Lab No.1

Thickness Map

The Aim:

Trace the path of air masses by drawing thickness contours between two levels pressure (5oomb-1000mb).

Tools:

Tow Weather maps for a level of 500mb, and 1000mb, colored pens (black, red, green, blue).

Methodology:

Thickness map is a distance between two different pressure surfaces, and its value represents to the average temperature of area between two pressure surfaces. The thickness value determines the type of air mass between the two surfaces. The distance between two surfaces is large due to the expansion of the warm mass, but if the value of the thickness is small, it indicates the presence of a cold air mass or the flow of cold air mass between the two surfaces, where the distance between two surfaces is small due to the contraction of the cold mass. Thickness maps are important in synoptic analysis and weather forecasting, especially in tracking the path of Thermal winds in the upper layers of the atmosphere, which have an important role in the development and movement of pressure systems, in addition to their importance in locating the wet, warm, cold and dry air masses, especially the thickness maps that show changes in thickness with time that allow tracking the path of air masses with specific heat and moisture content.

Thickness equation derive from the hydrostatic equation for column of air as in the equation below:

$$dp=-\rho *g *dz\text{--------}(1)$$

From the equation of state for ideal gas, we find that the density is:

$$\rho=p/R*Tv\text{----------}(2)$$

Whereas:

R is the general constant for gases and its value is (28704 erg/gm.).

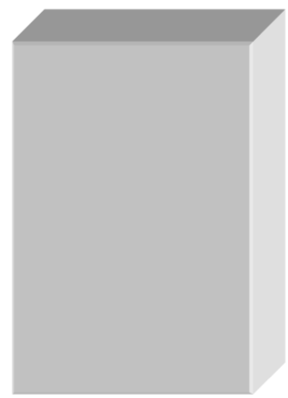
$\overline{T}_v$ virtual temperature is the estimated average temperature, which is defined as the temperature of the dry air column at which the pressure and density are the same for a sample of moist air for the two heights Z1, Z2, we get:

$$\Delta Z = Z2 - Z1 = (R/g) * \overline{T}_v * \ln (p1/p2) \text{ --------(3)}$$

The last equation is called the thickness (equation hypsometric equation); through which we note that the thickness contours (the lines passing between points of equal thickness) can be visualized as lines with the estimated isotherm of the air layer.

Thickness:

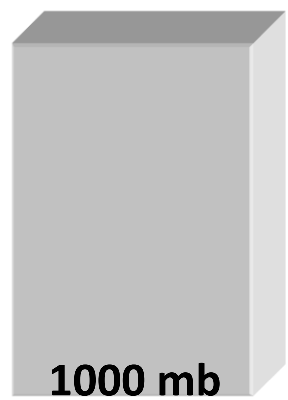
- Let's start with a column of air



- The base of the column is at sea level,

so the pressure at the bottom of the column

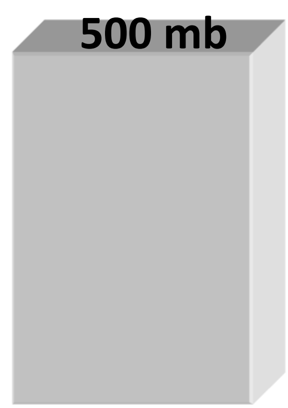
is 1000 hpa.



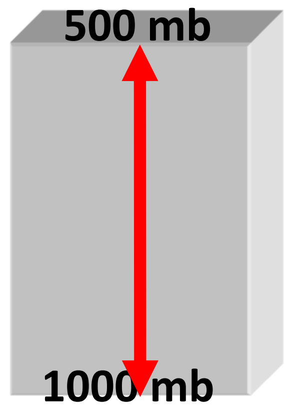
- The top of the column is very high so

that the pressure at the top of the column

is 500hpa.



- This column has **thickness**: the **thickness** is the distance between two pressure surfaces, and here the thickness of this column extends between two pressure levels (1000-500) hPa.



- If we heat up the column of air it will

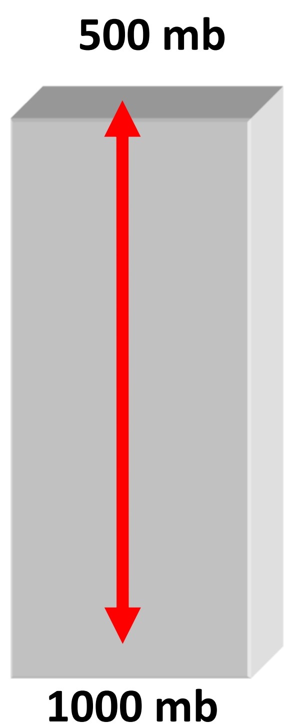
expand where the warm air is less dense

The thickness of the air column will increase

The pressure level of 500 hPa will be much

higher than the Earth's surface

Warmer



- If we cool the air column, the air column

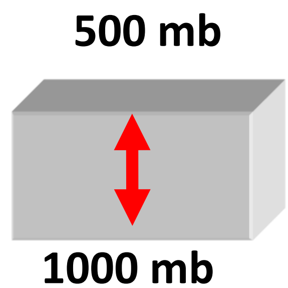
will shrink, the cold air will be denser.

