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Interactive comment on "A multi-site techniques intercomparison of integrated water vapour observations for climate change analysis" *by* R. Van Malderen et al.

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GENERAL COMMENTS

* This manuscript is well written and of high quality. Presented is an extensive intertechnique comparison of vertically Integrated Water Vapour (IWV). The study aim to intercompare IWV derived from AIRS, GOME, SCIAMACHY and GOME-2 satellites, in-situ radiosonde and ground-based GPS and sunphotometer technique for 28 global sites. A detailed analysis of technique/instrument specific biases is presented. The work is purely observation based and is a first step towards use of the derived IWV

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Interactive Discussion

Discussion Paper

time series for climate trend analysis. The GPS is used as reference dataset.

Author Reply: First of all, we want to thank the referee for the positive assessment of our work! We really appreciate the constructive suggestions that improved the manuscript.

SPECIFIC COMMENTS

* The main concern regarding the study is the data quality of the reference GPS tropospheric products. The IGS repro1 tropospheric products are used and assumed to be a homogeneous dataset (line 2-3, page 1100). This however is only partly true. It is to be noted that dataset is processed with the same processing strategy for the period of the study but this does not necessary mean that the equipment changes are investigated. This needs to be addressed in the paper.

Author Reply: We fully agree with this concern and we agree that we should have made more explicitly a distinction between the homogeneous reprocessing of the data at one hand, and the homogeneity of the hardware (equipment) at the other hand. This last point is indeed not considered in the paper and is obviously more important when doing time series analysis. We add the following piece of text in the description of the GPS data: "However, even using consistent data analysis, the GPS ZTD can be affected by inhomogeneities due to changes at the stations, e.g. GPS equipment and/or operating procedures (e.g. elevation cutoff angle). Vey et al. (2009) concluded that only one third of 62 IGS stations (covering a period of at least 7 years with data gaps smaller than 3 months) could be assumed to be homogeneous."

* The second comment is regarding the GPS-radiosonde comparison for Brussels. On page 1103, line 24-25 a wet bias is reported in the nighttime observations 0000 UTC. Further on page 1104 line 12 the GPS data is assumed to be insensitive to the diurnal cycle. However, the IGS repro1 processing is done with a processing time window of 24 hours changing at 0000 UTC. I will advice the authors to investigate this processing artifact. The high temporal resolution of GPS repro1 can be used to compare the

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2355 UTC observations from the end of the processing with the start of the next day processing at 0000 UTC. I assume that taking into account this effect will improve the the reported nighttime bias to the radiosonde. I insist that this additional test is carried out.

Author Reply: The presence of the day boundary jumps in the used IGS repro 1 dataset is a well-known feature by the authors, and the suggestion of the referee to study this effect for the comparison with the radiosondes at Brussels has been carried out. The following text was added to this section: "This daytime-nighttime difference might be explained by a different behaviour of the radiosonde humidity sensors and/or differences in the GPS IWV retrieval in daytime and nighttime conditions. For radiosondes, the heating of the humidity sensor by the solar radiation is likely to be at least partly responsible. Also the GPS data used here (IGS troposphere product) are not completely insensitive to the diurnal cycle, as the reprocessing is done with a time window of 24 hours, changing at 00:00 UTC. As a consequence, IGS orbit discontinuities between adjacent days are detected (Griffiths and Ray, 2009; 2013). The high temporal resolution of the IGS IWV dataset at Brussels (10 minutes) enables us to investigate the differences between consecutive IGS processing cycles. Therefore, we compared both the GPS IWV retrievals from the end of a processing cycle (at times ranging between 23:30 and 23:50 UTC) and from the start of the next day processing cycle (at times ranging between 00:00 and 00:30 UTC) with the radiosonde measurements at 00:00 UTC. From this test, we can conclude that the use of IWV values retrieved from the new processing cycle enhances the nighttime bias to the RS only up to 0.04 mm. Therefore, this effect could clearly be neglected for the remaining of the paper."

* The conclusions section can be improved. It is not appropriate to point to where the results are summarized (line 4, page 1123, and line 8) but the main findings are to be reported briefly. The purpose of the "conclusions" is to facilitate the reader, which is not willing to follow the details of the study, but is interested only in the main finding. This conclusion section is not written with this in mind and it is recommendable to rewrite it.

Author Reply: We completely rewrote the conclusions section, taking into account the remarks of the referee. This last section now gives a short overview of the main findings of the paper.

TECHNICAL CORRECTIONS

* On page 1089 line 24, it is not clear, which parameter has "4 mm jumps". I assume it is IWV but will recommend to be clarified.

Author Reply: these are indeed IWV jumps, so we clarified this in the text.

* Line 20-23, page 1091: the sentences "Because ..." is long and not clear.

Author Reply: This sentence is changed in "Because these different satellite devices have different ground pixel sizes, we apply different geometrical co-location criteria with the ground-based IGS stations:"

* Line 9-11, page 1096: the sentence "This number ... " is long and not clear.

Author Reply: This sentence is changed in "To obtain this number, they first constructed scatter plots (and linear regressions) of radiosonde IWVs integrated from altitudes higher than the launch site versus IWVs obtained by integrating the whole RS profile. Consecutively, they plotted those IWV linear regression slopes versus the lower integration altitude limits and could draw a linear fit through this relation."

* Parasite language constructions like: "we now want to", on page 1107 line 22, "we already" want" on page 1112, line 27, "when we now consider" on page 1114, line 19, "The finding strengthens us in" on page 1114, line 22, "When going through the literature reports on similar techniques intercomparison it turns out that" on page 1123, line 18-19 are often spotted in the manuscript and more appropriate for a casual conversation that a manuscript. Please correct.

Author Reply: The given examples and other "parasite language constructions" found in the manuscript have been replaced to more formal writing language.

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