دانشگاه رازی

Synoptic Meteorology 1

Lecture 6

Sahraei

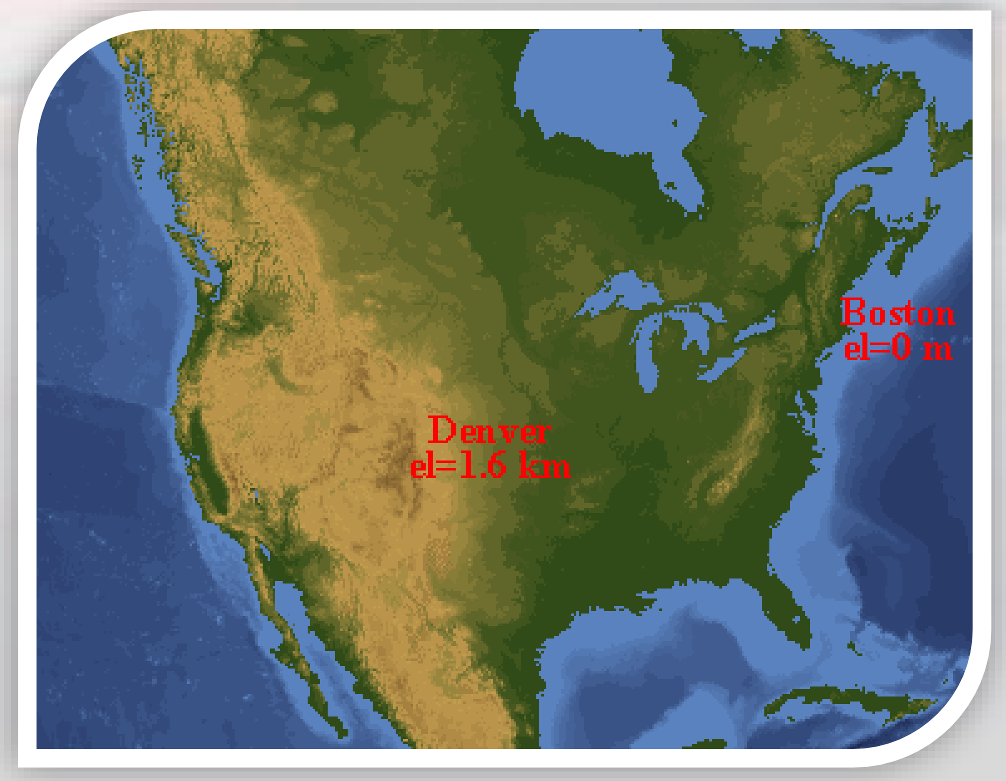
Physics Department

Razi University

http://www.razi.ac.ir/sahraei

Measuring Pressure at the surface - elevation differences

One very important source of error when generating a surface pressure chart is that not all stations are at sea level....



