

Response to Referee #1

We would like to thank the reviewer for the comments and suggestions, which are all valuable and very helpful for improving our paper. We have made revisions and a point-to-point response is present in the following.

Summary and comments:

1. The monthly near-surface air temperature dataset with 1 km * 1 km spatial resolution during 1961-2020 over the glaciers of the TP is useful and important. The data and method are reasonable. The data especially satellite data used in this research are huge and the methods of big data processing (regression, machine learning algorithm) are close to the advanced international level. Evaluations and warming trend analysis results are acceptable. Logical analysis and English expression in the manuscript are good. The figures, tables and results are enough. This paper may cause higher impact factor with more citations, considering the high spatial resolution, long time-series and the special location.

2. The key problems in this research are well resolved and described in the manuscript. (1) Parameter: from LST to air temperature. (2) Temporal preprocessing: from day/night MODIS observation to monthly data, from 2002-2020 to 1961-2020. (3) Spatial preprocessing: from observations at hundreds of stations and satellite retrieval LST in clear sky with 1 km * 1 km to this dataset with 1 km * 1 km spatial resolution. (4) clear/cloudy circumstance. (5) Choose ERA-5 land to evaluate, and select the typical stations (shown in Figure 1A, in blue) to reconstruct air temperature time series as basis functions.

Response:

[We thank Referee #1 for the encouraging comments.](#)

Comments:

3. Major comments.

3.1 Discuss. Why not keep monthly and 1 km in the title? Over the glaciers of the TP, how about over the TP? The coverage of the dataset with 1 km resolution may not only over the glaciers. It is larger if it is over the TP, with all these meteorological weather stations including automatic stations and glacier stations. L32. How about add "with altitude more than 3500 m" after "highest plateau".

Response:

(1) The reviewer's suggestion is very helpful. The authors have modified the title as "A long-term 1-km monthly near-surface air temperature dataset over the Tibetan glaciers by fusion of station and satellite observations". (2) The authors have completely understood the reviewer's concern. As a matter of fact, the reconstruction could be implemented on the entire TP for each 1-km grid. However, this work has not yet been conducted due to our limited computing resources. After the reconstruction work over the glaciers is published and there is a demand for the dataset over the TP, the authors will do it. (3) The suggestion for adding "with altitude more than 3500 m" is wonderful. The authors have corrected for this. The following words are added into the manuscript "with an average altitude greater than 3500 m" after "highest plateau" in L32.

Comments:

3.2 L103 and L107. For the first one and the second one dataset used, do you choose homogenized products? If so, please add the description. If not, the authors should pre-process the data. The time series are long enough. Without homogenization processing, the trend results are not confident.

Response:

The authors have totally understood the reviewer's concern. The authors have used the homogenized station dataset developed by Cao et al. The authors are sorry for neglecting this important information in the original manuscript and have added it into the revised manuscript as "The first one is the 60 years of daily near-surface air temperatures at a total of 145 weather stations on the TP, which are managed by the China Meteorological Administration (CMA), homogenized by Cao et al. (2016), and available from its website (<http://data.cma.cn/>), whose spatial distribution is shown in Fig. 1A (marked by the solid circles).....". At the same time, the corresponding article "Cao, L., Zhu, Y., Tang, G., Yuan, F., and Yan, Z.: Climatic warming in China according to a homogenized data set from 2419 stations, International Journal of Climatology, 36, 4384-4392, 2016." has been added into the revised manuscript.

Comments:

3.3 L123-125, what are these?

Response:

These characters have been caused in the process of converting the format. The authors are sorry for this. In the revised manuscript, they have been eliminated.

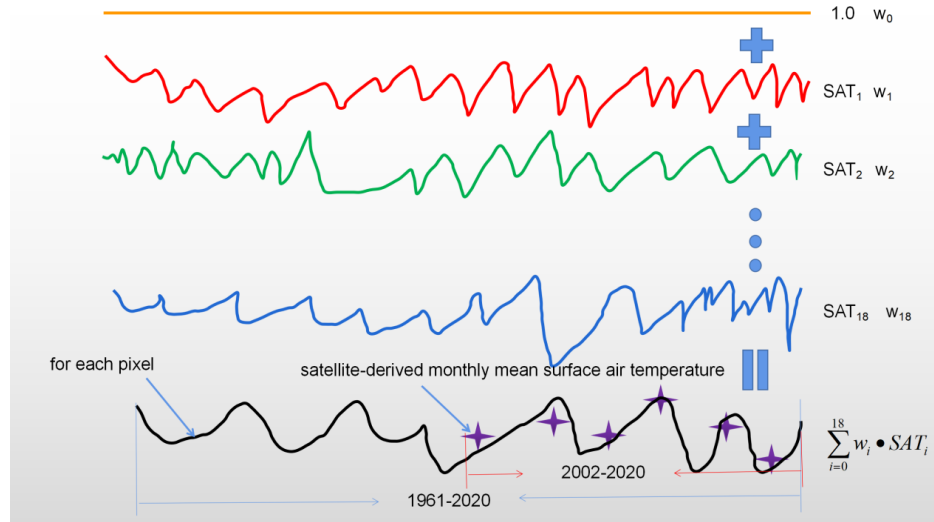
Comments:

