Response to the reviewers

Manuscript essd-2026-227: *A global hourly ISIMIP3 climate forcing dataset for impact modeling*

Dear Editor, dear reviewers,

We thank the reviewers for the careful and constructive evaluation of our manuscript. We have addressed every comment point by point below and have revised the manuscript accordingly. The main revisions are:

- We added a quantitative comparison of two of the four illustrative applications computed from daily instead of hourly forcing (new Figs. 4 and 6), which demonstrates directly how the temporal resolution of the forcing changes both the impact metric and its projected climate change signal.
- We substantially expanded the discussion of the limitations of our analogue-based approach under strong climate change signals, including what a declining number of unique analogue days does and does not imply, and which aspects users should weigh against the properties of native sub-daily climate model output.
- We harmonized the statements on flood applications between the introduction and the conclusions, quantified why flash floods are outside the scope of the dataset, and added a reflection on the hourly precipitation intensities of the WFDE5 reference.
- We clarified in the methods that the zonal-strip parallelization is a memory-management strategy only and does not affect the per-grid-cell analogue selection, and we now explain why wind speed and precipitation are disaggregated with lower skill than the other variables.
- We expanded the description of the ISIMIP3b setup with the CMIP6 experiments used and the criteria by which the five climate models were selected.
- We added the non-linearity of the wind-speed-to-wind-power conversion and the simplifications of the photovoltaic calculation as explicit limitations, updated the state of the art on global wind power assessments, added guidance for users who need coarser sub-daily resolution or regional subsets, and discussed the land-only coverage together with a possible ERA5-based offshore extension.

Because two figures were added within Sects. 4.3 and 4.4, the figures of the discussion paper have been renumbered: Figs. 1–3 are unchanged, the new wind comparison is Fig. 4, the photovoltaic power potential figure is now Fig. 5, and the new photovoltaic comparison is Fig. 6. In this letter, figure numbers refer to the revised manuscript unless stated otherwise.

Below, the reviewer comments are given in italics, our replies in blue, and new or modified manuscript text in bold blue. Line numbers in the reviewer comments refer to the discussion paper; for the revised manuscript we refer to sections rather than to line numbers.

On behalf of all co-authors,

Michel Bechtold

Reviewer #1

We thank Reviewer 1 for the positive assessment and for the constructive comments. The two points raised for further discussion have led to the most substantial additions of this revision, and we have implemented all line-by-line suggestions.

Comment R1.1

Dear Editor,

In the manuscript 'A global hourly ISIMIP3 climate forcing dataset for impact modeling' the authors present an hourly climate dataset that temporally disaggregates the ISIMIP daily climate datasets using a previously published disaggregation tool. In addition, several examples are provided illustrating the impacts of using hourly data versus daily data for impact modeling. The manuscript is well written, the data is useful for impact modeling, and the dataset is readily available. However, there are a few points where the authors could provide further discussion. Therefore, I would recommend minor revisions for this manuscript. Moreover, if possible, I would recommend that the authors provide 3-hourly and 6-hourly aggregations of the dataset. Below are my main comments, along with a line-by-line list of comments.

Further discussion

There are two points that require more detailed discussion. (1) The current methodology assumes that regional and seasonal daily cycles remain valid under future climate scenarios. As this assumption is most likely not the case, several questions remain to be discussed. How does the selection of unique days change over time, and how does this change the daily cycles? What are the limits of your methods, and when should users revert to the hourly CMIP6 datasets? (2) The manuscript states that the disaggregated dataset should not be used for flash-like floods due to the spatial resolution. At the same time, the introduction mentions potential improvements for hydrological model flood simulations. The discussion should harmonize these points and include a reflection on whether the WFDE5's hourly precipitation intensities actually match the observations.

Reply

Thank you for pointing to these two important limitations. They have shaped the largest part of this revision. The recommendation on 3-hourly and 6-hourly aggregations is answered under Comment R1.2.

(1) Stationarity of the diurnal cycles and the selection of unique days. This limitation is discussed in the Teddy model description paper (Zabel and Poschlod, 2023, https://doi.org/10.5194/gmd-16-5383-2023), and we have now expanded the corresponding discussion in the present manuscript. Under strong warming in end-of-century projections, the number of sampled historical days can decrease because the same historical day is selected repeatedly, which reduces the diversity of the diurnal profiles. The additional analysis for SSP370 with the GFDL-ESM4 climate model in Zabel and Poschlod (2023) shows that the number of unique analogue climate days does decline, as expected, but that

the diversity remains above 300 unique days at the end of the century for the moving window size of ±11 d used here (Figure 1 below).

