Dear Editor and the reviewer,

We are very grateful to your constructive comments and thoughtful suggestions. Based on these comments and suggestions, we have made thorough revisions to the original manuscript. In addition, we polished our language by the highly qualified native English-speaking editors at AJE in the revised manuscript. The changes made to the text are highlighted in blue so that they may be easily identified in the revised manuscript. Above these have led to an improvement of the paper, and we hope the revised manuscript is suitable for publication in the journal.

Yours sincerely,

Tonghua Wu on behalf of all co-authors

Response to comments:

The paper by Wu et al., presents 11 years of meteorological and soil data in a relict permafrost site of the Mahan Mountain on the northeast of the QTP. The paper is generally well organized and clear to me. As a permafrost researcher, I appreciate the considerable efforts taken by the authors to the permafrost community. I also very much welcome the publication of valuable permafrost datasets.

Major comment

1. **GST vs LSM**: "The ground surface temperature (GST) was measured by the IRP-P at a height of 2 m above the ground surface through non-contact infrared radiation" (P10, L167–168). In this context, the measured value is the radiative skin temperature of the land surface. The surface could be snow, grass, and a mixture of them, right? I would keep the "GST" for soil temperature and "LSM" for ground skin temperature. I hence suggest changing the GST to LSM throughout the manuscript.

Response:

Thanks for the suggestion. We totally agree with your suggestions. In

the revised manuscript, we changed GST to LST in the context.

2. **Permafrost and Active Layer**: Based on the authors' title—"Permafrost, active layer and meteorological data (2010–2020) from a relict permafrost site at Mahan Mountain", I would expect the detailed info of permafrost & active layer would be present. However, the paper in its current format is somehow unfocused, and the permafrost/active layer is very lightly discussed and seems equal or even less important than the meteorological data. Hence, I suggest enhancing the statistics of permafrost and active layer conditions and changes during 2010–2020. Since authors have a 11-years' time-series, this could be easily done by

(1) adding permafrost temperature profile (MAGT) in different years info Figure 7, so that readers could see permafrost temperature changes;

Response:

Thanks for your suggestion. The permafrost temperature data were not available during 2012-2016 due to the sensor failure. After 2017, a digital multimeter was used to manually measure the permafrost temperature for 2–4 times each month. Therefore, only 6 years of data are available. In order to analyze the changes of the permafrost temperature, we calculated the annual average permafrost temperature at the depth of 9 m and 15 m. The result shows that the annual mean ground temperature at these depths only showed slight changes during 2010–2020. To be clear, we explained this and added the figure in the result section as follows:

The permafrost temperature data were not available during 2012–2016 due to the sensor failure. After 2017, a digital multimeter was used to manually measure the permafrost temperature for 2–4 times each month. We calculated the annual average permafrost temperature at depths of 9 m and 15 m. The result shows that the annual mean ground temperature at these depths only showed slight changes during 2010–2020 (Fig. 10) (Line 386-391).

