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Topic 1:

Our Climate Is Changing

Lesson Plans for Children and Youth

Rise Up Against Climate Change!

A school-centered educational initiative
of the Inter-American Development Bank

IDB

Rise Up

Against Climate Change

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Rise Up Lesson Plans

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Rise Up

Against Climate Change

Rise Up is a climate change education initiative of the Inter-American Development Bank that seeks to encourage children and youth to use their creativity and energy to come up with feasible, sustainable, long-term strategies to mitigate and adapt to climate change. This set of lesson plans is one of nine on different climate change topics that can be used independently or together with the other lesson plans and materials of the Rise Up initiative, including instructional videos, learning games and a Green School Toolkit. Each set of lesson plans includes an introductory text about the topic that can serve as background material for the teacher or as a text for older students. The lesson plans can be used at the primary and secondary levels of education; they are divided into basic, intermediate, and advanced plans to help each teacher determine what activities are appropriate for his or her students. To find all the Rise Up materials please go to **www.iadb.org/riseup**

Emiliana Vegas, Chief, Education Division,
Inter-American Development Bank

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Our Climate Is Changing

General Introduction to the Lesson Plans

People used to take the weather and climate for granted—but not anymore! They are both now studied intensively by scientists and discussed by celebrities and newscasters as they become increasingly important to our own daily lives.

Every place on Earth has a *climate*. A climate includes factors that remain fairly constant for at least 30 years,[1] such as temperature, humidity, the amount of water present in the air, and rainfall.

The region between the Tropic of Cancer and the Tropic of Capricorn is called the intertropical (or equatorial) region (figure 1).[2] This is Earth's "waist" where there are no seasons. The weather tends to remain constant throughout the year. When discussing areas in these regions, instead of referring to seasonal weather changes, we might refer to them as having a rainy climate, meaning it rains frequently all year long.

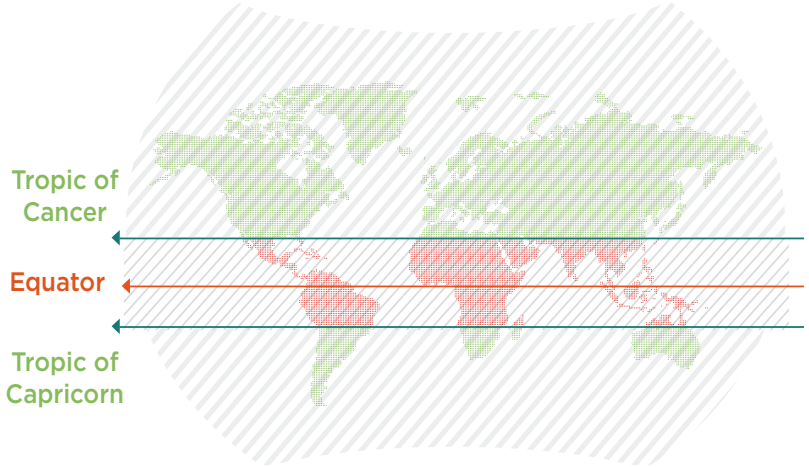
The weather in countries above and below the intertropical region are affected by seasons. For example, these climates may be rainy in the winter and dry in the summer.

Weather refers to short-term conditions in a particular area that can quickly change, sometimes within minutes. ***Climate***, however, does not normally change at a rapid pace. In fact, it can take years, decades, or even longer before changes in the climate can be felt.

1 According to the definition adopted by the Intergovernmental Panel on Climate Change (IPCC), climate is "the average state of the 'weather' ... a statistical description of the weather in terms of average values and variability of relevant amounts during periods that may consist of months to thousands or millions of years. The normal term is 30 years, according to the definition of the World Meteorological Organization (WMO)."

2 The tropics are those imaginary lines parallel to the equator, located at 23º 26' 16" north latitude and 23º 26' 16" south latitude from the equator (latitude = 0).

Figure 1. The equator, the tropics, and the polar circles



Climate variability, the greenhouse effect, and climate change

Climates change gradually over long periods of time. Most Andean capital cities—including La Paz, Bolivia; Santiago de Chile, Chile; Quito, Ecuador; and Bogotá, Colombia—were covered with ice until approximately 12,000 years ago. And many of today's deserts were once covered by lush forests. In these cases, transformations were due to natural phenomena. But today, climate changes aren't just coming from natural causes; they are also the result of human activities that produce large amounts of greenhouse gases (GHG).

In addition, human-made changes are speeding up the natural changes and increasing their impact. An example of this is *deforestation*, which occurs when people cut down trees to clear the land for other uses.

Interrelated systems

For a long time, it was believed that Earth was composed of various "layers": air layer or atmosphere, the water layer or hydrosphere, the rock layer or lithosphere, the ice layer or cryosphere, and the layer of living things, from viruses to humans—the biosphere.

Just as the systems in our bodies—our bones; our sense organs; and our respiratory, circulatory, digestive, and other systems—work together and ultimately form each one of us, the systems of the planet are similarly interdependent. If somethingis affecting one of the systems, the others will also be affected in some way.

Today, we know that Earth's layers are in fact interrelated systems—meaning they are interconnected (figure 2).[3] For instance, volcanic eruptions, which are changes in the lithosphere, affect the atmosphere, the soil, bodies of water (rivers, lakes, oceans, etc.), and of course the biosphere.

When a virus attacks our immune system, other systems in the body join in the fight to eliminate it. For example, these systems may work together to produce a fever so the body will be too hot for the virus.

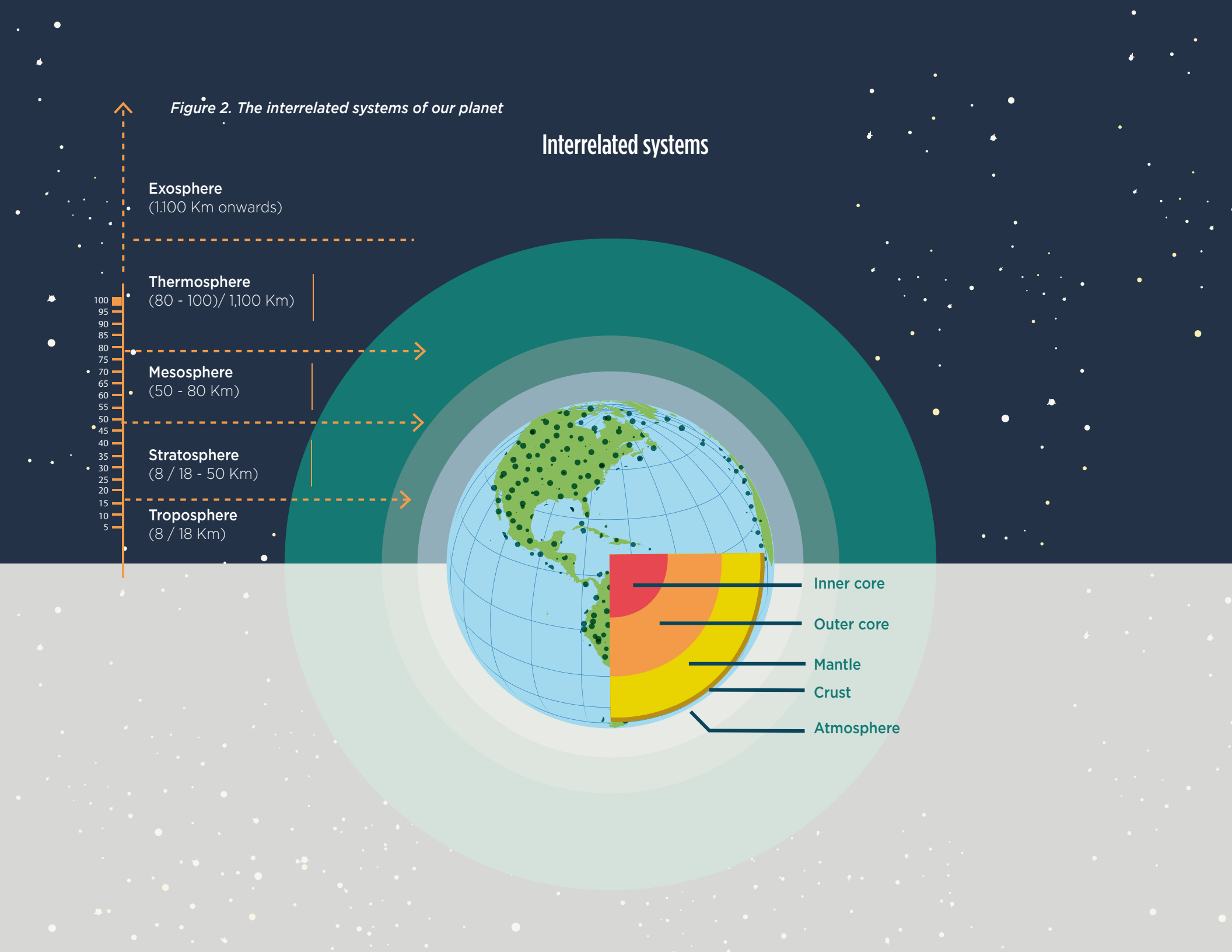
The interrelated systems of the planet interact in a similar way to changes in Earth's structure and processes.

Just as the body makes fevers, Earth's systems adjust to changes caused by human development. Collectively, these adjustments are called *climate change*.

System	Composition	Importance
Atmosphere	Gases, including water (H_2O), methane (CH_4), carbon dioxide (CO_2), nitrogen oxide (N_2O), and ozone (O_3)	Influences climate Oxygen is one of the gases necessary for life Plants need CO_2 for photosynthesis
Hydrosphere	Water, including salt water from the sea and freshwater from rivers	Living things need water to survive
Lithosphere	Rocks that form Earth	Provides materials for manufacturing and minerals and nutrients for all living things
Biosphere	Living things	Maintains balance in the systems Plants transform energy from the sun into food and oxygen Animals provide food, power for work, and company Fungi transform organic matter

3 We know now that climate depends not just on the atmosphere, but also on the interrelationship among all the systems that make up Earth, sometimes called *interrelated, coupled,* or *concatenated systems*. *Integration* has become an important indicator of the models we use to understand climate behavior. You can find more information on this topic at www.springerlink.com.

Figure 2. The interrelated systems of our planet



You may have noticed that we have not used the term *global warming*. This is because, although greenhouse gases are increasing the average temperature of the planet, we know that each region of Earth is warming at a different pace. So today, you might hear about some regions in the world experiencing temperatures above 40° Celsius while at the same time regions in the opposite hemisphere are enduring temperatures of minus 40° Celsius.

Extreme temperatures and similar changes affect more than just the climate; they also create and generate dramatic changes in many processes and human activities. Taken together, the effects of the adjustments triggered by climate change are known as *global change*. The consequences of global change have been disastrous for human communities that cannot adapt quickly enough.

To summarize, *climate variability* is the term used to describe naturally occurring changes; *climate change* refers to transformations that occur due to human activity, particularly activities involving greenhouse gas emissions and land-use changes.

Differentiating between climate and weather

What is weather?

People are constantly talking about the weather. You may have heard people talk about the weather on the television or radio many times.

Weather is a description of the state of the atmosphere at a given time. This description includes a number of factors, including temperature, rainfall, clouds, humidity, and air pressure. Weather varies throughout the day due to winds and storms and it varies throughout the year due to Earth's movement around the sun.

The changes occur because the planet Earth is a sphere that rotates on a tilted axis, causing the sun's rays to fall in varying intensities on the planet (figure 3). The sun's rays fall directly and perpendicularly on the equator, making those regions warmer. At the poles, however, the sun's rays light Earth at an angle, and this results in lower temperatures.