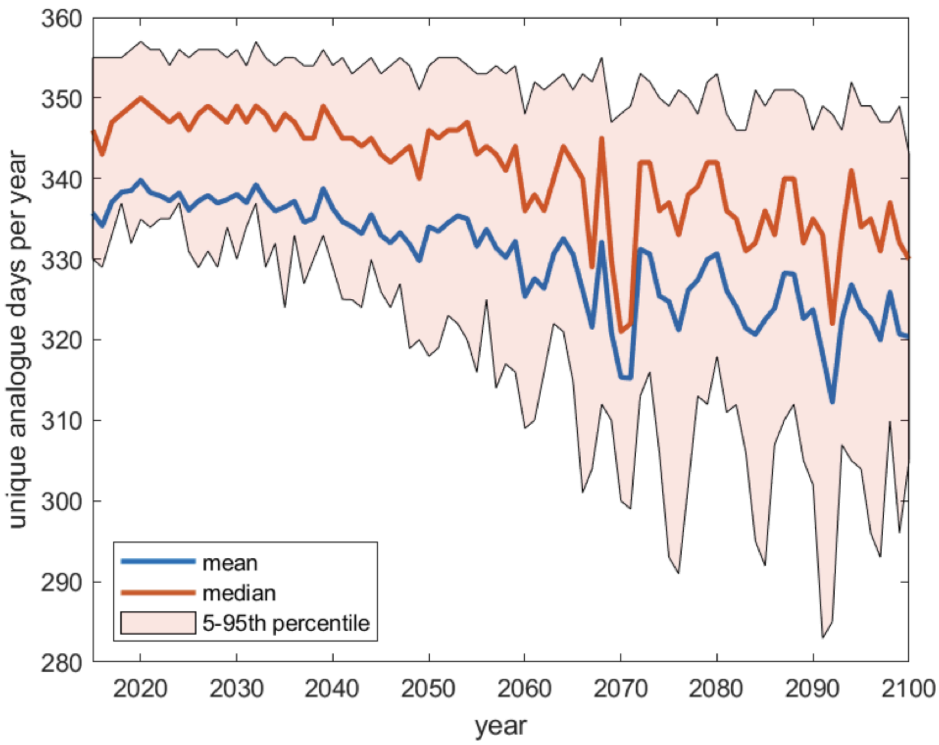

Figure 1 (response letter): Number of unique analogue climate days per year for the GFDL-ESM4 climate model under SSP3-7.0 for the years 2015–2100 and a selected moving window size of 11 days, showing the mean (blue) and median (orange), as well as the range between the 5th and 95th percentile for a number of 592 samples in the USA.

Two aspects should be separated here. First, a declining number of unique analogues does not translate one-to-one into a loss of variability. Because Teddy conserves the daily mass and energy of the climate model, the same analogue profile still produces a different diurnal course every time it is used, with a different offset and a different amplitude. What the approach cannot represent is a genuine change in the shape of the diurnal cycle itself, for instance a shift in the timing of convective rainfall or a change in the diurnal temperature range that is not already contained in the historical reference period.

Second, on the question of when users should revert to hourly CMIP6 data, we have refrained from formulating a prescriptive rule, because the answer depends on the application. Instead, we now set out the aspects that should be taken into account: the magnitude of the warming signal, and hence how far the projected daily statistics move outside the range covered by the reference period; the variable of interest, since the diurnal cycles of temperature and radiation are far more strongly constrained by the astronomical forcing than those of precipitation and wind speed; and the uncertainty of the climate projections themselves, which for most variables and regions remains substantial at the end of the century. The properties of the CMIP6 outputs also matter: native sub-daily output is archived for only a limited subset of models, variables and experiments in CMIP6, it is not bias-adjusted, and, as the manuscript already argued in the first paragraph of the conclusions, sub-daily processes are not reliably represented at the coarse spatial resolution of the models. We therefore give readers the information required to make the judgement for their own application rather than a recommendation that would not hold across applications.

(2) We thank you for pointing this out. We have harmonized the two statements. The introduction now restricts the claim about improved flood-peak simulation to catchments in which floods are generated by daily to multi-day precipitation and points forward to the conclusions. In the conclusions we now state why flash floods are outside the scope: flash floods typically develop in catchments smaller than a few hundred square kilometers and on timescales of at most a few hours (Borga et al., 2011), whereas a single 0.5° × 0.5° grid cell covers up to about 3000 km² and the underlying climate model information originates from global models with native resolutions on the order of 100 to 250 km. For large catchments, in contrast, the hourly resolution does add value, not only through the diurnal cycle of the energy balance but also through sub-daily process distinctions that matter for runoff generation, such as daytime rainfall versus overnight snowfall and the sub-daily dynamics of snowmelt.

On the hourly precipitation intensities of WFDE5: the bias adjustment applied in WFDE5 acts on monthly precipitation totals and on the monthly number of wet days (Cucchi et al., 2020), so the distribution of intensities within the day is inherited from ERA5, which is known to produce precipitation too frequently and at too low intensities and to underestimate the highest hourly rates (Lavers et al., 2022). Since Teddy takes its diurnal profiles from WFDE5, the disaggregated data inherit this characteristic, in addition to the tendency of the disaggregation itself to overestimate the intensity of rare hourly events reported by Zabel and Poschlod (2023). We now state this explicitly and advise care in the interpretation of absolute hourly rainfall intensities, in particular for convective extremes. We did not attempt an independent validation of WFDE5 precipitation against station observations, as this would duplicate the evaluation literature on the reference dataset rather than describe the dataset presented here.

