Response to Reviewers

Dear Editor and Reviewers:

Thank you very much for your constructive comments on our manuscript entitled “Development of a spatially distributed MERRA2-based typical-year dataset for solar-radiation evaluation in Australia”. We sincerely appreciate the reviewers’ careful reading and valuable suggestions, which helped us improve the clarity, methodological framing, and interpretation of the manuscript.

In the revised manuscript, we have narrowed the framing of the work from a high-resolution, fully validated multi-variable TMY dataset to a spatially distributed MERRA2-based typical-year product for GHI-centered solar-radiation evaluation. We have also clarified the distinction between TMY-MER and TMY-MER-IDW, the role of IDW-based bias-parameter interpolation, the definition of the 353 representative locations, the GHI-focused scope of the assessment, and the application-oriented nature of the DIRINT and LBT/Radiance analyses. The quoted manuscript passages below have been rechecked so that the black italic context and red italic modifications correspond to continuous text in the revised or final-polished manuscript.

The comments are highlighted with a yellow background. The response to the questions has been highlighted in blue. Modifications have been highlighted in red italics, and the context of the modifications has been highlighted in black italics.

Response to Reviewer 1

[General Comment] The manuscript presents a MERRA2-based TMY dataset for solar-radiation evaluation, but the framing, dataset definition, methodological description, and validation terminology require clarification.

Response: We appreciate the reviewer’s constructive assessment. In response, we revised the manuscript to clarify the scope and positioning of the work. The revised manuscript presents TMY-MER as a spatially distributed MERRA2-based typical-year product for GHI-centered solar-radiation evaluation, rather than as a high-resolution, fully validated, multi-variable TMY product. The title, abstract, objectives, methods, discussion, limitations, and conclusions have been revised accordingly.

Page 1 Line 1

Development of a spatially distributed MERRA2-based typical-year dataset for solar-radiation evaluation in Australia

Page 1 Line 24

Spatially distributed Typical Meteorological Year (TMY) products are important for solar-radiation evaluation and building-performance simulations, particularly in regions where conventional station-based TMY products have limited spatial coverage and delayed updates. This study develops TMY-MER, a recent-period MERRA2-based typical-year product for GHI-centered solar-radiation evaluation across Australia.

Page 4 Line 120

This study integrates MERRA2 reanalysis data with typical-year weather-file generation methods to develop TMY-MER, a spatially distributed MERRA2-based typical-year product for GHI-centered solar-radiation evaluation in Australia. The study focuses on product generation, product-level GHI discrepancy assessment, and application-oriented simulation consistency, rather than full multi-variable validation.

Page 27 Line 595

This study developed a spatially distributed MERRA2-based typical-year product (TMY-MER) for GHI-centered solar-radiation evaluation across Australia. A weather-type-conditioned GHI discrepancy assessment framework was introduced by integrating clear-sky identification, weather-type classification, and IDW-based GHI bias-parameter interpolation. The comparison with the reference TMY product is interpreted as an inter-product GHI discrepancy assessment rather than independent validation against ground-truth observations.

[Comment 1] The manuscript should clearly distinguish between the original TMY-MER dataset and the IDW-adjusted TMY-MER-IDW dataset.

Response: Thank you for this important comment. We agree that the distinction between the original MERRA2-based typical-year product and the IDW-adjusted product should be made explicit. In the revised manuscript, TMY-MER refers to the initial typical-year weather files generated from MERRA2, whereas TMY-MER-IDW refers to the product generated after weather-type-conditioned GHI bias-parameter interpolation using IDW. The framework and methodology now present IDW as a subsequent bias-parameter interpolation step rather than as part of the original TMY-MER construction.

Page 6 Line 135

Figure 1 illustrates the framework of this study, which aims to construct a spatially distributed MERRA2-based Typical Meteorological Year dataset for GHI-centered solar-radiation evaluation in Australia. The framework consists of three main modules: TMY-MER data generation, weather-type-conditioned GHI discrepancy assessment and IDW-based bias-parameter interpolation, and application-oriented solar-radiation modeling.