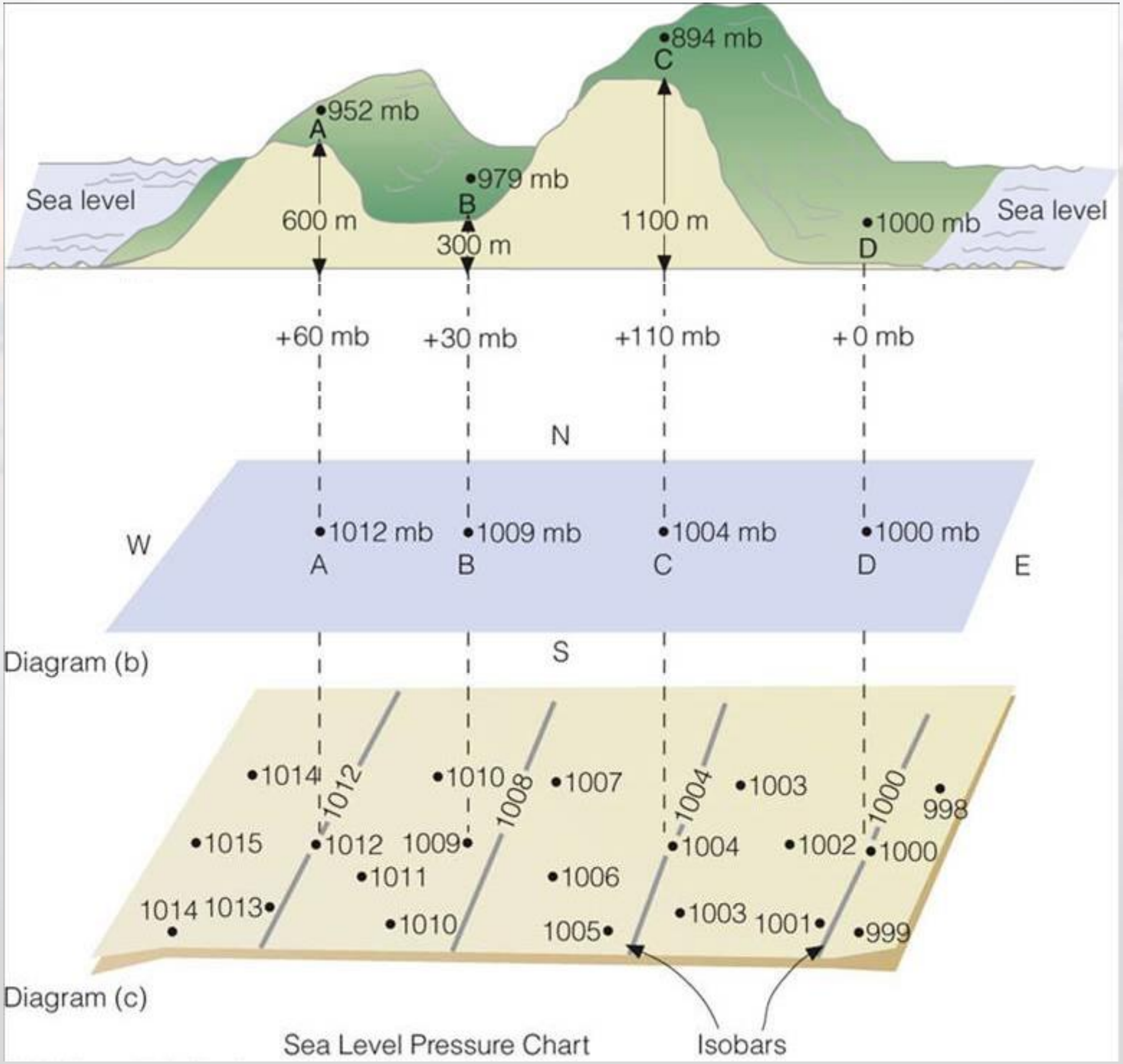
Measuring Pressure at the surface

reducing pressure to sea level

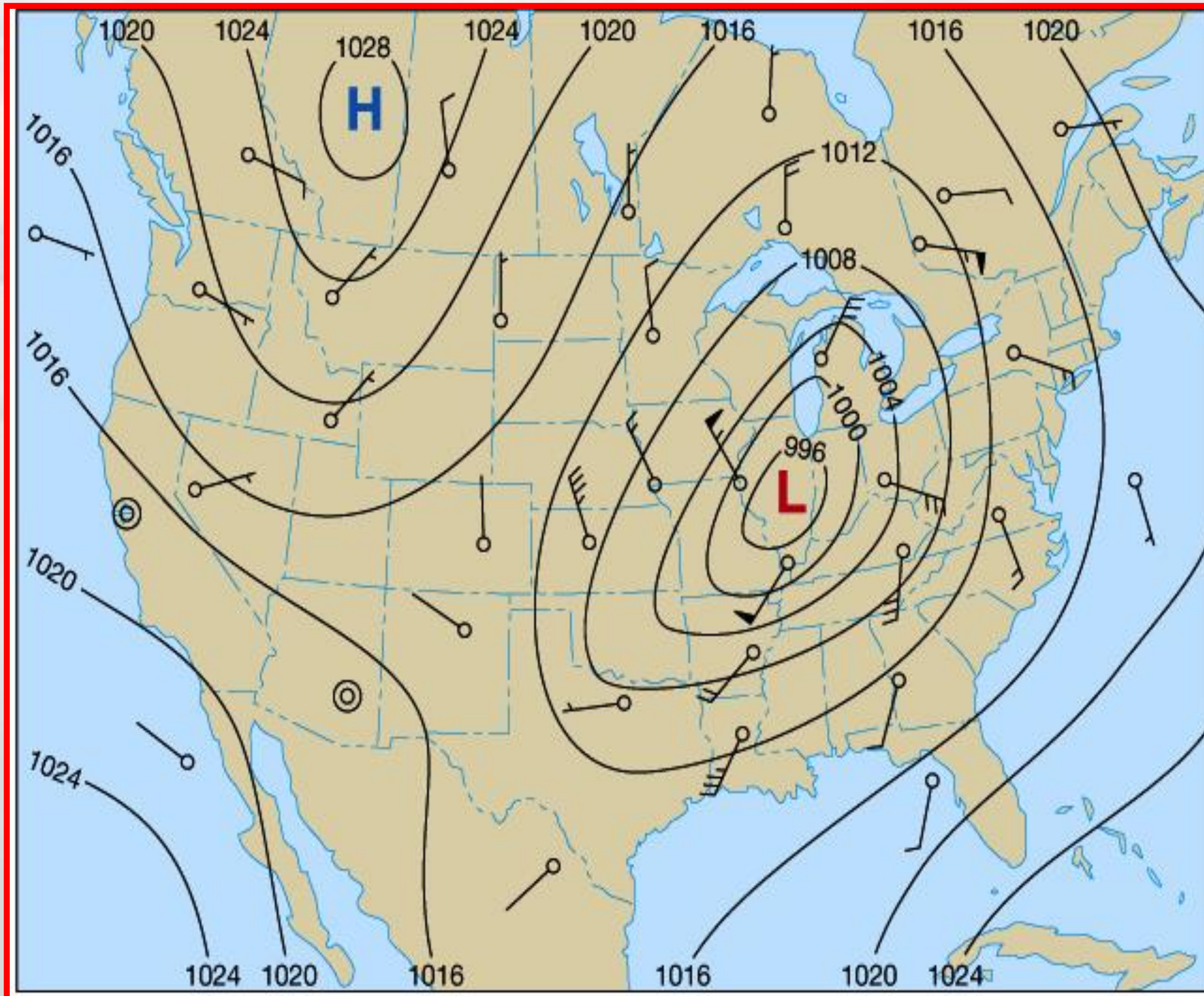
We can reduce the pressure measurements to sea level using the following rule:

In the lower part of the atmosphere, pressure changes by about 10 mb for every 100 meters of elevation change.

Using this rule, we reduce all pressure measurements to sea level, producing a constant elevation sea level pressure (SLP) chart, commonly referred to as a surface weather map.



