



Estimating Marine and Coastal Winds Formulas

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Examples!

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List of 28 Estimating Marine and Coastal Winds Formulas

Estimating Marine and Coastal Winds

Measured Wind Directions

1) Ambient Pressure at Periphery of Storm

$$\mathbf{p}_{\mathrm{n}} = \left(rac{\mathrm{p} - \mathrm{p}_{\mathrm{c}}}{\mathrm{exp}(-rac{\mathrm{A}}{\mathrm{p}})}
ight) + \mathrm{p}_{\mathrm{c}}$$

Open Calculator 🗗

$$egin{aligned} egin{aligned} egin{aligned} egin{aligned} 975 ext{mbar} & = \left(rac{975 ext{mbar} - 965 ext{mbar}}{ ext{exp} \left(-rac{50 ext{m}}{\left(48 ext{m}
ight)^5}
ight)}
ight) + 965 ext{mbar} \end{aligned}$$

2) Characteristic Wave Height given Dimensionless Wave Height

$$\mathbf{H} = rac{\mathrm{H'}\cdot\mathrm{V}_\mathrm{f}^2}{[\mathrm{g}]}$$

Open Calculator

$$extbf{ex} 110.1294 ext{m} = rac{30 \cdot (6 ext{m/s})^2}{ ext{[g]}}$$



3) Cyclostrophic Approximation to Wind Speed

$$\textbf{FE} \boxed{ U_c = \left(A \cdot B \cdot (p_n - p_c) \cdot \frac{exp\left(-\frac{A}{r^B}\right)}{\rho \cdot r^B} \right)^{0.5} }$$

Open Calculator 🗗

ex

$$oxed{0.027408 = \left(50 ext{m} \cdot 5 \cdot \left(974.90 ext{mbar} - 965 ext{mbar}
ight) \cdot rac{ ext{exp}\left(-rac{50 ext{m}}{\left(48 ext{m}
ight)^5}
ight)}{1.293 ext{kg/m}^3 \cdot \left(48 ext{m}
ight)^5}
ight)^{0.5}}$$

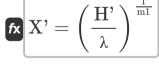
4) Dimensionless Fetch



Open Calculator 🗗

$$oxed{4.086104} = \left([\mathrm{g}] \cdot rac{15\mathrm{m}}{\left(6\mathrm{m/s}
ight)^2}
ight)$$

5) Dimensionless Fetch given Fetch-limited Dimensionless Wave Height

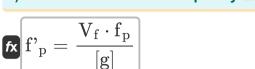


Open Calculator

$$= 2.330127 = \left(\frac{30}{1.6}\right)^{\frac{1}{2}}$$



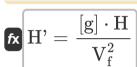
6) Dimensionless Wave Frequency



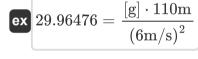
Open Calculator

$$7.953786 = rac{6 ext{m/s} \cdot 13 ext{Hz}}{[ext{g}]}$$

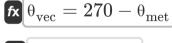
7) Dimensionless Wave Height



Open Calculator



8) Direction in Cartesian Coordinate System 🗗



Open Calculator G

| = 180 = 270 - 90 |

9) Direction in Standard Meteorological Terms fx $heta_{ m met} = 270 - heta_{ m vec}$



Open Calculator

|90| = 270 - 180



10) Distance from Center of Storm Circulation to Location of Maximum Wind Speed

 $m R_{max} = A^{rac{1}{B}}$

Open Calculator

 $\mathbf{ex} \ 2.186724 \mathrm{m} = (50 \mathrm{m})^{\frac{1}{5}}$

11) Fetch-Limited Dimensionless Wave Height

fx $H' = \lambda \cdot \left(X'^{\mathrm{m1}}\right)$

Open Calculator

 $\mathbf{ex} \left[29.584 = 1.6 \cdot \left(\left(4.3
ight)^2
ight)
ight]$

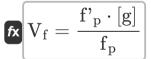
12) Frequency of Spectral Peak for Dimensionless Wave Frequency

 $\left|\mathbf{f_p} = rac{\mathbf{f'_p \cdot [g]}}{V_f}
ight|$

Open Calculator 🗗

= $13.07553 ext{Hz} = rac{8 \cdot [ext{g}]}{6 ext{m/s}}$

13) Friction Velocity for Dimensionless Wave Frequency



Open Calculator

 $= 6.034862 ext{m/s} = rac{8 \cdot [ext{g}]}{13 ext{Hz}}$



14) Friction Velocity given Dimensionless Fetch

 $V_{\mathrm{f}} = \sqrt{[\mathrm{g}] \cdot rac{\mathrm{X}}{\mathrm{X}'}}$

Open Calculator

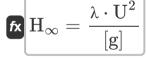
= $5.848867 ext{m/s} = \sqrt{[ext{g}] \cdot rac{15 ext{m}}{4.3}}$