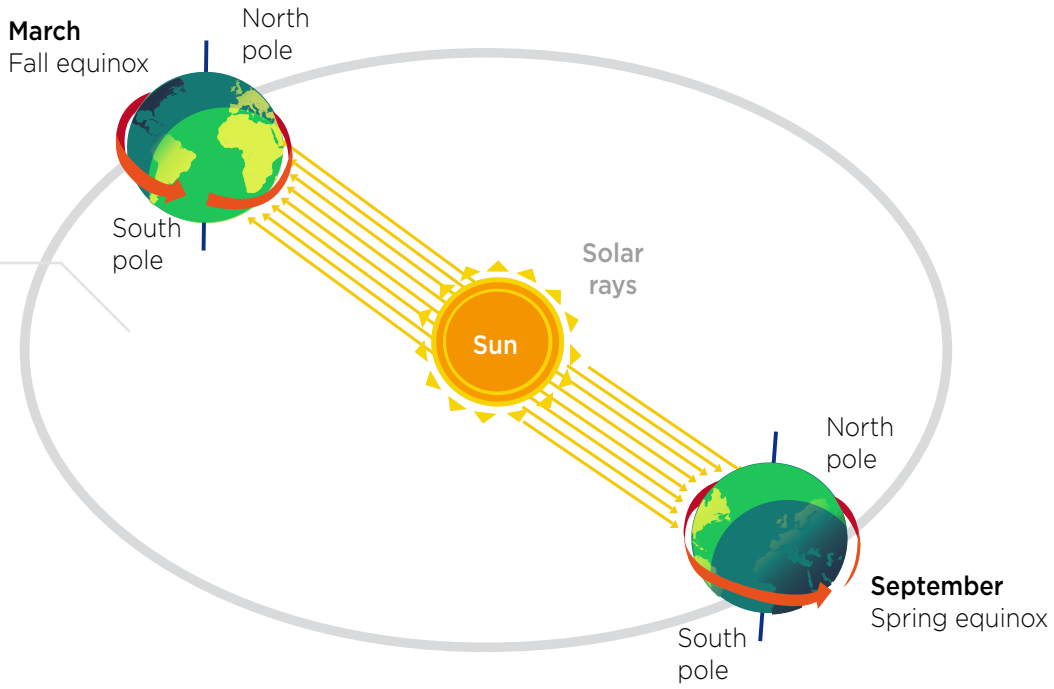


Figure 3. Variations in the angle at which the sun's rays reach Earth

These temperature differences create currents (figure 4). For example, when the air of a region is warmer than the air that surrounds it, it becomes less dense and starts to rise, allowing the denser air to descend and take its place. These air currents are called *winds*.

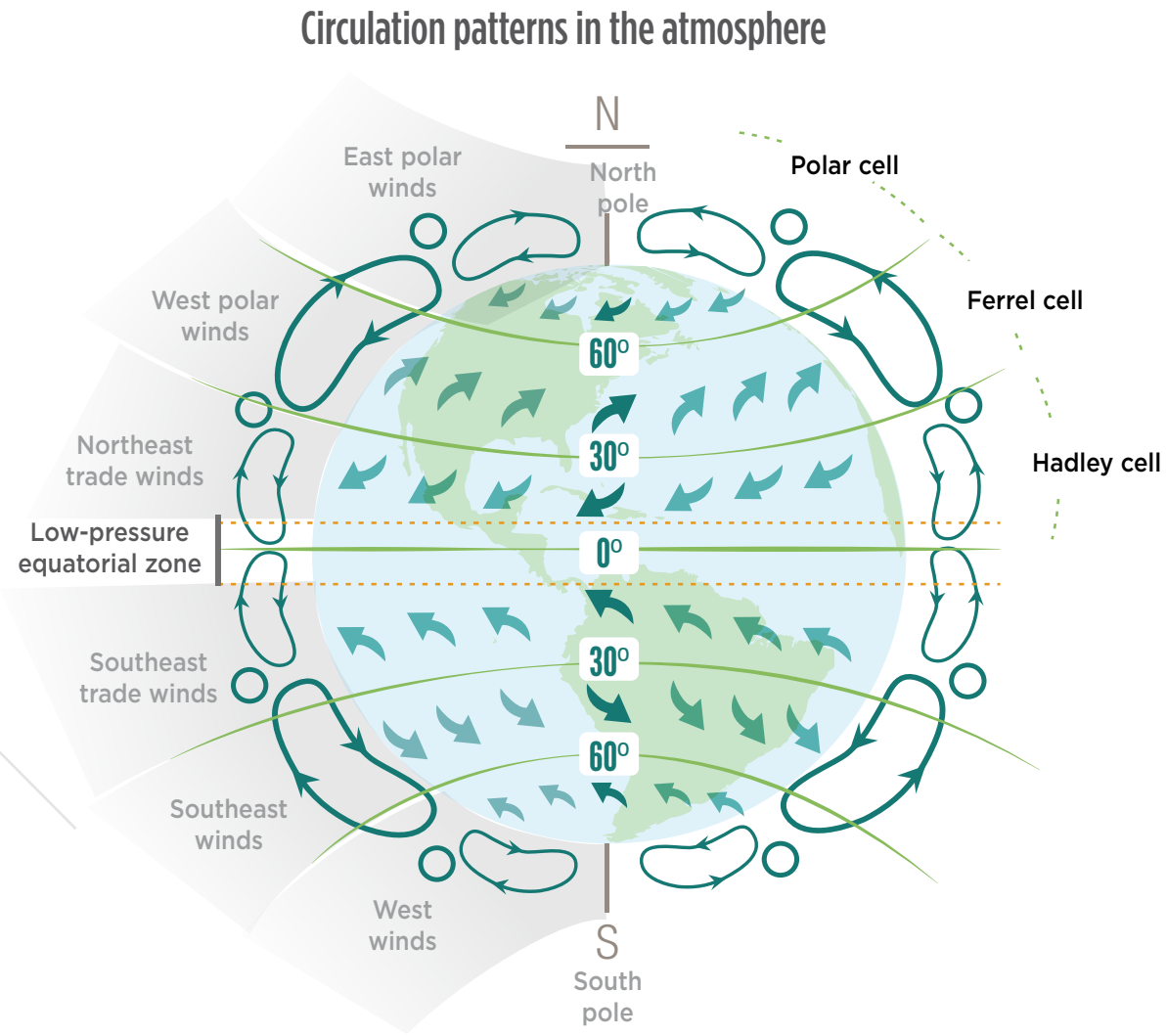
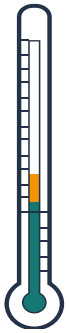


Figure 4. Circulation patterns in the atmosphere

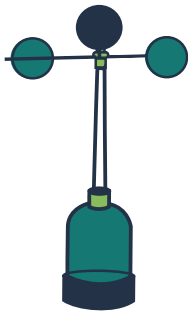
What variables determine a region's climate?

As we've already learned, climate is not the same as weather. Climate is the average weather in a region over a long period of time. The variables that determine a region's climate include:



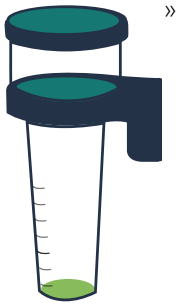
» **Temperature:** the amount of solar energy retained by the air at a given time expressed in degrees—Celsius or Fahrenheit—measured with a thermometer (figure 5).

Figure 5. Thermometer



» **Wind** is air in motion. It is produced by differences in temperature on Earth's surface. In the field of meteorology, there are two measures for the wind: speed and direction. The wind's speed is measured in either knots or kilometers per hour (km/h). A knot is equivalent to 1.8 km/h. The weather vane is the device traditionally used to measure the wind's direction; an anemometer (figure 6) is used to measure its speed.

Figure 6. Anemometer



» **Rainfall**—the amount of rain or hail that falls from the clouds. It is measured in millimeters (mm). Meteorologists use a device called a rain gauge (or pluviometer, figure 7) to measure how much rain (or precipitation) has fallen by measuring the depth or thickness of the layer of rainwater that forms on the flat, waterproof surface inside the device.

Figure 7. Rain gauge

» **Humidity** is the amount of water vapor in the air. It is expressed as the relationship or ratio between the amount of water actually in the air, divided by the amount of water that the air can hold at a given temperature and atmospheric pressure. (Atmospheric pressure is the force that comes from the air's weight.) Humidity is measured with a psychrometer (figure 8).

Figure 8. Psychrometer

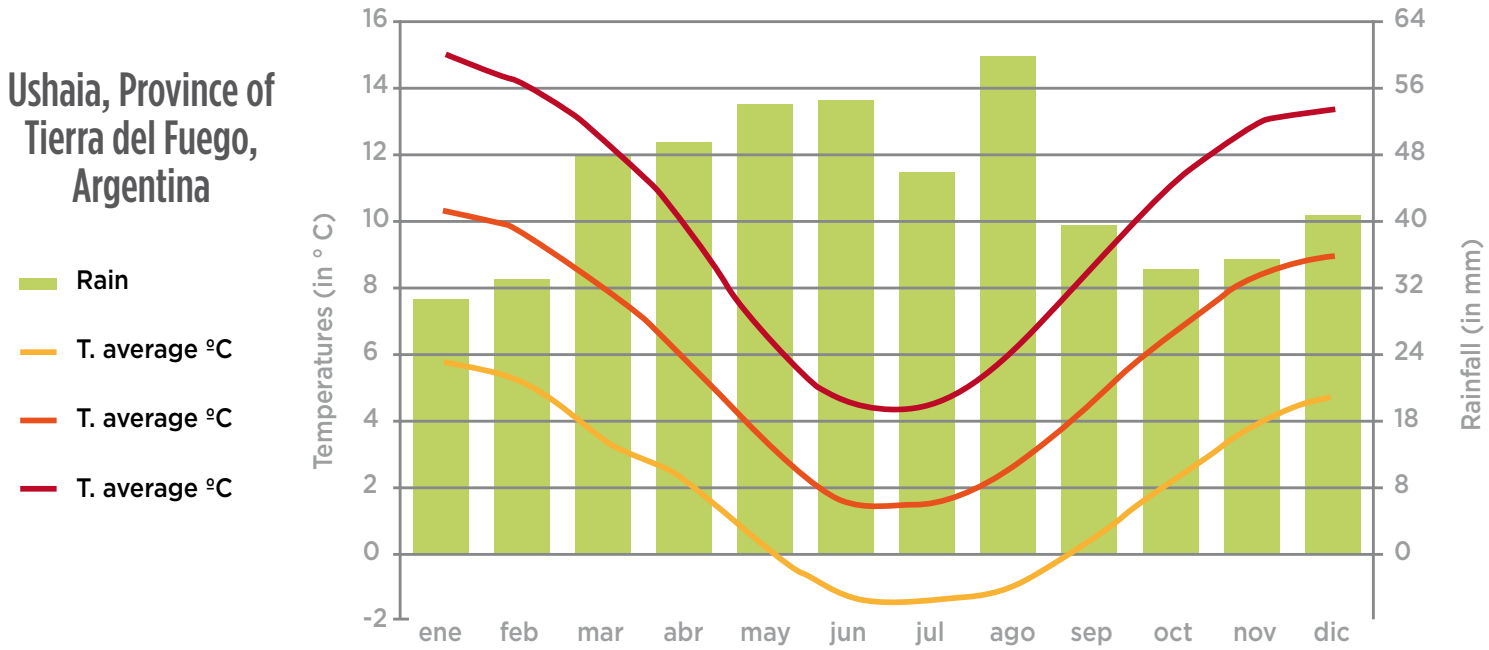
» **Altitude** is the height (elevation) above sea level of a particular place. It is expressed in meters above sea level (m.a.s.l.), and it is measured by an instrument called an altimeter (figure 9).