894 mb
C
952 mb
A
979 mb
B
Sea level
600 m
300 m
1100 m
1000 mb
D
Sea level
+60 mb
+30 mb
+110 mb
+0 mb
N
W
1012 mb
A
1009 mb
B
1004 mb
C
1000 mb
D
E
S
Diagram (b)
1014
1012
1010
1008
1007
1004
1003
1000
998
1015
1012
1009
1004
1002
1000
1011
1006
1014
1013
1010
1005
1003
1001
999
Diagram (c)
Sea Level Pressure Chart
Isobars



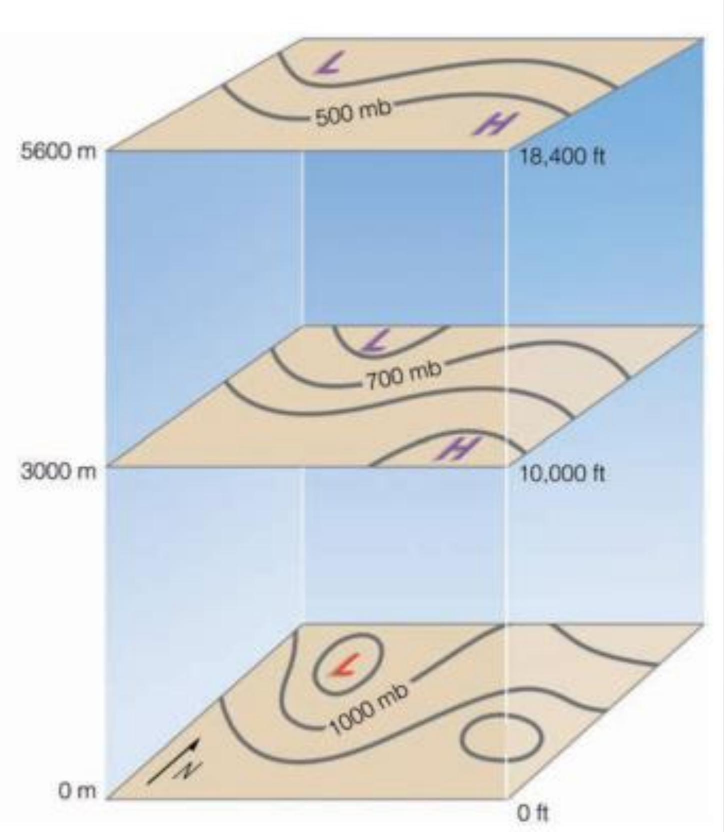
ff	Miles per hour
◎	Calm
	1–2
	3–8
	9–14
	15–20
	21–25
	26–31
	32–37
	38–43
	44–49
	50–54
	55–60
	61–66
	67–71
	72–77
	78–83
	84–89
	119–123

Upper Level Carts

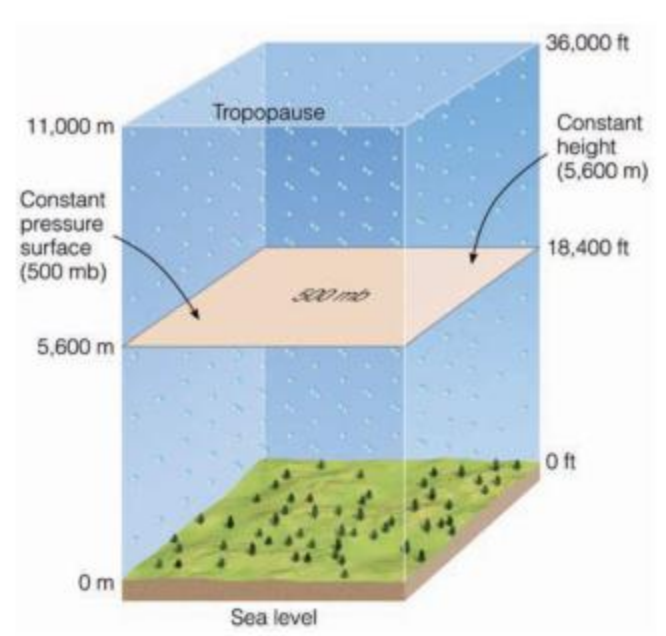
Each map shows isobars on a constant height chart.

The isobars represent variations in horizontal pressure at that altitude.

An average isobar at sea level would be about 1000 mb; at 3000 m, about 700 mb; and at 5600 m, about 500 mb.



Constant Pressure Chart
(isobaric Chart)



