Response to the RC3

RC3: 'Comment on essd-2024-9'

This manuscript provides an overview of in-situ observations of land-atmosphere interactions at 12 unique sites across the Tibetan Plateau (TP). The authors first identify and describe the standard flux tower (e.g., EC, meteorology, soil) measurements collected at each site (types of instruments and heights) and then outline the quality control and quality assurance processes that are completed, before examining the seasonal and diurnal trends between each site. The work is important and novel. I have a few general comments:

Response: We thank the reviewer for the attentive reading of our manuscript and the positive feedback. According to your nice suggestions, we have made extensive corrections to our previous manuscript, the detailed corrections are listed below. The revised contents are highlighted in blue in the following responses, corresponding changes are marked in red in the revised manuscript.

1.) Introduction - The introduction follows a logical framework: importance of TP with regards to Earth system interactions, how the the TP is warming faster than other areas (and the implications), importance of models and datasets for decision making, challenges with model data inputs due to scarcity of in-situ observations, past efforts, and then potential issues (QA/QC of data) with open access datasets, but in it's current state it is a bit long (mainly the first, third, and fifth paragraphs). I would recommend trimming the introduction if possible.

Response: Thank you very much for pointing out the problem in our introduction section. We thoroughly reviewed the content and realized that it is indeed a bit too long. Based on your recommendation, the following less important texts have been deleted in the revised manuscript to make the paragraph as brief as possible, while the overall logical framework remains unchanged.

Paragraph 1: These changes are significant and highly visible, while others, like shrinking permafrost areal extent (Ran et al., 2018), melting ground-ice (Chen et al., 2020), extensive thermokarst development (Luo et al., 2022), and shifting precipitation patterns (Yao et al., 2022), are typically more gradual and less obvious but still detectable (Thornton et al., 2021). Worsened desertification (e.g., Xue et al., 2009), enhanced terrestrial evapotranspiration (e.g., Ma and Zhang, 2022), rapid lake expansion (e.g., Zhang et al., 2021), and altered river discharges (e.g., Cao et al., 2006) are typically associated with the accelerated climate change.

Paragraph 3: For instance, declining glaciers and seasonal snow cover decrease surface albedo, raise solar radiation absorption, and promote further warming (Ghatak et al., 2014). This coupling between the land surface and atmosphere acts as feedback, exacerbating regional warming and hydroclimatic changes (Zhou et al., 2019).

Paragraph 5: These efforts are in accordance with international requests for open TP data to maximize the potential value of scientific data in broad applications and to advance scientific understanding of the interactions and feedback between the land and atmosphere… where the harsh environment itself poses fundamental threats to observation quality.

2.) Observation Network and Data Processing - Similar to some of the other referee comments, I would like to see more specific details outlining the typical on-site calibrations and maintenance of instruments at each site and better address how you compare measurements at varying heights between sites (e.g., from Table 1 - EC heights ranging from 3 to 4.5 m, and met observations from 1.5 m, 2.75m, or 5 and 10 m).

Response: This is an excellent suggestion. We highly value the concerns of the reviewers regarding the maintenance and calibration of the instruments. According to all the comments and suggestions, we tried our best to supplement this section, which outlines the on-site calibrations and maintenance of instruments at each site. The following content has been added in the revised manuscript. We hope that the modification made on the revised manuscript will cover the reviewer expectation.

