

# Unit 2:

## The atmosphere

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- 1. Composition and structure**
- 2. Atmospheric pressure and humidity**
- 3. Weather and climate**
- 4. Atmospheric phenomena**
- 5. Importance of the atmosphere**

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### Think and answer?

- What elements can you see in the photo?
- Name other meteorological phenomena you know.
- What are the gases that form the air?
- What is the cause of global warming?

### UNIT OBJECTIVES

In this unit you will learn:

- To describe the origin of the atmosphere
- To distinguish the components of the air
- To distinguish the meteorological phenomena and their origin
- To identify the different characteristics of the atmosphere layers
- To distinguish between climate and weather
- To identify the different atmospheric environmental problems
- To describe the importance of the atmosphere for living beings

# 1. Composition and structure of the atmosphere

The atmosphere is the gaseous outer layer that surrounds the Earth.

## a) Composition

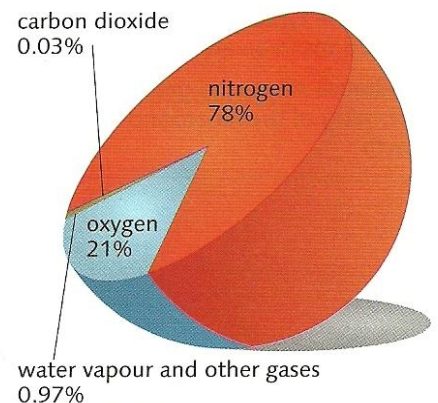
The Earth's atmosphere is a mixture of gases called **air**.

Air is composed by:

- 78 % Nitrogen (N<sub>2</sub>)
- 21% Oxygen (O<sub>2</sub>)
- 0.03% Carbon dioxide (CO<sub>2</sub>)
- 0.97% other gases (water vapour, Argon, etc)

The atmosphere was very different 4,600 million years ago. The primitive atmosphere was made up of water vapour, carbon dioxide, nitrogen, hydrogen, ammonia and methane and it did not have oxygen.

The first living beings (bacteria) produced oxygen by photosynthesis. It provoked a change in the atmosphere's composition 2,000 million years ago to become what it is nowadays.



## b) Structure

The atmosphere has four main layers. The separation in layers is caused by variation in temperature with respect to altitude.

### - Troposphere

This is the nearest layer to the Earth.  
The temperature decreases from 15°C to -50°C  
It is about 12 km thick.  
It contains 80% of the air in the atmosphere.  
*Meteorological phenomena* occur here.  
The upper limit of this layer is called *Tropopause*.

### - Stratosphere

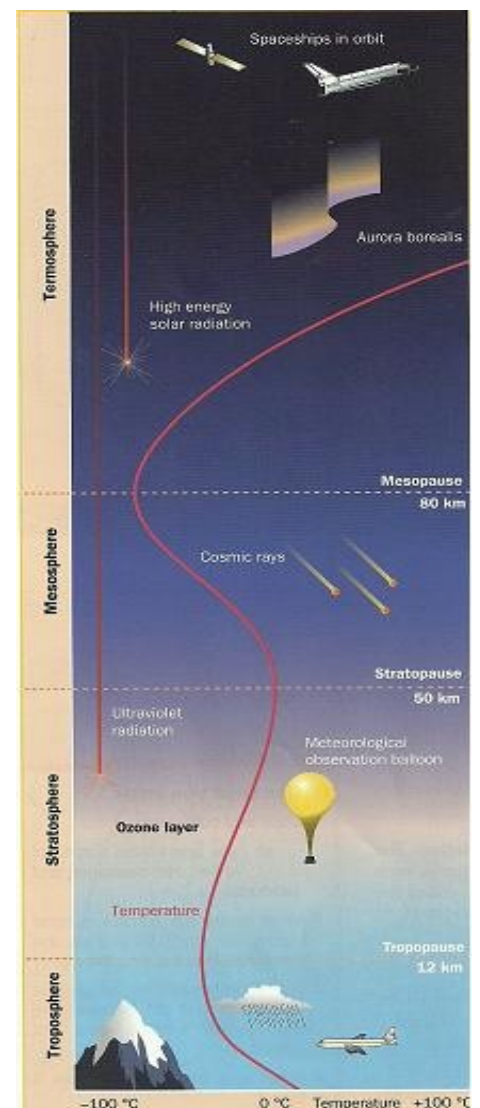
The temperature increases from -50°C to 0°C.  
It goes from 12 km up to 50 km.  
It includes the **ozone layer**, which absorbs the *ultraviolet radiation*.  
The upper limit of this layer is called *Stratopause*.