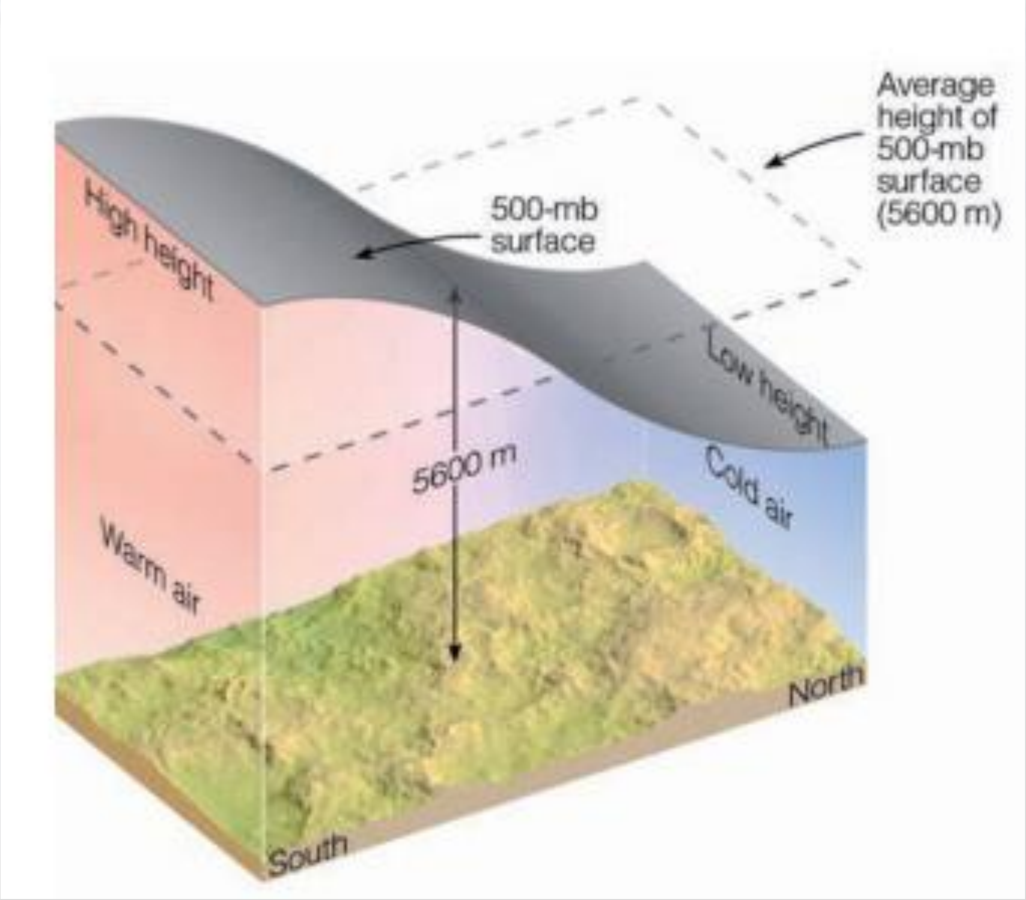
Upper Level Carts-Isobaric Charts

The tropospheric depth is proportional to the mean tropospheric temperature

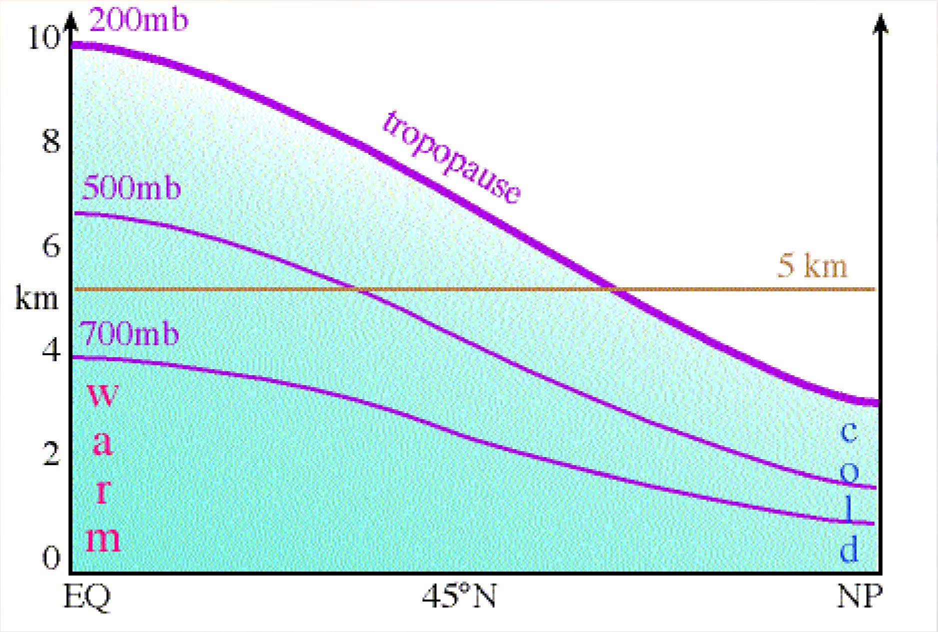
The area shaded gray in the above diagram represents a surface of constant pressure, or isobaric surface.

Because of the changes in air density, the isobaric surface rises in warm, less dense air and lowers in cold, more-dense air.

Where the horizontal temperature changes most quickly, the isobaric Surface changes elevation most rapidly.



