Appendix A – Soaring meteorology by region

1 Europe

General observations Thermal convection heavily depends on weather patterns that vary considerably around the world. In subtropical regions, statements such as "Hot weather is good soaring weather" hold true most of the time. European patterns differ a lot due to Europe's position outside the subtropics and inside the belt of cyclonic activity (with regular warm and cold fronts as well as passing troughs). This means that changes in weather patterns occur far more frequently.

Carsten Lindemann, a meteorological scientist and lecturer of at the Freie Universität von Berlin, delves a little deeper into the peculiarities of central European gliding conditions. Lindemann has taken his ASH-25 to many parts of the world, is a well-known competition pilot, has been on the German national team, and has served various German teams as their meteorological advisor.

Up to 160 fronts pass across Europe in a year. Days with very good soaring conditions are limited and, as a consequence, a number of consecutive good soaring days is quite rare indeed. However, long lasting and almost stationary high pressure systems over Scandinavia produce superb soaring weather in northern Germany and Poland for several weeks at a time.

The soaring season in central Europe is usually from early March to early October. During the winter there is very limited convection activity due to the predominantly stable air mass and rather windy conditions. Relatively high humidity levels lead to a high degree of cloud cover, which in turn limits the amount of radiation that can reach the ground. On the other hand, windy conditions favour other kinds of updrafts such as slope lift and lee waves that can extend the soaring season in areas of suitable topography.

Air mass behaviour based on different curvatures of isobars
When an air mass with a certain temperature and moisture content comes under the influence of a high or low pressure system (or when it travels over large bodies of water) it is highly likely to change its characteristics and behaviour. This is common knowledge; not so well-known is the fact that the characteristics of the air are less dependent on the actual pressure values than on the shape and curvature of the isobars. More on that later.

Figure A1 represents the most important meteorological features for the mainly flat or moderately hilly countryside of central Europe. They are presented firstly without an underlying map to show the isobar curvature in principle. Isobars are lines of identical pressure. It does not matter whether we are looking at high or low pressure systems (or whether we are north or south of the Equator), the air above the surface friction layer (about 3000 feet agl) is generally flowing parallel to the isobars. Primarily as a result of friction near ground level, the air flows out of the high and into the low at angles between 15° and 40° to the isobars. For a recap on the air flow around low and high pressure systems, review 2.13.

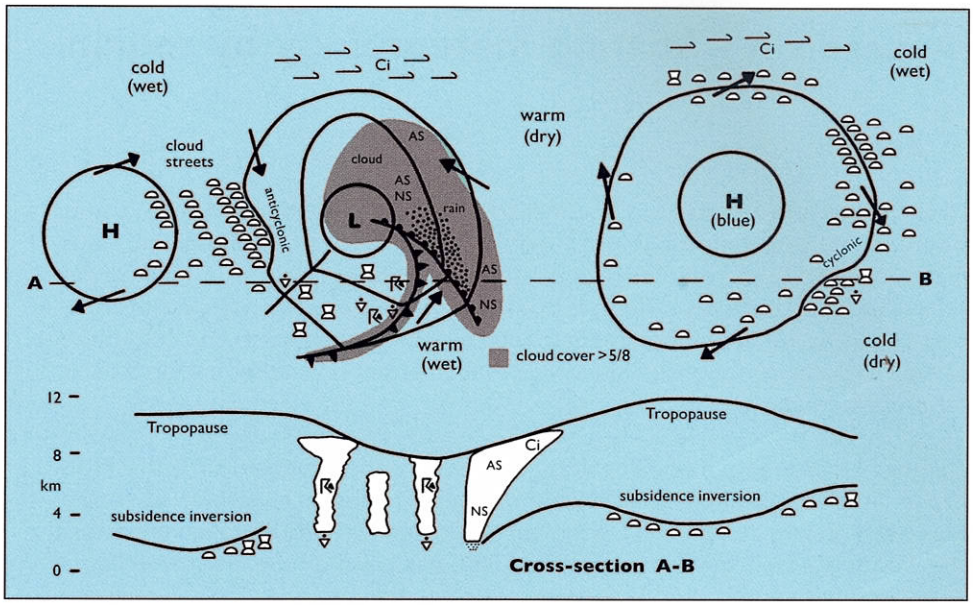


Figure A1
General European meteorological situation

As mentioned above, the shape and curvature of the isobars are more important than the actual pressure value when it comes to determining the general vertical movement of the atmosphere. In a low pressure area the air moves only upwards by a few cm/sec – a value not really relevant for soaring. Of much greater importance is the fact that more cloud is to be expected in areas with cyclonically shaped isobars compared to sections of the same isobar with anticyclonic curvature. The most rapid upward air motion in a low pressure system is found along its front line.

