

Reviewer #1: *The topic is highly relevant and supports the projects to improve climatological data quality. This is important to understand studies on trends in climate associated to climate change. Attention is given to the movement of observing sites due to urbanization in connection to harmonisation of datasets. Less attention is given to global activities, under the governance of WMO, to improve harmonisation of climate datasets world wide although these activities are recommended in the conclusions. The examples provided give a good idea of the issues with harmonisation in practice, in particular for an immense area like China.*

[Response]

Thank you for your careful review of our manuscript " Impacts of anemometer changes, site relocations and processing methods on wind speed trends in China" and for the valuable feedback. We understand your concerns about substantial problems and have diligently worked to address the major points you raised.

We acknowledge your observation regarding the emphasis on the movement of observing sites due to urbanization and the harmonization of datasets. Your feedback has highlighted a gap in our discussion. We read more documents regarding those global activities to improve the harmonization of climate datasets under the governance of WMO and add more referees and discussions to the manuscript.

[Reviewer #1 Major comment 1]

Although to topic is clear and plenty references are provided, a reference to the WMO World Climate Programme (WCP) is missing, in particular to the World Climate Data and Monitoring Programme (WCDMP) (see <https://community.wmo.int/en/world-climate-programme-wcp>). Within this program a number of guides are published which are relevant to learn from, like WMO/TD- No. 1186; WCDMP- No. 53 (Guidelines on climate metadata and homogenization). Also the constraint to have appropriate metadata in order to classify the quality and ability to process data is not regarded.

[Response]

Thank you for your insightful feedback and recommendations. We acknowledge the oversight in not referencing the WMO World Climate Programme (WCP), particularly the World Climate Data and Monitoring Programme (WCDMP). We have now incorporated references to

the relevant guides, including WMO/TD- No. 1186 and WCDMP- No. 53 (Guidelines on climate metadata and homogenization), into our manuscript.

However, most of the metadata is not public, therefore we added emphasis of the importance of publishing metadata in the manuscript: “Also, it is hard for external researchers to provide a better solution without a collaboration with National Weather Services and the access to station data records and/or metadata. Therefore, we hope National Weather Services could improve the data quality based on these feedbacks and World Climate Data and Monitoring Programme’s guidances and complete the process by introducing an R package with open-source code on GitHub and publishing the metadata.” (Line 359-364 in the clean version of the revised manuscript)

[Reviewer #1 Major comment 2]

In the introduction (2nd all.) surface friction is mentioned, but in the paper no attention is given to the parameter terrain roughness as defined and explained in WMO-No. 8, Vol. I (Wind Chapter). Trends in roughness are an essential analyses critria when evaluation wind datasets.

[Response]

Thank you for your astute observation regarding the omission of terrain roughness in our paper, especially as it pertains to the guidelines set out in WMO-No. 8, “*Roughness around the measuring site has to be documented*” and “*any significant changes (growth of vegetation, new buildings) should be recorded in the station logbook, and dated*”. While we did mention surface friction in the introduction, we recognize that we did not delve into the specifics of terrain roughness in the subsequent sections.

In light of your feedback, we have expanded our discussion on this issue. While we acknowledge the limitations of our data, which lacks detailed roughness records, we have attempted to estimate roughness changes using satellite imagery. We added more discussion about this issue: “However, this estimation of roughness change based on satellite data is rough. A more proper way as required by the World Climate Data and Monitoring Programme is to record the change in the station logbook (WMO, 2021), which will provide more reliable information about the quality of the data. But most stations don’t have such a record.” (Line 233-237)

To further address this gap, we've incorporated a quantitative analysis using a global roughness model. We analyzed the roughness change for the sample station in Figure 3 using the method proposed by Chappell & Webb (2016). Our findings, presented in Supplementary Figure S4, corroborate our satellite-based estimations, indicating a significant increase in roughness between 2000 and 2010. This likely influenced the observed wind speed decline, prompting the station's relocation. We have added supplementary figure S4 and further explained this in the main text: “Despite the absence of mete data, we used an established global roughness model through satellite albedo observations to monitor alterations in surface roughness. For the selected station, we employed the roughness estimation technique devised by Chappell & Webb (2016) to analyze changes in roughness across a 5 km x 5 km area encompassing the station’s location. Our quantitative examination of roughness alterations aligns with the findings derived from satellite imagery analysis, affirming a pronounced increase in roughness between 2000 and 2010 (Supplementary Figure S4). This increase in roughness likely contributed to the observed decline in wind speed and ultimately compelled the relocation of the station.” (Line 237-245)

