Reply to referee comments

We thank the reviewers for the corrections and suggestions which helped to clarify some sections of the manuscript and, in general, improve the quality of the text.

In the following, the comments from the reviewers are written in italic and highlighted in green.
A version of the manuscript with track changes, hereafter referred to as latexdiff file, is provided together with the reply. In this file, the part of the text that have been removed are highlighted in red, while the ones that have been added are highlighted in blue.

1. Reply to RC 1

1.2 Typos

All typos listed by the reviewer have been corrected. The changes can be observed at the following lines of the diff file: line 208, 812, Appendix C (835).

2. Reply to RC 2

2.1 Technical comments

Thank you for the information regarding the Doppler velocity range of the MRR-2 and the lack of R^2 dependence being a particularity of the MRR and not of all FMCW radars.

The suggested changes at lines 95 and 140 of the latexdiff file (originally lines 94 and 141) have been implemented.

As noted by the reviewer, Figure 2 was not clearly displaying the transfer function reconstruction as optional. Therefore, we added a decision block before this step, highlighting that the default option is to not execute the reconstruction.

3. Reply to RC 3

3.1 Major comments

Thank you for all your suggestions, which helped to improve the “Method” section of the manuscript.

Manuscript is very difficult to read. The problem is not an English language issue, nor a grammar issue.
Even though the English language and grammar are not pointed out as problematic, the difficulty in reading the manuscript mentioned in the comment prompted us to perform a grammar check of the whole text. Several mistakes scattered in the text have been found and corrected, as visible in the latexdiff file.

I believe the difficultly is that the manuscript is not written as a technical journal article describing the work that was performed. The manuscript seems to switch between a technical journal article, a software manual, and a personal history. While all are interesting topics, the manuscript should focus on being a technical journal article suitable for AMT. Writing in one style is difficult. But the end result will be a focused manuscript describing the work that was performed. I suggest the authors focus on one MRR data set and rewrite Section 3 with the focus on describing “the work that was done.” Note that I find Section 4 easier to read than Section 3. I believe that is because Section 4 describes details of the four data sets, which causes Section 4 to be more focused toward a technical article than Section 3.
We fully agree on the presence of major issues in Section 3, as pointed out by the reviewer.

Firstly, in the version of the manuscript that we previously submitted, we provided advice to a hypothetical user on how to handle scenarios different from the ones presented in the manuscript.

Such mentions have been removed, as visible in the following lines of the latexdiff file:

- line 150
  The user is advised to display $\tilde{S}(i,n)$, and look for the signature of precipitationin this matrix.
- line 155
  This value can be easily changed by the user in the dedicated section of the configuration file of the ERUO library
- line 203
  It should be noted that this part of the processing is optional, and it can be avoided by setting the flag controlling it in the configuration file equal to 0. However, we strongly recommend running the spectrum reconstruction, to keep the output products as clean as possible
- line 355
  At the end, the quantities $Z^{(Proc)}_{ea}(t,n)$, $V^{(Proc)}(t,n)$, $SW^{(Proc)}(t,n)$, $SNR^{(Proc)}(t,n)$, together with the noise floor and level are saved in a file, at the location specified by the user in the configuration file. The optional "quickplots" routine included in the ERUO library can provide a simple visualization of some of these products.
- line 370
  Therefore, the user can decide to execute both of them, to skip one or to ignore the whole postprocessing.
- line 395
  Therefore, the user may be required to change their value in the configuration file
- line 662
  This behavior can be controlled by the user by setting lower thresholds in the configuration file

Suggestions on how to handle the specific cases are still available in the User manual on GitHub or in the video tutorial.

As suggested by the reviewer, the text required more focus on the work that was performed and on the ERUO method. To achieve this, we decided to remove the vague mentions to what we encountered “in our case”. The style of the whole section has been modified to be more impersonal, mentioning specificities of the four MRR-PRO datasets only when strictly necessary. Moreover, all instances of the possibly ambiguous phrasing “in our case” have been removed from the manuscript.