Figure 9. Altimeter

» **Latitude** is the geographic location of a site in relation to the equator.

Together, these variables determine the climate patterns of every region on the planet and help us predict what the climate of a city or area will be throughout the year using climographs. Figure 10 shows the climograph of the city of Ushuaia in southern Argentina. Ushuaia is cold in July, hot in January, and rainy in August.

Figure 10. Climograph of the city of Ushuaia, Tierra del Fuego, Argentina



A variable climate

Earth is always changing. Geological records show that our planet has seen many changes in its landscape, climate, and living systems.

The climate is also constantly changing. Paleoclimatology, the field of science that studies past climates, reveals that our planet has experienced a wide range of climatic variability throughout its history.

Another kind of climate variability is closely related to the tilt of Earth's. It is caused by Earth's motion around the sun, which affects how the planet is struck by the sun's rays. It determines the climate zones and seasons.

The seasons and tropical climate

We know that Earth travels around the sun on an elliptical orbit, a trip that lasts about 365 days, or one year. Because Earth tilts on its axis as it travels around the sun, the sun's rays affect the planet differently over the course of its orbit (figure 11). These differences generate seasonal changes, explaining why Earth's northern and southern hemispheres have four major seasons every year.

Summer in the northern hemisphere and winter in the southern hemisphere: This season begins on June 20 or 21, when the sun's rays hit Earth at an angle and pass through the Tropic of Cancer. The first day of this season is called the solstice. In the northern hemisphere, which tilts toward the sun during this season, the days

are longer than the nights, making it the warmest time of the year. In the southern hemisphere, the opposite occurs: as *winter* begins, temperatures drop, and the sun rises late and sets early.

Autumn in the northern hemisphere and spring in the southern hemisphere: This season begins on September 22 or 23, when the sun's rays fall vertically on the equator. The beginning of this season is called the equinox because days and nights are of equal length.

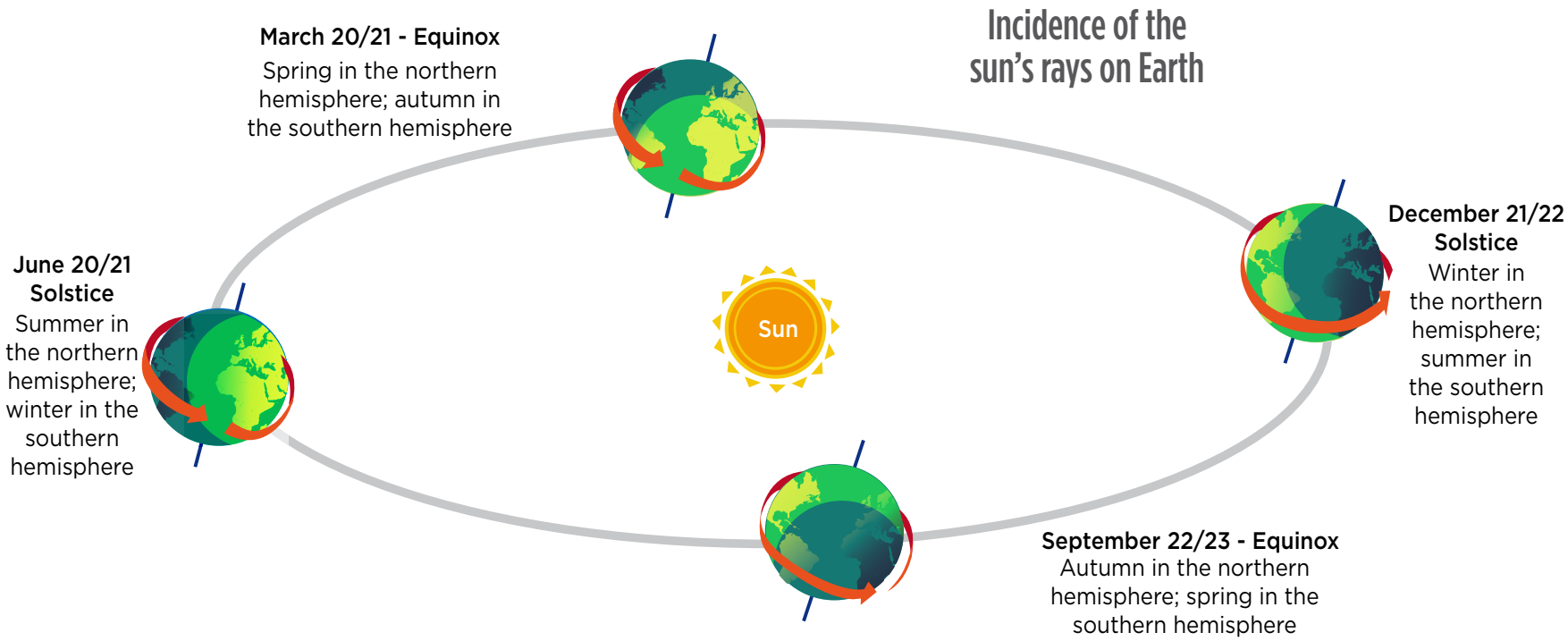
Winter in the northern hemisphere and summer in the southern hemisphere: This season begins on December 21 or 22, when the sun's rays hit Earth at an angle and pass through the Tropic of Capricorn. The beginning of this season is also a solstice, but it is the reverse of the one in June. The days are shorter than the nights in the northern hemisphere, with lower temperatures.

Spring in the northern hemisphere and autumn in the southern hemisphere: In this season, which begins on March 20 or 21, the sun's rays also fall vertically over the equator. The first day of the season is also an equinox— days and nights are of equal length.

Regions north of the Tropic of Cancer (the boreal regions) and south of the Tropic of Capricorn have climates that vary by season. In order to survive, the plants and animals there must adapt to seasonal climate changes, such as cold, heat, and wind.

In Latin America, all of the countries located below the Tropic of Capricorn, including Argentina, Chile, Uruguay, and Paraguay, share the same seasons.

Figure 11. Incidence of the sun's rays on Earth



Climate's effects on our housing, clothing, and food

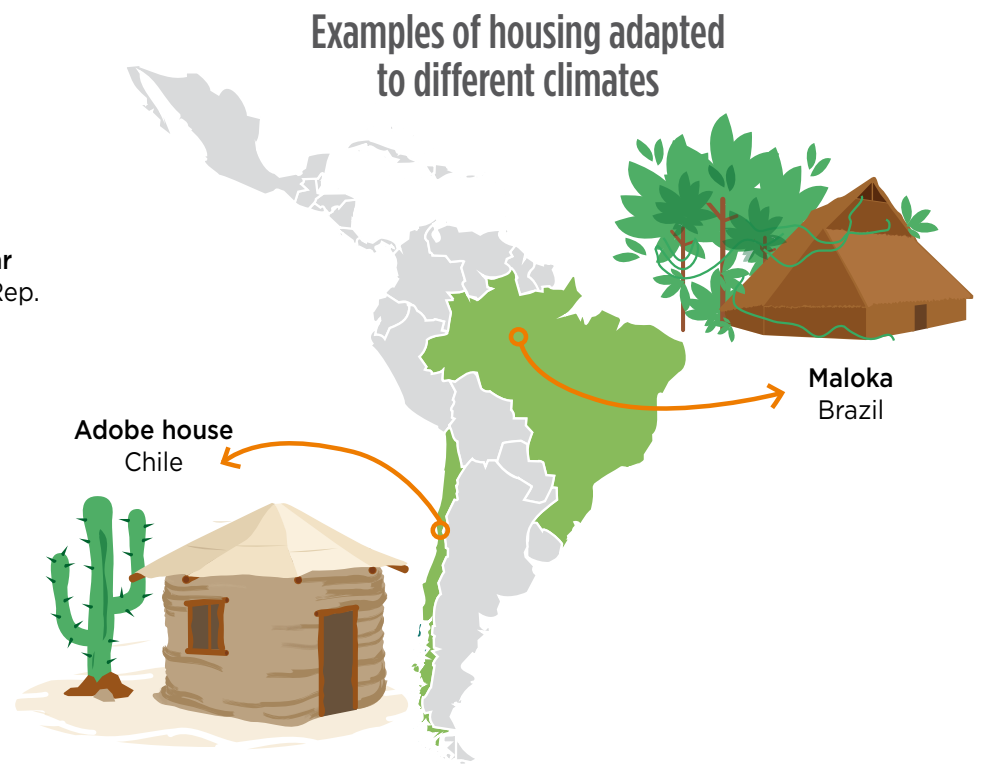
Climate is one of the factors that determine the landscape and our culture. It influences our clothing, what we eat, our activities, and how we build our homes.

People living in cold climates often wear heavy, dark clothes while people who live in hotter regions tend to wear light clothing. For example in La Paz, Bolivia, people who live in the mountains use *ruanas*, bulky woolen ponchos, to guard against cold temperatures, while in La Guajira, Colombia, which is close to the sea, people use large cotton blankets as protection from the heat (figure 12).

Figure 12. Traditional dress varies by region

Climate also influences how we build homes. In the Chilean desert of San Pedro de Atacama, for example, people build homes using adobe—clay mixed with manure and plant materials—with only a few small windows in order to protect themselves from high temperatures and strong winds. In the Amazon jungle, it is common to see bungalows with palm leaf roofs, which keep them cool (figure 13).

Figure 13. Examples of housing adapted to different climates. Left: typical adobe house of the Atacama Desert in Chile. Right: bungalow in the Amazon jungle.