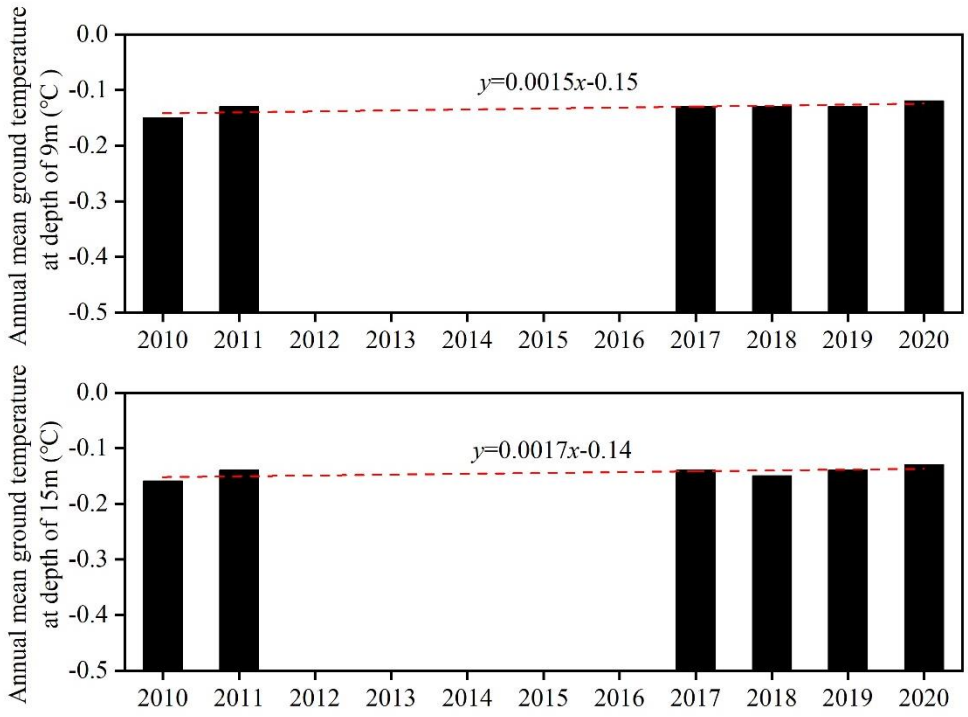

Figure 10. The annual mean ground temperature at depths of 9 m and 15 m during 2010–2020 at the permafrost site.

(2) presenting active layer thickness (conditions and changes) based on soil temperature;

Response:

Thanks for the suggestion. In the revised manuscript, we added the temporal changed in active layer hydro-thermal conditions and its thickness, which are as follows:

The results revealed that the average warming rate of soil temperature at different depths was 0.056 °C /year at Mahan Mountain from 2010 to 2020 (Fig. 6a). The highest warming rate of soil temperature was 0.107 °C /year at a depth of 30 cm, while the lowest value was 0.019 °C /year at a depth of 120 cm (Fig. 6a). The average changing trend of the volume soil water content was 0.013 m^3 m^{-3}/year from 2010 to 2020, and the highest value was 0.026 m^3 m^{-3}/year at a depth of 120 cm, while the lowest value was 0.005 m^3 m^{-3}/year at a depth of 10 cm (Figure 6b) (Line 305-311).

