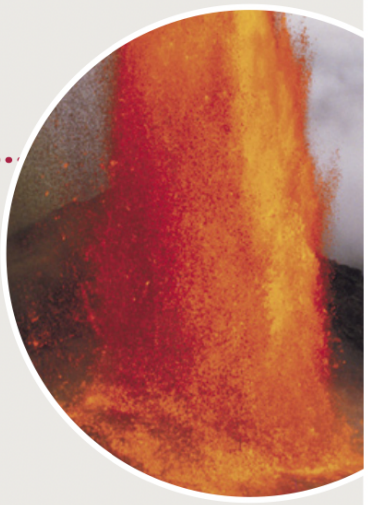
7.3 How does Earth support life?



The planet Earth is only a tiny part of our solar system but it is home to all known life in the Universe. Animals, plants and other organisms can live on Earth because it can provide the right amount of light, warmth, water, oxygen and nutrients.

Non-living systems on Earth contribute greatly to living systems. The Earth's atmosphere provides air, warmth and the weather, which brings life-giving rain. New rocks are brought to the surface of the Earth through volcanoes, and broken down by water, ice and wind to form the soil needed for plant growth.

Earth as a system

Earth is a *system* with inputs and outputs (Fig 7.32). Its major inputs come from the Sun's energy, which is absorbed by the Earth's surface. Overnight this heat is slowly released back into the atmosphere. A blanket of gases in our atmosphere stops some of this heat escaping into space, keeping the air warm and perfect for **living systems**, such as animals and plants.

The atmosphere is a **non-living system** that is vital to the survival of living things on Earth. The warming and cooling of the atmosphere also creates our weather, including the rainfall that is vital to the survival of life.

The Earth itself is a non-living system. Its huge mass creates the force of gravity that attracts objects to its centre. Without gravity, our atmosphere would float off into space. Beneath the Earth's crust, hot molten rock creates pressure that helps make our landforms. Molten lava is sometimes forced to the surface through volcanic eruptions. The rocks and landforms produced are broken down by **weathering** from water, ice and wind. The small rock fragments mix with organic material from plants and animals to form the soil that is important for plant growth.

Look at Figure 7.32 on page 244 before you answer the questions below.

What do you know about the Earth as a system?

1. List two examples of non-living systems on Earth.
2. List two examples of living systems on Earth.
3. What input does the Earth's system take from the solar system?
4. What inputs do Earth's living systems take from non-living systems on Earth?
5. What is weathering?
6. How are rocks and plants interrelated in one living system?

Our atmosphere

The **atmosphere** is a layer of gases that we commonly call air. The Earth has the only atmosphere in our solar system that sustains life. Oxygen in Earth's atmosphere allows organisms to live, ozone offers protection from the Sun's UV radiation and carbon dioxide and other greenhouse gases trap heat to keep us warm.

The most important gas for humans and other animals is oxygen (O_2), which makes up 21% of the atmosphere. Oxygen is the gas animals breathe in, and carbon dioxide (CO_2) is the gas we breathe out. Plants use carbon dioxide to make food and expel oxygen. Nitrogen (N_2) makes up 78% of the atmosphere. Nitrogen dilutes the oxygen gas to levels that our lungs can handle.

The atmosphere is thin in comparison to the size of the Earth. If the Earth were the size of a party balloon, the atmosphere would only be as thick as the rubber skin of the balloon.

The atmosphere is vital for our survival because it helps to keep us warm, controls our weather, protects us from dangers from space, carries

sounds and sustains all life. The Moon has no atmosphere, so there is no wind, no noise, no life and no protection from meteorites, which crash into the surface.

Layers in the atmosphere

The atmosphere is more dense at ground level and thins out as you go higher above the surface. Ninety-nine per cent of all the air in the atmosphere is found within 80 km of the Earth's surface. There is not really a top to the atmosphere—the air just get less and less until you reach the emptiness of space.

The atmosphere can be divided into several layers.