15) Friction Velocity given Dimensionless Wave Height

 $V_{
m f} = \sqrt{rac{[{
m g}] \cdot {
m H}}{{
m H}'}}$

Open Calculator

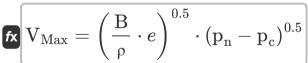
16) Fully Developed Wave Height



Open Calculator

 $\mathbf{ex} = 2.610474 \mathrm{m} = \frac{1.6 \cdot (4 \mathrm{m/s})^2}{[\mathrm{g}]}$

17) Maximum Velocity in Storm 🗗



Open Calculator 🗗

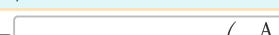
 $= \left(\frac{5}{1.293 \text{kg/m}^3} \cdot e\right)^{0.5} \cdot (974.90 \text{mbar} - 965 \text{mbar})^{0.5}$







18) Pressure Profile in Hurricane Winds 🗗



Open Calculator

Open Calculator G

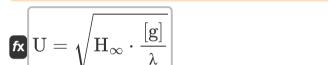
Open Calculator

Open Calculator

$$p = p_c + (p_n - p_c) \cdot \exp\left(-rac{A}{r^B}
ight)$$

$$\boxed{ 974.9 \text{mbar} = 965 \text{mbar} + (974.90 \text{mbar} - 965 \text{mbar}) \cdot \exp \left(-\frac{50 \text{m}}{\left(48 \text{m} \right)^5} \right) }$$

19) Wind Speed given Fully Developed Wave Height G



 $\left| \frac{1}{2} \right| = \sqrt{2.6 \mathrm{m} \cdot \frac{\mathrm{[g]}}{1.2}}$

Wave Hindcasting and Forecasting

20) Drag Coefficient for Wind Speed at 10m Elevation

 $|\mathbf{K}| \, \mathrm{C_D} = 0.001 \cdot (1.1 + (0.035 \cdot \mathrm{V_{10}}))$

 $0.00187 = 0.001 \cdot (1.1 + (0.035 \cdot 22 \text{m/s}))$

21) Limiting Wave Period

$$T_{
m p} = 9.78 \cdot \left(\left(rac{{
m D_w}}{{
m [g]}}
ight)^{0.5}
ight)$$

$$\boxed{20.95004\mathrm{s} = 9.78 \cdot \left(\left(\frac{45\mathrm{m}}{[\mathrm{g}]} \right)^{0.5} \right)}$$



22) Spectral Energy Density

 $\mathbf{E}_{(\mathrm{f})} = rac{\lambda \cdot \left(\left[\mathrm{g}
ight]^2
ight) \cdot \left(\mathrm{f}^{-5}
ight)}{\left(2 \cdot \pi
ight)^4}$

Open Calculator

Open Calculator

 $\boxed{ \begin{array}{c} \textbf{ex} \\ 0.003085 = \\ \hline \\ \hline \\ \left(2 \cdot \pi\right)^4 \end{array} }$

23) Spectral Energy Density or Classical Moskowitz Spectrum

fx $\mathrm{E}_{(\mathrm{f})} = \left(rac{\lambda \cdot \left(\left[\mathrm{g}
ight]^2
ight) \cdot \left(\mathrm{f}^{-5}
ight)}{\left(2 \cdot \pi
ight)^4}
ight) \cdot \exp{\left(0.74 \cdot \left(rac{\mathrm{f}}{\mathrm{f}_\mathrm{u}}
ight)^{-4}
ight)}$

 $= \left(\frac{1.6 \cdot \left([\mathrm{g}]^2 \right) \cdot \left((2)^{-5} \right)}{\left(2 \cdot \pi \right)^4} \right) \cdot \exp \left(0.74 \cdot \left(\frac{2}{0.0001} \right)^{-4} \right)$

24) Straight-Line Distance given Time required for Waves Crossing Fetch under Wind Velocity

 $\mathbf{x} = \left(rac{\mathbf{t}_{\mathrm{x,u}} \cdot \mathbf{U}^{0.34} \cdot [\mathbf{g}]^{0.33}}{77.23}
ight)^{rac{\overline{0.67}}{0.67}}$

Open Calculator

 $= \left(\frac{140 \cdot (4 \text{m/s})^{0.34} \cdot [\text{g}]^{0.33}}{77.23}\right)^{\frac{0.67}{0.67}}$





25) Straight-Line Distance over which Wind Blows

 $\mathbf{x} = \left(rac{V_{\mathrm{f}}^2}{[\mathrm{g}]}
ight) \cdot 5.23 \cdot 10^{-3} \cdot \left([\mathrm{g}] \cdot rac{\mathrm{t}}{V_{\mathrm{f}}}
ight)^{rac{3}{2}}$