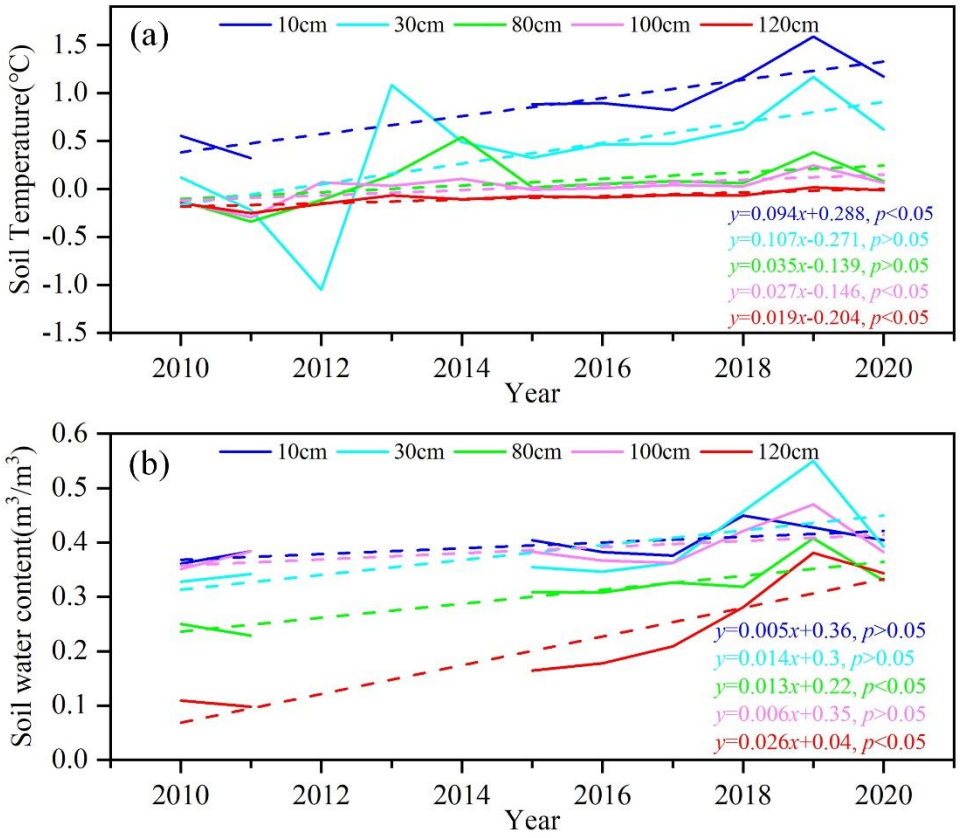

Figure 6. Soil temperature and soil volumetric water content at five depths from 2010 to 2020 at Mahan Mountain permafrost site: soil temperature (a), soil volumetric water content (b).

The active layer thickness (ALT) varied between 107 cm and 150 cm with a mean value of 127 cm from 2010 to 2020 (Fig. 7). The rate of change in ALT was 1.8 cm/year. The increasing rates of ALT in recent decades have varied considerably in different permafrost regions (Table 5) (Line 315-318).

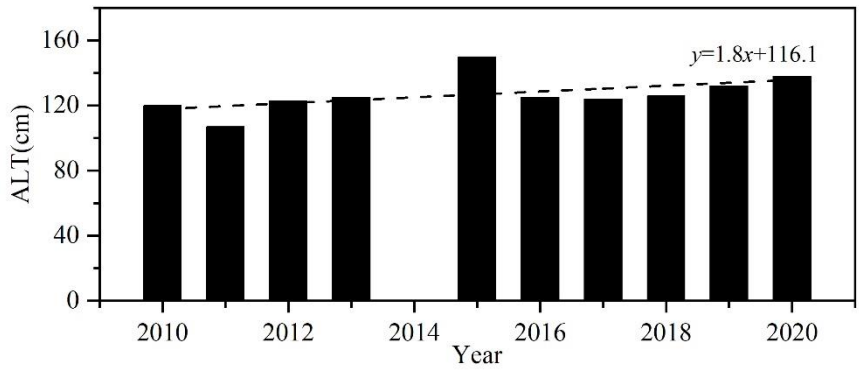

Figure 7. The active layer thickness (ALT) from 2010 to 2020 at Mahan Mountain permafrost site. The ALT data in 2014 were not available.

(3) discussing why permafrost could be relict here. This is the most unique feature for this site. The permafrost temperature is very very close to 0°C (i.e., around -0.1°C, and only slightly increased. With the presence of massive ground ice at this site, air temperature warming would mostly lead to significant phase change rather than temperature increase. Also, the thick peat layer and cloudy/foggy weather in summer are favorable for the presence of permafrost.

Response:

Thanks for the suggestion. The Mahan Mountain is the only region in the Loess Plateau (China) where permafrost exists. The permafrost is typical warm permafrost and remains in a very fragile and sensitive state. There is an important protective effect from the peat layer and ground ice. In addition, the foggy weather in summer is very frequent, which can shield local solar radiation into soil layer to some extent. Therefore, local permafrost could be relict here. In the revised manuscript, we explained this in the discussion section as follows:

The Mahan Mountain is the only region in the Loess Plateau (China) where permafrost exists. Due to the high mean annual temperature in this region, the permafrost existence can be mainly attributed to two mechanisms. First, the peat layer protects the permafrost from thawing. The organic carbon-rich layer can prevent heating from the air during the warm season as well as the heat loss during the cold season (Du et al., 2012). Second, the high content of ground ice can also favour the presence of the permafrost. It is well known that the phase change of ground ice can absorb a large amount of heat, and thus, the ground temperature will not change significantly in warm permafrost (Biskaborn et al., 2019). In addition, the frequent foggy weather in the area may also decrease the solar radiation and thus favour the presence of permafrost. (Line 79-88)

References:

Biskaborn, B. K., Smith, S. L., Noetzli, J., Matthes, H., Vieira, G., Streletskiy, D. A., Schoeneich, P., Romanovsky, V. E., Lewkowicz, A. G., Abramov, A.,

