



What is the impact of Harmattan surges on desert dust emission in North Africa?

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Desert dust aerosols have important implications in the Earth system, but their emission amount has a large model uncertainty. Improving the most important meteorological processes for dust-emitting winds helps to reduce this uncertainty. However, the dominant meteorological mechanisms for the large dust emission during spring remain unclear. This time of year is characterized by mobile, long-lived cyclones and Harmattan surges which are capable to uplift dust aerosol for long-range atmospheric transport. Emission near to the centre of mobile, long-lived cyclones are associated with a small mass of dust emission over the northern Sahara in spring, despite their most frequent occurrence in this season. Harmattan surges are proposed to be more efficient in emitting dust aerosol in spring. These events manifest themselves as a postfrontal strengthening of near-surface winds with a continental impact on dust emission.

The present study shows the first long-term climatology of dust emission associated with Harmattan surges over North Africa. Using a newly-developed automated identification, Harmattan surges are statistically analysed in 32 years of ERA-Interim re-analysis from the European Centre for Medium-Range Weather Forecasts. The results show 34 events per year in the annual mean. Spring is herein the most active season with the largest mean number and duration of Harmattan surges, in contrast to summer with virtually no activity.

The offline dust emission model by Tegen et al (2002) is used to calculate emissions with ERA-Interim data. Combining these results with the Harmattan surges allows a first quantitative estimate of the associated emission mass. The results highlight that a fraction of 32 % of the total emission is associated with these events, annually and spatially averaged across North Africa. This amount exceeds the annual mean contribution of nocturnal low-level jets to dust emission, which is known as one of the most important drivers for North African dust emission. Regionally, the importance of Harmattan surges for emission is even larger with a contribution of up to 80 % of the emission mass in spring. These maximum contributions are found primarily along the northern fringes of the Sahara, where also the seasonal maxima in total emission and in event occurrence are found. The emission anomalies from Harmattan surges underline the unusually strong emission in March 2004 that has been widely discussed in previous works.

The present study underlines the importance of Harmattan surges for North African dust emission. This knowledge helps to prioritize recommendations for model development of meteorological processes for dust emission. The study has been funded by the European Research Council project "Desert Storms" of Prof Peter Knippertz.

Tegen, I., Harrison, S., Kohfeld, K., Prentice, I., Coe, M., and Heimann, M.: Impact of vegetation and preferential source areas on global dust aerosols: Results from a model study, *J. Geophys. Res.*, 107, 4576, doi: 10.1029/2001JD000963, 2002.