Dear Reviewer:

We would like to sincerely thank the reviewer for the thoughtful comments and suggestions. All comments and suggestions have been considered carefully and well addressed. For clarity, the referees' comments are listed in black italics, and our responses and changes in the manuscript are shown in blue. We also mention where we made necessary changes in the revised manuscript by indicating page and line numbers in our responses. Please see our responses to your comments and suggestions below.

**Response to Reviewer #3**

*I appreciate that the authors have made great explanations and additional experiments on my concerns, yet I have some minor problems before publication.*

Author Response: We would like to thank Reviewer #3 for your insightful and constructive comments. All your comments and suggestions are very helpful for improving our manuscript. We have carefully considered and addressed all of these comments, and revised our manuscript. Please find our point-by-point response below.

*1. From Table 1 in the Response letter, the slope of all stations is minimal, so there may be limited topographic effects on the stations for evaluation. However, the improvement of Case 2 compared with Case 1 is substantial (Table 5), this is strange, could you give more explanations?*

**Author Response:** Thank you for this comment. Although field instruments are usually setup on a flat land surface, some stations are surrounded by high mountains. For example, QOMS is situated at the bottom of the lower Rongbuk Valley, to the north of Mt. Qomolangma. The spatial distribution of slope and azimuth angle around QOMS station is shown in following Fig. 1. The valley around QOMS has a north–south orientation, with a flat bottom of about 1.5 km width, which corresponds to a small slope. The mountains on both sides of the valley are of 600-900 m in height above the ground, sloping from 25° to 30° (Sun et al., 2018). The surface downward solar radiation is composed of direct radiation, diffuse radiation and reflected radiation. As identified by Chen et al. (2013), the solar diffuse radiation can account for 14% of the solar radiation at the surface of the QOMS station. And for the sunny hillsides, reflected solar radiation can be as high as 100 W $m^{-2}$ sometimes. The hillsides facing the solar incoming direction receive more radiation. The west-facing hillsides which are shaded by the terrain receive a relative low radiation. Therefore, for stations with complex surrounding terrain, the improvement may be significant. The RMSE of QOMS on the instantaneous scale in Case 1 is 165.81 W $m^{-2}$, and the RMSE on the instantaneous scale in Case 2 is 118.74 W $m^{-2}$. Some stations are not surrounded by high mountains, such as NLGS. The spatial distribution of slope and azimuth angle around NLGS station is shown in following Fig. 2. It can be seen that the terrain around NLGS is relatively smooth, compared to the surrounding area of QOMS station. The improvement of NLGS is minimal. The RMSE of NLGS on the instantaneous scale in Case 1 is 183.56 W $m^{-2}$, and the RMSE on the instantaneous scale in Case 2 is 180.77 W $m^{-2}$.

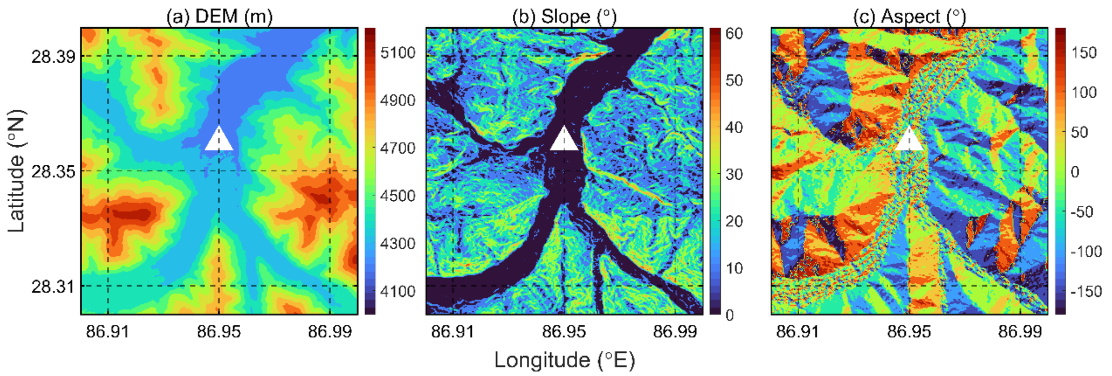


Figure 1. The DEM (a, unit: m), slope (b, unit: degree, 0-90°) and aspect (c, unit: degree) information around QOMS station.

