# Response to **Referee#2**

We thank the reviewer for their helpful comments on our paper. To facilitate the revision process we have copied the reviewer comments in black text. Our responses are in regular blue font. We have responded to all the referee comments and made alterations to our paper (**in bold text**).

1. According to some papers, the TIGR profiles contains some cloudy cases. I suggest the authors to confirm that. If some cloudy profiles indeed exists, you have to remove them from your used profiles. see: Wang, N., Li, Z.-L., Tang, B.-H., Zeng, F., & Li, C. (2012). Retrieval of atmospheric and land surface parameters from satellite-based thermal infrared hyperspectral data using a neural network technique. International Journal of Remote Sensing, 34, 3485-3502 Wu, H., Ni, L., Qian, Y., Tang, B.-H., & Li, Z.-L. (2013). Estimation of atmospheric profiles from hyperspectral infrared IASI sensor. IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing, 6, 1485-1494

Yes, it is very probably some cloudy profiles exists in the TIGR dataset (for this point we have contacted via e-mail with Dr. N. A. SCOTT, Laboratoire de Météorologie Dynamique, LMD, France), so in the revised manuscript **we have selected only 1531 atmospheric profiles under clear-sky from the TIGR dataset where the profiles with relative humidity at one of levels greater than 90% in TIGR were considered to be cloudy (Wang, N., Li, Z.-L., Tang, B.-H., Zeng, F., Li, C. : Retrieval of atmospheric and land surface parameters from satellite based thermal infrared hyperspectral data using a neural network technique. Int. J. Remote Sens., 34, 3485–3502, 2013).**

2. Compared to the work of Schroedter-Homscheidt et al. (2008), what is the improvement of your method? In the comparison part, the author wants to show their better results than Schroedter-Homscheidt et al. (2008). so I think the validations should also contain the results from Schroedter-Homscheidt et al. (2008). like figure4 and 5.

(Firstly, please see the response to the comment 3).

The response to these comments as given in the revised manuscript is as follows:

**For validation, we have firstly compared the total atmospheric water vapor content derived from MSG1-SEVIRI data with that measured by the radiosonde. On the one hand, Fig. 5a shows the comparison between the TAWV derived from MSG1-SEVIRI data using the algorithm proposed in this work and that measured by the radiosonde. We found acceptable results: the root mean square error (RMSE) equals 0.63 g cm-2, the standard deviation (SD) equals 0.63 g cm-2 and the correlation coefficient (R) equals 0.85. On the other hand, Fig. 5b shows the**

**comparison bet ween the TAWV derived from MSG1-SEVIRI data using the algorithm proposed by Schroedter-Homscheidt et al. (2008) and that measured by the radiosonde. We found the root mean square error (RMSE) equals 1.05 g cm-2, the standard deviation (SD) equals 0.33 g cm-2 and the correlation coefficient (R) equals 0.86. The comparison between Fig. 5a and Fig. 5b shows clearly that the results obtained using the algorithm proposed in this work are better than the results obtained using the algorithm proposed by Schroedter-Homscheidt et al. (2008).**

**We have secondly compared the total atmospheric water vapor content derived from MSG1-SEVIRI data with that measured by the AERONET. On the one hand, Fig. 6a shows the comparison between the TAWV derived from MSG1-SEVIRI data using the algorithm proposed in this work and that measured by the ARONET. We found good results: the RMSE equals 0.38 g cm-2, the SD equals 0.41 g cm-2 and the R equals 0.84. We can conclude that the TAWV can be estimated using the MSG1-SEVIRI observations with accuracy acceptable. On the other hand, Fig. 6b shows the comparison between the TAWV derived from MSG1-SEVIRI data using the algorithm proposed by Schroedter-Homscheidt et al. (2008) and that measured by the ARONET. We found the RMSE equals 0.73 g cm-2, the SD equals 0.17 g cm-2 and the R equals 0.86. We can conclude that the TAWV can be estimated using the MSG1-SEVIRI observations with accuracy acceptable. The comparison between Fig. 6a and Fig. 6b shows clearly also that the results obtained using the algorithm proposed in this work are better than the results obtained using the algorithm proposed by Schroedter-Homscheidt et al. (2008).**

