BCN™
DRONE CENTER

METEOROLOGY

DRONE PILOT COURSE

WIND

It is caused by the pressure differences that tend to balance, from high to low pressures. These differences are produced by the unequal heating of the surface, when the air heats up, it rises and to fill that void, the surrounding air moves towards the area. where the depression has occurred When the intensity of the wind is not constant and blows with different intensities in short periods of time, the wind is defined as gusty.

SURFACE WIND

The lowest part of the atmosphere close to the ground (up to 200, 500 m) is defined as the boundary layer, since the earth's surface has different orography and roughness, which causes disturbances in the movement of the wind.

- For the flight with UAS it is necessary to take into account that the intensity of the wind increases with the height of the flight
- When the wind speed is close to the maximum described in the manufacturer's manual, it can make the maneuverability of the UAS difficult and also negatively affects the autonomy of the batteries.
- The operational range of the UAS may be affected if there is wind during the operation

WIND

WIND DIRECTION

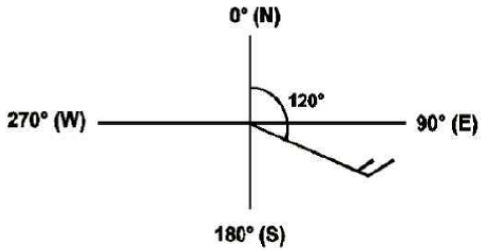
It is defined by the point on the observer's horizon from which it blows (where it comes from). Currently, the compass rose divided into 360 degrees is used internationally. The calculation is made taking north as the origin and counting the degrees clockwise. In this way, a wind from the SE is equivalent to 135 degrees; one from S, at 180 degrees; one from the NW, at 315 degrees, etc.

WIND SPEED

It is measured in knots. 1 knot = 0.514 m/s It is the unit of measurement through which the manufacturers indicate the limit of the maximum speed that a UA can support.

- How to represent wind in a graph?

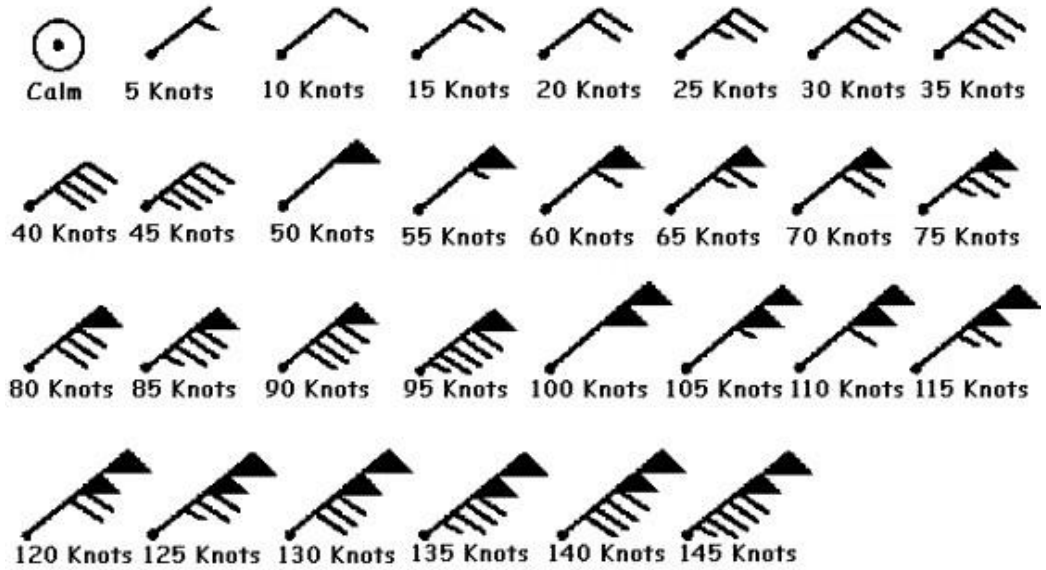
Wind direction is represented in degrees from 0 degrees to 360 degrees as shown above in the figure. In this, 0 degrees corresponds to the North, 90 degrees to the East, 180 degrees to the South, 270 degrees to the West and 360 degrees to the North again. In the following Fig. the wind has been represented with a direction of 120 degrees (approx. from the southeast), the point of the arrow indicates where the wind comes from and, the barbs, how the magnitude of the wind will be seen below, in this case, 15 knots.



WIND

WIND SPEED

- If it is a vector, the length represents the wind speed.
- In the case of barbed arrows, the wind speed is represented taking into account the following graphic scale.
- The shortest beard equals 5 knots, the longest 10 knots, and the triangle 50 knots, if we want to represent 70 knots, will be a triangle with two large beards.
- Speeds less than 5 knots are represented by arrows without barbs.



WIND

TURBULENCE

Classification according to origin

a) Mechanical turbulence: It originates due to the presence of obstacles such as buildings, mountains, trees, hangars, etc.
b) Convective/Thermal turbulence: It is produced by the rise of convective currents, in which the air masses in contact with the surface are heated during the day by the effect of solar radiation.
c) Wake turbulence: It is generated by the flight of the UA itself, since turbulent vortices are produced behind it.

Classification according to the effect it produces on the aircraft

a) Strong Turbulence: The aircraft is subject to sudden changes in altitude and attitude, and may become out of control and suffer structural damage.
b) Moderate Turbulence: The aircraft is subject to changes in altitude and attitude, but without losing control.
c) Light Turbulence: The aircraft does not present relevant changes in altitude and attitude.