Representing pressure above the surface

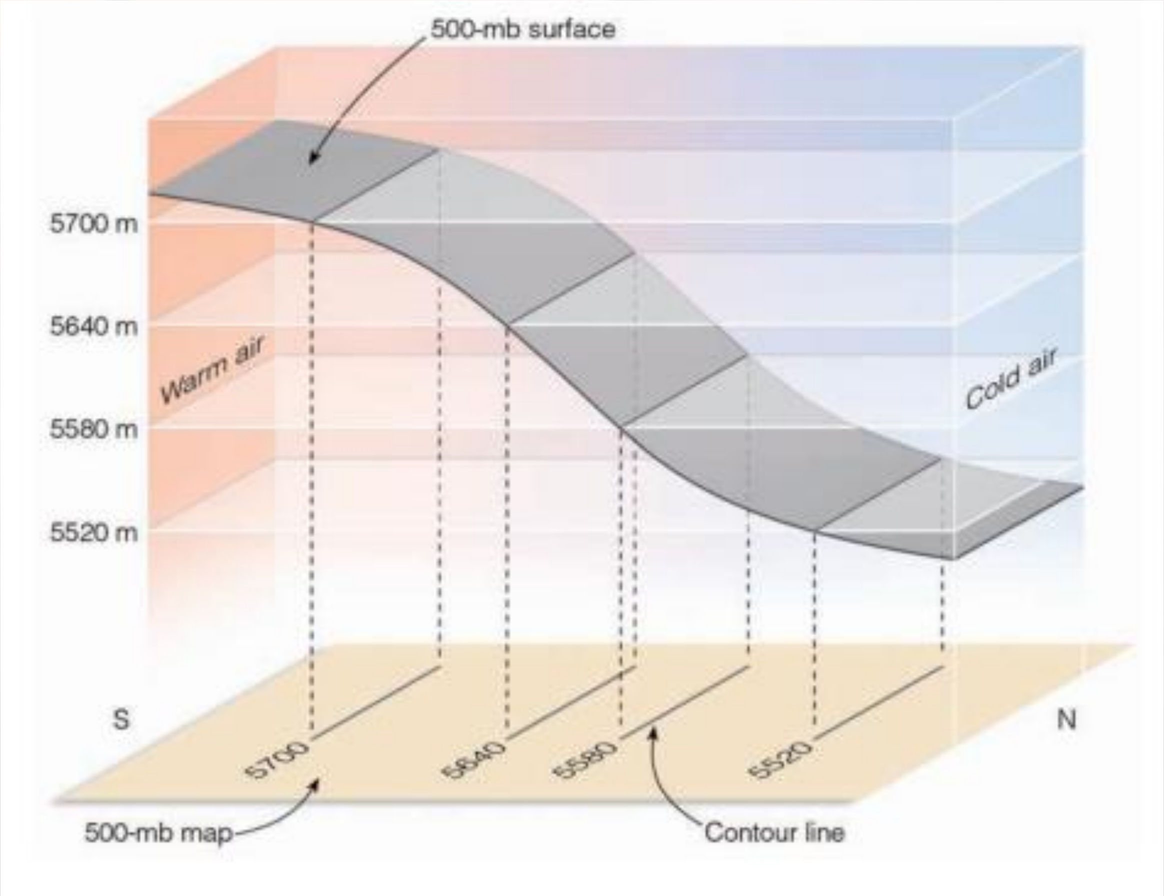


Tropopause height is proportional to the mean tropospheric temperature.

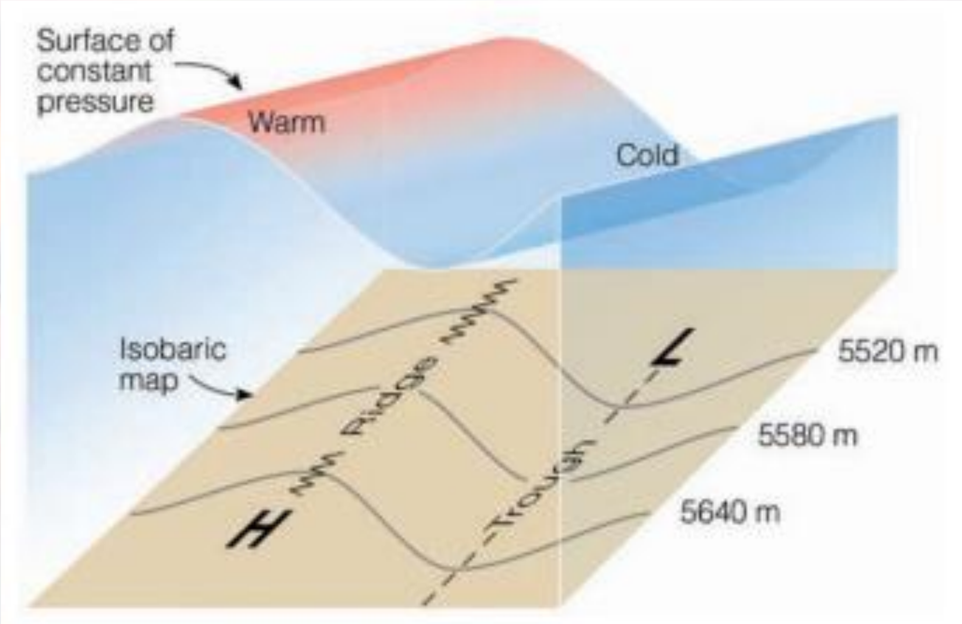
Higher near the equator - warm troposphere
lower at the poles - cold troposphere

Hence, on an isobaric chart (e.g., 500 mb) we plot isopleths of the height of the surface.

Changes in elevation of an isobaric surface (500 mb) show up as contour lines on an isobaric (500 mb) map. Where the surface dips most rapidly, the lines are closer together.



Isoheight - a line of constant height



The wavelike patterns of an isobaric surface reflect the changes in air temperature.

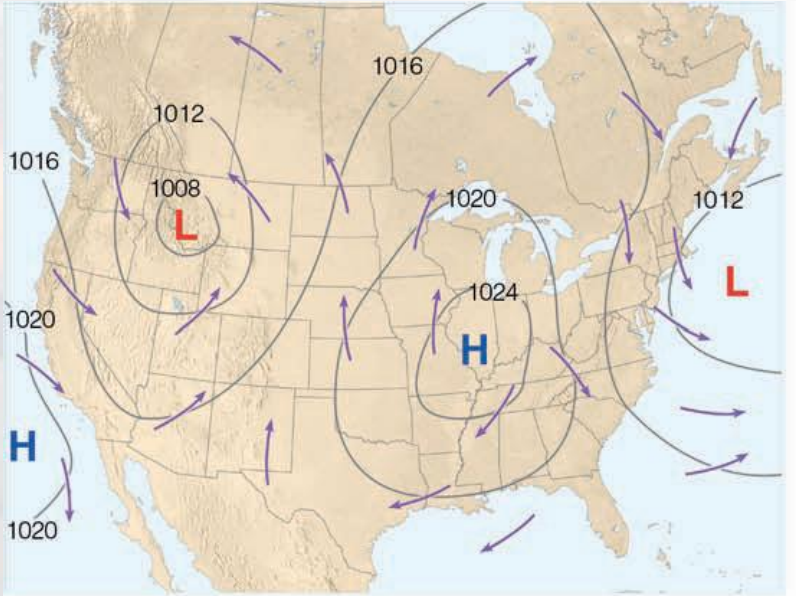
An elongated region of warm air aloft shows up on an isobaric map as higher heights and a ridge; the colder air shows as lower heights and a trough.

