Appendix B

Acronyms, Symbols, and Constant Values

Purpose: Defines acronyms and symbols used throughout the book. Where relevant, the value of the constant is provided

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>albedo</td>
<td>absorptivity at electromagnetic wavelength Λ</td>
</tr>
<tr>
<td>A</td>
<td>available potential energy</td>
<td>absorptivity at electromagnetic wavelength Λ</td>
</tr>
<tr>
<td>AMIP</td>
<td>Atmospheric model intercomparison project</td>
<td>absorptivity at electromagnetic wavelength Λ</td>
</tr>
<tr>
<td>amc</td>
<td>angular momentum conserving</td>
<td>absorptivity at electromagnetic wavelength Λ</td>
</tr>
<tr>
<td>aSA</td>
<td>shortwave absorptivity of ‘glass’ atmosphere</td>
<td>absorptivity at electromagnetic wavelength Λ</td>
</tr>
<tr>
<td>aSG</td>
<td>shortwave absorptivity of ground</td>
<td>absorptivity at electromagnetic wavelength Λ</td>
</tr>
<tr>
<td>aLA</td>
<td>longwave absorptivity of ‘glass’ atmosphere</td>
<td>absorptivity at electromagnetic wavelength Λ</td>
</tr>
<tr>
<td>aLG</td>
<td>longwave absorptivity of ground</td>
<td>absorptivity at electromagnetic wavelength Λ</td>
</tr>
<tr>
<td>Cp</td>
<td>specific heat of dry air at constant pressure, ( = 1004 \text{ J K}^{-1} \text{ kg}^{-1} )</td>
<td>specific heat of dry air at constant pressure, ( = 1004 \text{ J K}^{-1} \text{ kg}^{-1} )</td>
</tr>
<tr>
<td>Csd</td>
<td>specific heat estimate for dry soil, ( \sim 800 \text{ J K}^{-1} \text{ kg}^{-1} )</td>
<td>specific heat estimate for dry soil, ( \sim 800 \text{ J K}^{-1} \text{ kg}^{-1} )</td>
</tr>
<tr>
<td>Csw</td>
<td>specific heat estimate for wet soil, ( \sim 1500 \text{ J/(kgK)} )</td>
<td>specific heat estimate for wet soil, ( \sim 1500 \text{ J/(kgK)} )</td>
</tr>
<tr>
<td>Cv</td>
<td>specific heat of dry air at constant volume, ( \sim 717 \text{ J K}^{-1} \text{ kg}^{-1} )</td>
<td>specific heat of dry air at constant volume, ( \sim 717 \text{ J K}^{-1} \text{ kg}^{-1} )</td>
</tr>
<tr>
<td>Cw</td>
<td>specific heat for water, ( \sim 4200 \text{ J K}^{-1} \text{ kg}^{-1} ) varies with temperature. This value for ( T \sim 280 \text{ K} )</td>
<td>specific heat for water, ( \sim 4200 \text{ J K}^{-1} \text{ kg}^{-1} ) varies with temperature. This value for ( T \sim 280 \text{ K} )</td>
</tr>
<tr>
<td>CTW</td>
<td>cloud-track winds</td>
<td>cloud-track winds</td>
</tr>
<tr>
<td>c</td>
<td>speed of light ((3 \times 10^8 \text{ m/s}))</td>
<td>speed of light ((3 \times 10^8 \text{ m/s}))</td>
</tr>
<tr>
<td>cB</td>
<td>Boltzmann constant ((1.38 \times 10^{-23} \text{ J/K}))</td>
<td>Boltzmann constant ((1.38 \times 10^{-23} \text{ J/K}))</td>
</tr>
<tr>
<td>cd</td>
<td>drag coefficient ((3 \times 10^{-3} \text{ over land, } 10^{-3} \text{ over ocean; see surface stress, } \tau))</td>
<td>drag coefficient ((3 \times 10^{-3} \text{ over land, } 10^{-3} \text{ over ocean; see surface stress, } \tau))</td>
</tr>
<tr>
<td>ch</td>
<td>Planck constant ((6.625 \times 10^{-34} \text{ Js}))</td>
<td>Planck constant ((6.625 \times 10^{-34} \text{ Js}))</td>
</tr>
<tr>
<td>DT</td>
<td>total diabatic heating rate per unit mass, ( = \frac{D_f}{C_p} ) (units K/s)</td>
<td>total diabatic heating rate per unit mass, ( = \frac{D_f}{C_p} ) (units K/s)</td>
</tr>
<tr>
<td>Df</td>
<td>total diabatic heating rate in units ( \text{ J s}^{-1} \text{ kg}^{-1} ) (see C.3)</td>
<td>total diabatic heating rate in units ( \text{ J s}^{-1} \text{ kg}^{-1} ) (see C.3)</td>
</tr>
<tr>
<td>DNM</td>
<td>diabatic heating rate from processes other than net changes of water state (K/s units)</td>
<td>diabatic heating rate from processes other than net changes of water state (K/s units)</td>
</tr>
<tr>
<td>DOE</td>
<td>(U.S.) Department of Energy</td>
<td>(U.S.) Department of Energy</td>
</tr>
<tr>
<td>DSE</td>
<td>dry static energy, ( = C_pT+\Phi )</td>
<td>dry static energy, ( = C_pT+\Phi )</td>
</tr>
<tr>
<td>dω</td>
<td>solid angle increment</td>
<td>solid angle increment</td>
</tr>
<tr>
<td>ECMWF</td>
<td>European Centre for Medium-range Weather Forecasts</td>
<td>European Centre for Medium-range Weather Forecasts</td>
</tr>
<tr>
<td>ERA-40</td>
<td>ECMWF 40 year reanalysis datasets</td>
<td>ECMWF 40 year reanalysis datasets</td>
</tr>
<tr>
<td>ERA-Interim</td>
<td>ECMWF reanalysis dataset successor to ERA-40</td>
<td>ECMWF reanalysis dataset successor to ERA-40</td>
</tr>
<tr>
<td>Ew</td>
<td>evaporation of liquid water</td>
<td>evaporation of liquid water</td>
</tr>
<tr>
<td>E</td>
<td>radiance</td>
<td>radiance</td>
</tr>
<tr>
<td>E_i</td>
<td>radiance from layer i</td>
<td>radiance from layer i</td>
</tr>
</tbody>
</table>
\( E \)  
radiance (at wavelength \( \lambda \))