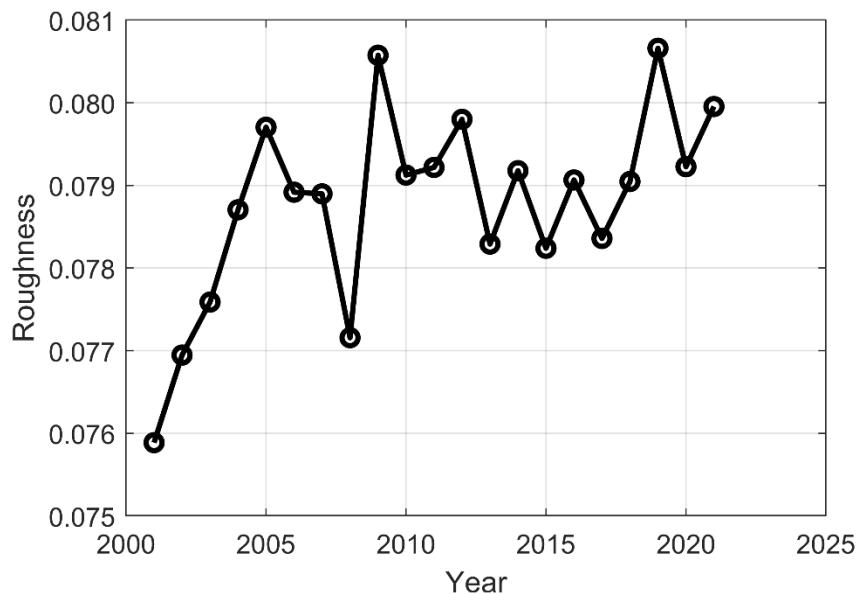


Figure S4. Surface roughness change around station 52974. The roughness is evaluated by u^*/U_h described in Chappell & Webb (2016).

Reference:

Chappell, A., & Webb, N. P. (2016). Using albedo to reform wind erosion modelling, mapping and monitoring. *Aeolian Research*, **23**, 63-78.

[Reviewer #1 Major comment 3]

The quality of wind data is associated with siting criteria, required functional specifications of wind sensors and their maintenance policy. These topics are not referred to, but relevant because trends in these items will affect data homogeneity.

[Response]

Thank you for highlighting the importance of siting criteria, functional specifications of wind sensors, and their maintenance policy in relation to the quality of wind data. In our manuscript, we did touch upon this point, mentioning: “**This change is potentially influenced by variations in measurement frequency, anemometer type, and data logging, as documented by Xin et al. (2012)**” (Line 163-165). However, we recognize the limitations posed by the lack of comprehensive and openly accessible records on siting criteria for many stations in China. While studies like that of Xin et al. (2012) have conducted field investigations and reviewed internal documents for some stations, the majority lack publicly available records. This absence of information undoubtedly impedes efforts to enhance data quality.

In light of your feedback, we have expanded our discussion in the manuscript to emphasize the significance of documenting siting criteria, wind sensor specifications, and maintenance policies. We added that specific information that should be included in the data to the manuscript: “**This example shows us the importance of recording siting criteria, required functional specifications of wind sensors and maintenance policy. However, those records are missing for most of the stations which hindered the quality classification and data processing.**” (Line 187-190)

[Reviewer #1 Miner comment 1]

[22] reference to the WMO World Climate Programme is missing

[Response]

We have added “**World Meteorological Organization (WMO) World Climate Programme guidelines**”. (Line 22)

[Reviewer #1 Miner comment 2]

[24] (~10m), to be 10 m [value and unit to be separated by a space]

[Response]

We have added the space.

[Reviewer #1 Miner comment 3]

[35] homogenization to become data homogenization.

[Response]

We have made the change accordingly.

[Reviewer #1 Miner comment 4]

[77] refer also to WMO World Climate Programme is missing, including policies on data homogenization.

[Response]

We have added reference to it: “**World Meteorological Organization (WMO) World Climate Programme**”.

[Reviewer #1 Miner comment 5]

[77] missing reference to WMO, 2003: WMO/TD - No. 1186; WCDMP - No. 53, Guidelines on Climate Metadata and Homogenization, https://library.wmo.int/doc_num.php?explnum_id=10751

[Response]

We have added this reference: “**World Meteorological Organization (WMO, 2003). Guidelines on Climate Metadata and Homogenization. WMO/TD - No. 1186; WCDMP - No. 53. https://library.wmo.int/doc_num.php?explnum_id=10751**”.

[Reviewer #1 Miner comment 6]

[90] Chosen is for the Thiessen Polygon approach (Thiessen, 1991), but explanation for this choice is not provided.