The thickness of the air column will decrease.

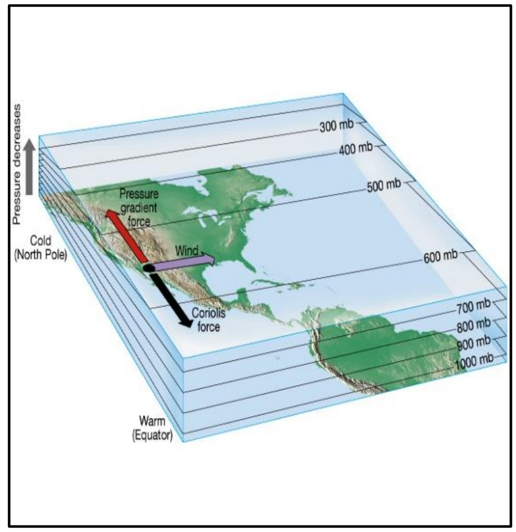
The pressure surface is 500hPa in this case

closer to the surface.

Colder

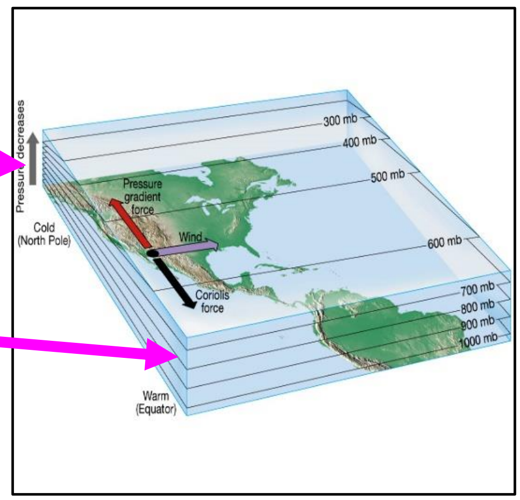


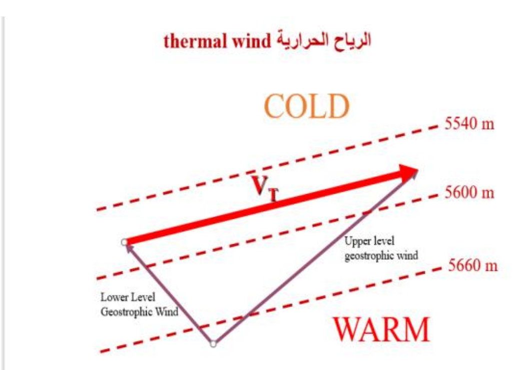
- In fact, temperature is the only parameter that gives an indication of thickness to the atmosphere. It does not matter which pressure level we choose; they all rise when the air column heats up. As shown in the following figure.

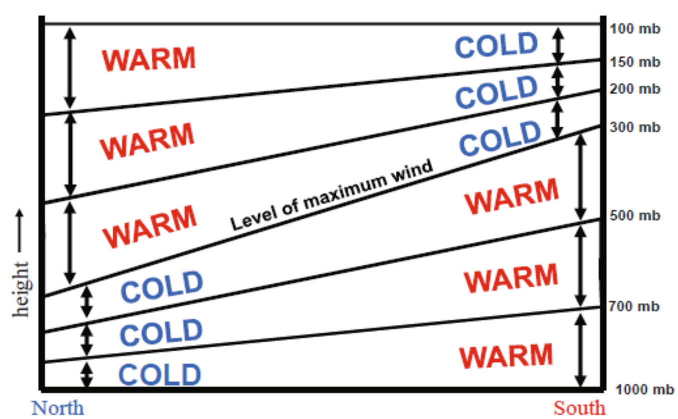


- At the electrode the pressure level is 700hPa very close to the surface This layer is thinner.