e  
vapor pressure

e\(_s\)  
saturation vapor pressure

F  
friction

f  
Coriolis parameter, \( = 2\Omega \sin \phi \)

f\(_0\)  
constant value of Coriolis parameter at latitude \( \phi_0 \), \( = 2\Omega \sin \phi_0 \)

g  
acceleration of gravity, \( = 9.81 \text{ m s}^{-2} \)

h  
elevation

H  
scale height, \( = g/(RT) \) where \( T \) has usually been averaged in some way

HCBE  
hypothetical boundary between atmospheric regions where Hadley Cells dominate versus baroclinic eddies.

i  
square root of \(-1\)

\( \mathbf{i} \)  
(bold) unit vector pointing eastwards

I  
irradiance (over all wavelengths)

I\(_A\)  
irradiance from atmosphere in glass slab model

I\(_G\)  
irradiance from ground in glass slab model

I\(_i\)  
irradiance from layer \( i \)

I\(_N\)  
irradiance input into glass slab model

I\(_S\)  
annual and global average solar radiation spread over the Earth \( (= I_{S\text{ol}}/4) \)

I\(_{S\text{ol}}\)  
solar constant \( (1356-1370 \text{ Wm}^{-2}, 1365 \text{ used here}) \)

I\(_\Lambda\)  
irradiance (at wavelength \( \lambda \))

ISCCP  
International Satellite Cloud Climatology Project

ICZ  
inter-tropical convergence zone

K  
k  
kinetic energy

\( \mathbf{j} \)  
(bold) unit vector pointing northwards

\( \mathbf{k} \)  
(bold) unit vector pointing locally outwards (i.e. ‘upwards’)

k\(_H\)  
horizontal viscosity coefficient for second order friction

k\(_R\)  
viscosity coefficient for Rayleigh friction

k\(_z\)  
vertical viscosity coefficient for second order friction

k\(_\beta\)  
transitional wavenumber for jets versus eddies

L  
latent heat of vaporization, \( = 2.5 \times 10^6 \text{ J kg}^{-1} \text{ at } 0 \text{ C.} \)

LHF  
lateral heat flux

M  
angular momentum per unit mass, \( = R_c (R_c \Omega + u) \)

MSE  
moist static energy, \( = C_p T + \Phi + Lq \)

N\(^2\)  
Brunt-Väisälä frequency, \( = \frac{g}{\theta_s} \left( \frac{\partial \theta_s}{\partial z} \right) \) in height coordinates for an ideal gas

