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Using a Parafoil Kite for Measurement of Variations in Particulate Matter—A Kite-Based Dust Profiling Approach

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Author(s)
Matthias Reiche, Roger Funk, Zhuodong Zhang, Carsten Hoffmann, Yong Li, Michael Sommer

ABSTRACT
This paper reports on the use of a kite-based system for measuring low-altitude particulate matter (PM) concentrations over grassland in Inner Mongolia. The motivation came from PM-concentration measurements at heights below 3 m over non-erodible surfaces which showed constant concentrations and made flux calculations relatively uncertain. One aim was the quantification of wind-driven matter fluxes across ecosystem boundaries, where the relevant layer can be assumed at heights below 100 m. Compared to other measurement techniques (e.g. LIDAR, towers and airborne systems) kite-based systems represent an inexpensive, highly flexible research tool which is well-suited for application in remote sites. The basis of the introduced system is a 4 m^2 Parafoil kite which has enough lifting capacity to carry equipment of about 6 kg at wind velocities between 3 ms^{-1} to nearly 20 ms^{-1}. A self-adjusting platform was constructed to balance moves and to carry a portable Environmental Dust Monitor (EDM), anemometer and a GPS receiver. So, all parameters necessary for a vertical profile of dust fluxes could be measured. In the first flights the applied kite-based dust profiling system (KIDS) was examined according to general technical application problems. Firstly, the influence of diverse surface characteristics, the flying condition and height-stability was tested. The result suggests that surface characteristics in general have a higher influence than the optimal wind velocity, which ranged from 9 ms^{-1} to 17 ms^{-1}. Secondly, uncertainties in the measured data were quantified and assessed. The uncertainties in wind velocity measurements due to motion in horizontal and vertical direction were not higher than 0.45% - 0.65% and 1.8% - 2.2% during the kite ascent. The outcome of the study illustrates the suitable application of KIDS for low-altitude measurements in remote sites.

KEYWORDS
Grassland; Wind Erosion; Particular Matter; PM_1; $PM_{2.5}$; PM_{10}; PM-Ratio

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