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.

This manuscript presents GloWE-8D, a global wind erosion dataset spanning 1982–2020 at 8-day temporal resolution and 0.05° spatial resolution, derived from the Revised Wind Erosion Equation (RWEQ). The topic is timely and the ambition to produce a long-term, high-spatiotemporal-resolution global wind erosion product is commendable. However, the manuscript has substantial deficiencies in uncertainty quantification that prevent it from meeting ESSD's standards for a data description paper

Minor Concerns

The claim that GloWE-8D is "the first publicly available long-term, high spatiotemporal resolution global wind erosion data product" should be more carefully substantiated, given that Chu et al. (2024), Sun et al. (2024), and Yang et al. (2021) are cited as closely related global products. A clearer differentiation in terms of temporal coverage, resolution, and open accessibility is warranted.

Responds: We thank the reviewer for this critical observation. We have carefully re-examined the three studies mentioned and revised our claim to more precisely reflect the unique contributions of GloWE-8D.

We acknowledge that Chu et al. (2024), Sun et al. (2024), and Yang et al. (2021) have indeed produced global wind erosion datasets using RWEQ. However, a closer comparison reveals clear distinctions:

Yang et al. (2021) covers only 2001–2010 and does not provide a publicly accessible dataset.

Sun et al. (2024) covers 1982–2019 at 0.1° spatial resolution, but its temporal resolution is half-month (not 8-day), and the dataset is not openly accessible.

Chu et al. (2024) covers 1980–2020 but uses a coarser 0.5°spatial resolution (after aggregating all inputs to the MERRA-2 grid); its temporal resolution is monthly (not 8-day), and the dataset is not publicly available.

In contrast, GloWE-8D offers 8-day temporal resolution, 0.05° spatial resolution, 39-year coverage (1982–2020), and open public access via Zenodo. No previous global wind erosion dataset combines all four features simultaneously.

We have revised the relevant statements in the Abstract and Conclusions to reflect this more precise differentiation. The revised claim now reads: "As the first publicly available long-term global wind erosion dateset with both 8-day temporal resolution and 0.05°spatial resolution.", which accurately represents its novelty without over claiming.

Major Concern: Inadequate Uncertainty Quantification

ESSD explicitly requires that data description papers provide transparent uncertainty assessment. This manuscript does not adequately fulfil this requirement. The RWEQ framework involves numerous parameters and input datasets, each carrying its own uncertainties, yet no systematic uncertainty analysis is presented. The following specific issues require attention:

1 Threshold Wind Speed

The universal threshold wind speed of 5 m/s is applied uniformly across all land surface types and geographic regions globally. The authors acknowledge in Section 4.3 that this parameter exhibits spatial heterogeneity depending on land use type, surface roughness, and topsoil conditions, yet no sensitivity analysis is provided to assess its impact on regional or global wind erosion estimates. Given that the threshold wind speed fundamentally controls whether erosion is initiated at all, this is arguably the single most consequential simplification in the entire model chain. Even a basic sensitivity test would substantially strengthen confidence in the dataset.

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 (Ut) on our results. We ran the full model with Ut 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.

2 Propagation of Input Data Uncertainties

The dataset integrates multiple input products — ERA5 meteorological reanalysis, GLASS FVC, GLC_FCS30D land use, SoilGrids soil properties, and Copernicus DEM — each carrying their own spatial and temporal uncertainties. No formal uncertainty propagation is attempted across these inputs. Furthermore, the temporal homogeneity of the 39-year record deserves scrutiny: ERA5 assimilates different observational data streams over time, and the GLC_FCS30D land use product has limited temporal resolution prior to 2000, with the authors using the temporally nearest available data as a substitute. These discontinuities could introduce spurious trends or step changes in the wind erosion time series that are artefacts of input data transitions rather than genuine environmental signals. The authors should address this risk explicitly, ideally by examining whether identifiable breakpoints in the time series coincide with known transitions in the input data record.

Responds: We thank the reviewer for this rigorous and constructive comment. We fully acknowledge that integrating multiple input datasets with heterogeneous uncertainties is a fundamental challenge in global-scale wind erosion modeling, and we appreciate the opportunity to address this issue explicitly.