The troposphere

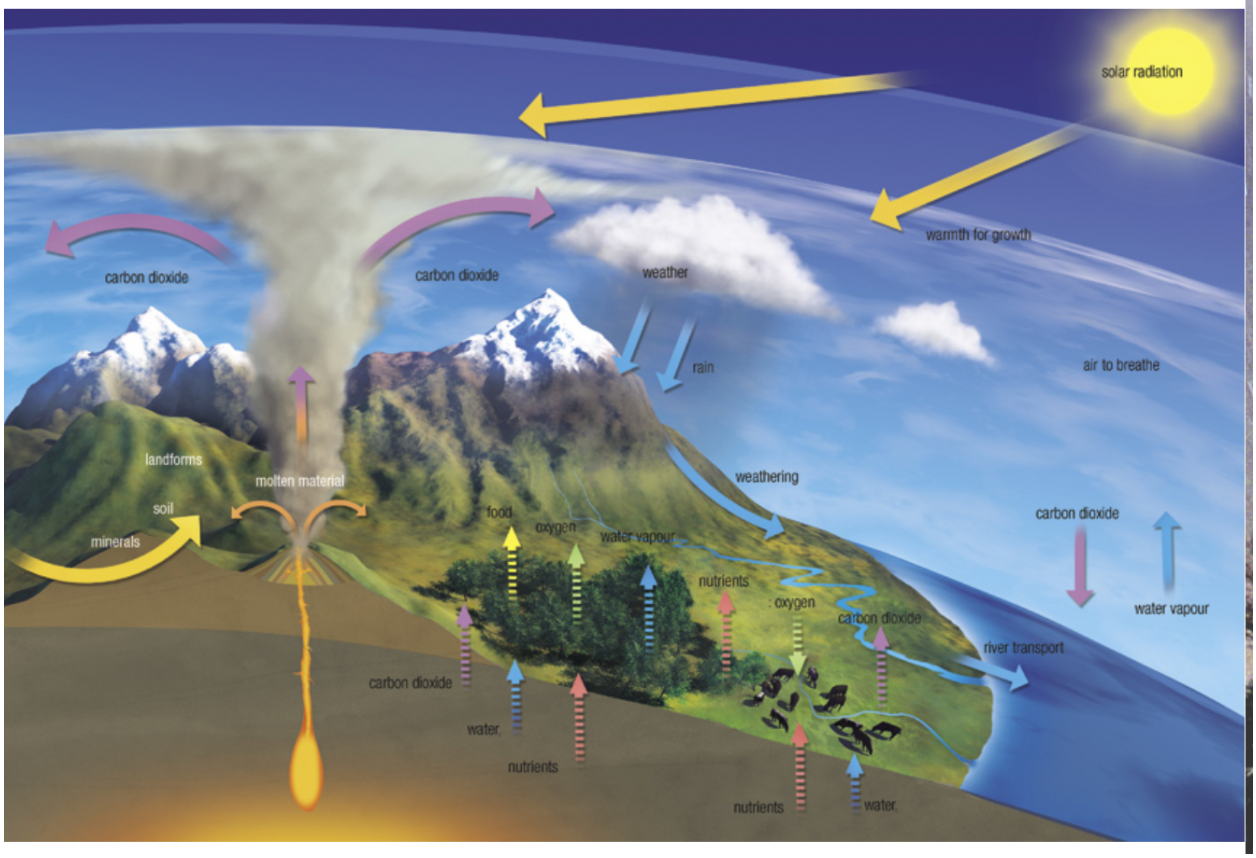
The troposphere is the bottom layer of the atmosphere, where we live. In this layer:

- all of our weather occurs
- due to gravity, 75% of all the atmosphere's air is found
- air temperatures drop rapidly as you climb higher, being about –60°C at the top of the troposphere
- due to the Earth spinning, the troposphere is thicker at the equator (18 km) and thinner at the poles (8 km)
- most aircraft fly.

The stratosphere

The stratosphere extends from the troposphere up to 50 km above the ground. In this layer:

- the temperature changes only slightly with increasing altitude—from –52°C at its lowest level to –30°C at its top
- a layer of ozone gas occurs, which blocks most of the harmful UV radiation that comes from the Sun
- the atmospheric conditions are very stable and there is little or no air turbulence
- it is almost completely free of clouds or other forms of weather
- passenger jets sometimes fly to take advantage of the fast jet-stream winds.



