Response to RC1

This manuscript presents the China New-type Power Systems Meteorological (CNPS-Met) dataset, a novel 25 km daily gridded product for the Chinese mainland covering 1980-2016. The authors validate their dataset against three existing gridded products (CN05.1, CMFD, CDMet), demonstrating superior performance for most meteorological variables. They further analyze the spatial patterns of these power-system-relevant events. Overall, the topic is highly relevant for ESSD, the methodology is sound and addresses a clear limitation of traditional optimal interpolation (OI) methods, and the dataset fills a critical gap at the intersection of meteorology and energy system. The manuscript is well-structured and the results are presented clearly. I would like to recommend an acceptance after a major revision.

Re: Thank you very much for your constructive comments on this study. We have revised the manuscript carefully according to your suggestions. Below are our point-by-point responses.

Major Comments

1. Methodological Justification (Lines 216-236): The spatially adaptive optimal interpolation (OI) scheme proposed in this study is sound, which dynamically adjusts the influence radius based on local station density. While the concept is clear, the paper would benefit from a more explicit demonstration of its impact. For example, how does the resulting field vary spatially across China? This would visually confirm that the algorithm is effectively expanding the radius in data-sparse regions (e.g., Tibetan Plateau) and contracting it in data-dense regions (e.g., Eastern China).

Re: Thanks, we agree with your opinion. In the revised manuscript, we have added a new figure (Figure 2, Figure R1 below) to show the spatial distribution of the influence radius in the spatially adaptive OI scheme across China. Results indicate that, the influence radius varies with the station density, that is, it is larger in data-sparse regions and is smaller in data-dense regions, which generally captures the spatial distribution of stations (Fig. 1a in the manuscript), suggesting that the spatially adaptive OI scheme proposed in this study could dynamically adjust the influence radius based on the density of local observations.

The above discussions have been provided in Lines 240-249 in the revised manuscript.

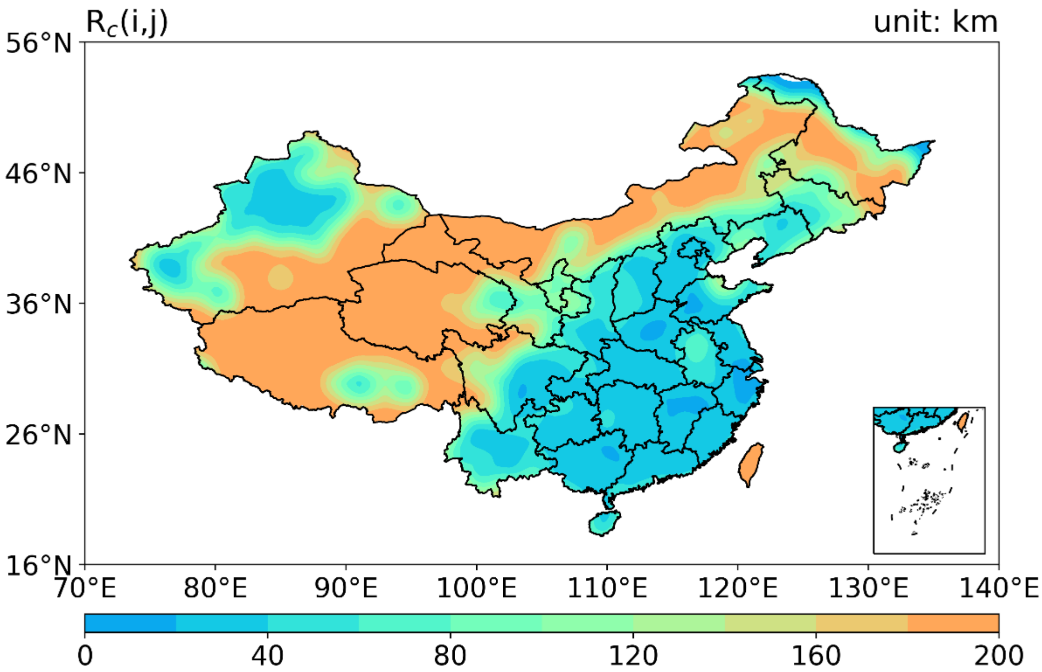

Figure R1. Spatial distribution of the influence radius (unit: km) in the spatially adaptive OI scheme.