### - Mesosphere

The temperature decreases from 0°C to -100°C.  
It goes from 50 km up to 80 km in height.  
Here is where most meteors burn up upon entry (shooting stars).  
The upper limit of this layer is called *Mesopause*.

### - Thermosphere

It is also called *ionosphere*.  
The temperature increases from -100°C to more than 100°C.  
This layer does not contain many gases.  
It absorbs *infrared radiation* and other very harmful radiation from the Sun and reflects *radio* and *television waves* back to the Earth.  
Here *aurora borealis* takes place.



**READING ACTIVITIES**

**After reading the text, copy and answer the following questions into your notebook:**

Remember: you must make complete sentences.

**1.1. Copy and complete, with the information from the text, the following chart about the layers of the Earth's atmosphere**

Layer of the atmosphere	Temperature variation (°C)	Thickness (km)	Name of its upper limit	Important events that occurs here
Troposphere				
				Ozone layer (absorbs the ultraviolet radiation)
	From 0°C to -100°C			
		From 80 km onward		

**1.2. Answer these questions about the atmosphere:**

- Which of the atmosphere's layer is closest to the Earth? And the farthest?
- Which layer reflects the radio and television waves back to the Earth?
- Where do the meteorological phenomena take place?
- Where is the ultraviolet radiation absorbed? And the infrared radiation?

## 2. Atmospheric pressure and humidity

### 2.1. Atmospheric pressure

Air has weight. The pressure it exerts on Earth's surface is called **atmospheric pressure**. It is caused by gravity.

#### a) Units of measurement

Pressure is a **magnitude**. The international unit for pressure is the *Pascal* (Pa). When we refer to atmospheric pressure we normally use the **atmosphere** (atm), the **millibar** (mb) or the **hectopascal** (hPa).

$$1 \text{ atm} = 1,013 \text{ mb} = 1,013 \text{ hPa}$$

#### b) Factors provoking variations of atmospheric pressure

##### - Altitude

Atmospheric pressure decreases when **altitude** increases. This means that the higher the altitude, the lower the pressure.

This is due to the lower layers supporting the weight of the upper layers and they are compressed.

The gases are compressed and denser near the Earth's surface. It provokes that the atmospheric pressure on the top of a mountain is less than at the sea level.

**Normal pressure** is the pressure at sea level (1 atm or 1,013 hPa).

- Pressure above this is **high pressure**
- Pressure below this is **low pressure**.

##### - Temperature

Atmospheric pressure decreases when temperature increases. This means that the higher the temperature, the lower the pressure.

Air moves because the Sun heats it. Hot air rises because its density is lower and the colder air move in to take its place. This is the origin of **wind**.

##### - Low pressure area (depression or cyclone).

In depressions the pressure decreases towards the center.

The air, light and hot, moves from down to up.

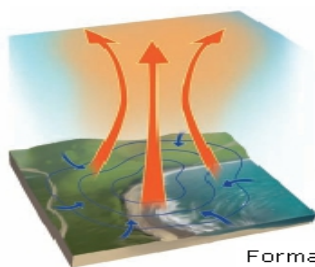
The ascendant air is moist. It provokes unstable weather, because when this water vapour gets colder, it condenses and provokes precipitations.

