amt-2016-304

An intercalibrated dataset of Total Column Water Vapour and Wet Tropospheric Correction based on MWR on board ERS-1, ERS-2 and Envisat

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Response to Reviewer 2

We thank the reviewer for his constructive comments. Below please find a detailed response on all reviewer comments.

A General comment: the methodology deployed in this paper seems to clearly indicate that anchors are defined on a monthly basis on ERA-Interim to perform the bias correction of the microwave measurements. In turn, the TCWV retrieval is expected to be subsequently anchored on average on the model itself. This deserves some more discussions in the paper and clear statements as to what added-value this TCWV dataset is bringing in the scope of climate studies, wrt trend assessment of average quantities for instance.

The main advantage of our dataset over the operational ESA dataset is that it actually is inter-calibrated. There has not been any attempt so far to inter-calibrate the three instruments and create a homogeneous time series. We have added some discussion of the issue in the conclusions now that hopefully brings this important point across better now.

Abstract L30-L32: not clear which products are referred to when stating on ’superiority’ (L30) and ’improvements’ (L31). is it compared to previous versions of the same processor, to numerical model forecasts/analyses, to other instruments’ WTC products, to other institutes’ MWR WTC products ? I suggest making specific references here to highlight more to what the proposed dataset is adding value.

We have made these statements more specific now by adding which models and algorithms we compared to.

p3.L3: typo "it's" –> "its"

Fixed

p3.L14: suggest adding a reference were the bias in v2.1 is characterised.

Fixed. We have added a reference to a technical report that specifies this issue.

p4.L3, editorial: first sentence is confusing

We have split this sentence in two now.

p4.L16-17, editorial: unnecessary repetition of the same info

FIXED. We removed the duplicate sentence.

p4.L24: were the uncertainties on the fixed SV parameters taken into account in the observation error matrix?

We have added discussion the values of the observation error covariance matrix now. S_o is a diagonal matrix with errors of 1 K in both channels. See also our answer to the question about LWP histograms further down, which justifies this choice.

p5.L2: Rodgers 2000 does not explain specifically how the Sa and So matrices were established for this particular retrievals. It is essential information to understand the new product. In particular also if that differs from the retrieval methodologies in other products. It is said in introduction that So includes forward modelling error and instrument noise. How was this estimated? Similarly, how was Sa determined?

We have now disentangled the general reference to Rodgers from the specifics of the error covariance matrices, which are discussed in Appendix B, where we refer to the appropriate reference. We have now included a statement in the main text referring to that.

p5.L11: does the retrieval methodology produce negative TCWV ? That reads odd, clarification of why/what is meant here may be required at this stage.

The retrieval only returns negative values (-999) only to indicate the retrieval has failed. Any converged retrieval will be positive as stated by the reviewer. We have rephrased this sentence to make this clearer.

p6.L25: Is this empirical bias correction assessment performed on cloud-free pixels only ? This is what I would guess from the statements made in the bullet point above. If some cloud screening was applied it should be made explicitly clear here and described. Figure

1: The fitted Gaussian on the main mode is presumably covering the cloud-free scenes. The Authors explain that the negative values result from the random instrument noise. At the same time the positive values outside this Gaussian fit are associated to cloudy scenes. However, the negative values go as low as 100g/m2, which is of the same magnitude (in absolute terms) as the LWP in cloudy cases. This suggests that the effect of the instrument noise has a very strong and direct impact on the precision of the retrieved quantities including in cloudy scenes. Can the Authors comment on this and what limitations this has in view of the climate application sought here? Possibly reflect some of this in the manuscript?

The reviewer's notion is correct. Typically, the observed standard deviation around zero for cloud-free scenes is about 30 g/m^2 for conically scanning microwave instruments such as SSM/I or AMSR ((Greenwald, 2009;Bennartz et al., 2010)). We reference this number in Section 3.1. In our case the width of the histograms shown in Figure 1 is about 41 g/m2, so that a negative value of, say, -86 g/m^2 would correspond to an about 2-sigma outlier. The above standard deviation, together with the sensitivity of the brightness temperatures to changes in LWP (Jacobians) can also yield a rough estimate on the effective noise in the retrieval. From Figure 2 (isolines) we get:

dLWP/dTb23 ~ 14 (g/(m^{2}K))

dLWP/dTB36 ~ 25 (g/(m^{2}K))

Thus, a noise in Tb36 of about 41/25 = 1.7 K would yield a histogram like this, givem T23 is noise-free. Assuming both channels to have the same noise and performing error propagation on the total differential dLWP, one ends up with an estimate for the uncertainty of both T23 and T36 of ~ 1.01 K.

We have now briefly added a discussion of this issue in the paper. However, since LWP is not our main focus, and similar issues have been discussed already earlier, we limit this discussion to just a few sentences plus references.

p6.L28: The reader would benefit from a brief explanation about the rationale and purpose of the 4% subsampling

This was just a compromise between having enough data for meaningful statistics and computational efficiency. We have added a statement to that extent.

P8.L29: typo, double '. '

FIXED.

Conclusions: it is not clear why the WTC record is still proposed by the Authors while, according to their assessment, this dataset is showing less skills than the operational one established by ESA. It is strongly recommended to elaborate and highlight more specifically the potential advantages of this dataset or the necessity to provide this independent record, for clarity to the reader.

We have added several paragraphs now that hopefully explain better what the advantages and disadvantages of the new dataset are. In brief: Our dataset is inter-calibrated whereas the original ESA dataset is not. That, in our view, precludes any use of the ESA dataset for climate studies.