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DOCUMENT TITLE

METEOROLOGY FOR AUSTRALIA

CHAPTER 4 – ATMOSPHERIC PRESSURE

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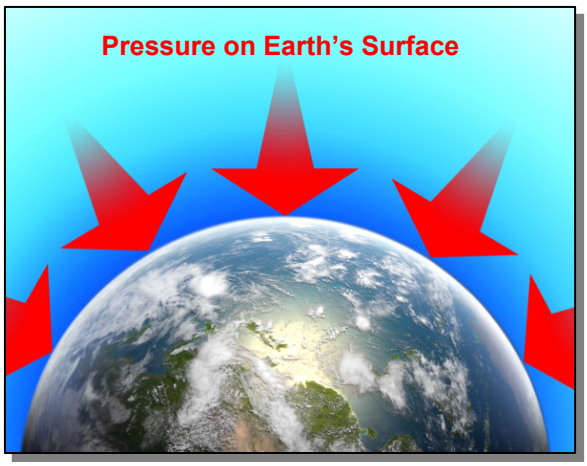
ATMOSPHERIC PRESSURE

INTRODUCTION



Pressure is the FORCE exerted by the motion of the molecules of a fluid (liquid or gas) on a UNIT AREA.

Pressure acts equally in all directions.

The atmosphere is attached to the earth as a result of gravity. It is prevented from collapse because of the molecular activity of the air. Therefore, an area on the earth's surface may be regarded as supporting the entire column of air above it.

It follows that atmospheric pressure at a point is defined as the force per unit area exerted by a column of air above the point.

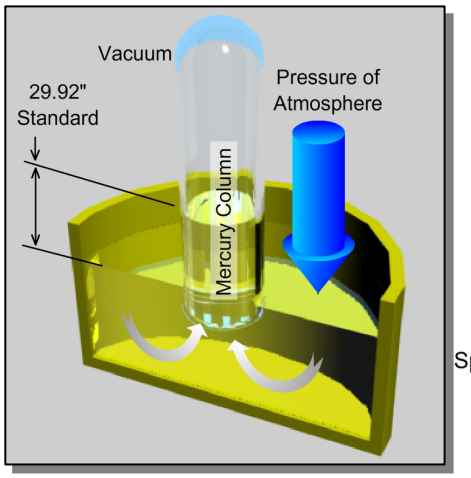
PRESSURE UNITS

Pressure is force/area:

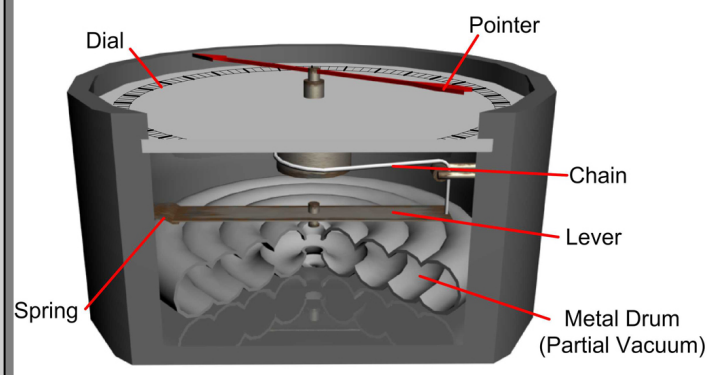
- Meteorological units of pressure are hectopascals (hPa), millibars (mb) or inches of mercury (" Hg)
- ISA average is 1013.25 hPa.(mb=hPa)
- Surface pressure normally varies from 970 to 1040 hPa, however an extreme low of 870 hPa was recorded in Guam during a tropical cyclone and a high of 1080 hPa was recorded during a Siberian winter.

BAROMETER

Measures and indicates pressure.



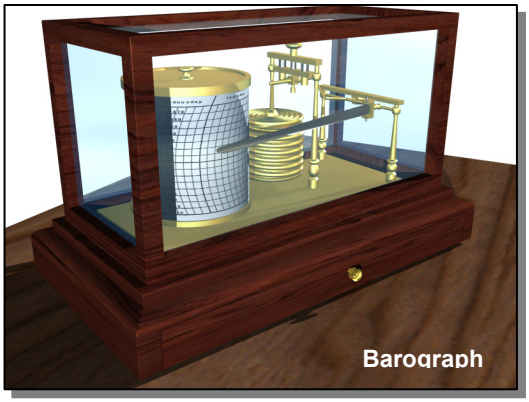
Mercury Barometer

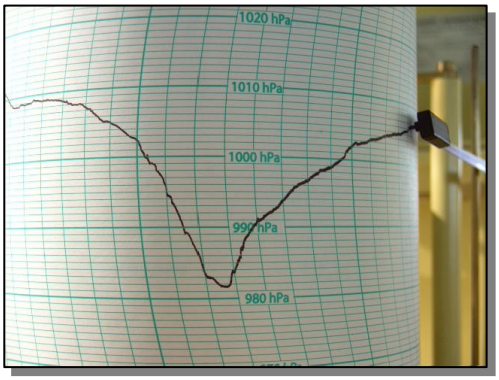


Aneroid Barometer

BAROGRAPH

The barograph works on the same principle as the barometer. The movements of the capsules are conveyed to a pen arm which registers pressure changes as an inked line on a graduated sheet of graph paper wound around a rotating drum.



