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Causes of recent increased aeolian dust productions over East Asia - An analysis using meteorological observatory data

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Production of aeolian dust (i.e., wind erosion) depends on aeolian erosivity and erodibility. The erosivity is an ability of wind to cause wind erosion, and it can be represented by one parameter, which is wind friction speed or simplistically wind speed. On the other hand, the erodibility is characterized as the sensitivity of a surface to wind erosion, which is influenced by an infinite number of soil and land surface characteristics, particularly the soil particle size distribution, soil water content, soil freeze/thaw processes, snow cover, vegetation coverage, vegetation type, and we do not clarify most relations between these parameters and erodibility. Even though all of these will be clarified, we will still have difficulties in monitoring the all erodibility factors. The above means monitoring erosivity is relatively easy but monitoring erodibility is difficult.

We can recognize the minimum wind speed initiating an dust production (hereafter, threshold wind speed) as an index of erodibility. Estimations of threshold wind speed have been conducted by a combination of anemometers and devices which measure instantaneous soil particles motions, such as SENSIT (Stout, 2004, Earth Surf. Processes Landforms) and SPC (Mikami et al., 2005, J. Geophys. Res.). However long-term erodibility monitoring by such devices in a broad area is not realistic due to problems of manpower and fund.

We can monitor a dust production in a broad area for a long term using synoptic data whose observation is made at meteorological observatories, which are widely distributed in the world. A meteorological observation is conducted at every 3-hour at many of synoptic observatories. A dust production is recorded in a present weather observation. Regarding erosivity, we have a wind speed observation. However, we have no observation of erodibility.

In this presentation, we will show a methodology of statistical estimate of threshold wind speed (Kurosaki et al., 2011, Geophys. Res. Lett.). We will show dust production frequency, strong wind frequency, and 5-percentile of threshold wind speed on April for 1990s (1990-1999) and 2000s (2000-2009) over East Asia, and we will discuss the contribution of erosivity and erodibility on changes in dust production from 1990s to 2000s from changes in strong wind frequency and 5-percentile of threshold wind speed. Here, a strong wind is defined as a wind whose wind speed exceeds 5-percentile of threshold wind speed on April for 1970-2009. We will also show analyses of precipitation for June?August (hereafter, summer precipitation) and annual maximum NDVI (Normalized Difference Vegetation Index) in order to examine dead-leaf hypothesis (Shinoda et al., 2010, SOLA). In this hypothesis, the precipitation amount during the vegetation growing season predominantly controls plant production in summer, the vegetation in summer remains as dead leaves until spring of the following year, and consequently the dead leaves chiefly control the erodibility in spring. Our main results are as below:

1. The dust production frequency increased at many observatories in Mongolia, Inner Mongolia, and northeastern China, whose land cover types are grassland and cultivated land, from the 1990s to the 2000s due to changes in erodibility.

2. We have some observatories where the dust production frequency increased for the period in the Gobi Desert in China and a western part of the Loess Plateau, whose land cover type is desert, due to changes in erosivity.

3. Both summer precipitation and annual maximum NDVI decreased at some observatories in Mongolia, but no such relationship is seen in other regions. This result suggests that the dead-leaf hypothesis can be applied to such observatories in Mongolia, but not to the other regions.

Keywords: aeolian dust, Asian dust, wind erosion, erosivity, erodibility