We sincerely appreciate the reviewer's expert guidance on our manuscript. In response to all comments, we have meticulously implemented comprehensive revisions throughout the paper. The specific modifications are detailed as follows:

Blue text indicates the authors' point-by-point responses to each suggestion.

Blue text highlighted in yellow denotes sections of the original manuscript revised according to the reviewer's recommendations.

All modifications in the revised manuscript are highlighted in red text for clear identification.

The authors have successfully constructed and made publicly available the long-term, high spatiotemporal resolution global wind erosion dataset, filling a critical gap in the field. The manuscript is well-written, logically structured, scientifically sound in its methodology, and thorough in its validation. The results are reliable and the discussion is insightful. The public availability of this dataset will provide invaluable support for research in wind erosion, dust cycles, land degradation, and climate change. Suggested to be published after revisions. The following are the questions and some mistakes in this manuscript:

The introduction does not explicitly state the research objective of this manuscript.

The abstract highlights the novel "residue factor scheme based on growing season identification." To better prepare the reader, it would be beneficial to briefly mention this core improvement at the end of the introduction. This would frame it as the key solution to addressing the limitations of previous models in simulating wind erosion suppression during vegetated periods.

Responds: We thank the reviewer for this constructive suggestion. We agree that explicitly highlighting the residue factor scheme as the key methodological improvement at the end of the introduction helps to better prepare the reader. Accordingly, we have revised the last paragraph of the Introduction. We now state: "In particular, a key improvement of our method is the introduction of a growing–season–aware residue factor scheme, which dynamically adjusts the protection effect of vegetation cover and residue to better represent the suppression of wind erosion during vegetated periods." This change directly links the limitation of previous models (insufficient representation of vegetation–period suppression) to our proposed solution. We believe this improves the logical flow and frames the dataset's novelty more clearly.

Equation (5) assumes a constant threshold wind speed of 5 m/s. This is a critical parameter known to vary significantly with surface characteristics globally. Please provide a justification for this single value (e.g., citing key literature that supports this as a global average) or discuss the potential uncertainties introduced by this simplification.

Responds: We thank reviewer for raising this critical issue regarding the threshold wind speed assumption. We fully agree that this parameter is one of the most consequential simplifications in the RWEQ model chain, and we have taken this comment very seriously. Below we provide a detailed response addressing both the justification for our choice and the associated uncertainties.

1. Justification for the 5 m/s threshold

The 5 m/s threshold wind speed is not an arbitrary choice—it follows the original RWEQ formulation (Fryrear et al., 2000) and has been widely adopted in regional and global wind erosion assessments (e.g., Li et al., 2020; Yang et al., 2021; Sun et al., 2024). While we fully acknowledge that the actual threshold varies spatially with surface characteristics, the original RWEQ developers established 5 m/s as a representative value for general application after extensive field calibration. Using this value ensures consistency and comparability with the broader literature.

2. Sensitivity analysis

To quantify the uncertainty introduced by this assumption, we conducted a comprehensive sensitivity analysis by running the full model with threshold wind speeds set to 4.0, 4.5, 5.5, and 6.0 m/s (representing ±10% and ±20% variations from the default 5 m/s). We then compared the results against our baseline (5 m/s) from three perspectives: annual totals, regional patterns, and seasonal characteristics.

2.1 Impact on annual total wind erosion

The global annual total wind erosion varies by approximately -47% to +75% when the threshold wind speed varies from 6.0 to 4.0 m/s, with each ±10% change in threshold producing roughly ±25–30% change in global totals. This high sensitivity is expected given that the wind factor (wf) includes the cubic term.

2.2 Impact on regional patterns

The relative sensitivity varies across regions, with arid regions (e.g., Southern Africa, Australia, Arabian Peninsula) showing higher sensitivity (up to ~200% increase at 4 m/s), while regions with denser vegetation (e.g., East Africa, South Asia) show lower sensitivity. This regional heterogeneity reflects differences in wind speed distributions: regions where wind speeds more frequently exceed the threshold exhibit higher sensitivity to threshold changes.

2.3 Impact on seasonal patterns (WECP)

Importantly, the seasonal distribution of wind erosion, including the timing of the Wind Erosion Concentration Period (WECP) and the concentration ratios, remains remarkably stable across all threshold settings. For example, the concentration ratio in East Asia varies only from 45.74% to 48.98% across the full range of thresholds (4.0 to 6.0 m/s), and the peak timing remains unchanged. The same stability is observed across all other regions. This indicates that while the magnitude of wind erosion is sensitive to the threshold choice, the seasonal timing and inter-annual trends are robust.

3. Why did we not use spatially explicit threshold data?

We acknowledge that spatially explicit threshold wind speed datasets exist, which derived from dust emission occurrence observations(Pu et al., 2020). However, we chose not to adopt them in the current study for the following reasons:

First, these datasets are often derived under specific land surface conditions (e.g., existing vegetation cover and soil moisture). Directly applying them in the RWEQ framework would risk double-counting the suppressive effects of vegetation and soil surface conditions, since these factors are already represented by the COG (combined vegetation factor) and SCF (soil crust factor) in RWEQ.

