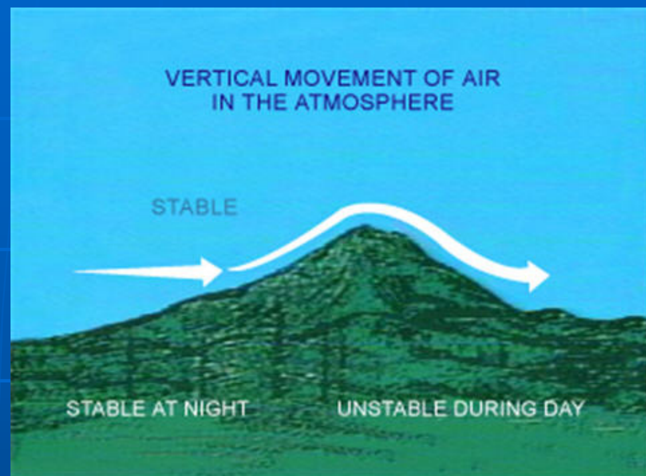
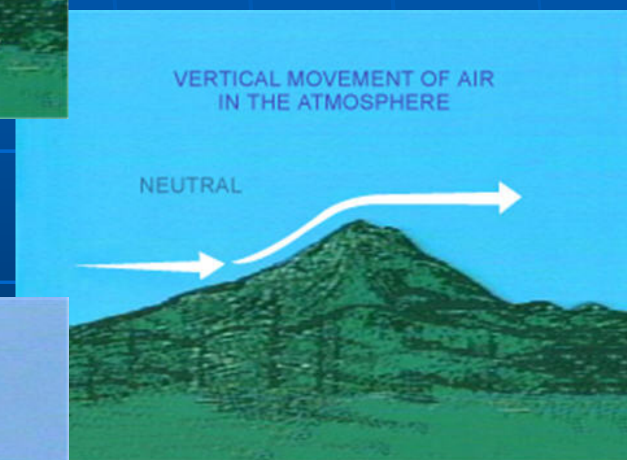
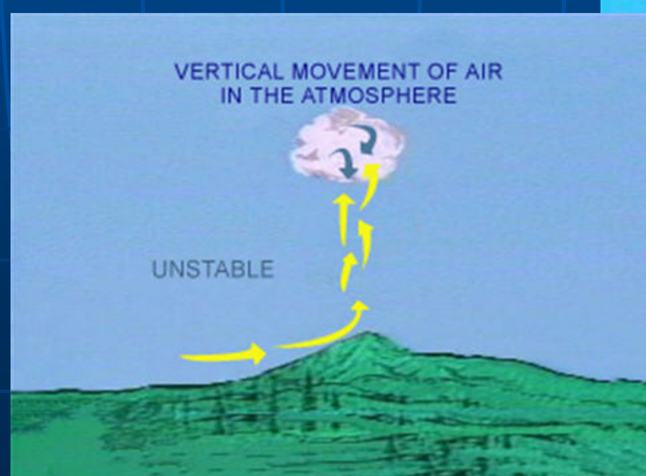
FWFC – INTRODUCTORY METEOROLOGY - PART 2

STABLE AND UNSTABLE AIR

Stability in the air Relates to the vertical movements of air parcels’







BUOYANCY

The action of the ascending parcel depends on its **buoyancy** within the surrounding atmosphere

HOW BUOYANCY CHANGES

Buoyancy depends on:

- How the temperature of the rising parcel changes (DALR or SALR)
- how the temperature of the surrounding air changes (ELR)

CONDITIONS OF STABILITY

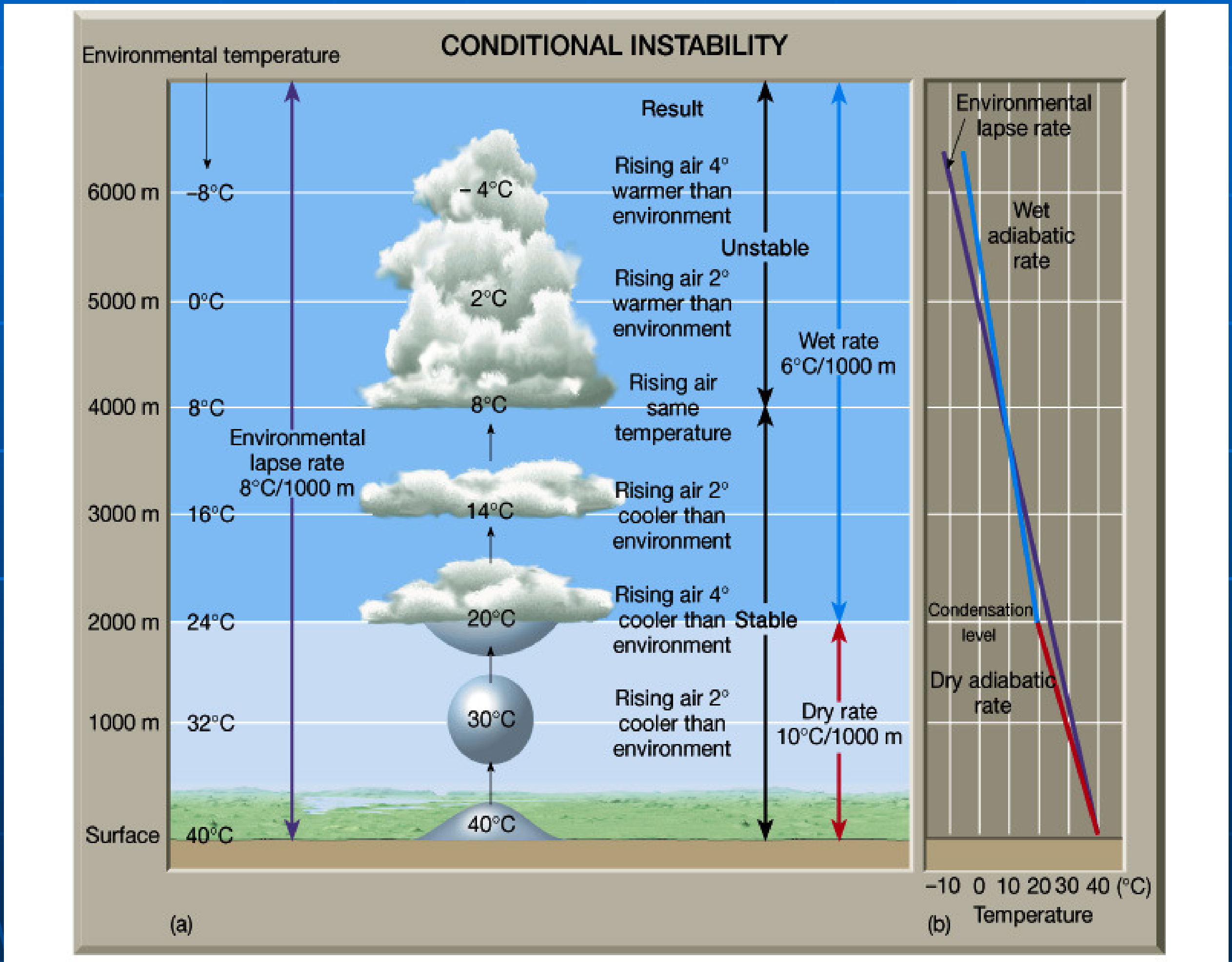
- **UNSTABLE - **the parcel is warmer than its environment
- **NEUTRAL** - the parcel is the same temperature as its environment
- **STABLE** - the parcel is colder than its environment

TYPES OF STABILITY

- Absolute Stability
  - vertical temperature distribution under which both dry and saturated air are stable
- Absolute Stability
  - vertical temperature distribution under which both dry and saturated air are unstable
- Potential Instability
  - stable air becomes unstable due to ascent

CONDITIONAL INSTABILITY

- stable when unsaturated
- unstable when saturated



CHANGING STABILITY

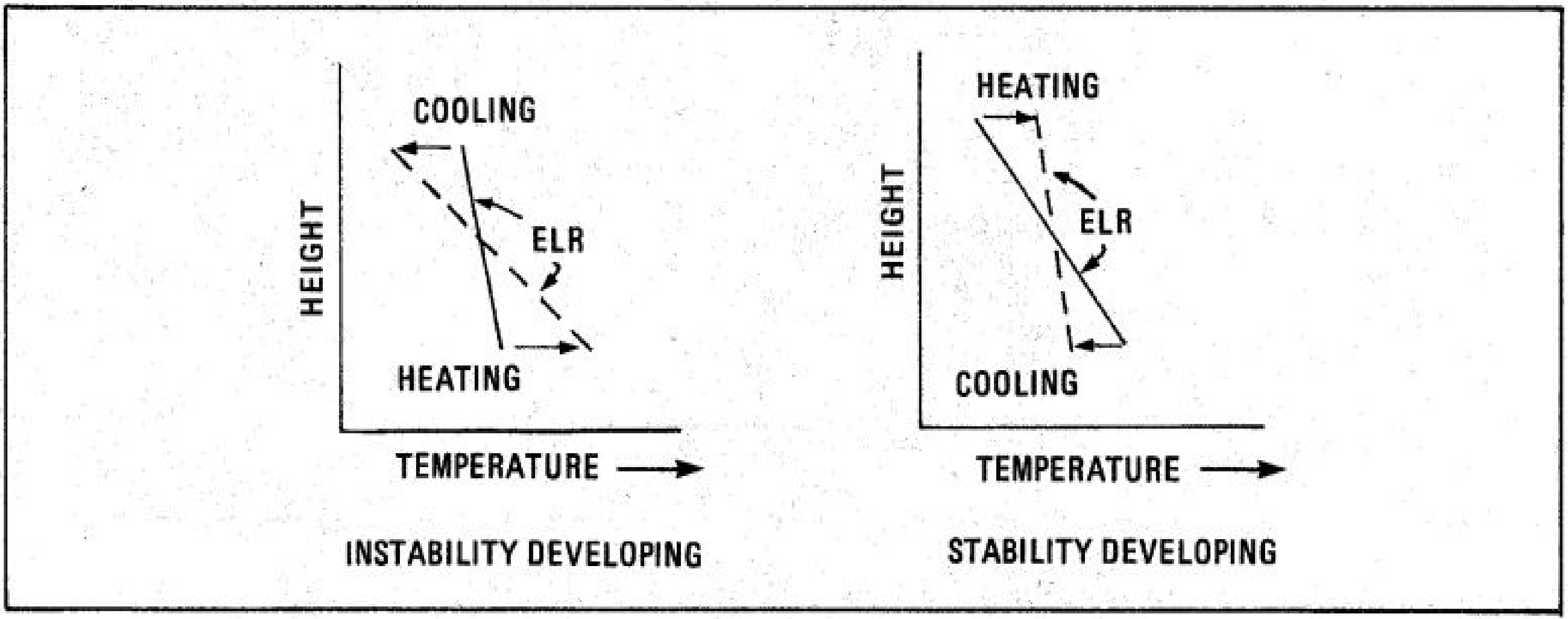
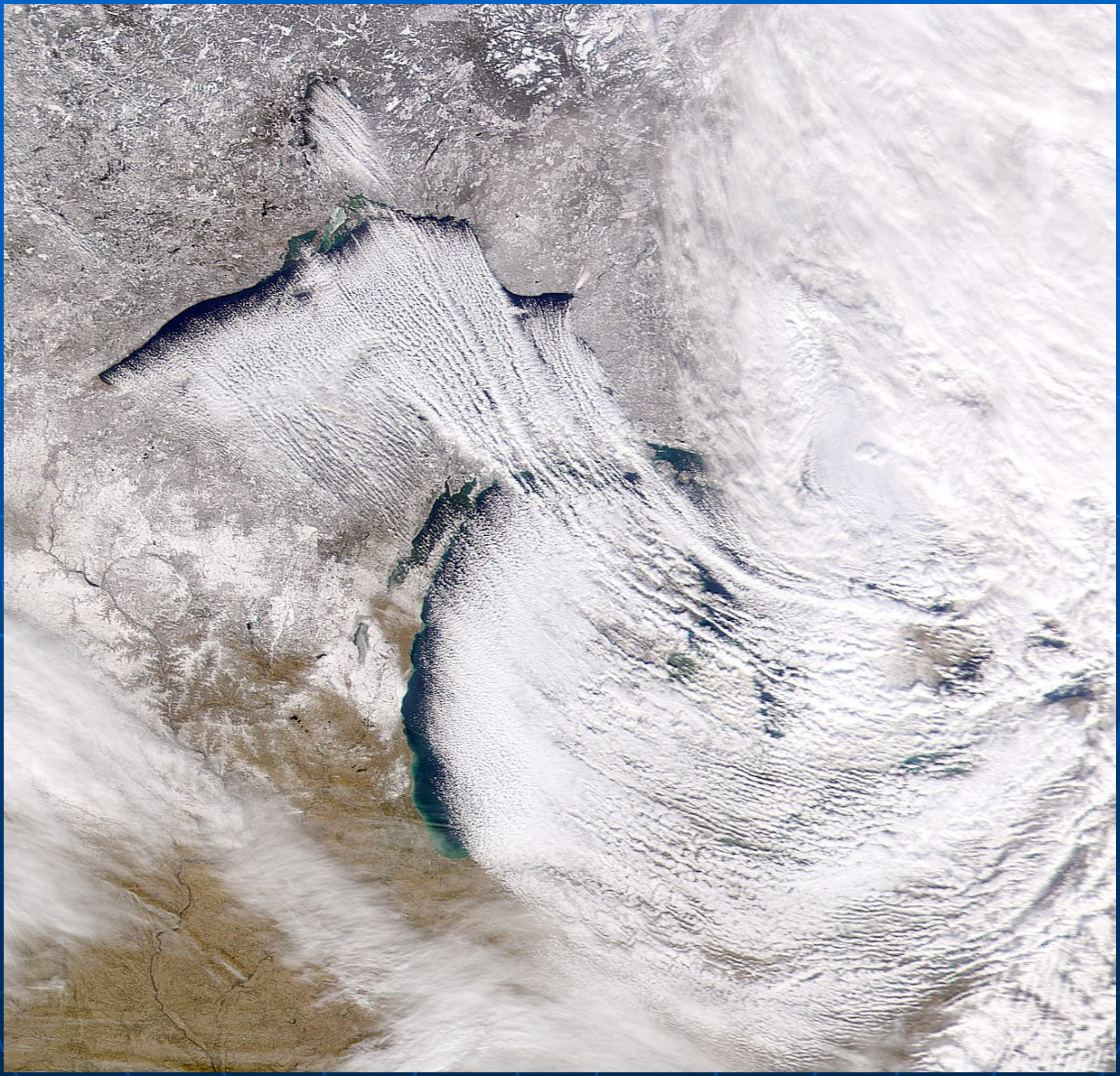


Figure 4-8 Development of Stability and Instability in a Layer of the Atmosphere

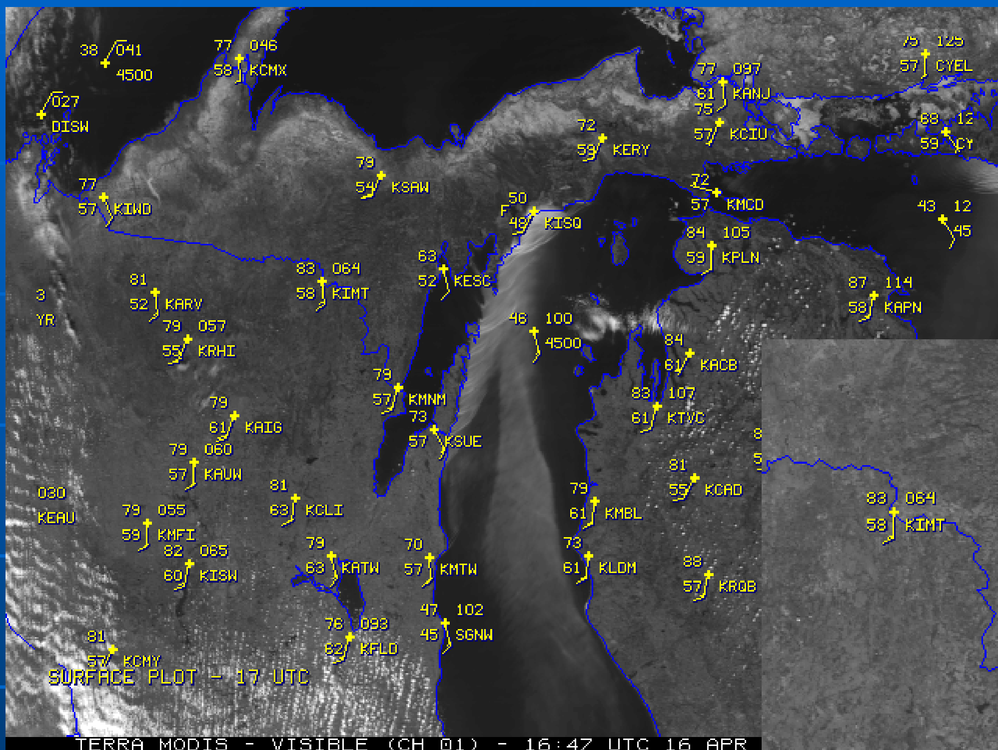
EXAMPLES OF STABILITY BEING CHANGED

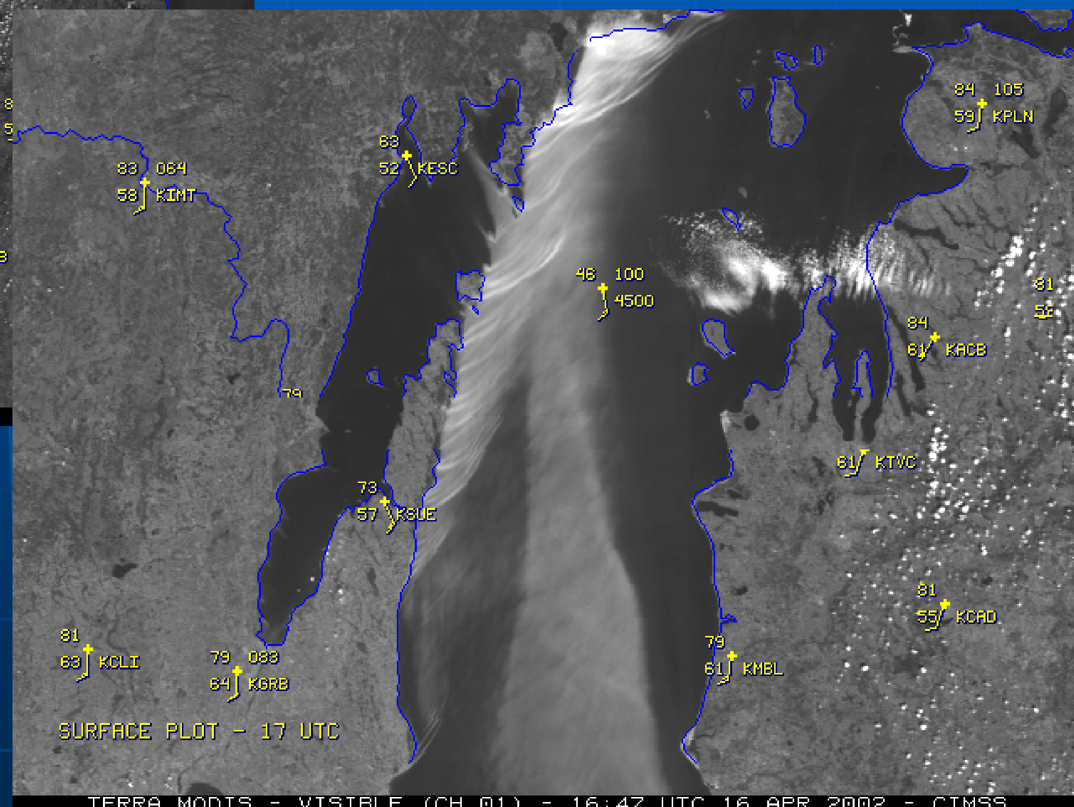
- Daytime Heating vs. Nighttime cooling
- Cold air advection vs. warm air advection
  - consider Gulf of Alaska; Great Lakes
- Subsidence Inversion

COLD AIR ADVECTION



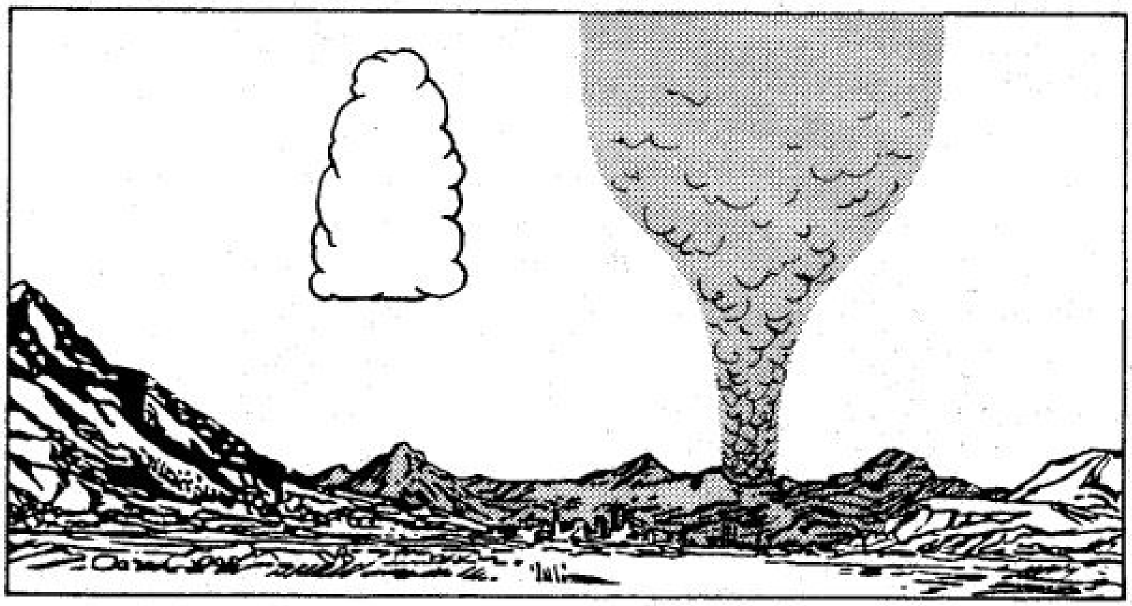
WARM AIR ADVECTION





UNSTABLE WEATHER

UNSTABLE CONDITIONS



UNSTABLE AIR

- turbulence
- showery, localized precipitation
- thunderstorms

CONVECTIVE CELLS

Note that convection can originate from any level and can be in pockets in stable layers