##### - High pressure area (or anticyclone).

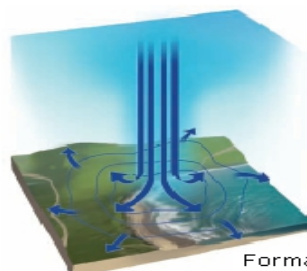
In anticyclones the pressure increases towards the center.

The air, heavy and cold, moves from up to down.

The descendent air is dry. It provokes stable weather, because clouds do not form.



Formation of a low pressure area (Depression)



Formation of a high pressure area (Anticyclone)

The air moves from the areas of high pressure to the areas of low pressure, causing **air currents**.

## 2.2. Atmospheric humidity

Air contains water vapour because of **evaporation** (from the surface of seas, lakes, and oceans) and **transpiration** (from living beings, specially plants)

**Humidity** is the amount of water vapour that the air contains.

It varies depending on the place, the time of day and the temperature. Hot air usually contains more water vapour than cold air.

If air is completely dry, its humidity is zero. If it is saturated then it is 100% and if it contains half the possible water vapour then humidity is 50%.

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### READING ACTIVITIES

**After reading the text, copy and answer the following questions into your notebook:**

Remember: you must make complete sentences.

#### 2.1. Answer the following questions about atmospheric pressure:

- What is the atmospheric pressure?
- Why does atmospheric pressure decrease when we climb a mountain?
- How does temperature affect atmospheric pressure?
- What measurement unit do we use to refer to atmosphere pressure?
- Where do we find normal pressure? What is its value?

#### 2.2. The following sentences are wrong. Correct them:

- Humidity is the pressure that the air exerts over the Earth's surface.
- The atmospheric pressure is lower at sea level than on the top of a mountain.
- The air is saturated of water vapour when it has 80% of humidity.
- The wind goes from low pressure areas to high pressure areas.
- Anticyclones provoke instable weather, precipitations and low temperatures.

## 3. Weather and climate

### 3.1. Weather

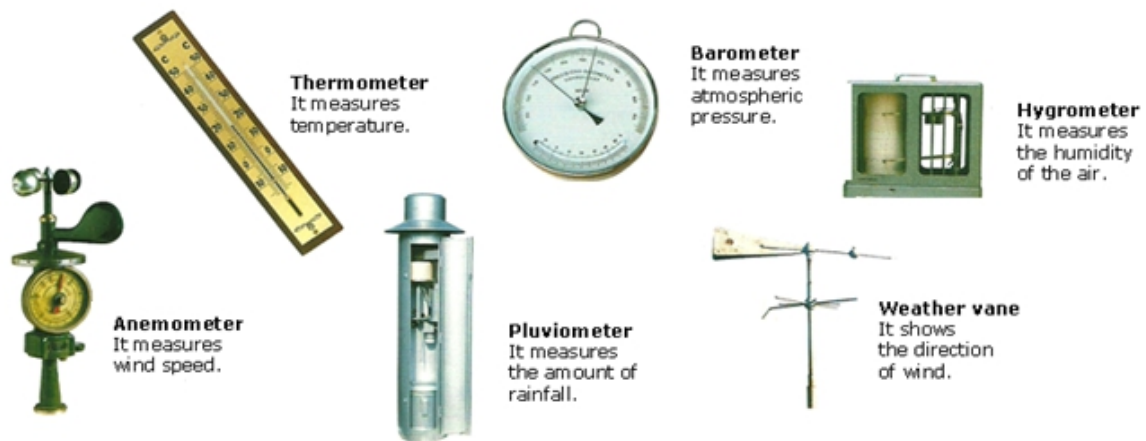
**Weather** describes the state of atmospheric conditions at a certain place, over a short period of time.

