performance, it is needed to validate the behavior of the observation operator itself. The added value of this study is explicitly identifying the unavoidable negative $Z_{DR}$ associated with small raindrops. We believe that by depicting these issues could guide future researchers toward more appropriate operator choices and make the simulation more reasonable.

**Specific comments:**
In some parts, the article is difficult to read as it does not follow a logical sequence in its descriptions and explanations.
For example, Section 2 introduces the LETKF system without ever having explained what it consists of (there is a brief mention of the ETKF). Moreover, it is unclear what it means that the WLTAS system is a deterministic ENKF.

Response: Additional descriptions of the LETKF will be incorporated into the Introduction, including its advantages such as the use of covariance localization to prevent analyses from being contaminated by spurious long-range correlations, the ability to compute analyses independently at each grid point, and the benefits of deterministic EnKF. Compared to the stochastic EnKF perturbing the observation before assimilation, deterministic EnKF don’t need to perturb the observation to prevent the sampling error resulting from using the perturbed observation.

From the introduction, it is unclear whether this study is conducted for all types of hydrometeors or whether, as it appears to be, it is conducted only for raindrops. If it is a choice, the reason must be given.

Response: In this study, we employ the same configuration for the ice-particle-related terms in the observation operator, using the power-law fitting approach based on Jung et al. (2008a) in all experiments. For the raindrop-related terms, however, we apply two different formulations—power-law fitting and direct numerical integration—to compute the polarimetric radar variables. The reason for modifying only the raindrop-related terms is to keep the control factors as simple as possible. Because the primary objective of this study is to investigate the unavoidable negative $Z_{DR}$ introduced by the power-law fitting approach for raindrop-related terms, isolating the impact of this single modification allows the errors to be identified more directly and unambiguously. For sure, it is always an important issue that how to properly simulate the ice-phase related term inside the operator, and our team would try hard to set up and examine the ice-phase term. At the same time, it should be noted that validation of ice-particle simulations is particularly challenging in Taiwan due to the limited availability of in-situ airborne observations. For these reasons, the present study focuses on raindrop-related terms and highlights the associated biases below the melting layer, which we consider an essential first step before extending the analysis to ice-phase processes in future work.

In section 3, it would be preferable to first describe the types of data used and then the selected case studies

Response: We agree that, in general, it is preferable to introduce the observational data prior to presenting the case descriptions. However, in this study, the scanning strategies of the operational radars—including elevation configurations and single- versus dual-polarization modes—differ among the three cases, as the radar systems have been gradually upgraded over the past decades. To clearly describe the scanning strategies relevant to each case, we therefore first introduce the cases themselves, followed by a detailed description of the corresponding radar observations.

In section 4, in the part concerning model configuration, it is assumed that the reader is already familiar with the specifications of the model used.

Response: To ensure that readers can clearly understand the background of our model configuration, a brief description of the WRF model and the microphysics parameterization scheme has been added to the manuscript. In addition, the model domain coverage is now described to provide clearer context for the simulations. We have made every effort to present the model configuration in a concise and accessible manner for the readers.