Point-by-Point Response to Reviewer #1 (Second Round)

Dear Reviewer #1,

We appreciate your prompt review of our revised manuscript. We are glad that the extensive revisions—particularly regarding the positioning of the dataset and the implications of the upstream data transition—have effectively improved the clarity of the paper.

We have carefully considered your additional feedback. Below, we provide our point-by-point responses to your remaining comments, which have been helpful in further enhancing the accuracy of our manuscript.

Specific Responses to Reviewer #1

Reviewer #1 Comment 1: *L57: Some of these references are missing in the list.*

Author's Response 1: We apologize for this oversight. We have added all four missing references (Alexander et al., 2006; Donat et al., 2013; Dunn et al., 2020; Zhang et al., 2011) to the bibliography. These works are cited in the paragraph on ETCCDI-based extreme climate indices and have been inserted in their correct alphabetical positions in the Reference list.

Changes in Manuscript:

> The following four references have been inserted alphabetically in the Reference list :
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> Alexander, L. V., Zhang, X., Peterson, T. C., Caesar, J., Gleason, B., Klein Tank, A. M. G., Haylock, M., Collins, D., Trewin, B., Rahimzadeh, F., et al.: Global observed changes in daily climate extremes of temperature and precipitation, J. Geophys. Res.-Atmos., 111, D05109, https://doi.org/10.1029/2005JD006290, 2006.
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> Donat, M. G., Alexander, L. V., Yang, H., Durre, I., Vose, R., Dunn, R. J. H., Willett, K. M., Aguilar, E., Brunet, M., Caesar, J., et al.: Updated analyses of temperature and precipitation extreme indices since the beginning of the twentieth century: The HadEX2 dataset, J. Geophys. Res.-Atmos., 118, 2098-2118, https://doi.org/10.1002/jgrd.50150, 2013.
>
> Dunn, R. J. H., Alexander, L. V., Donat, M. G., Zhang, X., Bador, M., Herold, N., Lippmann, T., Allan, R., Aguilar, E., Barry, A. A., et al.: Development of an updated global land in situ-based data set of temperature and precipitation

extremes: HadEX3, J. Geophys. Res.-Atmos., 125, e2019JD032263, https://doi.org/10.1029/2019JD032263, 2020.

Zhang, X., Alexander, L., Hegerl, G. C., Jones, P., Tank, A. K., Peterson, T. C., Trewin, B., and Zwiers, F. W.: Indices for monitoring changes in extremes based on daily temperature and precipitation data, Wiley Interdiscip. Rev.: Clim. Change, 2, 851-870, https://doi.org/10.1002/wcc.147, 2011.

Reviewer #1 Comment 2: *L69/L77: GHCNd is not homogenised so this characterisation is not accurate (GHCNm is homogenised). Although there is some significant latency in the receipt of observations into GHCNh from some parts of the world, it is more a near-real-time dataset that is implied here.*

Author's Response 2: We thank the reviewer for pointing out this inaccuracy. We agree that GHCNd is not statistically homogenized (unlike GHCNm), and that it operates with near-real-time updates for many regions.

We have revised the framing of the daily temperature dataset landscape to remove the inaccurate dichotomy. We now emphasize that while comprehensive databases like GHCNd integrate observations from diverse national networks, they inherently preserve varying local daily measurement periods (e.g., local morning versus midnight readings), which introduces Time of Observation Biases (TOB). GLBD-FED bypasses pre-aggregated daily summaries by extracting extremes directly from first-hand sub-daily synoptic reports, enforcing a universal 0000-2400 UTC window globally.

Changes in Manuscript:

Revised Introduction, dataset landscape paragraph

"Existing prominent temperature datasets serve vital but distinct purposes: GHCN-Daily (Menne et al., 2012) acts as the world's most comprehensive integrated database of daily climate summaries, while datasets like Berkeley Earth (BEST; Rohde et al., 2013) and HadGHCND (Caesar et al., 2006) provide spatially interpolated gridded products for climate analysis. This scarcity leaves a critical gap for a purely station-based, high-fidelity daily temperature dataset that can leverage the improved global accessibility of sub-daily observations to enforce strict temporal uniformity."

Revised Introduction, methodological approaches paragraph

"High-quality daily temperature datasets generally fall into two distinct methodological approaches: comprehensive integrated databases (such as

GHCNd) designed to assimilate reports from diverse national networks, and first-hand synoptic datasets designed for rapid global monitoring. While integrated databases are essential for climatology and provide near-real-time updates in many regions, they inherently preserve varying local daily measurement periods (e.g., local morning versus midnight-to-midnight), which introduces Time of Observation Biases (TOB). Conversely, legacy near-real-time datasets (such as GSOD) attempt to standardize time but exhibit severe temporal aggregation artifacts."

Reviewer #1 Comment 3: *L127: a reference here would be useful - unfortunately to my knowledge, this is the best that exists at the moment: Menne, M.J., et al., 2025, January. The Global Historical Climatology Network hourly (GHCNh) dataset. In 105th AMS Annual Meeting. AMS.*

Author's Response 3: We thank the reviewer for providing this citation. We have incorporated (Menne et al., 2025) at the point in Section 3.1 where we discuss the transition from the legacy ISD to the GHCNh framework. The full reference has been inserted in its correct alphabetical position in the Reference list.

Changes in Manuscript:

Revised Section 3.1

"It is important to note that NOAA formally terminated updates to the ISD in 2025, transitioning to the new Global Historical Climatology Network hourly (GHCNh) framework (Menne et al., 2025). However, our evaluation indicates that GHCNh currently lacks several critical meteorological elements present in the legacy ISD..."