In a high pressure region (anticyclonic air flow) the general motion of the air is downwards, leading to cloud break-up or perhaps even a cloudless sky. Even in a dry atmosphere, cyclonic curvature of isobars in the outer regions of a high can lead to cumulus cloud development. In summary:

Cyclonic curvature of isobars → clouds build-up
Anticyclonic curvature of isobars → clouds dissipate

This makes the outer fringes of high and low pressure systems especially interesting for our sport. Right in the center of a low we can expect a solid cloud cover, but if we have an anticyclonic curvature of isobars along its peripheral zone we can expect reasonable gliding conditions. Conversely, even in drier air near the fringes of a high pressure system we can expect cumulus clouds when the isobars show a cyclonic curvature.

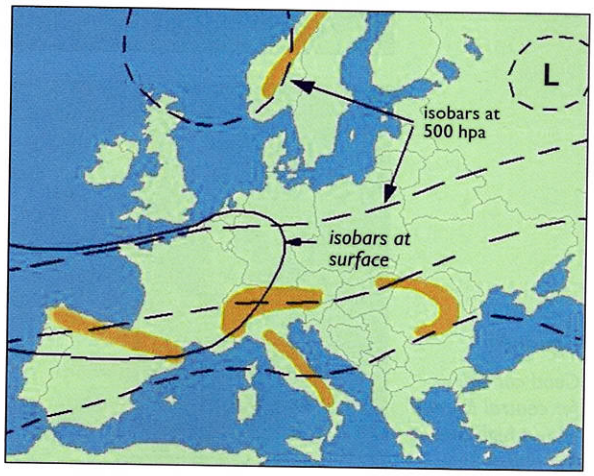
While looking closer at Figure A1, the following comments are applicable to situations usually encountered in the northern hemisphere. Possible areas of more than 5/8 cloud cover (in and near the center of the low) are indicated by the dark region. At the eastern side of a low and at the western side of a high, air masses are usually warm and either wet or dry – although they are often a little dryer towards the center of a high. The area between highs and lows is often governed by warm southerly air advection and warm fronts that become less active at shorter distances from the center of a high. The NW to N air flow

at the western side of the low is normally cold and often wet. Soaring conditions are very favourable where the curvature of the isobars becomes anticyclonic.

At the northern and eastern part of a high, which can again be considered as the western part of the next low to the east, cold air advection is present. This cold air (being anticyclonic and thus in a region with less cloud cover) usually results in good and strong convection after only little heating. Another very favourable area is the southern side of a high pressure system. Air passes through NE to SE direction, which is normally dry and potentially warm in summer. This often happens over Great Britain or Scandinavia when a high pressure system is located near the western or northern parts of these countries. This also makes for good to excellent soaring conditions from northern France to Poland.

Figure A2

Pressure distribution at surface and at 500 hPa

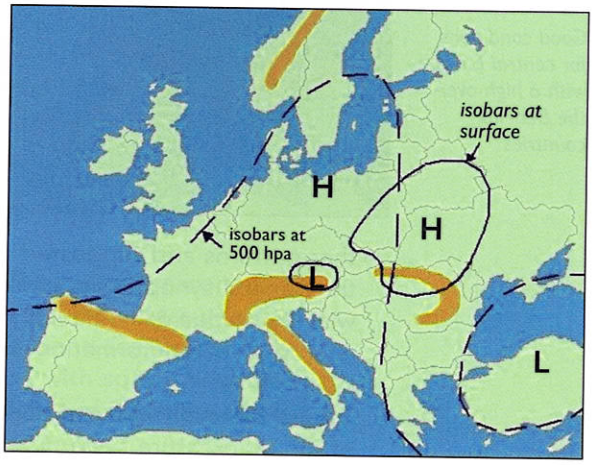


Applying the comments related to Figure A1, and after an assessment of a temperature trace and the wind, we can determine where the best soaring conditions can be found. However, a standard synoptic chart provides information on the pressure distribution at ground level, and only allows a short term weather assessment.