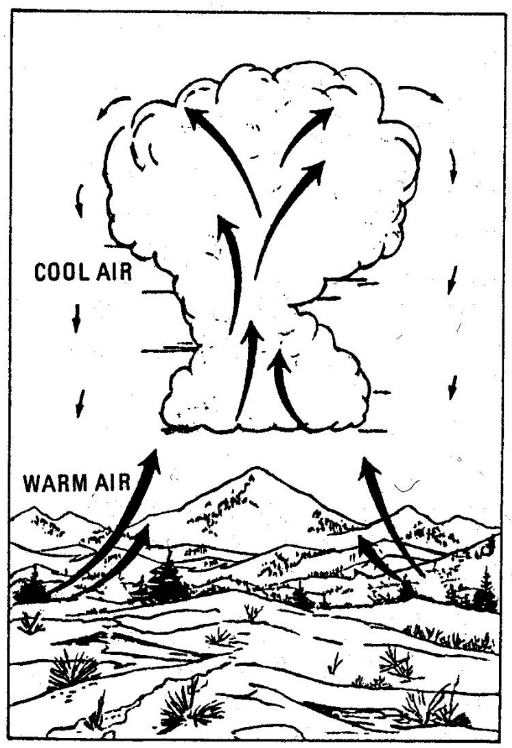


Figure 4-14 Convective Cell in Clear Air

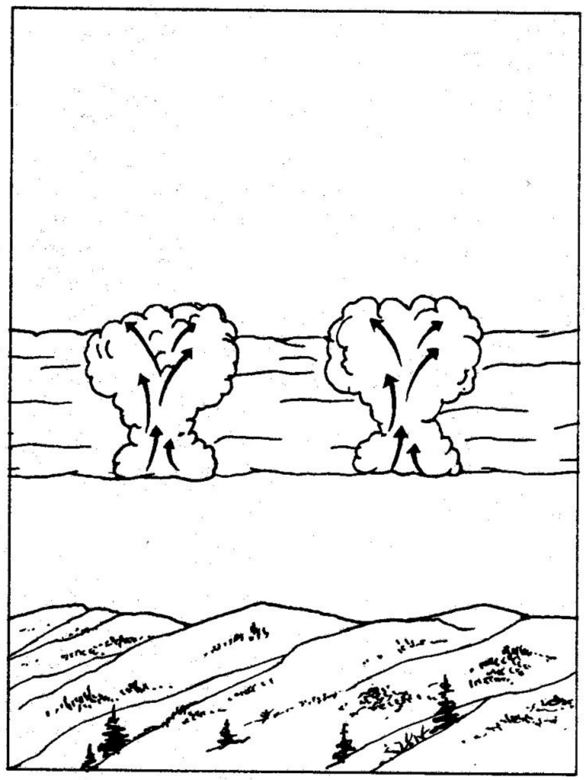


Figure 4-15 Convective Cell Embedded in Cloud

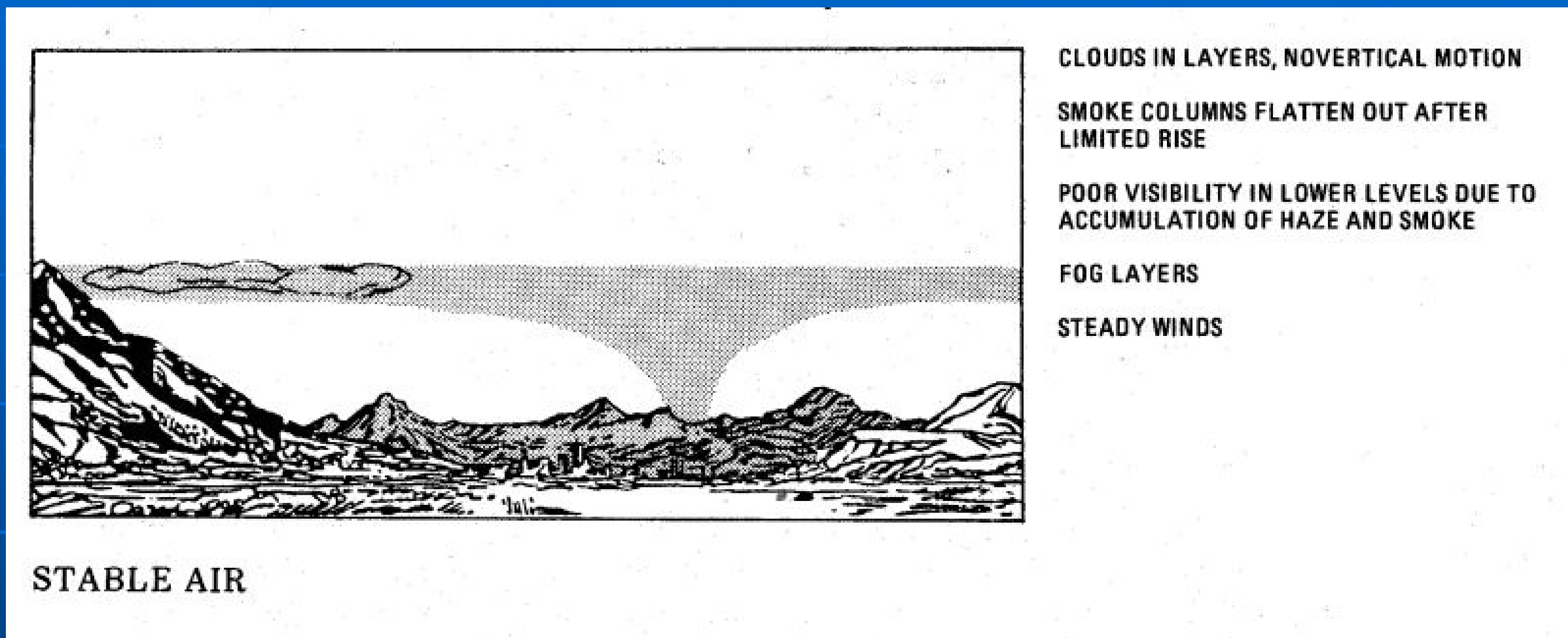
PYROCUMULUS

FIRENADO

- Two short videos to watch

STABLE WEATHER

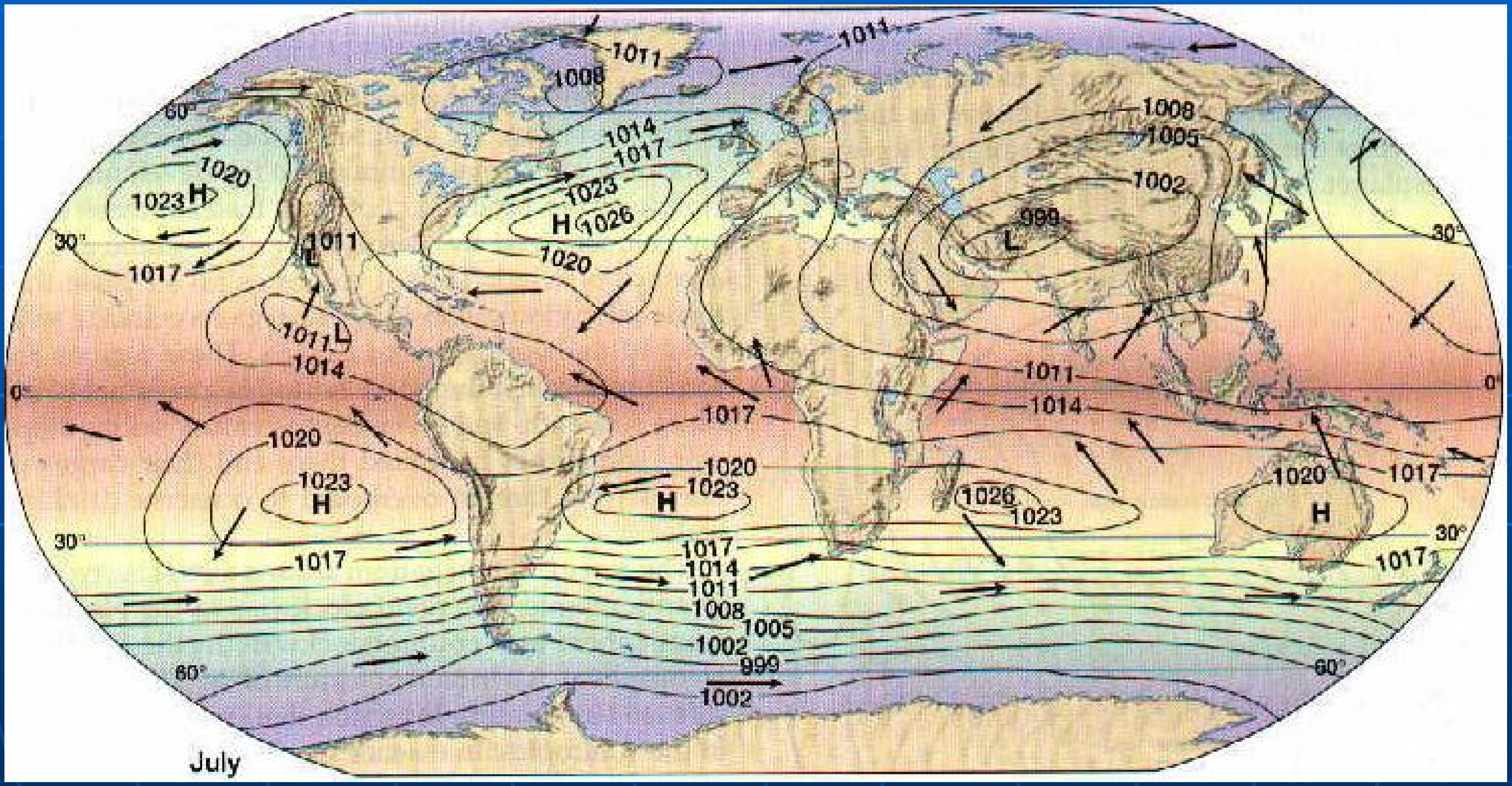
STABLE CONDITIONS



- little turbulence
- steady, widespread precipitation

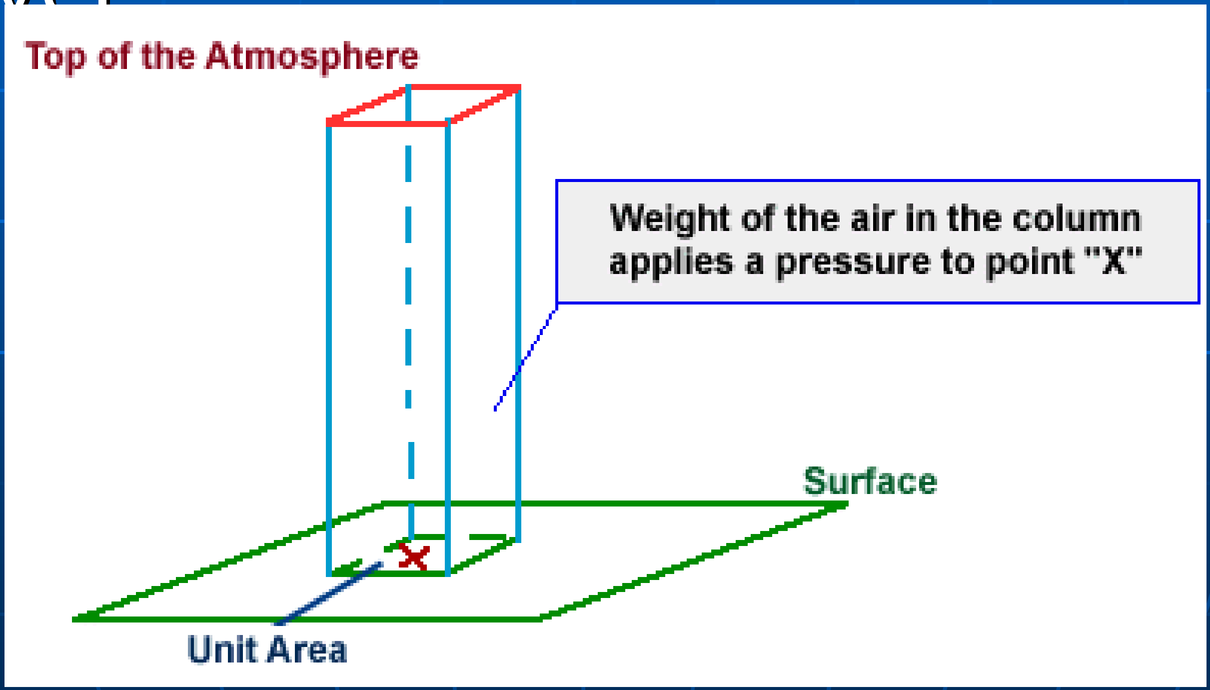
MIXED STABILITY

PRESSURE AND WIND



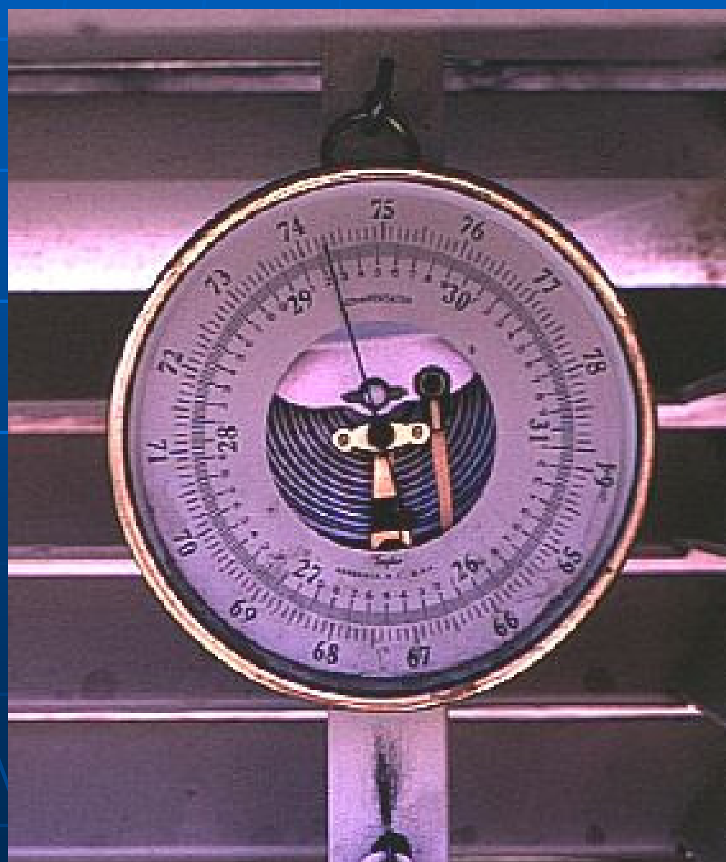
ATMOSPHERIC PRESSURE

The the force per unit area exerted by the weight of air above that level



MEASURING PRESSURE

- aneroid barometer



STATION PRESSURE

The atmospheric pressure as measured at the station elevation.

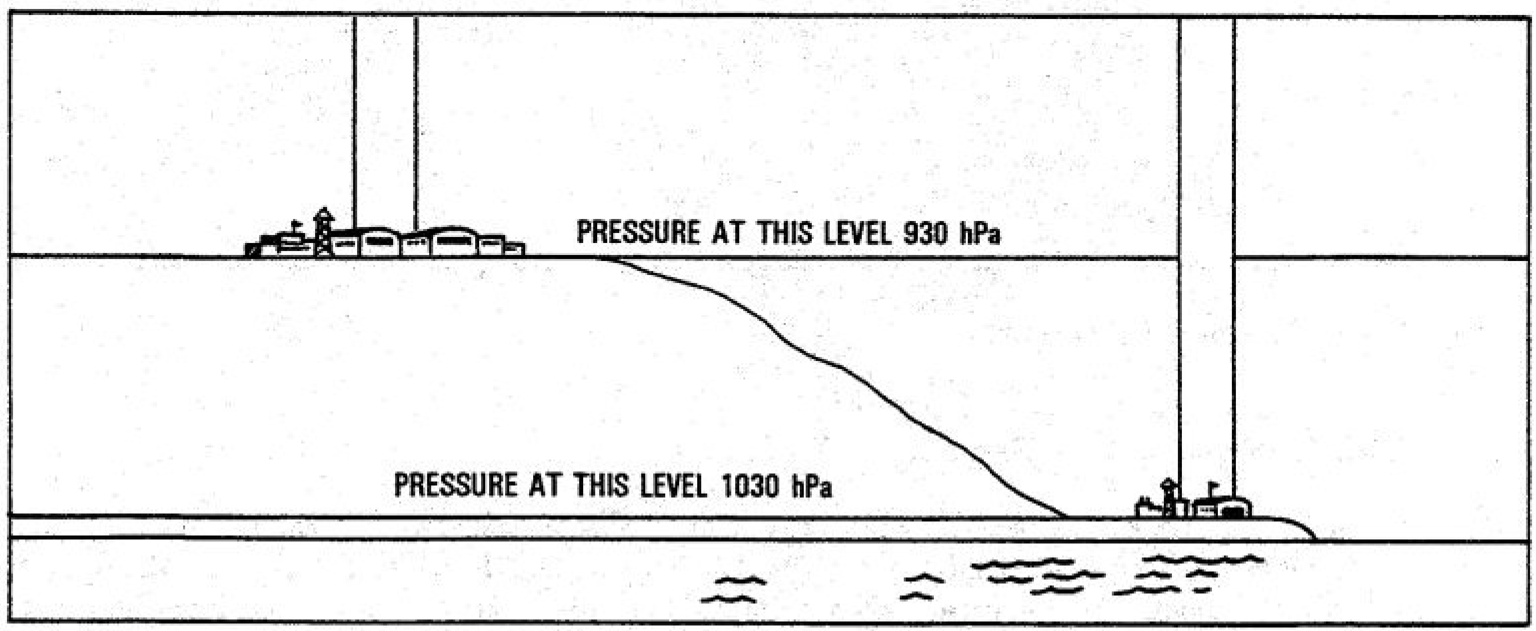


Figure 5-3 Difference in Station Pressure Due to Difference in Station Elevation

MEAN SEA LEVEL PRESSURE

Station pressure adjusted to ‘Mean Sea Level’ (MSL) to allow comparison with other sites.