Turbulence will be an important factor to take into account, especially in the most critical phases, such as takeoff and landing Normally, when flying in turbulent airflows, the UAS manufacturer usually recommends lower speeds and disconnection automatically, in order to avoid structural loads

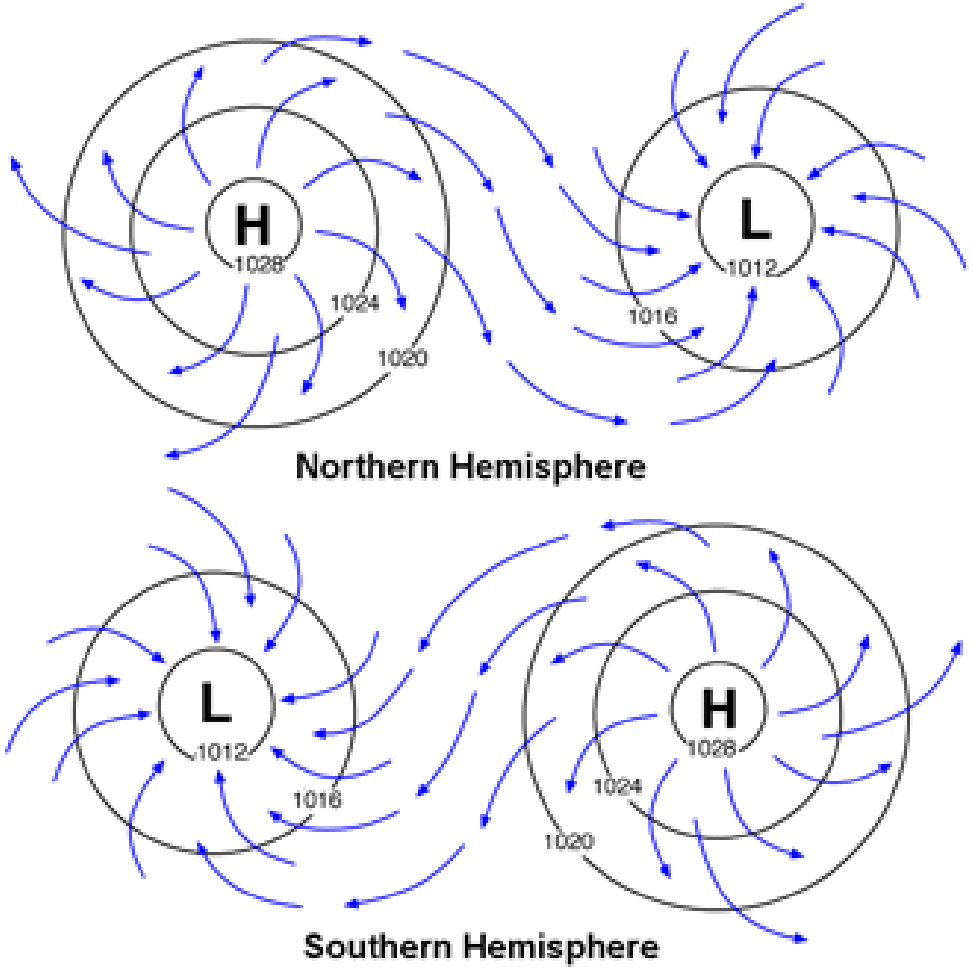
WIND

ATMOSPHERIC PRESSURE

Atmospheric pressure is the force exerted by the weight of air on the earth's surface. To distinguish whether it is low or high, it is based on the value of normal pressure at sea level: 1013 mb

- ISOBARS: Isobars are lines that join points of equal atmospheric pressure at sea level. They are represented on weather maps drawn at intervals of 2 or 4 mbar. When isobars are close together, they indicate pressure difference, and generally, strong winds.

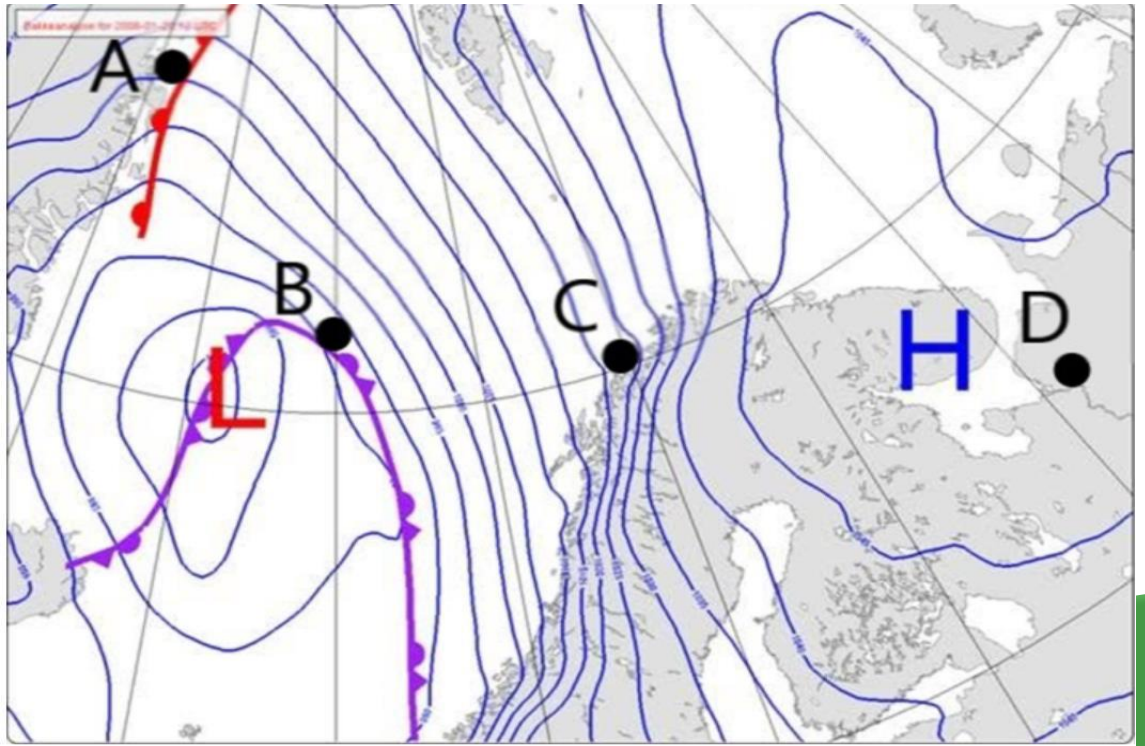
In this figure you can see the operation in the opposite direction of the low and high pressures in each of the hemispheres of the Earth



