Dear Refree#1, We’re grateful for your comments and here are our responses to your comments. Our responses to each comment are written with blue-font texts.

Page 1, Lines 19-22: The sentence should be moved to the first part of paragraph. 2.

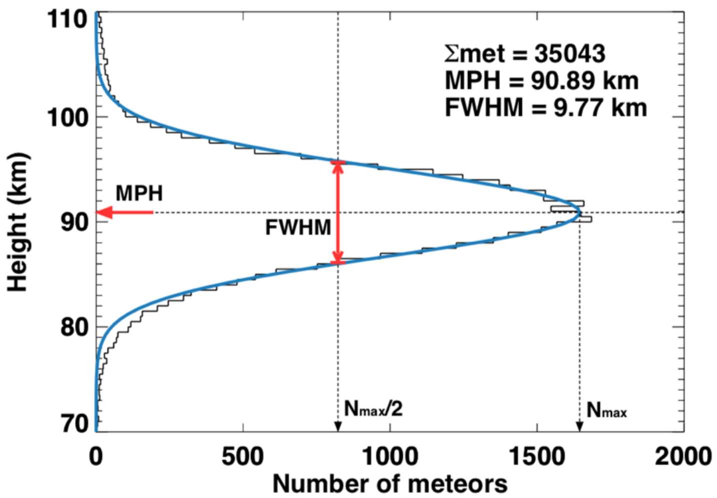
- According to your comment we moved the sentence to the first part of paragraph. Thanks.

Page 2, Liu et al. (Liu, L., H. Liu, H. Le, Y. Chen, Y.-Y. Sun, B. Ning, L. Hu, W. Wan, N. Li, and J. Xiong (2017), Mesospheric temperatures estimated from the meteor radar observations at Mohe, China, J. Geophys. Res. Space Physics, 122, 2249–2259, doi:10.1002/2016JA023776.) should be cited (reasons will be stated below.).

- We’ll added that paper as reference. Thanks.

3. Page 2, Lines 10-11: Since the MHC effect, how to describe the height distribution now because the normal distribution be fail? I am curious at that they still use Guassian function to fit the distribution (Line 21, Page 3) if the MHC effect is important.

- As you pointed out, the meteor radar observation at high altitude is affected by MHC effect and this makes asymmetry in the meteor height distribution as shown in the figure below. However, the extent of the asymmetry is not very severe and the Gaussian function is still the suitable model to determine the best FWHM values to be compared to the SABER temperature.



[Lee et al., 2016]

4. Page 2, Line 8: “invariance”must be deleted, because it is not so as this work presents.

- This study presents the linear relationship between SABER temperature and FWHM based on the fact that the meteor height distribution is primarily controlled by the background atmospheric pressures as shown in Figure 1. The proportionality constant between temperature and FWHM is defined to be a constant as in the equation (3), which was demonstrated from the observational data within measurement errors over the 5-year period as shown in Table 1 in the manuscript. And this is the key idea of the temperature estimation procedure using the observed FWHM, instead of using diffusion coefficient. Once it is determined from the independent measurements such as SABER in our study, the daily mean temperature can be estimated from the meteor radar observed FWHM alone without any additional information.

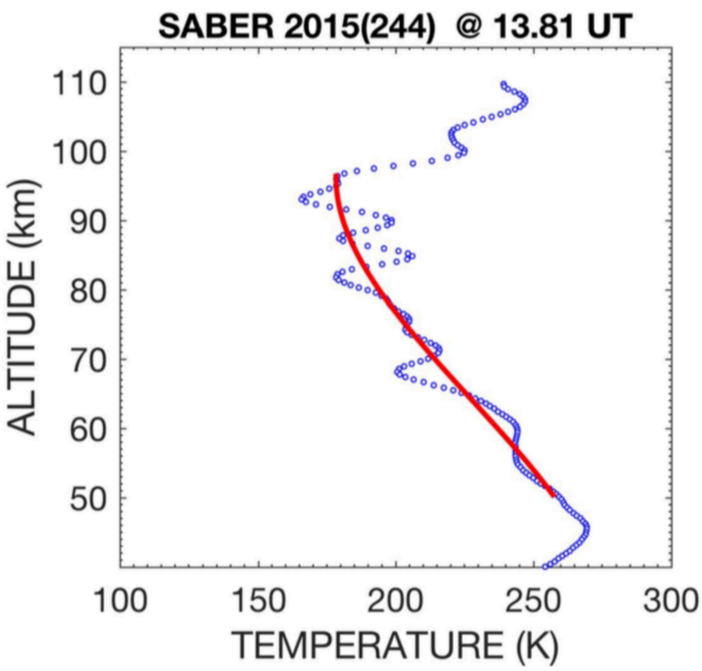
5. Page 3, Lines 1-2: Since there are so limited observations from SABER over the station (the authors can check the local time coverage of SABER), how can they obtain information of geopotential height at times without SABER passes.