Changes made

Introduction, second paragraph — the flood statement now reads (new text in bold):

> **Hence, hydrological simulations driven by hourly meteorological forcing can better reproduce the intensity of flood peaks compared to simulations driven by daily forcing (Huang et al., 2019), even in catchments where floods are generated by daily to multi-day precipitation rather than by short-duration convective events.**

Conclusions, paragraph on strong climate change signals — added after the existing sentence on the number of unique analogue days:

> **A decreasing number of unique analogues does not translate directly into a corresponding loss of variability in the disaggregated fields. Because Teddy conserves the daily mass and energy of the climate model, the repeated use of the same analogue profile still yields different diurnal courses, with a different offset and a different amplitude for each day. What the approach cannot represent is a genuine change in the shape of the diurnal cycle itself, for instance a shift in the timing of convective rainfall or a change in the diurnal temperature range that is not already contained in the historical reference period. Several aspects should be weighed when judging how relevant this is for a given application: the**

magnitude of the warming signal and thus how far the projected daily statistics move outside the range covered by the reference period; the variable of interest, since the diurnal cycles of temperature and radiation are more strongly constrained by the astronomical forcing than those of precipitation and wind speed; and the uncertainty of the climate projections themselves, which for most variables and regions remains substantial at the end of the century. The properties of the alternative also matter: native sub-daily output of global climate models is archived only for a limited subset of models, variables and experiments in CMIP6, it is not bias-adjusted, and, as mentioned above, it does not reliably resolve sub-daily processes at the coarse spatial resolution of the models.

Conclusions, paragraph on precipitation and floods — added and modified:

Beyond the disaggregation itself, the hourly precipitation intensities are constrained by those of the WFDE5 reference. The bias adjustment applied in WFDE5 acts on monthly precipitation totals and on the monthly number of wet days (Cucchi et al., 2020), so that the distribution of intensities within the day is inherited from ERA5, which tends to produce precipitation too frequently and at too low intensities and to underestimate the highest hourly rates (Lavers et al., 2022). Absolute hourly rainfall intensities from the disaggregated data should therefore be interpreted with care.

Consistent with this, and given the spatial resolution of the dataset of 0.5° × 0.5°, we do not recommend the disaggregated hourly data to be used for extreme events happening on small scales. This applies for flash floods, i.e. floods that develop in catchments smaller than a few hundred square kilometers and on timescales of at most a few hours (Borga et al., 2011). A single grid cell of the dataset covers up to about 3000 km², and the underlying climate model information originates from global models with native resolutions on the order of 100 x 100 to 250 x 250 km² km. We do argue, however, that the data disaggregation adds value for assessments of global water balance (Boulange et al., 2023) and for flood simulations of large catchments (Jiang et al., 2023), in which floods are driven by daily to multi-day precipitation. There, the hourly resolution improves the representation of the diurnal cycle and therefore of the energy balance and land surface processes, and it resolves sub-daily process distinctions that matter for runoff generation, such as daytime rainfall versus overnight snowfall and the sub-daily dynamics of snowmelt. This is the sense in which the hourly data can improve hydrological flood simulations.

Comment R1.2

Dataset aggregations

Although the current dataset sufficiently provides sub-daily climate data for impact modeling, providing 3-hourly and 6-hourly aggregations of the dataset could improve the dataset's usability and uptake. Even though climate variables are well-compressed, they each use approximately 100 GB for the historical and 150 GB for the future scenarios. Many impact models operate on sub-daily, but not hourly, timesteps, and could substantially reduce storage and post-processing requirements if aggregated timesteps are provided. Note that I *understand that this dataset aggregation is not necessary and involves substantial additional processing. Rather, it is my personal recommendation.*

Response

We agree that aggregated products would improve the usability of the dataset, and we would be glad to provide them once the necessary resources are available. For the present release, however, we cannot commit to them. Instead we make the alternative explicit. Users who need coarser sub-daily time steps or only a limited region do not have to download the archive in full: the data are organized as 5-year NetCDF files per variable, so each file can be retrieved, aggregated and cropped before the next one is processed, and only the reduced output has to be stored.

Changes made

Sect. 5 (Data availability) — new paragraph:

> **The dataset is provided at hourly resolution only. Users whose impact models operate at coarser sub-daily time steps, or who only require a limited region, are advised to process the archive sequentially. The data are organized as 5-year NetCDF files per variable, so that each file can be retrieved, aggregated to the required sub-daily time step and cropped to the area of interest before the next one is processed. In this way only the aggregated or cropped output has to be stored.**

Comment R1.3

> *Line-by-line comments. Line 18: More examples could be added from the first line of the abstract.*

Response

We agree. The opening sentence of the introduction now names the same range of applications as the first sentence of the abstract (heat stress, hydrological extremes and the land–surface energy balance in addition to renewable energy and agricultural yields) each with a reference.