2. Clarification on the Minimum Station Threshold (Lines 227-236): It seems that the performance of the new OI scheme is also influenced by the chosen parameters (minimum station threshold). However, the manuscript does not specify the actual value of Nmin, please explicitly state it. Furthermore, what was the rationale for specifying this threshold?

Re: Yes, the performance of the new OI scheme is influenced by the parameter N_{min}. This parameter is set to N_{min}= 5, meaning that for each grid point, the scheme dynamically expands the search radius until the number of available observation stations within the search region reaches at least 5.

The rationale for setting N_{min}= 5 is as follows. First, when N_{min}< 5, in extremely data-sparse regions (e.g., Northwest China), the search radius remains too small, which may cause assimilation results based on only a few stations (e.g., 1-2 stations) to become not robust due to insufficient representativeness or accidental errors (Figure R2a). Second, when N_{min}> 5 (i.e., 10 or 15), this could lead to missing values of the influence radius in the data-sparse regions (Figs. R2c-d).

The above discussions have also been provided in Lines 232-239 in the revised manuscript.

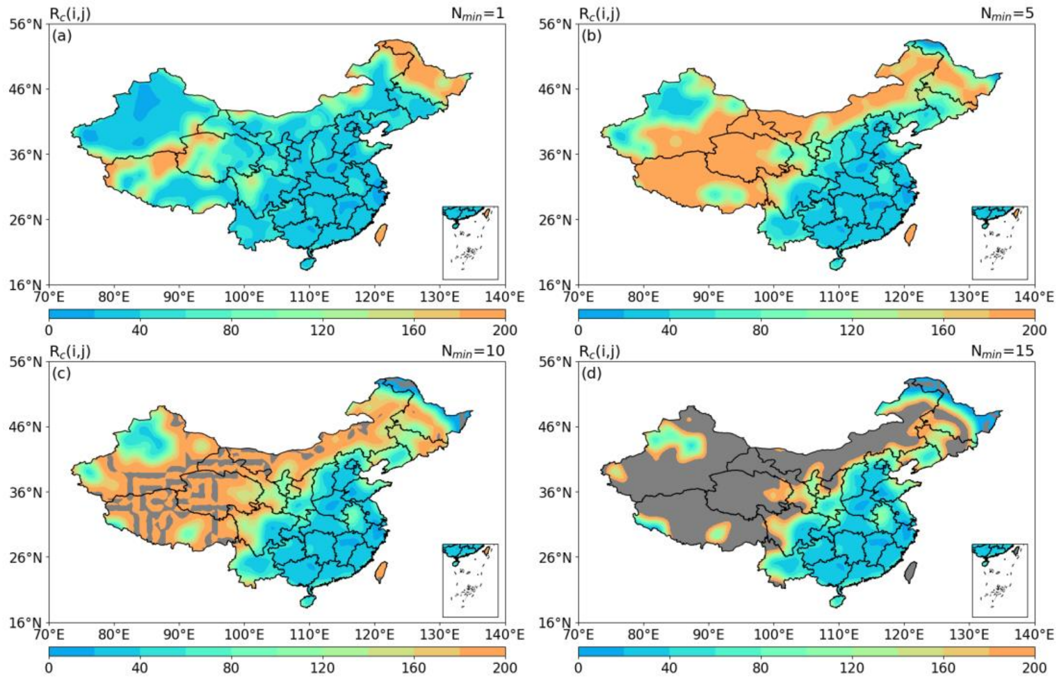

Figure R2. Spatial distribution of the influence radius (unit: km) in the spatially adaptive OI scheme with different minimum station threshold such as (a) N_{min}= 1, (b) N_{min}= 5, (c) N_{min}= 10, and (d) N_{min}= 15. The missing values are denoted as gray shaded color.

3. Verification independence (Lines 163-167): The validation uses CN05.1, CMFD, and CDMet. It is crucial to clarify the degree of independence of these datasets from the observations used to create CNPS-Met. All three validation datasets are themselves interpolated products based on station data. While CNPS-Met demonstrably performs better, the validation is not entirely independent (i.e., it's not a comparison against withheld station data). The authors should validate their results against an independent truth, or explicitly state this limitation and perhaps frame the validation more as a "comparison against existing state-of-the-art gridded products".

