Important Meteorology and Wave Climate Formulas PDF

Formulas
Examples
with Units

List of 24
Important Meteorology and Wave Climate Formulas

1) Estimating Marine and Coastal Winds Formulas

1.1) Air Temperature given Air-Sea Temperature Difference Formula

Evaluate Formula

Formula

$$T_a = \Delta T + T_s$$

Example with Units

$$303\,\text{K} = 55\,\text{K} + 248\,\text{K}$$

1.2) Air-Sea Temperature Difference Formula

Evaluate Formula

Formula

$$\Delta T = \left(T_a - T_s \right)$$

Example with Units

$$55\,\text{K} = \left(303\,\text{K} - 248\,\text{K} \right)$$

1.3) Coefficient of Drag at 10m Reference Level given Wind Stress Formula

Evaluate Formula

Formula

$$C_{DZ} = \frac{\tau_o}{U^2}$$

Example with Units

$$0.0938 = \frac{1.5\,\text{Pa}}{4\,\text{m/s}^2}$$

1.4) Coefficient of Drag for Winds Influenced by Stability Effects Formula

Evaluate Formula

Formula

$$C_D = \left(\frac{V_f}{U} \right)^2$$

Example with Units

$$2.25 = \left(\frac{6\,\text{m/s}}{4\,\text{m/s}} \right)^2$$

1.5) Coefficient of Drag for Winds Influenced by Stability Effects given Von Karman Constant Formula

Evaluate Formula

Formula

$$C_D = \left(\frac{k}{\ln\left(\frac{z}{z_0} \right) - \varphi \cdot \left(\frac{z}{L} \right)} \right)^2$$

Example with Units

$$2.2602 = \left(\frac{0.4}{\ln\left(\frac{8\,\text{m}}{6.1\,\text{m}} \right) - 0.07 \cdot \left(\frac{8\,\text{m}}{110} \right)} \right)^2$$

1.6) Friction Velocity given Height of Boundary Layer in Non-Equatorial Regions Formula

Evaluate Formula

Formula

$$V_f = \frac{h \cdot f}{\lambda}$$

Example with Units

$$6\,\text{m/s} = \frac{4.8\,\text{m} \cdot 2}{1.6}$$

1.7) Friction Velocity given Wind Speed at Height above Surface Formula

Evaluate Formula

Formula

$$V_f = k \cdot \left(\frac{U}{\ln\left(\frac{Z}{z_0}\right)} \right)$$

Example with Units

$$5.9007\,\text{m/s} = 0.4 \cdot \left(\frac{4\,\text{m/s}}{\ln\left(\frac{8\,\text{m}}{6.1\,\text{m}}\right)} \right)$$

1.8) Friction Velocity given Wind Stress Formula

Evaluate Formula

Formula

$$V_f = \sqrt{\frac{\tau_o}{\frac{\rho}{\rho_{Water}}}}$$

Example with Units

$$34.0601\,\text{m/s} = \sqrt{\frac{1.5\,\text{Pa}}{\frac{1.293\,\text{kg/m}^3}{1000\,\text{kg/m}^3}}}$$

1.9) Friction Velocity of Wind in Neutral Stratification as Function of Geostrophic Wind Speed Formula

Evaluate Formula

Formula

$$V_f = 0.0275 \cdot U_g$$

Example with Units

$$0.2747\,\text{m/s} = 0.0275 \cdot 9.99\,\text{m/s}$$

1.10) Geostrophic Wind Speed Formula

Evaluate Formula

Formula

$$U_g = \left(\frac{1}{\rho \cdot f} \right) \cdot dpdn_{gradient}$$

Example with Units

$$10\,\text{m/s} = \left(\frac{1}{1.293\,\text{kg/m}^3 \cdot 2} \right) \cdot 25.86$$

1.11) Geostrophic Wind Speed given Friction Velocity in Neutral Stratification Formula

Evaluate Formula

Formula

$$U_g = \frac{V_f}{0.0275}$$

Example with Units

$$218.1818\,\text{m/s} = \frac{6\,\text{m/s}}{0.0275}$$

1.12) Gradient of Atmospheric Pressure Orthogonal to Isobars Formula

Evaluate Formula

Formula

$$dpdn_{gradient} = \frac{U_g}{\frac{1}{\rho \cdot f}}$$

Example with Units

$$25.8341 = \frac{9.99\,\text{m/s}}{\frac{1}{1.293\,\text{kg/m}^3 \cdot 2}}$$

1.13) Gradient of Atmospheric Pressure Orthogonal to Isobars given Gradient Wind Speed Formula

Evaluate Formula

Formula

$$dpdn_{gradient} = \frac{U_{gr} - \left(\frac{U_{gr}^2}{f \cdot r_c}\right)}{\frac{1}{\rho \cdot f}}$$

Example with Units

$$25.8574 = \frac{10\,\text{m/s} - \left(\frac{10\,\text{m/s}^2}{2 \cdot 50\,\text{km}}\right)}{\frac{1}{1.293\,\text{kg/m}^3 \cdot 2}}$$

1.14) Height of Boundary layer in Non-Equatorial Regions Formula

Evaluate Formula

Formula

$$h = \lambda \cdot \left(\frac{V_f}{f}\right)$$

Example with Units

$$4.8\,\text{m} = 1.6 \cdot \left(\frac{6\,\text{m/s}}{2}\right)$$

1.15) Height z above Surface given Standard Reference Wind Speed Formula

Evaluate Formula

Formula

$$Z = \frac{10}{\left(\frac{V_{10}}{U}\right)^7}$$

Example with Units

$$6.6\text{E-}5\,\text{m} = \frac{10}{\left(\frac{22\,\text{m/s}}{4\,\text{m/s}}\right)^7}$$

