Effect of stone on sand saltation in Tsogt-Ovoo, Mongolia: Observation and Model simulation

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Non-erodible elements (i.e., pebble, stone, bedrock, vegetation, dead leaf) are key factors to control wind erosion. The non-erodible elements can protect the underlining surface by absorbing the wind momentum, thus increasing the threshold velocity for sand movement on the intervening surface (Tan et al., 2013). According to Haustein et al. (2015), however, all results of box models, which are 0-dimensional dust emission models installing schemes of Marticorena and Bergametti (1995), Shao (2004), and Alfero and Gomes (2001), overestimate the horizontal sand flux due to lack of consideration in the surface coverage by the non-erodible elements. This suggests current global and regional dust models don't consider the effects of them well. We will show observation and box models result of sand saltation at different land surface characteristics at Tsogt-Ovoo located in a northern part of the Gobi Desert, Mongolia.

An analysis of meteorological observatory data showed that the frequency of dust storms was the highest at Tsogt-Ovoo in East Asia (Kurosaki and Mikami, 2007). There is a topographic depression, whose sizes are about 10 km and 20 km in NE-SW and NW-SE directions, respectively. Such topography makes spatially different soil and land surface characteristics such as bedrock coverage, stone coverage, parent soil particle size and vegetation coverage. We made a measurement of sand saltation and wind speed at 7 sites during 31 April –5 May 2018. We installed ud-101 (Udo 2009; Sherman 2011) at 0.1 m height for sand saltation and anemometer (S-WSA-M003, Onset Company) at 1.7 m height at each site.

Our observation shows the sand saltation counts and threshold wind speed differs very much site-by-site due to differences in non-erodible elements like stone, dead leaf and soil crust. Even though wind speed is high, small counts of sand saltation were observed at Sub18A and Sub18C sites which are highly covered by bedrock and stone, whose coverages (hereafter, BSC) are 76.9% and 50.6%, respectively. Our sand saltation box model, which is based on Shao's dust emission scheme, also showed small sand flux under such high BSC like those sites. Big sand saltation counts were observed at Main and Sub14B sites, those stone coverages are 18.2 % and 17.6 %, respectively. The threshold wind speeds of sand flux with stone effect are similar with observation in the result of model. The observation and model simulations showed that BSC effect is a major controlling factor for sand saltation counts and flux for Sub18A, Sub18C, Main and Sub14B sites.
At Sub14A and Sub18D sites, even though stone coverages are small (2.1% and 6.4%, respectively), our observations show very small sand saltation counts even under strong wind conditions. These results suggest a hypothesis that other non-erodible elements such as standing dead leaves and soil crusts majorly suppress sand saltation, though we could find them by our eyes but we don't have their quantitative data. Our simulations show sand saltation fluxes increase with wind speed. One reason of it is the BSC effect doesn't work very much due to small stone coverages at sites. Another possible reason is effects of other non-erodible elements such as standing dead leaves and soil crusts are not installed in our model but they work very much in reality.

Keywords: Non-erodible elements, sand saltation, stone effect, box model

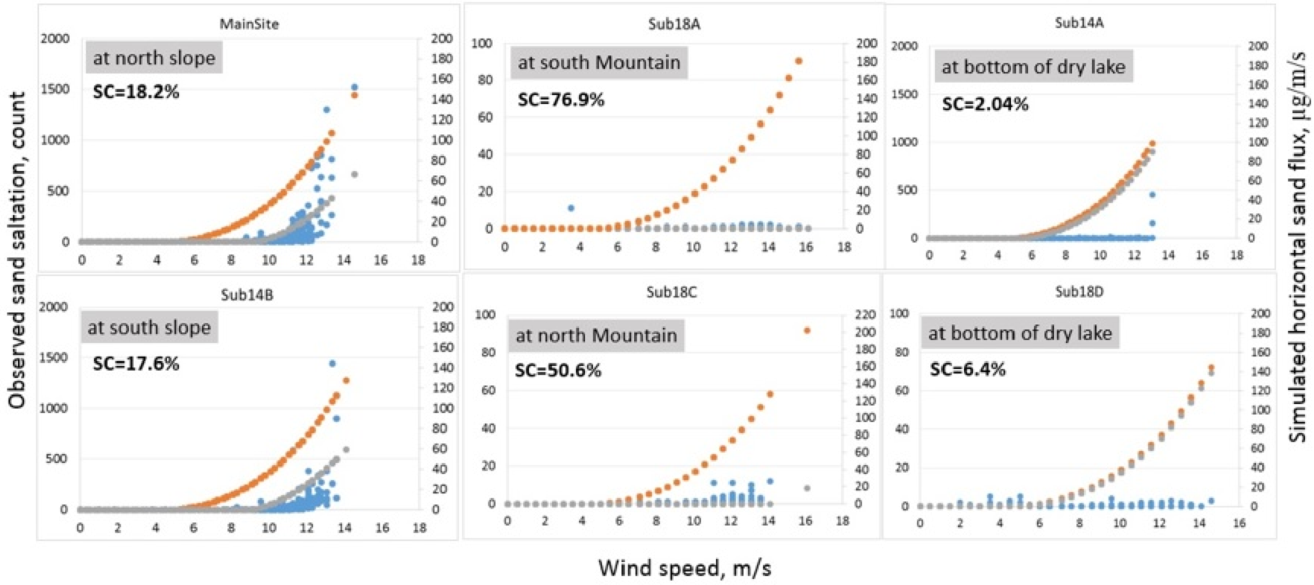

Fig. 1 Observed wind speed (x-axis) and observed sand saltation counts (left axis) (shown by blue dots) at sites which different stone coverage (SC) during the period of May 1-5, 2018 at Tsogt-Ovoo, Mongolia. Simulated wind speed (x-axis) and simulated sand fluxes (right axis) without BSC effect (BSC=0%) (orange dots) and same for with BSC effect (observed BSC value) (gray dots) for same sites and for same period.