WIND

ATMOSPHERIC PRESSURE

- In this isobaric map, it is observed that at point C the wind would be from the south at point D from the north at point B from the south and at point A from the south east.
- The closer together the isobars are, the greater the intensity of the wind and the further apart, the less intensity.
- In this example, the area where the L and H join will be where the intensity of the wind will be greatest.



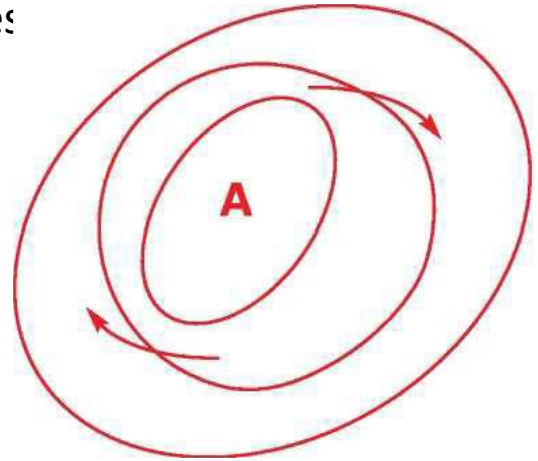
WIND

ANTICYCLONE

An anticyclone is an area where the atmospheric pressure is higher (1016 mb or more) than the surrounding areas. The isobars are usually very far apart, showing the presence of light winds that disappear near the center. It is accompanied by stable weather: in summer, sunny and dry; and, in winter, clear and cold.

Air moves clockwise in the Northern Hemisphere and counterclockwise in the Southern Hemisphere. The air that descends dries and warms up, so it brings stability and good weather, with little chance of rain.

However, in winter, the descending air can trap fog and polluting elements under a thermal inversion and form the so-called "smog" that occurs in large cities



ANTICYCLONE
(Northern Hemisphere)

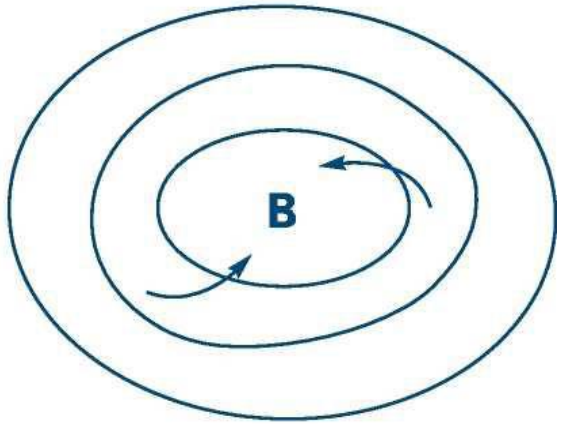
WIND

DEPRESSION/LOW PRESSURE AREA

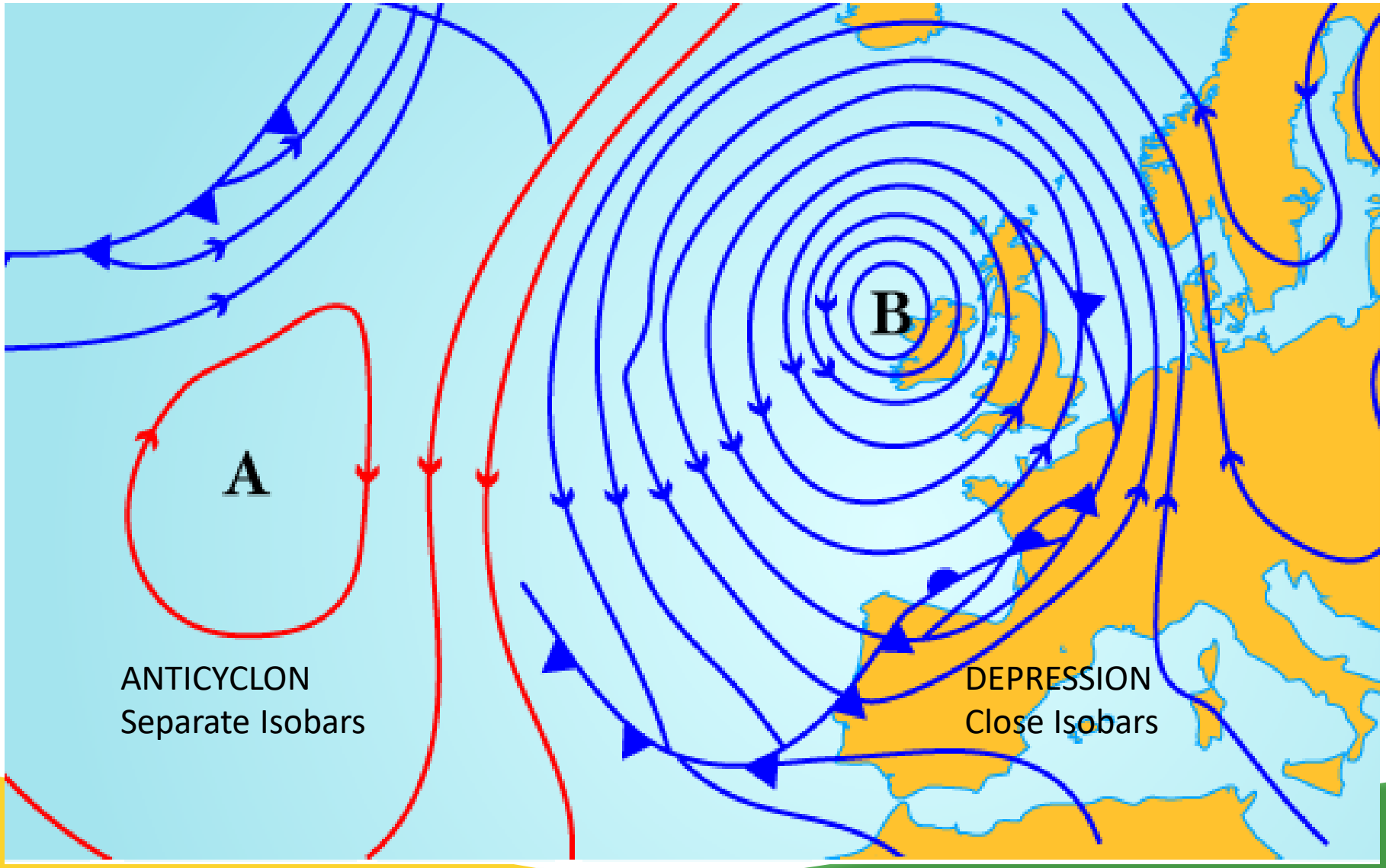
A storm or cyclone is an area of low atmospheric pressure (1012 mb or less) surrounded by a system of winds that move counterclockwise in the Northern Hemisphere, and counterclockwise in the Southern Hemisphere. It is accompanied by unstable weather, since the center of a low pressure the more humid and hot air rises, cools and condenses, forming clouds with a probability of precipitation.

