17. Different Types of Depressions and their Formation

There are different types of depression that can form besides that of the classical polar front process as already described. The features of an existing (primary) depression provide the necessary conditions for the development of subsequent, or secondary, depressions. Low pressure systems can be formed by thermal processes also.

17.1 Secondary depressions

A secondary depression is one which forms within the circulation of another depression. Initially the secondary has a higher pressure than the primary, but usually the secondary deepens and the primary fills.

In general the secondary moves around the primary in a cyclonic direction. When the primary is weak and the secondary is strong the primary may be absorbed in the circulation of the secondary. A secondary may also be frontal e.g. a cold front secondary.

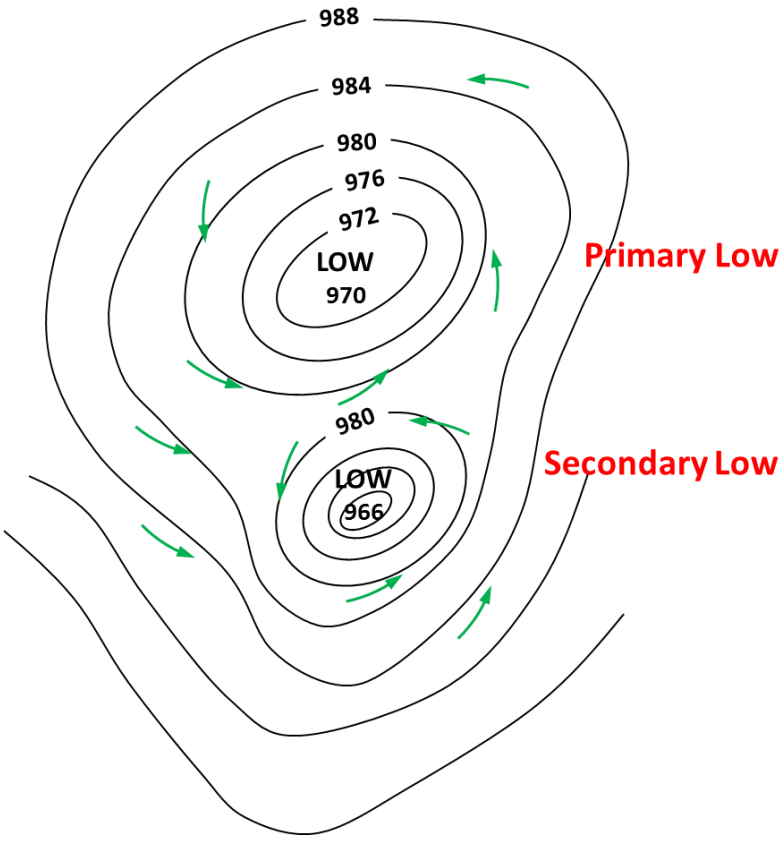

Fig. 17.1 - Secondary depression.

When the depressions have formed on the polar front,the secondary may simply be the next member of the family. This will play a secondary role in its early stages of

development but will often intensify and may ultimately become the dominant system.

We have already considered the family of depressions in Lesson 16; also see next section.

17.1.2 Cold front secondary depression

Secondary depressions can grow off the tail ends of cold fronts of the primary.

The cold front of the primary will often trail considerably to the south (in the northern hemisphere) which allows the cold polar air to encroach the warmer tropical air helping to maintain the temperature difference between the two air masses. This can create a further wave where a second warm front develops on the tail of the primary cold front allowing a secondary depression to develop.

It is usual that subsequent secondary depressions will form further to the south of the former primary to allow a family of depressions to develop.

