Geophysical Fluid Dynamics cheat sheet

Last update 2026/04/28, By Xinyi Huang

Most values are roughly estimated and only provides an approximation.

Default assumption: Northern Hemisphere

Atmosphere

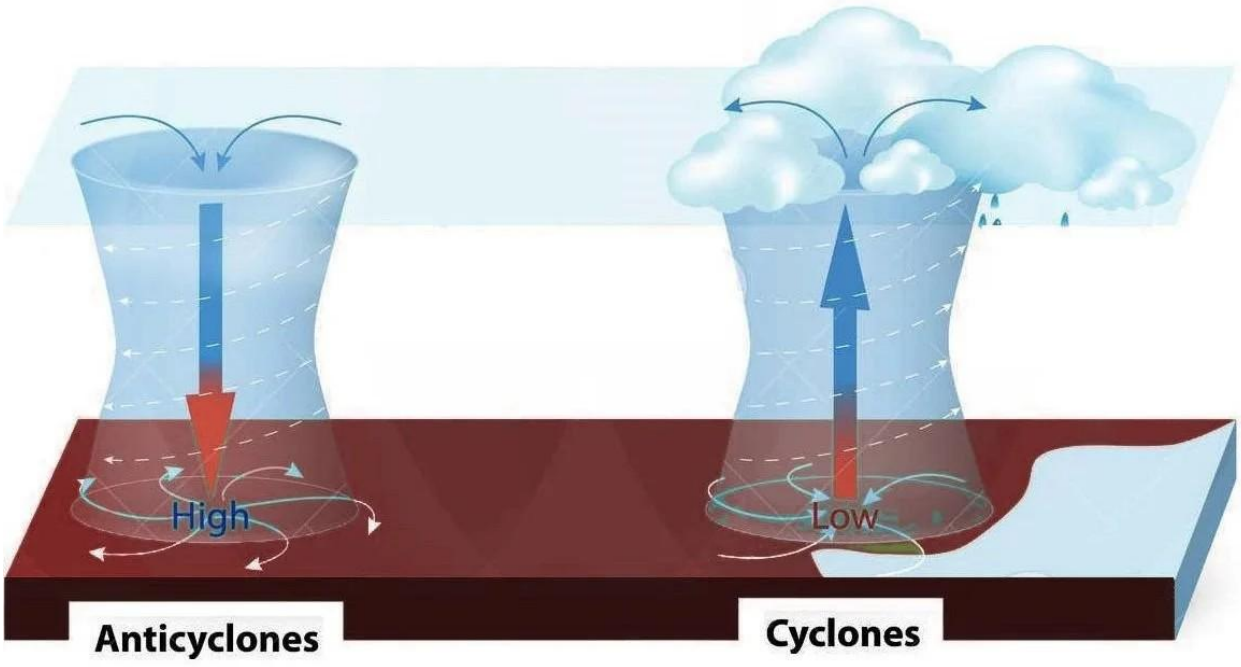
Atmosphere layers

Ground --------> Troptopause --------> Stratopause --------> ( ) -------->
Troposphere Stratosphere Mesosphere Thermosphere

0km --------> 12km --------> 50km --------> 80km

Cyclones and anticyclones

Anticyclone	Cyclones
≒ Pressure high at the ground center (always outward)	≒ Pressure low at the ground center (always inward)
Clockwise (NH), anti-clockwise (SH)	Anti-clockwise (NH), clockwise (SH)
Usually large and flat	Usually small and intense



Meteorology size

Microscale/storm scale --------> Mesoscale --------> Synoptic scale
~ 1km 5km~100km ~1000km

Ocean

Ocean layers

Mixed layer Thermocline deep water
0m --------> ~200m --------> 1000m --------> ~3km, Max ~10km
Halocline (Salinity)
Pycnocline (Density)

Oceanography size

Submesoscale --------> Mesoscale
O(1-10km) O(50km-500km)
10-100days

Terminology and abbreviation

Constants (for earth)

Coriolis frequency $f = 2\Omega \sin \varphi \sim 10^{-4}$ rad/s at mid-latitude

Brunt-Väisälä frequency $N^2 = -\frac{g}{\rho_0}\frac{\partial \rho}{\partial z} \sim 0.005$ rad/s

(Barotropic) Radius of deformation $L = \sqrt{gH}/f \sim 2000$km for mid-latitude ocean

(Baroclinic) Radius of deformation $L = NH/\pi f \sim 100$km for mid-latitude ocean

Rossby parameter $\beta = \frac{\partial f}{\partial y} = \frac{2\Omega \cos \varphi}{r_{\text{earth}}} \sim 2.2\text{e-}11$ rad/(s·m)

Earth 1° latitude ~ 110km (r_{earth}=6371km, circumference = 40,075km)

Average ocean depth H=4km

Mixed layer depth ~ O(100m)

Average convective boundary layer depth $z_i \sim 1000$m

Average scale height $H = R_d T_v / g \sim 8.5$km

Dry adiabatic lapse rate $\Gamma_d = \frac{g}{c_p}$ = 9.8℃/km (Actual atmosphere ~ 6.5 ℃/km)

Dew point lapse rate ~ 1.8K/km

Moist adiabatic lapse rate $\Gamma_s \approx$ 4-6K/km

Atmosphere friction velocity u_i ~ 0.3m/s

Monin-Obukhov length scale $L = -u_*^3 \Theta_0 / \kappa g Q_0$

Convective velocity scale $w_* = \left(\frac{g}{\theta_0} Q_0 z_i\right)^{1/3} \backsimeq$ 2m/s

Measurement abbreviation

ADCP = Acoustic Doppler Current Profiler

ADV = Acoustic Doppler Velocimeter

CTD = Conductivity, Temperature & Depth (instrument)

Harrison's clock: for time and longtitude

Nansen's bottle/Niskin bottle: for temperature, salinity, pressure, etc

XBT = eXpendable BathyThermograph

WOCE = world ocean circulation experiment

Argo (floats): for temperature and salinity

GPS = Global Positioning Satellites

Altimetry Geoid ($\pm$100m from reference ellipsoid)

VMCM = vector measuring current meter

GRACE = Gravity Recovery And Climate Experiment (by NASA)

Terminology

Barotropic/Baroclinic

Longitude/Meridional

Latitude/Zonal

Other abbreviation

IPCC = intergovernment panel on climate change

CMIP = coupled model intercomparison project

RCP = representative concentration pathways

SSP = shared socioeconomic pathways

ECS = equilibrium climate sensitivity

TCR = transient climate response

LCL = lifting condensation level

LFC = level of free convection

EL = equilibrium level; LNB = level of neutral buoyancy; LOC = level of convection

CIN = convective inhibition

CAPE = convective available potential energy