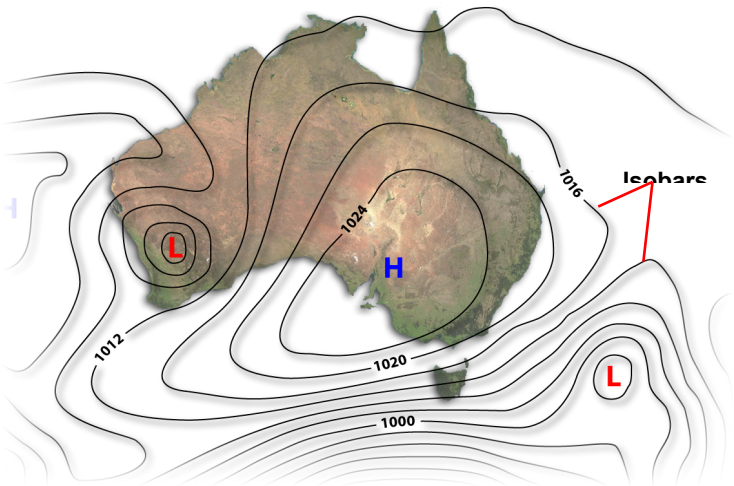


The drum, rotated by a clockwork mechanism, completes one revolution every 24 hours or in some instruments every week. In this way a continuous record of pressure changes is produced in a graphical form.

Because of the extreme accuracy required in pressure observations this instrument is not used for reading prevailing pressure, but only for observing the pressure tendency which is very important for forecasting.

ISOBARS

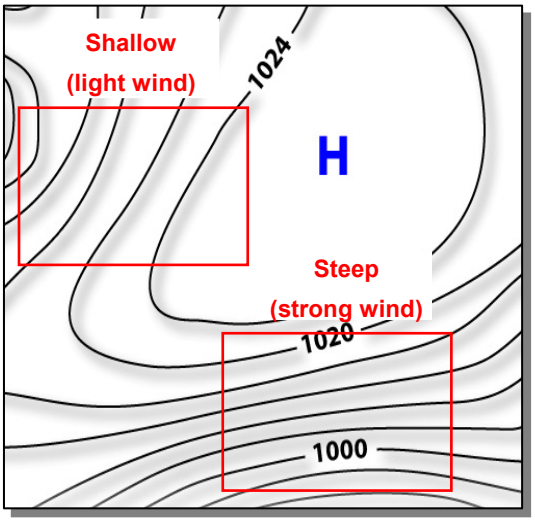
Isobars are lines joining points of equal barometric pressure. Readings are adjusted for the difference in height to bring them all to a common base (normally Mean Sea Level or MSL) to enable a chart of pressure distribution to be drawn.



Pressure readings from weather stations and ships are gathered and sent to a Meteorological Centre (e.g. Melbourne in Australia or Bracknell in the UK). Pressures are converted to sea level and a weather map (synoptic chart) is drawn. The lines joining places of equal air pressure are called isobars. The interval between isobars is usually 2 or 4 hPA.

PRESSURE GRADIENT

The rate of change of pressure with distance is known as the pressure gradient, sometimes expressed as the change in pressure in hPa per 100 nm, measured at right angles to the isobars. The pressure gradient is related to wind speed; the closer the isobar spacing the stronger the wind speed and vice versa.



A “steep” or “strong” pressure gradient occurs when the isobars are close together. A “shallow” or “weak” pressure gradient occurs when the isobars are far apart.

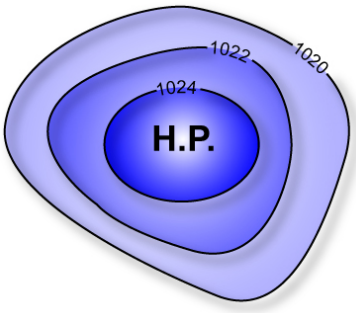
ISALLOBARS

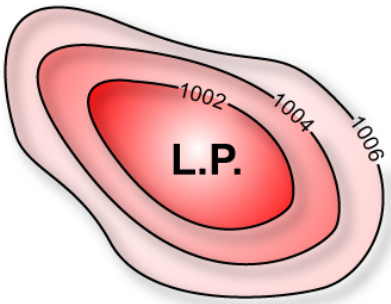
Stations measuring and reporting barometric pressure do so regularly at fixed times, so it is possible to determine the rate of change of pressure in millibars per hour, or millibars per three hours, as required. If points of equal rate of change of pressure are joined, the lines drawn are known as isallobars. Isallobars are often useful to help meteorologists predict the future path of pressure systems. An isallobar chart is drawn up every 3 hours.