Changes made

Introduction, first sentence:

> **In recent years, sub-daily climate data have become increasingly important in climate-impact analysis, e.g. for simulating solar and wind energy production or agricultural yields (Jägermeyr et al., 2021; Müller et al., 2021; Müller et al., 2024; Schneider et al., 2024), for quantifying human heat stress and the associated loss of labor capacity (Orlov et al., 2024), for representing hydrological fluxes (Huang et al., 2019; Shuai et al., 2022), and for closing the land–surface energy balance over the diurnal cycle (Renner et al., 2021).**

Comment R1.4

> *Line 64: The ISIMIP3a section contains a lot of details, whereas the ISIMIP3b section does not. Some more information could be provided on the setup of CMIP6 and the selection of climate models.*

Response

We agree that the two sections were unbalanced. We have added the CMIP6 experiments underlying the historical and future periods, the bias-adjustment and downscaling chain, and the criteria by which ISIMIP selected the five climate models from the CMIP6 ensemble. We cite the ISIMIP3b scenario paper, which documents the selection in detail.

Changes made

Sect. 2 (Data), ISIMIP3b paragraph — added after the existing description:

> **The historical period follows the CMIP6 historical experiment and the future periods follow the corresponding ScenarioMIP SSP–RCP combinations, with the bias adjustment and statistical downscaling from the native climate model grids to the common 0.5° grid performed per climate model and variable with ISIMIP3BASD (Lange, 2019) using GSWP3-W5E5 as the observational reference. The five climate models were selected from the CMIP6 ensemble by ISIMIP on the basis of the availability of all variables required by the impact models at daily resolution over the full period 1850–2100, the performance of the models over the historical period, their structural independence in terms of atmosphere and ocean components, an expert assessment of their process representation, and their equilibrium climate sensitivity, such that both the mean and the spread of the equilibrium climate sensitivity of the full CMIP6 ensemble are represented by the selected subset (Frieler et al., 2026).**

Comment R1.5

Line 87: Why do wind speed and precipitation perform worse?

Response

The difference reflects how strongly the diurnal course of a variable is determined by its daily aggregate. Temperature, relative humidity and radiation are governed by a strong and highly reproducible radiative diurnal cycle and are correspondingly autocorrelated within the day, so a day with similar daily statistics also tends to have a similar diurnal course. Precipitation and near-surface wind speed are dominated by intermittent, event-driven processes whose timing within the day is only weakly constrained by the daily aggregate, so an analogue day that matches the daily statistics need not reproduce the intra-day timing of individual rainfall or gust events. This is not specific to Teddy: the same ordering of variables by disaggregation skill is reported for other temporal disaggregation approaches, for example for MELODIST (Förster et al., 2016). We have added this explanation to the methods section.

Changes made

Sect. 3 (Methods) — added after the validation result:

> **The weaker performance for wind speed and precipitation reflects their larger intrinsic stochastic variability at sub-daily scales (Görner et al., 2021). Temperature, relative humidity and radiation are governed by a strong and highly reproducible radiative diurnal cycle and are correspondingly autocorrelated within the day, so that a day with similar daily statistics also tends to have a similar diurnal course. Precipitation and near-surface wind speed, in contrast, are**

dominated by intermittent, event-driven processes whose timing within the day is only weakly constrained by the daily aggregate, so that an analogue day matching the daily statistics does not necessarily reproduce the intra-day timing of individual rainfall or gust events. The same ordering of variables by disaggregation skill is reported for other temporal disaggregation approaches (Förster et al., 2016).

Comment R1.6

Line 217: Could the current methods be expanded to incorporate spatial sliding windows for the daily cycle selection?

Response

Thank you for this interesting suggestion. It addresses precisely the structural trade-off that we name at this point of the manuscript, namely that the temporal coherence between variables is obtained at the expense of spatial coherence.

Such an extension is conceivable in principle: the analogue search could be constrained to favor days that are compatible with those selected in the surrounding grid cells. It would, however, involve an unavoidable trade-off, because every additional constraint on the analogue search degrades the local fit. Spatial coherence would therefore be bought at the cost of the point-wise disaggregation performance for which Teddy is optimized and against which it was validated.

Assessing this for the present dataset would require the selected analogue day for every grid cell and time step as a baseline. This metadata was not saved during the production of the global hourly ISIMIP3 dataset, so the analysis cannot be carried out with our remaining resources.

Changes made

No change was made to the manuscript for this comment. The limitation itself is already stated in the conclusions and is unchanged: “However, the temporal coherence between the variables comes at the expense of spatial correlation, which is not guaranteed at hourly time steps in Teddy.”

Reviewer #2

Temporal disaggregation of daily climate data into hourly data is important for capturing short-duration extreme events and supporting multi-sector impact assessments at the global scale. This represents the main original contribution of the data paper. The method reconstructs sub-daily diurnal patterns by identifying the most similar meteorological day in a historical reanalysis dataset. Because the same historical analogue day is used across variables, the temporal dependence between meteorological variables is preserved, which also supports cross-sectoral impact assessment. This is an additional strength of the work.