The term cyclone has been used in a broader sense, applying it to the storms and disturbances that accompany these low pressure systems, in particular, violent tropical hurricanes and typhoons, centered in areas of extraordinarily low pressure.

DEPRESSION
(Northern Hemisphere)



WIND



WIND

PRESSURE GRADIENT

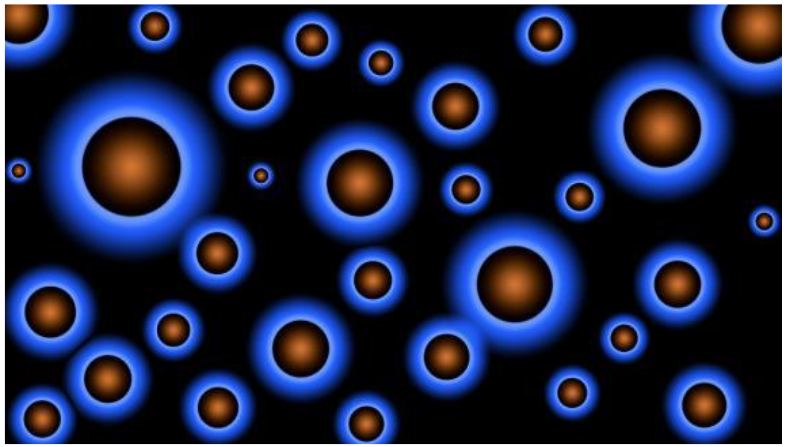
It is the pressure that balances the force that tends to move the air from high pressure to low pressure. The pressure gradient force has vertical and horizontal components.

- Vertical pressure gradient: The vertical component is approximately in equilibrium with the force of gravity This gradient causes a decrease of 1 hPa for every 8 m (27 ft) ascended up to the first 5,500 m above this height, the rate of descent will be 1 hPa for every 15 m 50 ft) The temperature of the air mass is a factor that will make the pressure gradient greater when it is colder, and less when it is warmer.
- Horizontal pressure gradient: The horizontal component is the variation of atmospheric pressure, being perpendicular to the isobars on a horizontal surface. If the isobars are separated or the distance between them is great, it means that the gradient is small and the winds that will blow will be weak.

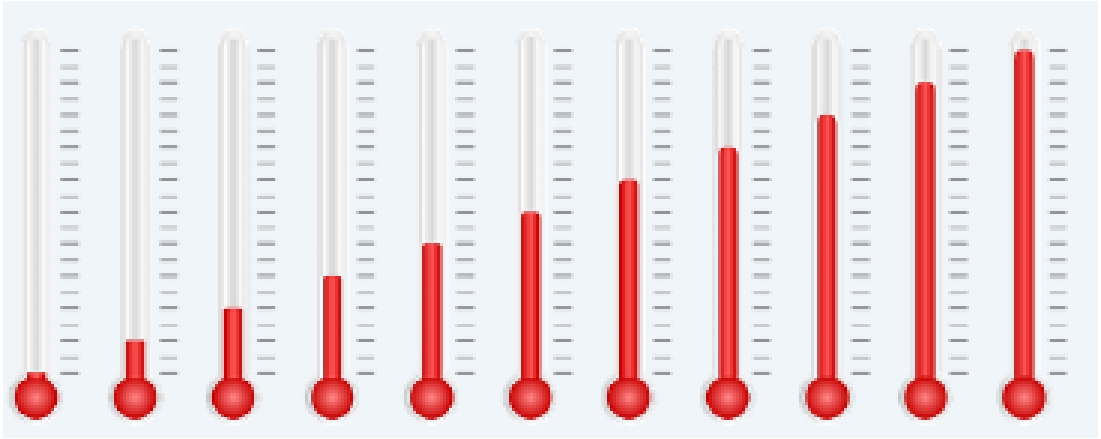
TEMPERATURE

Bodies are made up of molecules that are in continuous movement When heating a body, this internal movement increases, becoming disordered and giving rise to the molecules colliding with each other, producing, due to these shocks, an increase in heat inside the body that by conduction is transmitted throughout it.

