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WIND EROSION CLIMATIC EROSIVITY

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Abstract

A physically based wind erosion climatic factor was developed:

$$Q/K = \sum_{i=t}^{n} [\rho(au_i)^2 - \gamma_i]^{3/2} f_i$$

where Q/K is climatic erosivity, ρ is air density, a is a constant combined of other constants (von Karman, height of windspeed observation, roughness parameter), u is horizontal windspeed, γ is cohesive resistance of water on the surface soil particles, and f is duration of ith observation. The expression is summed for all winds with greater than threshold speed. Both terms inside the parenthesis have units of force per unit area. The first term is the shear stress exerted by the air stream and can be evaluated from individual windspeed observations or windspeed distributions from accumulated data. The second term is based on an evaluation of Chepil that γ was proportional to equivalent water content squared. It also can be evaluated from wide-range time period or a suitable dryness index.

Based on soil hydraulic properties and climatic variables, we developed a model for determining surface soil dryness. Precipitation is distributed between runoff and infiltration (effective precipitation). The effective precipitation is added to the soil water--filling the soil profile to field capacity from the top down. Water is evaporated from the soil at the potential rate until the evaporation ratio of (evaporation based on moisture flow equation)/(potential evaporation) becomes less than unity. Then, evaporation is calculated by the moisture flow equation. Equivalent water content at the surface is assumed equal to 1.0 when evaporation ratio is 1.0 or greater and assumed equal to 0.1 when evaporation ratio is less than 0.1. When evaporation ratio is between 0.1 and 1.0, equivalent water content is assumed equal to evaporation ratio. The equivalent water content at the surface is used in calculating the cohesive resistance of surface soil particles to detachment from wind-induced surface shear stress.

We are still in the process of validating our model. Preliminary results show a linear relationship between calculated suspension flux from 9 dust storms and climatic erosivity with an r^2 of 0.89.

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