Page 7 Line 145

Clear-sky and overcast days were distinguished based on the mean relative error index (MREI) between the daily maximum solar radiation intensity and the monthly maximum solar radiation intensity. Weather-type-conditioned GHI bias parameters were then derived separately for clear-sky and overcast conditions. To extend the derived GHI bias parameters from the 122 comparison locations to the 353 representative locations, IDW interpolation was applied, thereby generating the TMY-MER-IDW dataset.

Page 18 Line 399

By comparing GHI data from the 122 locations where the reference TMY product is available with their corresponding TMY-MER counterparts across Australia, weather-type-conditioned GHI bias parameters were derived under clear-sky and overcast conditions. These bias parameters were then spatially interpolated from the 122 comparison locations to the 353 representative TMY-MER locations using IDW. This procedure produced spatially distributed IDW-interpolated GHI bias estimates for all representative locations under both weather scenarios, as illustrated in Fig. 7a and c.

[Comment 2] The generation of TMY-MER is unclear, including the meaning of AMY, the number of variables, the reason for normalization, and the use of weights.

Response: Thank you for identifying these ambiguities. We revised Section 2.1.2 to clarify the TMY-MER generation procedure. AMY is now defined as the annual meteorological year extracted from the MERRA2 hourly dataset for each candidate year. We also clarified that nine selection parameters were used for typical-month selection, including eight non-GHI meteorological parameters and one GHI parameter. The normalized values are dimensionless values used for candidate-month selection, not physical meteorological variables bounded by 1.

Page 7 Line 177

The detailed selection procedure is described below. (1) Parameter selection and monthly value calculation: Nine selection parameters were extracted from the annual meteorological year (AMY) dataset spanning 2009 to 2023, including average, maximum, and minimum dry-bulb temperature; average, maximum, and minimum total column water vapor; average relative humidity; average wind speed; and global horizontal irradiance. Here, AMY refers to the annual meteorological year extracted from the MERRA2 hourly dataset for each candidate year. For each parameter, the monthly value was calculated for each month and year.

Page 8 Line 185

A month was considered a candidate typical month if the normalized values for all nine selection parameters were less than 1. Multiple candidate months could be identified under this criterion. This criterion indicates that the candidate month remains within the accepted relative discrepancy range defined in the selection procedure; it does not imply that the original meteorological variables themselves are bounded by 1.

Page 8 Line 191

Table 1 Factors and their weights for selection. Note: The typical-month selection uses nine selection parameters in total, including eight non-GHI meteorological parameters and one GHI parameter. The weights sum to 1.

[Comment 3] The error metrics and the role of IDW should be clarified, and the comparison should not be interpreted as independent validation.

Response: Thank you for this constructive suggestion. We revised the comparison basis and terminology to clarify that the main quantitative assessment is an inter-product GHI discrepancy assessment, not independent ground-truth validation. We also clarified that IDW interpolates weather-type-conditioned GHI bias parameters derived from 122 comparison locations. Therefore, discrepancy reductions at locations involved in deriving the bias parameters are interpreted as fitted or interpolated product-level agreement, rather than independent predictive validation at unseen locations.

Page 9 Line 215

Although ERA5 and MERRA2 data are widely used because of their broad spatial coverage, fine temporal granularity, and long time series, existing research has shown that reanalysis-based radiation data may contain systematic discrepancies. This study evaluates GHI discrepancies between TMY-MER and the reference TMY product under different weather types. The comparison is treated as an inter-product GHI discrepancy assessment rather than independent validation against ground-truth observations, because the reference TMY product is itself a statistically constructed dataset.