Line 214-228: Calibration of instruments is critical for ensuring accurate measurements. It is important to note, however, calibrating in a particularly harsh environment such as the TP is challenging. As a result, for meteorological and soil observations, both of which are relatively stable, calibrated reference instruments were used on a regular basis to perform field calibration across multiple stations, or the calibration was performed in a laboratory setting when instruments were returned for repair. In the case of turbulent observations, the measurement accuracy of the gas analyzer (i.e., LI-7500 and LI-7500DS) depends upon the cleanliness of the instrument lenses, it needs to be calibrated at regular intervals (once every six months at the five sites affiliated with the ITPCAS) due to signal attenuation for CO_2/H_2O. The calibration consists of two major components: 1) determining the values of the calibration coefficients, and 2) adjusting zero and span to align the gas analyzer's actual response with the previously determined factory response. In addition, we conduct monthly inspections of the operational status of all observational equipment (Ma et al., 2023), as well as semi-annual on-site instrument maintenance for all stations, which includes instrument cleaning, checking the level of commissioned instruments, and checking instrument cables and connectors. To the maximum extent feasible, qualified personnel will take over and rectify any instrument malfunctions found during routine inspection (on-site or remote) to ensure the accuracy and integrity of the observations. Data logger (e.g., CR6, Campbell Scientific, USA) recordings are first temporarily stored on the memory card before being routinely transmitted to our Data Processing Center by wireless transmission or on-site collection for processing, analysis, and archiving.

As for your concern about the varying heights between sites, we tried to use observations at the same height/depth as much as possible in our current comparative analysis. For example, the 0.1 m depth soil hydrothermal variations were compared except for the NASED station (0.2 m depth observations were used because observations at 0.1 m depth were not recorded prior to 2020, line 549-550). Since the primary purpose of the comparison was to show the micrometeorological characteristics at the near-surface layer, therefore, height adjustment was not implemented. We compare the variations at the lowest level of each site directly with varying heights between stations. it is imperative to acknowledge that the differences in observing height across the stations do affect the comparison. Surface roughness length and the vertical lapse rate of air temperature are required when adjusting observing heights, this may introduce additional uncertainty. Furthermore, sensible heat flux and latent heat flux are highly depended on the source area, which increases with observing height. This would require in-depth analysis of the flux contribution source region distribution, which is somewhat outside the scope of this paper. The following modifications have been made to the original manuscript to clarify the site comparison.

Line 359-360: Note that the lowest layer was chosen for stations with gradient meteorological parameters observed, although observing height vary among stations, height adjustment is not implemented in this study.

Line 450: Fig. 7 compares the multi-year mean diurnal and seasonal variations of the shallow-layer (0.1 m depth) soil temperature and soil moisture to better illustrate the hydrothermal differences due to the spatial variability in soil physical and chemical properties (e.g., soil type, porosity, organic matter content), vegetation characteristics, and meteorological conditions between stations.

Line 468-470: Figure 7. Seasonal variations of the diurnal (the first and the third column) and daily mean (the second and the fourth column) shallow-layer (0.1 m depth for stations except the NASED where 0.2 m was used) soil temperature (a-d), and soil water content (e-h) at the 12 stations.

3.) Eddy Covariance Data - Were there any differences found between the LI-7500s and the EC150 at Maqu? Was this examined? You might cite a supporting paper to address this if applicable. Also, skipping a bit ahead, but in Figure B3, all of the sensible heat (H) data are marked as 'bad' data quality. Why is this? Why are these data still considered/highlighted in the manuscript if they are so bad (Figure 8) ? Similarly, how can there be very good LE data but bad H data if they are both being derived from the H2O flux in the EC setup? Please address.

Response: You have raised an important question. Unfortunately, we do not have these two different types of gas analyzers installed at Maqu station to test the comparability of the turbulent fluxes. After searching the literature, we discovered that Frank and Massman conducted a careful comparative analysis of seven distinct kinds of fast-response hygrometers including open-path (e.g., LI-7500, EC150) and closed-path (e.g., LI-7000, LI-7200, and EC155) analyzers, results show that "there was minimal evidence to support that water vapor flux measurements are meaningfully different among common hygrometers in use today, as well as historically important sensors". Another study conducted by Polonik et al., (2019) reports that "all sensors, regardless of type, can be used to measure fluxes if appropriate corrections are applied and quality control measures are taken".

[1] Polonik P, Chan W S, Billesbach D P, et al. Comparison of gas analyzers for eddy covariance: Effects of analyzer type and spectral corrections on fluxes[J]. Agricultural and Forest Meteorology, 2019, 272: 128-142.