Weather conditions are variable and include:

- **Humidity.** This is the concentration of water vapour in the atmosphere.
- **Clouds.** They form when rising air cools.
- **Precipitation.** This is water that falls to the ground: rain, snow and hail.
- **Temperature.** It represents how hot or cold the air is.
- **Wind.** This is air in motion.

**Meteorology** is the study of different atmospheric variables to make weather predictions. Meteorologists collect information about weather conditions (temperature, precipitations, etc.)

The most important meteorological instruments are:



### 3.2. Climate

**Climate** describes the characteristic pattern of weather in an area, over a long period of time. The climate of a region is expressed in terms of **temperature** and **precipitations**.

The unequal warming of the planet provokes the formation of large air masses with different degrees of humidity and temperature. These masses can be cold or warm, and dry or humid.

These air masses move around and have interaction. The place where cold air meets warm air is called a **front**.

- A **warm front** occurs when a mass of warm air moves towards a mass of cold air.
- A **cold front** occurs when a mass of cold air moves towards a mass of warm air.

Factors affecting climate are:

- **Latitude.**  
It indicates how far north or south a place is from the Equator.  
The temperature increases from Poles to Equator.
- **Altitude.**  
This is the height above sea level. The higher a place is, the colder it will be.
- **Distance from the sea.**  
Water heats up and cools down slower than land.  
The sea keeps coastal areas warmer in winter and cooler in summer.
- **Ocean currents.**  
They can be warm when they come from tropics or cold when they come from poles.  
They make the climate softer.

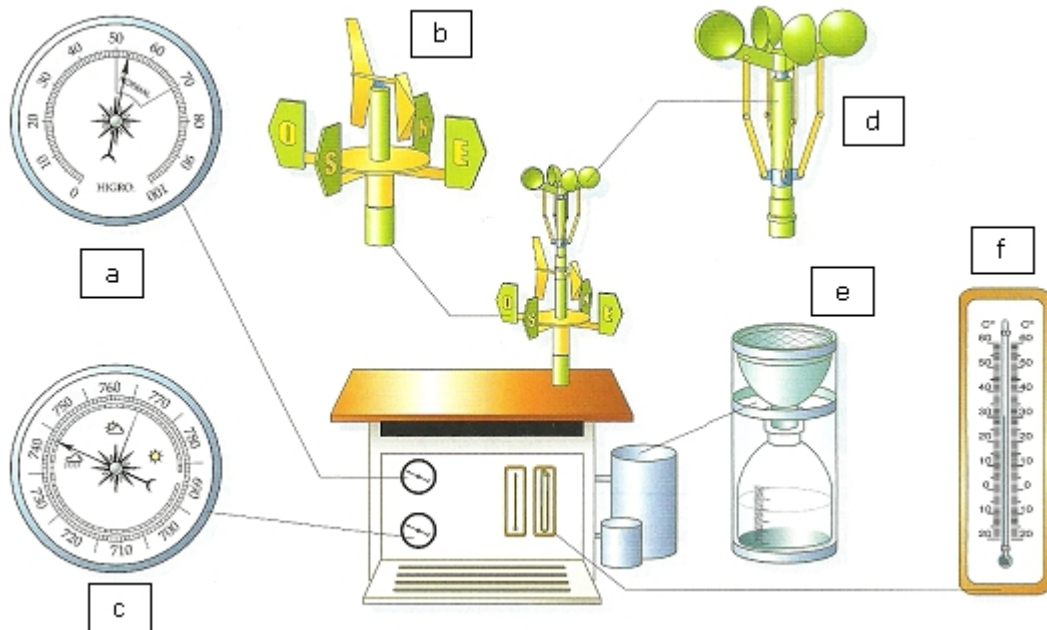


## READING ACTIVITIES

**After reading the text, copy and answer the following questions into your notebook:**  
Remember: you must make complete sentences.

