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Atmospheric Measurement Techniques Discussions

Interactive comment on "Column water vapor determination in night period with a lunar photometer prototype" *by* A. Barreto et al.

A. Barreto et al.

africabv@gmail.com

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First of all we would like to thank to D. Pérez-Ramírez for his suggestions. In the following lines we will answer the eight questions presented in the public discussion.

1. The authors point very well the needed of study atmospheric water vapor. They stated quite well the current state of the art of satellite measurements and also some ground-based measurements like GPS or balloon-borne radiosoundes. But there is a complete lack about the capabilities of microwave radiometry to compute precipitable water vapor and also atmospheric water vapor proïňĄles. Moreover, they mention the ability of Raman lidar for water vapor proïňĄles but some of the more recent references must be added. Finally, they stated quite well the necessity of night-time photometric measurements of precipitable water vapor. But particularly I also found a very recent

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work of precipitable water vapor radiometric measurements at night-time in Journal of Geophysical Research, D05202, doi:10.1029/2011JD016450 that present a similar day-to-night study. As Atmospheric Measurement Techniques claims to reference the last works on the topic relevant to the work you presented, I think you should include those works.

>We have included in the introduction section a description of the current state of the art of precipitable water vapor radiometry. A concise description of the different techniques, including microwave radiometer and Raman Lidar, is presented. Since microwave radiometer and Raman lidar techniques are not used in this paper, we consider an extended reference to these techniques are not necessary. Furthermore, we have included Brocard et al. (2012).

>Regarding the atmospheric water vapor profiles, we included two references to explain the details about PWV calculation, i. e., Miloshevich et al. (2009) and Romero et al. (2011). We also included the exhaustive intercomparison developed by Schneider et al. (2010), which compared PWV retrieved at Izaña using different techniques and long-term datasets.

>Finally, we have included a comprenhensive study concerning day to night PWV measurements using sun and star photometry (Galkin et al., 2011).

2. Page 773 line 9: Why do not you use AERONET 2.0 data?

>We have not used Level 2.0 data for Izaña since it was not available at the time of submitting this paper.

3. Pages 776-778. To my understanding, in Barreto et al., (2013) you presented the calibration of the water vapor channel. I think that this paper should be more autonomous and a larger overview must be given. For example, I feel lost when you mention in line 9 of page 777 'instrument calibration'. What are you referring? Is an relative calibration in terms of Vo(λ) or an absolute calibration in terms of kλ?

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>The authors would like to mention that this study is completely independent of Barreto et al. (2012) from a scientific point of view. In Barreto et al. (2012) the CE-318U calibration procedure is extensively described. However, in this work we have used the same calibration using the Lunar-Langley Method but including the two channels centered in the water vapor absorption bands (not included in the previous work). Thus, we consider relevant to include a brief description of this procedure as well as the calibration coefficients obtained (table 1).

>In page 777 line 9 we are referring to an absolute calibration following the Lunar-Langley calibration method described in Barreto et al. (2012).

4. Page 777. My question here is related to the previous question 4. If I understand well and you obtained k, is the model ROLO sensitive to the strong absorption bands of water vapor as you show in Figure 1? Would it affects to the accuracy of PWV of 10

>Since the ROLO model performs an estimation of the exoatmospheric lunar irradiance, the predicted values are not sensitive to any atmospheric absorption bands.

5. Figures 2 and 3: Those ïňĄgures need more clariïňĄcations. What is the line observed in the plot? Is it the 1:1 line? It should be interested if you make linear fits and show the parameters. Particularly, for the comparison with 930 nm in Figure 3b it seems a bias between PWVLC and GPS that could be easier to see by those linear fits.

>The line observed in those figures is the 1:1 line. It has been included in order to visually identify a possible overestimation/underestimation of AERONET/GPS PWV values with regard to Lunar Cimel PWV data. We have included the regression coefficients, standard deviation and RMSE. We can see how regression values are near 1, and then a good positive association between sample values is observed.

6. Figures 4 and 5: I do not understand how you compute water vapor pressure with this ïňĄne temporal resolution. Please clarify. Please also unify criterions. In tables

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you refer to Filter1 and Filter2 while in Figures you refer to filter of 937 and 938 nm. From plots it seems that the ïňĄlter at 938 nm has a bias versus GPS signal while from the table this bias appears in Filter1.

>These figures represent the vertical daily evolution of water vapor pressure in hPa during the two periods in July and August obtained from radiosonde data at 12:00 and 00:00 UTC. Figures were computed from 100 m vertical resolution soundings at 00:00 and 12:00 UTC. Then, in-situ water vapor was simply contoured in order to facilitate the water vapor evolution through a vertical cross-section, and the comparison with daily PWV evolution in lower panels.

>We agree with the last comment. We have included in figure captions more information about filters.

7. Page 779. I do not agree with the statement that the GPS is not able to retrieve PWV below 0.35 cm. There are many studies that did comparisons versus radiosondes or microwave radiometers that show good agreements. Also, many climatological studies of precipitable water vapor by GPS have been done. Do you suggest that all these studies needs corrections? The error for these low PWV can be larger for all the instrumentation. Moreover, sun-photometry and radiosondes also has problems in measuring PWV under dry conditions because they rely on radiative transfer codes for generating water vapor transmittance. As there is no a golden instrument to characterize PWV, I show my concern on this statement. This point needs clariïňĄcation. In my opinion, the answer to referee 1 to this question has not been well addressed because I can also observe from Figure 4 good agreements with CIMEL-AERONET (in fact, I saw only two outliers).

>We just referenced the existence of a detection limit in 0.35 cm in PWV retrieved using GPS technique previously defined by Schneider et al (2010). It does not mean that GPS is not able to retrieve PWV for drier conditions, but the precision of these retrievals is relatively poor (precision about 20%), as reported by Schneider et al. (2010). The

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estimated Cimel PWV precision is 10%, following Alexandrov et al. (2009), and 7% for PWV > 7mm and ≈25% for PWV < 2mm, following Schneider et al. (2011). RS92 PWV precision is about 15% (Schneider et al., 2011). That's why we conclude that the answer to referee's 1 question (#3) is well addressed.

8. Why you do not make a similar comparison between GPS and radiosondes? It could be helpful to establish a 'reference value' for your comparisons. I would also suggests to plot the histograms of the differences in PWV between the different methodologies to clarify the differences and agreements you found.

>The comparison of PWV derived from GPS and radiosondes is out of the scope of this paper. You can find specific papers concerning intercomparison studies, such as Schneider et al. (2010) or Brocard et al. (2012).

>Concerning the D. Pérez-Ramírez suggestion to include histograms, this information has been provided already in the paper since standard deviation and RMSE for CA/GPS, LC/GPS, CA/RS92 and LC/RS92 were presented in tables 3 and 4.

Interactive comment on Atmos. Meas. Tech. Discuss., 6, 767, 2013.