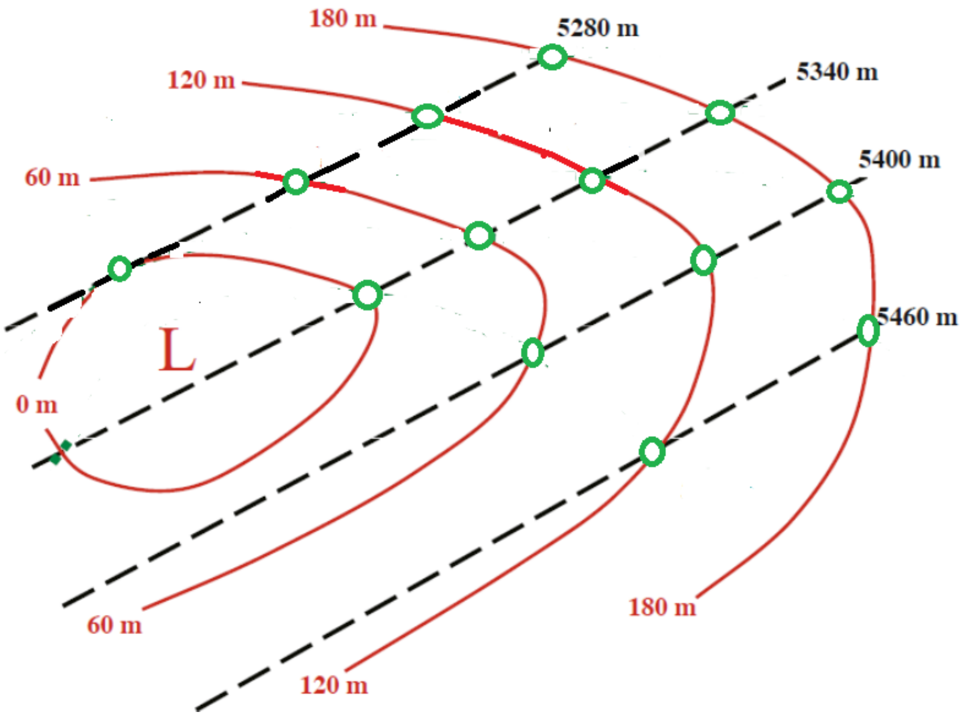
- At the equator, the surface pressure of 700 hPa is very high. Here the layer is thick.







The procedure:



1- Prepare a map in which each station contains two values of potential height, the first value at level 1000hPa and the second value at level 500hPa.

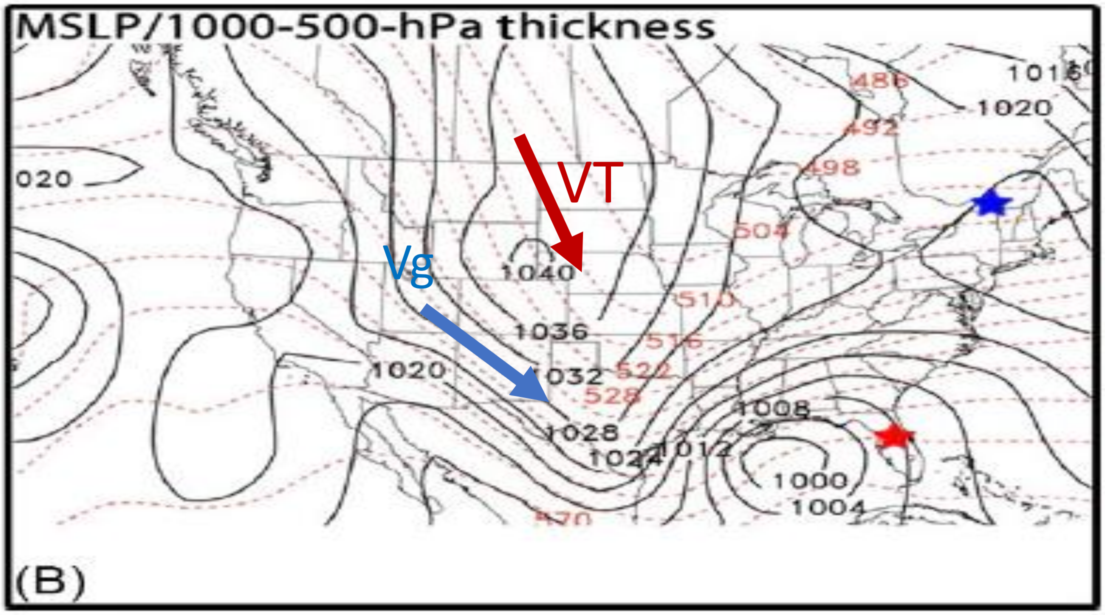
2- Draw geopotential height contours at 1000hPa level in red.

3- Draw geopotential height contours at 500hPa level in black.

4- We determine the value of the points of intersection between the lines equal to the geopotential height of two levels by subtracting the value of higher level from lower level and writing down the value of subtraction at each point.

5- We connect the points of intersection equal values with green lines, so that the line takes points' values that passes through. Where these green dash lines represent thickness lines.

6- The direction of thermal wind is determined as it is parallel to the thickness lines.



Desiccation:

Q1/Calculate the values of $\bar{T}_v$ for the layer lays between each of the two pressure levels from the thickness equation below:

$\Delta Z= (R/g) *\bar{T}_v*\ln (p1/p2)$ where ($\Delta Z=Z2-Z1$)

(500-300) hpa, (700-500) hpa, (850-700) hpa, (100-500) hpa

Whereas, R is the general constant of gases and its value is (R=28704 erg/gm.). g is the ground acceleration and its value is ($g=9.8m/s^2$)

Note/ the geopotential heights for each pressure level is:

850hPa=1500gpm,700hPa=3000gpm,500hPa=5000gpm,300hPa=9000gpm, 100hPa=15000gpm.

Q2/What expected relationship between the virtual temperature $\bar{T}_v$ values that calculated above and the distance between each level.

References:

[1] Gary. L., 2011,'Midlatitude Synoptic meteorology', American Meteorology Society, pp 16, USA.