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## ***Interactive comment on “Water vapor observations up to the lower stratosphere through the Raman lidar during the MAïdo Lidar Calibration Campaign” by D. Dionisi et al.***

### **Anonymous Referee #2**

Received and published: 7 November 2014

General comments: The paper presents a detailed discussion of the validation of a new Raman lidar for the measurement of upper tropospheric/lower stratospheric water vapor in a location of the globe that is under-represented with quality measurements. This paper is certainly worth publication in AMT. There will need to be some additional editing, however, not of the content of the paper, but of some of the style. There are several places where long and complex sentences are used, which sometimes confuses what the authors are trying to say. Simpler sentences are desirable in these cases. I have pointed out a few of those places in the comments below, but there are others throughout the paper. I have no major criticisms of the paper. What follows

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below are relatively minor, but important. They are mostly technical corrections to be made before publication.

### Scientific Comments

Pg 10365, Line 19, Clarify what is meant by “high spatial and temporal resolution” here. Lidar measurements in the UT/LS are generally integrated over a long time, but these long integrations can be made more frequently at substantially lower cost than frost-point sondes.

Pg 10369, Lines 19-27. This is confusing. What configuration is being used? Are both laser transmitting 532 and 355nm? Or is one laser transmitting only 532 and the other 532 and 355? There is talk about combining the beams from both lasers, but later on page 10370 it seems to state that the beams are not combined and that 532 and 355 are transmitted sequentially. Are the lasers being fired individually for 10 minutes or so each? Please simplify and clarify what is being done. Is the reported divergence of the beam 0.5 m Rad before or after expansion. This discussion of Figure 1 should be made more coherent. Fig 1 also indicates that M14 in the beam transmitter is a planar mirror, while the schematic shows the beam diverging off M13. Is M14 really spherical?

Pg. 10370 Line 8; Does the reference to Figure 14 in Hoareau 2014, really refer to Figure 1 in this paper? If so it should be corrected, if not then Figure 1 should be mentioned here. The power of the beam expander telescope should be mentioned here as well.

Pg 10370 Line 14. States that the variable field of view of the telescope is 0.5 – 3.0 mRad, while Table 2 shows it to be 0.1 – 2.0 mRad. Which is correct?

Page 10370, Going back to Figure 1, it appears that the polarization of each beam (532 or 355nm) must be different coming from each or the lasers, otherwise the re-combination through the cubes wouldn't work. Are there  $\frac{1}{2}$  wave plates in the beams to accomplish this? Mirror M8 seems to be mislabeled – shouldn't it be Tmax @355 and

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Rmax @532?

Pg 10374, Line 19. This paragraph seems to be talking about optimization of the lidar, not about validation of the measurements. Change “validation” to “optimization”

Pg 10379 Line 1 It would be useful to show this data in a figure

Pg. 10379 Line22, Figure 1 shows only one high pass filter and the bandpass filter before the 407nm detector. Also there appears to be a 407 bandpass filter in front of the 355 nm channels – should be BP-IFF3. The alpha-epsilon nomenclature seems to be left over from the original Figure 1

Pg. 10382, Line 14. Is C, the calibration constant, represented by K in Eq. 5? This should be consistent

Pg. 10390, referencing 10421; The X-axis scale for Figure 11 is not in percent but percent/100

With regard to the discussions about vertical resolution of the lidar, all I have seen in the paper, are several comments that state that “a height dependent sliding scale” is used. How is this defined. There are several methods currently in use within NDACC: a simple integration of adjacent data bins (e.g., a 5 bin integration could be quoted as a 75 meter resolution); a Savitsky-Golay fit to the data over a sliding scale of bins can result in a very different reported vertical resolution. I think it is important for the authors to define what they mean by their vertical resolution in this paper.

#### Technical Comments

Pg. 10363, Line 8 should end “ focus on UTLS Measurements.”

Pg. 10364, Line 3; Change “Thanks” to “Due”; change “is devoted to” to “will”

Pg. 10365, Line 4; Remove “Based on these considerations,” replace with “In order”

Pg. 10365, Line 5; Remove “thus”

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Pg. 10365, Line 13; Change “instrumentations” to “instruments”

Pg. 10365, Line 16, Should read “ Spaceborne passive remote sensors are limited by the abundance of cirrus clouds, as well as their coarse vertical resolution. . .”

Pg. 10365, Line 18, Should be “the lidar technique”

Pg. 10365, Line 20; remove “of an” replace with “for”

Pg. 10365, Line 23-24 Should read “that retrieves profiles of water vapor mixing ratio (WVMR), with good vertical and temporal resolution, by. . .”

Pg. 10365, Line 24-25 Should read “analyzing Raman backscattered”

Pg. 10366 Line 1-5 This sentence should be broken apart and clarified. My sense is that the authors are trying to mention that there are two areas of concern that need to be addressed to show that a water vapor lidar is capable to accurately and consistently measure vertical profiles which are suitable to extract long term trends. The sentence as written is not very clear on this.

