# A MONTHLY CLIMATIC FACTOR FOR THE WIND EROSION EQUATION

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THE wind erosion equation mathematically relates soil loss to five independent variables (*9*). It is used to calculate the erosion potential of a given field and to design erosion control practices by determining the different field conditions—cloddiness, roughness, vegetative cover, sheltering by wind barriers or width and orientation of the field—required to reduce potential soil loss to a tolerable amount under varying climatic conditions.

One independent variable in the equation is the climatic factor C′ which represents the influence of wind velocity and surface soil moisture on wind erosion. Chepil, Siddoway and Armbrust (*4*) devised a means of computing an annual factor and published a map in 1962 giving the general ranges of C′ values for the western half of the United States. Subsequent use of the annual factor in the wind erosion equation indicated the need for a short-term index to account for variations in wind velocity at different times of the year.

Now, a method of computing a monthly wind erosion climatic factor has been devised. Detailed maps have been prepared which indicate lines of equal wind erosion climatic factor for each month for areas of the United States where wind erosion is most severe, namely, the Great Plains, the Pacific Northwest, the Great Lakes and the Atlantic and Gulf Coast States. A portion of two of the 12 maps prepared are shown in figure 1. The maps are included in Agricultural Handbook 346, *Wind Erosion Forces in the United States and Their Use in Predicting Soil Loss.*

## Method of Evaluation

The annual climatic factor is calculated with the following equation:

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$$C_a' = 34.483 \frac{V_a^3}{(P\text{-}E)_a^2}$$

wherein $C_a'$ is the annual wind erosion climatic factor; $V_a$ is the average annual wind velocity; $(P\text{-}E)_a$ is the annual Thornthwaite precipitation-evaporation index (*8*); and 34.483 is a constant expressing the climatic factor as a percentage of the average annual value of $V^3/(P\text{-}E)^2$, for Garden City, Kansas. The Garden City value is used as a base to evaluate other factors in the wind erosion equation.

The equation was developed from research showing that soil movement varies directly as the cube of wind velocity (*1, 2, 10*) and inversely as approximately the square of effective surface soil moisture (*3*). Since detailed surface soil moisture data are not generally available for different geographic locations, the Thornthwaite precipitation-evaporation index was used as an indicator of soil moisture. Chepil and his coworkers used measured average annual wind velocities corrected to a 30-foot height in accordance with the Hellmann formula (*5*) for 145 of the 243 locations in their analyses. Wind records at the remaining 98 stations were inadequate, so velocities were estimated from projections based on records at the 145 stations.

To compute monthly climatic factors, the equation was modified to:

$$C_m = 34.483 \frac{V_m^3}{(P\text{-}E)_a^2}$$

wherein $C_m$ is the monthly wind erosion climatic factor, and $V_m$ is the average monthly wind velocity.

Monthly climatic factors were computed for 187 locations. Only measured and uncorrected average monthly wind velocities were used. Locations where wind flow might be obstructed by buildings or where all records were not complete were not used. The annual precipitation-evaporation index was used because monthly precipitation to evaporation ratios did not give meaningful monthly climatic factors. Furthermore, the Thornthwaite indexes were obviously not precise enough to evaluate soil moisture conditions for periods as short as 1 month.

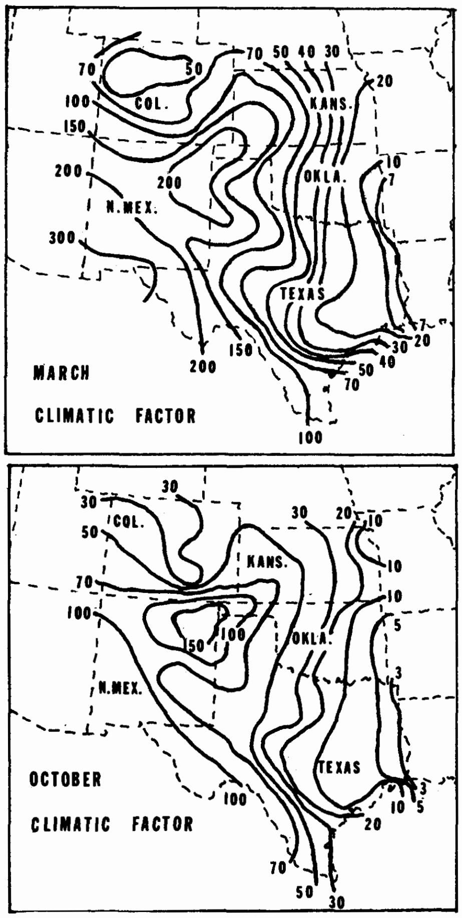


**Figure 1. Climatic factors for March and October, Southern Great Plains.**

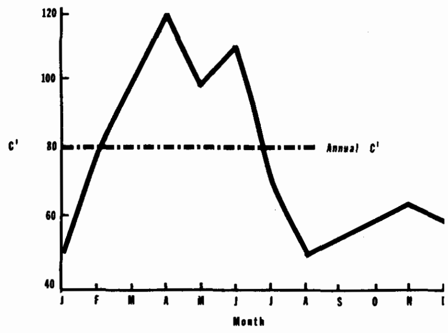


**Figure 2. Variation in monthly climatic factors during the year, Midland, Texas.**

## Significance of the Monthly Factor

Comparisions of annual and monthly climatic factors showed that the wind velocity differences strongly influence the climatic factor. The factor may vary from a small value, indicating low erosion potential, to a large value, indicating high erosion potential, during the year (Figure 2).

The importance of this variation and its influence in the wind erosion equation can best be shown by apply-

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ing the equation to a wind erosion problem. Assume a smooth, level field at Midland, Texas, with a 1,320-foot north-south width, 25 percent of the clods greater than 0.84 millimeter in diameter and 800 pounds of flattened wheat-stubble residue per acre. Also assume that we want to determine the erosion potential of the field based on the foregoing conditions, then determine how much residue would be required to reduce the erosion potential to a tolerable[1] 5 tons per acre per year.

Applying the techniques to account for prevailing wind direction and preponderance of wind erosion forces (*6, 7*) and solving the wind erosion equation by methods reported by Woodruff and Siddoway (*9*) produces the results shown in table 1.

## Recommend Use of Monthly Factors

Month to month variation in the climatic factor causes month to month variation in the erosion potential or residue requirements for wind erosion control even though soil, residue and roughness conditions remain constant throughout the year. Since different climatic factors significantly affect calculations with the wind erosion equation and use of the wrong factor could introduce substantial error in estimating erosion conditions and designing wind erosion control practices, climatic factors must be selected to reflect climatic conditions at the time the erosion hazard exists or is expected. The monthly climatic factors reflect the short-term condition better than the annual factors do. Therefore, use of the monthly factors is recommended in all applications of the wind erosion equation.

[1]What constitutes a tolerable loss depends on the crop, economic choice and soil reserves. Five tons per acre is an arbitrary value based on present knowledge of erosion effects.

**Table 1. Effect of climatic Factor C′ on erosion potential at Midland, Texas.**

| *Climatic Factor* | *Potential Erosion (tons/acre)* | *Residue Needed to Reduce Erosion to 5 Tons Per Acre Per Year (lbs./acre)* |
|---|---|---|
| 60 (October) | 18 | 1,250 |
| 80 (Annual) | 26 | 1,450 |
| 100 (March) | 36 | 1,600 |


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