Anonymous referee #3

Review for Characteristics of Aeolian sediments transported above a gobi surface, Preprint acp-2022-485

Thank you for coordinating the review of our paper. We have provided responses to review comments in the rest of this letter. We hope that our responses and the resulting changes will be acceptable, but we will be happy to work with you to resolve any remaining issues.

Detailed comments

General Comments:

The data collected is interesting, particularly given that such datasets are relatively scarce. However, there are multiple flaws in the application of the methodology and therefore in the results. Also, it is not clear whether the higher sand transport in this study compared to previous ones over shifting sands is just due to a different wind regime (higher wind speeds). In any case, there are not clear insights into the mechanisms that may cause the higher sand transport and the justification seems speculative.

Response:

The higher sand transport related to the both difference of higher wind velocity in the study region and non-erodible land surface above gobi surface (covered by gravel and soil crust).

We had expressed the difference of wind velocity in the study region in Line 314 as: For the abovementioned factors that control sediment transport above gobi surfaces, we conclude that both horizontal and vertical sediment transport above a gobi surface are controlled by wind velocity (Fig. 8). Because this result is similar to the result for a shifting sand surface, this means that the sediment transport mechanisms above a gobi surface are similar to those above a shifting sand (Kok et al., 2012). The sediment saltation height (z_s) was not related to wind velocity (Fig. 12b), which was also true for a shifting sand surface (Kok et al., 2012). However, the different sediment transport rates and saltation heights were caused by coverage of the gobi surface by gravel and a soil crust, which increased the rebound angle for saltating particles above the gobi surface, as Bagnold (1941) suggested.

The uncertainties associated with the measurements are not quantified, and therefore they not taken into account when assessing the results. For example, given that the paper attempts at providing insights into the size distribution, the information provided on the efficiency of the LDDSEG vertical segmented sediment sampler is notably insufficient. Does the 86 % refer to particle mass or number? What is the efficiency per particle size range? Does the efficiency change as a function of wind speed? Typically, passive samplers are much less efficient for small particle sizes. Given that the study also focuses on the dust "PM10" fraction, this aspect is critical, but nothing is discussed in that sense. Another example, is the rather crude derivation of the friction velocity based on only one measurement height.

Response:

This suggestion is similar as Anonymous referee #1. According to the suggestion of the Anonymous referee #1, we explained as following:

The LDDSEG sampler efficiency is calculated by mass using mixing sand in wind tunnel. The efficiency is referring to particle mass.

We did not calculate the effect of particle size effect on sampler's efficiency. This sampler can collect all mixed transported particle, so, we think that both dust and sand material can be collected simultaneous. This maybe a question, and we will study it in future.
The LDDSEG sampler efficiency is similar as most Aeolian sediment sampler, which related to wind velocity, the 86% is the mean value.
As the Anonymous referee #1 suggestions, we changed as grain size smaller than 10 µm transport, but PM10 concentration.
The friction velocity was calculated by wind profiles with five heights, please see Fig. 3.

What is PM10 in this paper? Is it the fraction derived from the Malvern analysis? If the "PM10" fraction is based on the Malvern analysis of the collected samples, how can we know the fraction of dust particles that were already airborne compared to those attached to other particles? I believe this is not possible.

Response:

As the Anonymous referee #1 suggestions, we changed as grain size smaller than 10 µm transport, but PM_{10} concentration. Please see the revised paper.

In eq 9. the gradient method to obtain the vertical dust flux relies on ambient dust concentrations (kg/m3) above the saltation layer. In your study you use c1 and c2 in kg /(m h) which are units of saltation flux at heights within the saltation layer. These units are wrong, and the units of F (vertical dust flux) are also wrong and inconsistent with your already incorrect "concentration" units. Throughout the paper the units of vertical flux are also expressed in kg /(m h) when in reality the vertical dust flux should be in Kg / (m2 h). In other words, you are expressing both concentrations and vertical fluxes with units of horizontal flux. There seems to be a certain lack of understanding of the vertical dust flux, which is defined throughout the paper with very different names (vertical sediment transport, vertical dust flux, vertical sand flux…). I believe that with your measurements you cannot obtain the vertical dust flux appropriately. You are measuring the horizontal fluxes in the saltation layer and at the same time, as mentioned in points 1 and 2 above, the PM10 fraction is likely very uncertain. This implies that the results in many figures (Figures 5, 6, 9 10) are incorrect and that the associated conclusions may be flawed.