**3.1. What is the difference between weather and climate?**

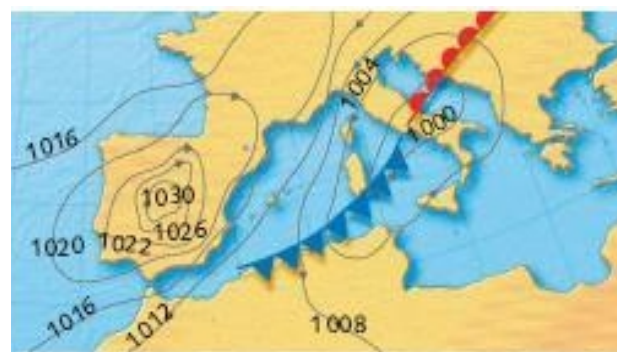
**3.2. The picture represents a meteorological station. Indicate which instrument each letter represents and explain what atmospheric variable each one measures.**



**3.3. What factors affect the climate of a region?**

**3.4. Look at the weather map and answer the questions into your notebook.**

- Over which country is the depression?
- Where do you situate an anticyclone?
- Which country is the cold front moving towards?  
And the warm front?
- Will there be clear skies in Spain?  
Or will it rain?
- Where is the wind stronger  
in the Iberian Peninsula or in Italy?



## 4. Atmospheric phenomena

Atmospheric phenomena occur in the troposphere. They are responsible for changes in the weather. The wind and water vapour in the air can cause these phenomena.

### 4.1. Atmospheric phenomena caused by the wind

#### - Hurricanes

These are violent tropical storms that form over the ocean. They consist of a central area (the eye), around which clouds and winds revolve at great speeds (200 km/h).

#### - Whirlwinds (or dust storms)

They occur on sunny days in dry open spaces. The ground heats up and it heats up the air. The air rises in a spiral and collects sand and dust particles. Whirlwinds only last a few minutes and can be 100 m high.

#### - Tornadoes

They start inside large storm clouds and have an inverted cone shape when they leave the clouds and reach the ground or the sea. These winds can reach speeds of 480 km/h and demolish everything in their path.

### 4.2. Atmospheric phenomena caused by water vapour

#### a) Due to condensation

- **Clouds** form when air that is charged with water vapour, rises, cools, and condenses around tiny dust particles, salt, or ash.
- **Fog** consists of low clouds that form close to the ground. This occurs when the air on the ground cools down but does not go below 0°C.
- **Frost** forms when the temperature of the earth's surface is below 0°C and water vapour freezes.
- **Dew** is condensed water vapour. This occurs during the night when temperatures drop.

#### b) Due to precipitation

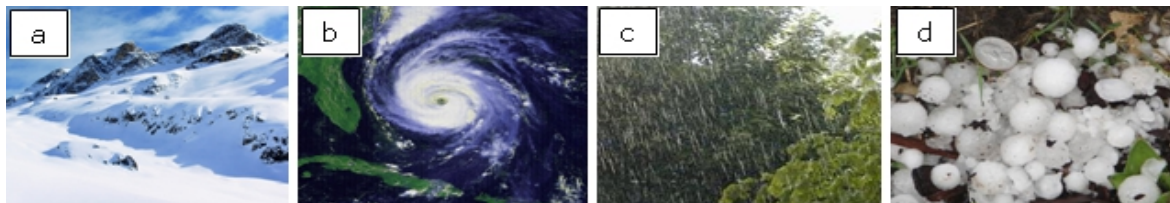
- **Rain** occurs when the water droplets in a cloud join together. When they are big enough, gravity makes them fall.
- **Snow** occurs when the temperature inside a cloud reaches 0°C. The water droplets freeze. They fall from the cloud when they are heavy enough.
- **Hail** occurs when there are strong rising air currents inside the cloud which deep freeze the water droplets (-50 °C).

## READING ACTIVITIES

**After reading the text, copy and answer the following questions into your notebook:**

Remember: you must make complete sentences.