Re: In this study, we validate the performance of CNPS-Met dataset against several products generated by different methodologies. This comparison can effectively evaluate the performance of different data generation schemes in the same region, and show the comparative advantages of CNPS-Met dataset.

To address your concern, we select 500 stations as independent validation stations and the remaining 2098 stations as assimilation sites (Figure R3). Verification results of independent truth from January to December 2013 (Figure R4-R5) indicate that the assimilation effects of 2-m specific humidity, precipitation, 2-m air temperature, 10-m wind speed, and surface pressure at 500 independent validation stations are generally consistent and good, with relatively lower *MREs* compared to other datasets.

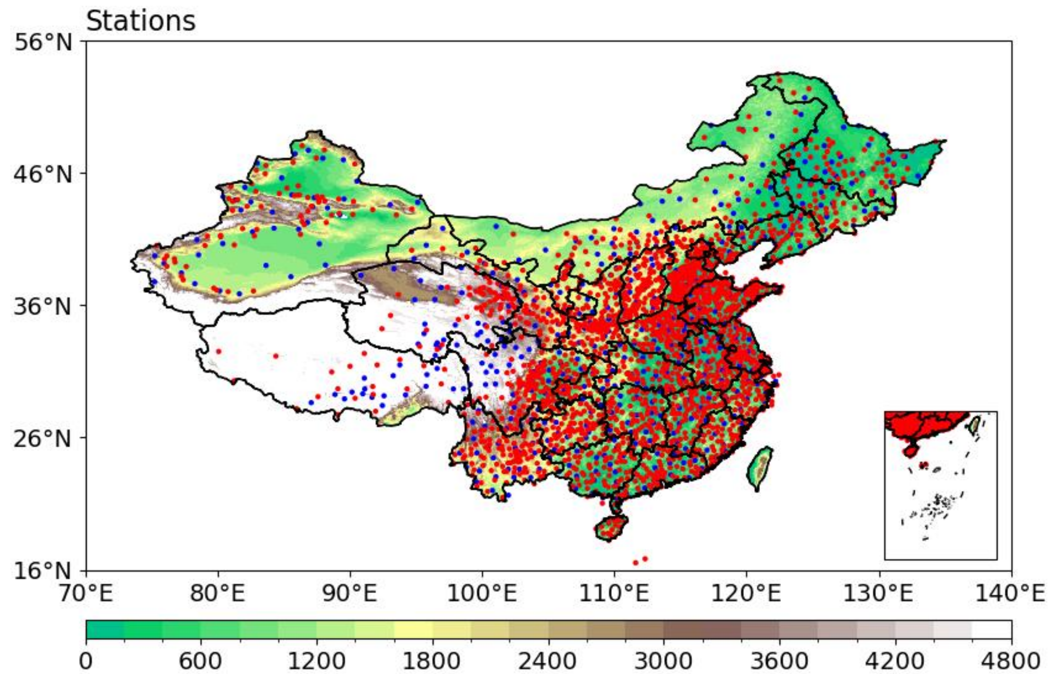

Figure R3. Distribution of ground-based meteorological stations for assimilation (red dots) and verification (independent truth; blue dots).

