# APPI PPG LECTURE 5: FURTHER METEOROLOGY

## Introduction:

This lecture covers Further Meteorology and aims to give you more of an understanding of advanced weather conditions and patterns. However Meteorology is a huge subject and to truly get to grips with it takes years!

## Airflow

### Ridge Lift (Use a White Board or a Diagram)

- Airflow meeting a smooth ridge or cliff creates an area known as the lift band. This is due to the air being forced up as it encounters the slope.
- Ridge Lift can be used by Paraglider pilots to soar the ridge. However, the wind must hit the ridge directly or by no more than 15 degrees, otherwise the wind takes the line of least resistance and accelerates along the ridge.
- The Lift band is more prominent when the wind is stronger and when the gradient of the slope is steeper.
- Do not take off or land downwind of a steep or jagged ridge when it's windy, as you will either encounter turbulence or strong wind. The strong wind is caused by the Venturi effect, which is when a gas or liquid is compressed, causing it to accelerate.

### Wind Gradient (Use a White Board or a Diagram)

- As a Paramotorist the wind gradient is very relevant as the higher we go the faster the wind becomes.
- This is caused because there is less friction between the higher air masses and the ground.
- E.G: There may be a 5mph wind on the ground but 30mph at 3000ft. In this instance a Paramotorist would be going backwards.
- Indications of a strong wind gradient are sloping clouds or fast moving clouds.
- Sometimes the stronger winds are only a few hundred feet about the ground and will probably drop down. In this case do not get caught out by them and if flying land immediately!

### Wind Sheer Turbulence (Use a White Board or a Diagram)

- WST is a form of turbulence caused by a variation in wind speed and or direction.
- WST can occur down wind of high mountain peaks where the wind is stronger.
- WST can also occur when cool air sinks from a Hill or Mountain with a warmer upper layer of air moving at a different speed or direction causing a layer of turbulence between the two air masses.
- WST also occurs in the morning when the temperature inversion layer exists.
- Another example of WST is when two air masses meet, both with different wind speeds and/or directions. This is also known as Clear Air Turbulence.
- WST can cause major wing malfunctions so make sure you chose the location to fly in carefully and take local advice when flying somewhere new, especially in mountainous regions.

### Inversion Layer (Use a White Board or a Diagram)

- The inversion layer occurs at low level up to 1000ft and is a characteristic of High Pressure.
- Warm air holds a layer of cool air below it and traps all of the smog resulting in bad visibility.
- The inversion layer can be dissipated by strong thermic activity hence weak inversion layers can no longer be seen by mid day.
- The higher the pressure the stronger the inversion layer.

## Pressure Systems

- Pressure systems are indicated on an Atmospheric Pressure Chart and normally measured in Millibars (mb). They move with the Earth's rotation; from west to east around the world. This is known as the Coriolis Effect.
- Isobars indicate areas of the same pressure and are similar to contour lines on an OS Map.
- The Isobars on an APC also indicate the pressure gradient; if they are close together there is a steep pressure gradient but if they are further apart there is a weak pressure gradient.
- If Isobars are close together you can expect strong winds and if they are spread out you can expect low winds.
- There are two types of Pressure, High and Low, and with them they bring frontal systems.

## High Pressure (Use a White Board or a Diagram)

- High Pressure systems are known as Anticyclones.
- They spin clockwise in the Northern Hemisphere and are generally a lot bigger and move slower than a low pressure.
- In a high the air is subsiding or sinking; hence the development of Inversion Layers. The wind flows along the isobars and shifts away from the centre of the high pressure.
- They are stable and resist upward development; including thermals. High Pressure is attracted to Low pressure.
- The air is warmed by compression and retains moisture meaning that no clouds form in strong high pressure systems.
- They normally denote good weather for flying.

## Low Pressure (Use a White Board or a Diagram)

- Low Pressure systems are known as Depressions or Cyclones.
- They spin anti-clockwise in the Northern Hemisphere and cover a smaller area, have a stronger pressure gradient and move faster.
- The air in a Low Pressure is rising; causing the clouds to form as the warm, moist air condenses. The wind flows along the isobars and shifts in to the centre of the low pressure.
- In the Northern hemisphere, if you put you back to the wind and stick out your left arm, you are pointing towards the centre of the low pressure. This is known as Buys Ballots Law.
- They normally denote bad and unstable weather and bring with them frontal systems.

## Warm Fronts (Use a White Board or a Diagram)

- Fronts are moving air masses of a different temperature to the air that it is meeting.
- When a warmer air mass meets a cooler air mass it slides over the top of the cooler air and a warm front is said to exist.
- A warm front is more gradual and shallow and moves slower with less impact.
- Indications of an approaching warm front are lowering stratiform cloud, sun dogs and an increase in temperature.
- Warm fronts are depicted on an Atmospheric Pressure Chart by Red Semi Circles pointing in the direction the front is moving.
- If you see signs of an approaching warm front make sure you fly towards it in order to keep an eye on its progression but be ready to land at any time as they can produce gust fronts and rain.

