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Meteorology and Wave Climate Formulas

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List of 24 Meteorology and Wave Climate Formulas

Meteorology and Wave Climate

Estimating Marine and Coastal Winds

1) Air Temperature given Air-Sea Temperature Difference

Open Calculator

fx $$T_a = \Delta T + T_s$$

ex $$303K = 55K + 248K$$

2) Air-Sea Temperature Difference

Open Calculator

fx $$\Delta T = (T_a - T_s)$$

ex $$55K = (303K - 248K)$$

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

Open Calculator

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

ex $$0.09375 = \frac{1.5Pa}{(4m/s)^2}$$

4) Coefficient of Drag for Winds Influenced by Stability Effects

Open Calculator

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

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

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

Open Calculator

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

ex $$2.260241 = \left(\frac{0.4}{\ln\left(\frac{8\text{m}}{6.1\text{m}}\right) - 0.07 \cdot \left(\frac{8\text{m}}{110}\right)}\right)^2$$

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

Open Calculator

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

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

7) Friction Velocity given Wind Speed at Height above Surface

Open Calculator

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

ex $$5.900733\text{m/s} = 0.4 \cdot \left(\frac{4\text{m/s}}{\ln\left(\frac{8\text{m}}{6.1\text{m}}\right)} \right)$$

8) Friction Velocity given Wind Stress

Open Calculator

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

ex $$34.06014\text{m/s} = \sqrt{\frac{1.5\text{Pa}}{\frac{1.293\text{kg/m}^3}{1000\text{kg/m}^3}}}$$

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

Open Calculator

fx $$V_f = 0.0275 \cdot U_g$$

ex $$0.274725\text{m/s} = 0.0275 \cdot 9.99\text{m/s}$$

10) Geostrophic Wind Speed

Open Calculator

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

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

11) Geostrophic Wind Speed given Friction Velocity in Neutral Stratification

Open Calculator

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

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

12) Gradient of Atmospheric Pressure Orthogonal to Isobars

Open Calculator

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

ex $$25.83414 = \frac{9.99 m/s}{\frac{1}{1.293 kg/m^3 \cdot 2}}$$

13) Gradient of Atmospheric Pressure Orthogonal to Isobars given Gradient Wind Speed

Open Calculator

fx $$\text{dpdn}_{\text{gradient}} = \frac{\text{U}_{\text{gr}} - \left(\frac{\text{U}_{\text{gr}}^2}{\text{f}\cdot\text{r}_{\text{c}}}\right)}{\frac{1}{\rho\cdot\text{f}}}$$

ex $$25.85741 = \frac{10\text{m/s} - \left(\frac{(10\text{m/s})^2}{2\cdot 50\text{km}}\right)}{\frac{1}{1.293\text{kg/m}^3\cdot 2}}$$

14) Height of Boundary layer in Non-Equatorial Regions

Open Calculator

fx $$\text{h} = \lambda \cdot \left(\frac{\text{V}_{\text{f}}}{\text{f}}\right)$$

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

15) Height z above Surface given Standard Reference Wind Speed

Open Calculator

fx $$\text{Z} = \frac{10}{\left(\frac{\text{V}_{10}}{\text{U}}\right)^7}$$

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

16) Rate of Momentum Transfer at Standard Reference Height for Winds

Open Calculator

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

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

17) Water Temperature given Air-Sea Temperature Difference

Open Calculator

fx $T_s = T_a - \Delta T$

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

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

Open Calculator

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

ex $3.990928\text{m/s} = \left(\frac{6\text{m/s}}{0.4}\right) \cdot \left(\ln\left(\frac{8\text{m}}{6.1\text{m}}\right) - 0.07 \cdot \left(\frac{8\text{m}}{110}\right)\right)$

19) Wind Speed at Height z above Surface

Open Calculator

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

ex $4.067292\text{m/s} = \left(\frac{6\text{m/s}}{0.4}\right) \cdot \ln\left(\frac{8\text{m}}{6.1\text{m}}\right)$

20) Wind Speed at Height z above Surface given Standard Reference Wind Speed

Open Calculator

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

ex $$21.30975\text{m/s} = \frac{22\text{m/s}}{\left(\frac{10}{8\text{m}}\right)^{\frac{1}{7}}}$$

21) Wind Speed at Standard 10-m Reference Level

Open Calculator

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

ex $$4.129565\text{m/s} = 4\text{m/s} \cdot \left(\frac{10}{8\text{m}}\right)^{\frac{1}{7}}$$

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

Open Calculator

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

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

23) Wind Stress given Friction Velocity

Open Calculator

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

ex $$0.046548\text{Pa} = \left(\frac{1.293\text{kg/m}^3}{1000\text{kg/m}^3}\right) \cdot (6\text{m/s})^2$$

24) Wind Stress in Parametric Form

Open Calculator

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

ex $$0.000207\text{Pa} = 0.01 \cdot \left(\frac{1.293\text{kg/m}^3}{1000\text{kg/m}^3}\right) \cdot (4\text{m/s})^2$$

Variables Used

- 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

- Function: **ln**, ln(Number)
  The natural logarithm, also known as the logarithm to the base e, is the inverse function of the natural exponential function.
- 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), 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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