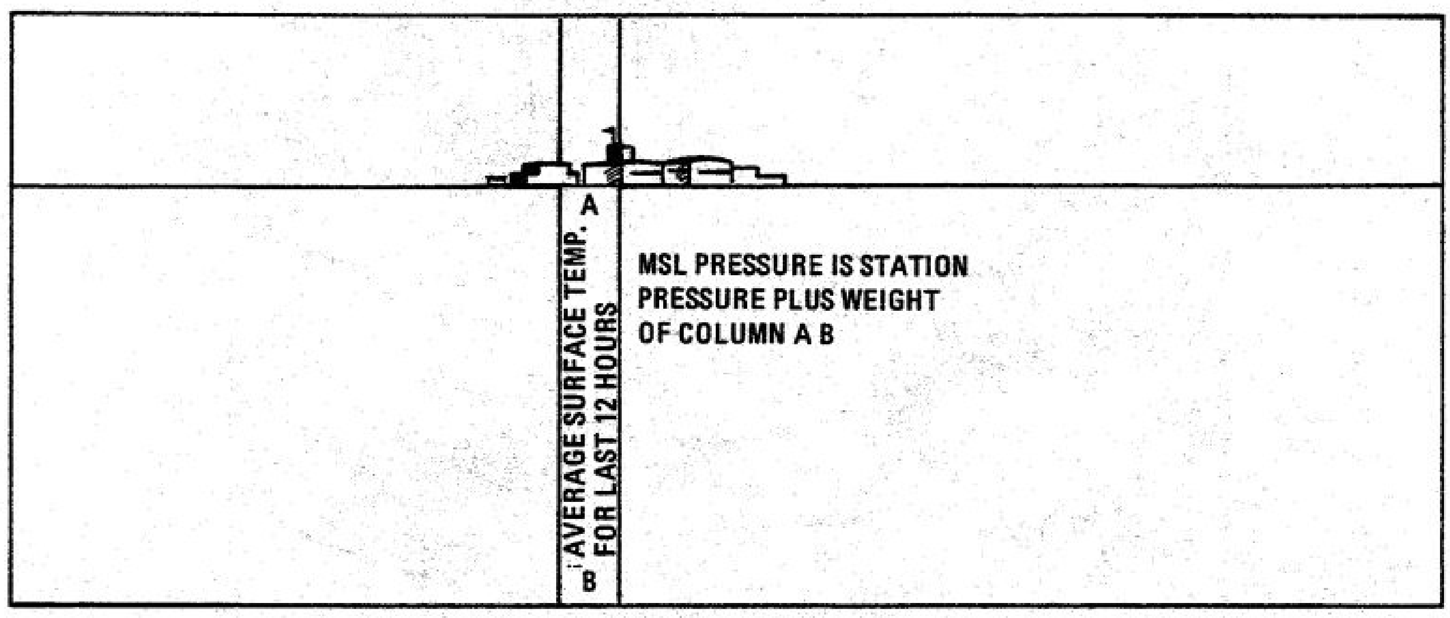
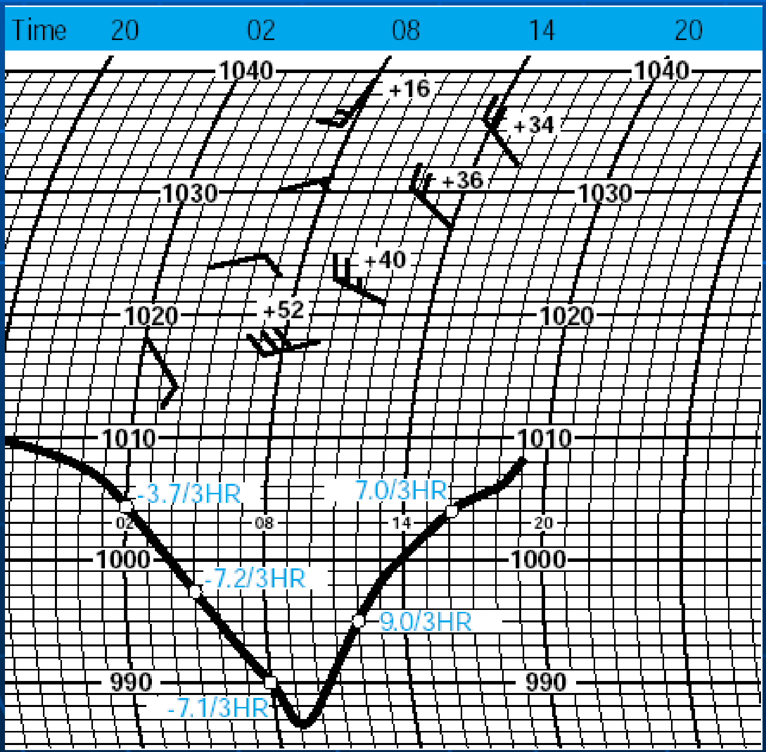


Figure 5-4 Mean Sea Level Pressure

PRESSURE TENDENCY

- Pressure tendency is the change in pressure over a 3-hour period
- PRESFR – pressure falling rapidly
- PRESRR – pressure rising rapidly

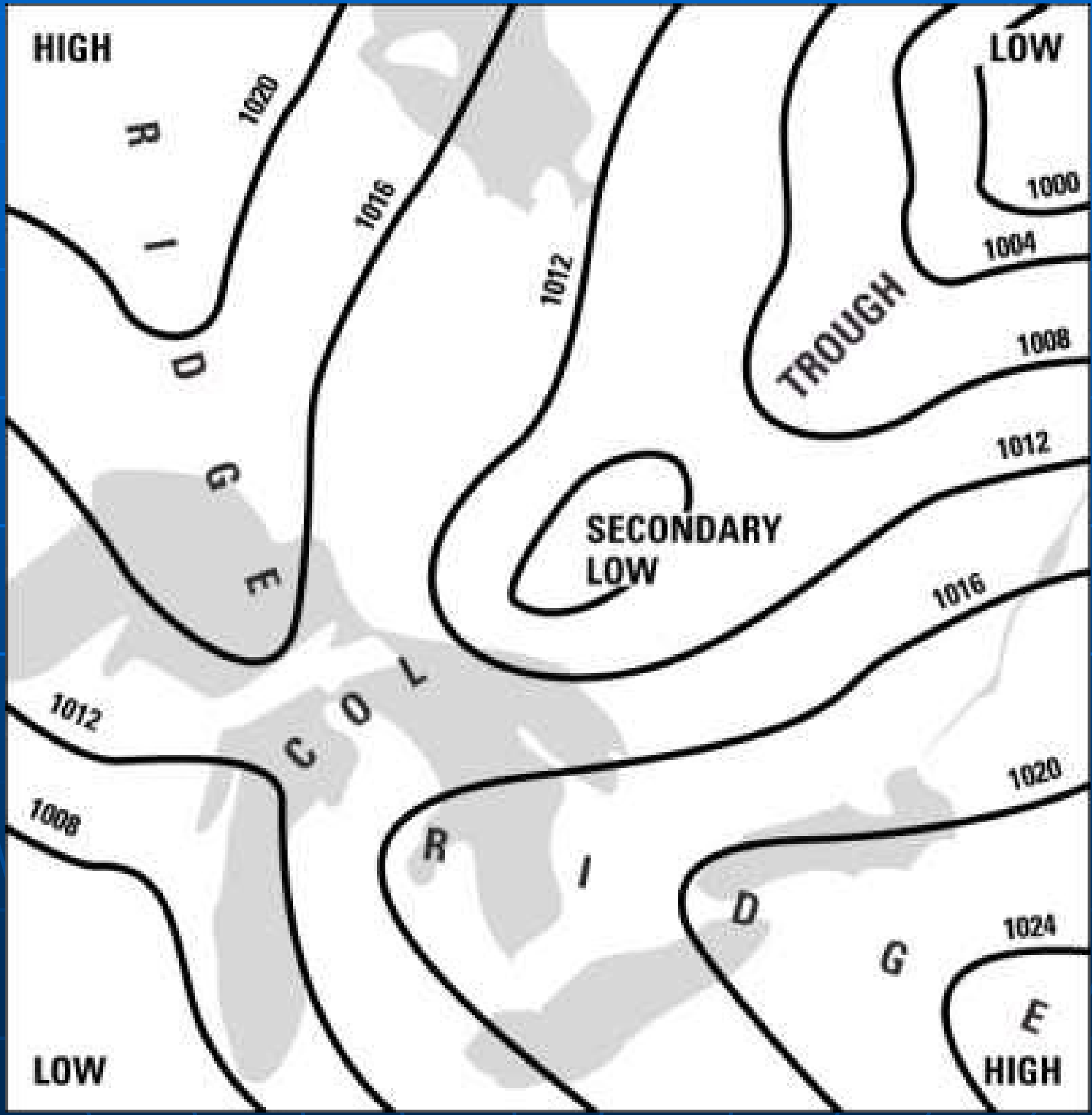


WEATHER MAPS

- pressure analysis using '**isobars**'
- pressure systems - patterns in the pressure field - **Low** (cyclones); **High** (Anticyclone), **Trough**, **Ridge**
l

Note: pressure systems are labeled relative to the surrounding pressure and not to the value of the central pressure

PRESSURE SYSTEMS



PRESSURE GRADIENT FORCE (PGF)

- force that causes the movement of air from high pressure to low pressure.
- strength is a direct function of the isobar (surface charts) or contour (upper charts) spacing.

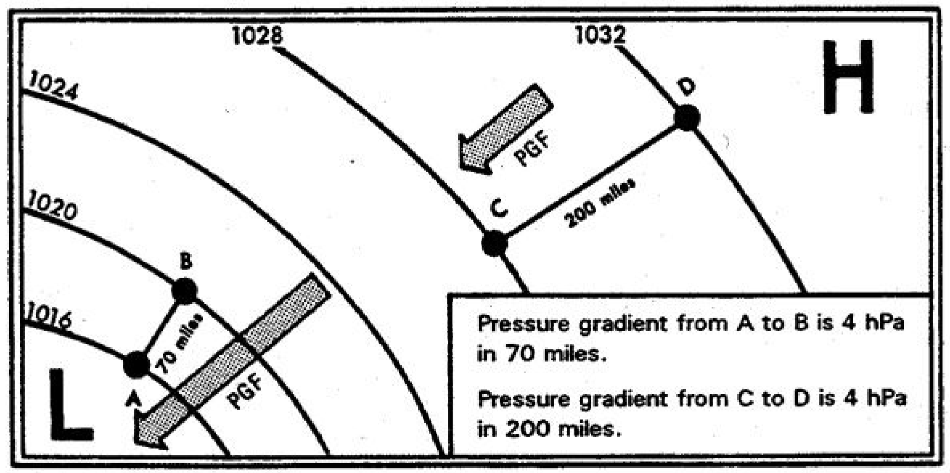
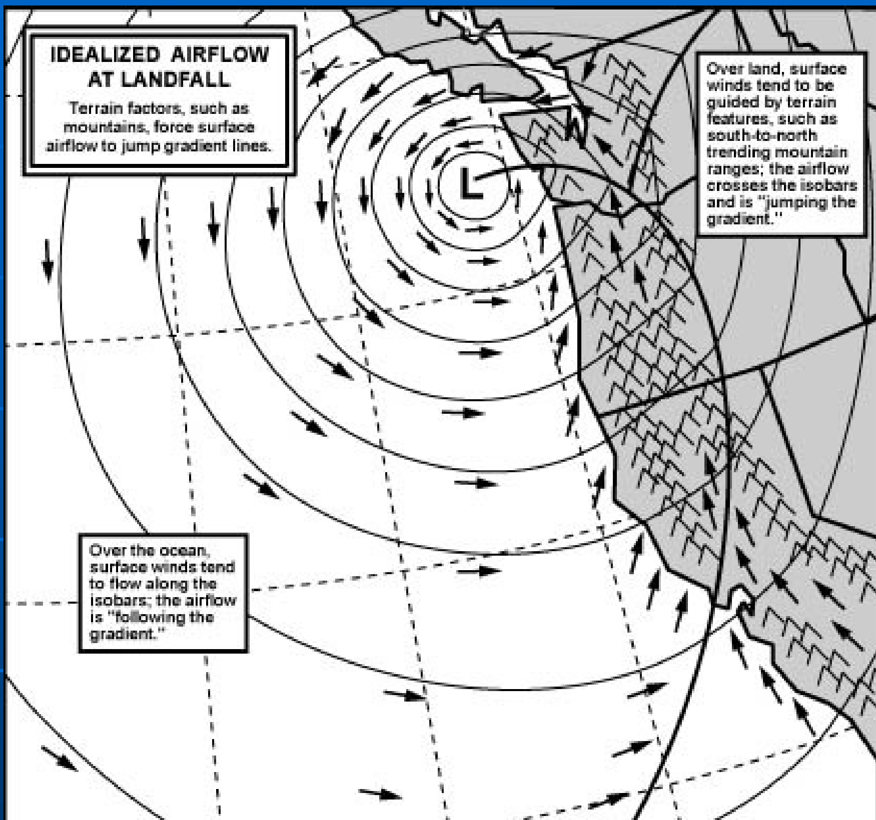
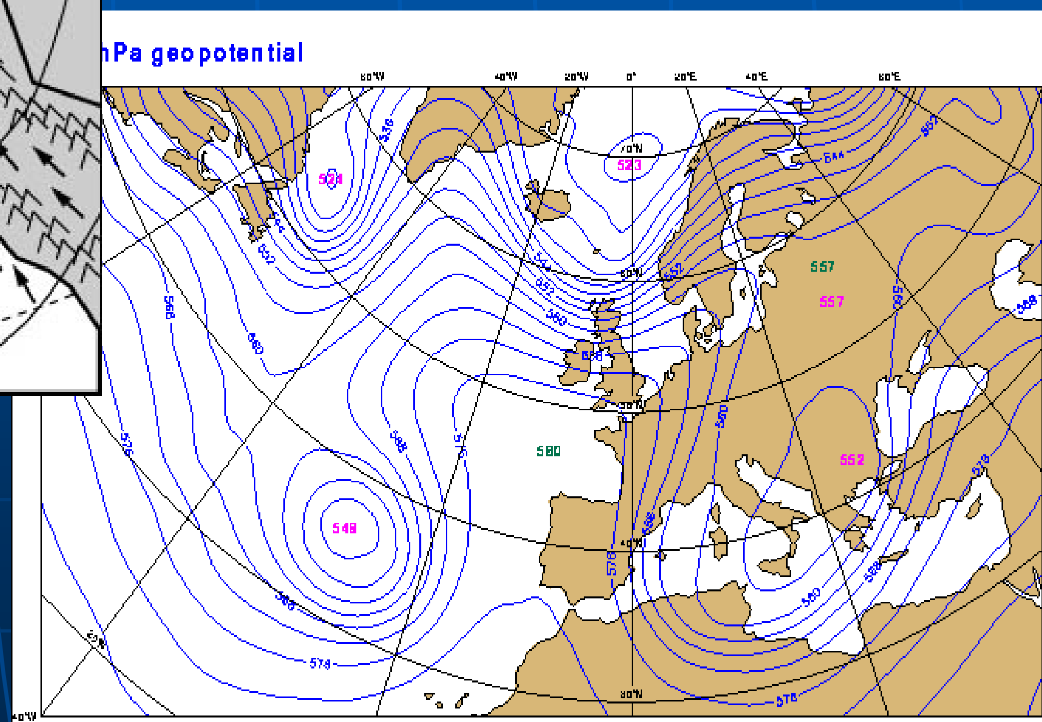


Figure 5-7 Pressure Gradient

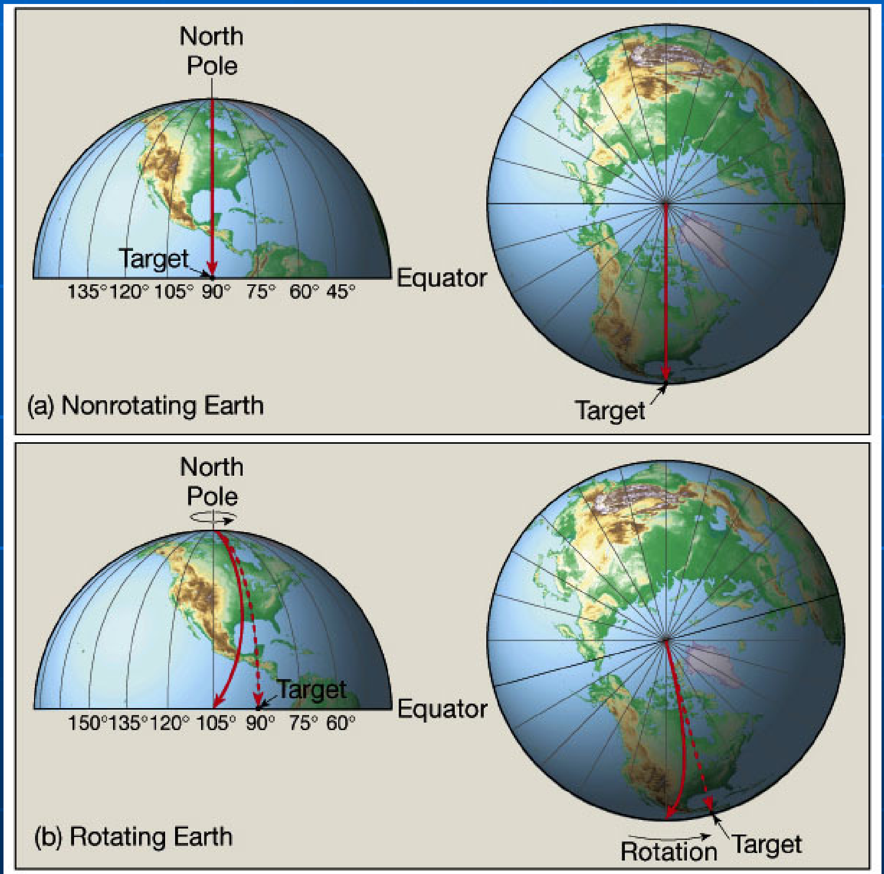
PRESSURE GRADIENT





CORIOLIS FORCE

- an 'apparent' force due to the earth's rotation causes air in motion to deflect to the right in the N. Hemisphere and to the left in the S. Hemisphere.

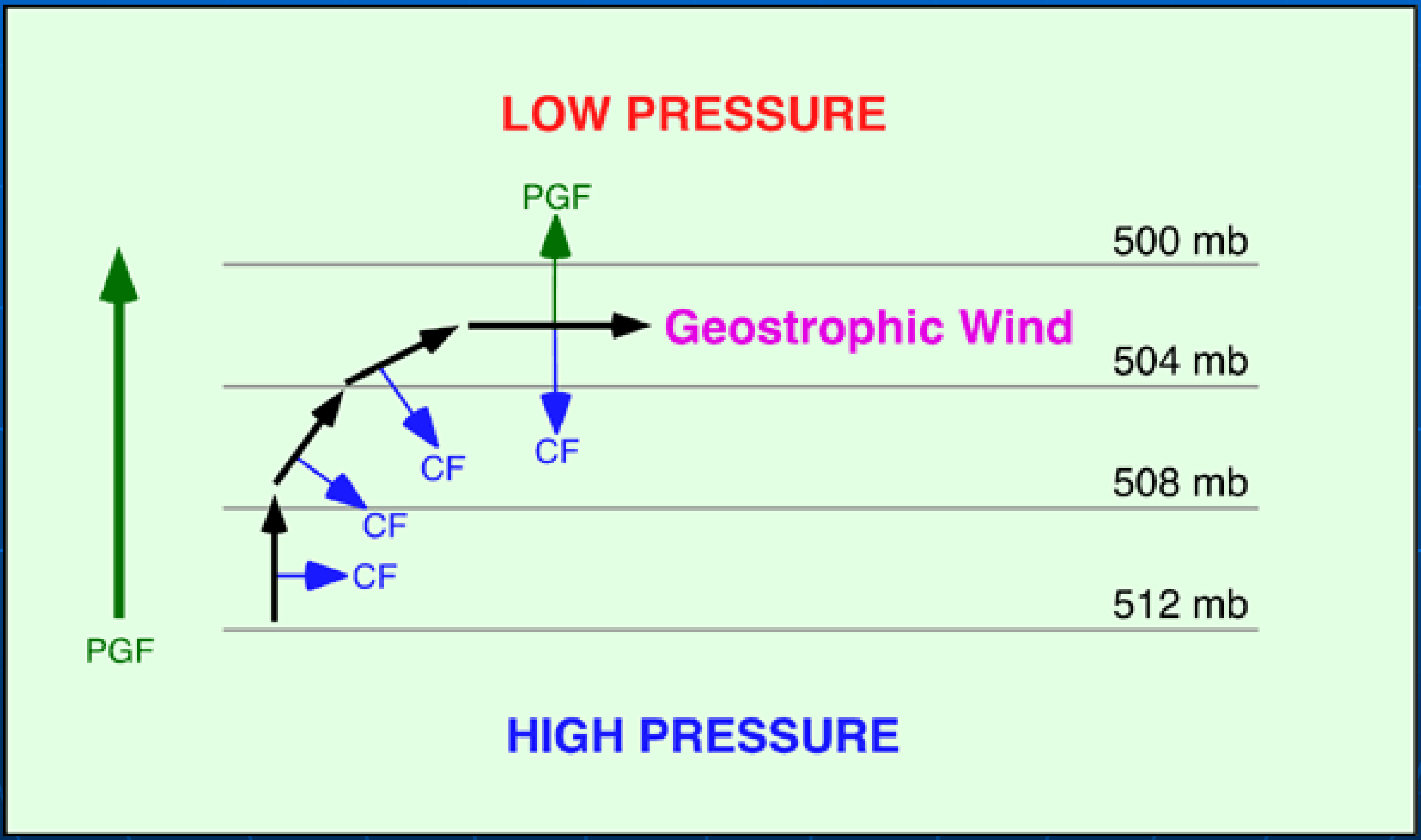


CORIOLIS FORCE

- strength of Coriolis Force increases with increased air speed

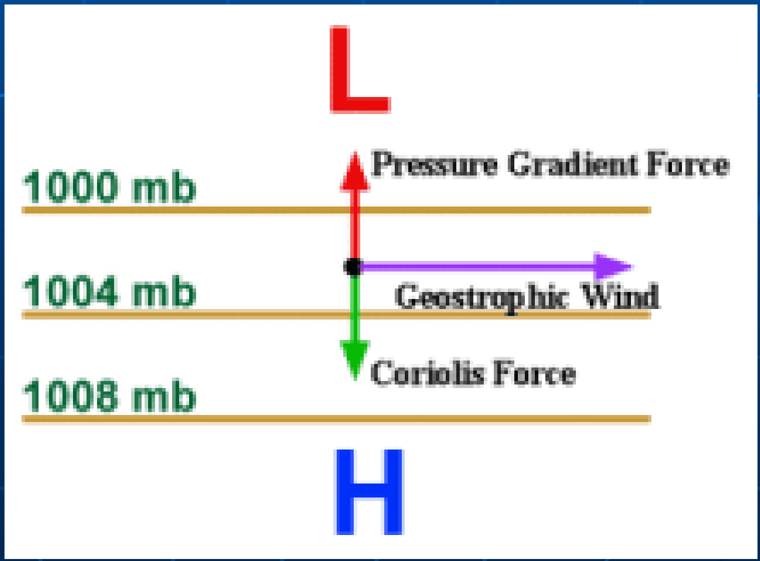
- Coriolis Force varies from zero at the equator to maximum strength at the poles

