Constants and Conversions for Atmospheric Science

Universal constants

Universal gravitational constant	G	=	6.67×10^{-11} N m^2 kg^{-2}
Universal gas constant in SI units	R^*	=	8.3143 J K^{-1} mol^{-1}
Gas constant in chemical units	$(R_c)^*$	=	0.0821 L atm K^{-1} mol^{-1}
Speed of light	c	=	2.998×10^8m s^{-1}
Planck's constant	h	=	6.626×10^{-34} J s
Stefan-Boltzmann constant	σ	=	5.67×10^{-8} J s^{-1} m^{-2} K^{-4}
Constant in Wien's displacement law	$\lambda_{max}T$	=	2.897×10^{-3} m K
Boltzmann's constant	k	=	1.38×10^{-23} J K^{-1} molecule^{-1}
Avogadro's number	N_A	=	6.022×10^{23} molecules mol^{-1}
Loschmidt number	L	=	2.69×10^{25} molecules m^{-3}

Air

Typical density of air at sea level	ρ_0	=	1.25 kg m^{-3}
Gas constant for dry air	R_d	=	287 J K^{-1} kg^{-1}
Effective molecular mass for dry air	M_d	=	28.97 kg kmol^{-1}
Specific heat of dry air, constant pressure	c_p	=	1004 J K^{-1} kg^{-1}
Specific heat of dry air, constant volume	c_v	=	717 J K^{-1} kg^{-1}
Dry adiabatic lapse rate	g/c_p	=	9.8×10^{-3} K m^{-1}
Thermal conductivity at 0°C (independent of pressure)	K	=	2.40×10^{-2} J m^{-1} s^{-1} K^{-1}

Water substance

Density of liquid water at 0°C	ρ_{water}	=	10^3 kg m^{-3}
Density of ice at 0°C	ρ_{ice}	=	0.917×10^3 kg m^{-3}
Gas constant for water vapor	R_v	=	461 J K^{-1} kg^{-1}
Molecular mass for H_2O	M_w	=	18.016 kg kmol^{-1}
Molecular weight ratio of H_2O to dry air	ε	=	$M_w/M_d = 0.622$
Specific heat of water vapor at constant pressure	c_{pw}	=	1952 J deg^{-1} kg^{-1}
Specific heat of water vapor at constant volume	c_{vw}	=	1463 J deg^{-1} kg^{-1}
Specific heat of liquid water at 0°C	c_w	=	4218 J K^{-1} kg^{-1}
Specific heat of ice at 0°C	c_i	=	2106 J K^{-1} kg^{-1}
Latent heat of vaporization at 0°C	L_v		2.50×10^6 J kg^{-1}
Latent heat of vaporization at 100°C			2.25×10^6 J kg^{-1}
Latent heat of sublimation (H_2O)	L_s		2.85×10^6 J kg^{-1}
Latent heat of fusion (H_2O)	L_f		3.34×10^5 J kg^{-1}

Constants and Conversions for Atmospheric Science (continued)

Earth and Sun

Acceleration due to gravity at sea level	g_0	=	$9.81\ \text{N kg}^{-1}$
Mass of the Earth	$m_\oplus$	=	5.97×10^{24} kg
Mass of the Earth's atmosphere	m_e	=	5.3×10^{18} kg
Radius of the Earth	R_E	=	6.37×10^6 m
Area of the surface of the Earth		=	$5.10 \times 10^1 4\ \text{m}^2$
Mass of an atmospheric column	m_a	=	$1.017 \times 10^4\ \text{kg m}^{-2}$
Atmosphere to Pascals	1 atm	=	1.01325×10^5 Pa
Rotation rate of Earth	Ω	=	$7.292 \times 10^{-5}\ \text{s}^{-1}$
Mass of the sun	$m_\odot$	=	1.99×10^{30} kg
Radius of the sun	$r_\odot$	=	6.96×10^8 m
Mean earth-sun distance	d	=	1.50×10^{11} m = 1.00 AU
Solar flux	E_s	=	3.85×10^{26} W
Average intensity of solar radiation	I_s	=	$2.00 \times 10^7\ \text{W m}^{-2}\ \text{sr}^{-1}$

Units and Conversions

Fahrenheit-Celsius conversion	T_C	=	$\frac{5}{9}(T_F - 32)$
Kelvin-Celsius conversion	T_K	=	$T_C + 273.15$
Hectopascal conversions	1 hPa	=	$1\ \text{mb} = 10^3\ \text{dynes cm}^{-2}$
Cubic meters to liters	$1\ \text{m}^3$	=	1000 L
Days to seconds	1 d	=	86,400 s
Calories to Joules	1 cal	=	4.1855 J
Latitude conversions	1° lat	=	60 nautical mi = 111 km = 69 statute mi
Longitude conversions	1° lon	=	111 km × cos(latitude)
Knots to miles per hour	1 knot	=	1 nautical mi/h = 1.15 statute mi/h
Meters per second to knots	$1\ \text{m s}^{-1}$	=	1.9426 kt
Sverdrups to $\text{m}^3\ \text{s}^{-1}$	1 Sv	=	$10^6\ \text{m}^3\ \text{s}^{-1}$
Dobson unit	1 DU	=	2.6×10^{16} molecules $O_3\ \text{cm}^{-2}$