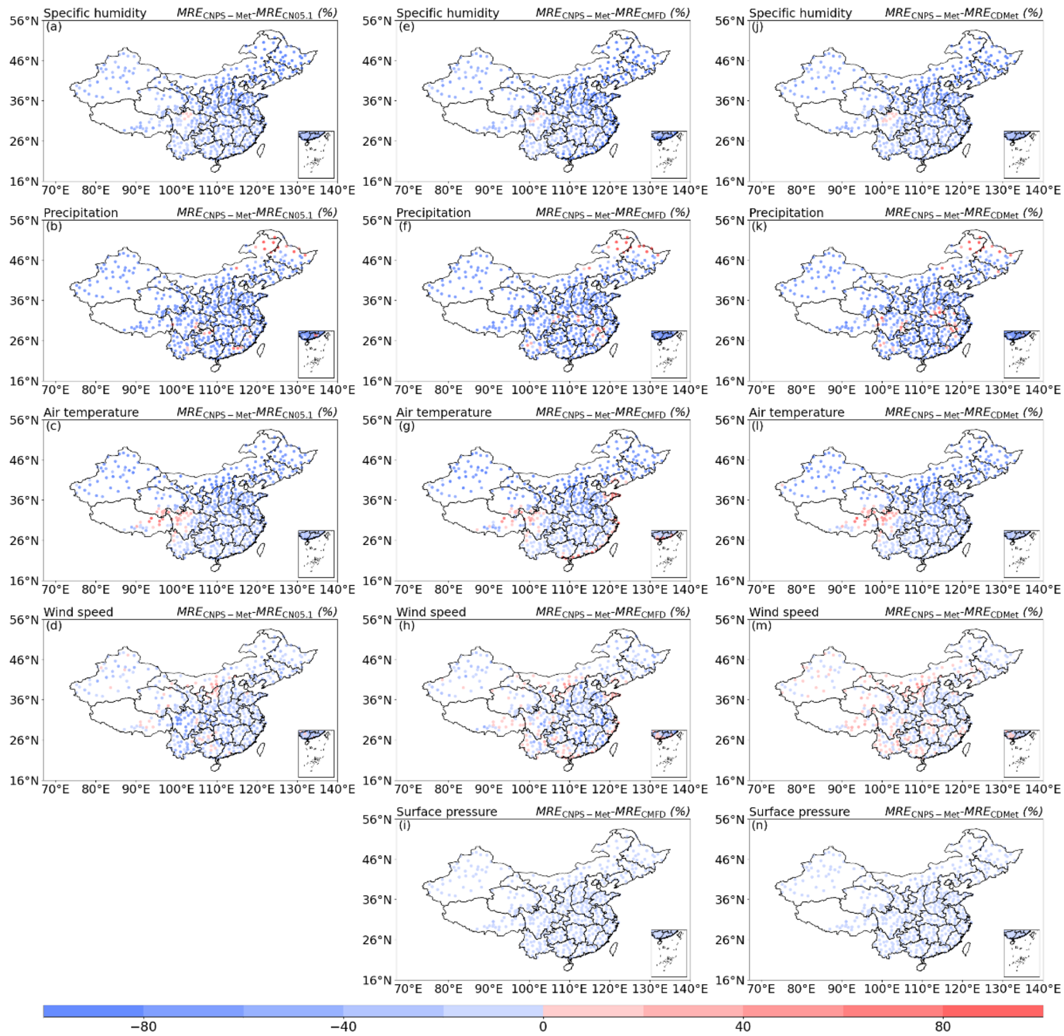

Figure R4. Spatial distribution of the differences in the mean *MREs* at the validation stations (unit: %) between three dataset pairs: (a-d) CNPS-Met and CN05.1 ($MRE_{CNPS\text{-}Met}$ minus $MRE_{CN05.1}$), (e-i) between CNPS-Met and CMFD ($MRE_{CNPS\text{-}Met}$ minus MRE_{CMFD}), and (j-n) between CNPS-Met and CDMet ($MRE_{CNPS\text{-}Met}$ minus MRE_{CDMet}). The differences are shown for (a, e, j) 2-m specific humidity, (b, f, k) precipitation, (c, g, l) 2-m air temperature, (d, h, m) 10-m wind speed, and (i, n) surface pressure.