- We agree that the SABER only scan two local times over one local position a day as it has a sun synchronous orbit but, we don't need SABER data to get geopotential height from the meteor echo data. There is a simple equation to convert between the geometric height (h) and geopotential height (hg) as follows,

$$hg=h*(r/r-h),$$

where r is the earth's radius. Based on this formula, all the geometric heights of meteor echo can be easily converted to geopotential height without SABER data.

6. As Figure shown below for example,



the authors should be stated clearly step by step in the revised manuscript how to obtain the layer mean temperature from SABER. As there are waves in the temperature profile, how to take them into account to get the background profile?

- Since the accumulated meteor height distribution during a day only provides one FWHM, it is more natural that the FWHM can reflect the daily mean temperature not the temperature at the moment. The layer mean temperature corresponds to the red solid line (of course there is height-bin dependence) and the red solid line still shows mean temperature information even if there is a wave structure in the profile. Daily mean temperature can be obtained by averaging the at least two individual temperature profiles (your figure is a single temperature profile at 13.81 UT) and wave structures is more likely getting weaker or even smoothed out in the average procedure.

7. More important, the SABER temperature lacks local time coverage, how to obtain daily mean temperature. If it fails to do so, how to reach the statement as given in Page 2, Lines 8-9.

- Since the SABER only covers two separated local times (day and night for each) over any geographic locations, we calculated mean temperature profile from the SABER temperature data recorded on a single day of year. Several previous studies [Meek et al., 2013; Holmen et al., 2016; Yi et al., 2016] used spatial grid to limit MLS or SABER temperature to the specific location for direct comparison with local meteor radar data and we also did in the same way. Determining the spatial grid for data selection is a tradeoff between number of available satellite data and accurate comparison with the local ground-based measurement.

References

1. Meek, C. E., Manson, A. H., Hocking, W. K. and Drummond, J. R.: Eureka, 80° N, SKiYMET meteor radar temperatures compared with Aura MLS values, Annales Geophysicae, 31(7), 1267–1277, doi:10.5194/angeo-31-1267-2013, 2013.
2. Holmen, S. E., Hall, C. M. and Tsutsumi, M.: Neutral atmosphere temperature trends and variability at 90 km, 70°N, 19°E, 2003–2014, Atmos. Chem. Phys., 16(12), 7853–7866, doi:10.5194/acp-16-7853-2016, 2016.
3. Yi, W., Xue, X., Chen, J., Dou, X., Chen, T. and Li, N.: Estimation of mesopause temperatures at low latitudes using the Kunming meteor radar, Radio Sci., 51(3), 130–141, doi:10.1002/2015RS005722, 2016.

8. Page 3, Lines 15-16, describe the daily profile number of SABER available over the station.

- When we limit SABER data to the distance of less than 500 km from the location of KSS, 3-4 profiles are available on average.

9. Page 4, Lines 20-21: It must be deleted, because Equation (1) is not valid under this case. In other words, the authors should be realized that there are assumptions being made.

- The thermodynamic state of the atmosphere at any point is determined by pressure, temperature and density. These variables are related to each other by the ideal gas law. The hydrostatic balance provides an excellent approximation for the vertical dependence of the pressure field in the real atmosphere [Andrew et al., 1987; Holton, 2004; North et al., 2014]. Of course the real atmosphere is different from its ideal state but they work very well. Below references obviously show that ideal gas law and hydrostatic equation can be used to describe atmospheric physics. It would be appreciated if you provide more appropriate equations better describing the FWHM and atmospheric pressure field than equation (1).