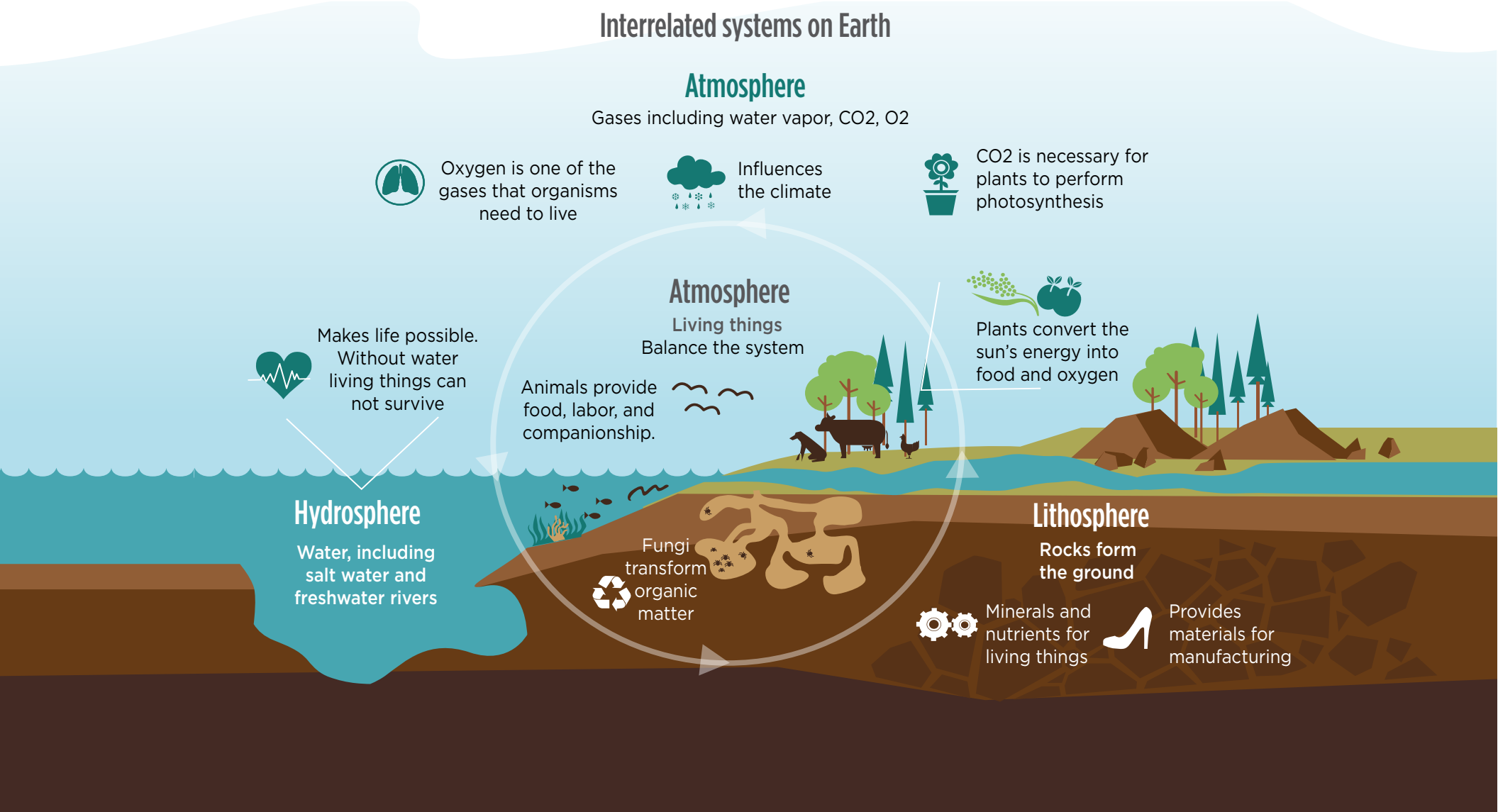


Interrelated systems on Earth

Air, water, and rocks are constantly interacting with each other, which fosters life on the planet. Each of these components is important. If one of them was absent or if the relationship between them were altered, there would be global consequences. These three components comprise the atmosphere, biosphere, hydrophere, and lithosphere (figure 14).

Figure 14. The Earth's interrelated systems

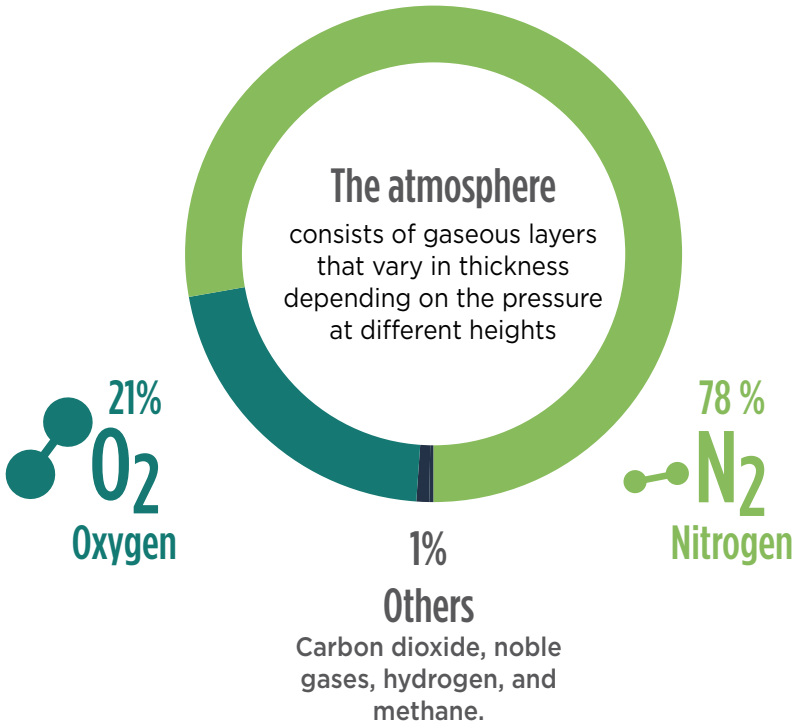
The *atmosphere* is the air that surrounds our planet and absorbs heat from the sun, which warms Earth. The atmosphere is comprised of gases, including water vapor (H_2O), methane (CH_4), carbon dioxide (CO_2), nitrogen oxide (N_2O), and ozone (O_3), so-called *greenhouse gases* (GHGs). GHGs trap the sun's energy and keep Earth's temperature an average of 14–15˚C, ideal for life.



The atmosphere plays an important role in maintaining life and regulating the climate. Life on our planet would be impossible without the atmosphere because it contains two essential gases: oxygen and carbon dioxide (figure 15). Animals and humans breathe oxygen, and green plants need carbon dioxide for *photosynthesis*, a process that transforms solar energy into food and oxygen.

Without greenhouse gases, less of the sun's heat would remain around Earth. Instead, it would bounce back into space, and this would make it impossible for life to exist on Earth.

Figure 15. The gases that make up our atmosphere



The gases in the atmosphere regulate Earth's temperature, keeping the sun's rays from directly hitting the surface of Earth and preventing excessive heat loss at night.

Atmospheric pressure also helps regulate the air near Earth. Atmospheric pressure is the force from the air's weight on the soil and on living things, including humans. It is a factor preventing the escaping of liquids and gases from our bodies.

The mixture of gases that make up the atmosphere has evolved over millions of years, and is constantly changing. However, a combination of factors—fossil fuel use, destruction of forests, changes in land use, decomposition of waste in dumps and landfills, among others—have increased the level of greenhouse gases in the atmosphere. More GHGs make the atmosphere absorb more heat, which has consequences for the climate and for living things.

From the greenhouse effect to climate change

The countries of Latin America and the Caribbean produce flowers, fruits, and vegetables. Sometimes, farmers grow their crops in greenhouses—plastic or glass structures that protect crops from the sun's rays, frost, and moisture in the air (figure 16). Both light and heat can enter, but while light can escape, much of the heat remains trapped inside. This is why it's hotter inside a greenhouse than outside.

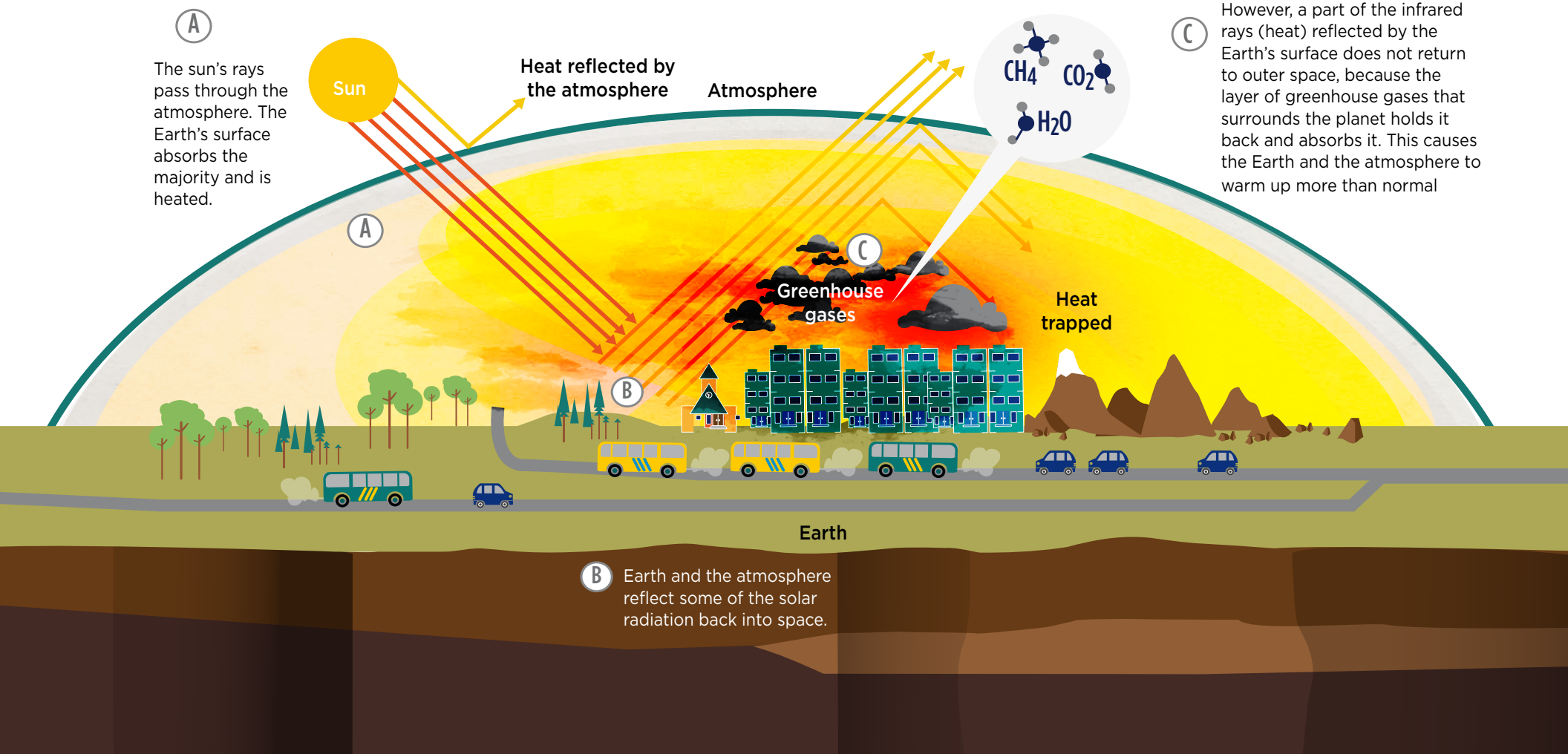
Atmospheric gases, such as water vapor (H_2O), carbon dioxide (CO_2), and methane (CH_4), contain heat in a similar way. This is known as the *greenhouse effect*—it keeps some of the sun's heat from escaping into outer space (figure 17). Instead, that heat gets trapped in the atmosphere. Without the greenhouse effect, the planet's average temperature would be –19°C or –7.7°F rather than the 14–15°C average temperature we now enjoy! [4]

4 Data on the temperature of Earth with and without the greenhouse effect are from the IPCC, among other sources.

Figure 16. A greenhouse Photo: Stable/Shutterstock

The greenhouse effect

Figure 17. The greenhouse effect



Under natural conditions, greenhouse gases act like a thin bed sheet you might use to cover yourself on a slightly cool evening. The sheet prevents body heat from escaping, allowing for a comfortable sleeping temperature.

But imagine sleeping under three thick wool blankets on that same evening. Not only would it probably be too hot to sleep, it might even make you sick!

This is what happened approximately 200 years ago with the invention of the coal-burning steam engine that spurred the *Industrial Revolution*. People were so excited about producing energy from coal, and later from oil, that they began to extract and burn ever-larger amounts of these *fossil fuels*.

Fossil fuels are so named because they come from dead plants and animals buried millions of years ago. Natural forces underground eventually converted them into oil and coal.

People use fossil fuels to power cars and other means of transportation, to provide electricity for homes and schools, and to operate industrial machinery (figure 18).