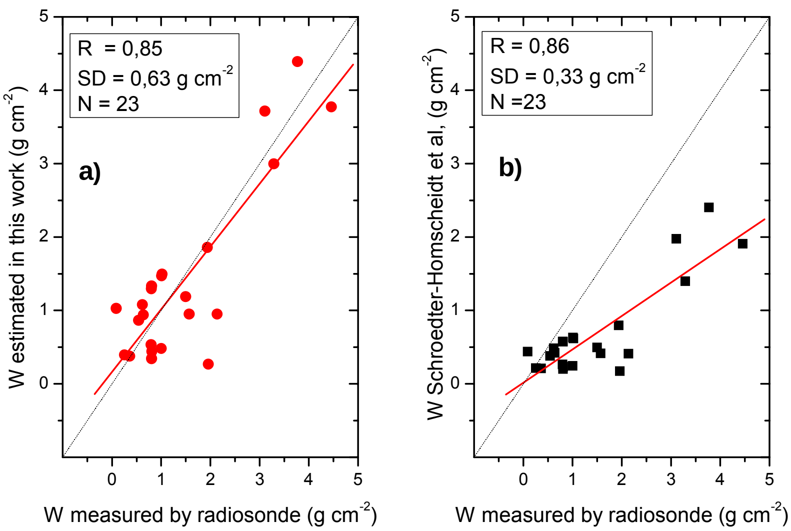

**Figure 5. Comparison between the total atmospheric water vapor content derived from MSG1-SEVIRI data and that measured by the radiosonde: a) using the algorithm proposed in this work, b) using the algorithm proposed by Schroedter-Homscheidt et al. (2008).**

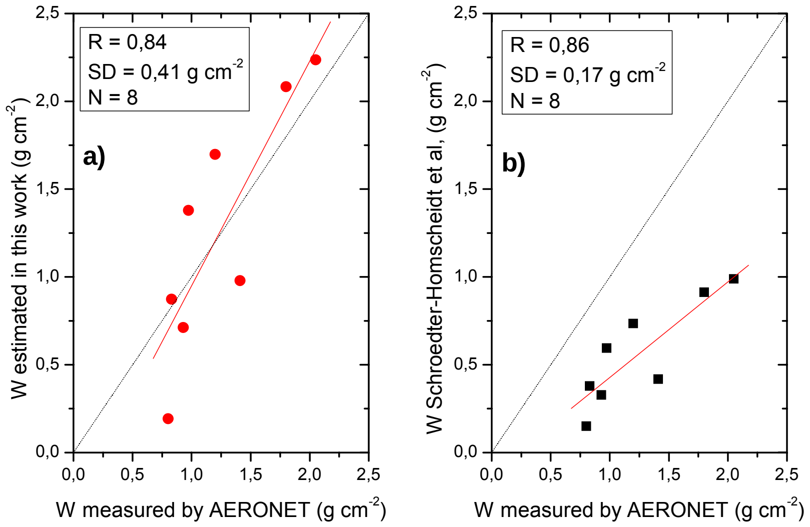


**Figure 6. Comparison between the total atmospheric water vapor content derived from MSG1-SEVIRI data and that measured by AERONET; a) using the algorithm proposed in this work, b) using the algorithm proposed by Schroedter-Homscheidt et al. (2008).**

3. I think that Eq. (6) should be dependent on the viewing zenith angle than can improve the accuracy.

We agree with you, so we have rewritten in the revised manuscript the coefficients of Eq. (6) as functions of satellite zenith angle. Besides, after the cloudy profiles are removed, we found in this case that the relationship between TAWV and the ratio of the two split-window channel transmittances ($\tau_{12}/\tau_{10.8}$) can be considered as a third order polynomial formula (see Fig.3).

We have rewritten Eq. (6) In the revised version as follow:

$$W = a\,r^3 + b\,r^2 + c\,r + d \qquad (6)$$

**where r is the transmittance ratio, it can be calculated as follow:**

$$r = \frac{T_{12}^{a} - T_{12}^{b}}{T_{10.8}^{a} - T_{10.8}^{b}} \qquad (7)$$

**and the coefficients a, b, c and d are dependent on the viewing zenith angle θ, figure 4 shows the fit function coefficients a, b, c and d as functions of satellite viewing angle. We found a third order polynomial formula between these coefficients and θ.Thus, these coefficients can be calculated as follows:**

$$a = -0.000299992\,\theta^3 + 0.0365\,\theta^2 - 0.02253\,\theta - 85.17$$

$$b = 0.000729268\,\theta^3 - 0.08568\,\theta^2 - 0.03185\,\theta + 192.40848$$

$$c = -0.000570985\,\theta^3 + 0.06616\,\theta^2 + 0.12204\,\theta - 155.98939$$

$$d = 0.000141237\,\theta^3 - 0.01694\,\theta^2 - 0.06817\,\theta + 48.80061$$

We have added also in the revised version, the figure which shows the variation of the third order polynomial coefficients a, b, c and d as functions of satellite zenith angle (see Fig. 4)