Reply: We thank the reviewer for this positive assessment and for recognizing the originality and strengths of our produced data set. The comments that follow have led to a clearer methods description, two additional analyses and a considerably more explicit treatment of the limitations, and we are grateful for them.

Comment R2.1

While this is an important and valuable contribution, several points would benefit from further clarification or discussion.

> ***Line 70.*** *The parallel implementation of the TEDDY tool using zonal strips to reduce computational demand may not guarantee that the same most similar meteorological day is selected across adjacent zones for a given calendar day. This could introduce spatial inconsistencies in the reconstructed sub-daily patterns. The authors should clarify how this issue is handled or assess its potential implications.*

Response

We thank the reviewer for raising this point, and we see that the original wording could easily be misinterpreted. The zonal strip implementation is solely a strategy for memory management and parallel processing of the large global dataset. It does not alter the analogue-selection procedure. As described in the Teddy model description paper (Zabel and Poschlod, 2023), the most similar meteorological day is identified independently for each individual grid cell using the historical WFDE5 record at the same location. Consequently, the selected analogue day is independent of the computational strip in which the grid cell is processed. Neighboring grid cells may indeed select different analogue days, but this is an inherent characteristic of the Teddy methodology rather than a consequence of the zonal strip implementation. This pixel-wise selection allows the method to preserve local meteorological characteristics and is identical to the validated approach described in Zabel and Poschlod (2023).

Changes made

Sect. 3 (Methods), first paragraph — added:

> **The striping serves only for memory management and computational efficiency and does not modify the analogue-search algorithm: the most similar meteorological day is determined independently for every individual grid cell from the reference record at that same location, so the selected analogue day does not depend on the strip in which a grid cell is processed.**

Comment R2.2

> *The use of historical reanalysis data to identify the most similar meteorological day implicitly assumes that climate change will not substantially alter existing sub-daily variability patterns or generate new ones in the future. This assumption should be discussed as a limitation of the approach.*

Response

We agree, and Reviewer 1 raised the same point. We have expanded the corresponding paragraph in the conclusions rather than adding a second, separate discussion. In short: the number of unique analogue days does decline under strong warming, but remains above 300 per year at the end of the century for the window size used here (Figure 1 of this letter, shown under Comment R1.1); because Teddy conserves daily mass and energy, repeated use of the same analogue still yields different diurnal courses; and what the method cannot represent is a change in the shape of the diurnal cycle that is not contained in the historical reference period. The revised paragraph also lists the aspects users should weigh, including the properties of native sub-daily climate model output as the alternative.

Changes made

Conclusions, paragraph on strong climate change signals, see the new text quoted under Comment R1.1.

Comment R2.3

> ***Line 160.*** *More recent global wind-power potential assessments already use hourly wind speeds from reanalysis datasets rather than daily averages or six-hourly data, for example: https://www.sciencedirect.com/science/article/pii/S0360544217308095. The citation and discussion should therefore be updated. In this context, the disaggregated hourly dataset may be particularly valuable for improving consistency between renewable-energy potential assessments and climate-impact assessments.*

Response

We thank the reviewer for pointing us to this reference. We have restructured the paragraph so that it distinguishes the earlier assessments based on average or 6-hourly wind speeds from the more recent, temporally explicit assessments based on hourly reanalysis data (Bosch et al., 2017), and so that the remaining gap is stated clearly: climate change effects on wind power generation are still estimated from daily climate model data. We also agree with the point about consistency and have made it explicit: the dataset allows renewable-energy potential assessments and climate-impact assessments to be driven by one and the same bias-adjusted forcing.

Changes made

Sect. 4.3 — the closing paragraph now reads:

> **Early global wind power potential assessments were based on average wind speed (Bandoc et al., 2018) or on 6-hourly reanalysis data (Lu et al., 2009), whereas more recent assessments derive temporally explicit global onshore wind energy potentials directly from hourly reanalysis wind speeds (Bosch et al., 2017). Climate change effects on wind power generation, in contrast, are still estimated from daily global climate model data (Miao et al., 2023). The disaggregated hourly data help to close this gap, because they capture the sub-daily variability of wind speeds needed for a realistic global assessment of wind power generation and are at the same time available for the full set of ISIMIP3 climate models and scenarios. Renewable-energy potential assessments and climate-impact assessments can thus be driven by one and the same bias-adjusted, temporally consistent forcing.**

Comment R2.4

> *The manuscript states several times that incorporating sub-daily variability is essential for representing nonlinear processes. However, this benefit is not*

directly demonstrated in the four illustrative applications. It would strengthen the paper considerably to include a comparison showing how estimated impacts differ when using hourly rather than daily data. At minimum, this issue should be discussed in greater depth.