For a longer term forecast, we must consider the pressure distribution at the 500 hPa level (about 18,000 feet, Flight Level 180 or FL180) and glider pilots can refer to these readily available figures. With a strong westerly air flow at this level (Figure A2), we can expect conditions to change quickly. Such a situation will normally last for a day or two, or until the upper air flow provides new characteristics for surface air and pressure systems. Upper and lower pressure systems do not act independently of each other – a fact that makes weather forecasting even more complicated. However, a high pressure system hovering above will provide good conditions for several days or even longer.

Figure A3

Favourable conditions with a high over Eastern Europe



Let's look at some favourable European weather patterns now. Figure A3 depicts an example of favourable soaring conditions over the Alps at the end of April. The high is located east of the Alps and at the 500 hPa level, it stretches into southern Scandinavia and the Baltic Sea.

Another favourable situation for the month of May is shown in Figure A4. Here the high pressure at ground level and 500 hPa are located over northern Germany/Denmark and are only marginally displaced. Over the Alps we find a weak heat low (due to a greater warming of the mountain area – see Figure 81 on page 150). Conditions are less favourable in northern Germany as a result of the subsidence inversion near the center of the high.

Figure A5 shows a weather pattern with a high pressure system over the North Sea and an elongated low over the Atlantic coast of France and

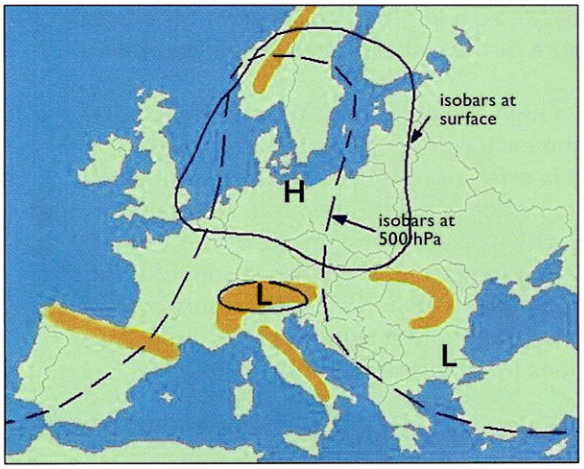


Figure A4
Favourable conditions with a high over Scandinavia

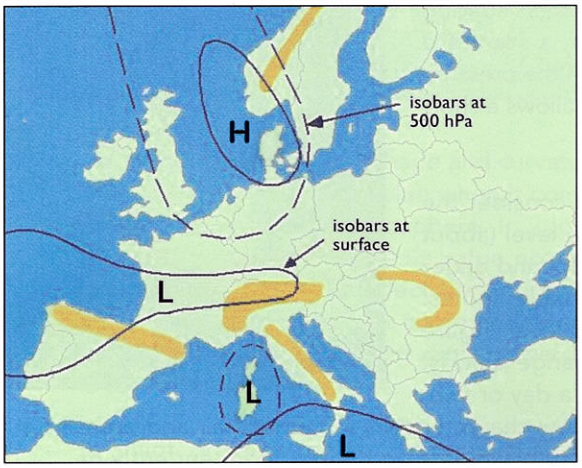


Figure A5
Good conditions for central Europe with a high over the North Sea

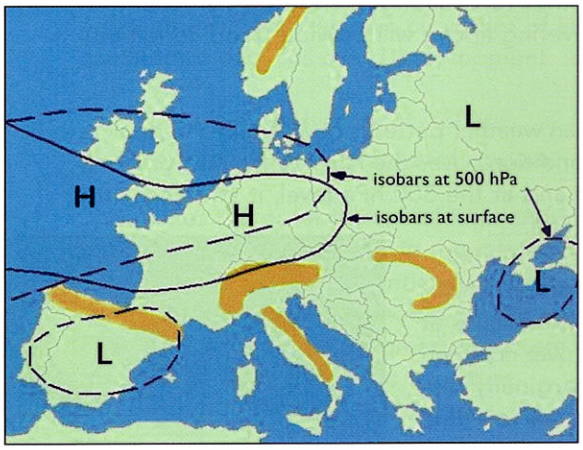


Figure A6
Good conditions for central Europe with a high over the Benelux countries

Spain. Good to very good conditions can be expected over the Alps and also in Germany and surrounding countries.