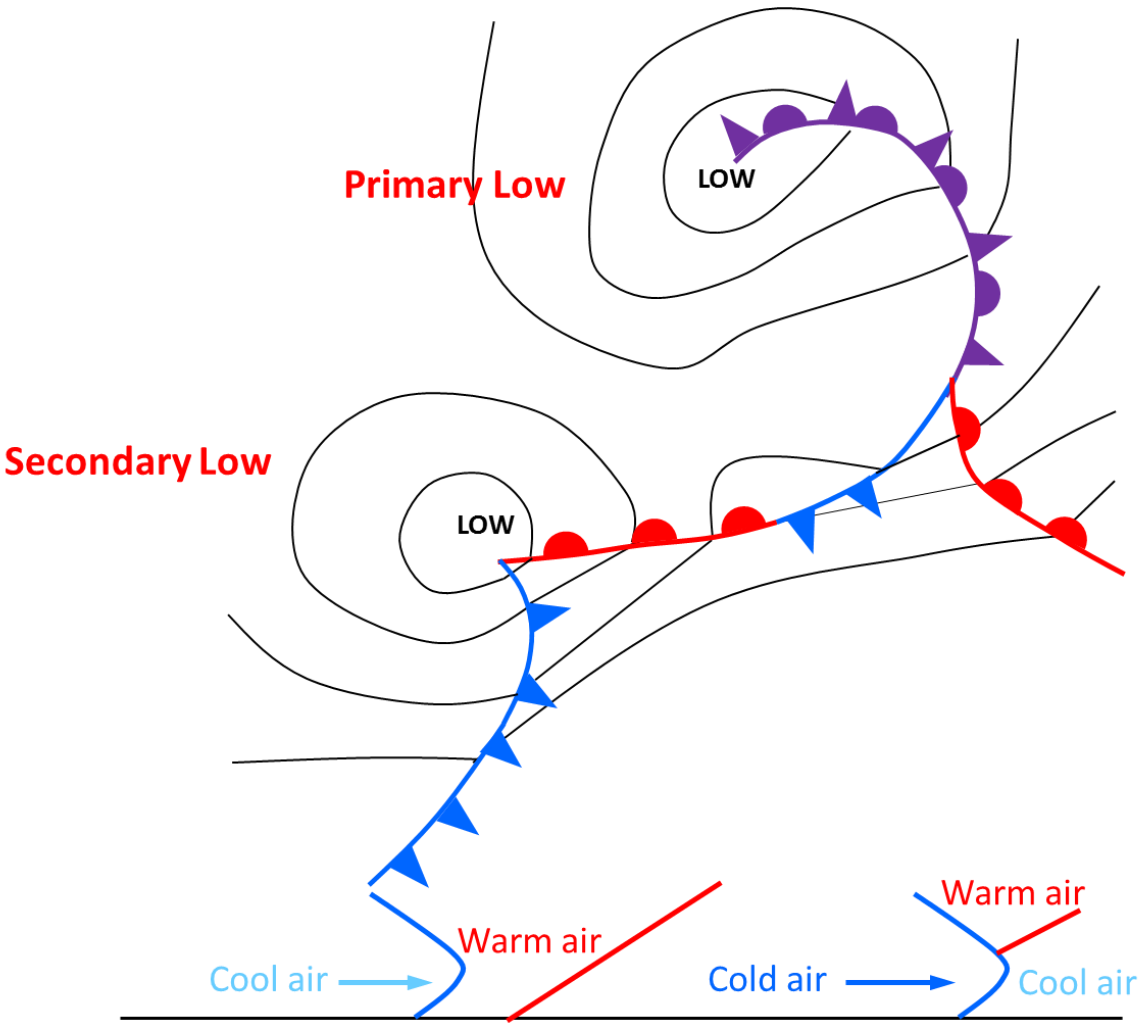

Fig. 17.2 – Secondary depression forming on the trailing cold front of the primary.

17.1.3 Secondary depression forming at the point of occlusion

If a depression cannot move towards the east it is described as being *blocked*. The block is usually caused by the presence of a high pressure system to the east but might also be caused by an extensive mountain barrier running in a near north-south direction.

The formation of the secondary is governed by the extent of the block. If the centre of the depression cannot move eastwards, but the equatorial side can move towards the east a new depression is likely to form. If the point at which the warm, cold and occluded fronts join, being the *point of occlusion*, can move forward a new depression will form with the point of occlusion forming the centre of the low.