While this type of modifications are placed all thorough section 3, the more evident example can be seen at the following lines of the latexdiff file:

- line 149
  This line is presented by the reviewer as example.
  For example, the paragraph on lines 145-151 starts with the sentence, “In our case, the signature of precipitation was never visible in this matrix, being instead relegated to lower quantiles.” The phrase “In our case” refers to a personal history, not a technical description. The reader needs to know which data set you are talking about when you say, “In our case” (i.e., which case?). and the characteristics of that data set. The phrase “signature of precipitation” is not described. What is a signature of precipitation? I would expect precipitation to produce an increase in power in the radar velocity spectra when compared to clear-sky conditions, yet, the end of the sentence implies that precipitation signal has a decrease in signal power and “relegated to lower quantiles”. The phrase “never” is not appropriate for technical journal articles.
  We removed first two sentences of the paragraph, highlighted in red in the following text.
  In our case, the signature of precipitation was never visible in this matrix, being instead relegated to lower quantiles. However, it may be possible that other datasets contain a higher proportion of precipitation measurements.
  The sentence has been changed to the following text, highlighted in blue.

In all the four datasets presented in section 2, no couple *(i, n)* experiences precipitation for more than 50% of the duration of the campaign. Due to this relative scarcity of precipitation, the usage of the quantile 0.5 (median) to compute *˜S(i,n)* is an adequate choice to isolate the non-meteorological background.
In the newer version, the term "in our case" has been substituted by a clearer mention to the four MRR-PRO datasets. The terms "signature of precipitation" and "never" are no longer used.
The reason why the median is used to compute *˜S(i,n)* is linked directly with the frequency of precipitation in the four datasets (no couple *(i, n)* experiences precipitation for more than 50% of the duration of the campaign). Additionally, the objective of the *˜S(i,n)* matrix is more explicitly stated (isolate the non-meteorological background).

- line 329
  In our case, the MRR-PRO 06 dataset was particularly affected, with spurious signals detected for almost the entirety of the time series collected in clear-sky conditions.
  Similarly to the previous point, this sentence did not provide useful information on "the work that was done". Additionally, it can be seen as redundant, since section 4 discusses the 2-dimensional distribution of the attenuated equivalent reflectivity factor from the MRR-PRO dataset, mentioning the same issue with spurious signal.

3.2 Specific comments

2. *Section 3.1 Preprocessing. What is the purpose of the preprocessing? This sections starts with stating the three output products (i.e., IM, BC, and P) that will be produced. Yet, there is not a general description of why the spectra need to be preprocessed. In other words, what is the problem being solved? Stating the purpose at the beginning of the section will help the reader understand the processing steps performed in this section.*
   The section now starts with a sentence that briefly explains the aim of this stage of the algorithm (line 135 of the latexdiff file):
   The preprocessing aims to identify regions in the spectra that are systematically affected by artifacts and to produce a series of products to assist in the processing of the data files.

3. *Line138. Why does the spectrum power decrease at the ends of the spectra? I find this to be an interesting problem. The questions that come to my mind include: What signal processing step causes this decrease? Does this occur for all spectra including with and without precipitation? Is the amount of power decrease on the ends dependent on the total signal power in the spectrum? How does the MRR manufacture handle this issue in their standard processing? These questions should be addressed to determine whether your correction method is appropriate for the issue observed in the raw spectra.*
   The cause of this power drop is now explained, and its appearance in both precipitation and clear-sky data is mentioned (line 141 of the latexdiff file):
   This drop is caused by the filtering performed by the algorithm of Metek, as described for the MRR-2 by Maahn and Kollias (2012). This behavior is visible in both precipitation and clear-sky measurements.

   Answering the more specific questions:

   - *Is the amount of power decrease on the ends dependent on the total signal power in the spectrum?*
     The power drop is independent of the total signal power in the spectrum.
   - *How does the MRR manufacture handle this issue in their standard processing?*
     It is not explicitly mentioned in the manual, therefore we could not include it in the manuscript. However, in the IMProToo algorithm for the MRR-2, a similar issue with the measurements at the border of the spectrum is handled by interpolating the spectra around the v_ny value. This interpolated result was used instead of the original spectrum in the few gates at the beginning and end of the Doppler velocity range.
     While this is a valid solution, in our opinion it may artificially lower the meteorological signal in

cases in which the location of the peak falls in one of the velocity bins affected by the issue.