GEOSTROPHIC WIND



GEOSTROPHIC WIND

- resultant wind that occurs when the value of the CF balances (is equal and opposite) the PGF
- the resulting ‘Geostrophic Wind’ is steady and parallel to isobars
- strength of the ‘Geostrophic Wind’ is a direct function of the pressure gradient



LATITUDE EFFECT

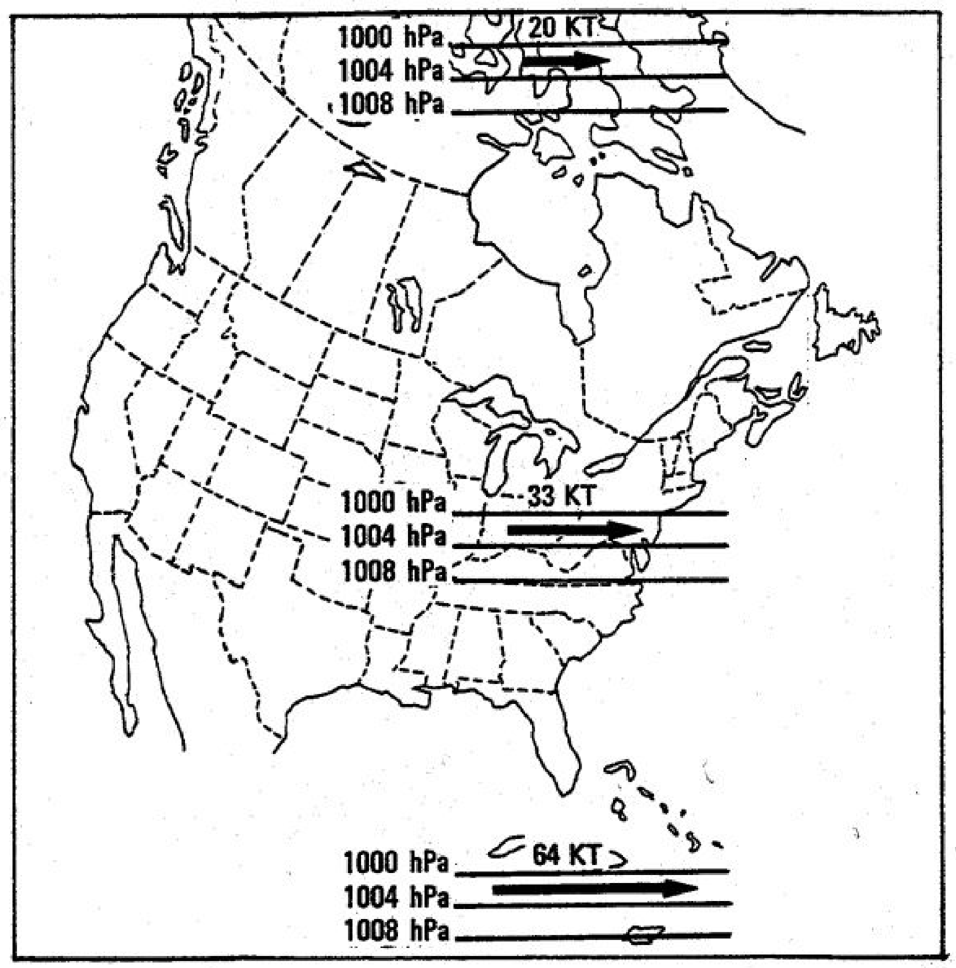


Figure 5-9 Latitude Effect on Geostrophic Wind

CURVATURE EFFECT

'geostrophic flow' is straight line flow. In curved,

flow another force vector, 'Centrifugal Force' is introduced.

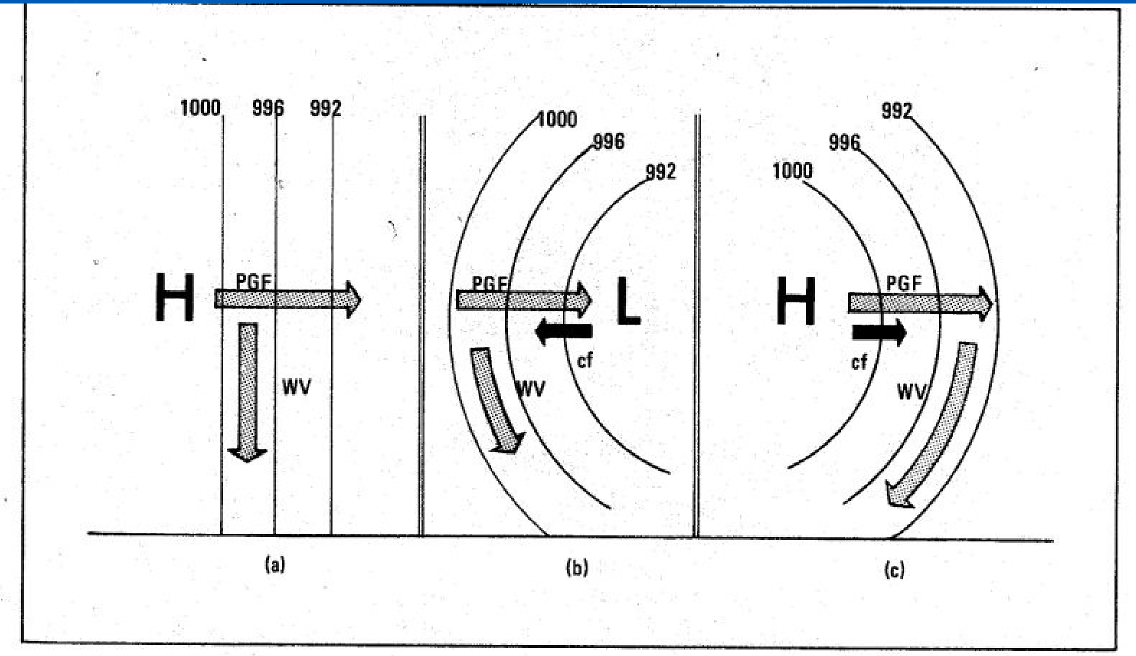


Figure 5-10 Effect of Curved Isobars

FRICTION EFFECT

- friction is a function of the 'roughness' of the terrain and acts opposite to wind

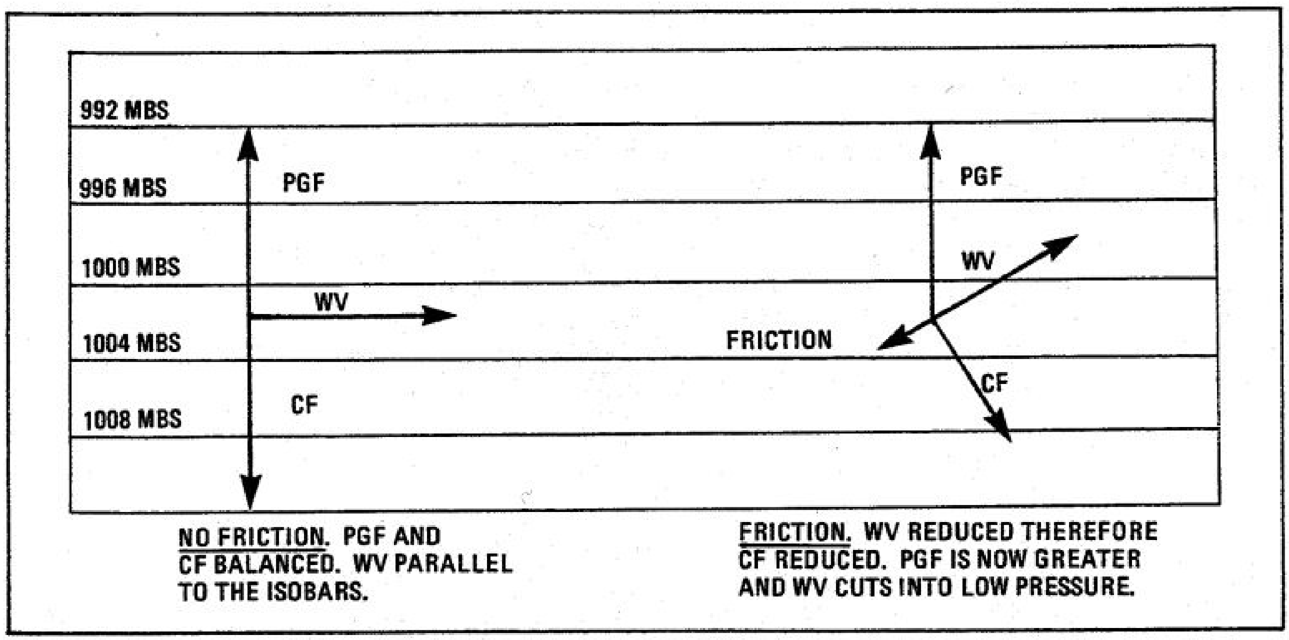


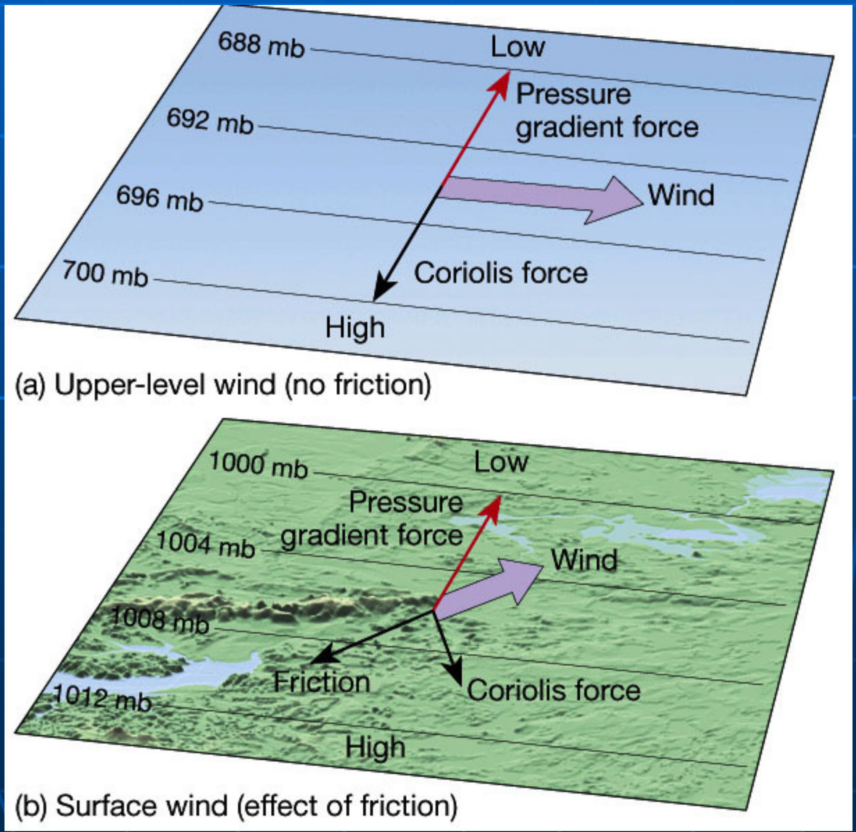
Figure 5-11 Surface Friction

FRICTION EFFECT

- friction is a function of the 'roughness' of the terrain and acts opposite to wind
- friction is greatest near ground but vertical mixing carries effect aloft
- 'friction layer'- surface to 3000 feet or so
- effect causes wind to cut across the isobars 'in' towards a low and 'out' away from a high

EFFECT OF FRICTION

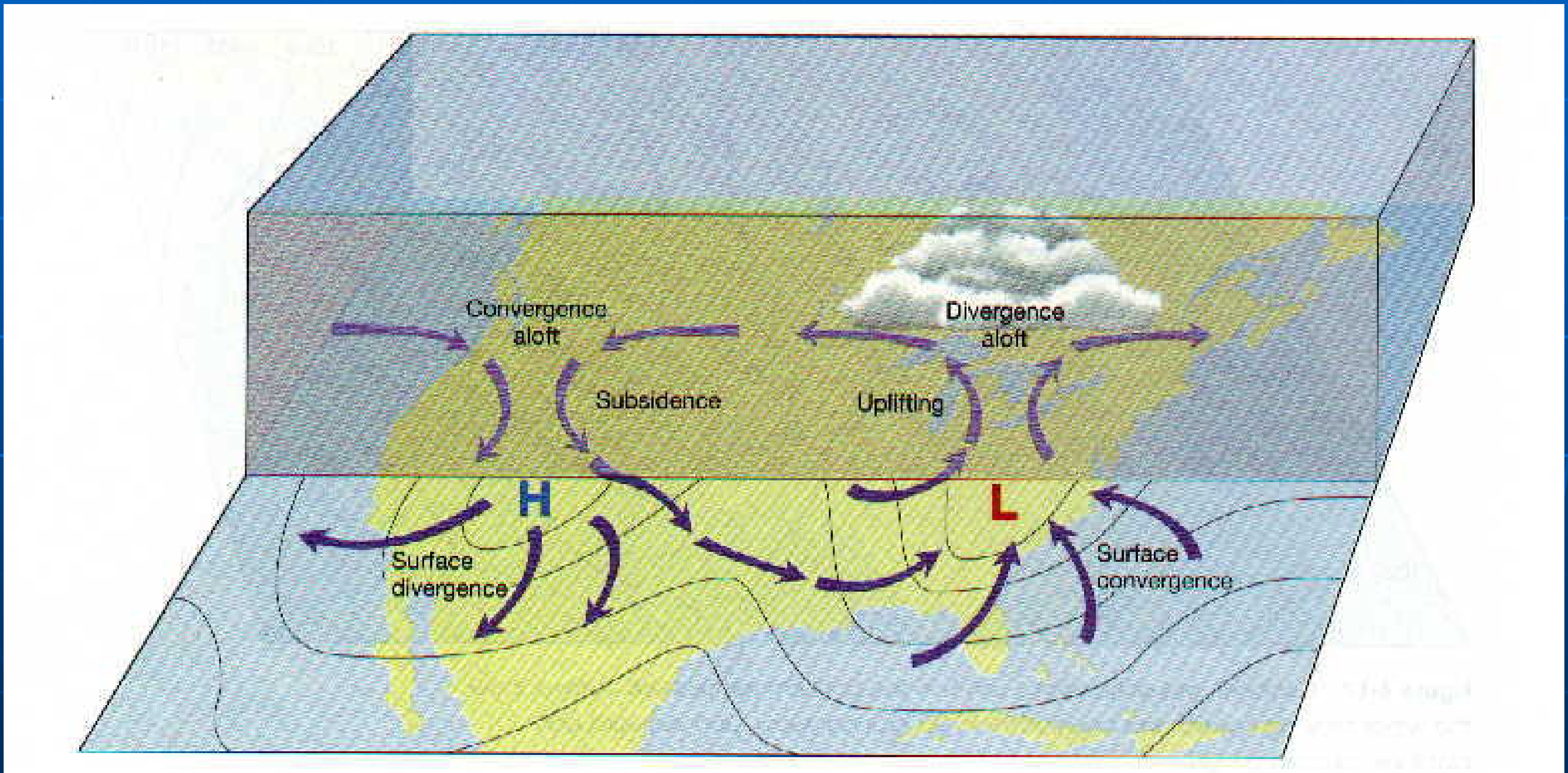
- average deflections - 10 degrees over ocean; 40 degrees over very rough terrain



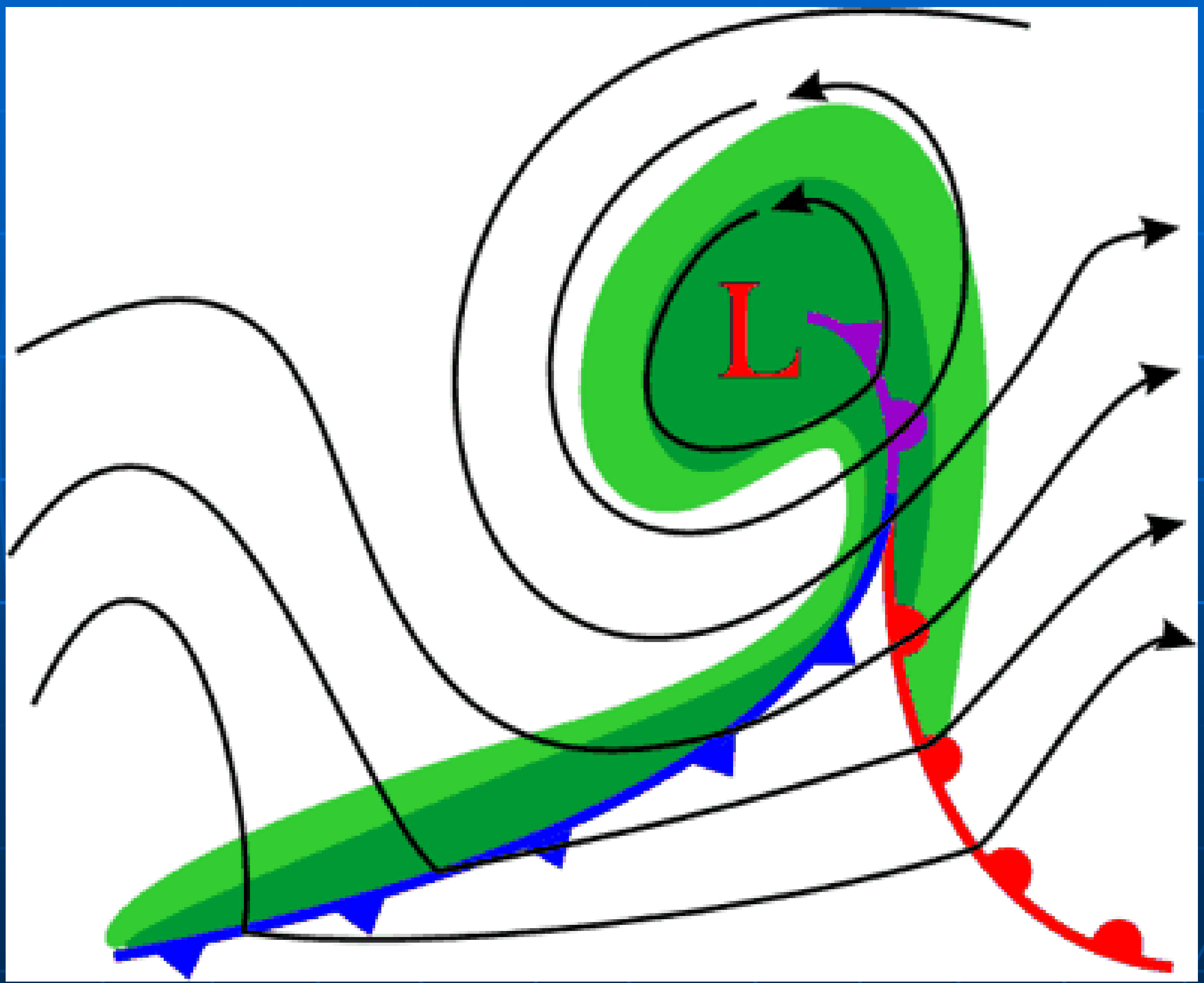
(a) Upper-level wind (no friction)

(b) Surface wind (effect of friction)

CONVERGENCE / DIVEREGENCE



AIR MASSES AND FRONTS



AIR MASS

- A body of air, usually 1000+ miles across (1600+ kilometers), with uniform temperature and moisture characteristics in the horizontal.
- Created by remaining over a uniform surface, called a source region, for a long period of time
- Weather can vary horizontally (due to lift, changes in stability, etc)

CLASSIFICATION OF AIR MASSES

Air masses - defined by MOISTURE ONTENT and TEMPERATURE

- moisture - dry - Continental (c)
  - moist - Maritime (m)
- temperature - cold - Arctic (A)
  - intermediate - Polar (P)
  - warm - Tropical (T)

MODIFICATION OF AIR MASSES

Amount of modification depends on:

- speed of movement
- moisture content of region it's moving over
- temperature difference between new surface and air mass