Response:

We had edited as vertical sediment transport throughout the paper.

In the conclusions it is stated: "the characteristics of sand transport and the underlying mechanisms for gobi surfaces differed from those for sandy surfaces." However, the paper just concludes that the coefficients that best fit the equations are different than for sand surfaces and does not provide any insight into the mechanisms.

Response:

We had added following sentences in the text:

Specific comments:

Figure 1g mentioned in the caption is missing

Response:

According to the suggestion of the Anonymous referee #1, we had edited Fig. 1 as following:

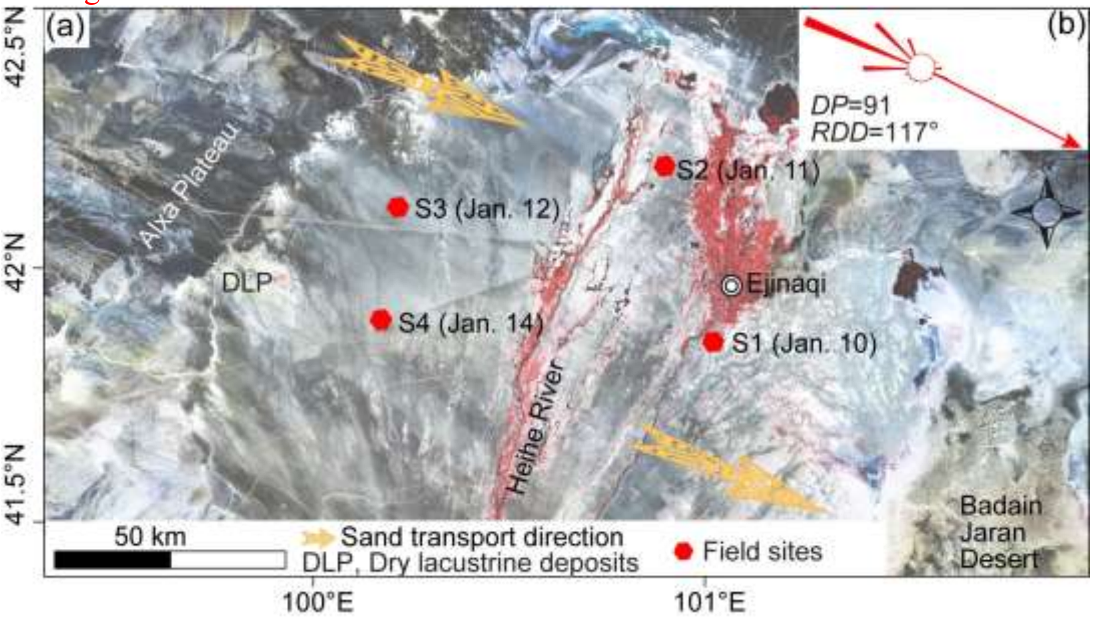

Figure 1 (a) Location of field experiment sites, (b) the potential sand transport (*DP*, drift potential; *RDD*, resultant drift direction). Field measurement layouts and samplers showed in Appendix A1.

Line 92: 7 or 8 periods?

Response:

We had edited 'seven' as 'four' for four-day field measurements.

In eq 1 R H and M are not specified. How these factors were calculated? How the final values in Table 4 were calculated?

Response:

We had calculated Eq (1) similar as our previous study (Zhang et al., 2021a), so we did not show the calculation process here. We had written this information in Line 122.

The detailed calculation process showed below.

