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Effects of coarse-textured soil potentially caused by wind erosion on water and nitrogen stresses, and plant production in Mongolian grasslands

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Wind erosion not only causes loss and redistribution of soil resource but also changes soil texture in the land-surface significantly. However, the mechanisms of how wind erosion changes soil texture and thereby affects plant production, have not fully been understood in wind-erosion regions, particularly in Mongolian grasslands (MGs). To examine these mechanisms occurring in the different types of MGs (steppe and desert steppe), we used an ecosystem model (DAYCENT) to simulate daily-based vegetation dynamics for these two areas during 2002-2011. We hypothesized a potential extreme scenario (the wind-eroded case) that wind erosion resulted in the topsoil (0-10 cm) with permanent loss of fine (clay) particles from the soil surface and coarse (sandy) particles that increased due to saltation or creep from the windward (99% sandy and 1% clay). As a result, the DAYCENT model simulated reasonably well the actual seasonal and interannual trends in vegetation compounds and soil moisture in the natural case. These results also showed that the effect of water stress on suppressing plant production was a few times larger than that of nitrogen stress at the steppe site, whereas water stress was predominant in inhibiting plant growth at the desert steppe site. As for the wind-eroded case, a significant decrease in plant production occurred due to water and/or nitrogen stresses. At both sites, water stresses primarily inhibited plant production. Conversely, plant production was enhanced for the wind-eroded case at the wetter steppe site mostly after precipitation due to the so-called “reverse texture effect” that the higher root-zone (10-30 cm depth) water, which is infiltrated from the top layer (0-10 cm), is maintained due to lower soil evaporation. In this case, nitrogen stress is the key player in controlling the plant production increase.