Interactive comment on “Accuracy assessment of water vapour measurements from in-situ and remote sensing techniques during the DEMEVAP 2011 campaign at OHP” by O. Bock et al.

Response to anonymous Referee #2

The authors would like to thank the reviewer for the constructive comments. In the following, the reviewer comments are typed in italics when necessary and the author’s response in straight font.

As a preliminary remark, we would like to emphasize that the three main unexplained results contained in the first submission could be fixed during the time of the open discussion: (1) the drift in the IGN Raman lidar calibration factor, (2) the large biases in the SOPHIE spectrometer data, and (3) and the large biases in the SAOZ data. We refer this Referee to the response to Referee #1 where the explanations and correction measures taken are detailed in the introductory paragraph.

Referee comment: “*Also, the comparisons of four different calibration methods for the Raman lidar measurements are very useful, and highlight insufficient understanding of the Raman lidar system by the unexplained large drifts in the lidar calibration factors just for a month.”*

The origin of the drift could be established as explained in the introductory paragraph of the response to Referee #1. We emphasize here that the first submission already mentioned the main hypothesis on the lidar drift, which appeared to be the correct one, P3449:

« There is possibly a relation between these events and the changes in the system calibration coefficient diagnosed in the following, but this point needs further investigation. » (L5-7). The events refer to « dismounting of the optics fibre and subsequent re-alignment» (L2) and « change of the optics fibre and again a complete re-alignment» (L4-5).

Referee comment: “*Abstract. "Raman lidar water vapour measurements were useful to distinguish between which of the radiosondes were biased." I think this is a misleading sentence because readers would think that this is a general conclusion”*

We removed this sentence from the abstract.

p. 3443, l. 22: done

p. 3444, l. 23: sentence removed because this statement was too general.

p. 3445 : a.g.l. stands for above ground level; this abbreviation was inserted by the AMT typesetter and seem conventional in this journal. IGN is expanded. WVMR was already defined on P3443 L 24.

p. 3447. *Hamatsu –> Hamamatsu* : changed

p. 3447, l. 29. Done

p. 3449, l. 7. Complementary investigation revealed the origin the drift as explained above. The text was updated were necessary to explain the origin the changes (Abstract, Section 2.1.2, etc.)

p. 3450, l. 1. Below is a photo showing how the payloads (M2K2DC, RS92, M10) were assembled with one balloon. In the case when a Snow-White was included, an additional cable was attached to the balloon, with the Snow-White 5 m beneath the first payload.

p. 3450, l. 6-8. Indeed, to make Raman lidars a reference requires using another reference... But the potential of Raman lidar for transferring calibration between in-situ (e.g. dew point sensors) and upper air measurements (e.g. from satellites) was already claimed by Revercomb, 2003. The strong argument is that, assuming proper instrument design, the calibration function can be reduced to only a function of time, i.e. dependence to altitude vanishes. When the calibration constant is appropriately fitted to surface measurements, this allows the lidar to transfer the calibration throughout the profile. The range over which a certain level of accuracy is guaranteed depends on the signal to noise ratio which usually decreases rapidly with altitude, but low signal to noise ratios generate primarily random errors, not biases.

p. 3450, l. 24-26. Miloshevich et al., 2009, concluded (paragraph 67) that "Relative to the CFH above the 700-mbar level, the RS92 mean bias for nighttime soundings (Figure 2f) varies with height from a moist bias at 700 mbar (3% for moist conditions and up to 20% for dry conditions), to a dry bias in the UT (5% for moist conditions and up to 20% for dry conditions)."

p. 3451, l. 1. Done

p. 3451, l. 2. According to Vaisala 2011b (reference added) about version 3.64: "Humidity measurement was also improved to take into account the effect of solar radiation on the sensor during a sounding. This effect has the most significant impact at altitudes of approximately ten to fifteen kilometers depending on the humidity profile and the tropopause height. A new solar radiation algorithm was developed to improve daytime humidity measurement accuracy. The modification has no effect on the mesurement results of nighttime soundings."

Added reference:

Vaisala 2011b: Improved Measurement Accuracy of Vaisala Radiosonde RS92, Vaisala News 185/2011, available at: http://www.vaisala.com/en/press/vaisalanews/vaisalanews185/Documents/vn185_04_ImprovedMeasurementAccRS92.pdf (last access: 4 July 2013), 2011.

p. 3452, l. 13 All the radiosonde height measurements are expressed with respect to geometric heights for consistency with the with lidar measurements. Differences in temperature are shown in Figure 10. The pressure, temperature, and humidity measurements from the radiosondes at the surface are compared to ground-based sensors in Sect. 2.5.3. The differences in surface pressure and in upper air temperature are small and are not a limitation for the IWV comparisons.

p. 3452, l. 21. Absolute accuracy is the accuracy evaluated in comparison to a reference with zero or negligible bias and relative accuracy is the accuracy in comparison to a reference which bias is unknown. We changed the sentence to: “Whether these numbers reflect an absolute or a relative accuracy not is not clearly established.”

p. 3453, l. 2. & p. 3453, l. 8. : changed according also to comments from Referee #1.

p. 3453, l. 14. Done

p. 3457, l. 19. The numbers were checked and RS92 shows a mean difference of 2.0 %RH compared to VTP-6 or PTU200 measurements (25 data pairs). The mean difference between PTU200 and VTP-6 is -0.02 %RH over the 45 days period (6596 data pairs, 1 point every 10 min).

p. 3460. You are right; the calibration constant is actually not a constant, neither in altitude nor in time. Its dependence on altitude is indicated by equation (2). We consequently changed the text to refer to C_lidar (z) as the calibration function. This modification concerns only section 3.1 since the rest of the manuscript uses the scaling factor f (which by definition is constant in altitude and should be constant in time, as long as nothing changes in the system).

p. 3463, l. 1-2. Reformulated: “The radiosonde measurements were screened automatically to retain only points with strictly increasing altitudes”

p. 3466, l. 16. The origin of the drift has been identified in the meantime (see above). This is explained in the text.

p. 3468, l. 10-11 bias changed to mean difference and fluctuations to standard deviation of differences here.

p. 3468, l. 13-19 ‘Absolute’ is maybe exaggerated, unless one considers that RS92, SW or GPS provide ‘absolute’ standards (which might be true at the level of, say, 5%). Note that the drifts in the calibration factor are corrected during the data calibration procedure (fit to GPS IWV or RS WVMR in the 0.3-1.3 km layer agl). So this error source is strongly reduced.

p. 3469, l. 13-15. The text refers to Table 4 which shows 2 different estimates of IWV: one over the altitude range 2-8 km and one over the total column.

p. 3470, l. 5. The Digicora software reports 1 %RH for the RS92 measurements where the other sondes report 0 %RH. We assume that there is an offset due to the processing algorithm. Changed “software bias” to “software offset”.

p. 3472, l. 22-24. Right, it is uncertain to generalize these results. Reformulated the sentence:
“Our results show that, in these two cases, the Raman lidar measurements are more reliable than radiosondes in detecting dry layers in the lower and middle troposphere (0-6 km agl), consistently with the lidar’s vertical resolution which is degrading with altitude.”