Use of simple passive methods for the assessment of the directional and vertical distributions of wind-blown particulates

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The near-surface vertical profile of the horizontal flux of soil particulates entrained by wind flow across the field has been studied by a number of authors using a variety of vertical array traps. Passive collectors are widely used in field experiments as they are inexpensive and require no power supply. Directional assessment provides useful information to identify local sources, combining the existence of specific dust sources and the wind directions around the study site; it is also complementary to airborne particulate concentration measurement.

We present the results obtained in the first campaign of the EroHondo project on the use of vertical arrays of two kinds of passive collectors. The Nature Park of El Hondo, in semi-arid SE Spain, suffers from desiccation-flooding annual cycles. The project aims to determine the horizontal flux of the sediment that lyes lying on the dry surface and its relation to suspended particle concentrations (see Orza et al., this conference, for an overview).

The first collector is a modified version of the Cox sand catcher, which features an omni-directional capture opening (1 cm height) where particles entering can impact on an inner cylinder. We have used stacked traps with openings at five heights. Particulate matter in each stage is gravimetrically quantified after a collection period of four weeks.

The second one is a sticky pad that allows for directional particulate assessment. Dust is collected on a 7 cm high transparent adhesive film fixed completely around a vertically mounted cylinder. Following exposure, the samples are scanned for later image analysis. Then we calculate dust levels from the scanned images by recording the position and size of individual coarse particles (greater than 20 μm). The presence or absence of dust in each pixel, as well as its colour, is recorded in addition. Collectors were mounted on masts at seven heights, sampling a combination of reptation, saltation and suspension over 48-hours.

These passive collectors have been previously tested in a number of sites with different vegetative coverage and affected by emissions coming from wind flow across the field and from vehicular traffic along a dusted paved road. They are described in Orza et al. (2009).

Aeolian erosion was registered by means of passive collectors at the two main measurement sites (where a number of instruments measure suspended particle concentrations) and in other 13 sites located in the main eroding area. Topsoil and saltating sediment samples were chemically analyzed for elemental composition and granulometry was determined with a Coulter Mastersizer LS200. Variations in the water sheet extension were followed during the whole study period.

The 2009 precipitation regime maintained high soil moisture levels that limited aeolian erosion. The mass collected into the sand catchers increased from month to month following the desiccation of the reservoirs. In turn, the contribution of raindrop splash to the amount of collected particles was higher than that of wind erosion.

The vertical profile of the mass collected by the omni-directional stacked collectors follows a negative exponential dependence with height ($r^2 > 0.99$). The profile associated to raindrop splash is also exponential, with coefficients following a logarithmic dependence on the accumulated precipitation. Sticky directional traps present more complex profiles, as in addition to saltation they include reptation and suspension contributions.

The proportion of particles in the range 0.7 - 15 μm in the collected sediments is higher than in the topsoil. Ca and Si are the major crustal elements; sediments are enriched in C (organic matter like plant debris and pollen), while present an impoverishment of NaCl with respect to the topsoil, where high concentrations are found in most of the sites.

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