



# Coastal Engineering

## Technical Note



### COMPUTER PROGRAM: WIND (MACE-5) ADJUSTED WINDSPEED FOR WAVE FORECASTING

PROGRAM PURPOSE: This program (version 4-85) takes observed windspeeds, the observation elevation, the location of the observation (over water or over land), the method of windspeed description (fastest mile or a time-averaged speed), the fetch distance, and general knowledge of the condition of the atmospheric boundary layer and calculates the adjusted windspeed or wind stress factor  $U_A$  suitable for wave forecasting using the curves or equations presented in the Shore Protection Manual (SPM) (1984) and ETL 1110-2-305 (Headquarters, Department of the Army 1983).

PROGRAM CAPABILITY: This program is written in Microsoft BASIC and is designed as a stand alone program to be used in conjunction with deepwater or shallow-water wave forecasting procedures. The program uses English, metric, or nautical units or a combination of these units.

PROGRAM APPLICATION: The SPM and ETL 1110-2-305 discuss the need and recommended procedure for adjusting windspeeds, measured at an arbitrary location on or near an open water area of interest, to estimate wind conditions on the water which would affect the growth of waves. The micro-computer program "WIND" performs the adjustments cited below.

1. The observed windspeed  $U_z$  is adjusted from a given elevation  $z$  to estimate the corresponding windspeed at 10 m above the water  $U_{10}$ . The elevations of the measured wind should be input with reference to the ground or the water level of interest, depending on whether the anemometer is located over land or water (SPM 1984). The relation applied between  $U_{10}$  and  $U_z$  is

$$U_{10} = U_z(10/z)^{1/7}$$

where  $z$  is in meters. The program converts English units to metric when necessary and checks to be sure  $z$  is less than 20 m (the maximum correction for the above relation).

2. The velocity  $U_{10}$  is further adjusted to estimate the corresponding average hourly velocity  $U_{1hr}$  represented by a measurement of shorter duration (fastest mile or average of a few minutes). The adjustment is (SPM 1984) when  $t < 3,600$  sec:

$$U_{1hr} = U_t / [1.277 + 0.296 \tanh(0.9 \log_{10}(45/t))]$$

where  $U_t$  = average velocity measured over time  $t$  and when  $3,600 \text{ sec} < t < 36,000 \text{ sec}$ :

$$U_{1hr} = U_t / [-0.15 \log_{10}(t) + 1.5334]$$

3. The 10-m, 1-hr average windspeed is adjusted to reflect over-water conditions according to the methods presented in the SPM (1984).

4. A further adjustment is made, according to methods presented in the SPM, to account for the effect of air-sea temperature differences on the stability of the atmospheric boundary layer.

5. The 10-m, 1-hr average over-water stability-adjusted windspeed is optionally corrected to become a wind stress factor, reflecting the non-constant coefficient of drag, according to the methods presented in the SPM. This adjustment has been incorporated into the curves presented in ETL 1110-2-305 and is not necessary if these curves are used.

PROGRAM AVAILABILITY: The program is available for the IBM PC on a 5-1/4-in. diskette or as a printed program listing and may be obtained from Ms. Rosemary Peck at (601) 634-2581 Engineering Computer Programs Library Section, Technical Information Center, US Army Engineer Waterways Experiment Station, PO Box 631, Vicksburg, MS 39180-0631. Questions concerning the applications of WIND can be directed to \_\_\_\_\_ or Mr. Doyle L. Jones at (601) 634-2023 \_\_\_\_\_, both of the Coastal Design Branch, CERC.

INPUT:

1. Observed windspeed
2. Level above ground or water surface
3. Location of windspeed observation (over land or water)
4. Method of windspeed description
5. Fetch distance
6. General knowledge of the condition of the atmospheric boundary layer.

OUTPUT: The adjusted windspeed or wind stress factor.

SAMPLE PROBLEM: The 5-min average windspeed is 55 mph measured over land. This windspeed was measured 15 m above ground level. The fetch distance is 15 miles, and the condition of the boundary layer is unstable. What is the wind stress factor?

RUN  
ADJUSTED WINDSPEED FOR WAVE FORECASTING  
VERSION 4-85  
USE UPPER CASE LETTERS FOR ALL RESPONSES

PRESS ANY KEY TO CONTINUE

UNITS OF DISTANCE ABOVE SURFACE (F)EET OR (M)ETERS ? M  
DISTANCE ABOVE SURFACE ? 15

WINDSPEED UNITS  
E-MILES/HOUR  
M-METERS/SECOND  
N-KNOTS

WHICH UNIT ? E  
INPUT WINDSPEED AT 15 METERS ABOVE SURFACE ? 55

WINDSPEED MEASUREMENT DESCRIPTION  
(F) FASTEST MILE  
(T) TIME-AVERAGED SPEED

WHICH METHOD ? T  
WHAT IS NUMBER OF MINUTES OF WIND OBSERVATION ? 5

UNITS OF FETCH DISTANCE  
M-MILES  
F-FEET  
N-NAUTICAL MILES  
K-KILOMETERS

UNITS ? M

OVERWATER FETCH DISTANCE ? 15

WINDSPEED OBSERVED OVER WATER OR OVER LAND (W OR L)  
ANSWER 'W' FOR ANEMOMETER LOCATED AT SHORELINE ? L  
FOR AN ANEMOMETER LOCATED NEAR SHORE, THIS ADJUSTMENT MAY  
GIVE CONSERVATIVE ESTIMATES

ADJUST THE WINDSPEED TO ACCOUNT FOR A NON-CONSTANT COEFFICIENT OF DRAG (Y OR N) ? Y  
IS TEMPERATURE DIFFERENCE KNOWN (Y OR N) ? N

S-STABLE CONDITIONS-AIR WARMER THAN WATER  
N-NEUTRAL STABILITY-AIR AND WATER AT SAME TEMPERATURE  
U-UNKNOWN CONDITIONS OR AIR COLDER THAN WATER

ENTER S, N OR U FOR CONDITIONS ? U

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UNADJUSTED WIND SPEED = 55.0 MILES/HOUR  
DISTANCE ABOVE SURFACE = 15.0 M = 49.2 FT  
FETCH = 15.0 STAT MILES = 13.8 NAUT MILES  
TIME-AVERAGED SPEED  
WINDSPEED OBSERVED OVERLAND  
BOUNDARY LAYER CONDITIONS :  
UNKNOWN CONDITIONS OR AIR COLDER THAN WATER

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WIND STRESS FACTOR = 65.9 MILES/HOUR (1 HOUR AVERAGE)

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REFERENCES:

Shore Protection Manual. 1984. 4th ed., 2 vols, US Army Engineer Waterways Experiment Station, Coastal Engineering Research Center, US Government Printing Office, Washington, DC.

Headquarters, Department of the Army. 1983. "Determining Sheltered Water Wave Characteristics," Engineer Technical Letter 1110-2-305, Office of the Chief of Engineers, Washington, DC.