The manuscript entitled "Generation of global 1 km all-weather instantaneous and daily mean land surface temperature from MODIS data" has been reviewed. The authors generated a global all-weather instantaneous and daily mean LST product spanning from 2000 to 2020 using XGBOOST, and then they systematically evaluated the accuracy of the produced LST dataset. The manuscript is written well and can be easily understood. I think the manuscript can be accepted if the following concerns have been answered well.

Thank you for your positive and constructive review comments. These comments are very helpful in revising and improving our paper, as well as guiding our future research. We have studied the comments carefully and tried our best to revise the manuscript.

1.Several most recent studies corresponding to all-weather LST datasets have been published on the ESSD, but they are not cited in this manuscript. Although the current study focuses on a global scale. Some regional/national-scale studies on all-weather LST datasets also have important contributions and need to be mentioned in this manuscript.

Response:

Thank you for your valuble comment. We cited several LST datasets which published on ESSD, but they were indeed not comprehensive. Therefore, under your suggestion, we have added more LST datasets from ESSD. The updated datasets references are as following:

(1) Ma, J., Zhou, J., Göttsche, F.-M., Liang, S., Wang, S., & Li, M. (2020a). A global long-term (1981–2000) land surface temperature product for NOAA AVHRR. *Earth System Science Data, 12*, 3247-3268 (Lines 55-56)

(2) Li, J.-H., Li, Z.-L., Liu, X., & Duan, S.-B. (2023a). A global historical twice-daily (daytime and nighttime) land surface temperature dataset produced by Advanced Very High Resolution Radiometer observations from 1981 to 2021. *Earth System Science Data*, *15*, 2189-2212 (Lines 55-56)

(3) Jia, A., Liang, S., Wang, D., Ma, L., Wang, Z., & Xu, S. (2023). Global hourly, 5 km, all-sky land surface temperature data from 2011 to 2021 based on integrating geostationary and polar-orbiting satellite data. *Earth System Science Data*, 15, 869-895 (Line 91)

(4) Tang, W., Zhou, J., Ma, J., Wang, Z., Ding, L., Zhang, X., & Zhang, X. (2024). TRIMS LST: a daily 1 km all-weather land surface temperature dataset for China's landmass and surrounding areas (2000–2022). Earth System Science Data, 16, 387-419 (Line 117)

2. I am concerned about the effects of station density on the model accuracy. Please include some analysis on this concern.

Response:

Thank you for your valuable comment. We add several experiments to further evaluate the station density on the model accuracy, experiments were conducted with station density and regional validation. Firstly, the stations were reduced randomly in the training dataset, and the model performance was evaluated based on the same test samples. The accuracies of the instantaneous and daily mean models were shown in the Table.1. The result shows that the accuracy of both models decreases as the number of stations in the training sample decreases. When the number of stations in the training sample is reduced from 238 to 158, the RMSE of the instantaneous model increases from 2.787 K to 2.988 K, and the RMSE of the daily mean model increases from 2.374 K to 2.479 K. The experiment indicates the model accuracy is affected by the station density, but to a limited extent when there is a sufficient amount of samples. It may be that the long time series of station data used in the experiment provided relatively sufficient samples.（Line 599）

Table.1.The training and testing accuracy of instantaneous and daily mean LST with the number of stations decreasing in the training model.

		instantaneous model			daily mean model		
training stations	training samples	RMSE (K)	Bias (K)	R^2	RMSE (K)	Bias (K)	R^2
238	539341	2.787	0.178	0.974	2.374	0.100	0.978
218	482986	2.828	0.203	0.974	2.397	0.121	0.978
198	426149	2.867	0.211	0.973	2.421	0.116	0.977
178	398148	2.877	0.243	0.973	2.426	0.140	0.977
158	321819	2.988	0.239	0.971	2.479	0.160	0.976