The first sign of an incipient secondary is the opening out of the isobars behind the cold front. This is a result of the weakening of the winds behind the front which slows the front down.

Remember that the speed of movement of the front is proportional to the geostrophic wind speed of the winds normal to the front.

The warm air, which is moving rapidly towards the east, then pushes northwards into the weakening cold front. This causes a wave to develop on the cold front to initiate the development of the secondary.

The secondary now formed continues to develop as the pressure falls with the secondary developing its own isobaric structure. Eventually it takes over from the primary, having stronger winds and heavier precipitation.

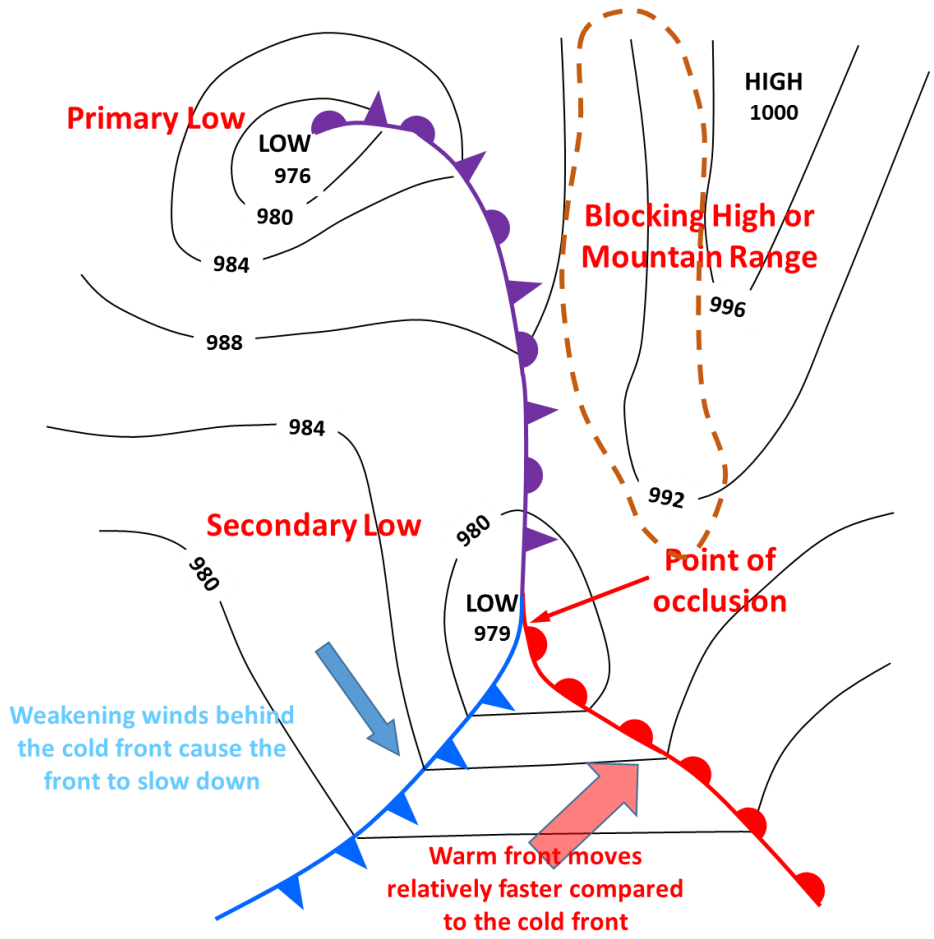

Fig. 17.3 - Secondary depression forming at point of occlusion caused by blocking high or mountain range.

17.1.4 Warm front secondary (breakaway low)

If the block is more extensive and the point of occlusion is also prevented from moving eastwards a new low may develop on the warm front of the primary.

A warm frontal secondary tends to form when the air ahead of the warm front is particularly cold.