We agree that a formal, full-chain uncertainty propagation would be the ideal approach. However, at the global scale and over a 39-year time frame, such an exercise faces two major practical obstacles: the lack of spatially explicit, temporally varying uncertainty estimates for most input datasets (e.g., SoilGrids provides only depth-wise uncertainties but no temporal dimension); and the computational cost of running thousands of perturbation simulations across 5 million pixels, 46 periods, 39 years would be prohibitive.

Instead, we adopted a pragmatic yet rigorous strategy: we directly examined the final output (wind erosion time series) for artificial breakpoints that could be traced back to input data transitions. This diagnostic approach directly addresses the reviewer's concern about spurious trends, without requiring a full uncertainty propagation that is currently infeasible at this scale.

Following the reviewer's suggestion, we applied the MK test to the annual wind erosion time series (1982–2020) for each 0.05°pixel globally.The results reveal that: the temporal distribution of breakpoint years shows no clustering around 2000 (the year when GLC_FCS30D transitions from temporally nearest data to annual products) or around major ERA5 assimilation system updates (e.g., 2004, 2010, 2015). Instead, breakpoints are scattered across the entire time series. Importantly, even in pixels where a breakpoint is detected, the overall trend direction (increasing/decreasing) remains unchanged before and after the breakpoint in more than 90% of cases, indicating that these shifts represent changes in the rate of erosion rather than reversals of trend direction. These findings strongly suggest that the long-term trends reported in our study are not artefacts of input data discontinuities, but rather reflect genuine environmental signals.

In addition, the reviewer correctly notes that GLC_FCS30D provides annual land cover maps only from 2000 onwards; for years before 2000, we used the temporally closest available data. We acknowledge this as a limitation. However, we argue that its impact on our wind erosion estimates is substantially limited for two reasons:

First, the dominant wind erosion areas, the Sahara, Arabian Peninsula, Central Asian deserts, and Australian outback, are predominantly natural barren lands or sparse vegetation, where land use transitions are minimal. Second, Land use data only affects the settings for our crop residue factor and has a limited impact on the total amount of wind erosion.

We have revised the Discussion section (Section 4.3) where we discuss the above considerations in detail. All modifications are marked in blue in the revised manuscript.

References

Chu, Z., Liu, M., Zhang, Q., Cai, X., Zhang, Y., Hu, T., Qiu, X., Huang, Z., and Wang, X.: Spatiotemporal distribution of global wind erosion over the past four decades, Environ. Res. Lett., 19, 114019, https://doi.org/10.1088/1748-9326/ad7d22, 2024.

Fryrear, D. W., Bilbro, J. D., Saleh, A., Schomberg, H., Stout, J. E., and Zobeck, T. M.: RWEQ: Improved wind erosion technology, Journal of Soil and Water Conservation, 55, 183–189, 2000.

Li, J., Ma, X., and Zhang, C.: Predicting the spatiotemporal variation in soil wind erosion across Central Asia in response to climate change in the 21st century, Science of The Total Environment, 709, 136060, https://doi.org/10.1016/j.scitotenv.2019.136060, 2020.

Pu, B., Ginoux, P., Guo, H., Hsu, N. C., Kimball, J., Marticorena, B., Malyshev, S., Naik, V., O’Neill, N. T., Pérez García-Pando, C., Paireau, J., Prospero, J. M., Shevliakova, E., and Zhao, M.: Retrieving the global distribution of the threshold of wind erosion from satellite data and implementing it into the Geophysical Fluid Dynamics Laboratory land–atmosphere model (GFDL AM4.0/LM4.0), Atmospheric Chem. Phys., 20, 55–81, https://doi.org/10.5194/acp-20-55-2020, 2020.

Sun, R., He, H., Jing, Y., Leng, S., Yang, G., Lü, Y., Borrelli, P., Chen, L., and Fu, B.: Global Wind Erosion Reduction Driven by Changing Climate and Land Use, Earth’s Future, 12, e2024EF004930, https://doi.org/10.1029/2024EF004930, 2024.

Yang, G., Sun, R., Jing, Y., Xiong, M., Li, J., and Chen, L.: Global assessment of wind erosion based on a spatially distributed RWEQ model, Progress in Physical Geography: Earth and Environment, 030913332110306, https://doi.org/10.1177/03091333211030608, 2021.