The ionosphere

The thickest of the layers is the ionosphere (or thermosphere). In this layer:

- just 1% of air particles occur
- temperatures are very high due to radiation from the Sun
- meteors begin to burn up
- some space shuttles and some satellites orbit
- aurora (Fig 7.34) happen—a glow in the sky caused by UV radiation and X-rays from the Sun.

The exosphere

The top of the atmosphere is called the exosphere. In this layer:

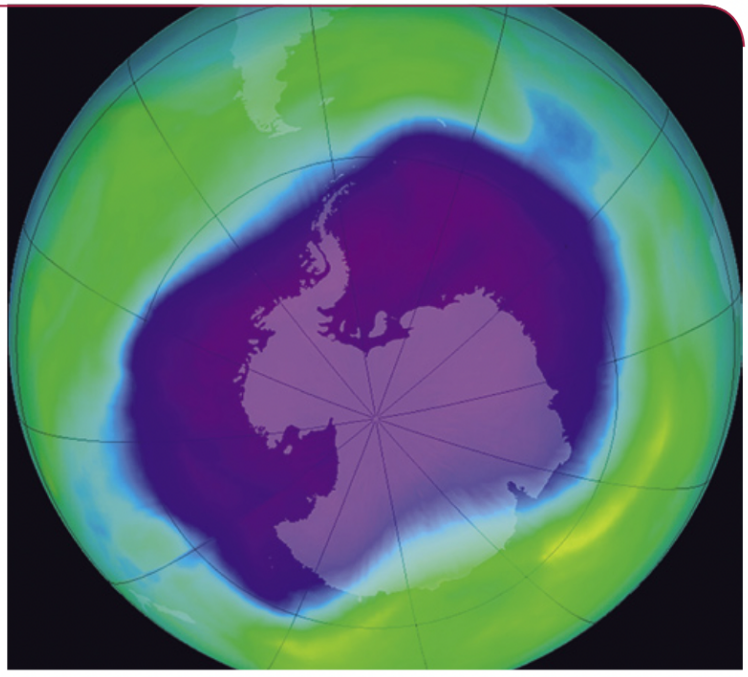
- the atmosphere merges with space
- communication satellites are found and receive messages from the other side of the Earth.

→ Fig 7.34 Aurora australis, also known as the Southern Lights, is seen here over icebergs in Antarctica. Aurora occur in the ionosphere, caused by UV radiation and X-rays from the Sun.

ZOOMING IN

The ozone hole

The protective ozone layer in the stratosphere becomes much thinner over Antarctica during August to October each year. Figure 7.35 shows the low values of ozone, referred to as a 'hole', in blue and purple. The ozone hole was discovered in 1985. A thinner ozone layer allows more harmful UV light to reach the Earth. UV rays are responsible for skin cancers in people and animals, and damage to plants. The main cause of the thinning of the ozone layer over Earth was the use of chemicals known as CFCs. These chemicals were used in aerosol spray cans and refrigeration units. Although they were banned some years ago, some of these gases are still present in the stratosphere.