The table gives "approximate" altitudes of the common isobaric charts used in meteorology.

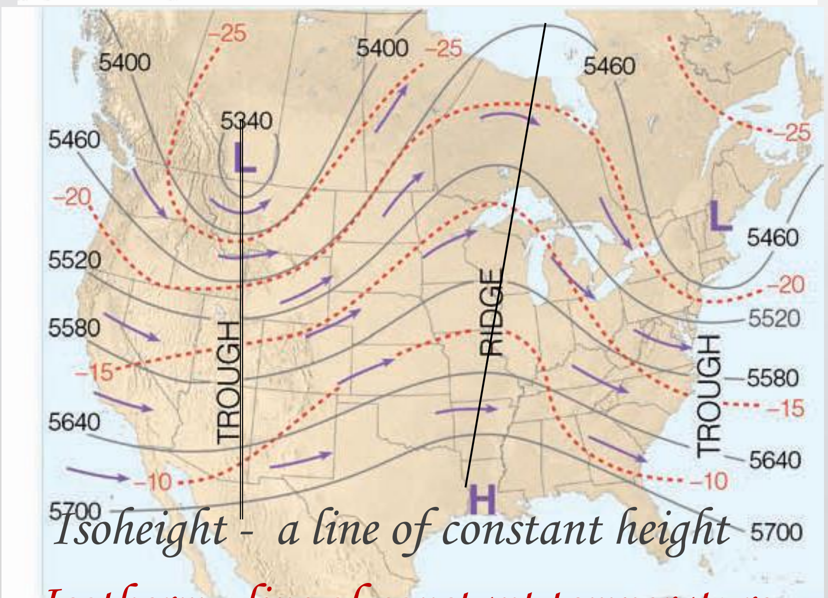
Isobaric Charts

Isobaric Surface (mb) Charts	Approximate Elevation (m)
1000	120
850	1,460
700	3,000
500	5,600
300	9,180
200	11,800
100	16,200

Isobar - line of constant pressure



(a) Surface map



(b) Upper-air map (500 mb)

Notice that the height lines are NOT oriented E-W

In fact, one can see a wave-type pattern in the height lines with:

Notice that the higher heights are towards the south where it is warmer

lower heights are found further north where it is colder.

There is warm air aloft associated with a ridge.

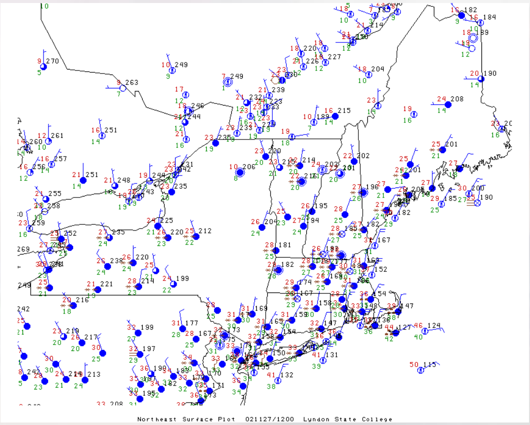
There is cold air aloft associated with a trough.

Notice that ridges aloft are associated with Highs at the surface (*anticyclon*)

Troughs aloft are associated with Lows at the surface (*cyclones*). BUT NOT ALWAYS

What creates wind?

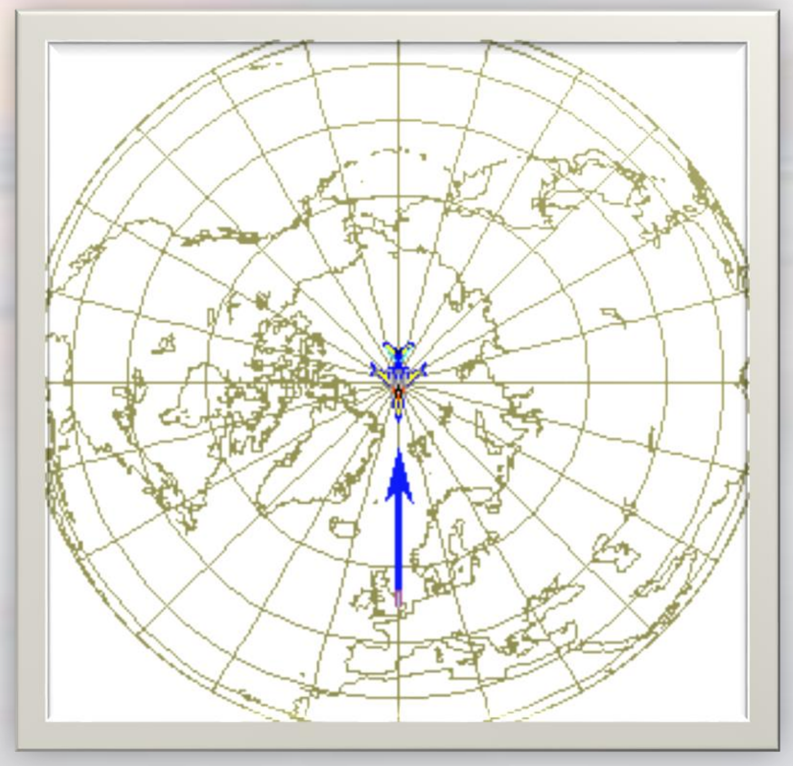
$$a_{net} = \frac{1}{m}\left(F_1 + F_2 + F_3 + \ldots.. F_n\right)$$



What are these forces in the atmosphere?