## Cold Fronts (Use a White Board or a Diagram)

- When a cooler air mass undercuts a warmer air mass a Cold Front is said to exist.
- Cold fronts move rapidly and are not gradual. They often appear as a wall of dark cumuliform cloud.
- As a cold front approaches there is often a drop in temperature and pressure.
- Cold fronts are depicted on an Atmospheric Pressure Chart by Blue Triangles pointing in the direction the front is moving.
- They normally give rise to strong winds and gust fronts as well as heavy precipitation. Never fly in cold fronts!

## Occluded Fronts (Use a White Board or a Diagram)

- Occluded fronts are caused when a faster moving Cold Front catches up with a slower moving Warm Front.
- It is effectively a combination of both a warm front and a cold front and the cloud formations can be both stratified and cumuliform.
- They are very deceptive as they can appear, at first, to be a warm front but are actually masking the approaching cold front.
- Occluded fronts are depicted on an Atmospheric Pressure Chart by a combination of either blue triangles and red semicircles, or purple/pink triangles and semicircles, pointing in the direction the front is moving.
- They give rise to strong gust fronts, heavy rain, thunder and lightening. Never fly in an occluded front!

# Further Weather Information

- Fog forms when the air remains in contact with a cold surface. The surface must cool the air below its dew point. They are particularly prominent in valleys and on the coast due to the large amount of moisture in the air. Do not fly in Fog!
- Sea Breezes are caused because the land heats up and cools quicker than the sea. As the land heats up it causes the warm air to rise in the form of thermals. The cooler air out at sea then rushes in to replace the warmer air which has risen, thus causing a sea breeze to develop. Throughout the day sea breezes tend to increase in wind speed as more cool air is sucked in to replace the rapidly rising air inland. They can be good to fly in as they produce smooth, laminar air however be aware that the wind speed can increase rapidly!
- Land Breezes are the opposite of Sea Breezes, caused by the land cooling quicker than the sea. During the evening and night time the relatively warm sea air starts to rise causing the cooler air inland to be sucked out to sea in order to replace it. Do not fly in close proximity to the sea during a Land Breeze as it could take you out to sea!

- The Lapse rate is the drop in temperature with altitude. The temperature normally drops 2℃ every 1000ft. However this varies depending upon the amount of moisture in the air. The Saturated Lapse Rate causes the temperature to drop at 1.5 degrees every 1000ft and the Dry Adiabatic Lapse Rate causes the temperature to drop at 3 degrees every 1000ft. Therefore warp up warm if you intend to fly high!
- Anabatic Wind is found in mountainous regions and is caused by the sun heating the bottom and side of a valley causing the warm air above it to rise up the slope. This rising air can make launching a wing very easy when taking off from the side of a mountain.
- Katabatic Wind is the opposite and is caused when the sun no longer heats the slope causing it and the air above it to cool. The cool air then begins to sink down the slope. Remember the phrase: 'Ana went up the slope to get the Kat down'. This sinking air can make launching a wing very difficult and dangerous, it can also cause the wing to sink and at times collapse!
- Valley Winds are caused by several local weather conditions. When anabatic wind causes the warm air to rise, it means that the air at the bottom of the valley needs to be replaced and therefore cooler air is sucked in to replace it. As the cool air is sucked in through the 'V' shaped valley the air is compressed and therefore sped up. This is another example of the Venturi Effect. When taking off or landing in a valley always be aware of potential valley winds as they can catch pilots out very quickly!
- Lenticular Clouds are lens shaped clouds that move horizontally with the wind. They are caused when air is forced up and over a series of mountains. As the air is forced above its condensation point, the Lenticular clouds are formed. These are often a sign of 'Wave' which can present enormous amounts of lift and sink and therefore not recommended to fly in. They can also be a sign of bad weather approaching.
- Orographic Clouds are clouds which pour down the lee side of a mountain. This can be a sign of a Foehn wind, caused by cool, moist air that has been forced up over the peak where it condenses into cloud or drizzle. As the air descends on the lee side it is heated by compression and is warmer and drier as it reaches the bottom. The Foehn wind tends to be strong. Do not fly down wind of a mountain if you see Orographic clouds.
- Dust Devils are miniature thermals on the ground which can be seen as they pick up dust and other debris. They denote that it is very thermic and dangerous to fly.
- Virga, also known as Cloud Curtains, are black tentacle like clouds which hang underneath Nimbus clouds. They indicate gust fronts and rain and if you see them never fly!

## Conclusion

The information described to you outlines, in basic detail, the most prominent weather conditions that you, as Paramotorists, need to understand. However, as a general rule of thumb the following are signs of potentially dangerous flying conditions:

- Rotating wind, often seen when the wind sock shifts more than 90° in a short space of time, indicate strong thermic conditions.
- Sloping, shallow cloud indicates there is a strong wind gradient.
- A different wind direction on the ground to that in the air indicates potential wind shear turbulence.
- A wall of gray, dense cumuliform cloud indicates an approaching cold front.
- Lowering stratiform cloud indicates an approaching warm front.
- Regularly check the weather forecast but do not rely upon it!
- IF IN DOUBT DO NOT FLY!

ANY QUESTIONS?

END OF LECTURE 5