Important Estimating Marine and Coastal Winds Formulas PDF

Formulas
Examples
with Units

List of 28
Important Estimating Marine and Coastal Winds Formulas

1) Measured Wind Directions Formulas

1.1) Ambient Pressure at Periphery of Storm Formula

Evaluate Formula

Formula

$$p_n = \left(\frac{p - p_c}{\exp\left(- \frac{A}{r^B} \right)} \right) + p_c$$

Example with Units

$$975\,\text{mbar} = \left(\frac{975\,\text{mbar} - 965\,\text{mbar}}{\exp\left(- \frac{50\,\text{m}}{48\,\text{m}^5} \right)} \right) + 965\,\text{mbar}$$

1.2) Characteristic Wave Height given Dimensionless Wave Height Formula

Evaluate Formula

Formula

$$H = \frac{H' \cdot V_f^2}{[g]}$$

Example with Units

$$110.1294\,\text{m} = \frac{30 \cdot 6\,\text{m/s}^2}{9.8066\,\text{m/s}^2}$$

1.3) Cyclostrophic Approximation to Wind Speed Formula

Evaluate Formula

Formula

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

Example with Units

$$0.0274 = \left(50\,\text{m} \cdot 5 \cdot \left(974.90\,\text{mbar} - 965\,\text{mbar} \right) \cdot \frac{\exp\left(- \frac{50\,\text{m}}{48\,\text{m}^5} \right)}{1.293\,\text{kg/m}^3 \cdot 48\,\text{m}^5} \right)^{0.5}$$

1.4) Dimensionless Fetch Formula

Evaluate Formula

Formula

$$X' = \left([g] \cdot \frac{X}{V_f^2} \right)$$

Example with Units

$$4.0861 = \left(9.8066\,\text{m/s}^2 \cdot \frac{15\,\text{m}}{6\,\text{m/s}^2} \right)$$