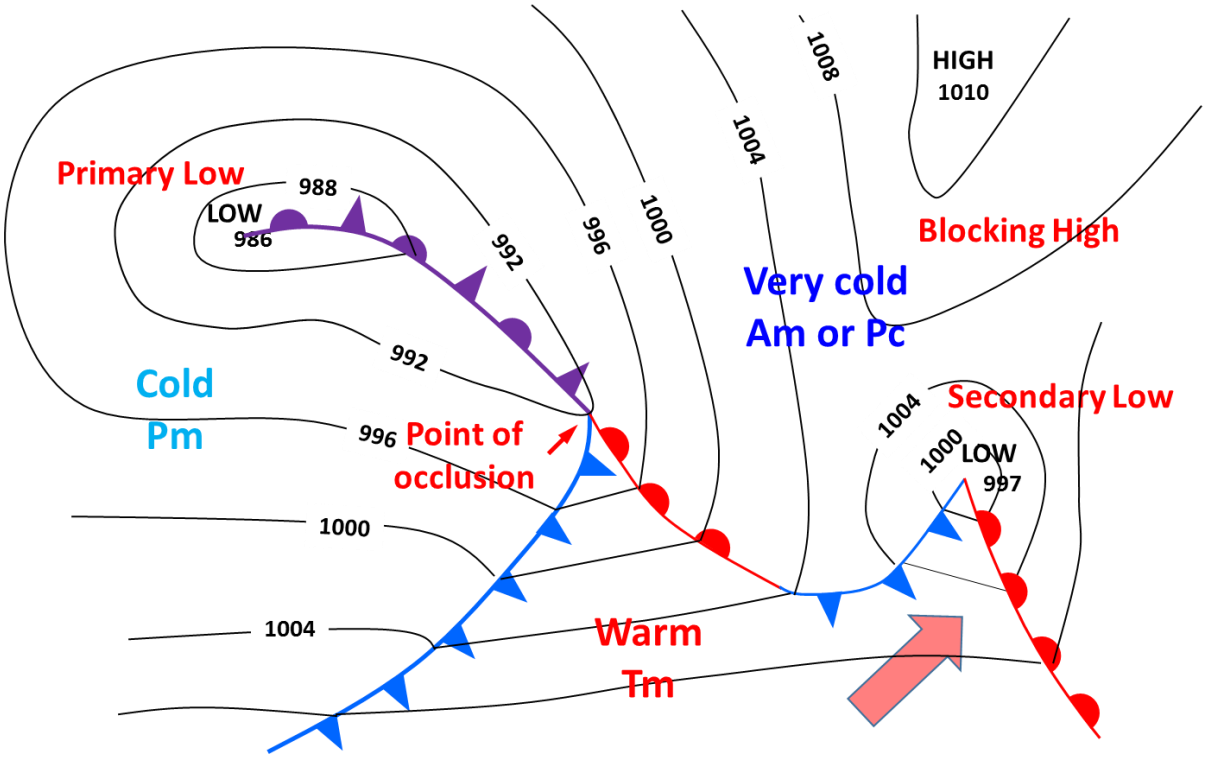

Fig. 17.4 - Warm front secondary on warm front with extensive blocking high or mountain range.

The southern tips of Scandinavia and Greenland are particularly suited to the formation of these types of secondary lows.

17.2 Non-frontal orographic or lee depression

An air stream flowing over a mountain range will be distorted. To the lee of the high ground a trough forms and sometimes a depression. These depressions are common to the south of the Alps.