Pressure gradient force
Coriolis force
Centripetal force
Friction

The Coriolis Force



Apparent Coriolis Force

The coriolis force arises due to the fact that the earth is rotating

Properties of the coriolis force:

Acts on objects not rigidly attached to the earth

Always acts to deflect an object to the right (left) of its direction of motion in the northern (southern) hemisphere

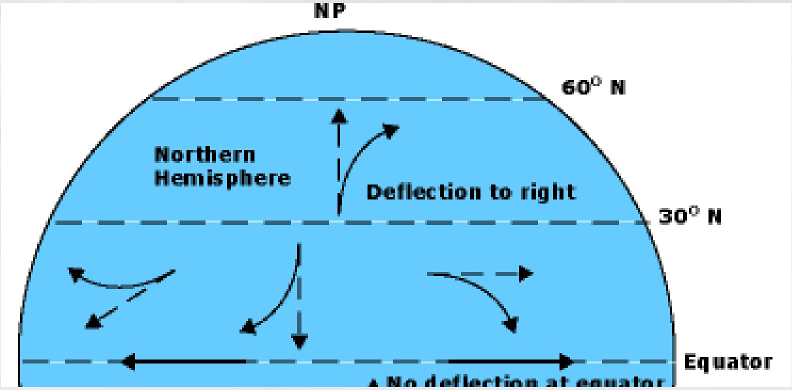
Magnitude is zero at the equator, maximum at the poles

Magnitude depends on the rotation rate of the earth

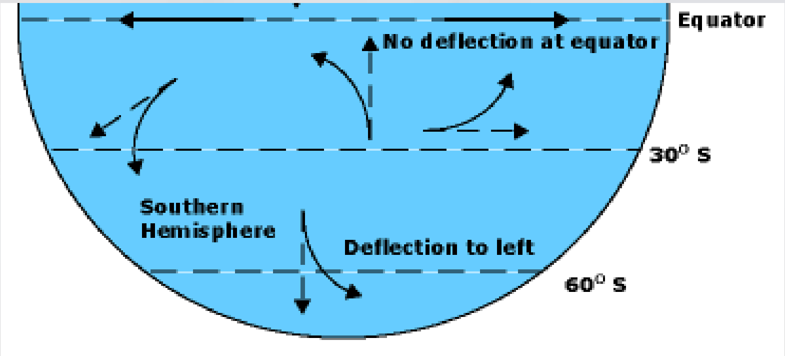
If the earth were not rotating, the coriolis force would be zero

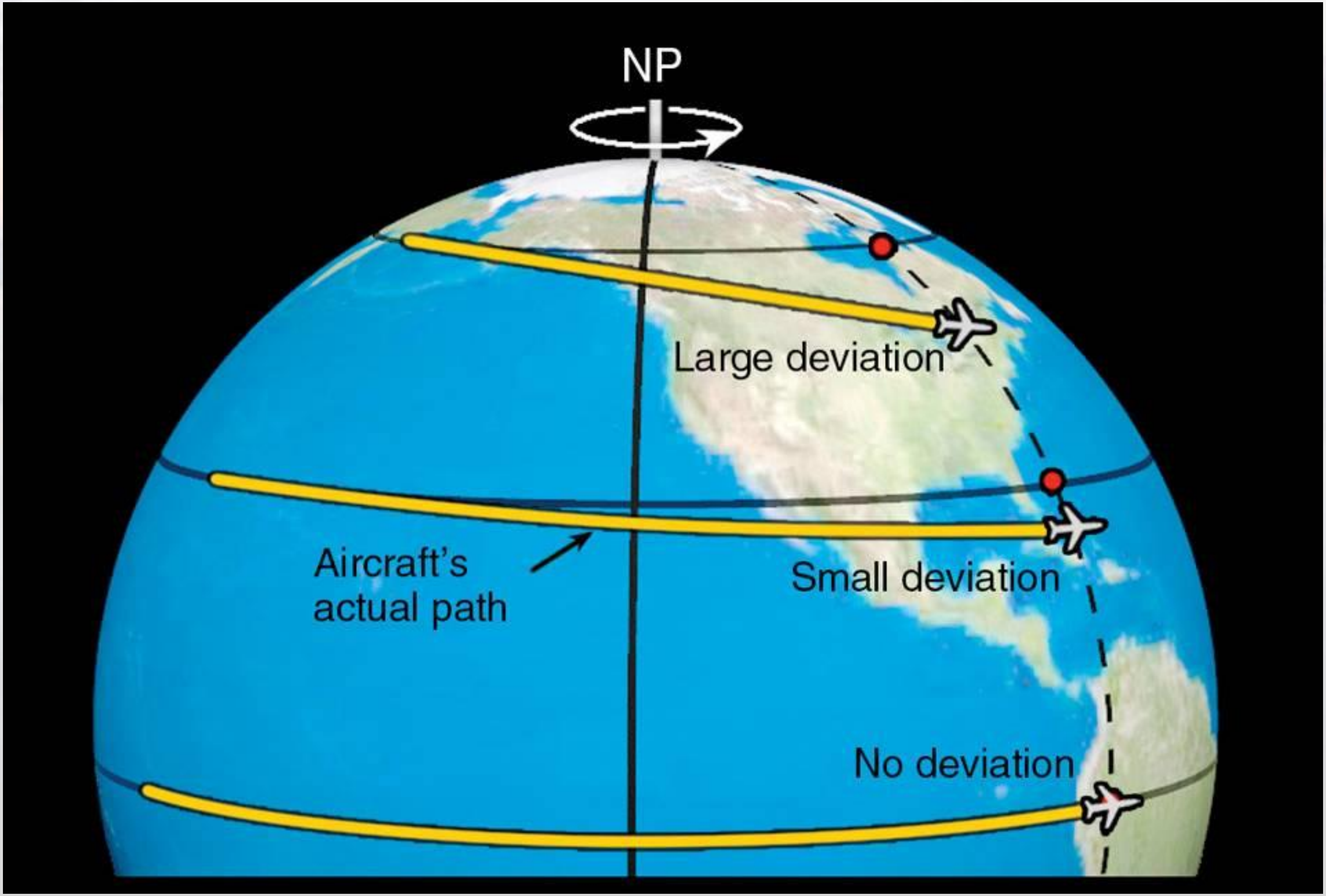
So the coriolis effect causes wind flowing from high pressure to low pressure to curve as the wind moves.