[Response]

We have added explanation: “However, given station distribution and wind speed spatial variation are often inhomogeneous with larger wind but fewer station in Northwest while smaller wind but more stations in Southeast (Feng et al., 2004; Fu et al., 2011; Liu et al., 2019), the wind variation in Northwest is underrepresented because of few stations. An improved average method (area weighted average) to rearrange the weight for each station based on the area it represents is needed and Thiessen Polygon (Thiessen, 1991) is widely used in which the area is only determined by the station locations while other method like grids is sensitive to the grids chosen.”

[Reviewer #1 Miner comment 7]

[115] 1.85km and $1.85*\cos\phi$ to become 1.85 km and $1.85 \times \cos \phi$ [the symbol " \times " should be used for multiplication, not "*"].

[Response]

We have edited them accordingly. (Line 119)

[Reviewer #1 Miner comment 8]

[146] for "the frequency of zeros", "zeros" should be defined (not trivial): Stans "zero" for no data or for no wind.

[Response]

We have added the definition: “zero wind speed”. (Line 150)

[Reviewer #1 Miner comment 9]

[151] "accuracy" stands for a subjective expression. For a quantitative use of accuracy the word "uncertainty" shall be used, not "accuracy".

[Response]

We have changed “increase in measure accuracy” to “decrease in measure uncertainty”. (Line 155)

[Reviewer #1 Miner comment 10]

[157] {see [151]}.

[Response]

We have deleted “accuracy”. (Line 161)

[Reviewer #1 Miner comment 11]

[159] missing: information on maintenance, functional specifications of wind sensor (including changes) and proven traceability to SI (calibration, see also WMO-No. 8). Also the required siting specifications are missing (including changes), see WMO-No. 8, Vol. I.

[Response]

We have expanded our discussion in the manuscript to underscore the significance of these details. We've added: “This example shows us the importance of recording siting criteria, required functional specifications of wind sensors and maintenance policy. However, those records are missing for most of the stations which hindered the quality classification and data processing.” (Line 187-190)

[Reviewer #1 Miner comment 12]

[183] missing: roughness data and their trend. Not determined? Are necessary to understand further analyses of data (see WMO-No. 8, Vol. I, Wind Chapter).

[Response]

We fully acknowledge the importance of documenting roughness around the measuring site. As stipulated in WMO-No. 8, significant changes, such as the growth of vegetation or the construction of new buildings, should indeed be recorded and dated in the station logbook. Regrettably, our dataset lacks this specific information.

We have resorted to satellite imagery to provide an approximate estimation of roughness changes, particularly noting an increase in roughness due to the construction of more buildings around the station. However, we recognize that this method offers only a rough estimation. We've expanded our discussion in the manuscript to emphasize this limitation: “Despite the absence of mete data, we used an established global roughness model through satellite albedo observations to monitor alterations in surface roughness. For the selected station, we employed the roughness estimation technique devised by Chappell & Webb (2016) to analyze changes in roughness across a 5 km x 5 km area encompassing the station’s location. Our quantitative examination of roughness alterations aligns with the findings derived from satellite imagery analysis, affirming a pronounced increase in roughness between 2000 and 2010 (Supplementary

Figure S4). This increase in roughness likely contributed to the observed decline in wind speed and ultimately compelled the relocation of the station.” (Line 237-245)

[Reviewer #1 Miner comment 13]

[320] sentence ends with a comma, not a dot.

[Response]

We have changed the comma with a dot. (Line 355)

[Reviewer #1 Miner comment 14]

[323] "lacked"; preference for "missing".

[Response]

We have replaced “lacked” with “missing”. (Line 358)

[Reviewer #1 Miner comment 15]

[328] Refrence to WMO Worls Climate Programme, in particular the World Climate Data and Monitoring Programme stimulating the proposed actions.

[Response]

We added the reference to the World Climate Data and Monitoring Programme: “**Therefore, we hope National Weather Services could improve the data quality based on these feedbacks and World Climate Data and Monitoring Programme’s guidances, and complete the process by introducing an R package with open-source code on GitHub and publishing the metadata**” (Line 361-364)

[Reviewer #1 Miner comment 16]

[476] Not a "WMO Technical Report", but a WMO Guide; to become WMO-No. 1203. Refrence to be replaced by principal source, https://library.wmo.int/doc_num.php?explnum_id=4166.

[Response]

We have edited the reference accordingly: “**World Meteorological Organization (WMO, 2017). WMO guidelines on the calculation of climate normals. WMO-No. 1203. https://library.wmo.int/doc_num.php?explnum_id=4166**” (Line 518-520)

[Reviewer #1 Miner comment 17]

[479] Not a "WMO Technical Report, but a WMO Guide; to become WMO-No. 1245..

[Response]

We have edited the reference accordingly. (Line 521-522)