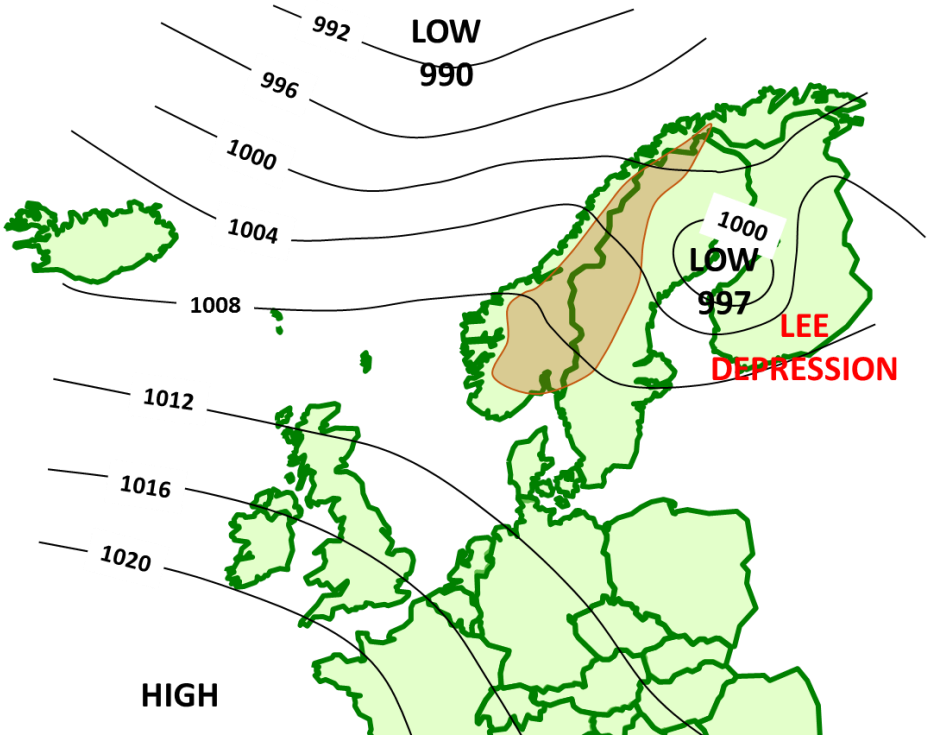

Fig. 17.5 - Lee depression over Scandinavia.

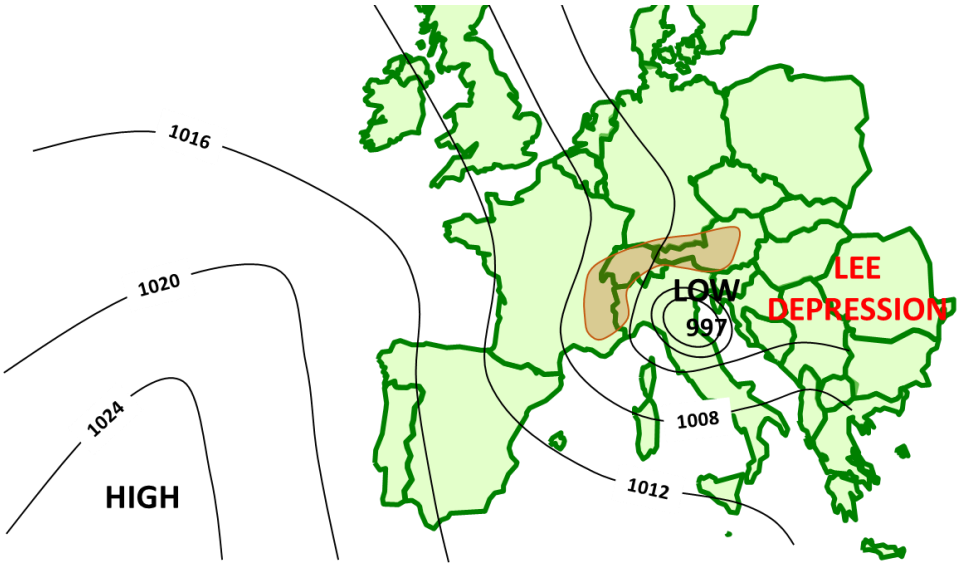

Fig. 17.6 - Lee depression in the lee of the Alps.

17.3 Thermal lows

A thermal depression or low is one that is formed over a warm surface. The process can start from calm conditions. The ground warms due to insolation and heat is transferred to the overlying air. A broad column of air becomes warmer than its surroundings; the air moves upwards and begins to spread out aloft. This then lowers the surface pressure and a small depression develops.