Air masses can change their identity,

i.e. cA $\Rightarrow$ mA $\Rightarrow$ mP

MAJOR AIR MASS TRACKS

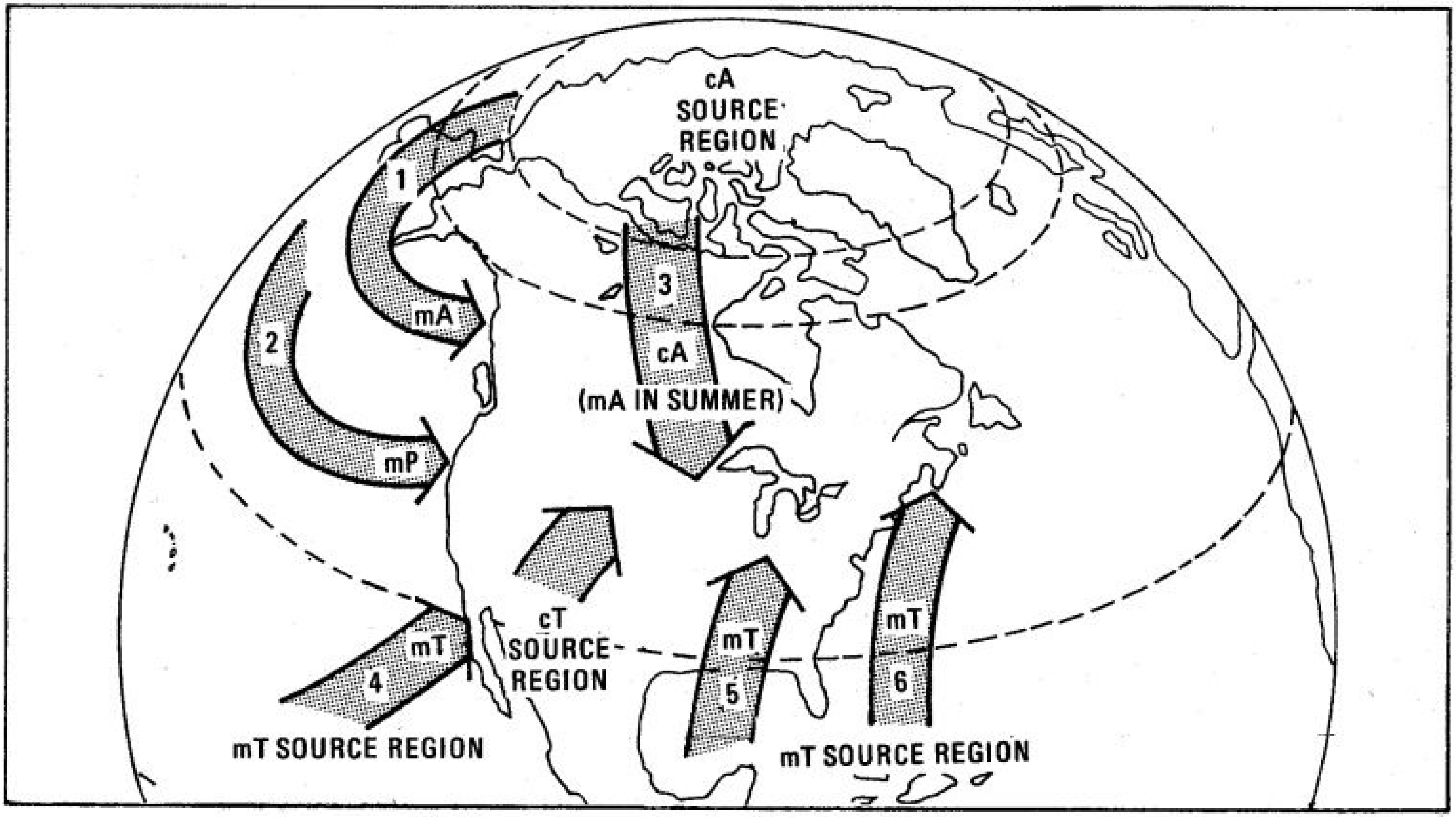
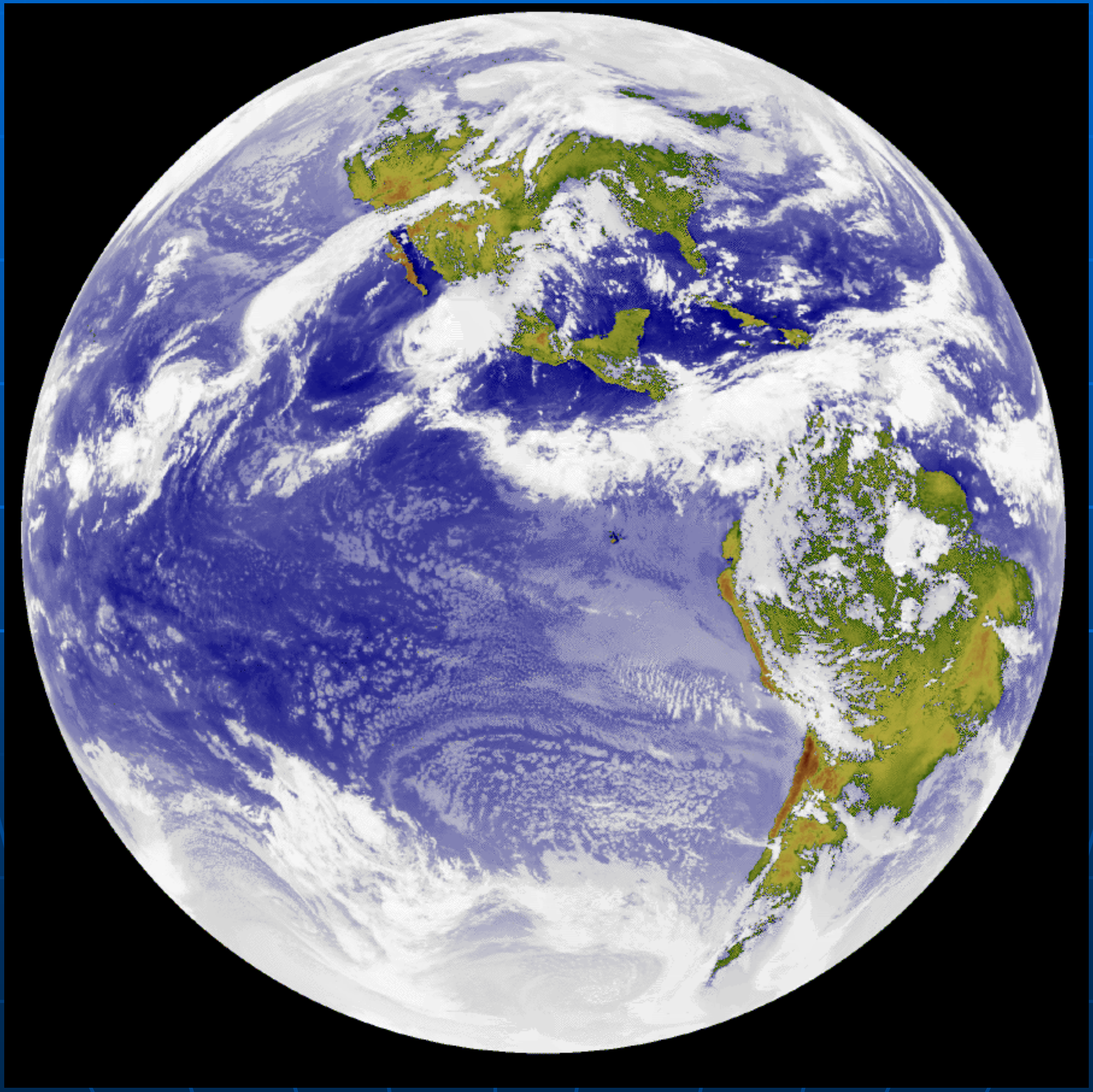


Figure 6-5 Air Mass Source Regions

FRONTS



FRONTS

A transition zone between two air masses

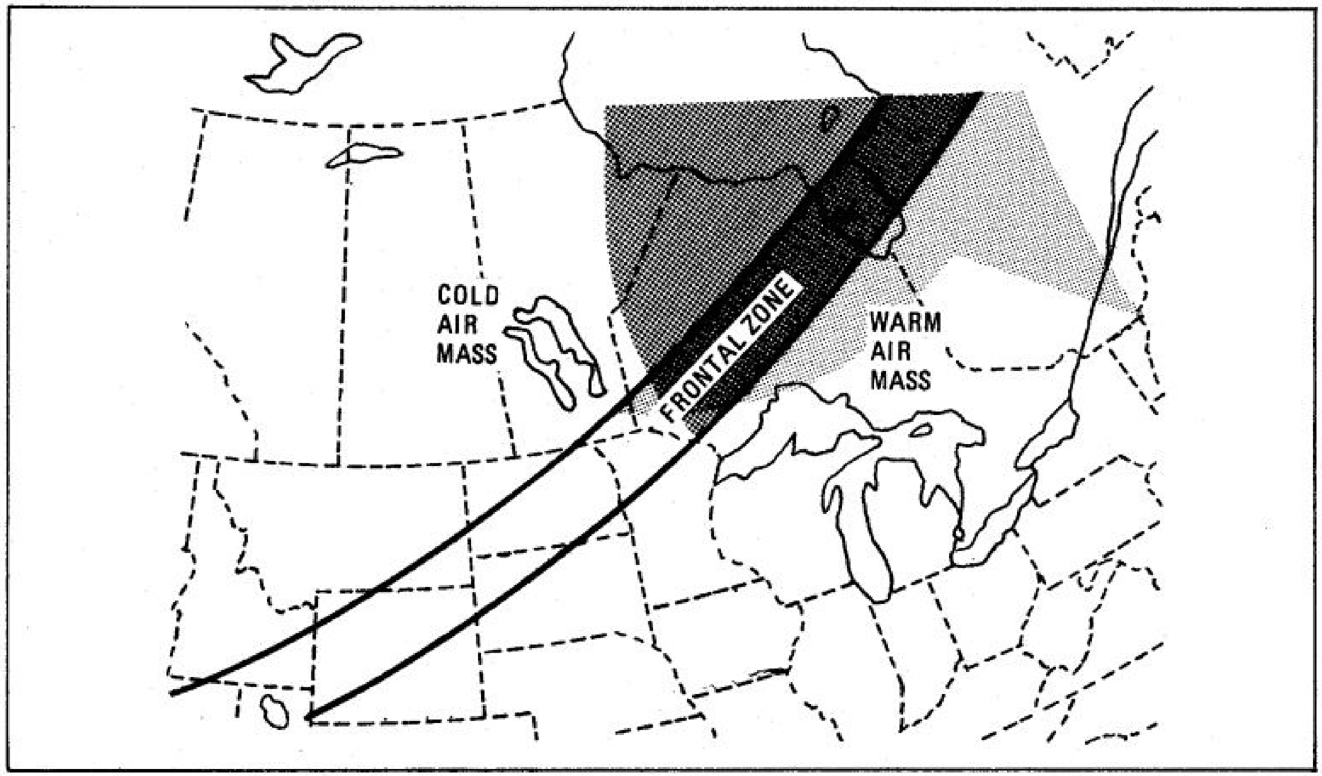
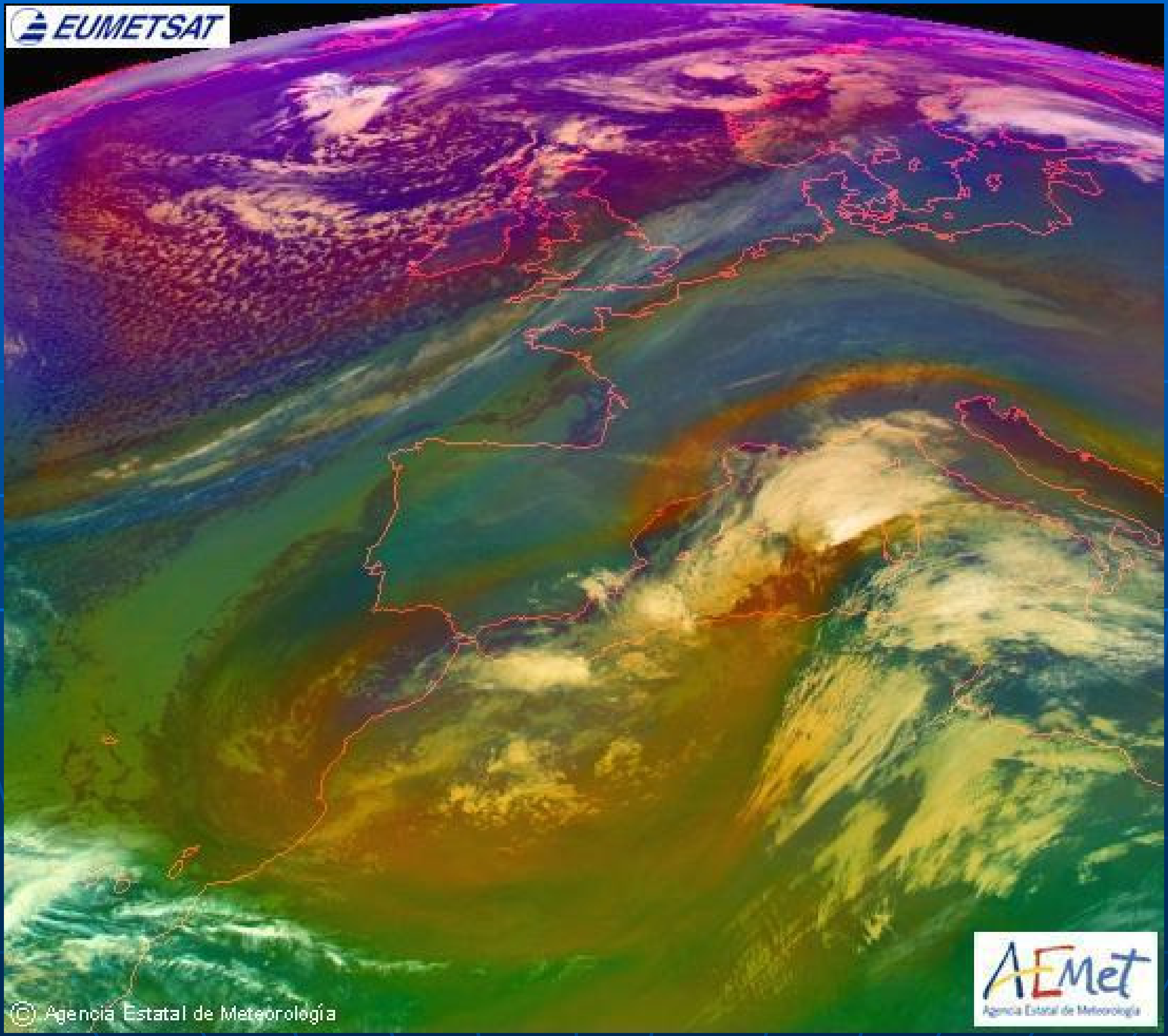


Figure 6-6 A Front Between Two Air Masses

FRONTS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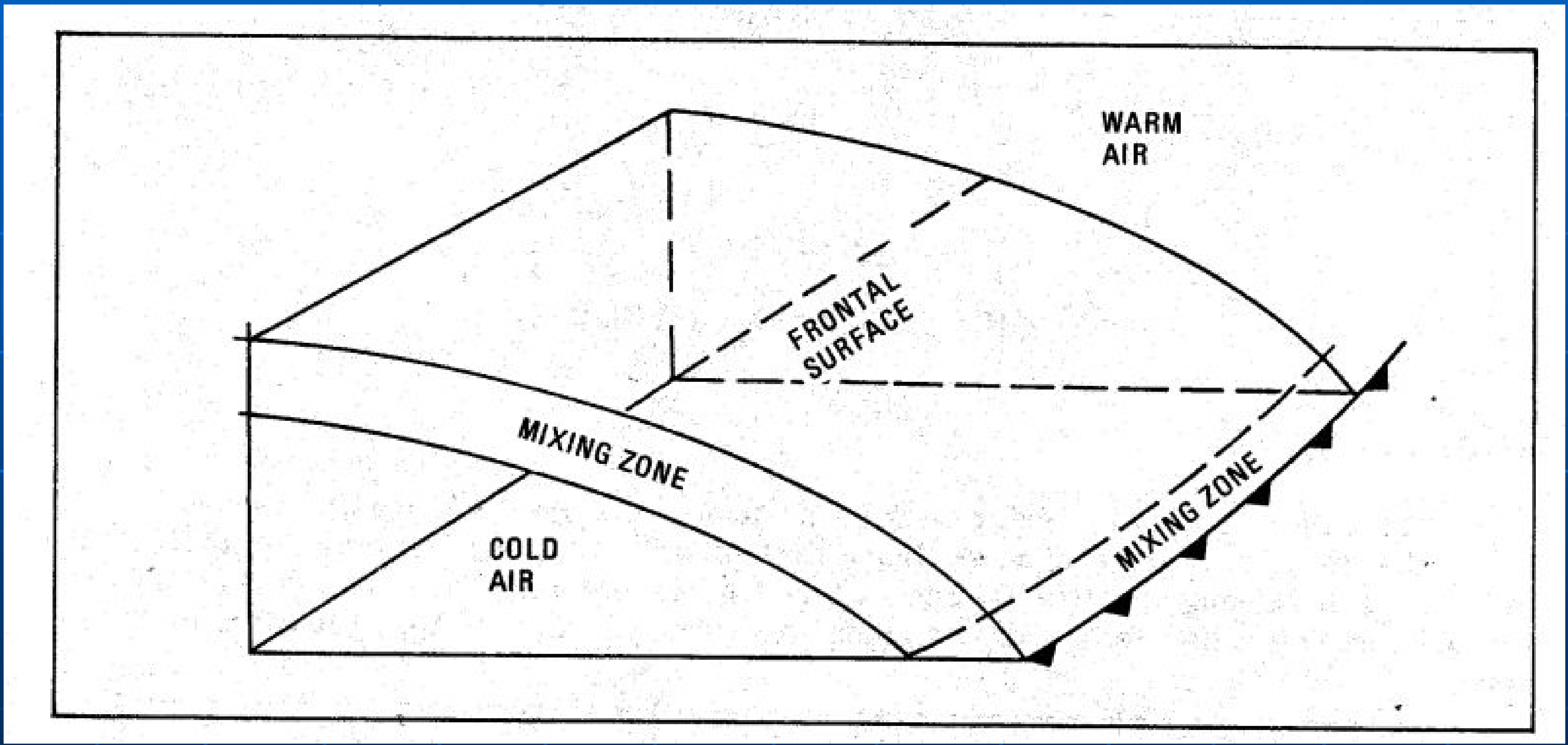
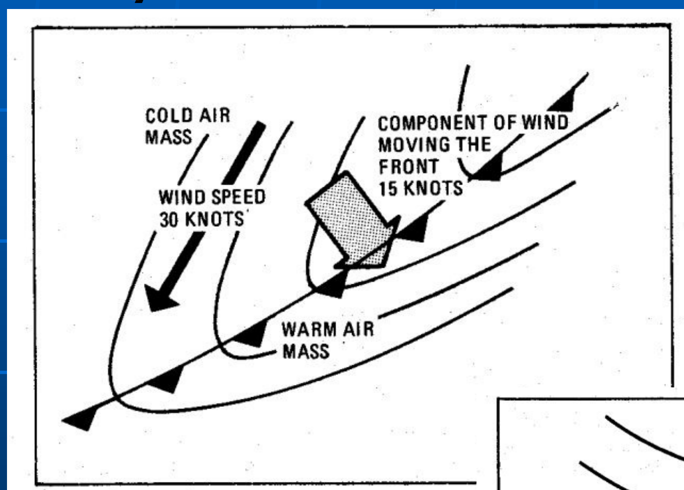
FRONTS

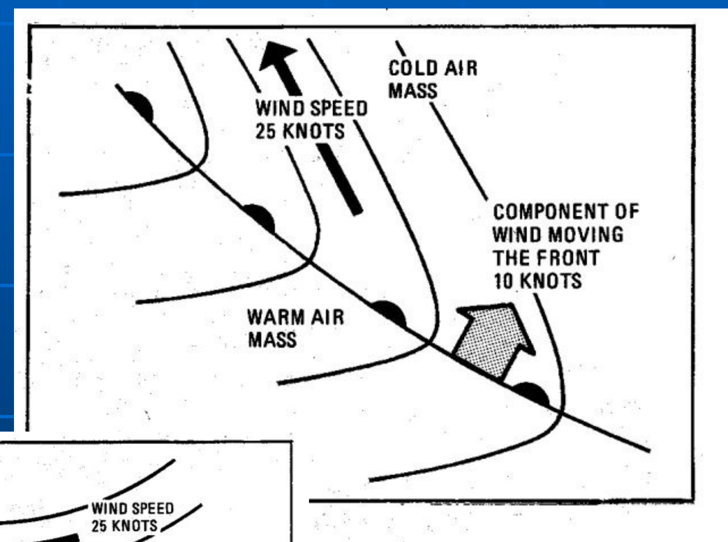


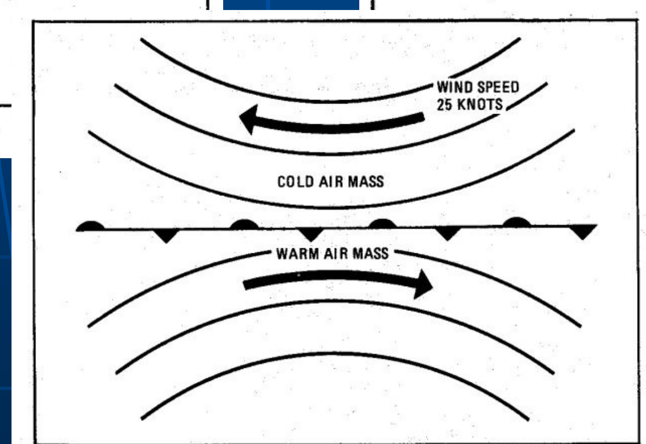
MOVEMENT OF FRONTS

- Movement is dependent on the motion of the cold air perpendicular to the front only



