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Controls on the temporal variability of global dust emissions: the role of surface gustiness

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Mineral dust is known to alter climate by changing the earth's radiation budget, and influencing biogeochemical cycles and cloud characteristics. Dust also has an impact on human health. The inclusion of dust in climate models is clearly vital for the realistic simulation of past, present and future climates. Soon after the release of the satellite derived TOMS Aerosol Index, key dust source areas or hotspots were identified as topographic depressions in the world's drylands. This provided the key spatial constraint on global dust emissions and relates primarily to the availability of erodible material for dust production. In contrast, the temporal control from these hotspots has remained more elusive. Here we provide the first global observational evidence that the annual cycle of dust emissions from the hotspots is determined by an erosivity feature in the form of wind gustiness. Whereas most model simulations of dust have relied on the mean wind, we show that gustiness holds overwhelmingly more power in explaining the annual cycle of dust emissions from hotspots across the world's drylands. The spatial scales on which gustiness is generated is far smaller than that which can be explicitly resolved by climate models. Although the reanalysis wind gustiness data used here is on a fairly coarse scale and highly paramaterised, the degree of agreement with the timing of dust emissions in the annual cycle suggests that the dust cycle in global climate models can benefit from exploiting this parameter.