In short, the energy that gives rise to the movement of molecules is what is called heat. The measure of this molecular activity is called temperature.



Molecules movement



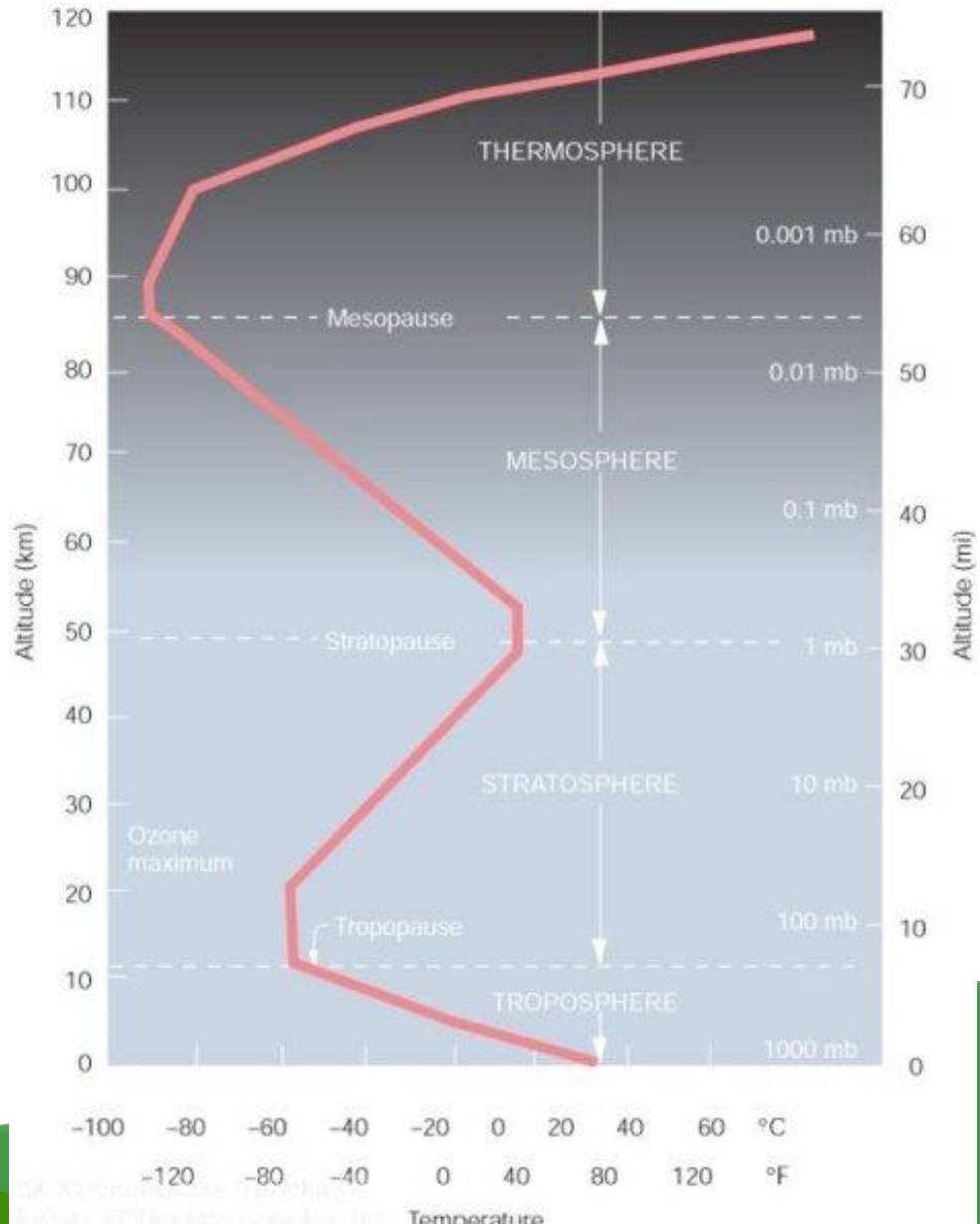
Temperature

TEMPERATURE

VERTICAL THERMAL GRADIENT

It is called vertical thermal gradient, to the variation that the temperature experiences in a given elevation interval The variation or gradient in the ISA atmosphere (standard atmosphere) is 2 ºC for every 1000 feet or 6 5 ºC for every 1000 m This standard value is rare time coincides with that of the real atmosphere, since this depends on many other factors, such as day night, horizontal and vertical currents, geographical position, etc.