Response

We thank the reviewer for this valuable comment. We agree that directly comparing impact estimates derived from daily and hourly forcing provide a useful demonstration of the added value of the dataset. For two of the four illustrative applications we have repeated the calculation with daily instead of hourly forcing and added the comparison to the manuscript as two new figures (Figs. 4 and 6 of the revised manuscript, reproduced as Figures 2 and 3 of this letter).

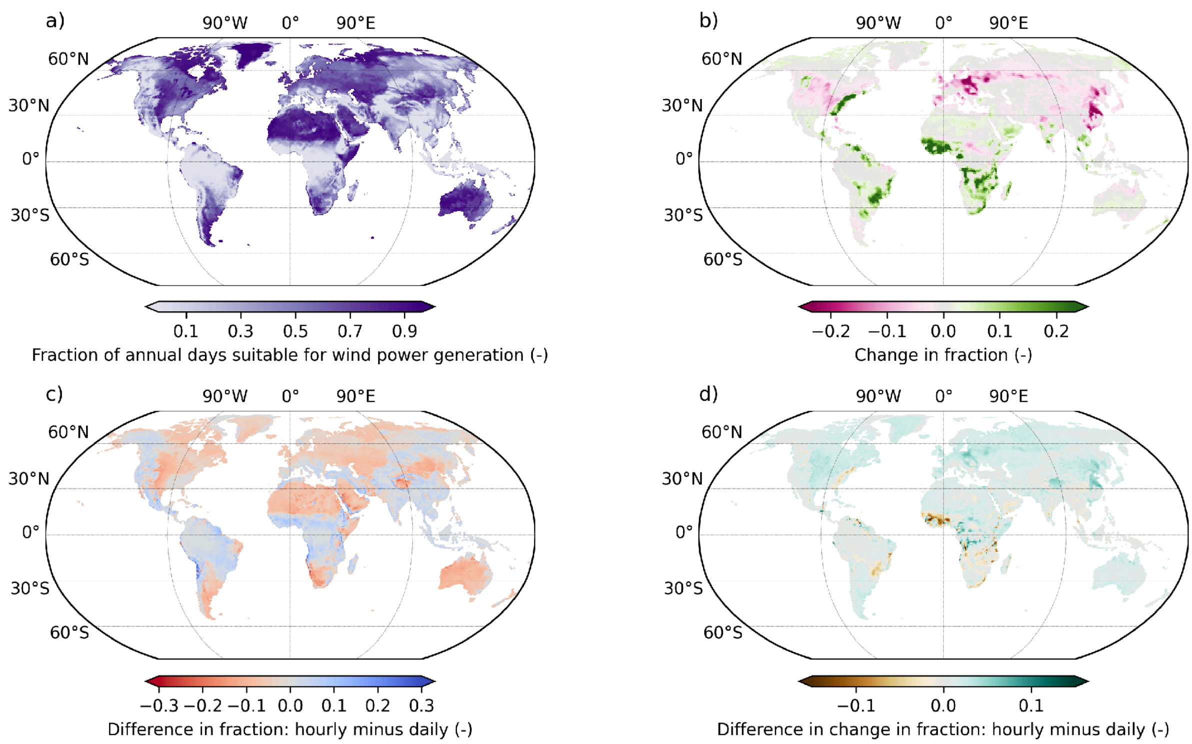

Figure 2 (response letter; Fig. 4 of the revised manuscript): Comparison of the assessment of suitable conditions for wind power generation based on daily and on hourly climate data. (a) Fraction of annual number of days suitable for wind power generation in 1981–2010 based on the daily MPI-ESM data (same color scale as Fig. 3a). (b) Change of the fraction until 2071–2100 under SSP370 based on daily data (same color scale as Fig. 3b). (c) Difference of the fraction in 1981–2010, hourly minus daily. (d) Difference of the projected change, hourly minus daily.