1.5) Dimensionless Fetch given Fetch-limited Dimensionless Wave Height Formula

Evaluate Formula

Formula

$$X' = \left(\frac{H'}{\lambda} \right)^{\frac{1}{m1}}$$

Example

$$4.3301 = \left(\frac{30}{1.6} \right)^{\frac{1}{2}}$$

1.6) Dimensionless Wave Frequency Formula

Evaluate Formula

Formula

$$f'_p = \frac{V_f \cdot f_p}{[g]}$$

Example with Units

$$7.9538 = \frac{6\,\text{m/s} \cdot 13\,\text{Hz}}{9.8066\,\text{m/s}^2}$$

1.7) Dimensionless Wave Height Formula

Evaluate Formula

Formula

$$H' = \frac{[g] \cdot H}{V_f^2}$$

Example with Units

$$29.9648 = \frac{9.8066\,\text{m/s}^2 \cdot 110\,\text{m}}{6\,\text{m/s}^2}$$

1.8) Direction in Cartesian Coordinate System Formula

Evaluate Formula

Formula

$$\theta_{vec} = 270 - \theta_{met}$$

Example

$$180 = 270 - 90$$

1.9) Direction in Standard Meteorological Terms Formula

Evaluate Formula

Formula

$$\theta_{met} = 270 - \theta_{vec}$$

Example

$$90 = 270 - 180$$

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

Evaluate Formula

Formula

$$R_{max} = A^{\frac{1}{B}}$$

Example with Units

$$2.1867\,\text{m} = 50\,\text{m}^{\frac{1}{5}}$$

1.11) Fetch-Limited Dimensionless Wave Height Formula

Evaluate Formula

Formula

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

Example

$$29.584 = 1.6 \cdot \left(4.3^2 \right)$$

1.12) Frequency of Spectral Peak for Dimensionless Wave Frequency Formula

Evaluate Formula

Formula

$$f_p = \frac{f'_p \cdot [g]}{V_f}$$

Example with Units

$$13.0755\,\text{Hz} = \frac{8 \cdot 9.8066\,\text{m/s}^2}{6\,\text{m/s}}$$

1.13) Friction Velocity for Dimensionless Wave Frequency Formula

Evaluate Formula

Formula

$$V_f = \frac{f'_p \cdot [g]}{f_p}$$

Example with Units

$$6.0349\,\text{m/s} = \frac{8 \cdot 9.8066\,\text{m/s}^2}{13\,\text{Hz}}$$

1.14) Friction Velocity given Dimensionless Fetch Formula

Evaluate Formula

Formula

$$V_f = \sqrt{[g] \cdot \frac{X}{X'}}$$

Example with Units

$$5.8489\,\text{m/s} = \sqrt{9.8066\,\text{m/s}^2 \cdot \frac{15\,\text{m}}{4.3}}$$

1.15) Friction Velocity given Dimensionless Wave Height Formula

Evaluate Formula

Formula

$$V_f = \sqrt{\frac{[g] \cdot H}{H'}}$$

Example with Units

$$5.9965\,\text{m/s} = \sqrt{\frac{9.8066\,\text{m/s}^2 \cdot 110\,\text{m}}{30}}$$

1.16) Fully Developed Wave Height Formula

Evaluate Formula

Formula

$$H_\infty = \frac{\lambda \cdot U^2}{[g]}$$

Example with Units

$$2.6105\,\text{m} = \frac{1.6 \cdot 4\,\text{m/s}^2}{9.8066\,\text{m/s}^2}$$

1.17) Maximum Velocity in Storm Formula

Evaluate Formula

Formula

$$V_{Max} = \left(\frac{B}{\rho} \cdot e\right)^{0.5} \cdot \left(p_n - p_c\right)^{0.5}$$

Example with Units

$$102.0118\,\text{m/s} = \left(\frac{5}{1.293\,\text{kg/m}^3} \cdot e\right)^{0.5} \cdot \left(974.90\,\text{mbar} - 965\,\text{mbar}\right)^{0.5}$$

1.18) Pressure Profile in Hurricane Winds Formula

Evaluate Formula

Formula

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

Example with Units

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

1.19) Wind Speed given Fully Developed Wave Height Formula

Evaluate Formula

Formula

$$U = \sqrt{H_\infty \cdot \frac{[g]}{\lambda}}$$

Example with Units

$$3.992\,\text{m/s} = \sqrt{2.6\,\text{m} \cdot \frac{9.8066\,\text{m/s}^2}{1.6}}$$

2) Wave Hindcasting and Forecasting Formulas

2.1) Drag Coefficient for Wind Speed at 10m Elevation Formula

Evaluate Formula

Formula

$$C_D = 0.001 \cdot \left(1.1 + \left(0.035 \cdot V_{10} \right) \right)$$

Example with Units

$$0.0019 = 0.001 \cdot \left(1.1 + \left(0.035 \cdot 22\,\text{m/s} \right) \right)$$

2.2) Limiting Wave Period Formula

Evaluate Formula

Formula

$$T_p = 9.78 \cdot \left(\left(\frac{D_w}{[g]} \right)^{0.5} \right)$$

Example with Units

$$20.95\,\text{s} = 9.78 \cdot \left(\left(\frac{45\,\text{m}}{9.8066\,\text{m/s}^2} \right)^{0.5} \right)$$

2.3) Spectral Energy Density Formula

Evaluate Formula

Formula

$$E_{(f)} = \frac{\lambda \cdot \left([g]^2 \right) \cdot \left(f^{-5} \right)}{\left(2 \cdot \pi \right)^4}$$

Example with Units

$$0.0031 = \frac{1.6 \cdot \left(9.8066\,\text{m/s}^2{}^2 \right) \cdot \left(2^{-5} \right)}{\left(2 \cdot 3.1416 \right)^4}$$