Furthermore, since stations are not uniformly distributed globally, to further validate the effect of station density on the models, we conducted validation in subregions around the world, shown in Fig.1. The continental United States (US) and Europe, which have relatively high station densities, were separately divided into two regions, one for high latitudes (those with an absolute value of latitude larger than 60°), and one for other mid- and low-latitudes. Four regions are shown in different colors (Fig.1.(i)). For the instantaneous model (Fig.1.a-d), the validation accuracy is higher in the continental US with RMSE= 2.43 K, comparable in Europe with RMSE= 2.94 K and other mid- and low-latitude regions with RMSE=2.9 K, and slightly lower in high-latitude regions with RMSE=3.06 K. For the daily mean LST (Fig.1.e-h), the validation accuracy is the highest in Europe with RMSE=1.98 K, the continental US with RMSE=2.2 K and the mid- and low-latitudes with RMSE=2.34 K, respectively, and the lowest in high-latitudes with RMSE=2.86 K. The result indicates that the validation of the instantaneous and daily mean LST do not differ significantly between other mid- and low-latitude regions with fewer stations and the continental regions of Europe and the continental US with more stations. The relatively lower validation accuracy at high latitudes is related to the larger uncertainty in data and station observations at high latitudes. Therefore, from the subregional validation results, the station density has a limited impact on the model construction in different regions.

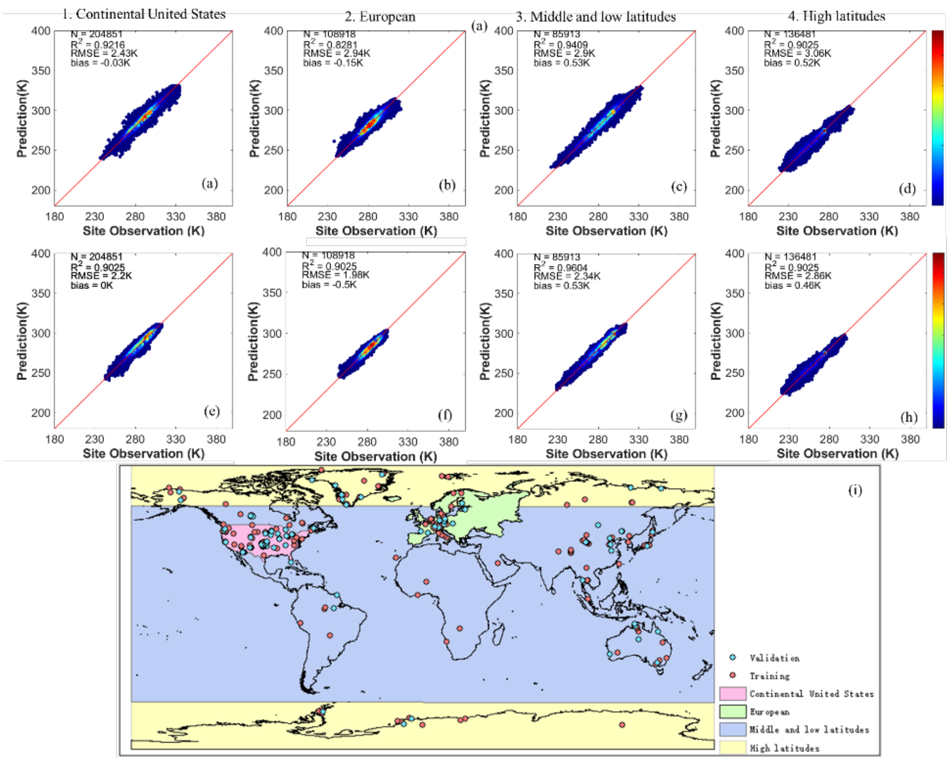

Fig.1 Validation for the instantaneous LST (the first row) and daily mean LST (the second row) based on four zones at global scale. Four zones are displayed by different colors.

3.I am especially concerned about the spatial pattern of the estimated LST data. The cloudy-sky LST may be mainly decided by the ERA5 data (coarse spatial resolution), which may lose some spatial details. Figs. 13 and 14 have shown the spatial pattern of LSTs. However, the terrains on the two selected tiles may be not representative. 1) Does the estimated LST can show spatial details in mountainous regions? 2) Meanwhile, can the urban heat island effects be shown clearly? 3) Are the estimated LST data spatially and naturally smoothing without any abnormal boundaries?

Response ：

Thank you for your questions about the spatial detail section of the manuscript, and we have further refined based on your comments.