### 4.1. Look at the following pictures and indicate if it is an atmospheric phenomena caused by wind, by condensation of water vapour, or by precipitation



### 4.2. Read and identify what atmospheric phenomenon is described:

- a. They form when wet air rises and water vapour condenses.....
- b. It forms when water vapour freezes on the Earth's surface.....
- c. They are large whirlpools and have cone invert shape.....
- d. It forms when water vapour condenses during night.....



## 5. Importance of the atmosphere.

The atmosphere has some characteristics that provide Earth with the right environment for life.

The air contains some of the raw materials necessary for life and protects the Earth against harmful radiations and the impact of meteorites:

- Carbon dioxide is necessary for photosynthesis.
- Oxygen is necessary for respiration.
- Carbon dioxide maintains the optimal temperature conditions for life to develop, thanks to the greenhouse effect.
- The ozone layer protects living things from harmful ultraviolet radiation from the Sun.
- Water vapour condenses and forms clouds, which provide water through rainfall.
- Rocky bodies from the outer space are disintegrated by friction with the atmospheric gases.

Changes in the composition of the atmosphere have serious consequences for living beings.

### a) Atmospheric pollution

Human activities cause atmospheric pollution: the release of harmful substances called **pollutants** into the atmosphere. They can be:

- Gases: sulphur dioxide, carbon dioxide and nitrogen oxide. They are produced by combustion from motor vehicles, by burning fossil fuels, and from industrial activities.
- Liquid and solid molecules: ash from forest fires, black smoke, dust and soot.

Pollutants in the air can cause health problems: respiratory system irritation, eye irritation, increase in asthmatic processes, headaches.

### b) Acid rain

Some pollutants such as sulphur dioxide and nitrogen oxide, form acids when mixed with water vapour of the air.

When it rains, these acids fall down mixed with water. This damages plants, and pollutes rivers and lakes destroying aquatic life. Acid rain also damages the monuments.

### c) The destruction of the ozone layer

CFCs are gases often used in fridges, air conditioning units, aerosols, etc. These gases interact with ozone and destroy it. Without the ozone layer, ultraviolet radiation can arrive to Earth's surface and provoke mutations in living beings. The destruction of the ozone layer mainly affects Antarctica, where we can find **ozone hole**.

### d) An increase in the greenhouse effect

The increase in the greenhouse effect has two main causes:

- Contamination: increase the amount of CO<sub>2</sub> in the atmosphere.
- Deforestation: the destruction of forest, which could have consumed this excess of CO<sub>2</sub> through photosynthesis

The direct consequence of an increase of greenhouse effect is **global warming**: an increase in the global temperature of the planet.

Global warming could have many other consequences:

- The melting of ice masses at the Poles will raise sea levels and many coastal areas will disappear
- It will increase evaporation, and the global pattern of rain and winds will change.
- Desertification will increase in many areas, while in others there will be torrential rains.
- Many animals and plants would disappear.
- The higher temperatures will provoke the spread of many tropical diseases to temperate areas.

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**READING ACTIVITIES**

**After reading the text, copy and answer the following questions into your notebook:**

Remember: you must make complete sentences.

**5.1. Why is the atmosphere so important for living beings?**

**5.3. What is atmospheric *pollution*?**

**5.4. Answer the questions:**

- a. What pollutant is responsible for the *destruction of the ozone layer*?  
Where do they come from?
- b. What pollutant is responsible for the increase of the *greenhouse effect*?  
Where do they come from?
- c. What pollutant is responsible for the *acid rain*?  
Where do they come from?

**5.5. Identify the consequences of the global warming among the sentences:**

- a. The melting of ice masses at the Poles
- b. The increase of mutations
- c. The raising of sea levels
- d. The alteration of global climate
- e. The increase of the size of the ozone hole
- f. The acid rain
- g. The increment of tropical diseases
- h. The extinction of many species
- i. The increment of the greenhouse effect
- j. The disappearance of lands near the coasts