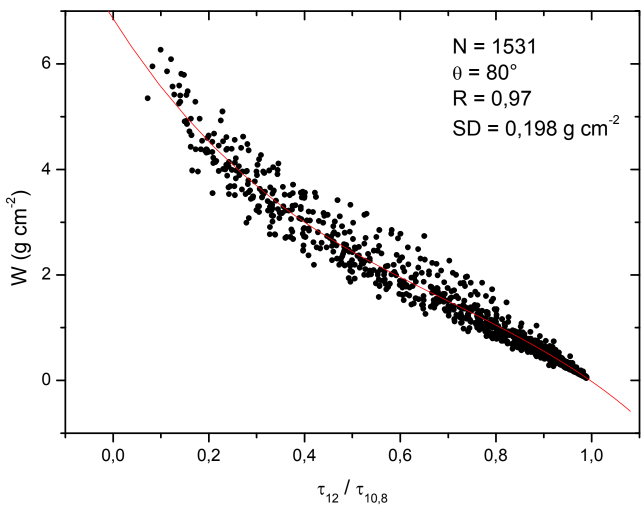


**Figure 3. Total atmospheric water vapor content plotted of the 1531 clear-sky atmospheric profiles as a function of the transmittance ratio, $\tau_{12}/\tau_{10.8}$, for MSG1-SEVIRI at viewing angle θ = 80°.**

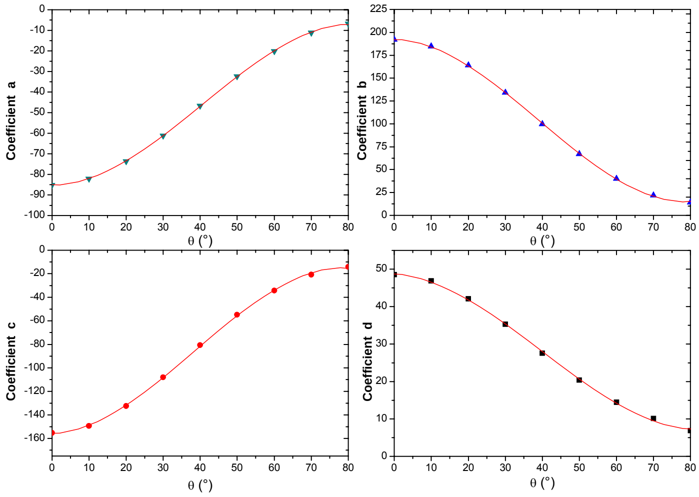


**Figure 4. Third order polynomial coefficients a, b, c and d as functions of satellite viewing angle.**

4. An important assumption for the AERONET observations is that the atmosphere is horizontally uniform and the observation data in the off-nadir direction can be converted to nadir observations. However, this assumption is less reliable if clouds exist in the nadir and/or off-nadir directions or if the spatial variation of the atmospheric conditions is signiïňˇA¸cant, particularly for the observations at large zenith angles. Besides, the viewing direction of SEVIRI may be totally different from that of the CE318 in the AERONET program. in this case, uncertainty is inevitable. I suggest that the authors should give same disscussion about this topic. The following papers may be useful. Besides, soom references should be added about the AERONENT in section 2.2. Ren, H., Du, C., Liu, R., Qin, Q., Yan, G., Li, Z.-L., & Meng, J. (2015). Atmospheric water vapor retrieval from Landsat 8 thermal infrared images. Journal of Geophysical Research: Atmospheres, 120, 1723-1738 Ichoku, C., Levy, R., Kaufman, Y.J., Remer, L.A., Li, R.-R., Martins, V.J., Holben, B.N., Abuhassan, N., Slutsker, I., Eck, T.F., & Pietras, C. (2002). Analysis of the performance characteristics of the five-channel Microtops II Sun photometer for measuring aerosol optical thickness and precipitable water vapor. Journal of Geophysical Research: Atmospheres, 107, AAC 5-1-AAC 5-17 Liu, C., Li, Y., Gao, W., Shi, R., & Bai, K. (2011). Retrieval of columnar water vapor using multispectral radiometer measurements over northern China. Journal of Applied Remote Sensing, 5, 053558-053558-053512

Firstly, we have added some references about the AERONENT in section 2.2:

- **Holben, B.N., Eck, T.F., Slutsker, I., Tanré, D., Buis, J.P., Setzer, A., Vermote, E., Reagan, J.A., Kaufman, Y.J., Nakajima, T., Lavenu, F., Jankowiak, I., Smimov, A.: AERONET—A Federated Instrument Network and Data Archive for Aerosol Characterization. Remote Sens. Environ., 66, 1-16, 1998.**
- **http://aeronet.gsfc.nasa.gov/**

In regards to the assumption for the AERONET observations is that the atmosphere is horizontally uniform and the observation data in the off-nadir direction can be converted to nadir observations and this assumption is less reliable if clouds exist in the nadir and/or off-nadir directions or if the spatial variation of the atmospheric conditions is significant, particularly for the observations at large zenith angles. Besides, the viewing direction of SEVIRI may be totally different from that of the CE318 in the AERONET program. We have discussed and added this source of error and other sources of error in the revised manuscript. **We can summarize the sources of error in the validation of results as follows:**

1- **The comparison is based on the assumption that the AERONET and satellite instruments observe the same TAWV. However, this assumption is less reliable because the viewing direction of SEVIRI may be totally different from that of the Sun photometer CE318 in the AERONET program.**
2- **The spatial size difference between AERONET and radiosonde data on the one hand and SEVIRI data on the other hand.**
3- **The temporal difference between AERONET and radiosonde data on the one hand and SEVIRI data on the other hand (for SEVIRI the time is in interval between two observations).**
4- **Satellite retrieval of TAWV is subject to uncertainties associated with radiometric calibration.**

5. In section 4.2, "(2) the input brightness temperatures with a variation larger than approximately 5 K during the daily cycle". There may be a long time interval (several hours) between two observations with brightness temperature difference up to 5K. As a result, the atmospheric water vapor has changed remarkably, and then the proposed work does not work. Please give more discussions.

We agree with you, **the atmospheric water vapor may be changed between two observations of SEVIRI with brightness temperature difference up to 5K. However**

**the assumption of a constant atmosphere between two observations with a minimum time difference is rationale for most cases**. For example, see the map of the total atmospheric water vapor content (Fig. 8) in which we used a time difference only equals 3 h, this map shows all available pixels in the study area with brightness temperature difference up to 5K (without taking into account of cloudy pixels).

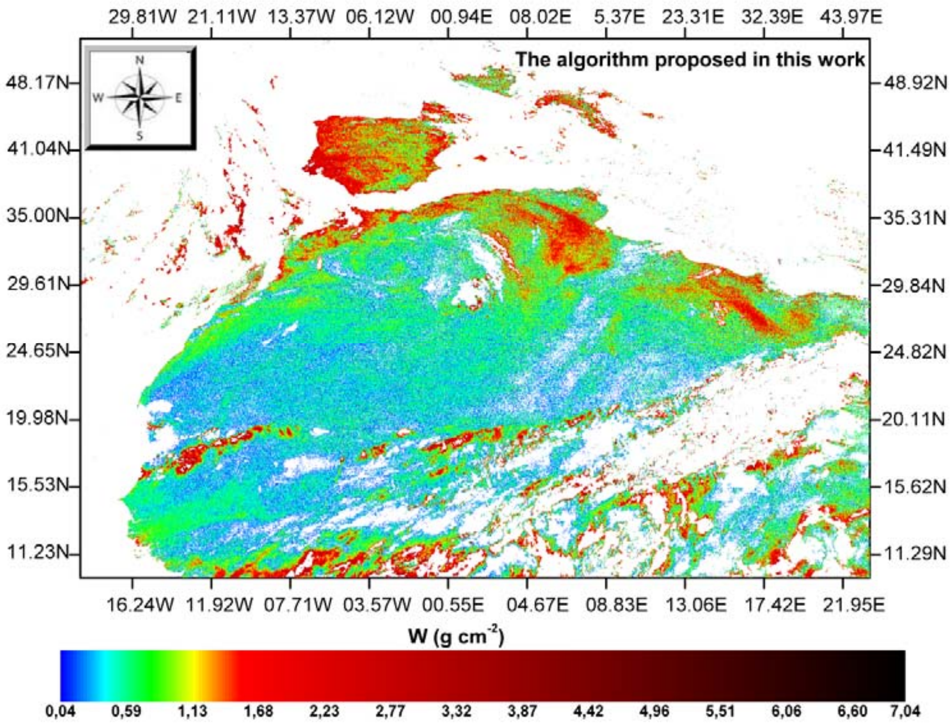


**Figure 8. Map of the total atmospheric water vapor content using the algorithm proposed in this work for all available pixels in the study area, the map was obtained from MSG1-SEVIRI data on 15 March 2006 at 12:00 UTC. Cloud was set to be white in the map.**