(1) Regarding your question about whether the estimated LST can reflect the mountainous detail, we have selected the tile of H24V05 covering the western regions of the Tibetan Plateau contains mountainous terrain. The instantaneous and daily mean LST are shown in Fig.3 and Fig.4 respectively. The estimated LSTs had spatial patterns similar to those of MODIS LST under clear-sky conditions. Compared with the ERA LST, which was used as the model input, our results showed more spatial details and corrected the underestimation in some regions. In particular, the results of H24v05 reflect that the estimated LST has mountainous details. Demonstrates that our approach is equally applicable to mountainous regions with high heterogeneity. The spatial details of the daily mean LST showed similar conclusions. (Line 523)

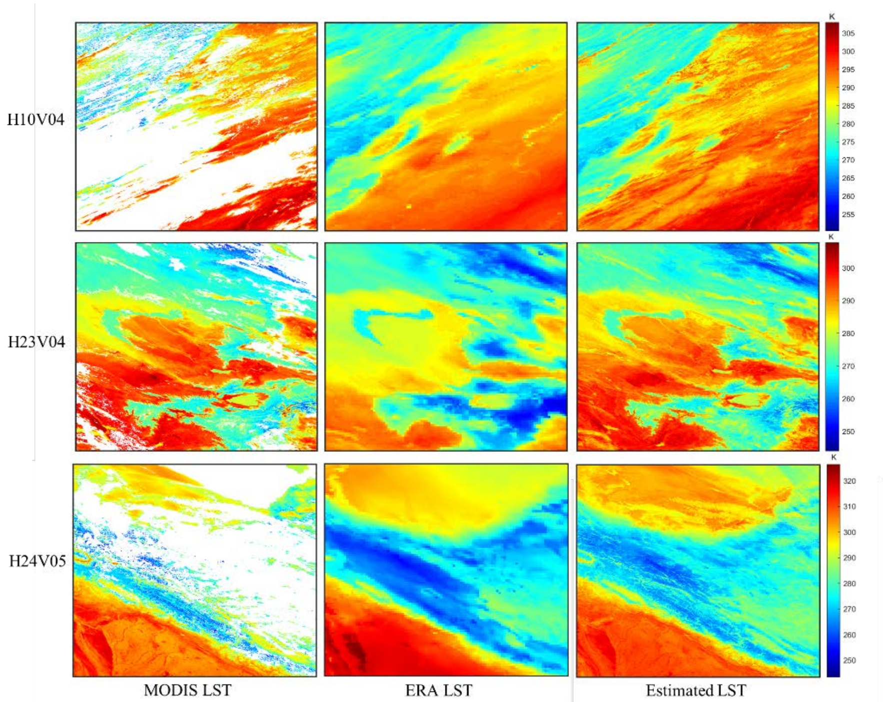

Fig.2 Spatial details of the MODIS LST, ERA LST and estimated instantaneous LST of three tiles, H10V04 (the first row), H23V04 (the second row) and H24V05 (the third row) from the ninetieth day in 2010

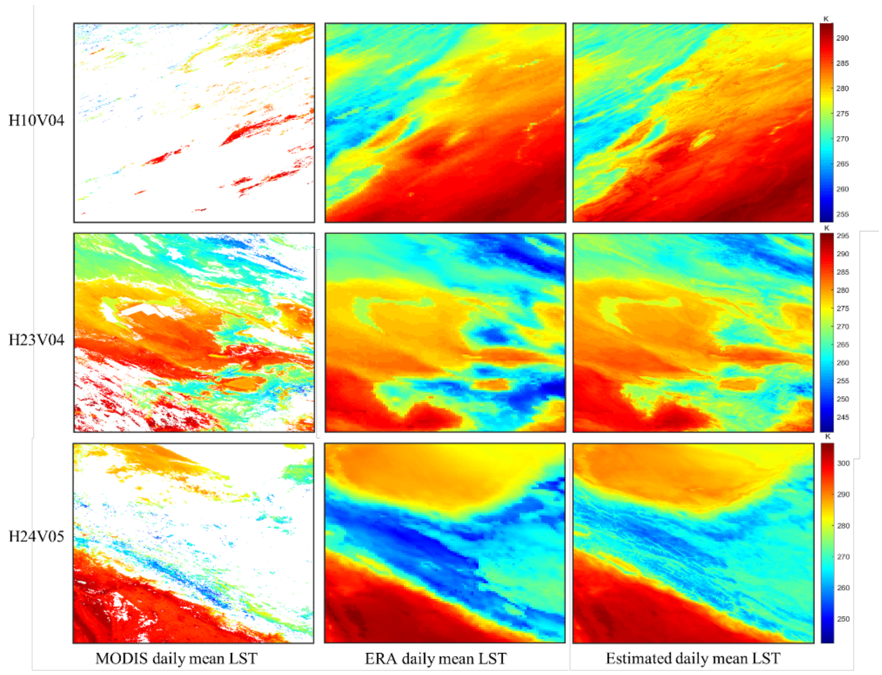

Fig.3 Spatial details of the daily mean LST retrieved from MODIS LST, ERA LST and estimated daily mean LST of three tiles H10V04 (first row) , H23V04 (the second row) and H24V05 (the third row) from the ninetieth day in 2010.