1.16) Rate of Momentum Transfer at Standard Reference Height for Winds Formula

Evaluate Formula

Formula

$$\tau_o = C_{DZ} \cdot U^2$$

Example with Units

$$1.5\,\text{Pa} = 0.09375 \cdot 4\,\text{m/s}^2$$

1.17) Water Temperature given Air-Sea Temperature Difference Formula

Evaluate Formula

Formula

$$T_s = T_a - \Delta T$$

Example with Units

$$248\,\text{K} = 303\,\text{K} - 55\,\text{K}$$

1.18) Wind Speed at Height above Surface in form of near Surface Wind Profile Formula

Evaluate Formula

Formula

$$U = \left(\frac{V_f}{k}\right) \cdot \left(\ln\left(\frac{Z}{z_0}\right) - \varphi \cdot \left(\frac{Z}{L}\right)\right)$$

Example with Units

$$3.9909\,\text{m/s} = \left(\frac{6\,\text{m/s}}{0.4}\right) \cdot \left(\ln\left(\frac{8\,\text{m}}{6.1\,\text{m}}\right) - 0.07 \cdot \left(\frac{8\,\text{m}}{110}\right)\right)$$

1.19) Wind Speed at Height z above Surface Formula

Evaluate Formula

Formula

$$U = \left(\frac{V_f}{k}\right) \cdot \ln\left(\frac{Z}{z_0}\right)$$

Example with Units

$$4.0673\,\text{m/s} = \left(\frac{6\,\text{m/s}}{0.4}\right) \cdot \ln\left(\frac{8\,\text{m}}{6.1\,\text{m}}\right)$$

1.20) Wind Speed at Height z above Surface given Standard Reference Wind Speed Formula

Evaluate Formula

Formula

$$U = \frac{V_{10}}{\left(\frac{10}{Z}\right)^{\frac{1}{7}}}$$

Example with Units

$$21.3098\,\text{m/s} = \frac{22\,\text{m/s}}{\left(\frac{10}{8\,\text{m}}\right)^{\frac{1}{7}}}$$

1.21) Wind Speed at Standard 10-m Reference Level Formula

Evaluate Formula

Formula

$$V_{10} = U \cdot \left(\frac{10}{Z}\right)^{\frac{1}{7}}$$

Example with Units

$$4.1296\,\text{m/s} = 4\,\text{m/s} \cdot \left(\frac{10}{8\,\text{m}}\right)^{\frac{1}{7}}$$

1.22) Wind Speed given Coefficient of Drag at 10-m Reference Level Formula

Evaluate Formula

Formula

$$U = \sqrt{\frac{\tau_o}{C_{DZ}}}$$

Example with Units

$$4\,\text{m/s} = \sqrt{\frac{1.5\,\text{Pa}}{0.09375}}$$

1.23) Wind Stress given Friction Velocity Formula

Evaluate Formula

Formula

$$\tau_o = \left(\frac{\rho}{\rho_{Water}}\right) \cdot V_f^{\,2}$$

Example with Units

$$0.0465\,\text{Pa} = \left(\frac{1.293\,\text{kg/m}^3}{1000\,\text{kg/m}^3}\right) \cdot 6\,\text{m/s}^{\,2}$$

1.24) Wind Stress in Parametric Form Formula

Evaluate Formula

Formula

$$\tau_o = C_D \cdot \left(\frac{\rho}{\rho_{Water}}\right) \cdot U^2$$

Example with Units

$$0.0002\,\text{Pa} = 0.01 \cdot \left(\frac{1.293\,\text{kg/m}^3}{1000\,\text{kg/m}^3}\right) \cdot 4\,\text{m/s}^{\,2}$$

Variables used in list of Meteorology and Wave Climate Formulas above

- C_D Coefficient of Drag
- C_{DZ} Coefficient of Drag to 10m Reference Level
- $dpdn_{gradient}$ Gradient of Atmospheric Pressure
- **f** Coriolis Frequency
- **h** Height of Boundary Layer *(Meter)*
- **k** Von Kármán Constant
- **L** Parameter with Dimensions of Length
- r_c Radius of Curvature of Isobars *(Kilometer)*
- T_a Air Temperature *(Kelvin)*
- T_s Water Temperature *(Kelvin)*
- **U** Wind Speed *(Meter per Second)*
- U_g Geostrophic Wind Speed *(Meter per Second)*
- U_{gr} Gradient Wind Speed *(Meter per Second)*
- V_{10} Wind Speed at Height of 10 m *(Meter per Second)*
- V_f Friction Velocity *(Meter per Second)*
- **Z** Height z above Surface *(Meter)*
- z_0 Roughness Height of Surface *(Meter)*
- ΔT Air-Sea Temperature Difference *(Kelvin)*
- λ Dimensionless Constant
- ρ Density of Air *(Kilogram per Cubic Meter)*
- ρ_{Water} Water Density *(Kilogram per Cubic Meter)*
- τ_o Wind Stress *(Pascal)*
- φ Universal Similarity Function

Constants, Functions, Measurements used in list of Meteorology and Wave Climate Formulas above

- Functions: **ln**, ln(Number)
  The natural logarithm, also known as the logarithm to the base e, is the inverse function of the natural exponential function.
- 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), Kilometer (km)
  Length Unit Conversion
- Measurement: **Temperature** in Kelvin (K)
  Temperature Unit Conversion
- Measurement: **Pressure** in Pascal (Pa)
  Pressure Unit Conversion
- Measurement: **Speed** in Meter per Second (m/s)
  Speed Unit Conversion
- Measurement: **Density** in Kilogram per Cubic Meter (kg/m³)
  Density Unit Conversion

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