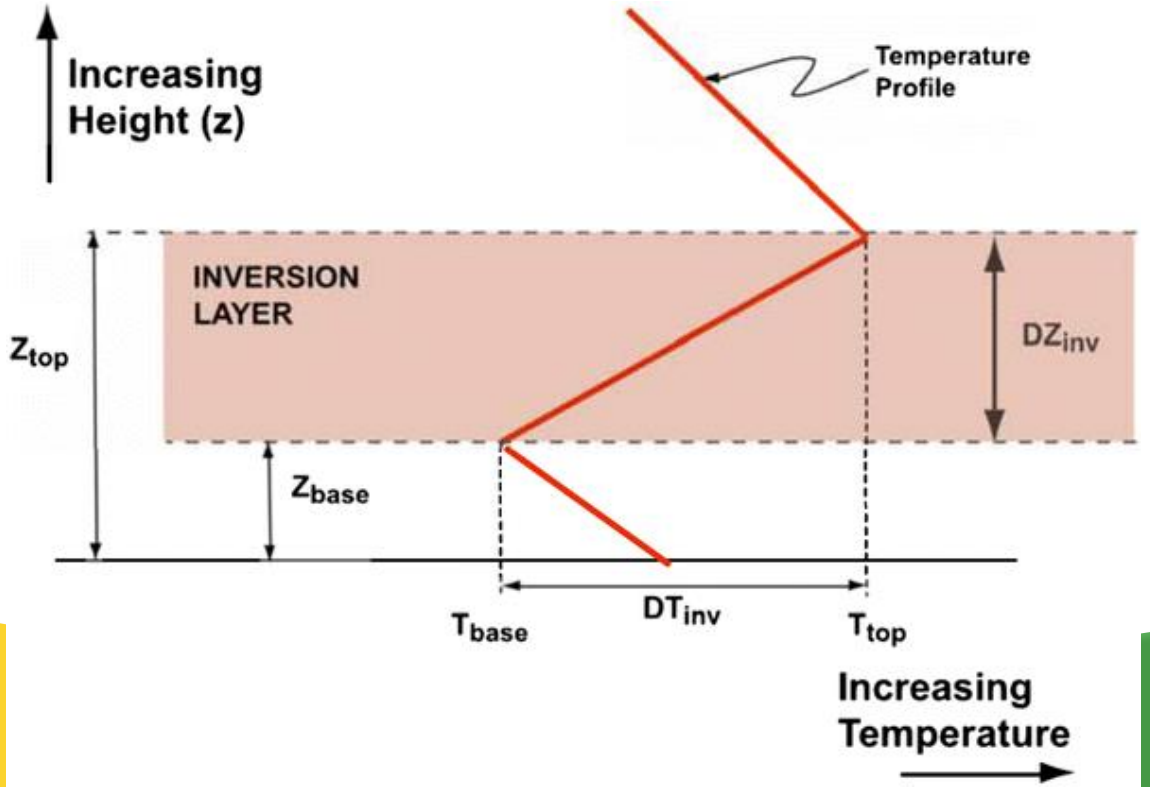
The temperature drops to 36,000 feet of altitude, after which the temperature remains constant with a value of 56 5º C below zero. The ISA atmosphere considers that at sea level it is 15º C.



TEMPERATURE

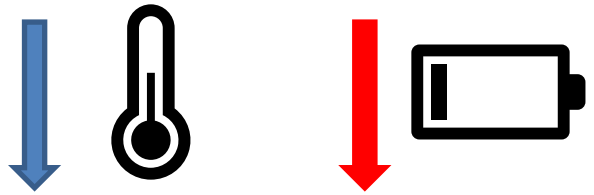
THERMAL INVERSION

There is a thermal inversion when the temperature of the air increases with height, instead of decreasing as it would normally, which means that the air is warmer above than in the lower layers. This increase in temperature can take place immediately above the ground or at a certain height. In the first case it is called inversion at ground level, and in the second, inversion in height.



TEMPERATURE

For operations with UAS, the ambient temperature must be taken into account, since a decrease in temperature implies a decrease in the duration of autonomy.



Likewise, it must be taken into account in the flight of the UAS that, when the temperature increases, the batteries can overheat and catch fire. In the same way, when the temperatures are very high, the performance of the unmanned aircraft is reduced due to the decrease of the air density.

The temperature range of the operation must be taken into account, since with very low temperatures in certain situations it may be necessary to preheat the batteries.

TEMPERATURE

In meteorology, the temperatures that are normally measured are the following:

- **Air or ambient temperature** is the air temperature recorded at the time of reading.
- **Dew point (dew point temperature)** is the temperature at which the air reaches saturation, i.e. condenses. This temperature is measured by means of the psychrometer, which is used to measure the content of water vapor in the air.
- **Maximum temperature** is the highest temperature recorded in a day, and that occurs between 2:00 p.m. and 4:00 p.m.
- **Minimum temperature** is the lowest temperature recorded in a day, and can be observed between 06:00 and 08:00.

VISIBILITY

Visibility is defined as the maximum horizontal distance at which an object on the sky can be seen or identified by an observer on the horizon or, in the case of night observations, could be seen and identified if the general illumination were increased to the intensity normal daylight.

The presence of meteors or factors that limit it, such as fog, mist, haze, etc. reduce visibility as noted in the table.

PHENOMENA	VISIBILITY (km)	HUMIDITY (%)	CONSTITUTION
Fog	<1	90-100	water/ice
Mist	1-2	80-90	water/ice
Haze	>2	<80	solid particles
Dense haze	>2	<80	solid particles
Rain	<3	100	water/ice
Drizzle	<1	100	water/ice

VISIBILITY

VISIBILITY MEASUREMENT

The ideal thing for the pilot would be to know, throughout the flight, the value of visibility. Unfortunately, the only data that the meteorologist can provide with certainty is the existing visibility on the earth's surface, measured in the direction or directions that are of interest for aircraft operations.

The different ways of measuring visibility are defined below.

- **Meteorological visibility:** is the greatest horizontal distance at which previously selected objects can be seen and identified.
- **RVR (Runway Visual Range):** is the greatest distance the runway can be seen from a position at the pilot's eye level at touchdown. A height of 5m 16ft is considered) corresponds to the level environment in which the pilot is at the moment of contact In practice, the visual range on the runway cannot be measured directly, from the point specified in the definition, but rather it is an evaluation of what a pilot would see from that point Logically, this information will not be included in the weather reports when visibility is high. It must be provided when visibility is less than 2000 m RVR.

AIR DENSITY

AIR DENSITY is the relationship between the mass of a body and the volume it occupies. The density of any body, whether solid, liquid or gas, expresses the amount of its mass per unit volume (d=m/v).

- The density is inversely proportional to the height, therefore when we ascend the density decreases in parallel as we ascend the atmospheric pressure also decreases.
- Likewise, the density is also inversely proportional to the temperature in such a way that when the temperature increases the density decreases.