Open Calculator 🗗

 $\boxed{ 14.99991 m = \left(\frac{\left(6m/s \right)^2}{[g]} \right) \cdot 5.23 \cdot 10^{-3} \cdot \left([g] \cdot \frac{51.9s}{6m/s} \right)^{\frac{3}{2}} }$

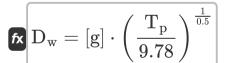
26) Time required for Waves Crossing Fetch under Wind Velocity to become Fetch Limited

 \mathbf{fx} $\mathbf{t}_{\mathrm{x,u}} = 77.23 \cdot \left(rac{\mathbf{X}^{0.67}}{\mathbf{U}^{0.34} \cdot [\mathrm{g}]^{0.33}}
ight)$

Open Calculator

 $\boxed{ 139.2724 \mathrm{s} = 77.23 \cdot \left(\frac{\left(15 \mathrm{m}\right)^{0.67}}{\left(4 \mathrm{m/s}\right)^{0.34} \cdot \left[\mathrm{g}\right]^{0.33}} \right) }$

27) Water Depth for given Limiting Wave Period



 $ext{ex} \ 45.2149 ext{m} = [ext{g}] \cdot \left(rac{21 ext{s}}{9.78}
ight)^{rac{1}{0.5}}$



28) Wind Speed given Time required for Waves crossing Fetch under Wind Velocity

 $\mathbf{E} \left[\mathbf{U} = \left(rac{77.23 \cdot \mathbf{X}^{0.67}}{\mathbf{t}_{\mathrm{x,u}} \cdot [\mathrm{g}]^{0.33}}
ight)^{rac{1}{0.34}}
ight]$

Open Calculator

$$= \left(\frac{77.23 \cdot (15\text{m})^{0.67}}{140\text{s} \cdot [\text{g}]^{0.33}} \right)^{\frac{1}{0.34}}$$



Variables Used

- A Scaling Parameter (Meter)
- B Parameter Controlling Peakedness
- C_D Drag Coefficient
- **D**_w Water Depth from Bed (Meter)
- E_(f) Spectral Energy Density
- f Coriolis Frequency
- f_p Frequency at Spectral Peak (Hertz)
- f'_p Dimensionless Wave Frequency
- **f**₁₁ Limiting Frequency
- **H** Characteristic Wave Height (Meter)
- H' Dimensionless Wave Height
- **H**_∞ Fully Developed Wave Height (*Meter*)
- m1 Dimensionless Exponent
- p Pressure at Radius (Millibar)
- pc Central Pressure in Storm (Millibar)
- p_n Ambient Pressure at Periphery of Storm (Millibar)
- r Arbitrary Radius (Meter)
- R_{max} Distance from Center of Storm Circulation (Meter)
- t Wind Duration (Second)
- T_p Limiting Wave Period (Second)
- $t_{x,u}$ Time required for Waves crossing Fetch (Second)
- **U** Wind Speed (Meter per Second)
- U_c Cyclostrophic Approximation to Wind Speed





- V₁₀ Wind Speed at Height of 10 m (Meter per Second)
- **V**_f Friction Velocity (Meter per Second)
- **V**_{Max} Maximum Velocity of Wind (Meter per Second)
- X Straight Line Distance over which Wind Blows (Meter)
- X' Dimensionless Fetch
- θ_{met} Direction in Standard Meteorological Terms
- θ_{vec} Direction in Cartesian Coordinate system
- λ Dimensionless Constant
- p Density of Air (Kilogram per Cubic Meter)





Constants, Functions, Measurements used

- Constant: pi, 3.14159265358979323846264338327950288
 Archimedes' constant
- Constant: [g], 9.80665

 Gravitational acceleration on Earth
- Constant: e, 2.71828182845904523536028747135266249
 Napier's constant
- Function: exp, exp(Number)

 n an exponential function, the value of the function changes by a constant factor for every unit change in the independent variable.
- Function: sqrt, sqrt(Number)
 A square root function is a function that takes a non-negative number as an input and returns the square root of the given input number.
- Measurement: Length in Meter (m)
 Length Unit Conversion
- Measurement: Time in Second (s)
 Time Unit Conversion
- Measurement: Pressure in Millibar (mbar)
 Pressure Unit Conversion
- Measurement: Speed in Meter per Second (m/s)
 Speed Unit Conversion
- Measurement: Frequency in Hertz (Hz)
 Frequency Unit Conversion
- Measurement: Density in Kilogram per Cubic Meter (kg/m³)
 Density Unit Conversion





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- Density Currents in Harbors
 Formulas
- Density Currents in Rivers
 Formulas
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