

## Reply to the Interactive comment on “Quantifying the value of redundant measurements at GRUAN sites” by F. Madonna et al.

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- *The authors of the manuscript “Quantifying the value of redundant measurements at GRUAN sites” by F. Madonna et al. would like to acknowledge Dr. Peter Thorne for his interest in the manuscript and for his useful comments. In the following, the authors report their answers to point raised by Dr. Peter Thorne (in italic).*

The authors have undertaken a valuable analysis that should be published. I won't add to the technical reviews already received but do offer a few suggestions.

I agree with reviewer #2 (I think) that although scientifically 'redundant' is the correct term that the optics of this word with connotations of 'not needed' to many, and most importantly funders, may be terrible. Would synergistic / synergy be a viable alternative? Synergistic has more positive connotations to it than redundant.

- *As reported in the answer to the other two reviewers, a short paragraph providing an overview of the meaning and benefits of redundancy is reported after the second paragraph of the introduction. To make it more explicit, the authors also added a definition of redundancy, and now the paragraph is as follows: “Redundancy can be defined as the duplication or the multiplication of the estimation of an atmospheric variable with the aim of increasing reliability in the study of the same variable over the time. Without doubt, redundant measurements provide added value towards the full exploitation of the synergy among different measurements techniques: the main advantages are related to:*
  - *Filling gaps and improving measurement continuity over time and vertical range,*
  - *Increasing the sampling rate by merging measurements from different instruments,*
  - *Addressing instrument noise and identifying possible biases or retrieval problems by comparing different techniques and instruments.”*

*Synergy should indicate a more specific aspect, like to use two measurements together to improve the knowledge of an ECV or the accuracy of a retrieval. This is more similar to conditional entropy discussed in the manuscript, so it looks less general than redundancy. Anyhow the authors tried in the text to link the word 'redundancy' to the word 'synergy' as much frequent as possible.*

I would add to the list on pp.6330-6331 "To aid site scientists, managers, and funders in making informed decisions on new instrument procurements to maximize the scientific return on the capital expenditure".

- *Thanks for this comment and the authors agree with "spirit" of the sentence. The item has been added to the list.*

p.6334 ln16-21 gives the impression (mistakenly) that GRUAN will only ever undertake processing and uncertainty quantification on radiosondes. This potential interpretation should be easily ameliorated by some editing to make clear that eventually GRUAN will develop processing and uncertainty quantification for a broad range of instruments.

- *The sentence now says: "The added value of GRUAN products is related to the implementation of data processing including several corrections for spurious effects for a broad range of instruments (including radiosonde, GPS, Raman lidars, radiometers), and therefore to the fidelity of the long-term records of measurements used for climate applications".*

p. 6335 ln6-20 Has thought been given to sensitivity to this time match? In terms of column wv would it be fairer to compare say 30 minutes after launch when the balloon is approx. in the mid-troposphere? Regardless, it may be nice either in this or in follow up work to consider the sensitivity to a reasonable range of this in combination with the work detailed in Fassò et al?

- *This is very good point raised by the reviewer. This type of analysis could be part of a separate paper since in literature several options have been used and nobody has never extensively assessed this aspect when different techniques are compared. However, the considered datasets have been provided by the stations with their own standard processing and to use different processing options for the data processing, for example for the lidar or the GPS, the raw data should be available. Therefore, the authors definitely consider this type of comparison as urgently needed but probably better addressed in a separate follow-up paper. This could also represent a new topic to be investigated by the GRUAN community.*

In Figure 2 the left hand panel x-axis was not clear to me what it meant from the caption or the text. Are the samples regular sequential? What date range do they cover? This made it hard to know whether I was looking at a real temporal series (a time series) or rather a series of samples. If it is the latter then maybe use sampling series to avoid conflation with a temporal series?

- *The reviewer is right. In Figure 2 the samples are not regular since they are referred only to those data satisfying the requirement described in the section 2.2 of the manuscript. So the presented data are not a real temporal series (a time series) but rather a series of samples. Therefore now in the manuscript this is now reported as a "series of samples".*