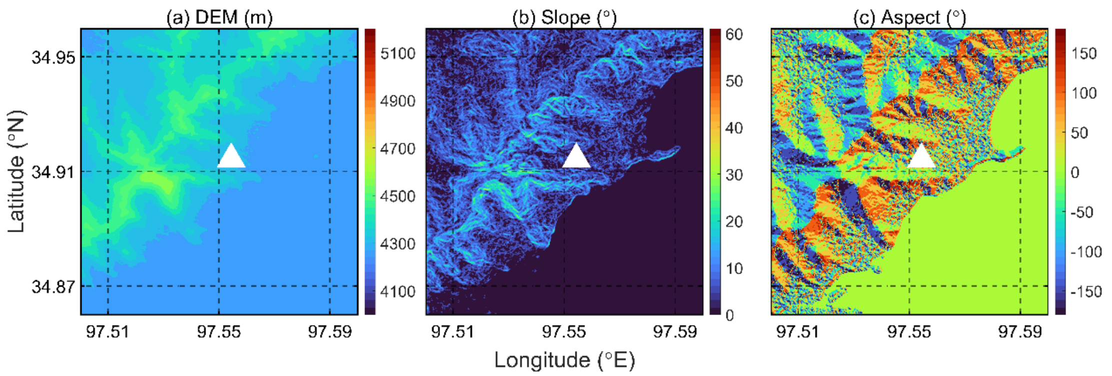


Figure 2. The DEM (a, unit: m), slope (b, unit: degree, 0-90°) and aspect (c, unit: degree) information around NLGS station.

The related references are as follows:


Sun F., Ma Y., Hu Z., Li M., Tartari G., Salerno F., Gerken T., Bonasoni P., Cristofanelli P., Vuillermoz E. Mechanism of daytime strong winds on the northern slopes of Himalayas, near Mount Everest: observation and simulation. Journal of Applied Meteorology and Climatology, 2018, 57(2): 255-272.

Chen, X., Su, Z., Ma, Y., Yang, K., and Wang, B.: Estimation of surface energy fluxes

under complex terrain of Mt. Qomolangma over the Tibetan Plateau, Hydrology and Earth System Sciences, 17, 2013.

*2. I suggest the authors add some discussions about the challenge of validating DSR products over mountains and the limitations of the current evaluation in the paper. Also discuss the limitations of the current method, e.g., not considering the sky view factor and hard to obtain daily mean DSR estimations. I think the in-depth discussion can greatly improve the impact of this paper and point out future studies. See Ma et al. (2023) Estimation of fine spatial resolution all-sky surface net shortwave radiation over mountainous terrain from Landsat 8 and Sentinel-2 data.*

**Author Response:** Thank you for this comment. Some discussions have been added in the revised manuscript as follows. (P26, L561-L572)

'In this study, topographic effects are coupled in the DSR parameterization scheme by taking shading and terrain reflections into account. Sky view factor is also an important factor for DSR in mountainous areas (Ma et al., 2023). Further improvements may be achieved by introducing the sky view factor into the parameterization scheme. It's still a great challenge to evaluate DSR products over mountainous areas. Currently, it is difficult to do fully evaluations for this complex topography due to lack of in situ measurements on different aspect and slopes over the TP (Yan et al., 2020; Ma et al., 2023). Additionally, the generating of daily shortwave radiation datasets remains a challenge. New-generation geostationary satellites with higher temporal and spectral resolutions, such as FengYun-4 and Himawari-8, have been launched successfully (Bessho et al., 2016; Guo et al., 2017). This provides an opportunity to obtain hourly and daily DSR. Moreover, this allows us to further extend this method to obtain more details of surface radiation components over the TP in the future.' (P26, L561-L572)

The related reference has been added in the revised manuscript as follows (P35, L802; P39, L917):

Ma, Y., He, T., Liang, S., McVicar, T. R., Hao, D., Liu, T., and Jiang, B.: Estimation of fine spatial resolution all-sky surface net shortwave radiation over mountainous terrain from Landsat 8 and Sentinel-2 data, Remote Sensing of Environment, 285, 10.1016/j.rse.2022.113364, 2023.

Yan, G., Chu, Q., Tong, Y., Mu, X., Qi, J., Zhou, Y., Liu, Y., Wang, T., Xie, D., Zhang, W., Yan, K., Chen, S., and Zhou, H.: An operational method for validating the

downward shortwave radiation over rugged terrains, IEEE Transactions on Geoscience and Remote Sensing, 1-18, 10.1109/tgrs.2020.2994384, 2020.

*3. Now I understand the method to make temporal upscaling, yet I suggest the authors explain it in the paper (average by instantaneous values), because readers may misunderstand it as averaging from daily mean values (in the DSR fields, most studies focus on daily and monthly mean values).*

**Author Response:** Thank you for this comment. Relevant statements have been added in the revised manuscript to make it clear as follows. (P12, L266)

'It is upscaled to ten-day and monthly timescales via averaging by instantaneous values.' (P12, L266)