The final example of a good soaring weather pattern for central Europe is shown in Figure A6. The upper level high over the UK and Denmark and the weaker surface high over central Europe provide for excellent gliding conditions. Even better soaring can be expected when the high is stationed further north between Great Britain and Scandinavia. The resulting weather pattern is conducive to easterly air flow and can delight glider pilots in the Benelux countries, eastern France, Poland, Germany, the Czech Republic and Slovakia for long periods – sometimes weeks. However, soaring in the Alps can be negatively affected when different air masses mix. The resulting instability can lead to extensive cloud cover.

To sum it up with a more general statement, the position of the surface high has a major bearing on the ideal location for good thermal activity, but speed and direction of the upper air mass dictate the duration of suitable weather patterns. The upper air mass also impacts on thermal strength and convection height.

Alps soaring conditions

The first general observations of alpine soaring weather were recorded by Jochen von Kalkreuth in the 1970s. He divided the Alps into four zones of differing weather patterns and suggested different flying tactics depending on the season and the general synoptic situation. Even today his recommendations are still valid, but with knowledge gained during some fantastic alpine long range flights, more detailed and up-to-date information is now available.

Typical thermally induced circulations in alpine regions (under the general influence of a high pressure system) are shown in Figure A7. Generally, good soaring con-

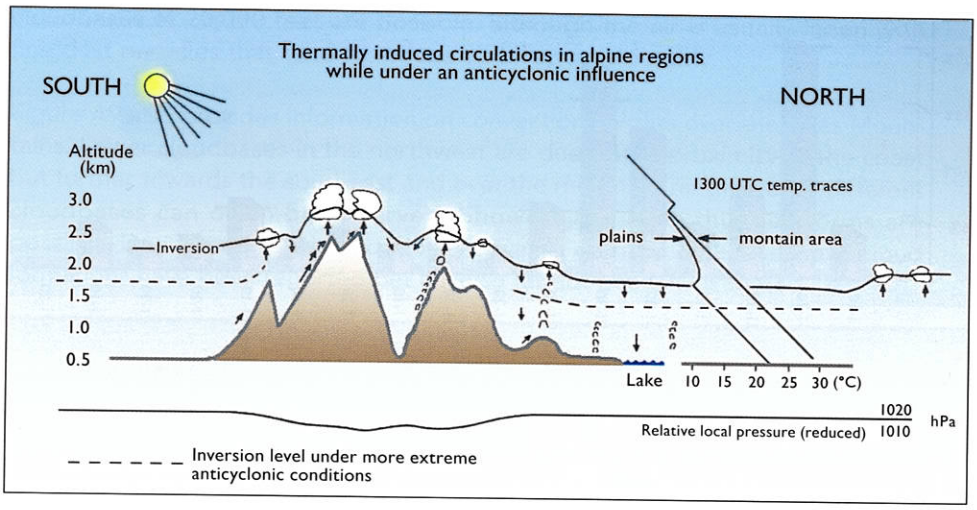


Figure A7
Convection currents in alpine regions

ditions are found from early April until June. Later in the season the area to the south of the Alps is influenced by warm and humid Mediterranean air, which often results in less favourable conditions. However, the western alpine regions and Provence are better protected from the Mediterranean air and usually offer good soaring conditions, even during the latter part of the season. Experience shows that a high pressure system at surface level (with higher heating rates in the mountains) can lead to a slight drop in air pressure over the Alps as a result of the strong daytime thermal activity in the region. This is sometimes referred to as a heat low. A similar situation can be observed in other subtropical European regions such as Spain and Italy. Gliding conditions are particularly favourable if such areas are blanketed by a weak high level westerly air flow.

In this context it should be noted that excellent Mediterranean soaring conditions are frequently encountered when central Europe is plagued by successive low pressure systems. Equally, good gliding weather in central Europe (especially when there is a high pressure system over Scandinavia) often goes hand in hand with less reliable soaring conditions in Mediterranean countries.