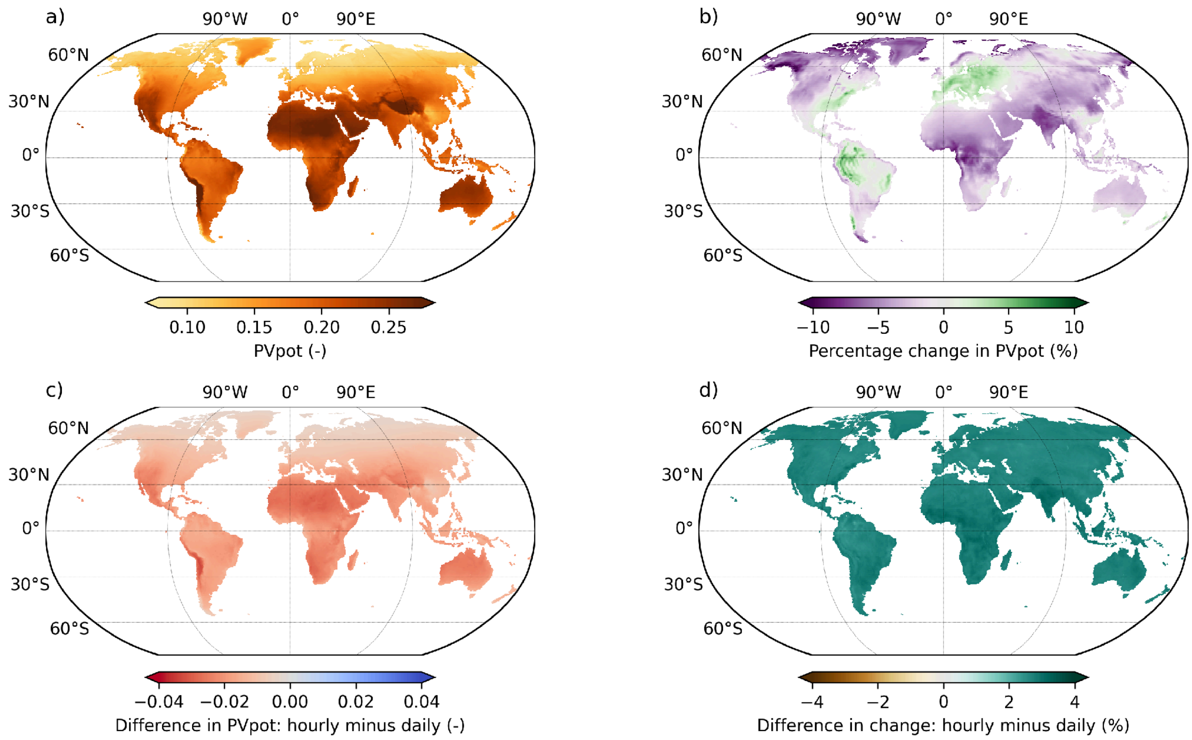

Figure 3 (response letter; Fig. 6 of the revised manuscript): Comparison of the photovoltaic power potential (PVpot) calculated from daily and from hourly climate data. (a) PVpot in 1981–2010 based on the daily MPI-ESM data (same color scale as Fig. 5a). (b) Percentage change of PVpot until 2071–2100 under SSP370 based on daily data (same color scale as Fig. 5b). (c) Difference of PVpot in 1981–2010, hourly minus daily. (d) Difference of the projected percentage change, hourly minus daily.

The differences are substantial and, importantly, not uniform. For wind power, the daily assessment yields a considerably higher fraction of suitable time steps in windy regions, where the daily mean exceeds the cut-in wind speed on most days while many individual hours do not, and a lower fraction in the humid tropics, where the daily mean rarely reaches the cut-in speed but individual windy hours still occur. For the photovoltaic power potential the sign is the same everywhere: PVpot from hourly data is lower than PVpot from daily means across all land regions, which follows directly from the non-linear coupling between radiation and cell temperature, since daily mean radiation is much lower than the radiation actually received around midday and the daily calculation therefore underestimates the cell temperature and overestimates the performance ratio. In both cases the projected climate change signal is affected as well, so the choice of temporal resolution is not merely a matter of resolving short-duration events.

A comparison of estimated impacts for crop yields, runoff, labor capacity requires dedicated simulations with the individual impact models and is specific to each model and application; carrying this out for even a subset of the ISIMIP sectors would be a study in its own right and is beyond the scope of this data description paper.

Changes made

Sect. 4.3 — new paragraph and new Fig. 4:

> **To illustrate the order of magnitude in which hourly and daily assessments differ, we repeat this analysis with the daily mean wind speed of the same climate model data, i.e. counting suitable days instead of suitable hours (Fig. 4) (Poschlod and**

Zabel, 2025d). In regions with generally high wind speeds, such as North America, the Sahara–Arabian belt and Australia, the daily assessment yields a considerably higher fraction of suitable time steps, because the daily mean exceeds the cut-in wind speed on most days while a substantial share of the individual hours does not (negative differences in Fig. 4c). In the humid tropics the sign reverses: there the daily mean rarely reaches the cut-in wind speed, whereas the hourly data still resolve individual hours with sufficient wind, so that the hourly assessment gives the higher fraction. The projected climate change signal is less sensitive to the temporal resolution of the forcing, but regionally, in particular in the African and South American tropics, the differences reach a magnitude comparable to the signal itself (Fig. 4d).

Sect. 4.4 — new paragraph and new Fig. 6:

> **As for the wind power example, we repeated the calculation of PVpot with daily mean values of rsds, tas, and v10 (Fig. 6) (Poschlod and Zabel, 2025b). Across all land regions, PVpot derived from hourly data is lower than PVpot derived from daily means (Fig. 6c). This is a direct consequence of the non-linear coupling between radiation and cell temperature in Eqs. (2)–(4): the daily mean radiation is much lower than the radiation actually received around midday, so that the daily calculation underestimates the cell temperature and thus overestimates the performance ratio during the hours in which most of the energy is generated. The temporal resolution of the forcing also affects the projected climate change signal, which is systematically more positive when computed from hourly data over nearly all land areas (Fig. 6d). Both examples show that the differences between daily and hourly forcing are not restricted to the representation of short-duration events but propagate into the projected changes themselves.**

Sect. 7 (Conclusions) — added:

> **For two of the four illustrative applications, we additionally quantified how the results change when the same metric is computed from daily instead of hourly forcing (Sects. 4.3 and 4.4). These comparisons show that the temporal resolution of the forcing affects both the magnitude of the impact metric and its projected climate change signal, and that the sign of the effect is metric- and region-dependent, so that it cannot be anticipated from the daily data alone.**

Comment R2.5

For wind energy, the conversion from wind speed to wind power is strongly nonlinear and is approximately cubic below the rated wind speed. As a result, estimating wind generation from daily mean wind speed may underestimate output relative to calculations based on hourly wind speeds.