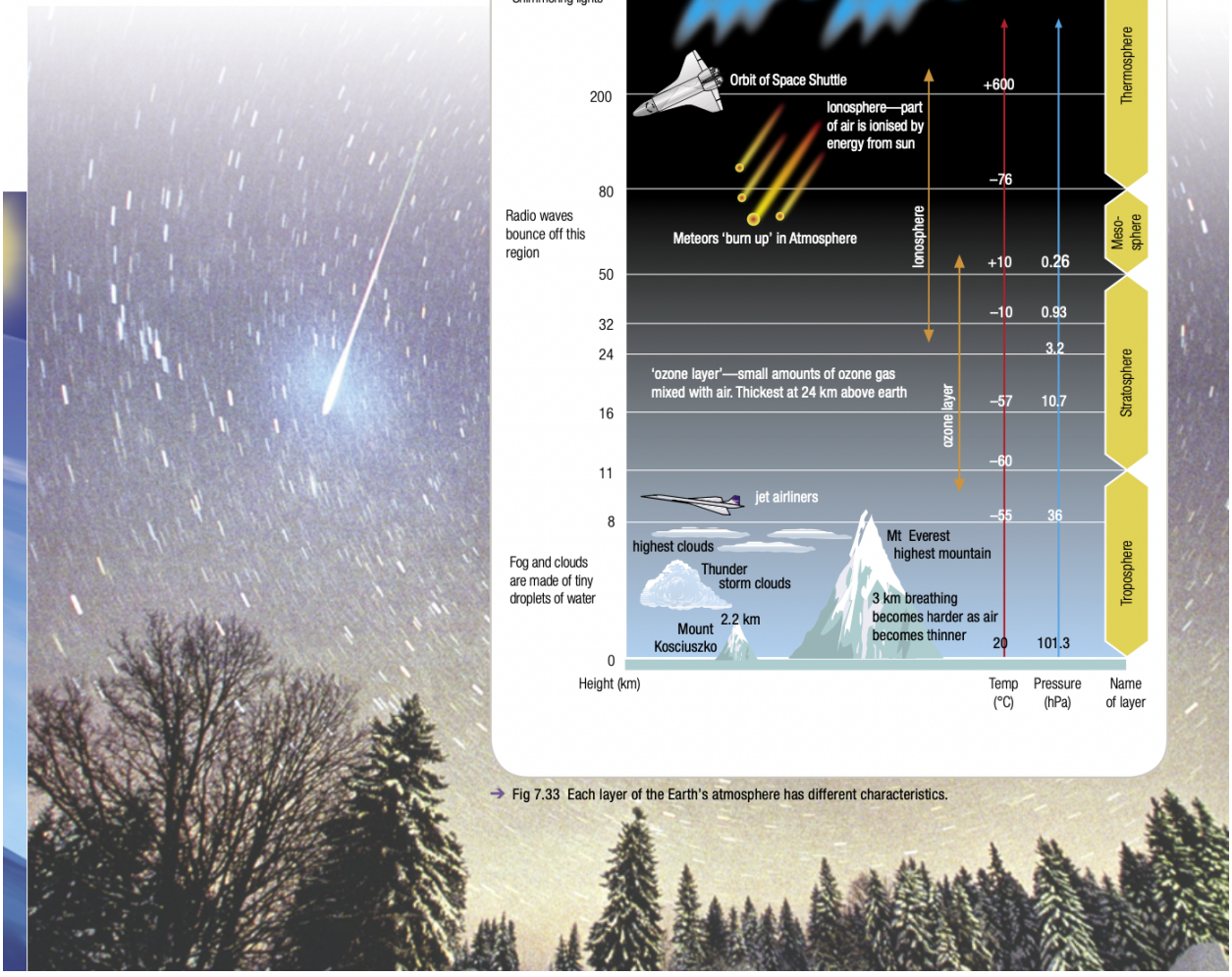


→ Fig 7.35 The hole in the ozone layer over Antarctica in 2006.

The mesosphere

Above the stratosphere the temperature again gets colder. This layer is called the mesosphere, or middle layer. In this layer:

- temperatures can fall to –93°C
- millions of meteors burn up daily as a result of heat caused by collisions with the gas particles contained there.



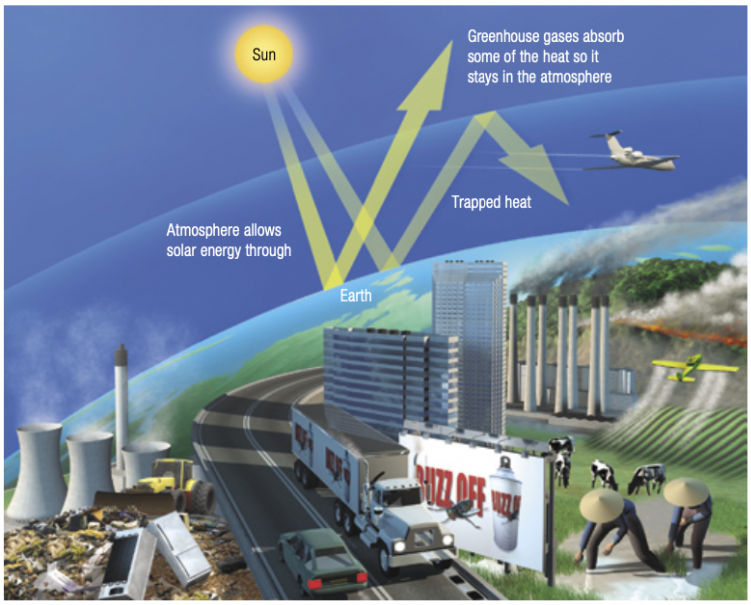
→ Fig 7.33 Each layer of the Earth's atmosphere has different characteristics.