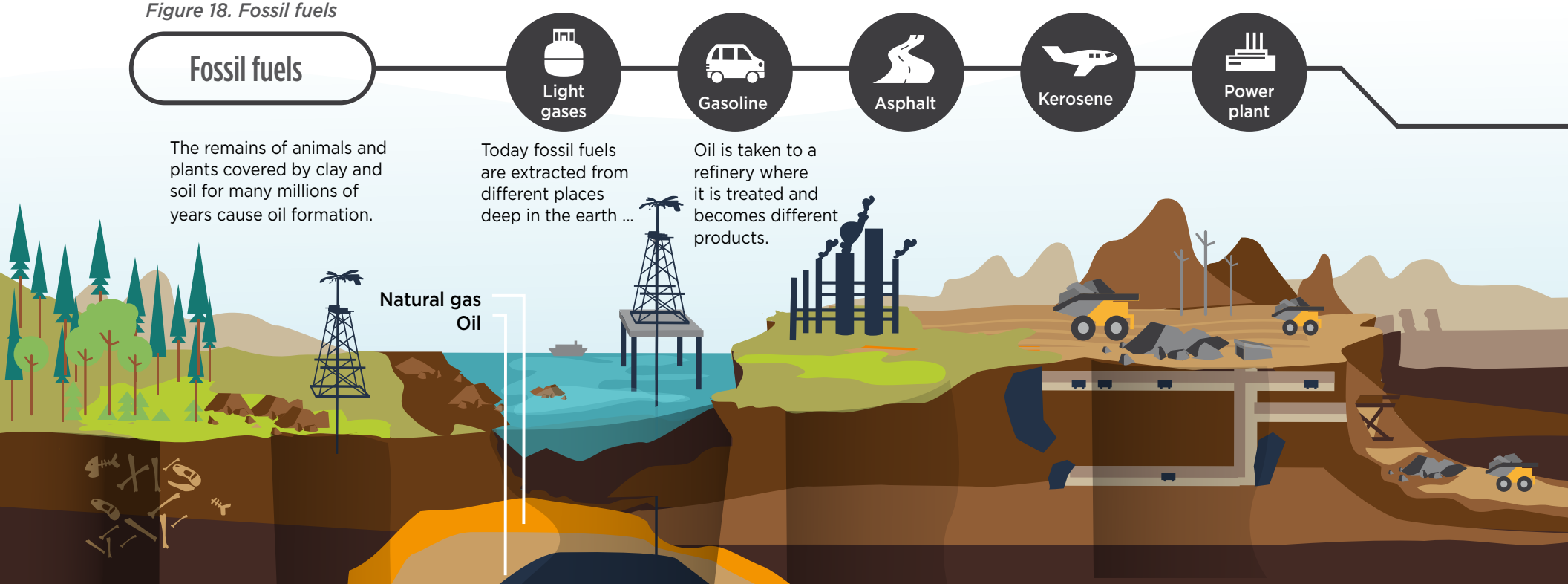
The problem is that fossil fuels are nonrenewable energy sources, meaning there is a limited amount of them on the planet, and we use so much that scientists think that we may even run out in the near future! Scientists also worry about the greenhouse gases that are released into the atmosphere when fossil fuels are burned, which releases more carbon dioxide (CO_2) into the atmosphere.

A large amount of methane, another major greenhouse gas, is produced by cattle farming (cows produce methane gas when they digest food) and decomposing garbage (microbes that break down waste emit methane).

Another important contribution to the greenhouse effect is deforestation, usually caused by the burning of trees and vegetation that otherwise protect the soil, releasing greenhouse gases into the atmosphere. Deforestation also results in fewer plants to soak up carbon dioxide from the atmosphere.

In addition, human beings have developed pesticides, fertilizers, and industrial chemicals with significant heat-retention power. These substances add to the greenhouse effect by releasing heat into the atmosphere.

Figure 18. Fossil fuels



Concern over the greenhouse effect has prompted people to talk about low carbon development, which is intended to reduce the amount of greenhouse gases released into the atmosphere by human processes. A reduction of greenhouse gas emissions is known as *mitigation*.

In Latin America and the Caribbean, we only generate about 6 percent of all greenhouse gases released into the atmosphere. But, combined with deforestation, we are still harming the planet and ourselves.

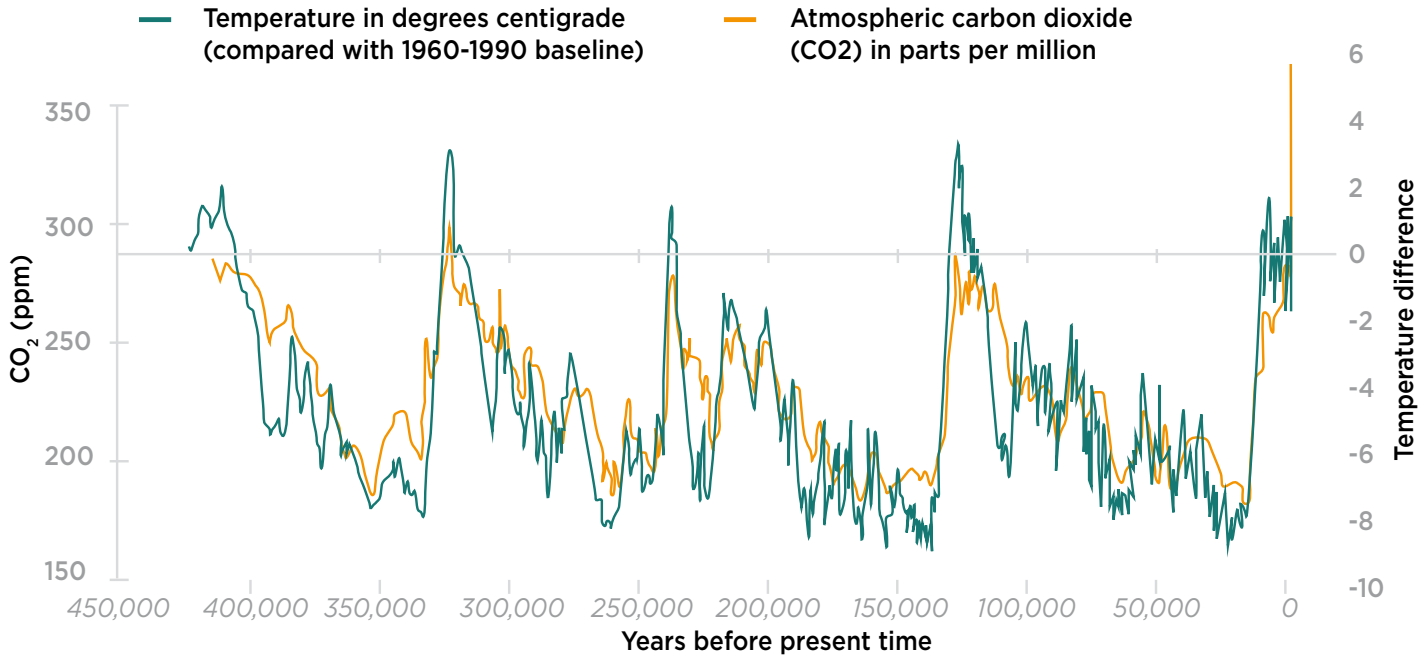
Although today we are not among the most significant emitters of greenhouse gases, this could change, which is why we need to adopt development strategies that lower our carbon footprint.

Why are people so concerned about rising temperatures? We have to go back 18,000 years to answer this question. Back when most of Earth was covered with ice, the average temperature was 4˚C. Today, it is 14–15˚C —it took 18,000 years for the temperature to rise by 10˚C (figure 19).

We know that with the 40 percent increase in greenhouse gas production, the average temperature on Earth has risen by more than half a degree Celsius over the last one hundred years. In fact, the greenhouse effect has sped up the pace of change to such an extent that, according to the Intergovernmental Panel on Climate Change (IPCC), average temperatures are estimated to increase by anywhere from 0.3° and 4.8°C over the next century, making it much harder for many organisms and ecosystems to live.

In the short term, higher average temperatures affect global weather patterns. For example, tropical cyclones and hurricanes obtain their energy from masses of hot water. Scientists predict that with climate change, the frequency of stronger hurricanes will increase. Likewise, higher temperatures lead to higher rates of evaporation, taking more water from the soil and causing droughts. When moisture is released, rain and snowfall become more intense.

Figure 19. Stability of the climate for the last 18,000 years and rising temperatures over the past 100 years



Source: www.Tiempo.com/ram/2424/la-historia-del-clima (consulted 23 January 2013).

The El Niño and La Niña phenomena: Climate variability or climate change?

Ocean currents are partly due to the movement of air currents.

The American trade winds circulate toward the equator and then toward the west (figure 20). In North America, these winds first circulate south, and upon reaching the equator, are deflected toward the Asian coasts. The winds in South America first circulate toward the north and then out toward the Asian coasts, moving the Pacific surface waters toward the west. The air currents in the atmosphere circulate west to east.

As the Pacific Ocean absorbs heat from the sun, the warm waters on the southern coasts of Asia and the northern coasts of Australia evaporate, creating rain clouds. While these regions experience heavy rainfall, the Pacific waters in southern Colombia, Ecuador, and Peru remain cold.

The El Niño phenomenon, which occurs every three to five years, decreases the circulating speed of the trade winds, altering the air flow between the continents (figure 21) and causing the surface waters of the Pacific Ocean to switch directions and move west to east. This strongly changes precipitation patterns in countries like Colombia, Ecuador, and Peru and often leads to flooding or extreme droughts in some areas. Meanwhile, water temperatures drop in Indonesia and Australia, and that climate becomes drier.

A second phenomenon, called La Niña, increases the speed of westward circulating trade winds, causing more surface water to move toward Asia and Australia (figure 22). This produces cooler water temperatures and severe droughts in South America, while it significantly increases the rainfall on the western Pacific coasts.

During La Niña, cold deep waters coming from the west move eastward by upwelling, carrying a large amount of nutrients beneficial to the fishing industry. The industry suffers during El Niño, however, when this does not occur.

These phenomena have existed for a long time, and many scientists assert that they are a part of climate variability. However, other scientists claim that climate change has increased their frequency and their capacity to cause disasters.

While the El Niño and La Niña phenomena directly affect the northern coasts of Australia, southern Asia, and equatorial South America, they also influence the global climate.