Page 10 Line 250

In the IDW model, the power parameter controls the smoothing effect, typically set to 2 to minimize the mean absolute error. Because the IDW procedure interpolates parameters derived from the comparison locations, discrepancy reductions at locations involved in deriving these parameters should be interpreted as fitted or interpolated agreement relative to the reference TMY product, rather than independent predictive validation at unseen locations.

Page 18 Line 402

This procedure produced spatially distributed IDW-interpolated GHI bias estimates for all representative locations under both weather scenarios, as illustrated in Fig. 7a and c. Because the IDW step is based on bias parameters derived from comparison with the reference TMY product, the adjusted TMY-MER-IDW results should be interpreted as fitted or interpolated product-level agreement achieved through the bias-adjustment and interpolation procedure, rather than as independent validation at unseen locations.

[Comment 4] The reviewer recommends clarifying how the proposed product differs from existing TMY products or methods.

Response: Thank you for this helpful suggestion. We clarified the positioning of TMY-MER relative to conventional station-based TMY products and reanalysis-based typical-year products in the objectives and discussion sections. Rather than adding a separate comparison table, we sharpened the manuscript framing to state what the proposed product is and is not: it provides spatially distributed representative-location coverage for GHI-centered solar-radiation applications, but it does not increase the native spatial resolution of MERRA2 or replace independent observational validation.

Page 4 Line 124

The major contributions of this study are: (1) Development of a spatially distributed MERRA2-based typical-year product. Based on 15 years of MERRA2 data from 2009 to 2023, TMY-MER provides broad regional coverage for representative locations across Australia. The dataset is not intended to increase the native spatial resolution of MERRA2, but to support solar-radiation-related applications where conventional station-based TMY products have limited coverage or delayed updates.

Page 23 Line 483

By using MERRA2 data from 2009 to 2023, TMY-MER provides a recent-period typical-year product for GHI-centered solar-radiation evaluation, reducing reliance on sparse and infrequently updated ground-based TMY sources. The dataset is positioned as a spatially distributed product for representative locations, rather than as a product that increases the native spatial resolution of MERRA2, and is intended to support solar-radiation-related analysis and building-scale applications.

[Comment 5] Figures 3 and 4 should include scatterplots and summary statistics, such as standard deviation values.

Response: Thank you for this useful suggestion. We agree that scatterplot-based comparisons and additional summary statistics would provide a more direct quantitative description of daily radiation-profile similarity. In this revision, instead of claiming that new scatterplots or summary statistics were added, we clarified the role of Figs. 3 and 4 to avoid overinterpreting them as standalone quantitative evidence. The figures are now described as illustrative hourly GHI-profile examples used to support weather-type classification. The quantitative product-level GHI discrepancy assessment is presented through the annual, monthly, weather-type-conditioned, IDW-interpolated, and regional bias analyses shown in Figs. 2 and 5–8.

Page 14 Line 341

Figure 3: Illustrative hourly GHI profiles of clear-sky-like days at representative comparison location P38 (Unit: W/m²). Each curve represents the hourly GHI distribution of one classified clear-sky-like day.

Page 15 Line 352

Moreover, although these curves generally follow a diurnal cycle, overcast conditions introduce pronounced nonlinearity due to dynamic cloud interactions affecting solar transmittance. Figure 4: Illustrative hourly GHI

profiles of overcast or cloud-affected days at representative comparison location P38 (Unit: W/m²). Each curve represents the hourly GHI distribution of one classified overcast or cloud-affected day.

[Comment 6] The clear-sky threshold τ should be defined, and its sensitivity should be discussed.

Response: Thank you for pointing this out. We clarified τ as the clear-sky MREI threshold in the nomenclature and in the weather-type classification workflow. The threshold is treated as an operational classification parameter rather than a universal physical clear-sky criterion. We also acknowledged that τ may influence the derived weather-type-conditioned GHI bias parameters and that sensitivity analysis of τ should be examined in future work.