The greenhouse effect

Solar energy passes through the atmosphere and warms the Earth's surface. Heat gradually leaves the Earth's surface and is radiated back into space. Some heat is trapped by a blanket of **greenhouse gases**. If heat were not trapped, the temperature would drop to –100°C each night, and in the day would rise to 80°C.

People have made some gases that upset this balance. These gases stay in the atmosphere and absorb and hold the heat, which should be radiated into space. As a result, the atmosphere is warming, which also means that the land and oceans are warming. This is called the **enhanced greenhouse effect**.

The main greenhouse gas is carbon dioxide. It is formed by the burning of **fossil fuels**, such as coal, petrol, oil and gas. The amount of carbon dioxide in the atmosphere has increased by 37% in the last 200 years due to the use of fuels by our society.



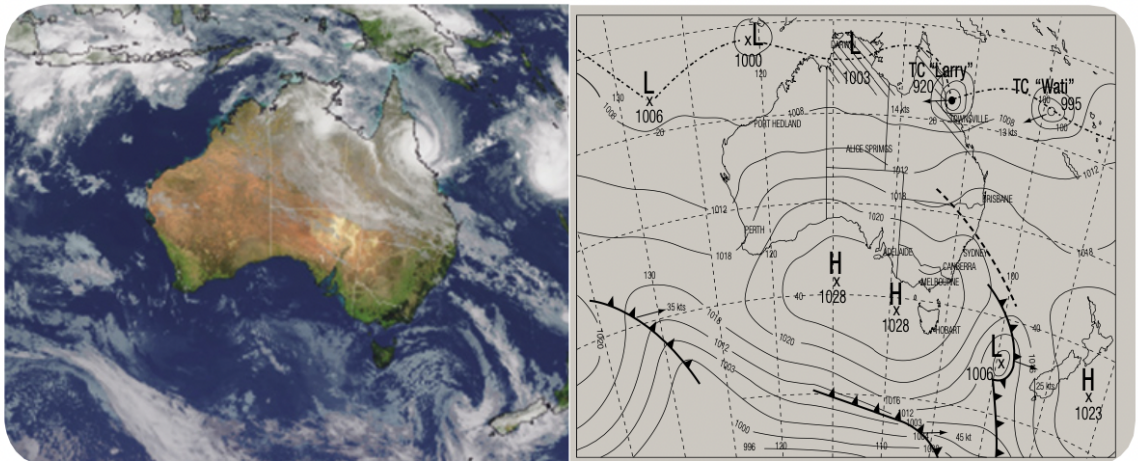
→ Fig 7.36 The greenhouse effect.

Weather

Weather happens in the Earth's troposphere. Conditions in the troposphere are always changing, producing changes in our weather.

Wind

As air is heated it becomes lighter and rises—a **low pressure** area. Heavier, cool air—**high pressure**—rushes in to replace the air that has risen. This movement of air is known as **wind**. **Trade winds** move from the colder polar regions to replace the hot rising air near the Equator. Local winds are created due to the differences in temperature and air pressure over small areas. Over warm seas, the air can rise rapidly, sucking in air quickly at its base and moving in a spiral motion. These intense low pressure systems are known as **cyclones** in Australia, typhoons in Asia and hurricanes in North America. Their strong winds and torrential rain can bring great destruction to any area it moves over.



What do you know about Earth's atmosphere?

1. What input from the solar system has the greatest influence on our weather?
2. In which layer of the atmosphere do we live?
3. What happens to the amount of air as you reach higher into the atmosphere?
4. List three things that air does when it is heated.
5. What happens to the pressure of the air when it is heated?
6. How are winds related to rising air?
7. How do cyclones form?
8. What conditions must occur for water vapour in clouds to fall as precipitation?
9. Consider why you feel cooler when water is evaporated from your skin on a hot summer's day.
10. Look at Figure 7.36 on page 247. Make a list of all the things in this illustration that are contributing to an enhanced greenhouse effect.
11. List four different fossil fuels that cause increased carbon dioxide emissions.