This property in the air is initially poorly assimilated because it is not very intuitive, since it is true that the density of air is low if we compare it, for example, with that of water, but it is precisely this difference that makes flight possible.

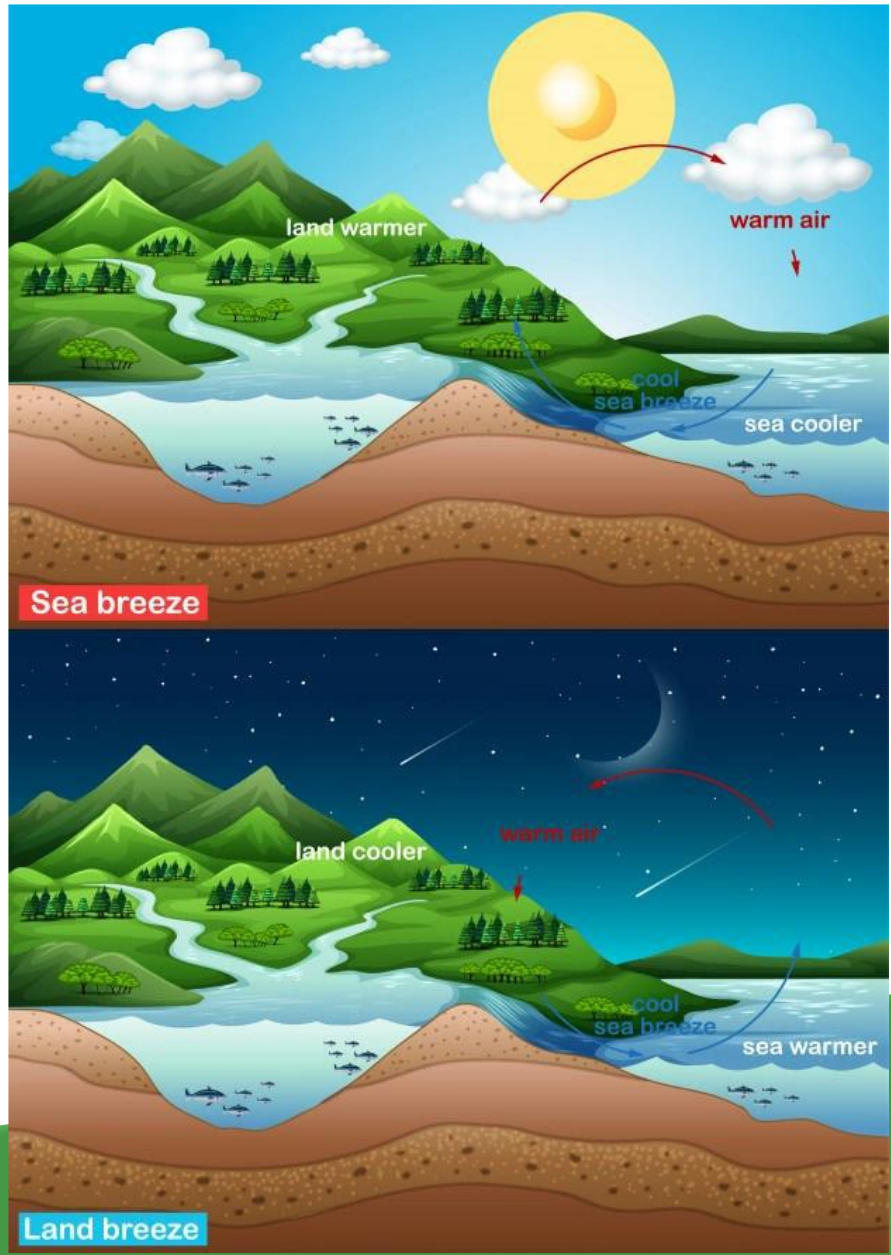
- Since pressure and temperature change with height, they also affect density.
- The decrease in density also brings positive things, the resistance to progress decreases, so consumption does the same.

AIR DENSITY

What is the thermal breeze?

They are local winds whose origin is in the temperature difference between the marine and terrestrial surfaces.

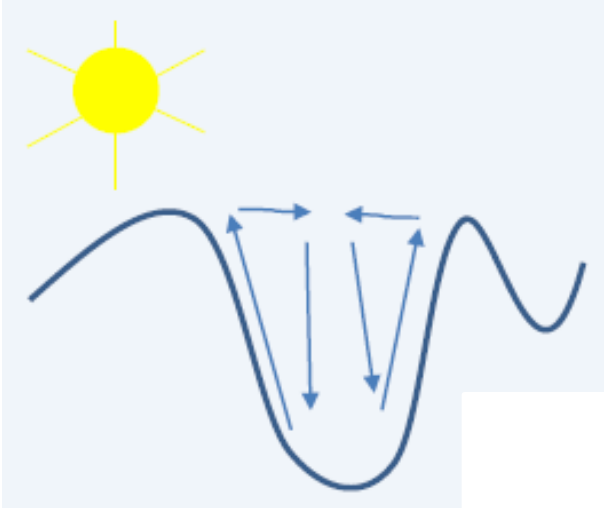
- **Sea breeze:** On the coasts, during the day, solar radiation heats the land more easily, since water has more thermal inertia. Therefore, the land is hotter and the air pressure increases, which causes a displacement of the high masses from this towards the sea The vacuum that forms in the coastal area to recover the air that has escaped through the high areas, produces a wind towards the coast from the sea. In this way, the sea breeze is generated during the day.
- **Land breeze:** During the night, this movement of thermal air is reversed, since the land cools faster than the sea surface, and there is an increase in pressure in the land area and a low pressure area over the sea. dry air from the land that enters the sea.