Page 9 Line 223

First, the mean relative error index (MREI) between the daily maximum solar radiation intensity and the monthly maximum solar radiation intensity was calculated. Days with MREI values below a predefined operational threshold (τ) were classified as clear-sky-like days, while the remaining days were treated as overcast or cloud-affected days. This classification defines relative radiation-pattern classes for product-level GHI discrepancy assessment, rather than independently validated sky-condition labels.

Page 27 Line 582

Fourth, because IDW is used to interpolate weather-type-conditioned GHI bias parameters derived from 122 comparison locations, the IDW-adjusted results do not by themselves demonstrate independent predictive performance at unseen locations. Future work should conduct leave-one-out or spatial-block cross-validation to evaluate the generalizability of the interpolation-based adjustment. In addition, the clear-sky threshold τ used in weather-type classification may influence the derived bias parameters, and sensitivity analysis of τ should be examined in future work.

[Comment 7] DIRINT introduces an additional layer of uncertainty and should not be treated as validation.

Response: Thank you for this constructive suggestion. We agree that DIRINT-based decomposition introduces additional uncertainty and should not be interpreted as independent validation of TMY-MER or TMY-MER-IDW. We retained Fig. 9 and a concise summary of the DIRINT-derived outputs in the main text because these results illustrate the downstream sky-radiance modeling workflow. However, the revised text now clarifies that the DIRINT-derived DNI and DHI components are application-oriented derived variables rather than independently validated radiation variables. We also removed any statement claiming that DIRINT details were moved to the Supplementary Information, because Fig. 9 and the corresponding discussion remain in the main text.

Page 10 Line 260

The model also accounts for relevant atmospheric and environmental conditions, such as pressure and temperature, and has been widely used for direct–diffuse radiation decomposition. Because DIRINT is an empirical decomposition model and may introduce model-specific uncertainty, the derived DNI and DHI components are treated as application-oriented variables rather than independently validated radiation components. The derived radiation components were then used in the LBT-based simulation workflow.

Page 21 Line 456

After constructing the TMY-MER and TMY-MER-IDW datasets for GHI-centered solar-radiation evaluation, the DIRINT model was applied to decompose GHI into DNI and DHI for downstream application-oriented

modeling. Because DIRINT is an empirical decomposition model and may introduce additional uncertainty, the derived DNI and DHI components are treated as application-oriented radiation variables rather than independently validated radiation components. Figure 9 illustrates the DIRINT-derived DNI/DHI time series, component-level comparison, and sky-radiance modeling outputs for representative cases.

Page 23 Line 470

The sky-radiance models generated from the decomposed radiation components show broadly similar spatial patterns between TMY-MER-IDW and the reference TMY product, supporting the use of TMY-MER-IDW for application-oriented sky-radiance modeling and building-scale solar-radiation simulations. However, because DNI and DHI are derived through empirical decomposition rather than directly corrected or independently validated, the results in Fig. 9 should be interpreted as an application-level consistency illustration rather than independent validation of the original MERRA2 GHI, the DIRINT-derived radiation components, or the TMY-MER-IDW dataset.

Response to Reviewer 2

[General Comment] The manuscript has fundamental issues in dataset definition, methodological scope, correction scope, and validation independence. The reviewer recommends narrowing or clarifying the framing.

Response: Thank you for this important and constructive comment. We narrowed the framing of the manuscript. The revised manuscript no longer presents the dataset as an independently validated, high-resolution, fully corrected multi-variable TMY dataset. Instead, it presents TMY-MER as a spatially distributed MERRA2-based typical-year product for GHI-centered solar-radiation evaluation, with TMY-MER-IDW generated through weather-type-conditioned GHI bias-parameter interpolation. We also clarified that the LBT/Radiance simulations are application-level consistency checks rather than validation.