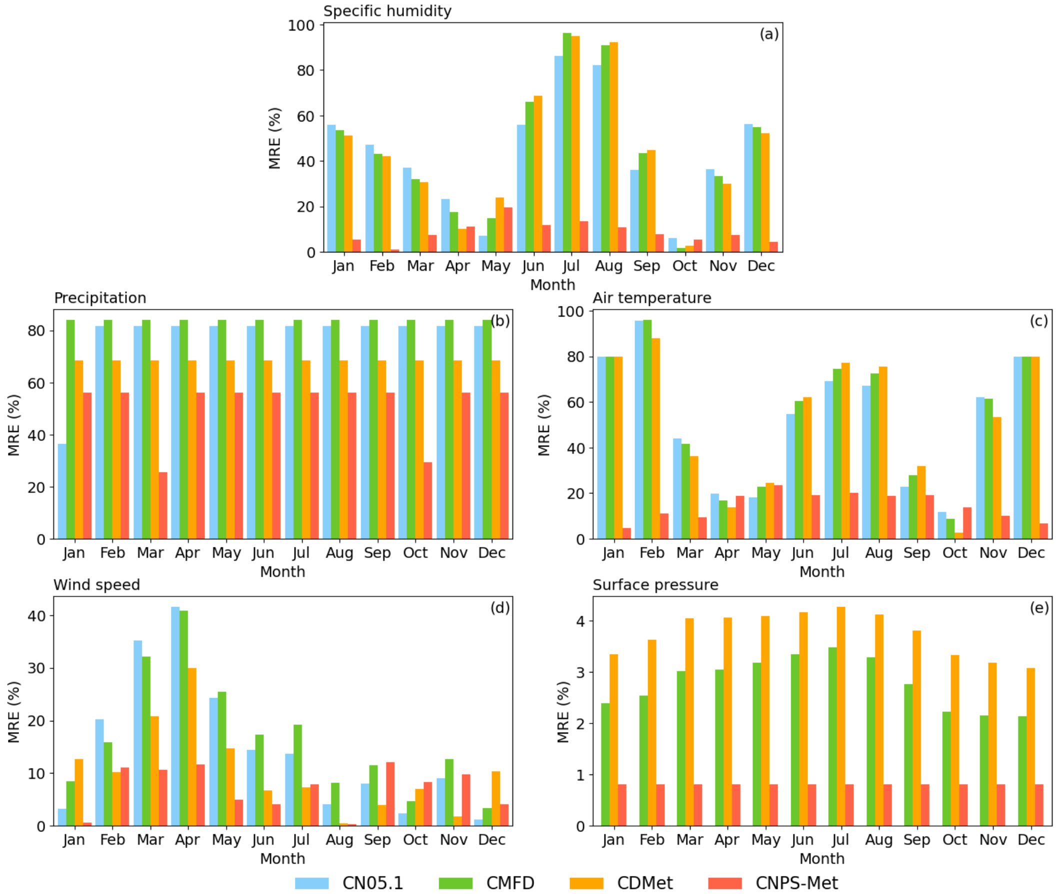

Figure R5. Monthly variation of the mean *MREs* at the validation stations (unit: %) for (a) 2-m specific humidity, (b) precipitation, (c) 2-m air temperature, (d) 10-m wind speed, and (e) surface pressure in different datasets.

4. Spatio-temporal Mismatch in Event Definition (Section 2e): This is a critical point. The high-impact weather events are defined using hourly thresholds, but the CNPS-Met dataset has a daily temporal resolution. How are these hourly events identified from a daily dataset? For example, a day with a mean wind speed of 15 m/s could still have an hourly gust exceeding 25 m/s. The manuscript must clearly explain this. Besides, is the “frequency” reported the number of days where the event occurred, or an estimate of the number of hours? This distinction is fundamental for the utility of the dataset.

Re: Thanks, we understand. In fact, the CNPS-Met dataset is generated by assimilating hourly *in-situ* observations into hourly ERA5 reanalysis, therefore, the minimum temporal resolution of the meteorological variables is 1 hour. On this basis, high-impact weather events are identified according to their respective definitions. After all such events are identified at hourly scale, they are aggregated to the daily scale. In other words, the CNPS-Met dataset supports both hourly and daily temporal scales. The hourly variables, including all meteorological elements and high-impact weather events, are subsequently stored and published online at daily scale.

We need further clarify that, the "frequency" refers to the number of days where the event occurred (i.e. the number of days where the event occurred at least once), rather than an estimate of the number of hours. For example, if a grid point experiences a high-impact weather event for at least one hour on a certain day, then that day is marked as a high-impact weather event day for that grid point.

The above discussions have been provided in Lines 349-361 in the revised manuscript.

5. Uncertainty in the Composite Weather Index (CWI) (Lines 322-330, Eq. 13): The CWI is an interesting metric, but its formulation needs clarification. (1) The term "" is not clear, does this represent the maximum possible value of the variable, or the maximum value observed in the dataset at that location? (2) The notation "" in the piecewise function appears to be a typo. Please clarify the condition(s) for calculating the product.