（2）Urban heat island effect is one of the main applications of LST data. To further assess the spatial details of the estimated all-weather LST and the potential of urban heat island applications, we selected four cities in different regions around the globe and demonstrated the estimated LST in conjunction with the boundary of urban regions extracted by using global artificial impervious area data (Li et al. 2020), as shown in Fig.15. The figure shows that the built-up areas of four cities present higher LST than the periphery, and confirms that our estimated all-weather LST can capture the urban heat island phenomenon and present relevant details. (Line 543)

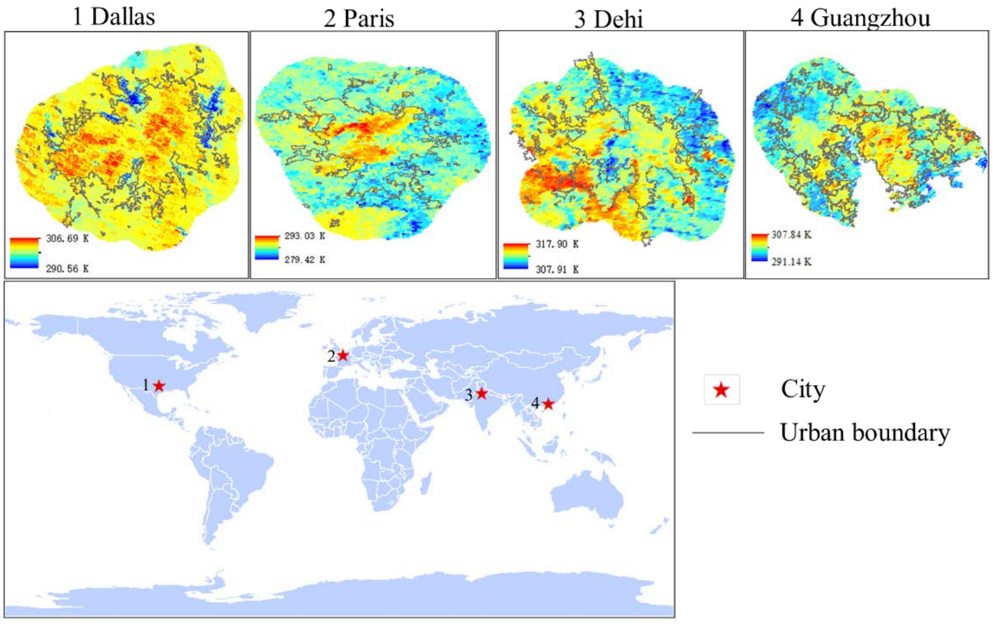

Fig.4 Spatial pattern of the estimated all-weather LST in four representative cities. The black lines are the boundary of urban regions extracted by using global artificial impervious area data.

（3）Initially, when constructing the model, the boundary problem was taken into account, so the official clear-sky LST of MODIS was not directly used, and all-weather LST models were constructed instead. We can see the spatial details maps from the Fig.2 and Fig.3 in this document. The estimated instantaneous and daily LST all have no obvious boundary under clear-sky and cloudy conditions, and there is no obvious boundary effect in the global map (Fig.16 and Fig.17 in the manuscript).

4. I would like to check more daily mean LST data, instead of the daily mean LST on the first day of a year, nor the monthly-scale LSTs. The shared LSTs are not representative of quality checking by reviewers.

Response:

Thank you for your valuable comment. Due to the large amount of data, we have only uploaded part of the data on the Zenodo platform to obtain DOI. Recently, we have uploaded all the daily mean LST data on another platform. Hoping to satisfy your needs.

The dataset link is https://glass.hku.hk/archive/LST/MODIS/Daily/1KM/.

5.Why not include LST data in 2021 and 2022?

Response:

Thank you for your comment. The reason why we produce the data until 2020 is because some of the auxiliary data used is updated to 2020, such as LWDN, albedo, etc. If these auxiliary data update, we will update our product in the future, thank you for your suggestions.