NCEP  
(U.S.) National Centers for Environmental Prediction

NDRA2  
NCEP-DOE (AMIP-II) reanalysis datasets

P\(_w\)  
precipitation of any solid or liquid form of water

P\(_{QG}\)  
quasi-geostrophic potential vorticity

P\(_{SWE}\)  
shallow water equations potential vorticity, \( = \frac{\tilde{\xi}_g + f}{h} \)

p  
pressure

P\(_{oo}\)  
reference pressure, typically set to \( 10^5 \text{ Pa} \)

QE  
potential vorticity in isentropic coordinates (see C.49)

Q\(_{QG}\)  
quasi-geostrophic potential vorticity (see C.47)
QGy meridional gradient of quasi-geostrophic potential vorticity
QG quasi-geostrophic
q specific humidity
R gas constant for dry air, = 287 J K⁻¹ kg⁻¹
Rv gas constant for water vapor, = 461 J K⁻¹ kg⁻¹
Re r cos(φ)
Ro Rossby number, = U/f₀Ls, where U and L_s are speed and horizontal length scales.
r mean radius of the solid earth, 6370 km
rms root mean square
Sa enthalpy, = C_p T
So entropy, dS_o = C_p dln(θ)
SHF sensible heat flux
SLP sea level pressure
SWE shallow water equations
T temperature
T_A atmospheric temperature
T_G surface temperature
TOA top of atmosphere
t time
U_amc a zonal wind component conserving angular momentum
U_s wind speed
u zonal component of the wind
u_ag zonal component of the ageostrophic wind, = u - u_g
u_g zonal component of the geostrophic wind, = \frac{1}{f} \frac{\delta Z}{\delta y} in pressure coordinates
V vector wind, 3 dimensional unless otherwise stated
v meridional component of the wind
v_ag meridional component of the ageostrophic wind, = v - v_g
v_g meridional component of the geostrophic wind, = \frac{1}{f} \frac{\delta Z}{\delta x} in pressure coordinates
[v_R] meridional component of the zonal average residual circulation
w vertical velocity in height coordinates
wd mixing ratio, equivalent to saturation mixing ratio at dewpoint temperature
WBC western boundary current
Z geopotential height
z elevation
α specific volume, = 1/ρ
α_v specific volume for water vapor, = 1/e
β meridional derivative of the Coriolis parameter
εΛ emissivity?
ε_f efficiency factor?
Λ wavelength of electromagnetic radiation
λ longitude or azimuth based on context
μ =sin(φ)
ρ density
\( \rho_w \) density of fresh water, \( = 10^3 \text{ kg/m}^3 \)
\( \theta \) potential temperature
\( \theta_e \) equivalent potential temperature
\( \sigma \) Stefan-Boltzmann constant, \( = \frac{(2\pi^2 c_B^4)}{(15 c_p^2 c_h^3)} = 5.67 \times 10^{-8} \text{ W m}^{-2} \text{ K}^{-4} \)
\( \tau \) surface stress by wind
\( \tau_{\lambda} \) surface stress in zonal direction (\( = \rho c_d |V| u \))
\( \nu_\Lambda \) electromagnetic frequency at wavelength \( \Lambda \)
\( \Omega \) angular rotation rate of the earth, \( 7.292 \times 10^{-5} \text{ rad/sec} \)
\( \Omega, \vec{\Omega} \) (bold or with arrow) angular rotation vector for the earth, \( = (0 \hat{i}, \Omega \cos(\phi) \hat{j}, \Omega \sin(\phi) \hat{k}) \)
\( \omega \) (vertical) pressure velocity, \( \omega = \frac{dP}{dt} \)
\( [\omega_R] \) (vertical) pressure component of the zonal average residual circulation
\( \Phi \) geopotential, \( d\Phi = g \, dz = -RT dp/p \) (for hydrostatic balance)
\( \phi \) latitude or zenith angle based on context
\( \zeta \) vertical component of relative vorticity, \( \zeta = \hat{k} \cdot \vec{\nu} \times \vec{\nu} = \frac{\partial v}{\partial x} - \frac{\partial u}{\partial y} \)
\( \zeta_a \) vertical component of absolute vorticity, \( \zeta + f \)
\( \zeta_{ay} \) meridional gradient of vertical component of absolute vorticity
\( \zeta \) three dimensional vorticity, \( \hat{\nu} \times \vec{\nu} \)
\( \Psi \) streamfunction