The solar-energy example assumes a horizontal PV panel, whereas real PV systems are typically tilted. This simplification may mask important nonlinearities in PV conversion. A more realistic assessment would require decomposition of surface downwelling shortwave radiation (rsds) into direct and diffuse components, followed by transposition to the plane of the array. These processes cannot be represented adequately using daily mean data alone.

Response

We thank the reviewer for these valuable suggestions. The examples presented in our manuscript just represent simplifying illustrations for promising applications of the new hourly dataset. For wind energy, we have added the approximately cubic dependence of the extractable power on wind speed between the cut-in and the rated wind speed. This is in fact the strongest argument for hourly data in this application, and it also explains why we restrict the metric to the frequency of suitable conditions rather than reporting generated power: a power estimate from daily mean wind speeds would not be meaningful.

For solar energy, we have added the simplifications explicitly: the calculation refers to a horizontal plane, rsds is used without separation into direct and diffuse components, and no transposition to the plane of an inclined or tracking array is performed. We would add that this cuts in favor of the dataset rather than against it: the decomposition and transposition depend on the position of the sun and on the sub-daily evolution of the radiation components, so they can only be carried out with sub-daily forcing. The hourly dataset is thus a prerequisite for the more realistic assessment the reviewer describes.

Changes made

Sect. 4.3, first paragraph — added:

Between the cut-in wind speed and the rated wind speed, the power extracted by a turbine increases approximately with the cube of the wind speed (Bosch **et al., 2017). Wind power generation therefore responds strongly non-linearly to sub-daily wind speed variations and cannot be recovered from daily mean wind speeds, which is why the metric presented here is deliberately restricted to the frequency of suitable conditions rather than to the generated power.**

Sect. 4.4 — new paragraph:

This example is a simple illustration of a possible application. The calculation refers to a horizontal plane, and rsds is used as provided, i.e. without separating it into its direct and diffuse components and without transposing the radiation onto the plane of an inclined or sun-tracking array. A realistic assessment of installed photovoltaic systems requires both steps, and the resulting values of PVpot would differ, in particular at high latitudes and for tracking systems. Such a treatment depends on the position of the sun and on the sub-daily evolution of the radiation components and can therefore only be carried out with sub-daily forcing data, so that the hourly dataset is a prerequisite for a more complete photovoltaic assessment.

Comment R2.6

In addition, I encourage the authors to complete the development of the disaggregated hourly dataset for offshore areas. This would be particularly valuable for energy applications. Given the growing role of offshore wind in the energy transition, realistic representation of fixed and floating offshore wind resources and their generation profiles is increasingly important for energy-system modelling. Without consistent offshore coverage, the applicability of the dataset may be constrained, as both onshore and offshore resources should ideally be represented within the same modelling framework.

The authors could consider using raw ERA5 data as the offshore reference dataset, even though it is not bias-corrected over sea areas.

Response

We agree that an offshore extension would broaden the applicability of the dataset, particularly for offshore wind energy, and we agree that raw ERA5 is a good candidate for an offshore reference. The current land-only coverage follows from the bias-corrected WFDE5 reference used throughout the Teddy methodology, which exists over land only, and staying with it is what keeps the product consistent with the ISIMIP bias-adjustment framework.

We are not able to add offshore coverage within this revision: it would require a new production run and its own validation, and it raises questions that needs investigation first, in particular how to document and handle the fact that offshore fields based on raw ERA5 would not be bias-adjusted and therefore not fully consistent with the land fields. We consider it a plausible route for a future version and have added the constraint, the suggested approach and this caveat to the conclusions.

Changes made

Sect. 7 (Conclusions) — new paragraph:

> **A further constraint of the present dataset is its restriction to land. The disaggregation relies on the bias-adjusted hourly WFDE5 reference, which is available over land only, and keeping to this reference preserves the consistency with the ISIMIP bias-adjustment framework. It does, however, limit applications that require onshore and offshore resources within a single modeling framework, such as energy-system studies that include offshore wind. An extension of the disaggregation to the oceans using raw hourly ERA5 (Hersbach et al., 2020) as the reference is technically feasible and is a plausible route for a future version of the dataset. The offshore fields would then not be bias-adjusted and would consequently not be fully consistent with the land fields, which is a trade-off that would have to be documented and taken into account by users.**

Sincerely,

Michel Bechtold on behalf of all co-authors