4. *Line 140. "…a guess of the signal recorded...". Choose a different word than "guess", unless this is a "first guess" of an iterative process.*
   The phrasing "a guess of the signal" has been changed to "the typical return".

5. *Line 166. "Examples of interference lines of both types of are displayed in subsection 4.3, alongside a description of how the ERUO library handles their presence and a discussion on some possible impacts on the final radar variables." Please show an example of interference lines in this section and show how the preprocessing steps discussed in this section removes those interference lines.*
   We agree on the importance of a visualization of the interference lines in this section, so we included an additional figure, displaying their appearance in two of the datasets.
   However, the removal of the interferences is performed by the "spectrum reconstruction", part of the processing (section 3.2.1). The current explanation of the method follows the order in which the components of ERUO are executed, therefore we did not include information from section 3.2.1 in the preprocessing section.

6. *Section 3.2.1, lines 182-231. "The first step of the spectrum-by-spectrum processing can be considered as the most delicate one of the whole ERUO library." Can you show an example spectrum profile showing the masking procedure and the spectrum reconstruction? Also, since this processing is complicated to describe in words, can a flow diagram be used to describe the logic?*
   A visual representation of the reconstruction is illustrated in section 4.3 (verification). To avoid repetition, we now simply included a reference to section 4.3 in the main text.
   Unfortunately, we could not find a clear way to summarize the procedure in a flow diagram. We decided, instead, to change the phrasing of some part of the sections, in an attempt to make it more understandable.

7. *Line 221: What is the black box named "astropy.convolution.interpolate_replace_nans" function actually doing? Please describe the analysis or method applied to the data set, not the tool that was used with the "default" values. You can reference this tool and include it in the reference section. But the text should describe the method applied to the data set*
   The sentence has been rephrased, mentioning the kernel interpolation before referencing the Astropy function.
   The reason why the parameters have been chosen is now mentioned more clearly (from line 237 of the latexdiff onward):
   The kernel type used in the procedure is a Gaussian one. Its combination of standard deviation and kernel size has been chosen for its ability to capture the typical shape of the meteorological signal observed in the four datasets.
   In particular, the kernel standard deviation has been fixed to 1 along the i-axis. A higher value causes an artificial broadening of the reconstructed peaks compared to the precipitation signal directly above and below. On the n-axis, the kernel needs to be large enough to contain non-NaN values at both its extremes to perform a meaningful interpolation. To satisfy this condition, the standard deviation size along this axis is set equal to the number of consecutive range gates containing at least one NaN divided by a scaling factor, set by default to 3.

8. *Lines 212-231. I find this section hard to read because there are a lot of descriptions of NaNs and threshold values. Can this section be shortened?*
   We agree with the statement: the section is indeed hard to read and full of technical details. However, by removing part of this section, a hypothetical reader willing to replicate the procedure for another radar would not have access to all the information needed to implement the procedure, reducing slightly the usefulness of the whole explanation.
   However, as mentioned in the answer to comment 6, the text section 3.2.1 has been modified in an attempt to make it more clear and understandable.

9. *Line 233. "…and converted to linear units." I am confused. Is this saying that in the previous sections, the spectra were in logarithmic units? I thought the spectra in those sections were processed in linear Spectra Units (S.U.) as described in lines 91, 198, 206, and 216. So, is the work before line 233 performed in linear or logarithmic units? I am confused.*
   We apologize for the confusion. The preprocessing is performed in logarithmic units. The first

appearance of “S.U.” in the manuscript is now labeled as “logarithmic spectral units”, while the first appearance of “s.u.” (in the section “Peak detection and dealiasing”) is labeled as “linear spectral units”.

10. *Line 649. “…variables Zea, V, SW, and SNR.” Expand the names of the variables in the conclusion so that the reader does not need to search the manuscript for their definition.*
    The acronym of each variable is now preceded by the full name of the variable (line 686 of the latexdiff file).