Re: Thanks, we have revised the Eq. (14) and improved the associated introductions. Please see Lines 366-371 in the revised manuscript.

$$CWI = \begin{cases} \prod_{k=1}^{n} \frac{\alpha_k - th(\alpha_k)}{\max(\alpha_k) - th(\alpha_k)}, & \alpha_1 \geq th(\alpha_1), \mathrm{L}\ , \alpha_n \geq th(\alpha_n) \\ 0 & , else \end{cases} \quad (1)$$

where α represents a high-impact weather event composed of n meteorological variables, with the index of each variable is denoted by subscript k (k= 1, 2, …, n). The threshold and the daily maximum value of the k-th variable (α_k) are denoted as $\mathrm{th}(\alpha_k)$ and $\max(\alpha_k)$, respectively. The $\max(\alpha_k)$ represents the multi-year daily maximum value of the k-th variable in the corresponding different grid point.

6. Interpretation of Wind Speed MREs: In this paper, the MRE is selected to validate the dataset performance. The authors note that the improvement in wind speed is "relatively modest" yet it exhibits the "smallest MREs among all meteorological variables". This apparent paradox needs clarification. Is it because wind speed is inherently harder to improve (due to its intermittency), but also easier to estimate with low relative error because the values themselves are small? The discussion could be expanded to explain why MRE is a suitable metric for wind speed, and whether other

metrics like RMSE might tell a different story.

Re: Thanks, we need to clarify the expression “relatively modern” means that, compared with the improvement of temperature and precipitation etc. in CNPS-Met dataset, the improvement of wind speed is smaller.

We understand that root mean square error (*RMSE*) reflects the root mean square of absolute errors and is sensitive to large errors, while *MRE* reflects the mean relative error and eliminates the influence of dimensions and numerical scales. Since we need to compare variables with different dimensions (e.g., simultaneously evaluating the prediction accuracy of wind speed, temperature, and atmospheric pressure), therefore, *MRE* is selected in this study.

We accept your suggestion and compare root mean square error (*RMSE*) and mean absolute error (*MAE*). Results of *RMSE* and *MAE* are completely consistent with the conclusions of *MRE* (Figure R6-R7). The *RMSE*, *MAE* of wind speed in CNPS-Met is also lower than that of all existing reference products involved in the comparison.

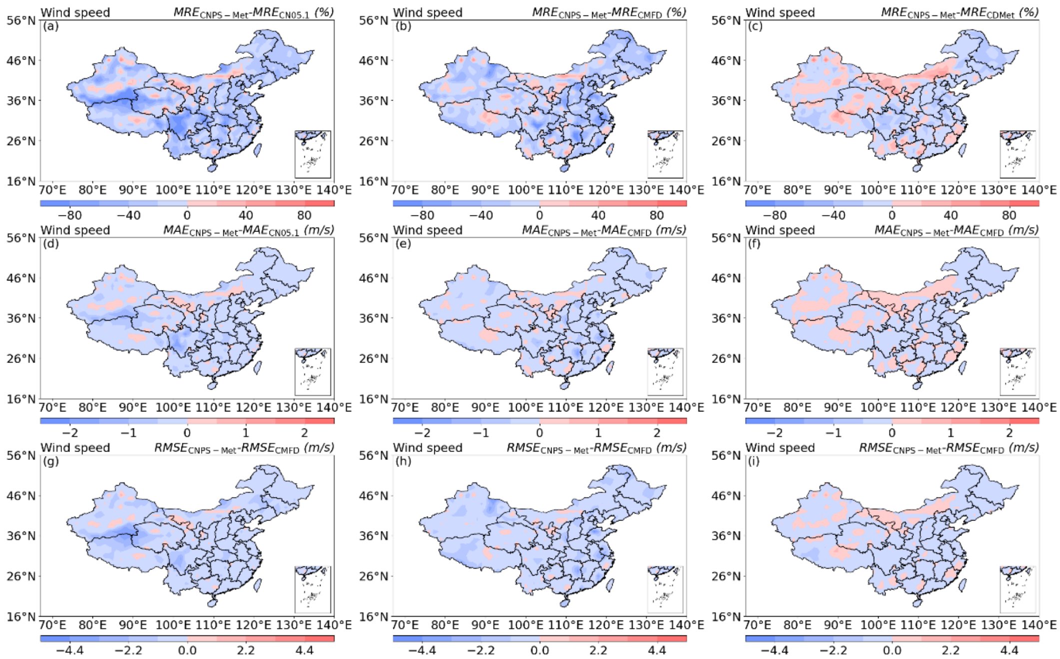

Figure R6. Spatial distribution of the differences in the (a-c) *MREs* (unit: %; averaged over 1980-2016), (d-f) *MAEs* (unit: m/s; averaged over 1980-2016), and (g-i) *RMSEs* (unit: m/s; averaged over 1980-2016) of 10-m wind speed between three dataset pairs: (a, d, g) CNPS-Met and CN05.1, (b, e, h) between CNPS-Met and CMFD, and (c, f, i) between CNPS-Met and CDMet.

