Chapter 6: Air Pressure
Measuring air pressure
Variations due to temperature and water vapor
Development of pressure systems
Generation of winds

Understanding Air Pressure:
- pressure exerted by the weight of air above
- force exerted against a surface by the continuous collision of gas molecules
- sea level pressure (slp) = 14.7 lbs/in², 1 kg/cm²

Measuring Air Pressure:
Newtons: unit of force (F = ma, kg m/s²)
slp: 101,325 Newtons
100 Newtons = 1 milibar (slp = 1013.25 mb)

Inches of Mercury: mercury barometer
slp = 29.92 in of mercury

Measuring Air Pressure:
aneroid barometer: metal chamber changes shape based on pressure, changes lever locations

Rising pressure: fair and dry
Falling pressure: rainy, wet, stormy
**Measuring Air Pressure:**
barograph: continuous log of aneroid barometer measurements

![Digital barographs](image)

**Pressure Changes With Altitude:**

| Density decreases w/ altitude |
| Weight of overlying column of air decreases with altitude |
| Pressure decreases w/ altitude |
| halves – every 5 km |

<table>
<thead>
<tr>
<th>Height (ft)</th>
<th>Pressure (mb)</th>
<th>Temperature (°F)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1013.2</td>
<td>-47</td>
</tr>
<tr>
<td>10,000</td>
<td>937.5</td>
<td>-22</td>
</tr>
<tr>
<td>20,000</td>
<td>914.0</td>
<td>-22</td>
</tr>
</tbody>
</table>

**Pressure Altimeter:** aneroid barometer marked in meters

![Pressure Altimeter](image)

High flying commercial jets tend to fly along lines of constant pressure

**Adjusting to Sea-Level Pressure**
Correction depends on temperature

**Horizontal Variations in Air Pressure:**
Horizontal pressure variations rarely exceed:
- 30 mb > sea level pressure
- 60 mb < sea level pressure

![Isobars](image)
Pressure Changes with Temperature

Cold air mass temperatures
Low kinetic energy
Slow moving molecules
Closer together
Higher Pressure

Pressure Changes with Temperature

Warm air mass temperatures
High kinetic energy
Fast moving molecules
Further apart
Low Pressure

Pressure Changes with Temperature

Pressure Changes with Temperature

Water molecule lighter than N₂ and O₂
Adding water vapor displaces heavier molecules
Air pressure decreases

Airflow and Pressure:
Keep in mind atmosphere is 3D
Regions of Convergence = pressure increases
Regions of Divergence = pressure decreases

Summarize:
Cool, dry = high pressure
Warm, moist = low pressure
Wind:
Horizontal movement (advection) of air
Results from horizontal differences in air pressure

Factors Affecting Wind:
1. The pressure gradient force
2. The Coriolis force
3. friction

Pressure Gradient:
Pressure change occurring over a given distance
Closely spaced isobars = steep pressure gradient, stronger winds

Horizontal Pressure Gradient and Wind
balanced by gravitational force
hydrostatic balance or equilibrium
large scale vertical movements are slow
Coriolis Force:

\[ F_c = 2\nu \Omega \sin(\phi) \]

- \( \nu \) = wind speed
- \( \Omega \) = angular velocity
- \( \phi \) = latitude

**Effect of Friction**

Greatest near surface

Negligible a few km above the surface

**Ex. 1 hr move from pole to equator**

Equatorial Circumference 40,076 km

Effect of Friction

F = m(\text{kg})a(\text{m/s}^2)

\( F/m = a \) (m/s^2)
Winds Aloft and Geostrophic Flow
pressure gradient force = (balanced by) coriolis force
giostrophic balance, reach equilibrium, no acceleration
giostrophic winds flow in a straight line parallel to isobars

Upper Level Geostrophic Winds
Ridge = high pressure
Trough = low pressure

Geostrophic Winds
High = anticyclones, clockwise flow (NH)
Low = cyclones, counter clockwise flow

Gradient Winds
Near the surface friction slows winds
pressure gradient force exceeds coriolis force
Unbalance force turns winds, centripetal acceleration

Surface Winds
Friction = reduces speed, weakens coriolis force
ocean = 2/3 geostrophic speed (10-20° isobars)
rugged terrain = 1/2 geostrophic speed (45° isobars)

Surface H & L Pressure Systems
High = divergence, net flow of air away from the center
Low = convergence, net flow of air toward the center
Low Pressure System: vertical motion
surface convergence
rising column of air (inc pres)
divergence aloft to maintain system

High Pressure System: vertical motion
surface divergence
descending column of air
(adiabatic warming, clear skies)
convergence aloft to maintain system

Wind Measurement
Wind Vane
Prevailing Wind
Cup Anemometer
Aerovane

Wind Rose