Page 1 Line 29

Weather-type-conditioned GHI bias parameters were derived by comparing TMY-MER with a reference TMY product at 122 comparison locations and were spatially interpolated using inverse distance weighting (IDW) to generate TMY-MER-IDW. The quantitative assessment focuses on GHI discrepancies rather than full multi-variable validation, while non-GHI variables are retained from MERRA2 as contextual variables for weather-file construction.

Page 1 Line 33

The results show that TMY-MER exhibits relatively small GHI discrepancies under clear-sky conditions, generally within 5% on an annual basis, whereas overcast conditions show larger deviations, with maximum discrepancies reaching approximately 40% due to uncertainties in cloud and aerosol representation. DIRINT-based decomposition and Ladybug Tools building-cluster simulations were further conducted as application-oriented analyses to examine downstream usability and simulation consistency.

[Comment 1] The physical definition of the 353 sites is unclear. Please clarify whether they are weather stations, city points, or MERRA2 grid cells, and provide coordinate information.

Response: Thank you for pointing out this important issue. We revised the terminology and definition of the 353 representative locations throughout the manuscript. The revised text clarifies that the 353 locations are administrative-center or city-coordinate-based representative locations associated with Australian local-government areas and mapped to the nearest native MERRA2 grid cells. They should therefore be interpreted as grid-referenced representative sampling points derived from the MERRA2 reanalysis field, rather than ground-based weather stations, independent observational sites, or newly generated high-resolution grid nodes. We also clarified that multiple representative locations may share the same underlying MERRA2 grid-cell meteorological representation.

Page 11 Line 300

A total of 353 TMY-MER weather files were generated for representative locations across Australia. These locations were defined using administrative-center or city-coordinate information associated with Australian local-government areas. For each representative location, the geographic coordinate was mapped to the nearest native MERRA2 grid cell, and the corresponding MERRA2 hourly meteorological variables were extracted from that grid cell. Therefore, the 353 locations should be interpreted as grid-referenced representative sampling points derived from the MERRA2 reanalysis field, rather than ground-based weather stations, independent observational sites, or newly generated high-resolution grid nodes.

Page 11 Line 300

These locations were defined using administrative-center or city-coordinate information associated with Australian local-government areas. For each representative location, the geographic coordinate was mapped to the nearest native MERRA2 grid cell, and the corresponding MERRA2 hourly meteorological variables were extracted from that grid cell. Therefore, the 353 locations should be interpreted as grid-referenced representative sampling points derived from the MERRA2 reanalysis field, rather than ground-based weather stations, independent observational sites, or newly generated high-resolution grid nodes. Because the native spatial resolution of MERRA2 is 0.5° × 0.625°, multiple representative locations may be associated with the same MERRA2 grid cell.

Page 11 Line 305

Because the native spatial resolution of MERRA2 is 0.5° × 0.625°, multiple representative locations may be associated with the same MERRA2 grid cell. In such cases, these locations share the same underlying MERRA2 meteorological representation before any subsequent bias-parameter interpolation or product-level adjustment is applied.

[Comment 2] The manuscript overstates the dataset as high-resolution, while MERRA2 has a native spatial resolution of 0.5° × 0.625°.

Response: Thank you for this valuable comment. We agree that "high-resolution" may overstate the spatial characteristics of the dataset. We replaced this framing with "spatially distributed" and clarified that the dataset does not increase the native spatial resolution of MERRA2. The contribution is positioned as broad representative-location coverage rather than high-resolution gridded downscaling.

Page 1 Line 1

Development of a spatially distributed MERRA2-based typical-year dataset for solar-radiation evaluation in Australia

Page 5 Line 124

Based on 15 years of MERRA2 data from 2009 to 2023, TMY-MER provides broad regional coverage for representative locations across Australia. The dataset is not intended to increase the native spatial resolution of MERRA2, but to support solar-radiation-related applications where conventional station-based TMY products have limited coverage or delayed updates.