(a) COLD FRONT

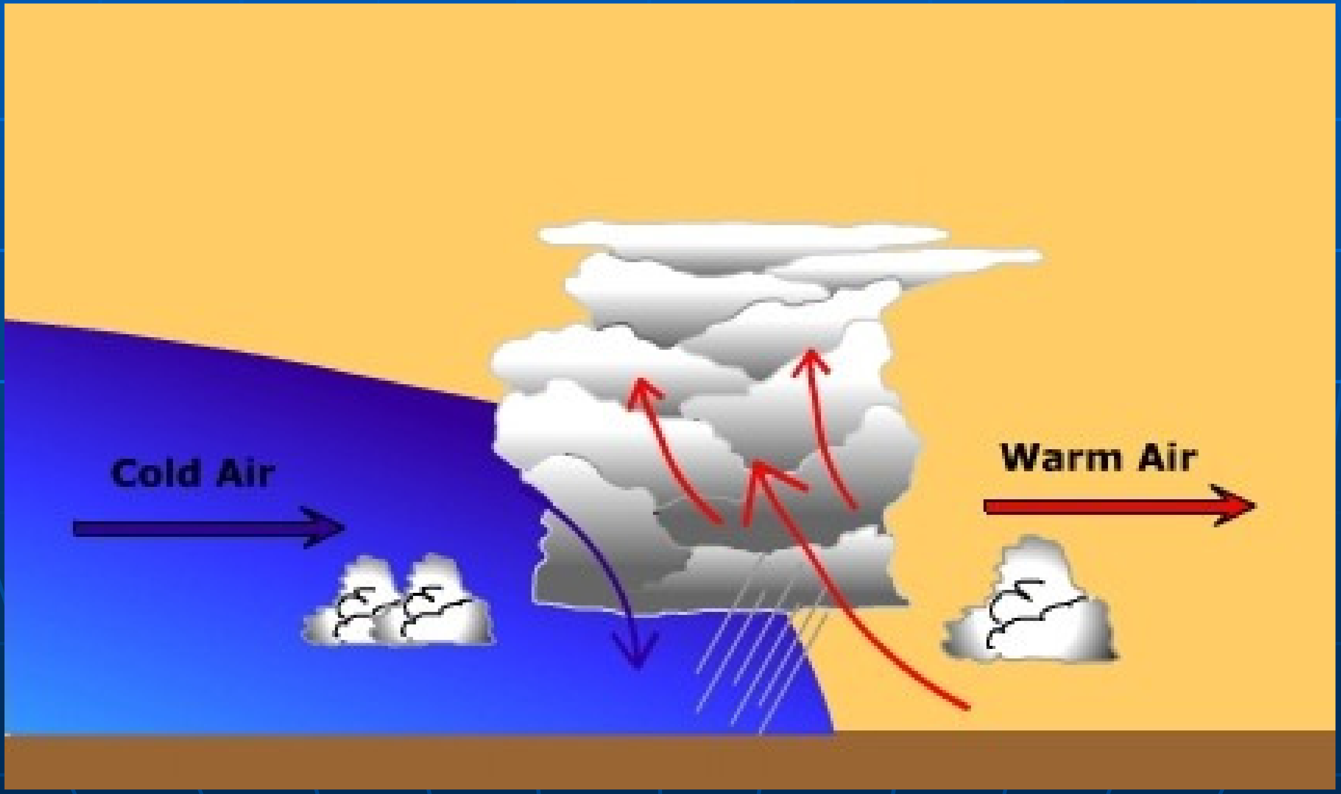




(c) QUASISTATIONARY FRONT

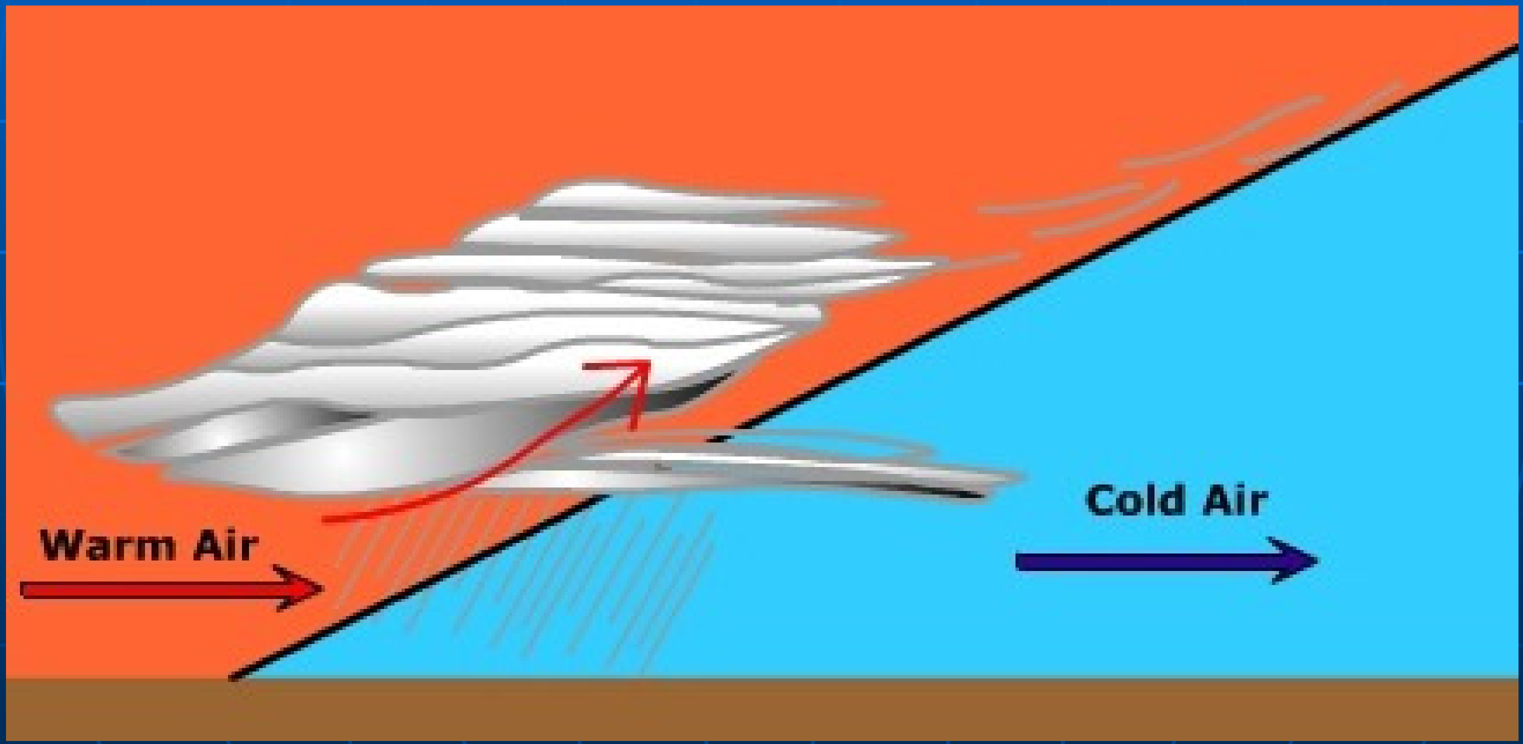
COLD FRONT

- Slope: 1-½ degree (1:50)
- Lift: undercutting



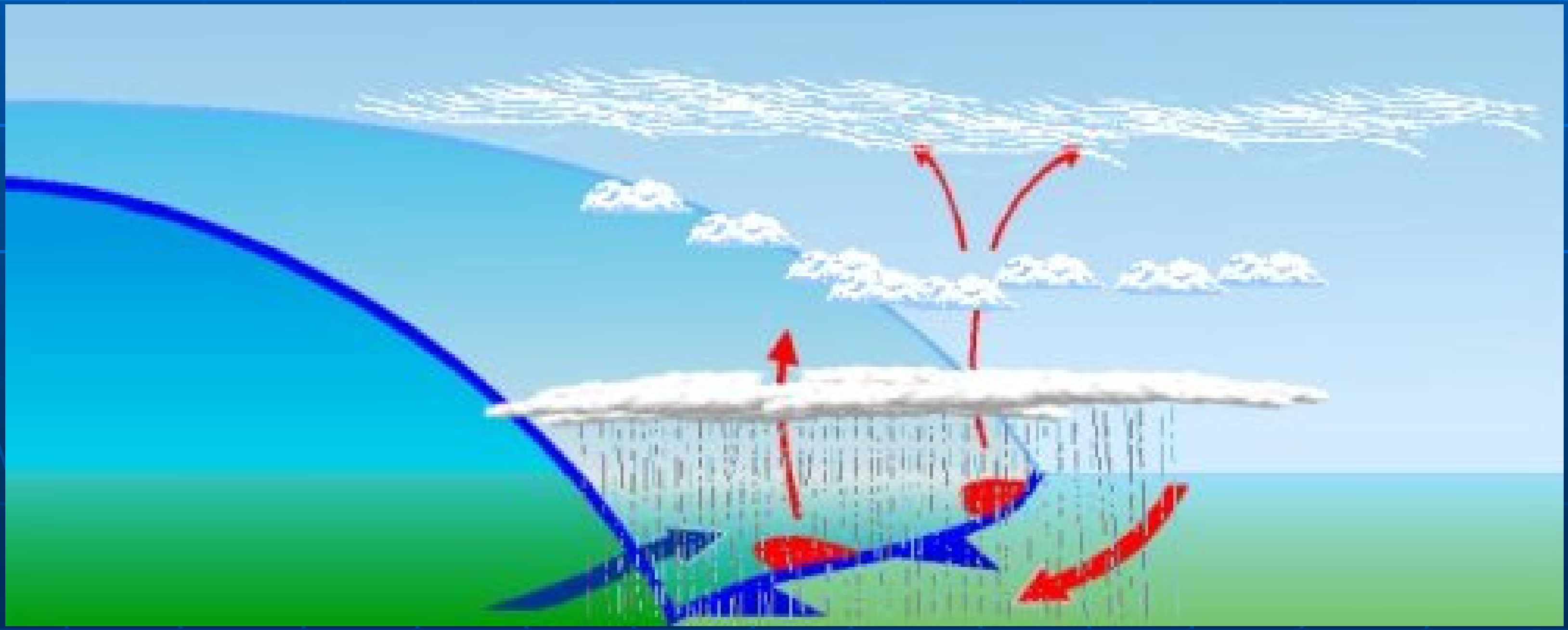
WARM FRONT

- Slope: ½ degree (1:200)
- Lift: Overrunning



QUASISTATIONARY FRONT

- Slope: approx. 1 degree (1:125)
- Lift: Mainly overrunning



UPPER FRONTS

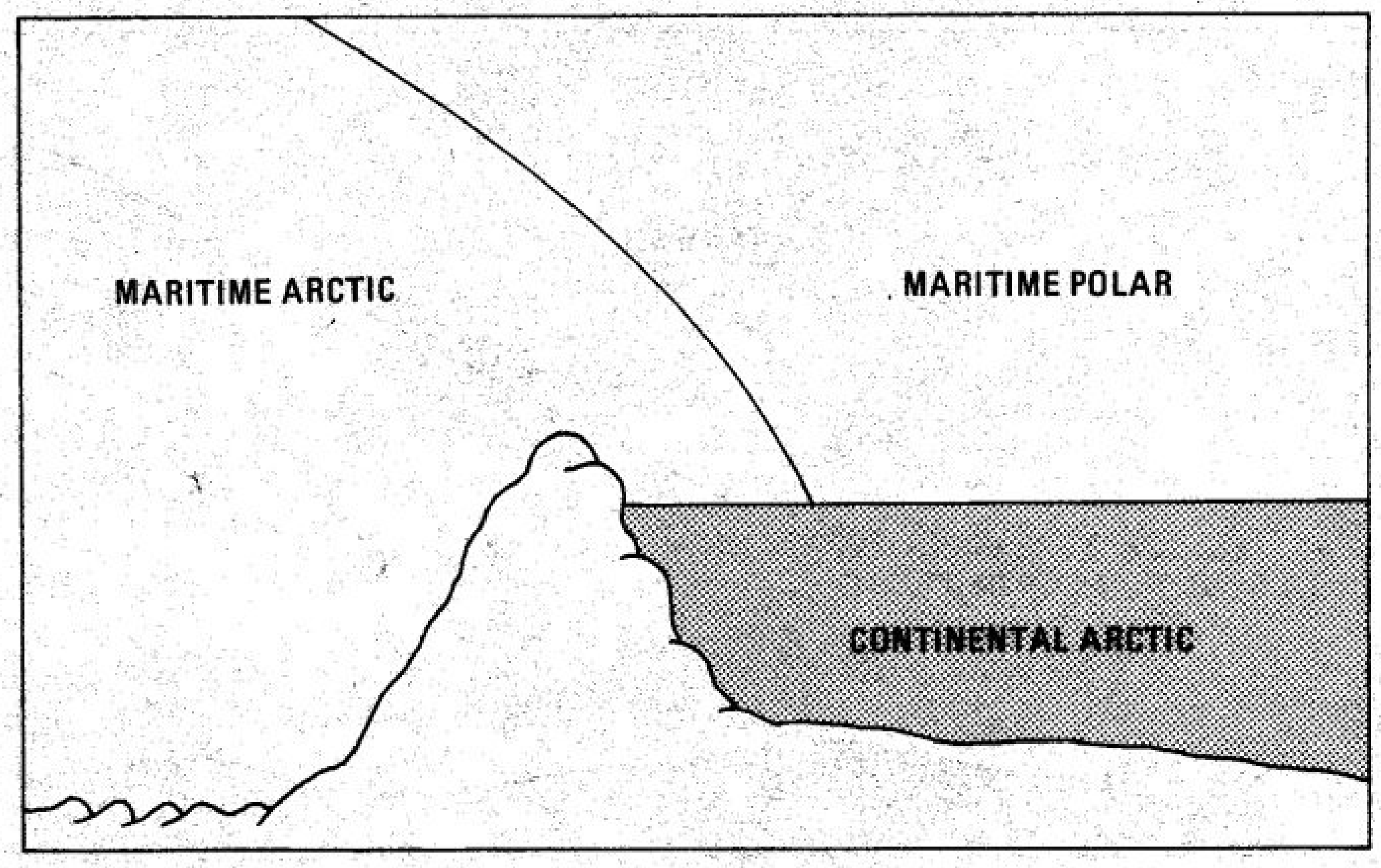


Figure 7-12 An Upper Cold Front

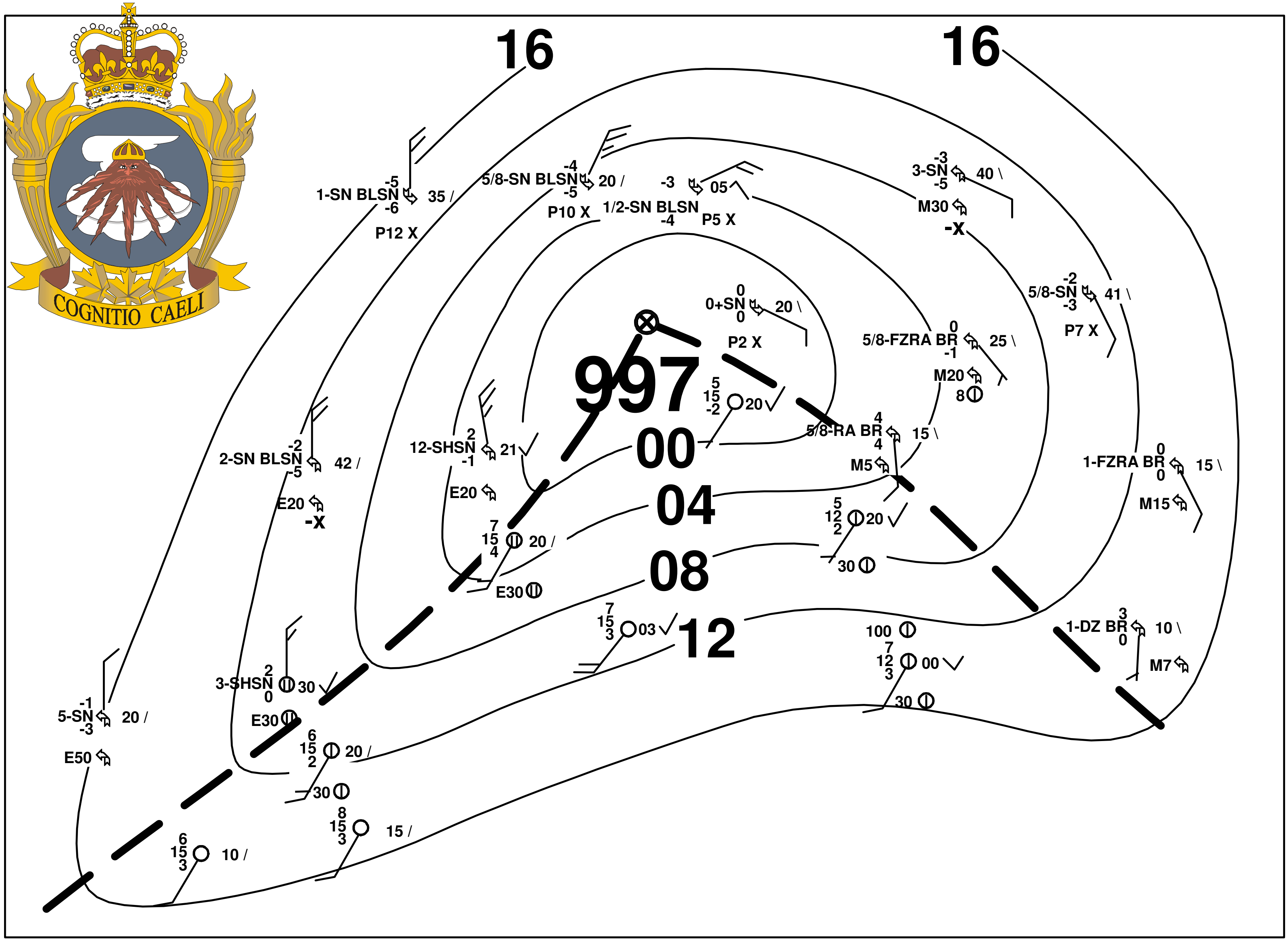


Fig. C7.2.1 Surface frontal discontinuities.

WEATHER CHANGES ACROSS FRONTS

Different air masses; different properties

- temperature
- dew point
- pressure
- wind
- visibility

COLD FRONT PASSAGE (WARM TO COLD)

- wind shift - southwest to northwest
- temperature - decreases
- dew point - decreases
- pressure - rises often rapidly
- visibility - improves
- clouds - mainly convective

COLD FRONT PASSAGE (WARM TO COLD)

- weather tend to be ‘active’
- weather band is narrow
- weather varies speed of front, amount of moisture and stability

WARM FRONT PASSAGE (COLD TO WARM)

- wind shift - east-southeast to southwest
- temperature - rises
- dew point - increases
- pressure - falls then steadies or rises slowly
- visibility – improvement as precipitation stops

WARM FRONTAL PASSAGE (COLD TO WARM)

- clouds - layered (possible embedded convective types)
- weather band is broad and gets worse as you approach front
- weather varies speed of front, amount of moisture and stability

FRONTOLYSIS and FRONTOGENESIS

Frontolysis - the dissipation of front
Occurs when the temperature gradient between the two air masses becomes too ‘broad’ to identify the front

Frontogenesis - the formation of front
Occurs when the temperature gradient between the two air masses ‘tightens up’ enough to identify the front