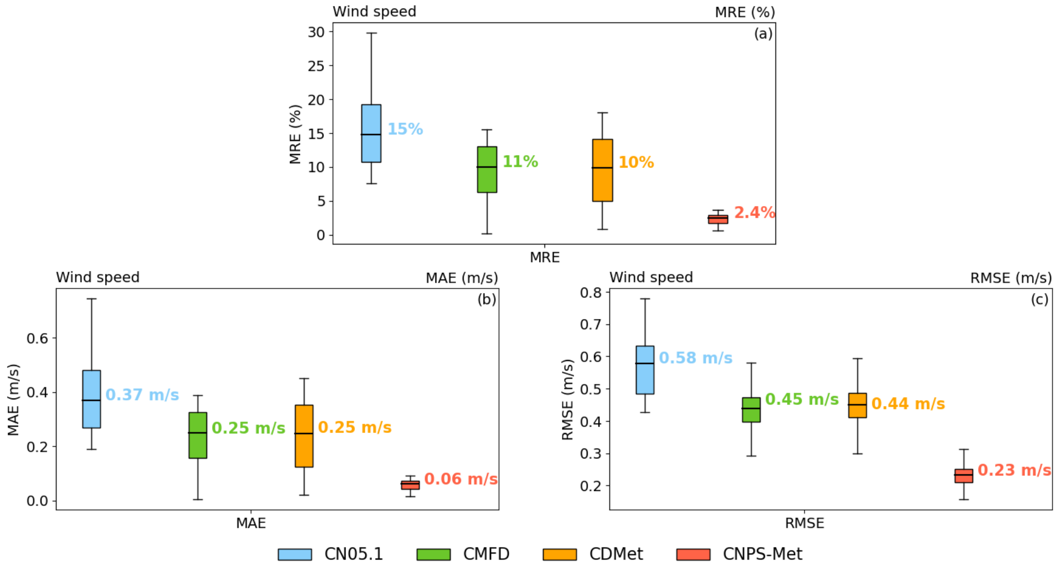

Figure R7. The mean (a) *MREs* (unit: %), (b) *MAEs* (unit: m/s), and (c) *RMSEs* (unit: m/s) averaged over China from 1980 to 2016 in different datasets for 10-m wind speed.

7. Analysis of Intensity Extremes (Figure 7): Figure 7 is visually rich but the criteria for defining an "intensity extreme" at the 90% confidence level is not described in the text or caption. How is this confidence level calculated? Is it based on a statistical test of the intensity values at a grid point compared to the surrounding area, or is it simply the 90th percentile of intensity for that event type? Please add a clear explanation to the text or the figure caption.

Re: Thanks, the "intensity extreme" at the 90% confidence level is obtained through T-test and refers to the 90^{th} percentile of intensity of high-impact weather events. We have added this statement in Lines 472-473 in the revised manuscript.

8. Relevance of Wind Speed Height for Power Systems: The dataset provides wind speed at 10 m. However, for wind power generation, the variable of interest is typically wind speed at turbine hub height (e.g., 70 m). The thresholds for cut-in and cut-out wind speeds defined in Table 2 are based on operational standards that implicitly refer to hub-height wind speeds. Please clarify whether the wind speed provided in the CNPS-Met dataset is intended to represent hub-height conditions. If so, a detailed explanation of the methodology used to extrapolate from 10 m to hub height is essential.

Re: Thanks, wind speed in CNPS-Met dataset is at 10 m above ground level, which can be found in Table 2 and data description section (Lines 603-621) in the revised manuscript.

We agree that cut-in and cut-out wind speeds should correspond to hub height. In this study, when identifying cut-in and cut-out wind speed that are relevant to high-impact weather events, the wind speeds at 10 m are converted to 70 m using the empirical power law method, which can be expressed as:

$$u_2 = u_1 \left(\frac{h_2}{h_1} \right)^{\alpha} \quad (2)$$

where u_2 and u_1 represent wind speed at 70 m and 10 m, respectively; h_2 and h_1 represent the target height (70 m) and the reference height (10 m), respectively; α is a prescribed constant, taken as 0.14.