AIR DENSITY

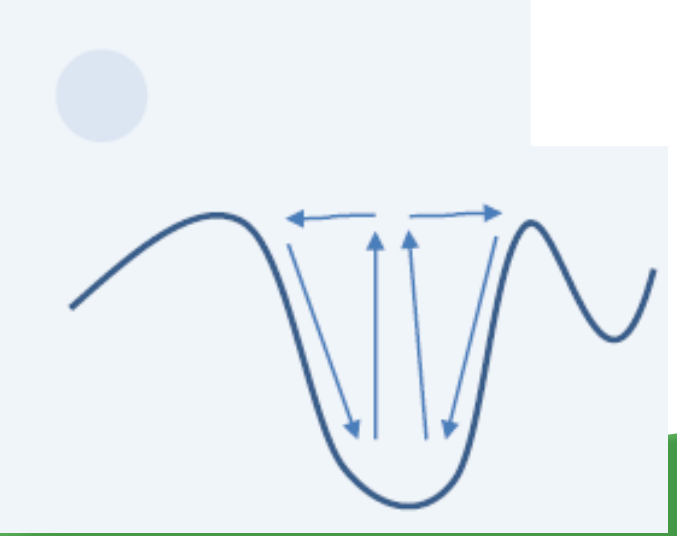
ADIABATIC WIND

Also called 'valley breeze', it is produced after the upper layers of a mountain slope heat up and produce movement of the surrounding air, the lower layers of the valley are colder and more humid, it rises up a slope and condenses causing the formation of clouds in the top, by thermal convection.



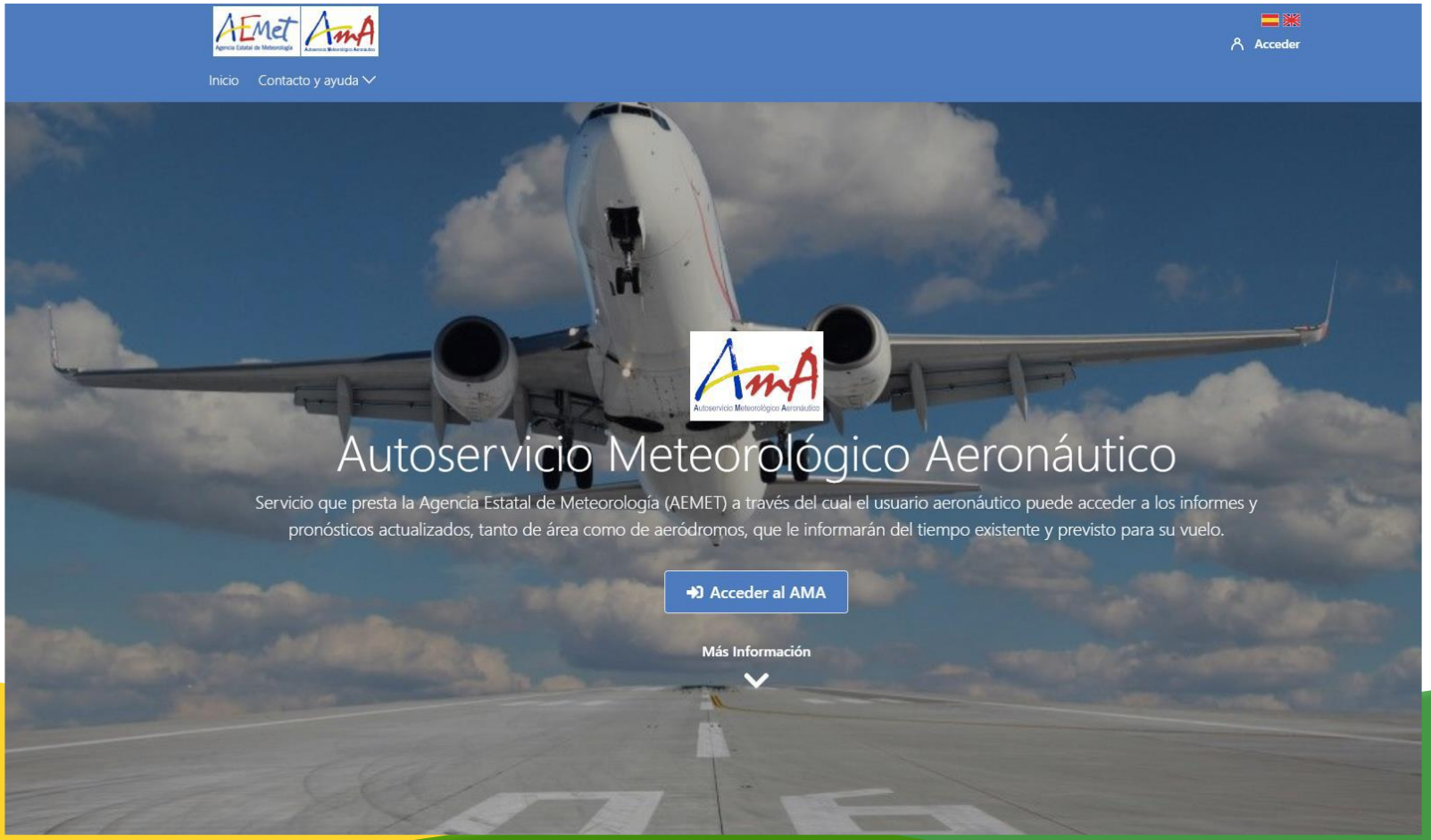
KATABATIC WIND

Also called 'autumn winds', they usually occur in the early hours of the night, after the temperature drops, the density increases and the air flows downwards, producing heating by compression in the descent of the air.



METEOROLOGICAL PREDICTIONS

The responsibility for obtaining weather forecasts lies solely with the remote pilot of the unmanned aircraft. To do so, he must consult the available official sources, such as the AEMET applications https://ama.aemet.es/



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Thanks for your attention

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