Second, these threshold datasets typically contain extensive data gaps, particularly in sparsely monitored regions, making them unsuitable for global-scale, gap-free modeling.

Given these limitations, we consider the constant 5 m/s threshold, despite its simplification, the most appropriate choice for a globally consistent, gap-free dataset. This approach maintains methodological transparency and ensures comparability with existing RWEQ-based global studies.

4. Additions to the manuscript

To address reviewe’s concerns, we have added a dedicated sensitivity analysis section (including the results described above) that explicitly quantifies the uncertainty introduced by the threshold wind speed assumption from the perspectives of annual totals, regional patterns, and seasonal characteristics. Expanded to explicitly discuss the limitations of the constant threshold assumption and our rationale for not adopting spatially explicit threshold datasets as follow:

“This study made progress in global wind erosion assessment, but it still has several limitations, primarily stemming from data availability and simplifications in model parameterization. First, we acknowledge that threshold wind speed exhibits spatial heterogeneity depending on land use type, surface roughness, and topsoil conditions. Therefore, a comprehensive sensitivity analysis was conducted to assess the impact of the threshold wind speed (U_t) on our results. We ran the full model with U_t set to 4.0, 4.5, 5.5, and 6.0 m/s (representing ±10% and ±20% variations from the default 5 m/s) and compared the results against the baseline. The analysis examined three dimensions: annual totals, regional patterns, and seasonal characteristics. Globally, the annual total wind erosion varies by approximately -47% to +75% across the tested threshold range, with each ±10% change in Ut producing roughly ±25–30% change in global wind erosion. Regional sensitivity varies, with arid regions showing higher responsiveness (e.g., Southern Africa: up to ~220% at 4 m/s) and more humid regions showing lower sensitivity. This regional heterogeneity reflects differences in wind speed distributions that regions with more frequent near-threshold winds exhibit greater sensitivity. Critically, however, the seasonal distribution of wind erosion, including the timing of the WECP and concentration ratios, remains remarkably stable across all threshold settings. For example, the concentration ratio in East Asia varies only from 45.74% to 48.98% across the full range of thresholds, and peak timing remains unchanged across all regions. This indicates that while the magnitude of wind erosion is sensitive to the threshold choice, the seasonal timing and inter-annual trends are robust. While spatially explicit threshold datasets derived from dust emission observations exist, we chose not to adopt them in this study for three reasons. First, these datasets are often derived under specific land surface conditions (e.g., existing vegetation cover); directly applying them in RWEQ would risk double-counting the suppressive effects of vegetation and soil surface conditions, since these factors are already represented by the COG and soil factors. Second, these threshold datasets contain extensive data gaps, particularly in sparsely monitored regions, making them unsuitable for global-scale, gap-free modeling. Third, the observed threshold values themselves carry significant uncertainties due to differences in measurement methods and temporal scales. Given these limitations, the constant 5 m/s threshold, despite its simplification, represents the most appropriate choice for a globally consistent dataset.”

We believe these additions substantially strengthen the manuscript by providing a transparent, quantitative assessment of the single most consequential simplification in our modeling chain.

The use of a “50% threshold” to define growing season timing is stated. While a reference is provided, it would strengthen the methodology to briefly explain why this specific threshold was chosen and comment on its applicability across diverse global ecosystems (e.g., forests vs. grasslands).

Responds: We thank the reviewer for this valuable suggestion. We realize that our original description was ambiguous; we have now clarified that the 50% threshold is a relative threshold (i.e., 50% of the pixel’s annual maximum FVC), not an absolute FVC value.

The reasons for choosing this relative threshold are as follows:

1. Adaptability across ecosystems: Absolute FVC values vary enormously among biomes, dense forests can maintain FVC > 0.8 year round, whereas arid grasslands may never reach FVC > 0.2. A fixed absolute threshold (e.g., 0.5) would either never be met in drylands or would incorrectly indicate no growing season, while in forests it would be exceeded nearly permanently, losing seasonal information. The relative threshold (50% of annual maximum) normalizes these differences, allowing a consistent definition of “active growth period” across all vegetation types.

2. Robustness and simplicity: The 50% relative threshold is widely used in global phenology studies (Gu et al., 2022; Shi et al., 2025) because it balances sensitivity to green-up with resistance to noise, and it avoids subjective biome-specific tuning.

We have revised the Methods section accordingly. We believe this clarification addresses the reviewer’s concern and makes our methodology more transparent.

Equation (6) is used twice. Please renumber the subsequent equations to correct this.

Responds: We thank the reviewer for identifying this numbering error. We have corrected the equation numbering throughout Section 2.2.1 and adjusted all subsequent equation numbers accordingly. We believe this revision eliminates the duplication and ensures correct referencing throughout the manuscript.