We have added the above descriptions to the "Data and methods" section, please see Lines 286-293 in the revision.

9. Clarity on CWI for "Heat and Humid Environment" (Lines 484-489, Fig. 10): The manuscript states that the intensity for this event is based on the CWI, which is dimensionless. However, the definition in Table 2 is simply a threshold. How does the CWI in Eq. 13 apply here? The specific variables (n) and their scaling need to be defined for the HHE event. This is currently unclear.

Re: The Heat and Humid Environment (HHE) is a bivariate composite extreme event, corresponding to the number of composite variables n= 2 in Eq. (14) of the revised manuscript. The variable thresholds listed in Table 2 are the prerequisite conditions for calculating the CWI. Only when both input variables simultaneously meet their respective threshold requirements is a non-zero CWI computed to quantify the strength of the HHE. If either variable fails to meet its threshold requirement, the CWI is set to 0, indicating that no HHE event occurred on that day. In other words, the threshold serves to determine whether an event occurs, while the CWI distinguishes the intensity of events that have occurred.

Minor Comments

1. Line 56: "Chapter 1 in Xin 2023" – It is unusual to cite a book chapter like this. Please provide a proper citation for the book.

Re: We have recited it in Line 56 in the revised manuscript.

2. Line 69: "It has at spatial resolution" – Should be "It has a spatial resolution".

Re: Revised, please see Line 71 in the revised manuscript.

3. Line 79: "699 ground-based observations" – Are these stations, or individual observation points? Please clarify.

Re: This is a typo, we have revised it as "699 ground-based meteorological stations" in the revised manuscript, please see Lines 80-81.

4. Line 121: "In cases of uneven observational coverage, however, the use of a fixed

radius... " – The sentence beginning here is a comma splice. Consider: "In cases of uneven observational coverage, however, the use of a fixed radius can introduce significant errors..."

Re: Revised, please see Line 123 in the revised manuscript.

5. Line 144: "meteorological stations are densely distributed" – This is redundant with Fig. 1a. Consider removing the text or referencing the figure more directly.

Re: Revised, please see Lines 143-145 in the revised manuscript.

6. Equation (6): The formatting of the piecewise function is not clear for me. Please confirm its expression.

Re: Thanks for your carefully review. The Eq. (6) has been revised as follows:

$$w_{ijk}=\begin{cases}\dfrac{R_c^2(i,j)-d_{ijk}^2}{R_c^2(i,j)+d_{ijk}^2}, & d_{ijk}\le R_c(i,j)\\ 0, & d_{ijk}>R_c(i,j)\end{cases} \tag{3}$$

where d_{ijk} represents the spatial distance between grid point (i, j) and observation at k^{th} ground-based station; $R_c(i,j)$ represents the influence radius. Please see Lines 214-216 in the revised manuscript.

7. Line 249: "referred as" – Should be "referred to as".

Re: Revised, please see Line 269 in the revised manuscript.

8. Figure 6 caption: "The concentric circles represent different datasets (from inner to outer: CN05.1, CMFD, CDMet and CNPS- Met." – The closing parenthesis is missing.

Re: Corrected, please see Line 462 in the revised manuscript.

9. Line 431: "Northern Tibet Plateau" – While commonly used, the standard geographic term is "Tibetan Plateau", thus, "Northern Tibetan Plateau" is acceptable.

Re: Revised throughout the manuscript.

10. Line 460: "relative weak" – Should be "relatively weak".

Re: Revised, please see Lines 503-504 in the revised manuscript.

11. Table 2: The table formatting is broken on pages 15 and 16. This is likely a PDF conversion issue, but ensure the final table is clean. Also, the "Impacts" column entries for extreme temperatures and ice accretion are fragmented and difficult to read. Please rewrite them as complete, coherent sentences.

Re: Thanks, we understand. Initially, we tried to place Table 2 in one page, however, this would cause the blank part occurred in the page, which is not allowed by the journal. Therefore, this issue is temporarily unavoidable, and we will further improve it during the later formatting by the editorial department.