Geophysical and Environmental Fluid Dynamics:

Some useful numbers (mainly from Gill's book):

Solar 'constant' $S = (1.36\,_8 \pm 0.00_1) \times 10^3$W m^{-2}, where '$\pm$' indicates the order of magnitude of the 11-year variability associated with the solar activity (Schwabe) cycle. This knowledge depends crucially on space-based measurements. Not known is whether larger fluctuations, of more obvious climatological significance, say $\sim \pm 0.5\%$ or more, occurred during earlier decades and centuries; nor is it known to what extent the climate system can nonlinearly amplify solar fluctuations.

Molecular mass of dry air, $m_{\rm a} = 28.966$, of water, $m_{\rm w} = 18.016$, of ozone, $m_{\rm o_3} = 48.01$

Universal gas constant, $R_* = 8.3145$ J mole^{-1} K^{-1} (Nature **331**, p.477; Amer. Inst. Phys. 1993); 1 mole is 10^{-3}kg times the molecular mass

Gas constant for dry air, $R = R_*/m_{\rm a} = 287.04$ J kg^{-1} K^{-1}; $c_p = 1004$, $c_v = 717$, same units

Pressure scale height in hydrostatic atmosphere ($\simeq$ density scale height) $= RT/g = 7$ km when $T = 239$K, 8 km when $T = 273$K, 9 km when $T = 307$K; recall J kg^{-1} K^{-1} = m^{2}s^{-2} K^{-1}

Gas constant for water vapor, $R_{\rm w} = R_*/m_{\rm w} = 461.50$ J kg^{-1} K^{-1}

Molecular weight ratio $m_{\rm a}/m_{\rm w} = R_{\rm w}/R_{\rm a} = 1.6078 = 0.62197^{-1}$; $\gamma \equiv c_p/c_v = 1.40$; $\kappa \equiv R/c_p = \frac{2}{7}$;

Stefan–Boltzmann constant $\sigma = 5.67 \times 10^{-8}$ W m^{-2}K^{-4}

Gravitational force per unit mass g (in ms^{-2}) as a function of latitude φ and height z (in m)

$$g = (9.78032 + 0.005172 \sin^2\varphi - 0.00006 \sin^2 2\varphi)(1 + z/a)^{-2}$$

Mean surface value, $\bar{g} = \int_0^{\pi/2} g \cos\varphi d\varphi = 9.7976$

Radius of sphere having the same volume as the earth, $a = 6371$ km (equatorial radius = 6378 km, polar radius = 6357 km)

Rotation rate of earth, $\Omega = 7.292 \times 10^{-5}$ s^{-1}; Coriolis parameter $f = 2\Omega \sin\phi = 1 \times 10^{-4}$s^{-1} at latitude $\phi = 43.29°$N

Mass of earth 5.977×10^{24} kg

Mass of atmosphere $= 5.3 \times 10^{18}$ kg

Mass of ocean 1.4×10^{21} kg

Mass of water in sediments and rocks $= 2 \times 10^{20}$ kg

Mass of ice on earth $= 2.2 \times 10^{19}$ kg

Mass of water in lakes and rivers $= 5 \times 10^{17}$ kg

Mass of water vapor in atmosphere $= 1.3 \times 10^{16}$ kg $\simeq \frac{1}{4}\%$ of mass of atmosphere

Mass of ozone in atmosphere $= 3 \times 10^{12}$ kg $\simeq 0.00006\%$ of mass of atmosphere $\simeq 3$ mm layer at surface (Ozone replenishment rate, if 3 year circulation timescale, $\simeq 3$ million tonnes per day)

Area of earth $= 5.10 \times 10^{14}$m^2; Area of ocean $= 3.61 \times 10^{14}$m^2; Area of land $= 1.49 \times 10^{14}$m^2

Area of ice sheets and glaciers $= 1.62 \times 10^{13}$m^2

Area of sea ice $= 1.75 \times 10^{13}$m^2 in March and 2.84×10^{13}m^2 in September

Area of Antarctica 1.41×10^{13}m^2; Area of USA 0.93×10^{13}m^2

Dry adiabatic lapse rate $\Gamma = g/c_p = 9.7_6$K km^{-1}

Moist adiabatic lapse rate Γ_s depends on temperature T and pressure p:

e.g. at

30°C	(303K)	and 1000 mbar (10^5 Pa),	$\Gamma_s = 3.5$ K km^{-1}
25	298	"	3.8
20	293	"	4.2
0	273	"	5.2
-30	243	"	8.4

[Gill (p 607) gives an empirical formula for $\Gamma_s(T, p)$]

Typical values of buoyancy (Brunt–Väisälä) frequency N: most of stratosphere, $\sim 2 \times 10^{-2}$s^{-1} (period 5 min); most of troposphere, $\sim 1 \times 10^{-2}$s^{-1} (period 10 min); main ocean thermocline, $\lesssim 0.2 \times 10^{-2}$s^{-1} (period $\gtrsim$ 1 hour)