The process is enhanced if there is cloud formation with the release of latent heat which creates a greater temperature gradient with height and promotes further convection.

Thermal lows are not associated with very large falls of pressure. They are often associated with sea breezes where cumulus convection clouds form just inland parallel to the coast; the further inland they form the stronger the sea breeze.

This process is significant in the formation of the SW monsoon that forms over India in summer.

17.4 Polar depressions

These form predominantly in winter to the north of the UK when very cold Pm or Am air flows southward. The temperature difference between the air and the ocean surface is greatest at this time.

The process is the same as that for the thermal low but these form over the ocean. The heating of the air from below produces very unstable air and strong convection currents develop.

A polar trough or a polar depression will develop. Cu or Cb cloud will form and heavy squally showers with rain or snow are a feature.

At sea temperatures remain steady throughout the day and night so the polar low will continue to develop at night.

The low generally moves southwards being entrained in the prevailing airstream.

If the low passes over land in summer the heating from the warm ground during the day will increase the instability.

In winter the low tends to weaken and fill as it encounters cold ground.

The airflow behind an occluded depression is suited to the development of this type of low.

17.5 Trough of low pressure

A trough is an elongated extension or bulge in the isobaric pattern surrounding a low pressure.

Troughs may be *frontal* or *non-frontal*.

17.5.1 Frontal troughs

Frontal troughs may be associated with any type of front: warm, cold or occluded.

An occluded front is described in the next lesson; it is a front where the warm sector of a depression has been lifted off the surface progressively as a depression continues to move eastwards and starts to decay.

When associated with a front it is normal for the isobars to have a sudden change in direction at the front. It follows that wind shifts will be abrupt and the barograph trace angled as the frontal trough passes.

The weather associated with the trough is that of the associated front. Isobars resemble 'V' contours of a steep valley, sometimes called a 'V' shaped depression. It is an extension of a low into a high-pressure area. There is a marked change in wind direction with the passage of a trough line.

In the northern hemisphere the wind *veers* and in the southern hemisphere the wind *backs*.

Veering is a term used to describe a clockwise change in wind direction e.g. the wind is expected to veer from the North to the Northeast.

Backing is a term used to describe an anticlockwise change in wind direction e.g. the wind is expected to back from the South to the Southeast.

Frontal troughs move similarly to a front.

Both patterns of isobars 'point' towards the Equator.

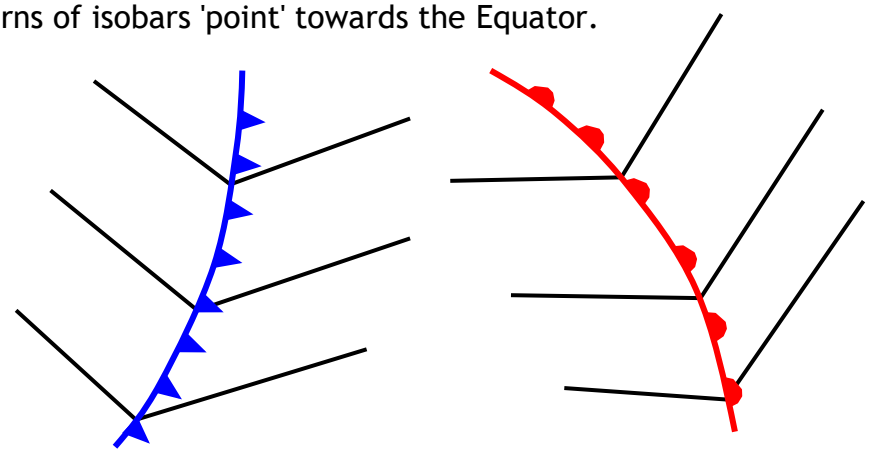

Fig. 17.7 - Frontal troughs (northern hemisphere).

17.5.2 Non-frontal troughs

Non-frontal troughs are rounded elongations of low pressure extending from low pressure areas which are *not* associated with fronts.

