Atmos. Meas. Tech. Discuss., 8, C4738–C4744, 2016
www.atmos-meas-tech-discuss.net/8/C4738/2016/

Atmospheric Measurement Techniques Discussions

Interactive comment on "Observations of water vapor mixing ratio and flux in Tibetan Plateau" *by* S. Wu et al.

S. Wu et al.

wush@ouc.edu.cn

Received and published: 6 January 2016

Thank you for your review of our manuscript. We greatly appreciate the substantial amount of time and effort that you dedicated to this review process. Here we provide the response to you and you can also refer to the mark kept revision of PDF file in "Supplement". Thanks again.

This paper describes measurements of water vapor using Raman lidar in Tibetan Plateau. It also reports estimation of vertical flux of water vapor using simultaneous coherent Doppler lidar measurement. The content of the paper is suitable for AMT. However, the manuscript is not very well written and requires revisions. Some of the descriptions are not accurate or clear. Also, English must be polished. Planetary

boundary layer (PBL) structure in Tibetan Plateau is a very interesting subject. Although it is mentioned in abstract, no discussion is provided in the text on PBL. It will be useful if a time-height indication of aerosol is also presented. The period of vertical wind profile measurement presented in the manuscript is very short. It will be better to show vertical wind profile for a longer period, at least one day, even if the water vapor measurement is limited in the nighttime. References should be given for the coherent Doppler wind lidar system used in the observation.

A: The manuscript has been rewritten with improved English. And the descriptions of the data and statement have been polished. For the discussion of the PBL and vertical wind profile for a longer period, we provide one case study measured by CDL in Fig. 9. Please refer to the corresponding figure and discussion in the revision. The reference for the CDL: Wu, S., Yin, J., Liu, B., Liu, J., Li, R., Wang, X., Feng, C., Zhuang, Q., and Zhang, K.: Characterization of turbulent wake of wind turbine by coherent Doppler lidar, 2014, 92620H-92620H-92610. And the reference has already been added in the manuscript.

Specific comments:

1. p.2 ,l.22- p.3, l. 4: The description on the role of water on radiation and energy transfer is not well organized. "Water vapor influences the radiative budget ..... directly and indirectly" sounds strange. The water cycle should be described more consistently, and the importance of measuring water vapor, especially in Tibetan Plateau, should be explained.

A: The sentence of "Water vapor influences the radiative budget ..... directly and indirectly" has been changed as "It influences the radiative budget of the planet both directly and through coupling with clouds. (Dinoev et al, 2013)". (Please refer to the revision.) For the description and explanation of the water cycle and the importance of the measuring water vapor in Tibetan Plateau, the content below has been added in the revision: "The Tibetan Plateau lies at a critical and sensitive junction of four climatic systems: the Westerlies, the East Asian Monsoon, the Siberian cold polar airflow and the Indian monsoon. The Tibetan Plateau is an outstanding topographic feather in the middle of the Eurasian Continent with averaged height above 4500 m (MSL), and has important roles in global and regional climate system. (Kuwagata et al., 2001) The Tibetan Plateau influences the atmosphere in East Asia area and even the whole northern hemisphere. The Tibetan Plateau has great impact on the water vapor budget of area around. The water vapor transportation based on the plateau-monsoon interaction affects the drought and flood of Asia and even the whole north hemisphere. During the middle of the monsoon season, from the end of June to early September, very intense cloud activity continually exists over the Tibetan Plateau. Even though the altitude is very high, a relatively wet condition is maintained over the Tibetan Plateau and the hydrological cycle is active during the monsoon season (Kuwagata et al., 2001). Consequently, it is a significant scientific problem to study the development of water vapor in Tibetan Plateau. The water vapor mixing ratio is monitored twice one day (00:00 and 12:00 UTC) by the applying of operational radiosondes. However, because of the limitation of the temporal resolution and measurement frequency, the water vapor mixing ratio data from radiosonde cannot satisfy the requirement of now-cast due to the various meteorological situation, especially in the high elevation area with strong radiation and convection. Moreover, the lack of the vertical profiles of water vapor mixing ratio make it difficult to obtain and analyse the vertical distribution of water vapor. Fortunately, with the development of the knowledge, some other remote sensing techniques appear. These techniques include passive and active remote sensing. The paper introduces the lidar technique, an active sensing technique. The lidar is capable of providing vertical profiles of water vapor mixing ratio with the advantages of high spatial resolution."

2. p.4, l.12- : The first paragraph of Methodology section is not well organized.

A: The first paragraph of the Methodology section has been revised and rewritten. Please refer to the section of "Lidar technology and methodology"

3. p.4, l.23: The paper describing the detailed design of the Raman lidar system should be cited.

A: The principle and basic layout of WACAL is described in this section for the integrality and the detailed design is described in a separated paper (Wu et al., 2015). The reference: Wu, S., Song, X., Liu, B., Dai, G., Liu, J., Zhang, K., Qin, S., Hua, D., Gao, F., and Liu, L.: Mobile multi-wavelength polarization Raman lidar for water vapor, cloud and aerosol measurement, Opt. Express, 23, 33870-33892, 2015. The brief introduction of the WACAL system was also provided in section 2 "Lidar technology and methodology". Please refer to the revision.