Page 27 Line 600

A recent-period TMY-MER dataset was generated for 353 representative locations across Australia. The dataset provides broad spatial coverage for GHI-centered solar-radiation applications, but it does not increase the native spatial resolution of MERRA2 and should not be interpreted as a high-resolution gridded dataset.

[Comment 3] The 15-year base period is shorter than the conventional 30-year climatological period.

Response: Thank you for this comment. We agree that the 2009–2023 period is shorter than a conventional 30-year climatological period. In the revised manuscript, we explicitly define the dataset as a recent-period typical-year product and acknowledge this limitation in the data-source description, limitations, and future work sections.

Page 7 Line 161

Its radiation calculation and data assimilation are implemented within the GEOS-5 system, with aerosol-related assimilation and evaluation described in previous MERRA2 studies. In this study, 15 consecutive years of MERRA2 data from 2009 to 2023 were selected to construct a recent-period MERRA2-based typical-year product. This period is shorter than the conventional 30-year climatological period and is therefore interpreted as representing recent climate conditions rather than a long-term climatological normal.

Page 26 Line 570

Several limitations should be noted. First, the dataset is based on a recent 15-year period from 2009 to 2023. Although this period is relevant for contemporary solar-radiation applications, it is shorter than the conventional 30-year climatological period and may influence typical-month selection. Future work should compare the 15-year recent-period dataset with longer MERRA2 baselines, such as a 30-year period or the full MERRA2 record available since 1980.

[Comment 4] Only GHI is corrected or assessed. Other meteorological variables are passed through from MERRA2 and are not independently evaluated or corrected.

Response: Thank you for this important observation. We revised the manuscript to clarify that the quantitative discrepancy assessment and bias adjustment focus on GHI. Other meteorological variables are retained from MERRA2 as contextual variables for weather-file construction and downstream simulations, but they are not independently corrected or validated in this study. This revision prevents overstatement of the dataset as a fully corrected multi-variable TMY product.

Page 1 Line 29

Weather-type-conditioned GHI bias parameters were derived by comparing TMY-MER with a reference TMY product at 122 comparison locations and were spatially interpolated using inverse distance weighting (IDW) to generate TMY-MER-IDW. The quantitative assessment focuses on GHI discrepancies rather than full multi-variable validation, while non-GHI variables are retained from MERRA2 as contextual variables for weather-file construction.

Page 7 Line 165

The variables extracted from MERRA2 include mean dry-bulb temperature, maximum dry-bulb temperature, minimum dry-bulb temperature, mean total column water vapor, maximum total column water vapor, minimum total column water vapor, mean relative humidity, mean wind speed, and hourly GHI. These variables were used for typical-month selection and weather-file construction, whereas the quantitative discrepancy assessment and subsequent bias-parameter adjustment focused on GHI.

Page 12 Line 312

The weather files were also converted to EnergyPlus Weather (EPW) format for downstream building-performance and solar-radiation simulations. In this study, the quantitative discrepancy assessment focuses on GHI, while the other meteorological variables are retained from MERRA2 as contextual variables to preserve the weather-file structure and support application-oriented simulation workflows.

Page 26 Line 573

Second, the quantitative discrepancy assessment and bias adjustment in this study focus on GHI. Other meteorological variables, including dry-bulb temperature, relative humidity, wind speed, and wind direction, are retained from MERRA2 as contextual variables and are not independently corrected or validated. Future work should evaluate non-GHI variables and inter-variable coherence, particularly the coupling among GHI, temperature, humidity, wind, and cloud-related conditions.

[Comment 5] The comparison with the reference TMY product is not independent validation, and IDW fitted using the same comparison locations may cause leakage. Cross-validation is recommended.

Response: Thank you for this important and rigorous comment. We revised the manuscript to distinguish between inter-product comparison, fitted or interpolated agreement, and independent validation. Comparisons with the reference TMY product are now described as product-level GHI discrepancy assessment rather than ground-truth validation. We also state that IDW-adjusted results do not by themselves demonstrate independent predictive performance at unseen locations and identify leave-one-out or spatial-block cross-validation as necessary future work.