In the Northern Hemisphere, the coriolis effect causes things to curve to the Right.



In the Southern Hemisphere, the coriolis effect causes things to curve to the Left.

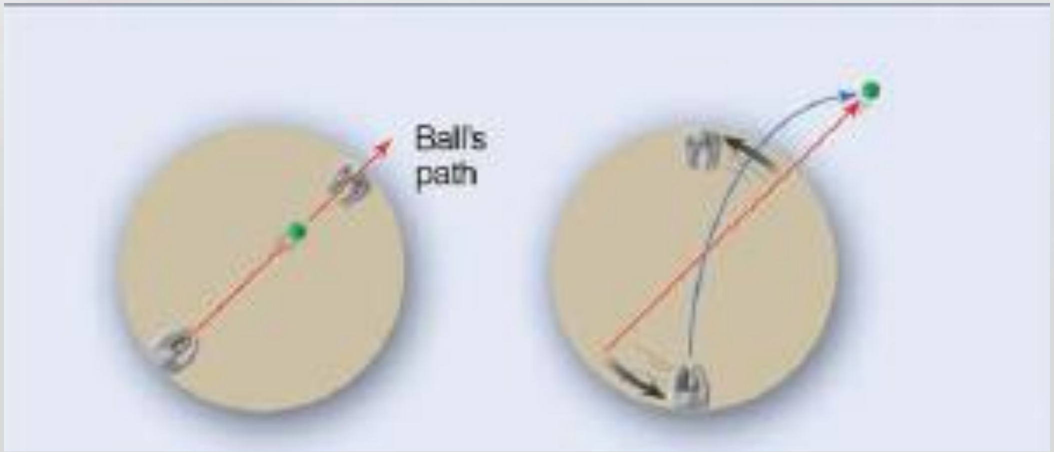



NP
Large deviation
Small deviation
Aircraft's
actual path
No deviation

$$\omega = \frac{2\pi}{1day} = \frac{2\pi}{86400s} = 7.292 \times 10^{-5} rad/s$$

$$\vec{F}_{co} = -2(\vec{\omega} \times \vec{V})$$

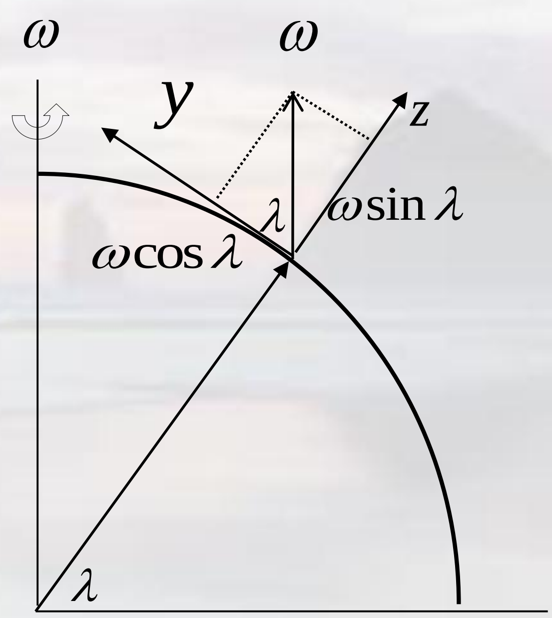
$$\vec{V} = u\hat{i} + v\hat{j} + w\hat{k}$$



$$\omega_x = 0$$

$$\omega_y = \omega \cos\lambda$$

$$\omega_z = \omega \sin\lambda$$



$$\vec{F}_{co} = -2\vec{\omega}\times\vec{V} = -2\omega \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 0 & \cos\lambda & \sin\lambda \\ u & v & w \end{vmatrix}$$

$$F_{co\,x} = -2\omega\,(w\cos\lambda - v\sin\lambda)$$

$$F_{co\,y} = -2\omega\, u\sin\lambda$$

$$F_{co\,z} = 2\omega\, u\cos\lambda$$

An Introduction to Weather Maps

The surface chart depicts weather at the Earth's surface

Fronts, or boundaries between air masses, shown using lines with triangles and semicircles

Isotherms connect observations of the same temperature

Isobars connect observations of the same pressure

Data from specific locations coded using the station model

Thanks

For your

Attention