STABLE WAVES

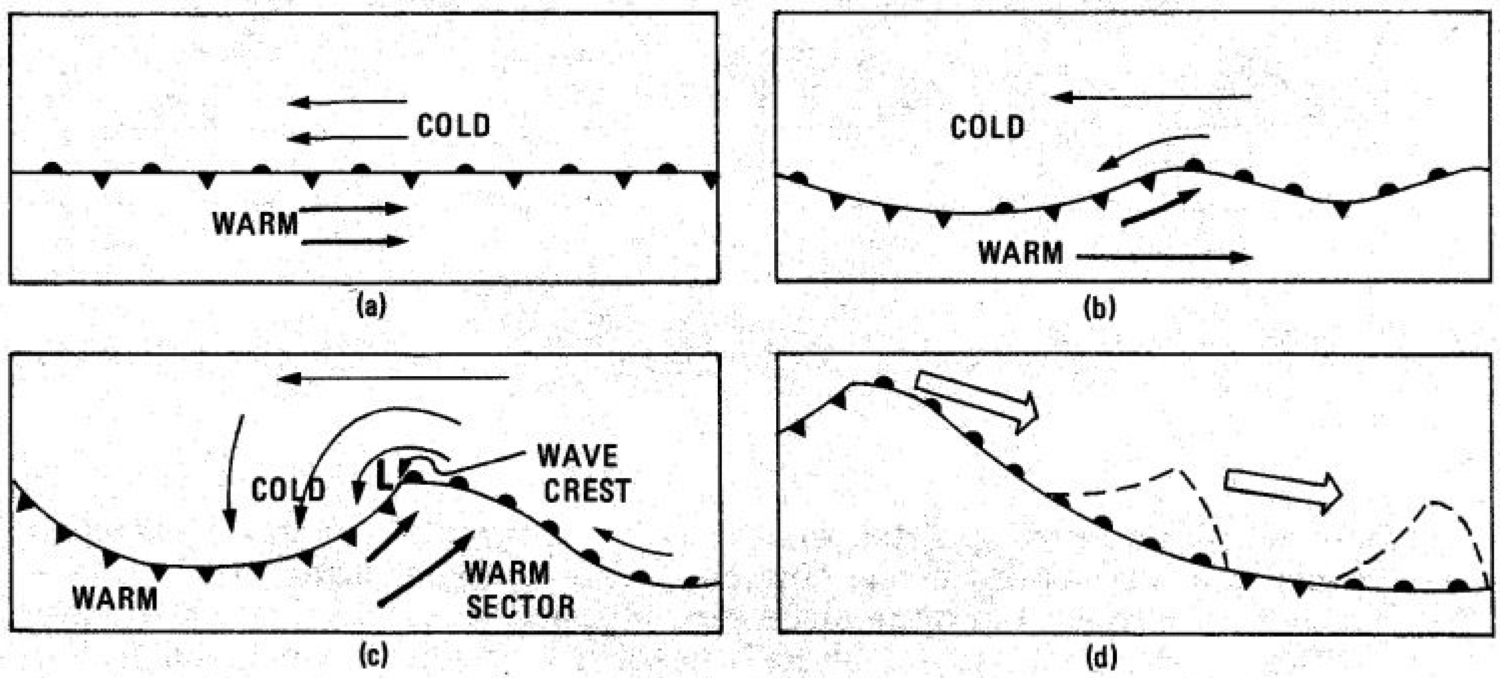
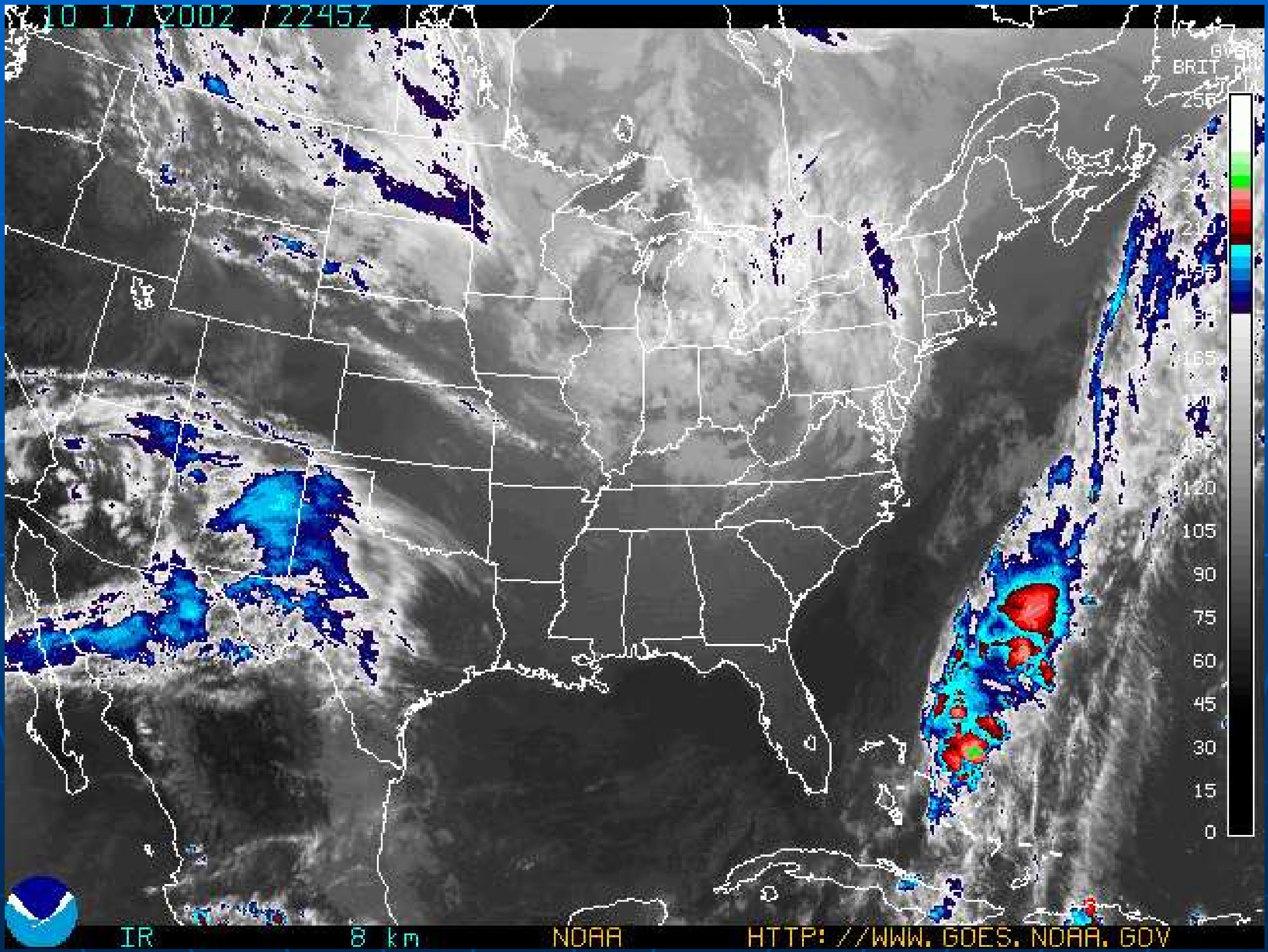


Figure 7-16 Formation of a Frontal Wave

STABLE WAVES



UNSTABLE WAVES AND OCCLUSIONS

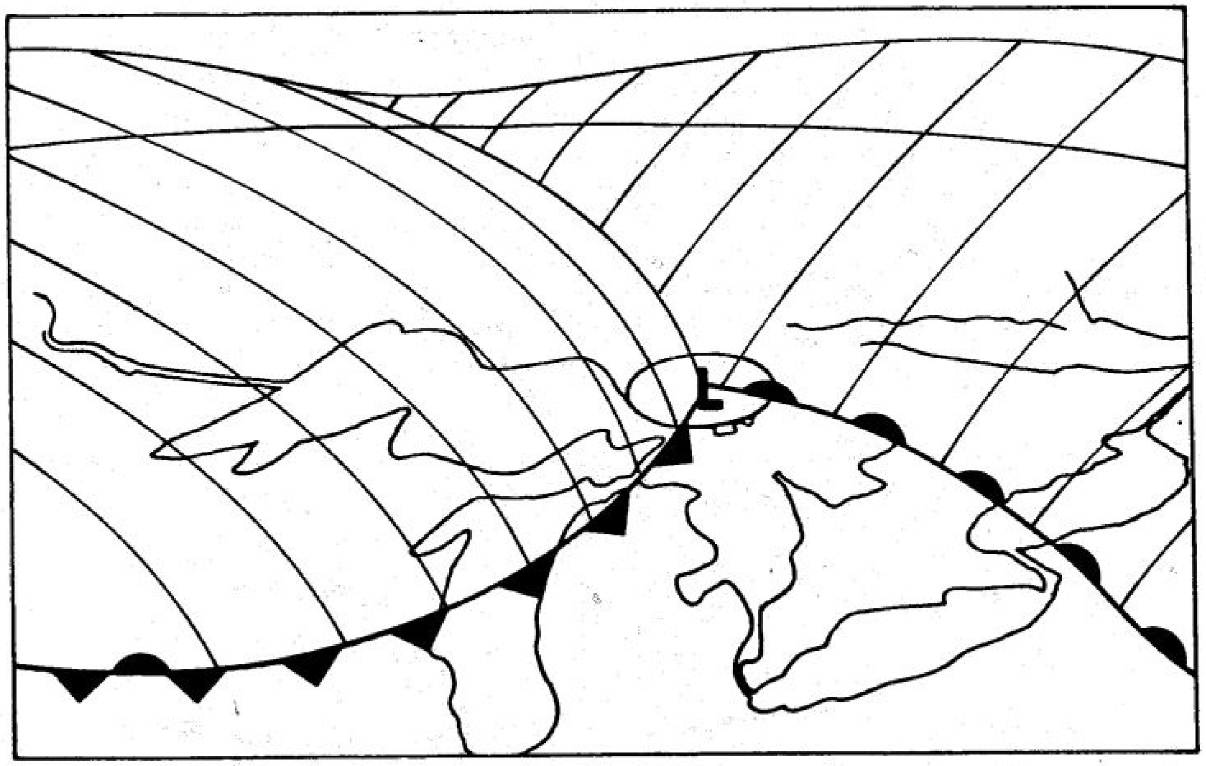
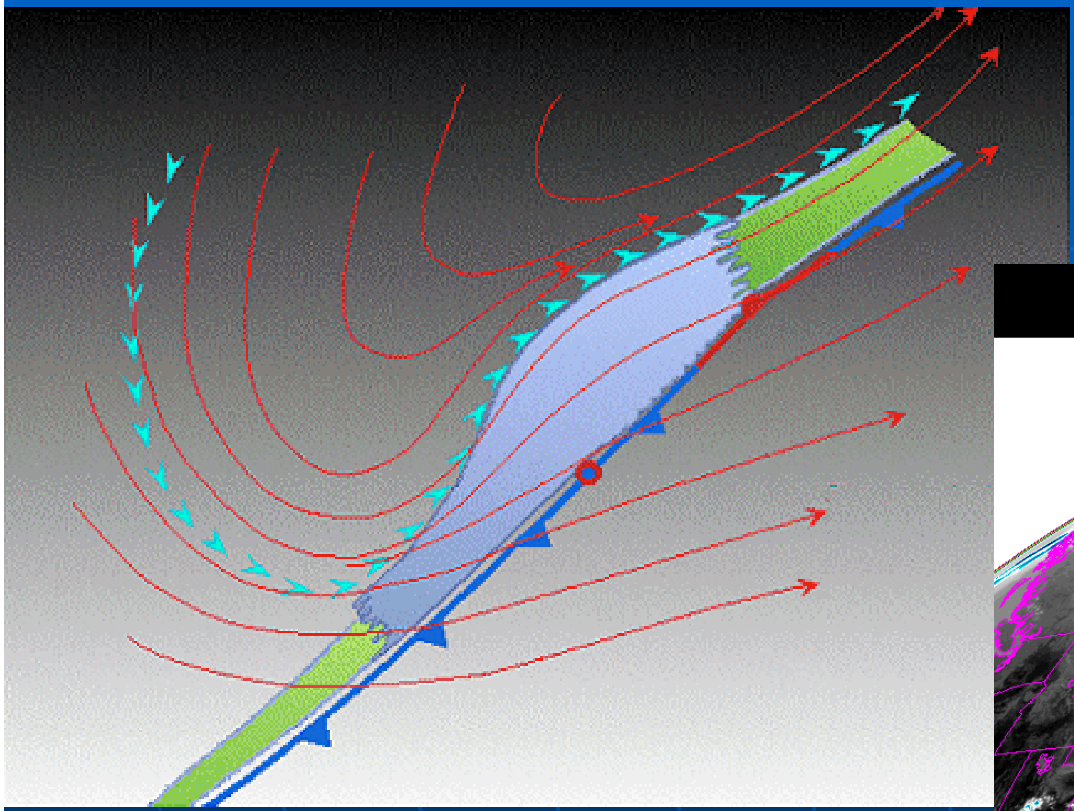
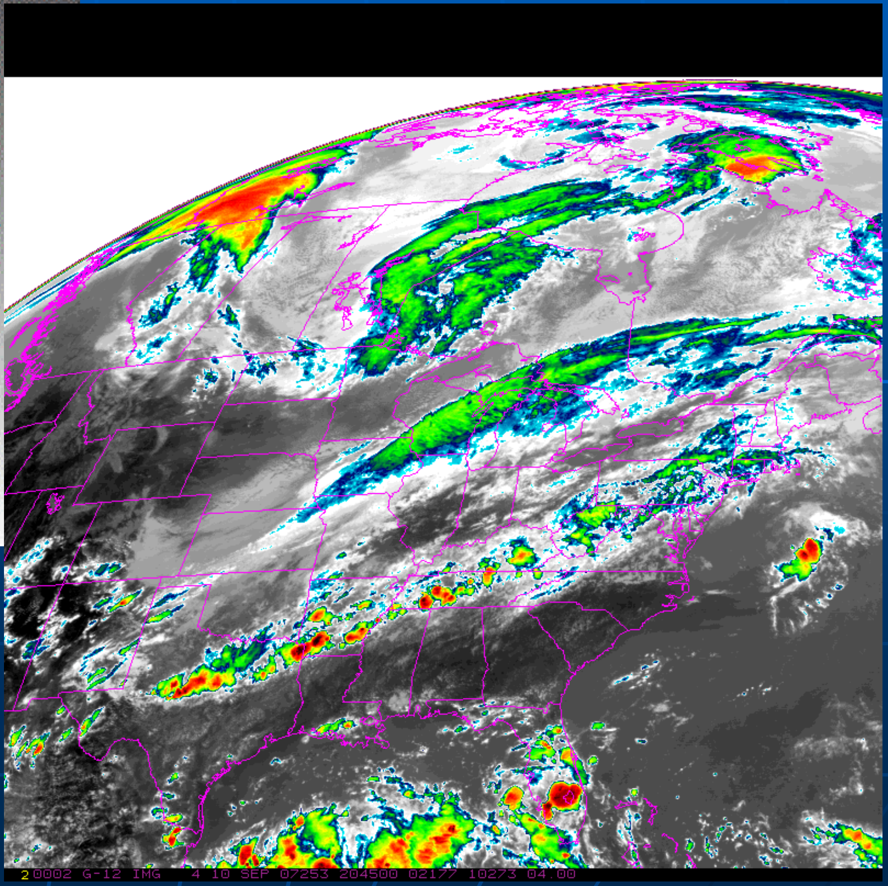