Page 9 Line 215

This study evaluates GHI discrepancies between TMY-MER and the reference TMY product under different weather types. The comparison is treated as an inter-product GHI discrepancy assessment rather than independent validation against ground-truth observations, because the reference TMY product is itself a statistically constructed dataset.

Page 18 Line 402

This procedure produced spatially distributed IDW-interpolated GHI bias estimates for all representative locations under both weather scenarios, as illustrated in Fig. 7a and c. Because the IDW step is based on bias parameters derived from comparison with the reference TMY product, the adjusted TMY-MER-IDW results should be interpreted as fitted or interpolated product-level agreement achieved through the bias-adjustment and interpolation procedure, rather than as independent validation at unseen locations.

Page 27 Line 578

Third, the comparison with the reference TMY product should be interpreted as an inter-product comparison rather than independent ground-truth validation. The reference TMY product is itself a statistically constructed dataset, and therefore the reported discrepancies represent product-level differences rather than true observational errors. Future work should conduct independent validation against high-quality ground-based solar-radiation observations where such data are available.

Page 27 Line 582

Fourth, because IDW is used to interpolate weather-type-conditioned GHI bias parameters derived from 122 comparison locations, the IDW-adjusted results do not by themselves demonstrate independent predictive performance at unseen locations. Future work should conduct leave-one-out or spatial-block cross-validation to evaluate the generalizability of the interpolation-based adjustment.

[Comment 6] The Ladybug Tools/Radiance building-cluster simulation is an application, not validation.

Response: Thank you for pointing out this important issue. We repositioned the LBT/Radiance building-cluster simulations as an application case study and simulation-consistency assessment. Because both TMY-MER-IDW

and the reference TMY product are processed within the same simulation engine, the revised manuscript no longer treats these comparisons as independent validation of dataset accuracy.

Page 7 Line 151

The Direct Insolation Separation Model (DIRINT) was applied to decompose GHI into DNI and DHI, and the resulting radiation components were used in Ladybug Tools (LBT) building-cluster simulations. The simulated building-surface solar-radiation distributions and sky-dome luminance patterns were compared with those obtained from the reference TMY product to assess application-level consistency, rather than to provide independent validation of dataset accuracy.

Page 24 Line 532

To examine the applicability of the adjusted TMY-MER-IDW dataset in building-scale solar-radiation simulations, two representative building clusters with complex shading conditions were selected. Monthly surface solar-irradiance distributions were simulated using both the reference TMY product and the adjusted TMY-MER-IDW dataset at a spatial resolution of 0.5 m × 0.5 m. Accordingly, this analysis is interpreted as an application case study and simulation-consistency assessment, rather than as independent validation of dataset accuracy.

Page 25 Line 552

Overall, the similarity in surface solar-irradiance distributions and sky-radiance patterns indicates application-level consistency between TMY-MER-IDW and the reference TMY product within the same LBT/Radiance simulation workflow. However, because both datasets were processed using the same simulation engine, these results should be interpreted as indicators of simulation consistency and downstream applicability, rather than as independent evidence of dataset accuracy.

[Comment 7] The methodology is insufficiently described, including AMY, the status of IDW, the clear-sky threshold τ, and Table 1.

Response: Thank you for this comment. We revised the Methods section to improve clarity and reproducibility. The revised manuscript defines AMY, clarifies the nine selection parameters and their weights, explains the role of IDW as bias-parameter interpolation, and identifies τ as the MREI threshold used in weather-type classification. We also acknowledge that sensitivity analysis of τ should be conducted in future work.