4. p.6, l.6: "atomic fine structure and atomic physics" and "the transitions of the atoms" are not correct. It is the molecular rotational structure.

A: Revised. Please refer to the 5th paragraph in section 2 "Lidar technology and methodology".

5. Table 2: Shift of wave number for Delta J= +-2 should be also indicated in Table 2. Also, the difference in intensity should be discussed.

A: The S-branch ( ) and O-branch ( ) are well separated in energy and appear as side bands on the either side of the Q-branch (Inaba and Kobayasi, 1972). As a consequence, the shift of wave number is difficulty to be determined. For the discussion about the difference in intensity: The cross section of nitrogen in Q-branch is about , which is two orders of magnitude bigger than the cross section in S- and O-branch (about). Moreover, by using the narrowband interference filters, the cross-talk of S- and O-branch backscatter light is highly suppressed and will not affect the Q-branch backscatter light. The details should be referred to figure 3 in Inaba and Kobayasi, 1972. (As shown in Fig.1 in the response).

6. p.6, l.3: "OD" is not defined in the manuscript.

A; Revised. OD stands for the Optical Density.

7. p.6. l.19, Table 3: “Licel” should be “Data acquisition system”. Name of manufacturer should be in the Specification column. Manufacturer and type of the photomultiplier tubes should be provided in the table.

A: Revised. Please refer to the revision.

8. p.6, l.21, Eq.(1): “P_{BG} and O(z) are not defined.

A: Revised. Please refer to the Eq. (1) and the corresponding description in the revision.

9. p.9, l.8: “Oxygen” must be wrong. It should be water vapor.

A: Yes. The “oxygen” has been changed to “water vapor”.

10. p.10,l.18- and Fig. 6: The decreasing trend is not seen in the radiosonde data. How can it be explained? Change is seen rather in the vertical profile.

A: We add some new results in the Fig. 6 of the revision. According to the figure, the decreasing trend is not so distinct and we rewritten the statement of the trend. We also find the difference between water vapor mixing ratios measured by WACAL and radiosonde. This difference maybe results from the measurement time difference ($\sim$1.5 h) of the WACAL and radiosonde. In Fig. 6, the water vapor mixing ratio measured by WACAL and radiosonde are presented. The time serials of water vapor mixing ratio from these two systems are provided in Fig. 6(a) and (c) respectively. And the trend of is shown and two dry or low water vapor content time periods are found. Fig. 6(b) and (d) provides the mean water vapor mixing ratio and the deviation measured by WACAL and radiosonde. The deviation of water vapor mixing ratio from WACAL and radiosonde which is shown in Fig. 6(e) indicates that the water vapor mixing ratio measured by WACAL is about 0.7 g kg-1 smaller than that measured by radiosonde. This result is also consistent with the mean deviation from Fig. 4 and can also explain the different of water vapor mixing ratio between Fig. 6(a) and (c).

11. p.11, l.4: “calculated by Eq.(9)” should be “calculated by Eq.(11)”

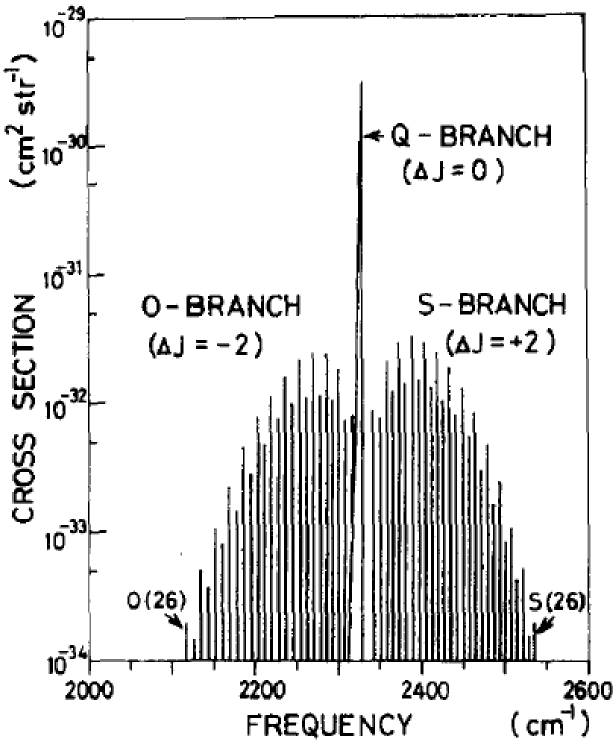
A: Revised.

12. p12, l.6: “calculated by Eq.(12)” should be “calculated by Eq.(14)”

A: Revised.

Please also note the supplement to this comment:
http://www.atmos-meas-tech-discuss.net/8/C4738/2016/amtd-8-C4738-2016-supplement.pdf

Interactive comment on Atmos. Meas. Tech. Discuss., 8, 11925, 2015.



CROSS SECTION (cm² str⁻¹)
10⁻²⁹
10⁻³⁰
10⁻³¹
10⁻³²
10⁻³³
10⁻³⁴
Q - BRANCH
(ΔJ = 0)
O - BRANCH
(ΔJ = −2)
S - BRANCH
(ΔJ = +2)
O(26)
S(26)
2000
2200
2400
2600
FREQUENCY
(cm⁻¹)

Fig. 1.