Allard, M., Boike, J., Cable, W. L., Christiansen, H. H., Delaloye, R., Diekmann, B., Drozdov, D., Etzelmüller, B., Grosse, G., Guglielmin, M., Ingeman-Nielsen, T., Isaksen, K., Ishikawa, M., Johansson, M., Johannsson, H., Joo, A., Kaverin, D., Kholodov, A., Konstantinov, P., Kröger, T., Lambiel, C., Lanckman, J.-P., Luo, D., Malkova, G., Meiklejohn, I., Moskalenko, N., Oliva, M., Phillips, M., Ramos, M., Britta, A., Sannel, K., Sergeev, D., Seybold, C., Skryabin, P., Vasiliev, A.,Wu, Q., Yoshikawa, K., Zheleznyak,M., and Lantuit, H.: Permafrost is warming at a global scale, Nat. Commun., 10, 264, https://doi.org/10.1038/s41467-018-08240-4, 2019.

Du, R., Peng, X., Frauenfeld, O.W, Sun, W., Liang, B., Chen, C., Jin, H., Zhao, Y.; The role of peat on permafrost thaw based on field observations, Catena, 208: 105772, https://doi:10.1016/j.catena.2021.105772, 2022.

3. **Language**: The English need to be carefully checked and revised by native speakers.

Response:

Thanks for the suggestion. We polished our language by American Journal Experts (https://www.aje.com/) which is a partner of many publishing groups. The changes were highlighted in blue so that they may be easily identified. The editing certificate by AJE were presented as follows:

AJE

Editing Certificate

This document certifies that the manuscript

Permafrost, active layer and meteorological data (2010–2020) from a relict permafrost site at Mahan Mountain, Northeast of Qinghai-Tibet Plateau

prepared by the authors

Tonghua Wu, Changwei Xie, Xiaofan Zhu, Jie Chen, Wu Wang, Ren Li, Amin Wen, Dong Wang, Peiqing Lou, Chengpeng Shang, Yune La, Xianhua Wei, Xin Ma, Yongping Qiao, Xiaodong Wu, Qiangqiang Pang, Guojie Hu

was edited for proper English language, grammar, punctuation, spelling, and overall style by one or more of the highly qualified native English speaking editors at AJE.

This certificate was issued on **February 8, 2022** and may be verified on the AJE website using the verification code **C85B-8D21-C762-B3C5-0241**.

Neither the research content nor the authors' intentions were altered in any way during the editing process. Documents receiving this certification should be English-ready for publication; however, the author has the ability to accept or reject our suggestions and changes. To verify the final AJE edited version, please visit our verification page at aje.com/certificate. If you have any questions or concerns about this edited document, please contact AJE at support@aje.com.

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Specific comments

P2, L39: The permafrost extent is from Zhang et al., (2000), right? If so, I would only cite the related reference and remove the others here.

Response:

Yes. It is from the literature of Zhang et al. (2000). In the revised manuscript, we removed other unrelated references (Line 37).

P3, L44: There are "increasing"...

Response:

Changed. (Line 41-42).

P4, L98: This is a repeat of L83.

Response:

Thanks for the suggestion. In the revised manuscript, we have deleted this sentence in the Line of 83-85.

P5, L111: Relict permafrost will not disappear in the next 40–50 years, this means it is not sensitive to climate warming...

Response:

Agree. In the revised version, we changed this sentence as: The relict permafrost is not sensitive to climate warming. (Line 114-115)

P10, L166: was ranging → ranged.

Response:

Changed. (Line 181)

P14, L269--271: Please remove the missing data info in the figure caption as this has already shown well in the Figure. In such a case, the sentence could be much short, i.e. The blank gap stands for the missing data.

Response:

Thanks for the suggestion. In the revised manuscript, we removed the

missing data information and replaced it with “The blank gap stands for the missing data”. (Line 283). In addition, we also made changes for similar errors throughout the manuscript.

P18, L350: In general, it is difficult to distinguish the permafrost model and LSM, it largely depends on the research purpose. Permafrost models, i.e., CryoGRID 3 model (Westermann et al., 2016) has the land surface processes (snow, energy bucket), and permafrost physics have also been implemented into the land surface models, i.e., CLM5, Noah, CLASSIC. What about changing to "...valid models..."?