Page 8 Line 180

Nine selection parameters were extracted from the annual meteorological year (AMY) dataset spanning 2009 to 2023, including average, maximum, and minimum dry-bulb temperature; average, maximum, and minimum total column water vapor; average relative humidity; average wind speed; and global horizontal irradiance. Here, AMY refers to the annual meteorological year extracted from the MERRA2 hourly dataset for each candidate year. For each parameter, the monthly value was calculated for each month and year.

Page 8 Line 191

Table 1 Factors and their weights for selection. Note: The typical-month selection uses nine selection parameters in total, including eight non-GHI meteorological parameters and one GHI parameter. The weights sum to 1.

Page 10 Line 244

⑤ *Spatial interpolation of GHI bias parameters. Weather-type-conditioned GHI bias parameters derived from the 122 comparison locations, including the baseline clear-sky-day count and the GHI bias parameters MREB, MREL, MREG and MRET, were spatially interpolated to the 353 representative TMY-MER locations using IDW, as defined in Eqs. (3)–(4). This step generates the TMY-MER-IDW dataset for the 353 representative locations.*

Page 27 Line 583

Future work should conduct leave-one-out or spatial-block cross-validation to evaluate the generalizability of the interpolation-based adjustment. In addition, the clear-sky threshold τ used in weather-type classification may influence the derived bias parameters, and sensitivity analysis of τ should be examined in future work.

[Comment 8] The limitations and future work should acknowledge remaining constraints without overstating the dataset.

Response: Thank you for this suggestion. We revised the limitations section to state the remaining constraints concisely. The revised limitations include the 15-year recent-period baseline, the GHI-focused assessment scope, the lack of independent ground-truth validation, the need for cross-validation of IDW-based interpolation, the sensitivity of τ, and the grid-referenced nature of the 353 representative locations. We kept this section concise to avoid overemphasizing limitations already clarified in the Methods and Results sections.

Page 26 Line 570

Several limitations should be noted. First, the dataset is based on a recent 15-year period from 2009 to 2023. Although this period is relevant for contemporary solar-radiation applications, it is shorter than the conventional 30-year climatological period and may influence typical-month selection. Future work should compare the 15-year recent-period dataset with longer MERRA2 baselines, such as a 30-year period or the full MERRA2 record available since 1980.

Page 26 Line 573

Second, the quantitative discrepancy assessment and bias adjustment in this study focus on GHI. Other meteorological variables, including dry-bulb temperature, relative humidity, wind speed, and wind direction, are retained from MERRA2 as contextual variables and are not independently corrected or validated. Future work should evaluate non-GHI variables and inter-variable coherence, particularly the coupling among GHI, temperature, humidity, wind, and cloud-related conditions.

Page 27 Line 578

Third, the comparison with the reference TMY product should be interpreted as an inter-product comparison rather than independent ground-truth validation. The reference TMY product is itself a statistically constructed dataset, and therefore the reported discrepancies represent product-level differences rather than true observational errors. Future work should conduct independent validation against high-quality ground-based solar-radiation observations where such data are available.

Page 27 Line 585

In addition, the clear-sky threshold τ used in weather-type classification may influence the derived bias parameters, and sensitivity analysis of τ should be examined in future work. Finally, the 353 representative locations are administrative-center or city-coordinate-based locations mapped to the nearest native MERRA2

grid cells, rather than ground-based weather stations or newly generated high-resolution grid nodes. Therefore, multiple representative locations may share the same underlying MERRA2 grid-cell meteorological representation.

Supplementary Modifications

Update on Author Affiliation

Response: During the revision of this manuscript, author Pingan Ni has completed his doctoral program and joined the School of Architecture, Tsinghua University as a postdoctoral researcher. Accordingly, his primary affiliation has been updated to the School of Architecture, Tsinghua University, Beijing, 100084, China. This update only reflects the author's current institutional appointment and does not alter his intellectual contributions to this study.

Page 1 Line 3

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Page 1 Line 7

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We again thank the editor and reviewers for their constructive comments. We believe that these revisions have improved the clarity, transparency, and methodological positioning of the manuscript.