Figure 20. Normal conditions in the Pacific Ocean

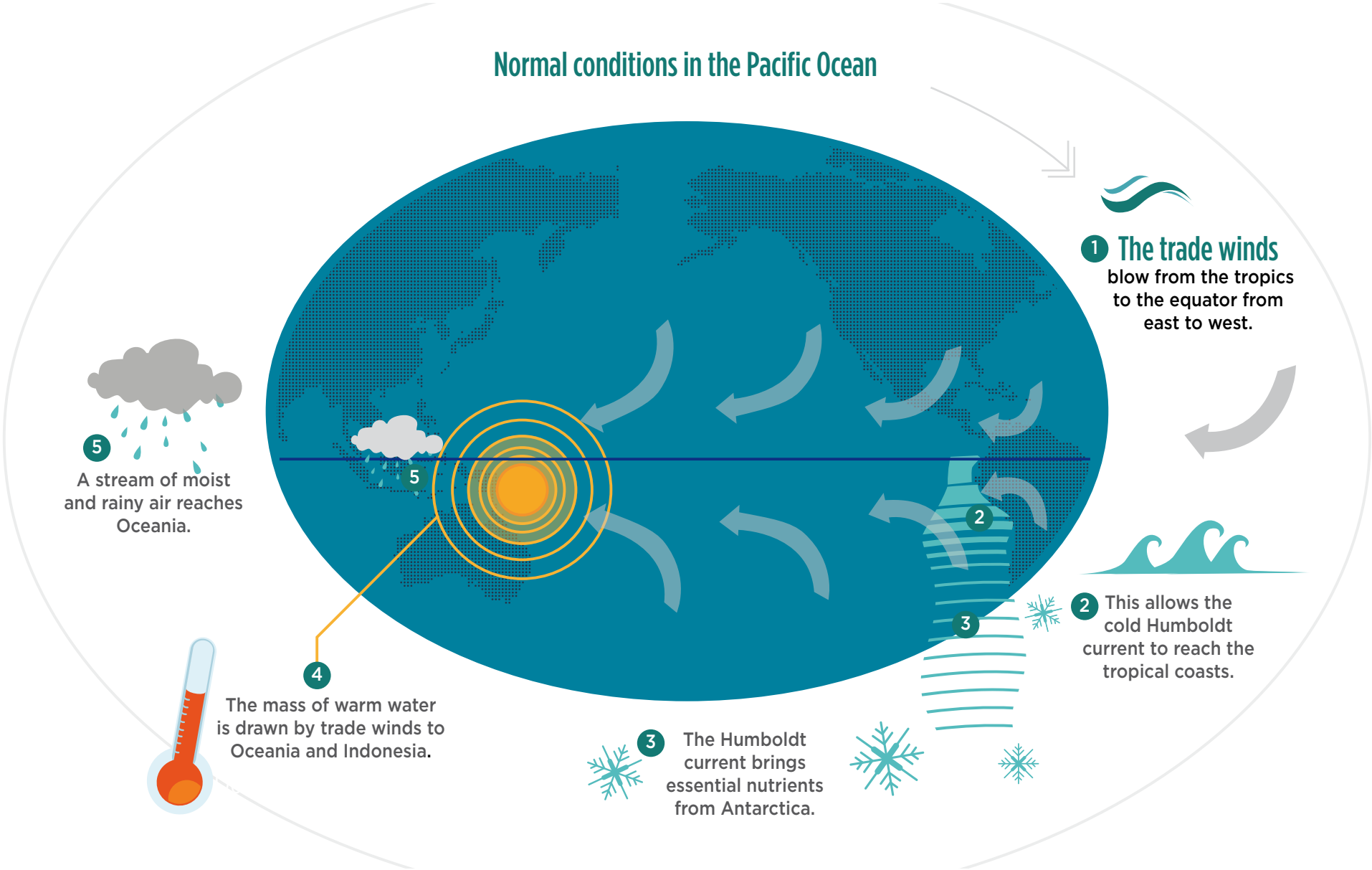


Figure 21. The El Niño phenomenon

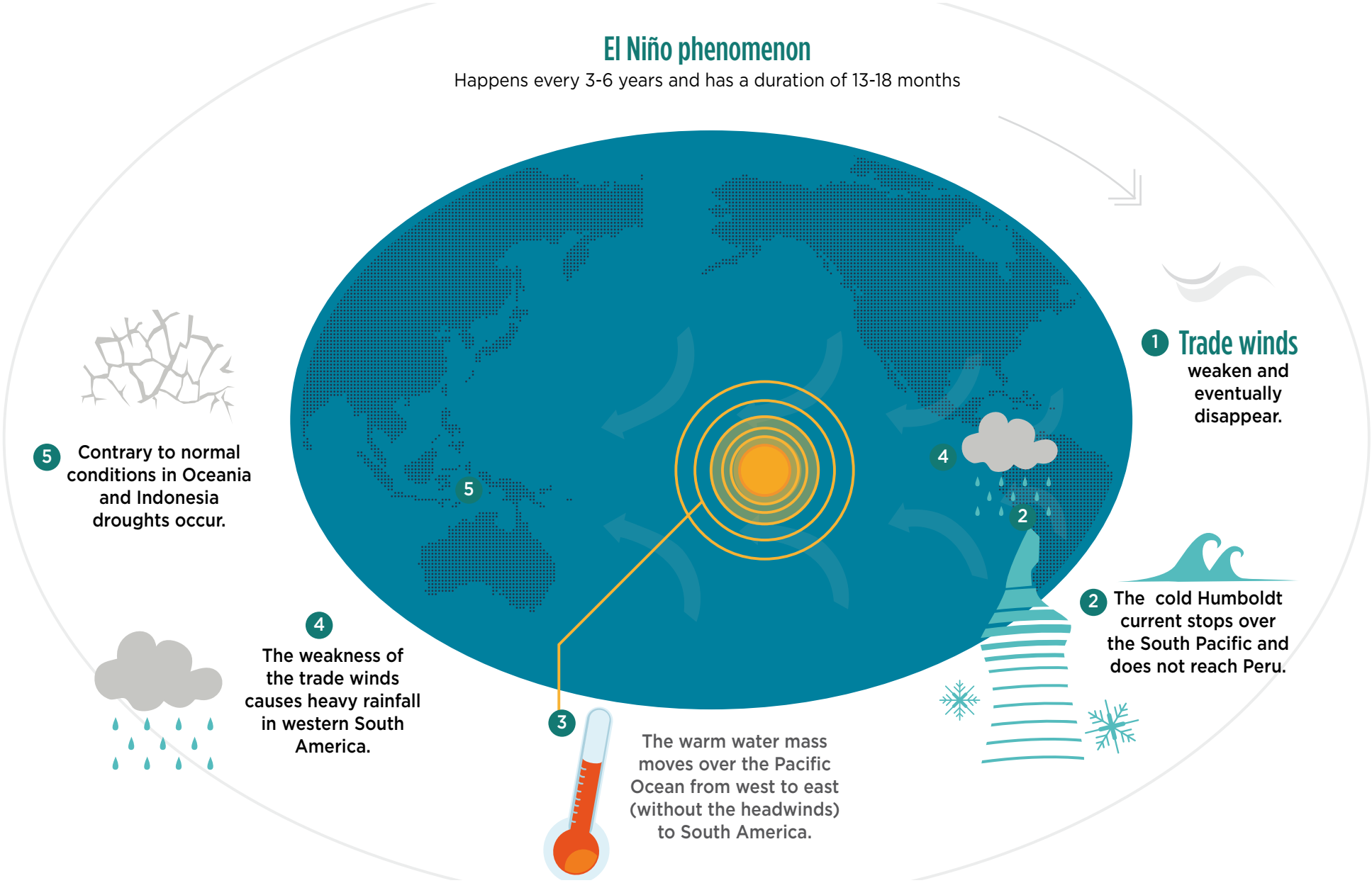
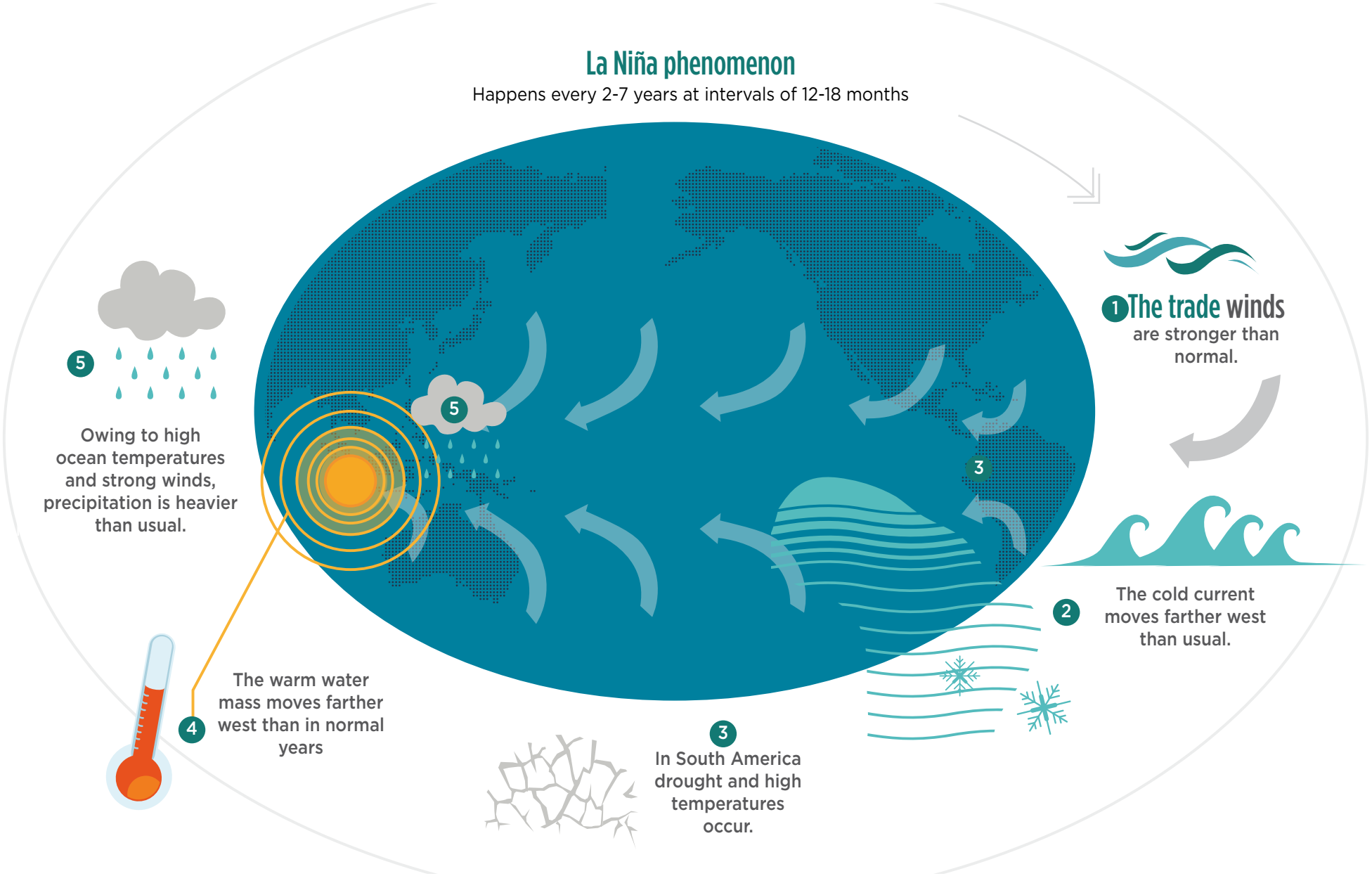


Figure 22. The La Niña phenomenon



Climate change and global environmental change

The effects of climate change are quite varied, including changes in water, air, infrastructure, communities, and food. This is why we say that global environmental changes occur along with climate change—not just the weather. Some of these effects are detailed in the table below.