2.4) Spectral Energy Density or Classical Moskowitz Spectrum Formula

Evaluate Formula

Formula

$$E_{(f)} = \left(\frac{\lambda \cdot \left([g]^{2} \right) \cdot \left(f^{-5} \right)}{\left(2 \cdot \pi \right)^{4}} \right) \cdot \exp\left(0.74 \cdot \left(\frac{f}{f_u} \right)^{-4} \right)$$

Example with Units

$$0.0031 = \left(\frac{1.6 \cdot \left(9.8066 \text{m/s}^2 \right)^{2} \cdot \left(2^{-5} \right)}{\left(2 \cdot 3.1416 \right)^{4}} \right) \cdot \exp\left(0.74 \cdot \left(\frac{2}{0.0001} \right)^{-4} \right)$$

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

Evaluate Formula

Formula

$$X = \left(\frac{t_{x,u} \cdot U^{0.34} \cdot [g]^{0.33}}{77.23} \right)^{\frac{1}{0.67}}$$

Example with Units

$$15.1171 \text{m} = \left(\frac{140 \text{s} \cdot 4 \text{m/s}^{0.34} \cdot 9.8066 \text{m/s}^2{}^{0.33}}{77.23} \right)^{\frac{1}{0.67}}$$

2.6) Straight-Line Distance over which Wind Blows Formula

Evaluate Formula

Formula

$$X = \left(\frac{V_f^{2}}{[g]} \right) \cdot 5.23 \cdot 10^{-3} \cdot \left([g] \cdot \frac{t}{V_f} \right)^{\frac{3}{2}}$$

Example with Units

$$14.9999 \text{m} = \left(\frac{6 \text{m/s}^{2}}{9.8066 \text{m/s}^2} \right) \cdot 5.23 \cdot 10^{-3} \cdot \left(9.8066 \text{m/s}^2 \cdot \frac{51.9 \text{s}}{6 \text{m/s}} \right)^{\frac{3}{2}}$$

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

Evaluate Formula

Formula

$$t_{x,u} = 77.23 \cdot \left(\frac{X^{0.67}}{U^{0.34} \cdot [g]^{0.33}} \right)$$

Example with Units

$$139.2724 \text{s} = 77.23 \cdot \left(\frac{15 \text{m}^{0.67}}{4 \text{m/s}^{0.34} \cdot 9.8066 \text{m/s}^2{}^{0.33}} \right)$$

2.8) Water Depth for given Limiting Wave Period Formula

Evaluate Formula

Formula

$$D_w = [g] \cdot \left(\frac{T_p}{9.78} \right)^{\frac{1}{0.5}}$$

Example with Units

$$45.2149 \text{m} = 9.8066 \text{m/s}^2 \cdot \left(\frac{21 \text{s}}{9.78} \right)^{\frac{1}{0.5}}$$

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

Evaluate Formula

Formula

$$U = \left(\frac{77.23 \cdot X^{0.67}}{t_{x,u} \cdot [g]^{0.33}} \right)^{\frac{1}{0.34}}$$

Example with Units

$$3.9392\,\text{m/s} = \left(\frac{77.23 \cdot 15\,\text{m}^{0.67}}{140\,\text{s} \cdot 9.8066\,\text{m/s}^2{}^{0.33}} \right)^{\frac{1}{0.34}}$$

Variables used in list of Estimating Marine and Coastal Winds Formulas above

- **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_u 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)*
- p_c 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
- V_{10} 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)*

Constants, Functions, Measurements used in list of Estimating Marine and Coastal Winds Formulas above

- constant(s): **pi**, 3.14159265358979323846264338327950288 *Archimedes' constant*
- constant(s): **[g]**, 9.80665 *Gravitational acceleration on Earth*
- constant(s): **e**, 2.71828182845904523536028747135266249 *Napier's constant*
- Functions: **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.*
- Functions: **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*

- X' Dimensionless Fetch
- θ_{met} Direction in Standard Meteorological Terms
- θ_{vec} Direction in Cartesian Coordinate system
- λ Dimensionless Constant
- ρ Density of Air *(Kilogram per Cubic Meter)*

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