PRESSURE SYSTEMS

High Pressure (HP) or anti-cyclone

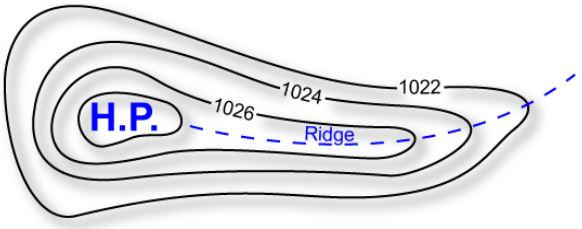
Wind flows parallel to the isobars (above 2 000’) and anticlockwise around a HP in the Southern Hemisphere. (Clockwise in the Northern Hemisphere)





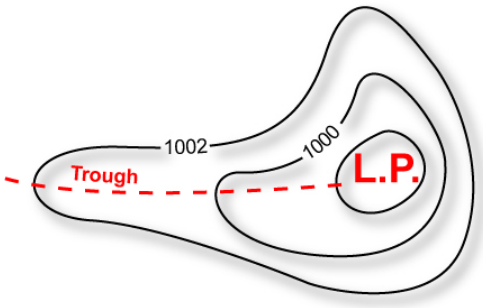
Low Pressure (LP), cyclone or depression

Wind flows parallel to the isobars (above 2 000’) and clockwise around a LP in the Southern Hemisphere. (Anticlockwise in the Northern Hemisphere)



RIDGE

An area of HP extending from a central HP

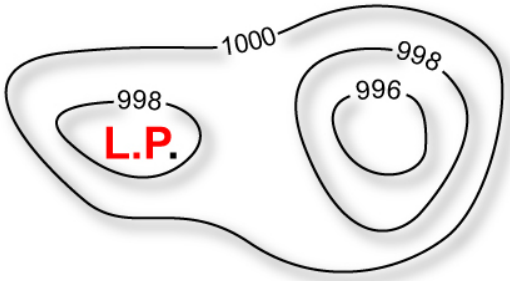


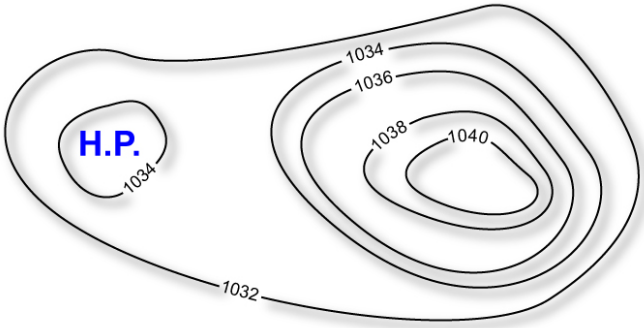
TROUGH

An area of LP extending out from a central LP

SECONDARY LOW PRESSURE

A LP that forms near, or in association with, an existing primary LP, and is initially contained within the primary low.



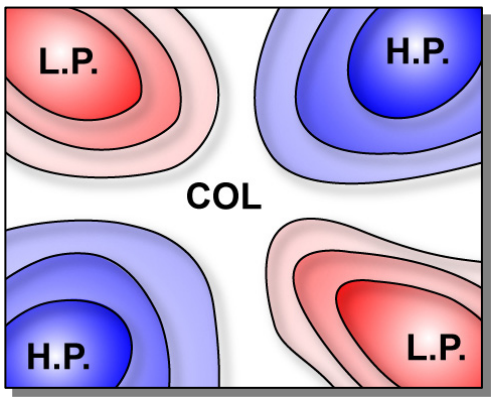


SECONDARY HIGH PRESSURE (BUBBLE)

A HP that forms near, or in association with, an existing primary HP, and is initially contained within the primary high.