Response:

Agree. We rewrote the sentence as “These high-quality and long-term observation data can be used for model validation, including permafrost models, e.g., the CryoGRID 3 model (Westermann et al. 2016), and land surface models, e.g., CLM5 and Noah (Li et al. 2021).” (Line 428-431)

References:

Westermann, Sebastian; Langer, Moritz; Boike, Julia; Heikenfeld, Max; Peter, Maria & Etzelmuller, Bernd (2016). Simulating the thermal regime and thaw processes of ice-rich permafrost ground with the land-surface model CryoGrid 3. Geoscientific Model Development. ISSN 1991-959X. 9(2), p. 523–546. doi: 10.5194/gmd-9-523-2016.

Li, X., Wu, T., Wu, X., Chen, J., Zhu, X., Hu, G., Li, R., Qiao, Y., Yang, C., Hao, J. and Ni, J., 2021. Assessing the simulated soil hydrothermal regime of the active layer from the Noah-MP land surface model (v1. 1) in the permafrost regions of the Qinghai–Tibet Plateau. Geoscientific Model Development, 14(3), pp.1753-1771.

Tables & Figures

Table 1: The operation period is the same for all measured variables, right? In this case, I would suggest removing the column and putting the temporal coverage info in the table caption.

Response:

Thanks, we removed the column of operation period, and added the information in the title of Table 1.

Figure 6 Should the unit of y-axis be "cm"?

Response:

Yes, we changed the unit in Figure 6, which is as follows:

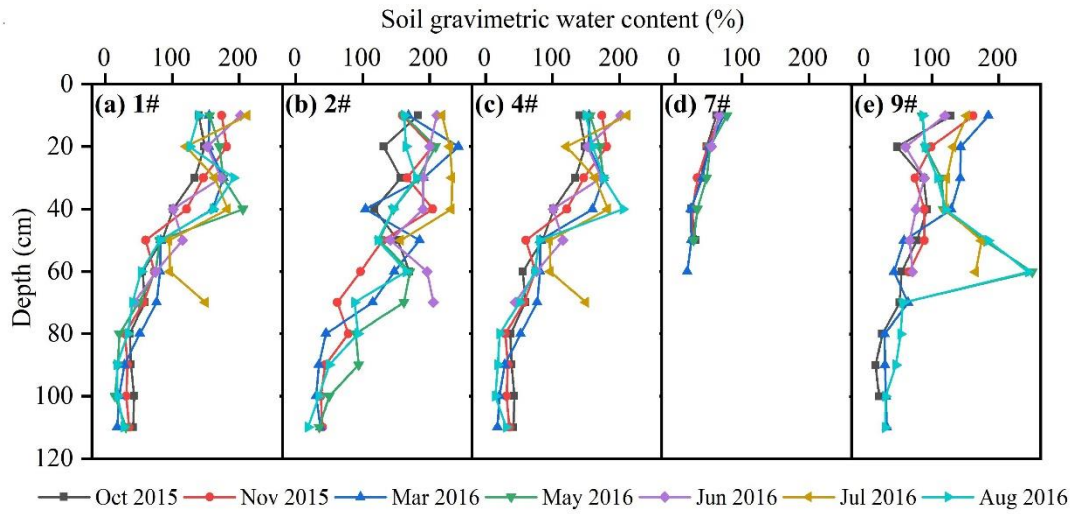

Figure 8. Soil gravimetric water content at five sampling sites (1#, 2#, 4#, 7#, and 9#) from October 2015 to August 2016 at Mahan Mountain. The location and information of the sampling sites are shown in Figure 1(b) and Table 3, respectively.

Figure 3: Please somehow change the y-axis range of relative humidity (g). A maximum value of 120 is not reasonable here (as you mentioned in L208). A tricky would be to give the y-axis range a little bit greater than 100%, but only show the value labels between 0–100.