The Wind Erosion Concentration Period (WECP) is defined as the peak period plus the five preceding and five subsequent periods (an ~88-day window). What is the basis for selecting this specific window size? Was a sensitivity analysis performed, or is it based on the typical duration of wind erosion events in key regions? A brief explanation would increase methodological transparency.

Responds: We thank the reviewer for this question regarding the methodological basis for selecting the 11-period window (peak ±5 periods, approximately 88 days) to define the Wind Erosion Concentration Period (WECP). We agree that the rationale for this window size should be made more transparent, and we have now added a brief explanation in Section 2.3.

To determine the appropriate window size, we conducted a series of sensitivity tests by varying the window extent from ±1 to ±10 periods around the peak. The selection of ±5 periods was based on the following considerations:

First, we found that when the window size was smaller than ±5 periods, the inter-annual identification of the concentration period was highly sensitive to the window size, with considerable fluctuations in the estimated concentration. Starting from ±5 periods, the inter-annual variability of the identified window began to stabilize, indicating that the window was sufficiently large to capture the main seasonal pulse of wind erosion.

Second, the ±5 window ensures that the wind erosion intensity during all periods within the concentration window exceeds the annual mean value. This provides a physically meaningful threshold—it guarantees that the identified concentration window genuinely represents a sustained period of elevated wind erosion activity rather than merely an arbitrary temporal aggregation.

Third, and most importantly, we found that expanding the window beyond ±6 periods would obscure the bimodal seasonal pattern observed in the Arabian Peninsula, where two distinct peaks occur during the year (as shown in Figure 5a).

Based on these sensitivity analyses, we selected the ±5 period window as the optimal balance: it is sufficiently wide to capture the main concentration period with stable inter-annual identification, yet narrow enough to preserve the distinctive bimodal structure in regions where two separate wind erosion seasons exist. We have added this justification in the revised manuscript to improve methodological transparency.

Table 1 shows some notable differences for specific regions (e.g., Mu Us Sandy Land, Mongolia). While differences in data sources are mentioned, could a more specific hypothesis be offered for these particular cases? For instance, does the higher spatial resolution of this study capture localized, high-erosion hotpots that coarser studies averaged out? A more targeted discussion would strengthen the analysis of the dataset's characteristics.

Responds: We thank the reviewer for this suggestion. We agree that providing a more specific hypothesis for the regional discrepancies would strengthen the discussion. However, we also acknowledge that, at present, we are only able to attribute these differences to the use of different input data sources and characterization choices, rather than to any single factor such as spatial resolution. A rigorous quantification of the contribution of each factor would require controlled sensitivity experiments using a consistent modeling framework, which is beyond the scope of this study. We have added a brief statement in Section 4.1 to explicitly acknowledge this limitation as follow:

"While we attribute the observed regional discrepancies primarily to differences in input data sources and parameterize choices, we acknowledge that we cannot quantify the contribution of each factor without controlled sensitivity experiments. This represents a limitation of the current comparison."

We believe this honest recognition of uncertainty will help users of the datasets interpret regional comparisons more cautiously.

The discussion on applications for climate models and policy is good but could be slightly expanded. A concrete example of how the 8-day data could be used to improve dust emission parameterizations in a global model, or how it could inform the timing of seasonal sand-fixing measures, would powerfully illustrate the dataset's practical utility.

Responds: We thank the reviewer for this constructive suggestion. We agree that concrete examples would better illustrate the dataset's practical utility. Following this advice, we have added examples in Section 4.2 as follow:

"From an application perspective, the 8-day resolution wind erosion assessment results provide a more detailed basis for decision-making in formulating timely and precise prevention and mitigation strategies. It enables decision-makers to identify short-term threat windows for wind erosion in specific areas, thereby optimizing farming management, adjusting the timing of vegetation restoration projects, or enhancing the targeting of dust storm warnings. For instance, the Wind Erosion Concentration Period (WECP) identified in Section 3.3 can pinpoint the onset and cessation of the high-erosion season in different regions, offering actionable guidance for scheduling seasonal sand-fixing measures (e.g., cover crops or straw checkerboards) in vulnerable areas such as northern China and Central Asia. Furthermore, the long-term, 8-day time series can be aggregated into a sub-seasonal climatology of wind erosion, which could serve as a reference for evaluating and calibrating dust emission schemes in global climate models—particularly their ability to reproduce the seasonal timing and intensity of dust events. These concrete applications highlight the dataset's value for both management-oriented and model-oriented users. This holds clear practical value for ecological protection and sustainable land management in wind erosion-active regions such as northern China and Central Asia."

Please improve English expression in the manuscript.

Responds: We thank the reviewer for this suggestion. We have carefully revised the entire manuscript to improve the clarity, conciseness, and overall readability of the English expression.

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