Direct effects and impacts of climate change

Direct effects	Impacts
» **Higher temperatures** » **Extreme temperatures and increased climate variability** » **Droughts and floods**	Increased rainfall and extreme weather in some parts of the world, such as, tsunamis, droughts, fires, and floods
	Increased water availability (sometimes too much) in the already-wet tropics and at high latitudes
	Reduced water availability and increased drought in the semi-arid mid and low latitudes
	Increased human displacement
	Death and disease due to natural disasters, such as heat waves, floods, and droughts
	Greater risk of forest fires
	Increased damage from floods and storms
	Landslides
	Greater risk of pest infestation in forests
	Decreased diversity of plant and animal species
	Death of coral reefs leading to the decline or extinction of marine species
	Difficulty or displacement for some foraging animal species
	Soil damage
	Negative impacts on small-scale farming, subsistence farmers, and fishermen
	Crop damage and loss
	Increased malnutrition and undernourishment
	Decreased food production from extreme changes in water availability
	Increased respiratory, diarrheal, and infectious diseases
	More air pollution
	Human bodies biologically and culturally adapted to a certain range of temperatures enter into crises when ranges are exceeded without adequate time to adapt
	Expands geographical distribution of some disease-carrying organisms, or vectors, such as mosquitoes that carry malaria and dengue. Mosquitoes normally live in warm climates. As temperatures increase around the world, they—and the diseases they carry—will move to new regions.
	Reduced water availability in some regions
	Fewer water resources for operating hydroelectric power plants
	Increased energy demand for cooling and heating systems

» **Melting of the poles and snowy peaks**	Snow on mountain peaks helps meet water needs when it melts; available drinking water decreases without it
	Accelerated melting may cause landslides and disasters
	Difficulty or displacement for some species of foraging animals
	Extinction of animal species
» **Increased ocean acidity as more CO2 is absorbed from the atmosphere**	Destroys the habitats of many fish species
	Changes availability of foods
	May destroy entire ecosystems
	More acidic oceans hurt the fishing industry
» **Warming of the oceans**	Warmer oceans change climate systems, creating more storms, floods, etc.
» **Rising ocean water levels**	Since heat increases the movement of atoms, oceans expand when the water heats up. This thermal expansion is expected to increase sea levels between 26 cm and 82 cm over the next 100 years.
	Rising sea levels lead to flooding
	Islands and cities near sea level may flood and ultimately disappear
	Human displacement

In Latin America and the Caribbean, we have seen some of the effects of rising temperatures, including less rainfall in some areas, more rainfall and flooding in other areas, lighter snowfalls, and disappearing ice-caps. Experts predict that the Caribbean Sea will rise 40 cm in the next 50 years. If we are not prepared for this, living things in the region may find themselves in serious trouble!

The outlook seems quite negative since climate change has already begun. Mitigation will require numerous actions by the world's populations and governments over a number of years to reduce greenhouse gas emissions. Current ecosystems and human societies will be sensitive to the magnitude and speed of this change, but while controlling emissions is essential, it must be combined with efforts to minimize damage through adaptation.

The decisions and collective work of states, governments, and communities, communication among area residents, adaptation and risk management plans, and increased awareness that action can be taken will be essential. Adaptation is the secret to life's ability to evolve in response to global changes.

Climate agreements

As we have seen, climate change poses many challenges, not only for individuals and communities, but also for governments. For several decades, the United Nations has tried to get its members—especially industrialized countries—to agree to reduce greenhouse gas emissions, including holding conventions and meetings with members about the issue, the most important of which are noted below.

Intergovernmental Panel on Climate Change (IPCC)

In 1988, the United Nations and the World Meteorological Organization (WMO) created the IPCC to "assess on a comprehensive, objective, open and transparent basis the scientific technical and socioeconomic information relevant to understanding the scientific basis of risk of human-induced climate change, its potential impacts and options for adaptation and mitigation" (www.ipcc.ch).

This panel reviews climate change research, prepares documents for scientists and others, and supports the United Nations Framework on Climate Change.

United Nations Framework Convention on Climate Change (UNFCCC)

At the 1992 United Nations Conference on Environment and Development in Rio de Janeiro, also known as the Earth Summit or Eco 92, more than 160 governments signed the Framework Convention on Climate Change. Its objective was to limit human threats to the climate system and protect food sources, ecosystems, and social development, in part by lowering the greenhouse gas emissions of industrial countries in 2000 to 1990 levels.

The convention also launched the "principle of common and differentiated responsibility," which states that all countries have a responsibility to protect climate stability, but countries that have emitted the most CO_2 in the past should now be the first to protect the atmosphere.

Kyoto Protocol

Signed in 1997 in Japan, the Kyoto Protocol was a new component of the United Nations Climate Convention. It obligated the most industrialized countries to reduce their CO_2 emissions by 5.2 percent between 2008 and 2012 (based on 1990 levels).

Durban Platform

The emission reduction targets set in in the Kyoto Protocol were not met. Emissions actually *increased* from 2008 to 2012.

In late 2011, the Durban Platform, or Conference of the Parties (COP17) of the Climate Convention, held in Durban, South Africa, sought to renew the Kyoto Protocol for five years, setting 2015 as the deadline for creating a legal instrument to obligate signatory countries to comply with their commitments. However, the United States, Canada, Japan, and Russia did not sign it.

The great accomplishment of the new agreement is that members of the Climate Convention will have to meet mandatory emission reduction targets by 2021. Even so, this agreement gives countries a long time before they must begin making significant reductions in GHG emissions. Time is on the side of climate change. Much damage has already been done. Scientists on the Intergovernmental Panel on Climate Change (IPCC) warn that delays in meeting commitments will have irreversible impacts, including the extinction of many species and ecosystems; an increase in droughts, human displacement, floods, and extreme storms; and as ocean levels rise, even the disappearance of entire island countries.

As citizens, we have a responsibility to encourage our leaders to work on measures that protect Earth's climate, including creating meaningful public policies, laws, and treaties, and adhering to current international environmental treaties.

The ecological footprint

Since we know human activity influences climate change, it's important that individuals, communities, companies, states, and governments consider how they are affecting our environment. Scientists have come up with a tool called the *ecological or environmental footprint* to help with this effort.

The ecological footprint is the impact of human activity on the environment. It is **negative** if human activity hurts the structure and function of ecosystems and **positive** if it helps improve their integrity and biodiversity.

The ecological footprint helps us measure how much pressure or impact we are having on the planet. We use it to gauge how often we use renewable rather than nonrenewable resources. It also helps us see how many resources we'll need to continue living our lifestyles.

Right now, our ecological footprint is negative because we're using resources faster than Earth can replace them. Recent calculations show that at today's pace, it would take 1.4 Earths to replace the resources we are using (figure 23). If we continue along this path, scientists predict that by 2050, we'll be consuming the equivalent of 2.5 Earths each year! Is that sustainable?

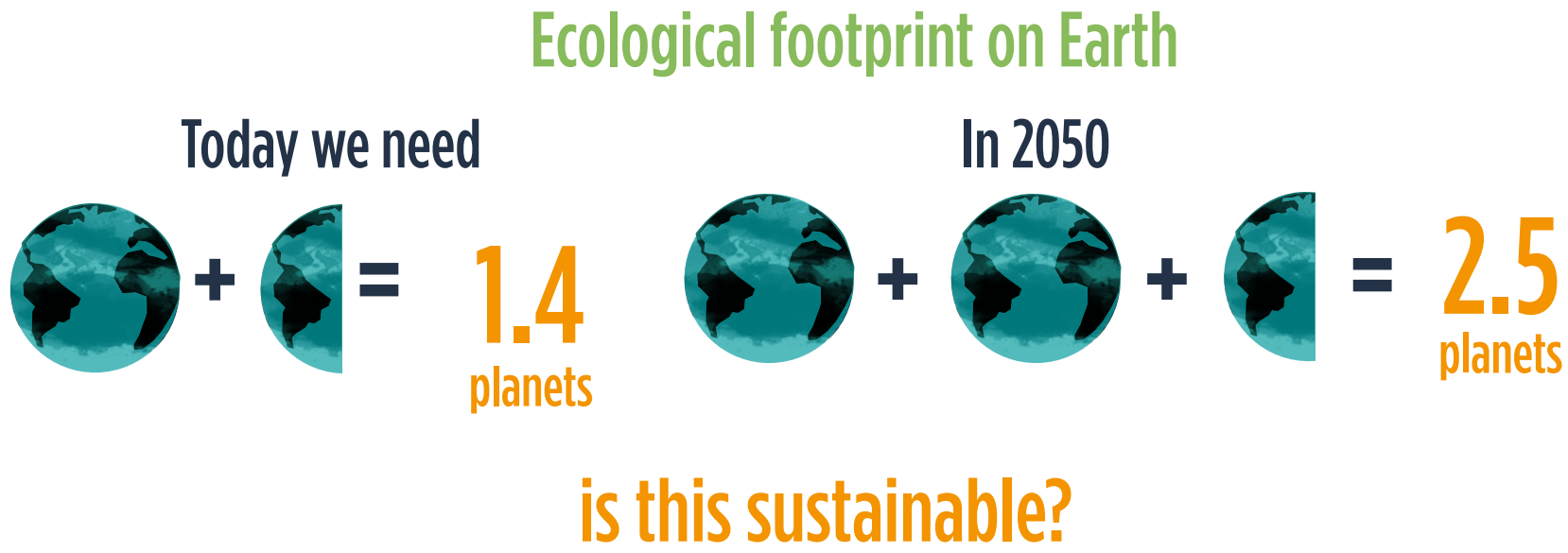
What about the carbon footprint?

When we talk about the carbon footprint, we are talking about the part of the ecological footprint that measures the total direct and indirect effect of GHGs on our atmosphere. We include the carbon footprint when calculating the ecological footprint.

Impacts of the ecological footprint

Deforestation, the fishing crisis, the food crisis, damage to and depletion of water resources, and pollution are some of the more serious impacts. Unless we act fast, climate change and its impacts are expected to worsen over the next 100 years.

Figure 23. Sustainability of our ecological footprint



Lesson Plans at the Basic Level

1 Basic lesson plan 1: Differentiating between climate and weather

General objectives

» Learn about the variables that determine a region's climate.

» Understand how the climate affects the landscape, humans, plants, and animals.

» Differentiate between climate and weather.

Class activity 1: What is the weather forecast for today?

Objective	Time	Place
Understand the concepts of weather and regional weather forecasts	30 minutes	Classroom

Materials

» Local newspaper clipping of the local weather forecast

Preparation

Find the weather forecast for your city/region on the Internet or the local newspaper.

Step by step

» Talk to the students about the weather forecast. Why is it important? Knowing the weather forecast is important for making decisions regarding planning any kind of outing—a walk, an activity, or even your daily commute to school. Will you need a raincoat? Also, knowing the weather is useful for air navigation (determining flight paths, avoiding storms, and preventing accidents), marine navigation (avoiding large waves caused by strong winds), construction (planning activities that cannot be performed in the rain), and many other events.

» Read the weekly weather forecast for the region.

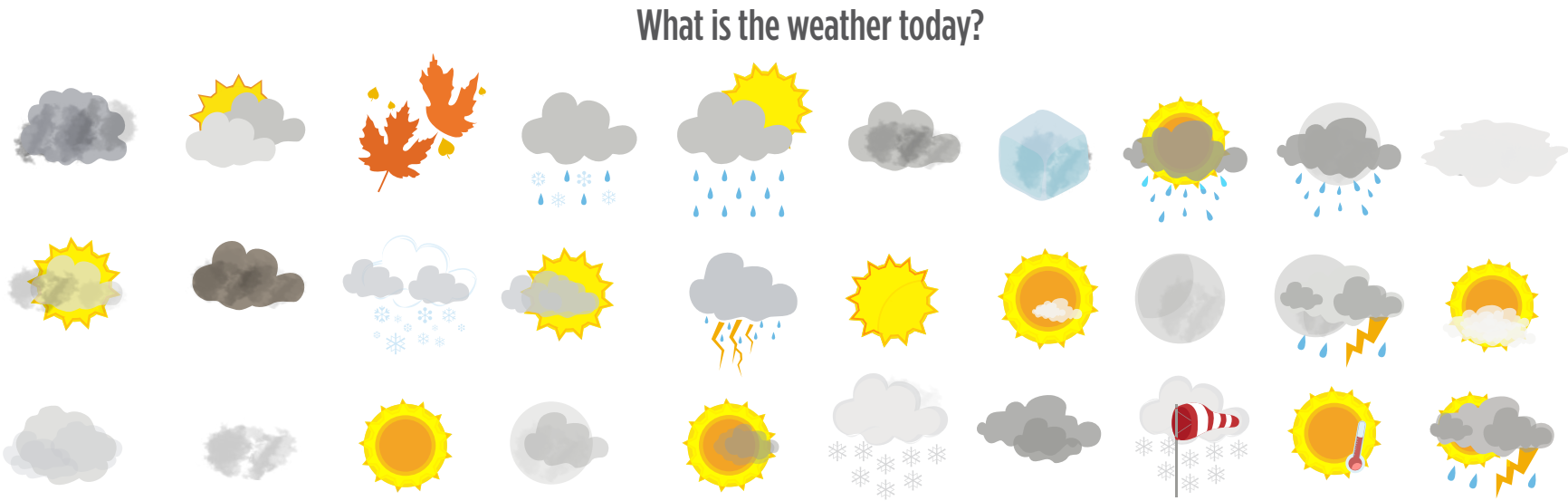
» Stop and read the details of today's forecast.