COL

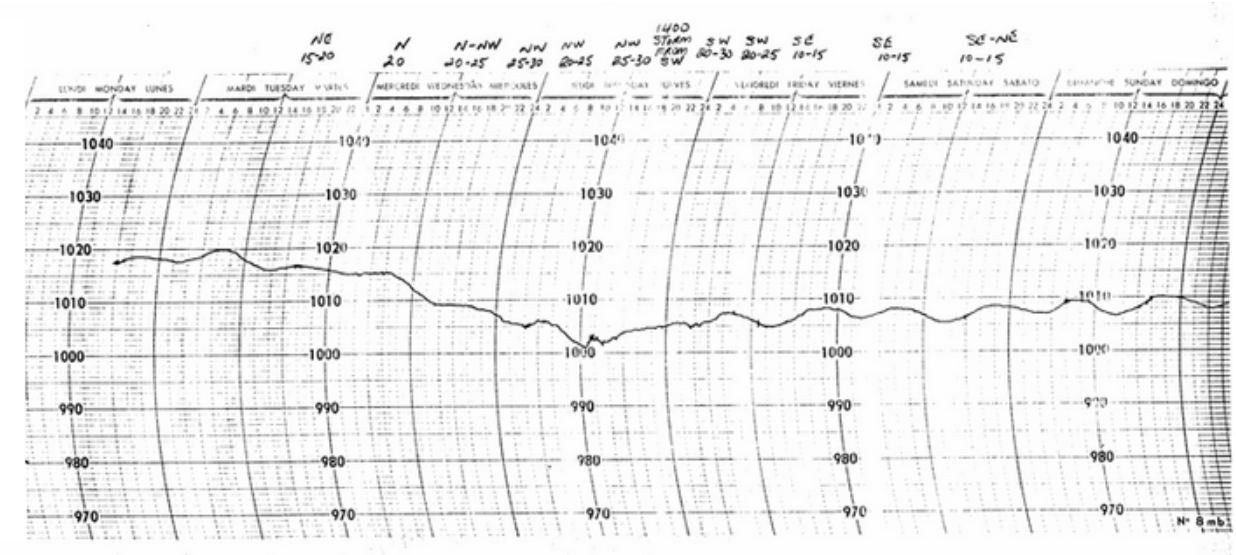
A region of light but variable winds between two opposite highs and lows. Conditions can vary from fog to thunderstorms.



DIURNAL PRESSURE VARIATION

Pressure systems usually migrate from west to east but at times remain stationary. Even if this happens, pressure varies during the day due to temperature changes. Diurnal variation occurs with a maximum at about 1000 hrs and 2200 hrs. and a minimum at about 0400 hrs and 1600 hrs. The greatest maximum usually occurs at 1000 with a smaller maximum at 2200. The lowest minimum occurs at 1600 with a lesser minimum at 0400. The Barograph chart on the next page shows this variation well.

In temperate latitudes the variation is about 1 - 2 hPa about the mean pressure, but in tropical areas it can be up to 4 hPa with the largest variation (a fall in pressure) occurring in the hot afternoons.

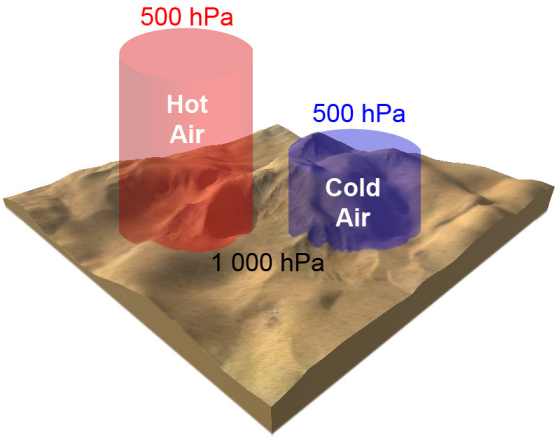


Barograph Chart

PRESSURE AND HEIGHT

Because barometric pressure is the weight of air above a datum, pressure must reduce with height in the atmosphere. How much it reduces depends upon the density of the air.

Density is defined as mass per unit volume. When air is heated it expands, and the same mass (or weight) occupies a larger volume and so density becomes less. Similarly, given a fixed volume of air, its mass or weight will be less at a higher temperature than at a lower temperature. In two columns of air, one warm and one cold, the cold column will be denser, and therefore heavier, than the warm. **The rate of decrease of pressure with height is therefore greater in the cold air than in the warm.**



Pressure, Temperature and Height

The table below shows the equivalent pressures and heights in the Standard Atmosphere.

Height	Pressure (mb or hPa)
Sea level	1013.2
5000 ft	850
10000 ft	750
18500 ft	500
23500 ft	400
30000 ft	300
34000 ft	250
38500 ft	200
44500 ft	150

ISA Pressure against Height

ISOBARIC SURFACE

A constant pressure surface, or “Isobaric” surface, is a surface in the atmosphere where the pressure is equal everywhere along this surface. For example, the 100hPa surface is the surface in the atmosphere where the pressure at every point along that surface is 100hPa. Meteorologists use pressure as a vertical coordinate to simplify thermodynamic computations that are performed on a routine basis.

The atmospheric variables typically plotted on isobaric maps include; height of the pressure surface, temperature, moisture content and wind speed and direction.