References

1. Andrew, D. G., Holton, J. R., Leovy, C. B., Middle Atmospheric Dynamics, Academic Press. 1987.
2. Holton, J. R., An introduction to dynamic meteorology, vol. 88, Academic Press, 2004.
3. North, G. R., Pyle, J. A. and Zhang, F.: Encyclopedia of Atmospheric Sciences, Elsevier. 2014.

10. Page 4, Lines 24-25: It should be removed as reason being given in the above and also in the Table.

- As we already mentioned in previous response to comment 4, time-invariance of proportionality constant is a fundamental idea to make the FWHM estimate background atmospheric temperature. Otherwise whenever we determine the atmospheric temperature from the FWHM, we need SABER or MLS temperatures to conduct linear regression procedure. This study wants to tell that the temperature can be estimated from the FWHM alone without any further information. The proportionality constant in the table has its own standard error due to uncertainties in FWHM and SABER temperature measurements, please note that the constant does not change within a given standard errors during the entire periods.

11. Page 4, Lines 25-31: Words are required to tell how to get such result.

- Firstly, we try to find the two height layers where the envelopes of the FWHM meet (please refer to figure 1 in the manuscript) and SABER pressure values at those two height layers can be found every day. Once two pressure values over the entire observational period are recorded, we calculate mean value of two pressures (P1, P2) and they can be used to obtain the proportionality constant from $C = \frac{g}{R}\left[\ln\left(\frac{P_1}{P_2}\right)\right]^{-1}$

12. Page 5, Lines 3-5: no ideal local time coverage is reached for the SABER observations, how to get FWHM with geopotential height information from SABER and layered mean temperature? Figure is welcome to show it.

- We already mentioned how to get geopotential height without SABER data in our response to comment 5. All the geometric height of meteor echo data can be converted to geopotential height using a simple formula.

13. Page 5, Lines 20-23: the statement is invalid, because geopotential height of each echo should be given and the ratio of layer mean temperature to FWHM be given.

- From the simple relation in our response to comment 5 between the geometric and geopotential height we already obtained all the geopotential height from the meteor echo data. Based on the linear relationship between the FWHM and the temperature, T = C*FWHM, we can calculate the daily mean temperature directly using FWHM alone. Lee et al., (2016) already showed that FWHM can provide better temperature estimation with lower uncertainties than meteor decay times.

Reference

Lee, C., Kim, J. -H., Jee, G., Lee, W., Song, I. S. and Kim, Y. H., New method of estimating temperatures near the mesopause region using meteor radar observations, Geophys. Res. Lett., 43(2), 10, doi:10.1002/2016GL071082, 2016.

14. Page 5, Lines 30-32: It is not the same in the height range as FWHM covered. If the statement here is true, what is usefulness of Equations (1)-(3).
They are no the same now. Further, how to understand the result presented in Figure 3. I now strongly feel the authors make the layer mean temperature over FWHM and temperature at specific height confusing (although they may mean the temperature within 2.4 km).

- According to your comment, we'll add more description in data analysis part for better understanding about the layer mean temperature. All the equations are essential to approve the linear relationship between the FWHM and background temperature based on the fact that the FWHM corresponds to the height difference between two fixed atmospheric pressures as shown in figure 1 in the manuscript. When we compare the proportionality constant from the least-squares fitting with one from the equation $C = \frac{g}{R}\left[\ln\left(\frac{P_1}{P_2}\right)\right]^{-1}$, the height difference between P1 and P2 have to be identical to the FWHM, and we have done in that way as we explained in our response to comment 11. Since the SABER has a better vertical resolution than MLS, we can find representative height where the FWHM can estimate the temperature by using finer height bin size. If we used height bin size comparable to the FWHM instead, we have to assume that FWHM estimate atmospheric temperature near the meteor peak height as Lee et al., (2016) did using MLS.
- In this study, we started with calculation the layer mean temperature having a height bin of 2.4 km and further analyses were conducted.

15. Page 8, Line12: As stated above, it is misleading now. Further the statement in

Page 1, Lines 11-13.