3.4 For clear-sky days, how to pre-process if it is than a certain criterion like 8 days or 5 days, or even 3 days? What is the criterion? Sometimes (what is the portion?) maybe the monthly LST results are missing in some 1 km pixels, the low-quality retrieval data are also not useful. The TP coverage of Terra and Aqua/MODIS is limited. The typical characters of LST in these months are kept missing or the interpolation from the adjacent two months?

Response:

As the reviewer points out, monthly 1-km LSTs are sometimes missing. In order to mitigate this issue, the averaging is implemented once the number of high-quality LSTs at one pixel is greater than or equal to one. Of course, the authors know that the representativeness is rather weak when only a few LST values (even one value) in one month are used to calculate the mean. However, the authors think that data should not be discarded easily. Every data is informative and valuable. The suitable algorithm should be developed to handle the possible negative effect caused by this averaging procedure. So, Bayesian linear regression is taken to merge four estimated satellite SATs. Its most significant advantage is the ability to reduce the risk of being disturbed by points with large noises by adding a regularization term as shown in Equation (6). Moreover, the weight (λ) for this term can be estimated together with the regression coefficients. In reality, there have not existed any LST value in one month at a certain pixel and thus no monthly LST. As a matter of fact, it does not matter when this situation happens. As illustrated in the following figure, the basis functions (monthly mean SATs at 18 weather stations in this study) are continuous and their linear combination is fitted to the estimated satellite SATs. Thus, the reconstructed long-term (60 years) SATs are certainly continuous even though some estimated satellite SATs do not exist during 2002-2020. Bayesian linear regression is used to evaluate the

combination coefficients (β). The authors believe that the above explanations could address the reviewer's concerns. In the revised manuscript, the sentence "Then, the averaging procedure is only performed on these LST values for each 1-km pixel on the TP" has been revised as "Then, the averaging procedure is only performed on these LST values for each 1-km pixel on the TP even though only one LST is available." to give more details on the averaging procedure.



Comments:

3.5 Why not choose GeoTIFF and ASCII format both?

Response:

"GeoTIFF" format is a commonly used format and can be easily opened in many software. Moreover, data self-description can be realized. If the ASCII format is taken, the situation will become a little complicated. Besides the data files, files that describe the meta data (such as lon/lat for each grid) for the temperature dataset have to be made. However, the ASCII format is more visual for the data users. The authors will convert the format from GeoTIFF to ASCII and provide the dataset in these two types of formats.

Comments:

4. Minor comments.

4.1 It is suggested to change the word "own".

Response:

The authors have replaced the original word "owns" by the word "accommodates".

Comments:

4.2 Figure 1 in L100. (a)(b), revise it to (A)(B). L100 and L105, 116. Figure 7 in Line 242, add (C). Figure 9 in L269, it is suggested to use A~I but not A2~D2 in the second column. Figure 9 is not clear, and the font size is too small.

Response:

(1) The authors are sorry for these errors and have corrected them one by one. (2) It is a good advice to use A~I but not A2~D2 in Figure 9. Since, for example, the data in Figs. 9A1 and A2 are the same and just are displayed in two distinct ways, it can embody their internal logic connection to name them A1 and A2. Of course, if the reviewer think that it is more helpful for readers' understanding to use A~I, the authors will modify them according to the reviewer's comment in the next round revision. (3) The authors have revised Figure 9 according to reviewer's comments, enhancing the resolution and enlarging the font size.