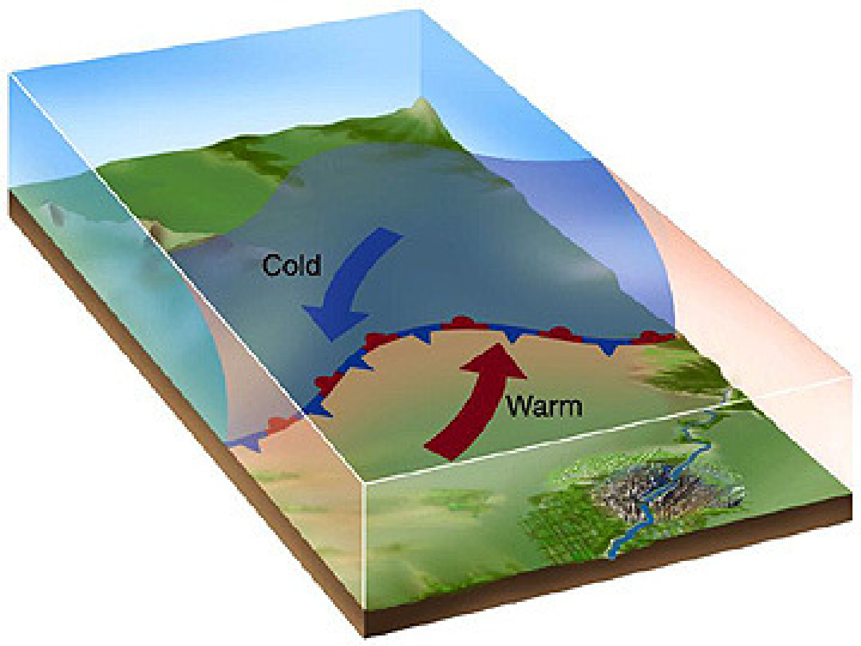
Figure 7-17 A Frontal Wave

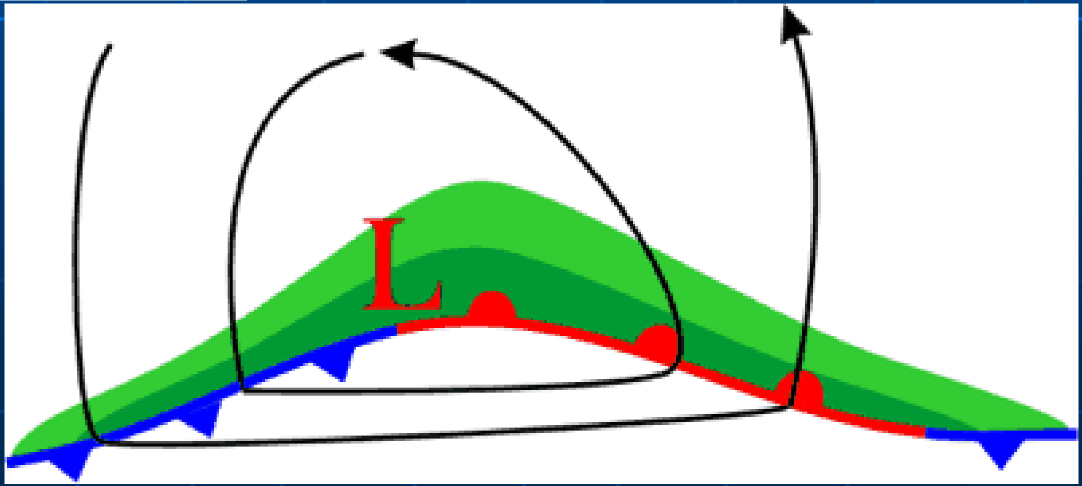
BAROCLINIC LEAF



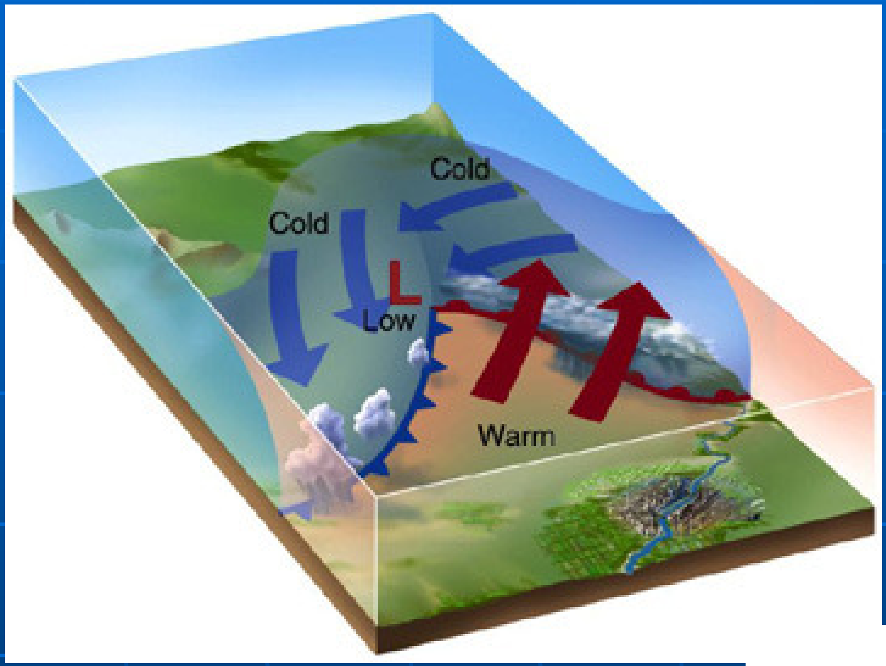


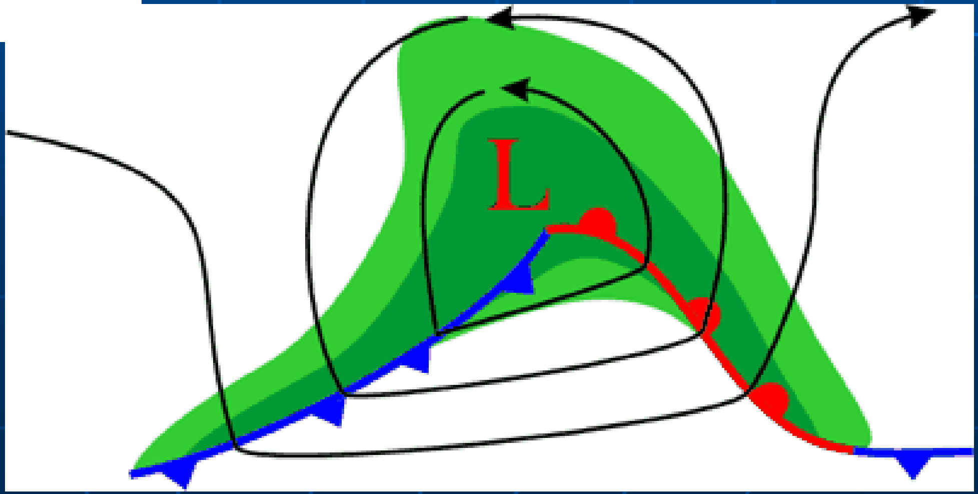
IN THE BEGINNING



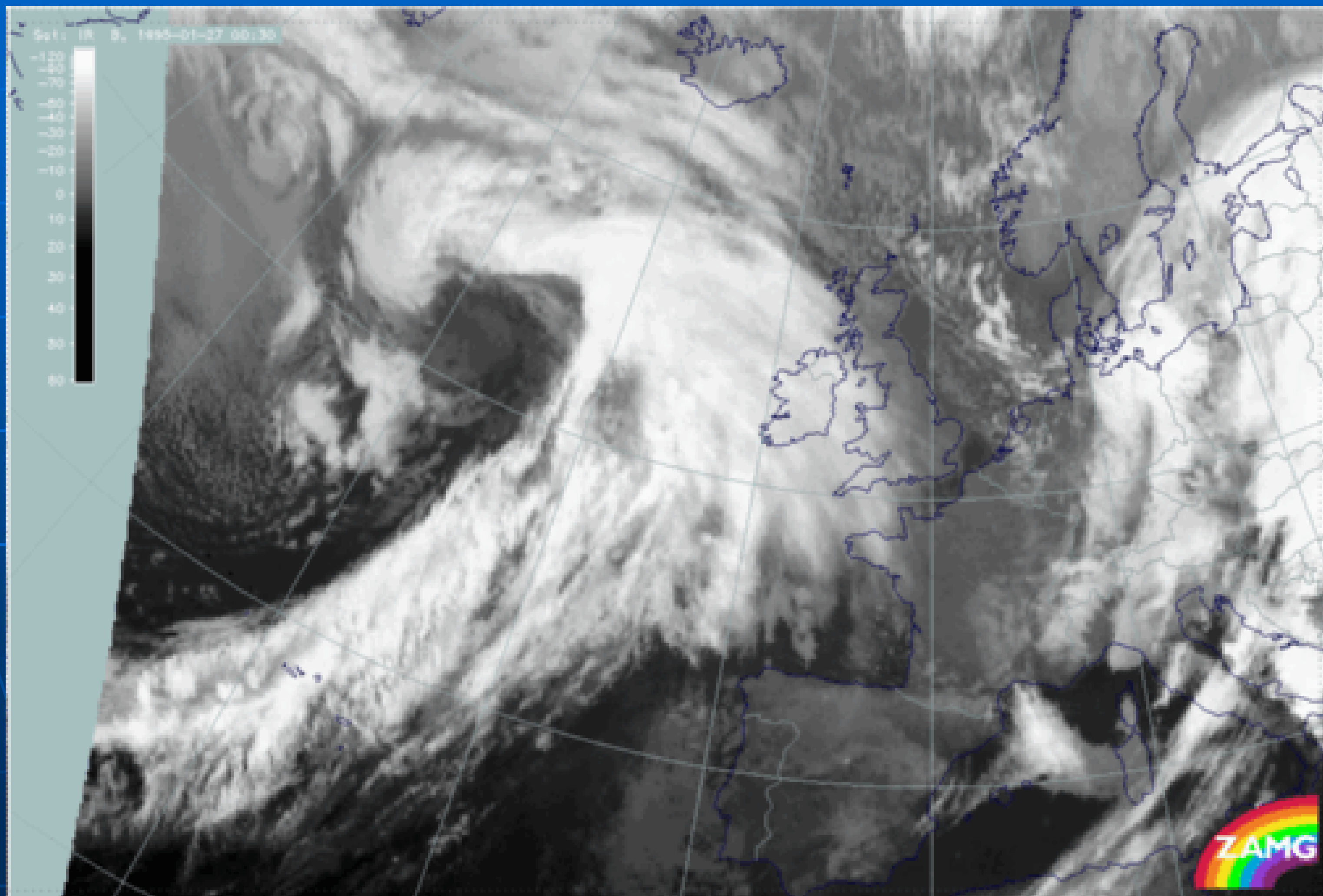


FRONTAL WAVE FORMS

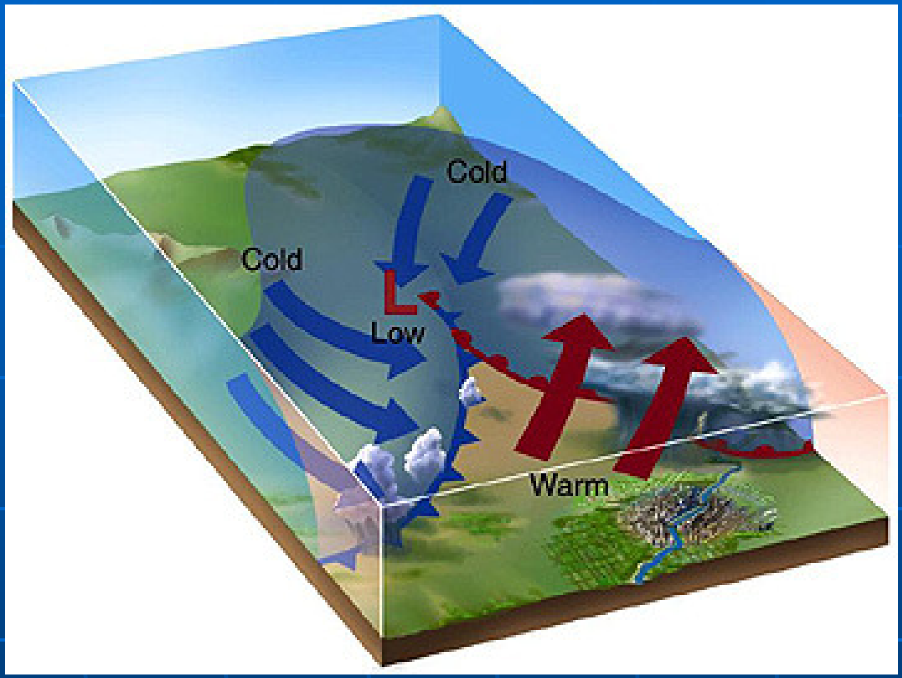


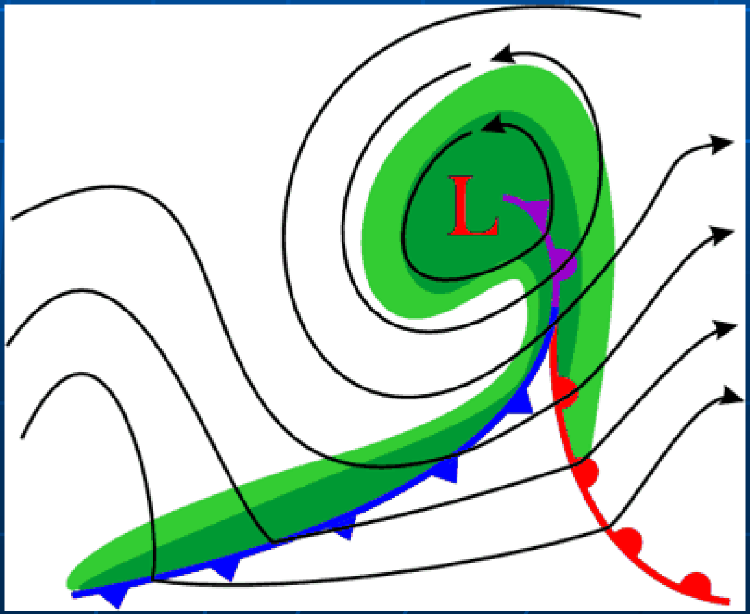


FRONTAL WAVE

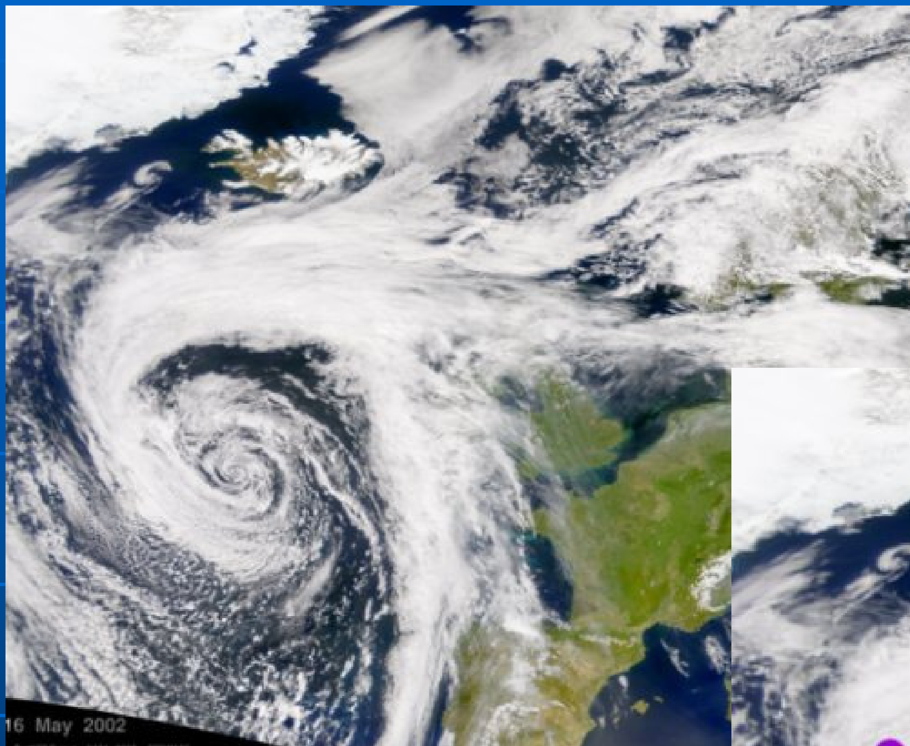


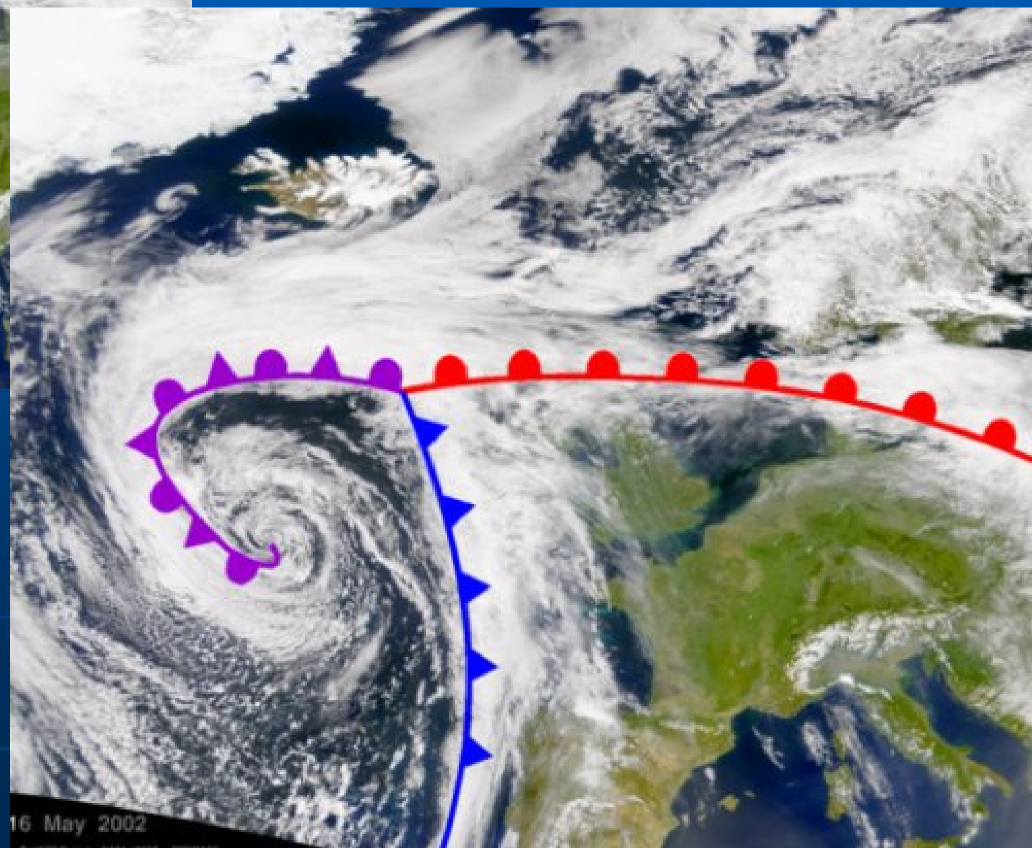
OCCLUSION BEGINS



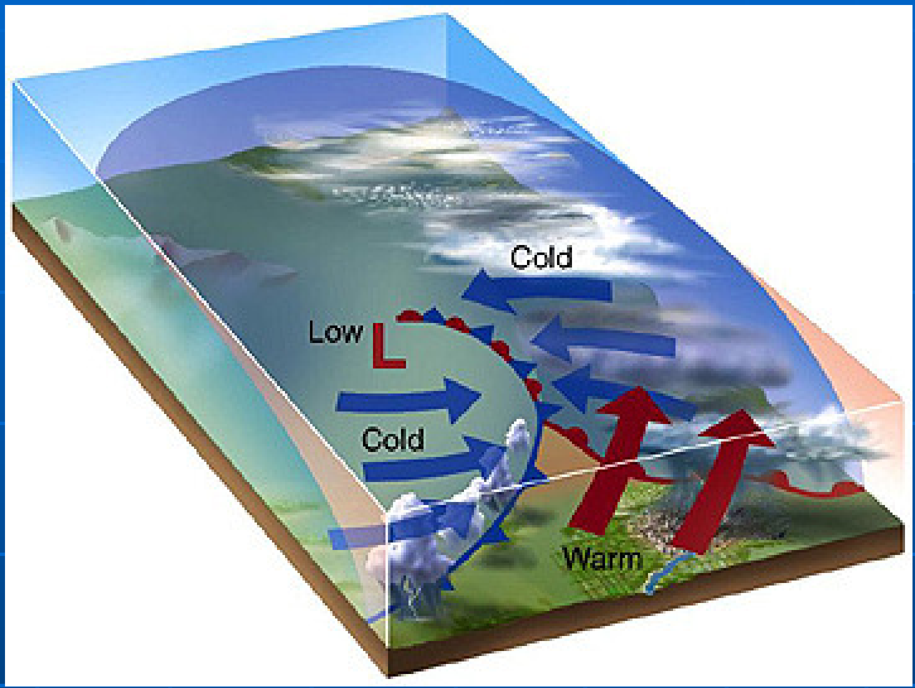


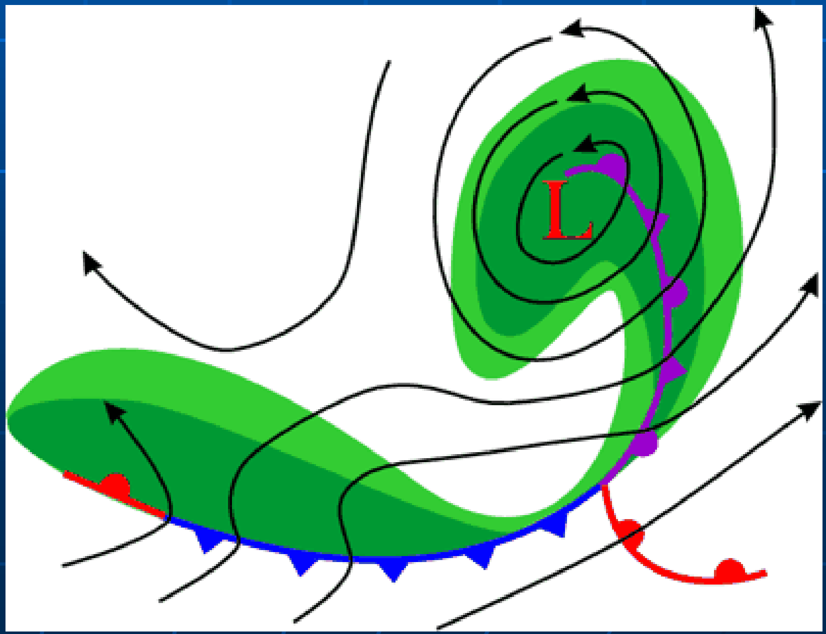
OCCLUSION



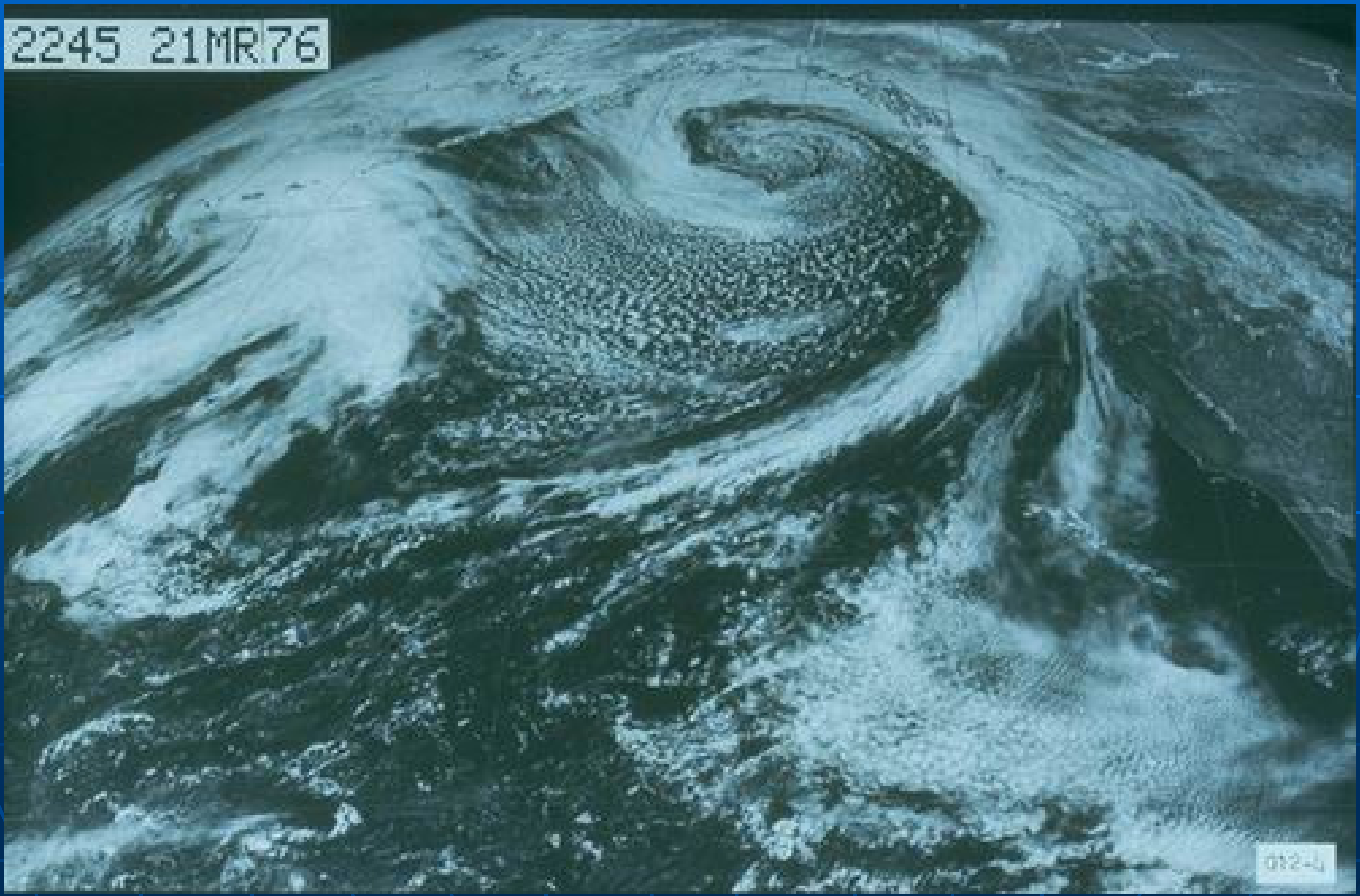


DISSIPATING WAVE





DISSIPATING WAVE



WEATHER AT A TROWAL/OCCLUSION

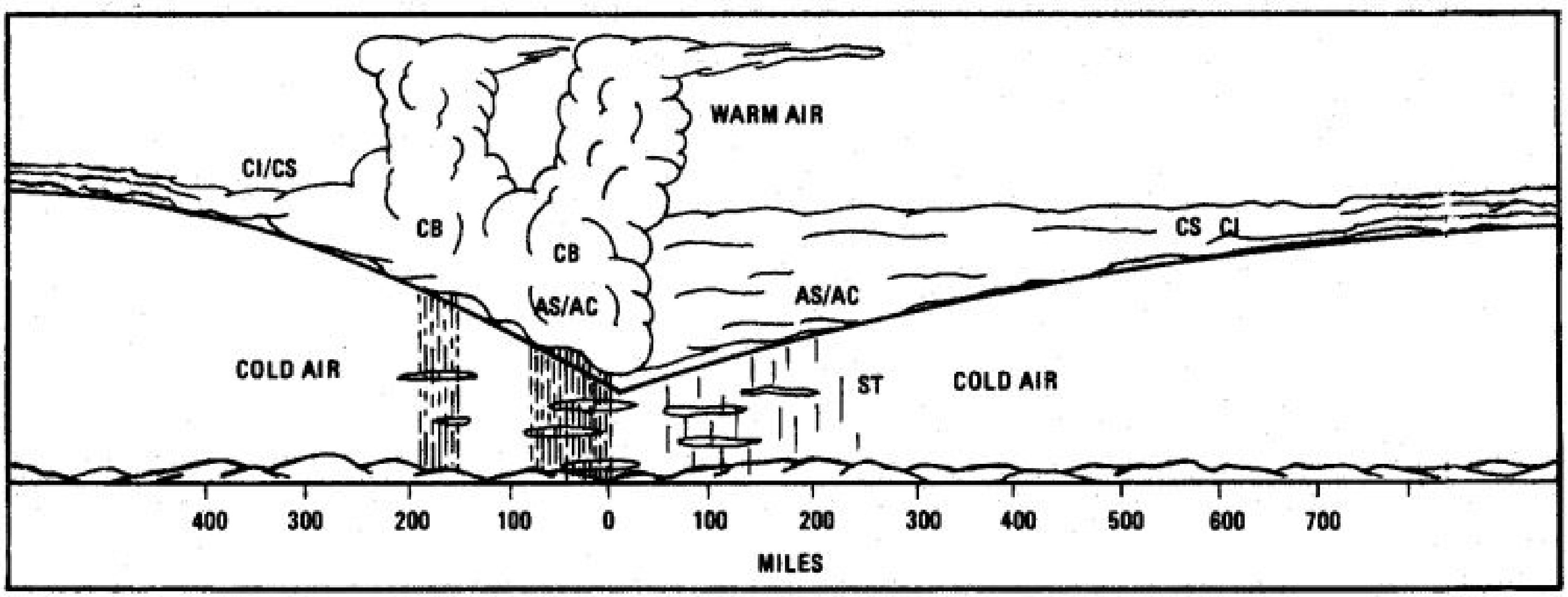


Figure 15-11 Thunderstorm at a Trowal

ISN'T IT CUTE THE WAY HE THINKS WE ARE ACTUALLY LISTENING?