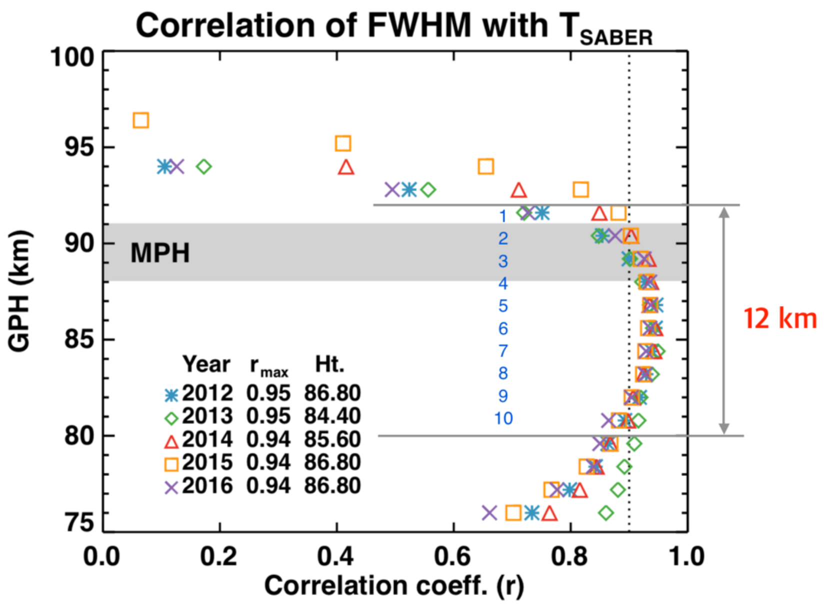
- We're very sorry to say this but, we don't understand where misleading part is. Page 8 line12 and page1 line11-13 tell the exactly same feature that the FWHMs have the best correlation with the temperature at around 87 km, which is a little lower than the meteor peak height (~90 km). We also pointed out that rapid decrease in correlation coefficients above MPH is caused by the MHC effect. You can easily find above description in figure 3 in the manuscript.

16. Figure 2: the vertical axis of left panel listed MLS, no points in the panel.

- Yes. We admit that MLS data was not used in this study, but we just want to show that SABER has less number of available data compared to MLS due to its limited geometrical coverage for high-latitude (> 52 degrees) regions as described in the manuscript. This can be used to explain higher fitting error of proportionality constant in least-squares fitting procedure.

17. Figure 3: SABER temperature? Layer mean temperature over FWHM?

- As we described in our response to comment 14, SABER temperature data were interpolated every 1.2 km first and the layer mean temperatures were obtained within 2.4 km height bin. This means the height layer for mean temperature is overlapped by 50 % (height-bin=2.4 km height step=1.2 km). You can find there are 10 data points in 12 km height region in the figure below.



18. This work and Lee et al. is done with TEMPERATURE= C times FWHM, while Liu et al. [2017] adopts TEMPERATURE = C times FWHM +A. Liu et al. introduces another term A to fit the relationship between TEMPERATURE and FWHM. Further, Table 1 shows the coefficient, or C, is changing or different in years separately or together, and differs from those in column 4. At last, the authors need clarify what temperature from

SABER used, layer mean temperature over FWHM range, or temperature within 2,4 km.

- The linear relationship between the temperature and the FWHM is derived from the basic equations (ideal gas law and hydrostatic equation) and we also showed that the FWHM closely follows background atmospheric pressures (P1, P2) from independent observations. In this study, we clearly showed the physical meaning of “T=C*FWHM” and C should be considered as the constant over 5-year observational period under a given uncertainty.
- When we used “T=C*FWHM+A” form as Liu et al. (2017) did to define the relationship between FWHM and the SABER temperature, both C and A dramatically changes for each year and they are unpredictable as summarized in the table below. What if we have to estimate the mesospheric temperature using “T=C*FWHM+A” in 2016 or 2017 ? We can easily expect that independent temperature measurement from the MLS or SABER is necessary to find new C and A in a given period.

Year	C	A
2012	15.11 ± 0.03	16.52 ± 0.35
2013	17.23 ± 0.04	-5.11 ± 0.45
2014	13.67 ± 0.03	36.71 ± 0.31
2015	11.82± 0.03	55.08. ± 0.30