[2] Frank J M, Massman W J. A study of the role of seven historically significant fast-response hygrometers and sensor calibration on eddy covariance H2O fluxes and surface energy balance closure[J]. Agricultural and Forest Meteorology, 2023, 334: 109437.

We sincerely thank you for your careful checks on the Figure 3B. We apologize for the mistake of loading the wrong data when drawing Figure 3B. We have redrawn the figure and double-checked the data for other figures in the Appendix to ensure a problem-free manuscript. Both H and LE are good in the dataset. Thank you again for pointing this issue out.

4.) Data Descriptions - I have some general questions/comments about Section 3. Could the higher nighttime wind speeds at Yakou be attributed to the higher measurement height (10 m at that site vs 1 m at other sites)? What benefit do the pressure data provide given the different site altitudes? Can you comment on the diurnal offset in H and LE at Jingyangling (Figure 8)? All others sites in Figure 8 follow a similar trend, except for Jingyangling, does this mean H and LE are peaking at night? Lastly, since this is a data paper, it might be better to forgo the results and site comparisons outlined in much of Section 3, and instead provide a brief comparison of how these in-situ data stack up against aforementioned model or remote sensing data within the TP.

Response: We sincerely thank the reviewer for careful reading. The response to each of the above questions are listed as follows:

- The higher nighttime wind speed at Yakou station is mainly due to the unique topography of the station (located on the highland). The wind speeds at the Arou, Jingyangling and Dashalong stations are measured at a height of 10 m.
- It can be seen from the comparison of pressure that the air pressure is highly dependent on the site altitude, and the variations in barometric pressure between stations with small difference in altitude were essentially the same. Therefore, it may be further considered to use the barometric formula and combined with air pressure observations measured at nearby station to perform data quality control and gap filling for the time series of barometric pressure.
- We regret to admit that, although some of the data recorded in 2021 did pass the tests, we believe that the quality of the data for this period cannot be fully guaranteed due to the excessively large values of turbulent fluxes at night (a plausible reason for this could be related to the timestamp). This is based on a careful analysis and evaluation of the turbulent flux observations. This resulted in the abnormally high values of the nighttime turbulent fluxes in the diurnal variation at the Jingyangling station. We have manually adjusted the QC code to 2 to guarantee the accuracy of the observations and to prevent this portion of data from being misused in subsequent analysis and research. Once the problematic observations discarded, the variation of turbulent fluxes are consistent with other stations.
- We express our gratitude for your insightful suggestion and comment to the Section 3. After discussion, we think that the site comparison of the observation variables is crucial, primarily for the following reasons. This preliminary comparative analysis provides initial insights into topographic influences, seasonal cycles, interannual variability, and spatial heterogeneity that can be explored in greater depth through focused studies using this multi-site dataset. It can also be a very good way to demonstrate data quality and potential scientific value by locating differences among stations and special variations (e.g., the positive nighttime turbulent fluxes observed at the Jingyangling station). Furthermore, a great deal of work has been done on the assessment of model results and remote sensing products based on the observations provided in our dataset (e.g., Minola et al., 2024; Yao et al. 2023; Tong et al., 2023), while comparative analysis is rare, this is one important reason we did not compare the field observations with the model results and remote sensing products. Meanwhile, following the general practice widely used in some previous articles published in this journal describing the field observation dataset, the site comparisons outlined in Section 3 is retained in the revised

manuscript. We appreciate your understanding. Thank you.

[1] Minola L, Zhang G, Ou T, et al. Climatology of near-surface wind speed from observational, reanalysis and high-resolution regional climate model data over the Tibetan Plateau[J]. Climate Dynamics, 2024, 62(2): 933-953.

[2] Yao T, Lu H, Yu Q, et al. Uncertainties of three high-resolution actual evapotranspiration products across China: Comparisons and applications[J]. Atmospheric Research, 2023, 286: 106682.

[3] Tong L, He T, Ma Y, et al. Evaluation and intercomparison of multiple satellite-derived and reanalysis downward shortwave radiation products in China[J]. International Journal of Digital Earth, 2023, 16(1): 1853-1884.