Pg. 10366 Line 6-10. The paragraph is confusing – the second sentence seems not to flow from the first and is disconnected

Pg. 10366 Line 14: remove “In a context. . . .characterization”. Start sentence with “Reunion”

Pg 10366 line 16: After “crucial” add “for long term monitoring, as well as for studies of physical processes.”

Pg 10366 Line 22 Replace “Have been” with “are”

Pg 10366 Line 23 Delete “the” at the beginning of the line

Pg. 10366 Line 27 Remove “the” before water vapor; Remove “ in the whole troposphere up” Replace with “ from ground level”

Pg. 10367 Line 1, Remove “could allow improving” replace with “improve”; change

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“performances” to “performance”

Pg 10367, Line 4 Remove “the” after “between”

Pg 10367 Line 11 Add “a” before “few”

Pg 10367 Line 14 “resumed” should be “reviewed, and”

Pg. 10367 Line 17 Replace sentence with “Section 3 compares the results of different instrument configurations, along with the related bias characterizations, to those theoretically estimated by Hoareau, et al. (2012).”

Pg. 10367 Line 21 Delete “the” before NDACC

Pg. 10367 Line 23 Delete “the” before “Sect 5”

Pg. 10369 Line 2, replace “conceived” with “designed”

Pg. 10369 Line 3-4 Add “,” after “stratosphere”, Delete “and” before “temperature” replace with “as well as”; should be a period after “mesosphere”

Pg. 10369 Lines 6-10. The sentence is confusing as written. The authors are pointing out that the measurement of water vapor in the lower stratosphere is difficult for several reasons mostly related to low signals because of 1. The Raman cross-section is very low (as pointed out by the authors); 2. The water vapor mixing ratio decreases by as much as three orders of magnitude from the ground to the lower stratosphere; 3. In the tropics the tropopause is higher than at higher latitudes; and 4. At 408 nm there is significant ambient background even on clear, moonless nights. To increase signal is difficult and expensive (larger telescopes, more powerful lasers). Decreasing the noise is easier and much less expensive. With so much going on here it is less confusing to use a number of simpler sentences rather than one long complex one. This should be rewritten in more simple sentences.

Pg. 10370, Line 3 “swift” should be “shift”

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Pg. 10370 Line 18, replace “permits to avoid” with “avoids”

Pg 10370 Line 20 – 22, should read “Figure 1 indicates that backscattered radiation is first separated into the visible separation unit (VSU) and the UV separation unit (USU) by BS1.”

Pg. 10370, Line 23, delete “have the purpose to”

Pg. 10370 Line 29 to Page 10371 Line2 “that splits the 355 nm beam into low altitude and high altitude channels to optimize the temperature measurement”

Pg 10371 line 17. Delete last sentence – Figure introduced on previous page

Pg 10371 Line 19, “Hamamatsu R7400-03g and -020g photomultiplier tubes are used to detect the UV and Visible backscattered returns, respectively”

Pg. 10375 Line 1, Change “continued” to “continuous”

Pg. 10375, Line 26, Change “column” to “columns”; change “resume” to “show”

Pg. 10378 Line 10, change “conceived” to “designed”

Pg. 10379 Line 4, change “that are invested” to “excited”

Pg. 10379 Line 25 delte “The” in front of “Fig.2”

Pg. 10380 Line 9, Shouldn't “cloud base” be “cloud top”?

Pg. 10380 Line 9 delete “It is noteworthy that”

Pg. 10380 Line 14, “statistical” not “statistic”

Pg 10383 Line 22; Delete “the” before NDACC; delete “conceived to foresee an” replace with “designed to utilize a”

PG. 10384, Line 1, delete “have been foreseen” replace with “are used”

Pg. 10384, Line 4, delete “it is noteworthy to specify that”

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Pg. 10384, line 11-12. Is the lamp removed and installed for each measurement? Can this account for some of the variation seen in Figure 4?

Pg. 10384 Line 17, delete “the” before “background”

Pg. 10384, line 18, “on 3 April, we replaced the PMT”

Pg. 10385 Line 19, delete “of even” insert “up to”

Pg. 10385 Line 25 delete “that”; replace “arrangement” with “position”

Pg. 10386, line 2, should read “Once the ISP’s are identified”

Pg. 10389, Line 21, delete “faraway”

Pg. 10389, Line 25-26, delete “the” before “Fig. 10”

Pg. 10390, Line 1, “sessions”

Pg. 10390 Line 12, “have been calibrated”

Pg. 10391, Line 8, replace “on” with “in”

Pg 10391, Line 8, delete “ between the atmospheric layer”

Pg. 10391 Line 9, insert “the” in front of “upper”

Pg. 10391 Line 10, cut “distant from the launching site(and from the lidar station)” and insert after kilometers on the next line.

Pg. 10391 Line 13, delete “the” before “NDACC”

Pg. 10391, Line 20, replace “foreseen” with “proposed”

Pg. 10392, Line 28, delete “a” before “less”

Pg. 10393, Line 16, insert “geometry” after “sampling”

Pg. 10394, Line 4, delete “the” before “sea level”

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