Isobars resemble 'U' shaped contours, being well rounded. Non-frontal toughs occur typically in the cold air mass behind an occluded depression and the resulting increase of pressure gradient often leads to a renewal of strong winds or gales after the depression centre has passed.

A trough may be described as being deep or shallow depending upon the curvature of the isobars. The line joining the points in the trough where the lowest pressures are recorded at each point on the ground during the passage of the trough is known as the *trough line*.

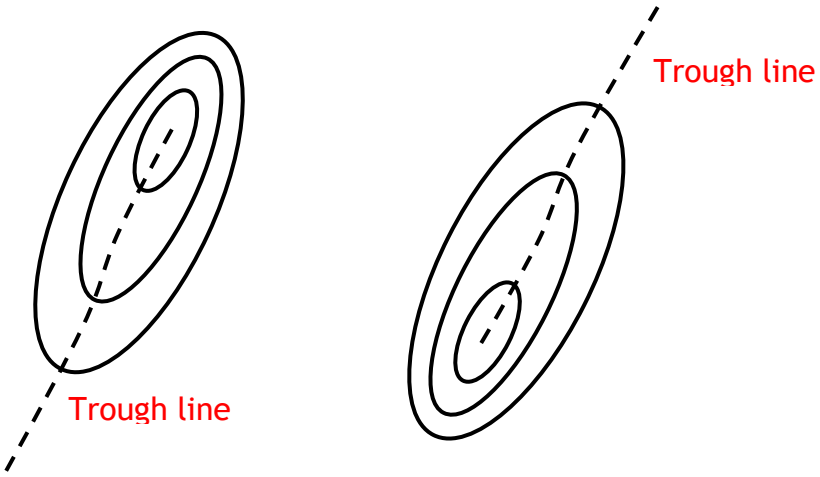

Fig. 17.8 - Isobar pattern for non-frontal troughs.

Note that any wind shift can be either a *veer* or a *back* depending both upon the direction of the extrusion and the general movement of the system will be gradual.

The weather associated with the non-frontal will be that of a low-pressure area (tendency for the general ascent of air) giving cloud at all levels and long life to any convection or orographic cloud which forms.

The most extensive cloud and precipitation is usually found ahead of the trough line.

The extent of the bad weather depends upon the curvature of the isobars. Over the British Isles the most extensive cloud and precipitation usually being found ahead of the trough line.

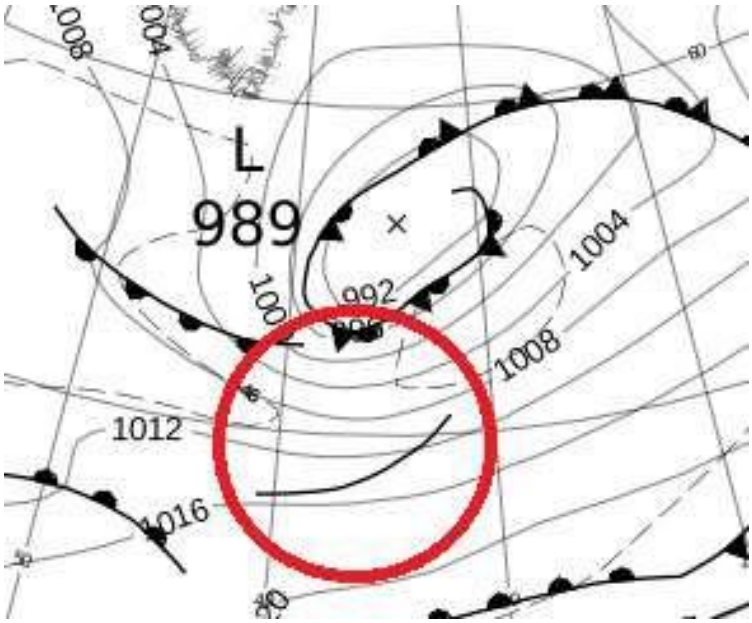

Fig. 17.9 – Non-frontal trough on a synoptic chart.