Response:

In the revised manuscript, we recreated the Figure 3 as follows:

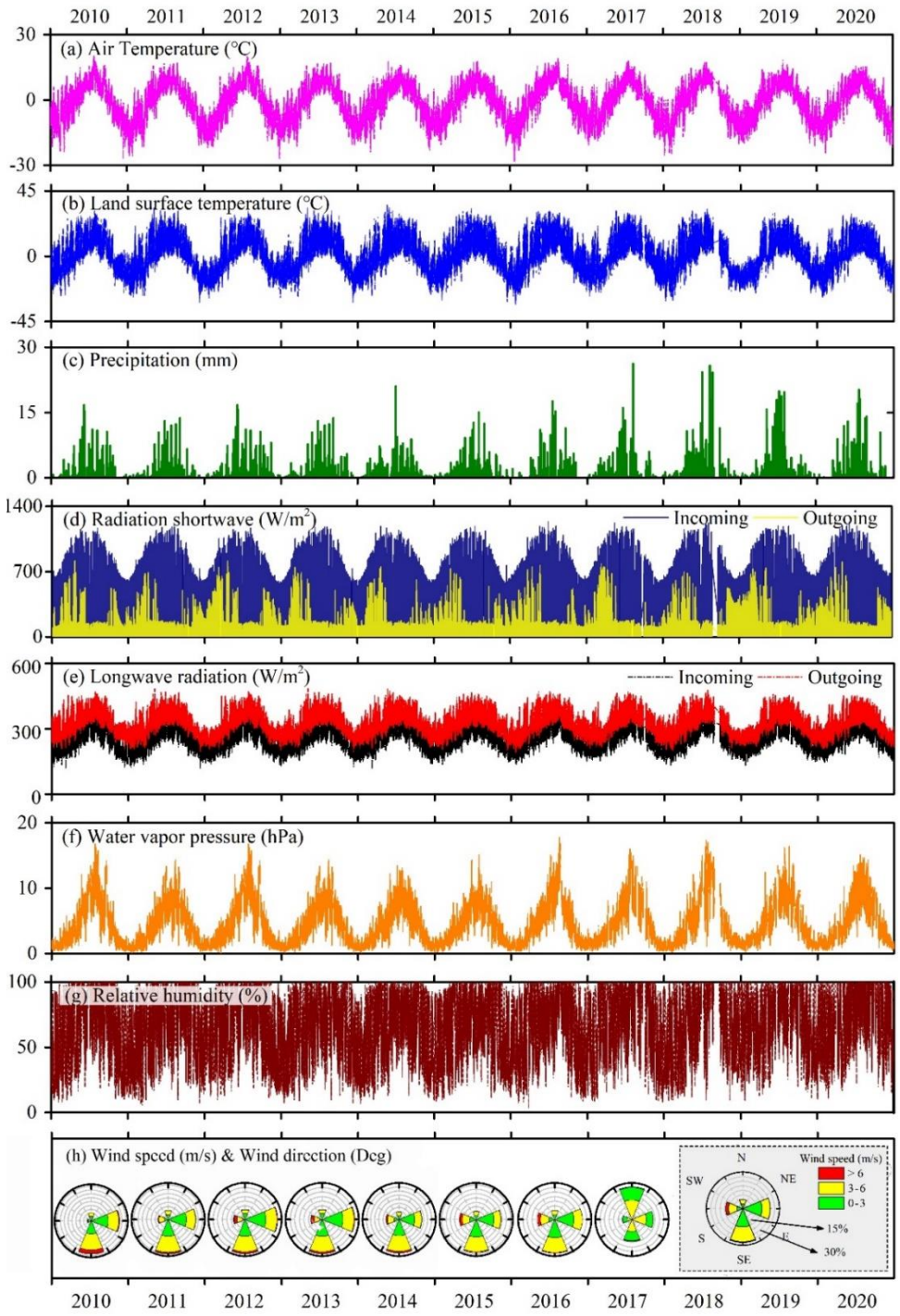

Figure 3. Time series of meteorological variables from 2010 to 2020 at Mahan Mountain, including air temperature at 2 m height (a), land surface temperature (b), precipitation at 1.6 m height (c), shortwave radiation at 2 m height (d), longwave radiation at 2 m height (e), water vapor pressure at 4 m height (f), relative humidity at 4 m height (g), wind speed & direction at 2 m height (h). The temporal resolution of precipitation data is daily scale, and hourly scale for other all variables.