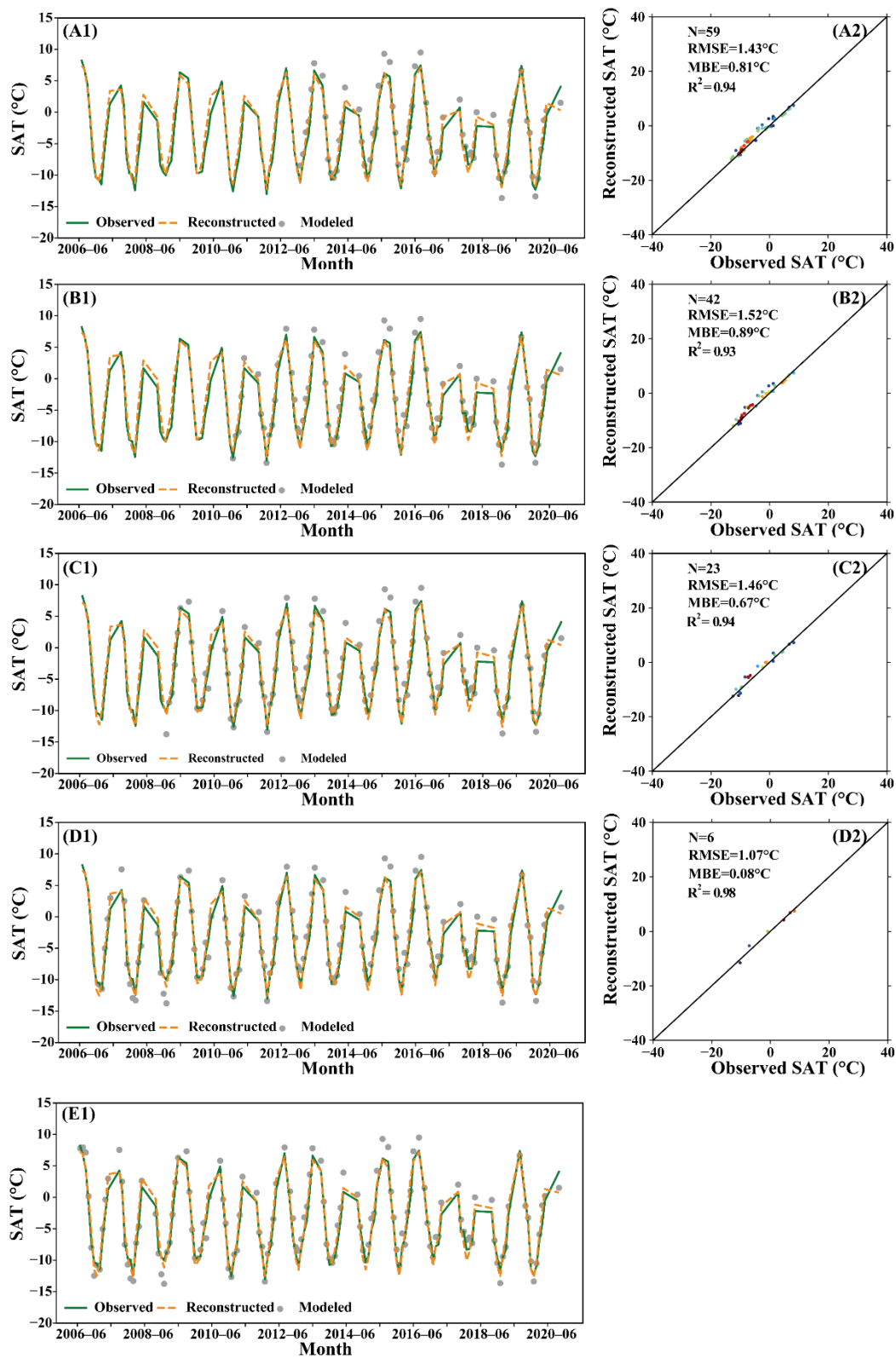


Figure 9

Comments:

4.3 Overfitting. Is it under fitting?

Response:

Overfitting is a concept in data science, which occurs when a statistical model fits exactly against its training data. When this happens, the algorithm unfortunately cannot perform accurately against unseen data. In this study, a machine learning algorithm (random forest) is taken to estimate near-surface air temperatures. Since its capacity is strong and the number of training samples is relatively scant, the overfitting easily happens. So, all weather stations in the northern hemisphere are used to increase the number of samples. In addition, Bayesian linear regression is used to merge four satellite-derived SATs. In this method, a regularization term is added into the cost function in order to avoid the adverse impact of outliers. In essence, this is a kind of mechanism to reduce the risk of overfitting.

Comments:

4.4 L16 and L140. Is it near-surface air pressure? It is suggested to add "near-surface" in the abstract and the main body when it is the first time to mention.

Response:

The authors are sorry for not clarifying this. The authors have added "near-surface" to L16 and L140 after "air pressure" in the revised manuscript.

Comments:

4.5 Maybe "minimum and maximum" is better.

Response:

The reviewer's comment is sensible. The words "maximum and minimum" in the original manuscript have been modified as "minimum and maximum" in the revised manuscript.

Comments:

4.6 Add a blank between 1 and km. Check it in other places.

Response:

The authors are sorry for these errors. The authors have examined the original manuscript and corrected them in the revised manuscript.

Comments:

4.7 It is suggested to add one sentence to describe larger DISO and better result here. Just like it is mentioned in L276.

Response:

The authors have added "Overall, the smaller DISO is, the better estimates are" after Equation (8) to qualitatively describe the implication of DISO in the revised manuscript.

Comments:

4.8 L338 and L446, 2021a and 2018a, delete "a" for the paper from the same first author is only listed once. Please check others. L370, 375, 400, 405, is the first author right or the order of the first name and the second name should be changed? Please check others.

Response:

(1) The authors are sorry for this. The authors have checked and corrected the problem of "L338 and L446, 2021a and 2018a". (2) They are not the first names of the authors in L370, 375, 400, 405.