Soaring in the Provence region of France As early as March, fantastic gliding conditions can be encountered in the Provence region of France. Being protected by mountains, the area warms to the east and northeast due to the sheltering effect of the Alps and the Massif Central. Northerly to northwesterly cyclonic air flow usually leaves moisture in the mountains. Lee waves are a regular occurrence and thermal soaring conditions are marvellous given low to moderate wind speed. The Alps lose their winter snow first in Provence, and if a *mistral* (a local wind) is persistent and strong, it produces lee waves until a low forms in the Gulf of Lyon region. Once a low forms, a southeasterly to southwesterly warm and wet air flow governs this region with a period and rain falls for about a week. This happens quite often during early April.

Soaring conditions in central Europe The soaring season usually begins at the end of March or in early April when the first high pressure system from the Azores pushes into west and central Europe. Good soaring conditions start in the west and later extend to the east in line with spring vegetation development. At this time of year there is a good chance of first class soaring, especially in France, the Netherlands, Belgium, and Luxembourg. At the end of

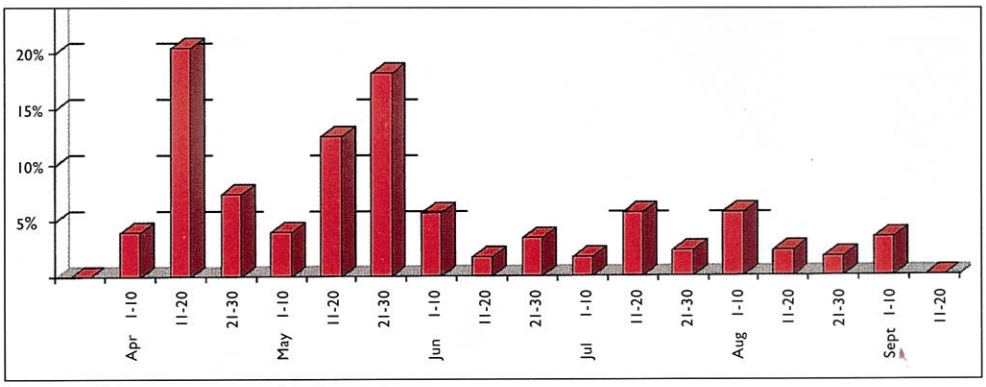


Figure A8
Historic favourable soaring times in Europe

April, favourable weather patterns can be found in the whole of central Europe and in the Alps. Later in the year, warm air advection can become detrimental to gliding conditions further west. Pilots need to pay more attention to soil characteristics and vegetation if this is the case.

Soaring conditions in Spain Special attention should be given to soaring conditions in Spain, which can be the best in Europe from mid-June to mid-August. Sometimes cold fronts from the west to northwest pass over Spain and reduce the quality of thermals below that of central Europe. After days of heating (or in a relative warm air mass), conditions improve and can be good to excellent. The situation is usually governed by a westerly air flow at the 500 hPa level and a heat low at the surface. This creates a daily pressure variation – high at night and low during the day due to surface heating.

Often, convergence lines develop over mountain ranges, especially the Sierra de Guadarrama. Here the convergence line(s) can be directly above the mountains or to the north of the range and can extend hundreds of kilometres. These convergence lines are a result of elevated heating effects and wind profiles, and they provide for one of the most exciting thermal flying experiences in Europe.

2 Morocco

Like central and southern Europe, Morocco offers favourable soaring conditions during the summer months. Notice that the Atlas Mountains divide the country into two different weather zones. In the lower northwestern regions, the temperatures are higher and, due to the proximity to the Atlantic Ocean, the air is usually moister as well. As a result we see cumulus clouds, especially near the mountains when temperatures climb above 40°C. East or southeast of the 12,500 foot Atlas Mountains we are already close to the Sahara Desert. Here the ground is about 3500 feet asl but similar temperatures and very dry air often result in cloud streets under convergence lines as high as 16,000 feet. However, ingress of moist air from the Mediterranean can result in a somewhat lower cloudbase in areas closer to the coast.

Figure A9 shows a cross-section through Morocco's coastal strip, which runs through Casablanca, Beni-Mellal, Tinerhir and Alnif – roughly along a 320°–140° line. The height of convection shown is for the hottest part of the day, which is usually between 3 and 4 pm local time. With east to southeast winds even