In gravel deserts, gravels act as roughness elements to produce a sheltering effect on the surface, which effects the value of u_{*t}, and is accounted by the function R, which, according to Raupach (1992), is calculated following

$$R(\lambda) = \left[\frac{1}{(1-m\sigma\lambda)(1+m\beta\lambda)}\right]^{1/2}, \quad (3)$$

where $\beta=C_R/C_S$, with C_R being the drag coefficient for isolated roughness elements and C_S that for the underlying soil surface, and σ is the basal-to-frontal-area ratio of the roughness elements. Following Raupach et al. (1993), we set β = 90 and m = 0.5 in Eq. 3. The roughness (namely, gravel) frontal area index is defined as

$$\lambda = nbh/s, \tag{4}$$

where n is the number of gravel pebbles within the ground area s, and b and h are the typical gravel width and height, respectively. Supposing the gravel pebbles are cylinders, then $n\pi b^2/4s$ is the gravel coverage, and σ approx. b/h. Our observations show that h approx.5 mm (measured using a Vernier caliper) and b approx. 8 mm (varying between 4 and16 mm), giving σ = 1.6. Therefore, the frontal area index λ is calculated as

$$\lambda = 1.6 f_g, \tag{5}$$

with f_g being the gravel cover fraction.

We calculated H according to Fécan et al. (1999) as

$$H(w) = \begin{cases} \sqrt{1 + 1.21(w - w_t)^{0.68}} & , w > w_t \\ 1, & , \text{otherwise} \end{cases} \tag{6}$$

where w_r is a function of the soil clay content given by $w_r = 0.0014 f_c^2 + 0.17 f_c$, with f_c being the percentage of volumetric clay fraction, w is the gravimetric soil moisture for the top-most 0–2-cm soil layer (Fécan et al. 1999; Darmenova et al. 2009; Xi and Sokolik 2015). Gravel deserts in north-west China have little soil moisture. According to their field observations, Liu et al. (2011) found that the gravel desert soil moisture is approximately 0.03 % throughout the year, due to the very small amount of precipitation (< 100 mm per year). Therefore, we set w = 0.03 % for all gravel surfaces.

The enlargement function M is another important factor affecting the value of u_{*t} (Marticorena et al. 1997; Batt and Peabody 1999; Ishizuka et al. 2008). In earlier studies, as very limited data concerning the soil crust were available, the value of M was often set to 1 (Lu and Shao 2001). Sharratt and Vaddella (2014) found that the value of u_{*t} for a crusted soil surface increases exponentially with the clay content and soil crust thickness. Following the latter authors, the value of M is computed as

$$M = e^{0.026 f_c{}^n}, \tag{7}$$

where n is soil crust thickness in mm.

Line 122: Note that you do not infer the friction velocity threshold from observations, you calculate it based on an approximation, which is likely uncertain.

Response:

Yes, we calculated the threshold shear velocity by empirical method, however, as we know, at present, almost all Aeolian research had used empirical method to solve this problem.

Line 123: Why mean and not median diameter?

Response:

The most Aeolian sediment transport study used the mean grain size.

Table 5: 10^-3 instead of 10^3. Note that the differences in roughness are small (probably much smaller than the uncertainty in the method to derive the roughness length)

Response:

We had changed 10^3 as 10^{-3}, thanks.

Line 190… I do not understand the description of Figure 4a here. Are you really referring to Figure 4a?

Response:

Yes, it referred to Fig. 4a. Here, for the obvious difference of sand transport above and below threshold height, we used the ratios of the mean sediment transport above and below T_h (q_u/q_l, respectively) to express these differences.

Figure 6: you mention PM10 concentration but in reality, it is the fraction of PM10.

Response:

According to the suggestion of the Anonymous referee #1, we did not consider the PM_{10} concentration in the paper, but the grain size smaller than 10 µm, and we had changed all related content in the paper.

Thank you for your efforts to improve our manuscript. We hope that our responses and the resulting changes will be acceptable, but we will be happy to work with you to resolve any remaining issues.

Best regards,
Zhengcai Zhang and all coauthors