Reference inserted in alphabetical order in the Reference list

Menne, M. J., Noone, S., Casey, N., Dunn, R., McNeill, S., Kantor, D., Thorne, P., Orcutt, K., Cunningham, S., and Risavi, N.: The Global Historical Climatology Network hourly (GHCNh) dataset, in: 105th AMS Annual Meeting, American Meteorological Society, New Orleans, LA, USA, 2025.

Reviewer #1 Comment 4: *L155-157: Given the peaks described are in UTC, the daytime and nighttime periods cannot be described in this way, as the heating/cooling portions of the day are dependent on local time, not UTC. I think it is important to include a comment to the effect that 1800 UTC would be intended to capture daytime maxima for*

regions around 0-longitude, and similarly 0600 UTC night time minima, but that this is not applicable at other longitudes.

Author's Response 4: We thank the reviewer for pointing out this geographical inaccuracy. We fully agree that describing the 0600 and 1800 UTC peaks as nighttime cooling and daytime warming is globally inaccurate, as diurnal cycles depend on local time.

Following your precise suggestion, we have revised the text to explicitly state that this UTC-to-diurnal alignment is physically valid only for regions near the Prime Meridian (0 degrees longitude). For the rest of the globe, this concentration is purely an administrative artifact of WMO synoptic reporting standards.

Changes in Manuscript:

> "Similarly, the 12-hour extremes present a highly asymmetric reporting pattern, reaching absolute volumetric peaks at 0600 UTC (for Tmin-12h) and 1800 UTC (for Tmax-12h). It is important to clarify that aligning 1800 UTC with daytime maxima and 0600 UTC with nighttime minima is physically applicable only for regions near the Prime Meridian (0 degrees longitude). For the vast majority of the globe, local solar heating and cooling cycles do not coincide with these specific UTC hours. Therefore, this overwhelming global concentration is not a reflection of natural diurnal cycles, but rather an administrative artifact of international synoptic data exchange protocols."

Reviewer #1 Comment 5: *Fig 8 - please add to the caption that the red and blue lines have been offset from the hourly data for clarity.*

Author's Response 5: We thank the reviewer for this observation. We would like to respectfully clarify that the red and blue lines in Figure 8 have not been artificially offset for visual purposes. Their position above the discrete hourly readings reflects physical reality: the red lines represent derived upper limits over continuous 12-hour windows, while the blue lines represent those over 24-hour windows. Because a continuous maximum over a time window must necessarily be greater than or equal to any single instantaneous reading within that window, the derived limit lines will naturally plot at or above the hourly observations.

Nevertheless, to prevent this from being misinterpreted as a deliberate artistic offset, we have added an explanatory note to the Figure 8 caption to clarify this physical basis.

Changes in Manuscript:

Revised Figure 8 caption in the manuscript

"...The misrecorded Tmax-24h (blue lines in panel a) are restored as Tmax-12h (red lines in panel b). (Note: The derived upper limits naturally plot slightly above the discrete hourly observations. This is not a visual offset, but reflects the physical reality that the continuous maximum temperature over a time window must be greater than or equal to any instantaneous hourly reading taken within that same period.)"

Reviewer #1 Comment 6: *L435: state which figure number for b1, b2, b3.*

Author's Response 6: We thank the reviewer for pointing out this omission. We have explicitly added the reference to Figure 7 before the panel designations in the text.

Changes in Manuscript:

"As shown in Figure 7 (panels b1, b2, and b3), the global daily data volume rose from approximately 3,000 entries per day in the 1980s to around 10,000 entries per day in recent years."

Reviewer #1 Comment 7: *L444: I think you mean Fig 12 here.*

Author's Response 7: We appreciate the reviewer catching this typographical error. You are correct; the reference at this line should be to Figure 12 (the targeted sensitivity analysis for Ulan Bator). We have corrected the figure citation in both the main text and the corresponding figure caption in the revised manuscript.

Reviewer #1 Comment 8: *L609: you use "METAR" on line 614. You could also include the WMO codes to be explicit (e.g. FM-12 for SYNOP, FM-15 for METAR).*

Author's Response 8: We thank the reviewer for this helpful suggestion. We have updated the relevant text in Section 5.3.2 and the associated Table 2 case study to include the explicit WMO report format codes. Synoptic reports are now identified with code FM-12, and METAR reports with FM-15 (and FM-16 where applicable).

Changes in Manuscript:

Revised text in Section 5.3.2

"GLBD-FED prioritizes Synoptic reports (e.g., FM-12) over METAR reports (e.g., FM-15, FM-16) as data sources, whereas GSOD does the opposite. [...] Table 2 presents a case study for Ulan Bator, Mongolia, where two specific types of sub-daily reports (FM-12 and FM-15) labeled under the identical ID 442920-99999 actually originate from different sites in the ISD. Figure 12

provides a targeted sensitivity analysis for Ulan Bator. Panel (a) displays the standard GLBD-FED daily Tmin calculated using our default preference for Synoptic reports (FM-12), while panel (b) shows the results when the algorithm is specifically forced to utilize only METAR reports (FM-15) from the same station ID."

Revised Figure 12 caption

“Figure 12 Comparison of daily Tmin at Ulan Bator, Mongolia (442920-99999) between GLBD-FED and GSOD in 2024. Panel (a) compares the default GLBD-FED output (prioritizing Synoptic reports, FM-12) with GSOD, while panel (b) shows a special comparison using GLBD-FED results derived exclusively from METAR reports (FM-15) from the same station ID."