» Take the students outside and compare the predicted weather with the actual weather (figure 24).

» Ask students to observe the weather for a week and describe what they see in the following table using words and drawings similar to the icons at the bottom. Students can do this exercise in their notebooks, but we suggest making a poster for the class and having students take turns drawing how the weather changes over the course of the week.

» Discuss with the students: If the forecast doesn't match what happens during the day, what can happen? Does it mean the meteorologists don't know how to do their jobs? They do, of course, but the climate and weather are complex systems. Overall conditions can change due to minor changes in some components, which makes weather forecasts uncertain. Meteorologists can tell us the likelihood of something occurring, but cannot make predictions with complete certainty.

Figure 24. What is the weather today?



Weather observation log

	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Early morning 5:00–9:00 a.m.							
Mid-morning 9:00–12-00 p.m.							
Noon 12:00 p.m.–2:00 p.m.							
Afternoon 2:00 p.m.–6:00 p.m.							
Night 6:00 p.m. to 10:00 p.m.							

Class activity 2: What is the climate of our region?

Objective	Time	Place
» Become familiar with climate variables » Describe the climate of a region	2 hours	Classroom

Materials

» Index cards on climate variables (figures 25–28)
» Photographs of landscapes (from posters, classroom texts, or online photos that students obtain from Internet searches)
» Magazines or newspapers to cut
» Pictures of types of clothing
» Pictures of types of housing

Preparation

» Print and cut out the climate variables cards.
» Find pictures of landscapes in posters or books in your classroom that show large differences in the climate or ask students to find and print/cut out pictures of various landscapes from the Internet, newspapers, or magazines.

Step by step

» Talk to students about climates and how they differ from the weather. Show students images of different climates.
» Formulate research questions with the students on the various climate types. For example: What is a tropical climate? What is a mountain climate? What is a desert climate?
» Organize students into groups and have each group research the characteristics of a given climate.
» Provide students with magazines and newspapers so that they can create collages to describe the climates in each region of the world.
» Give each group resources for preparing a presentation about the climate of their assigned region.
» Have students present what they've learned using their collages.
» Ask students to select one image that best describes each variable—temperature, humidity, the rainy season, and wind—in their region's climate at this time of year.
» Have them describe the climate of their region using the images selected.
» Instruct them to focus on the general climate of the region, not on the current weather.
» Divide students into groups and ask them to compare their descriptions.
» Talk about what happens when a region's climate changes. What would happen if a dry region suddenly started to receive a lot of rain? What would happen if it didn't snow in an area that usually gets a lot? What would happen if the climate of a warm region suddenly got cold?
» Ask students: What would happen if our region's climate changed? To research this question, divide students into four groups. Ask them to imagine that the climate will suddenly change into:
  - A very hot, dry region with no wind or rain
  - A very hot region with a lot of rain, no wind, and high humidity
  - A windy, dry region with snow, but no rain
  - A cold, wet region with a lot of rain and mist, and little wind

Figure 25. Temperature

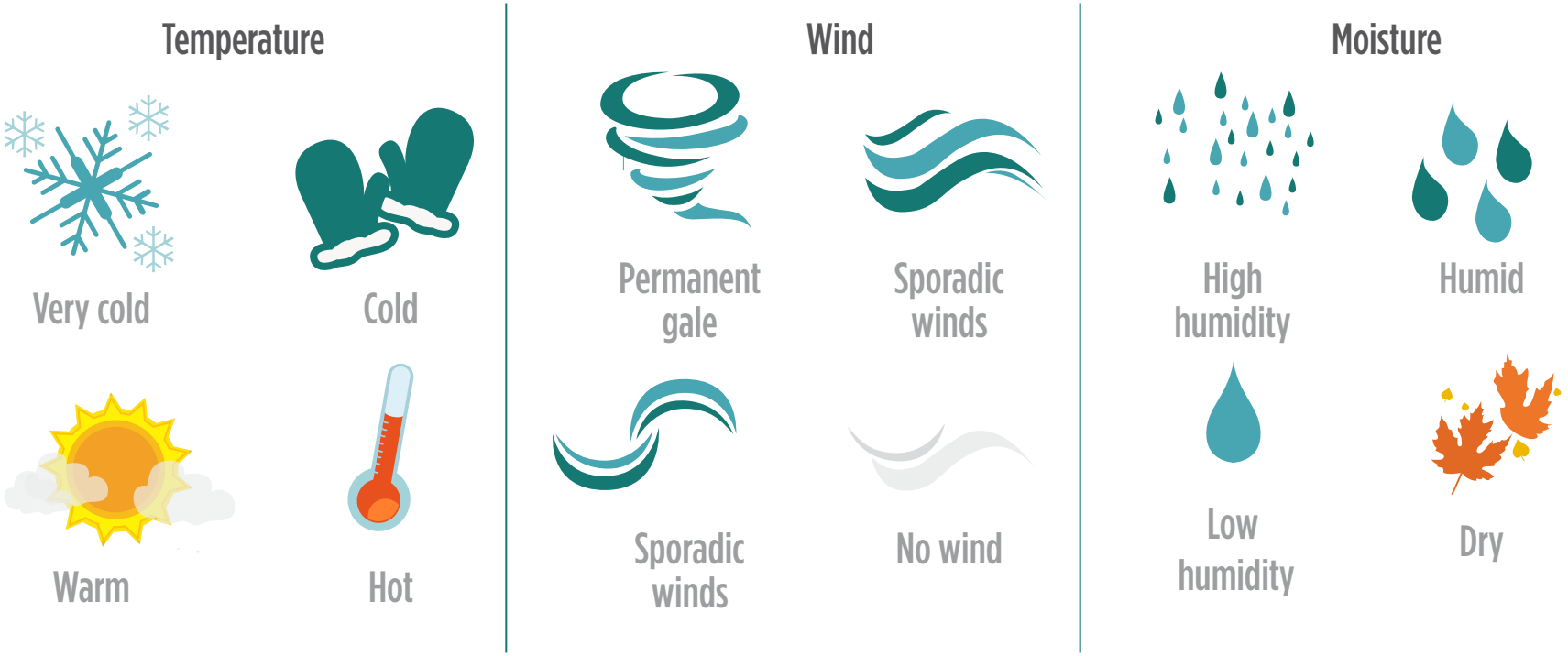
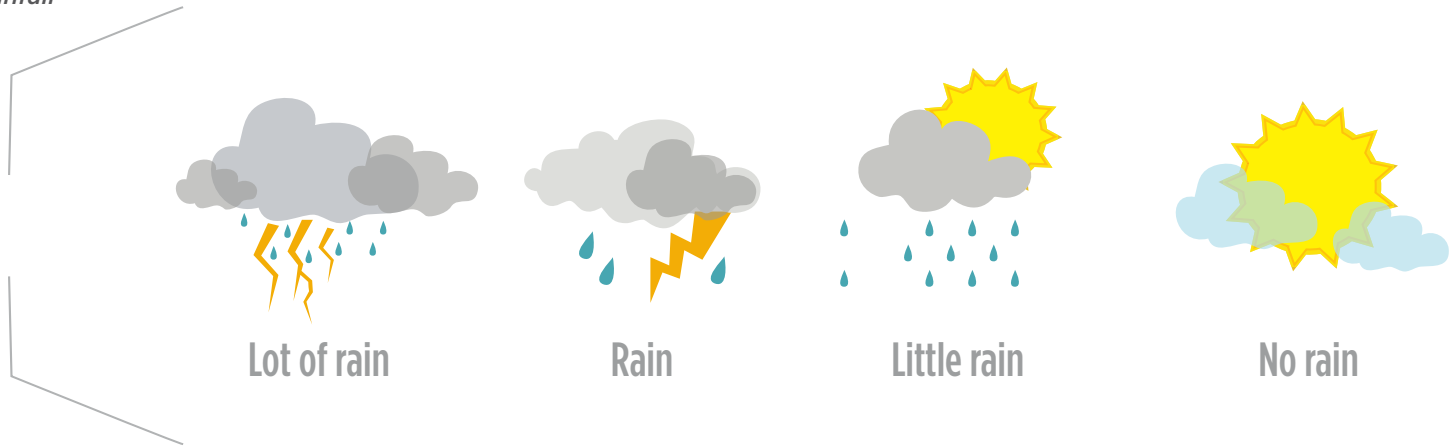


Figure 26. Rainfall



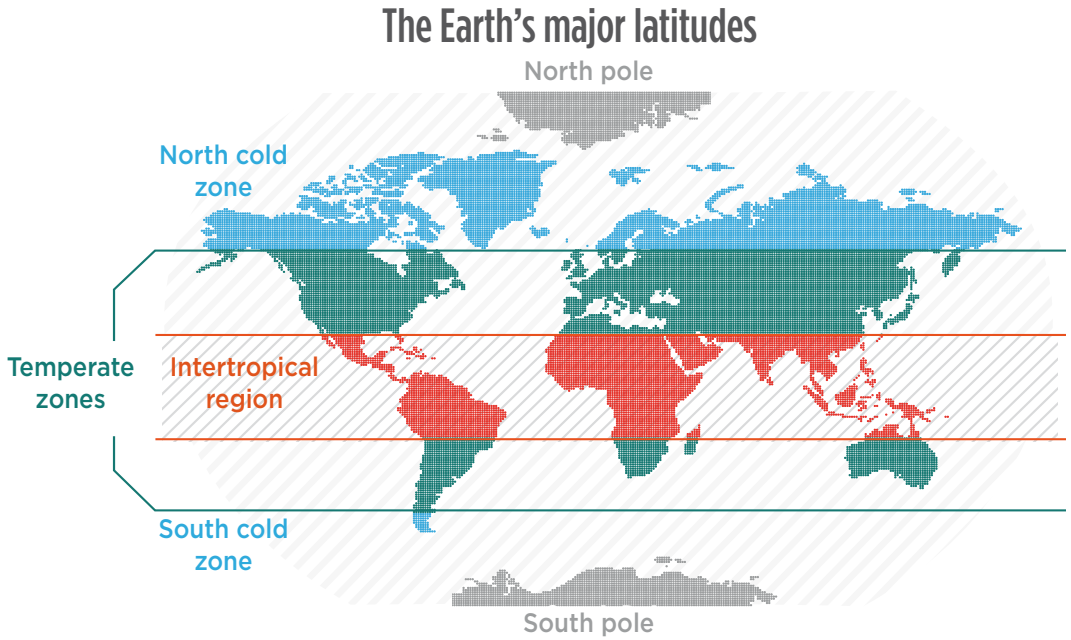


Figure 27. Major zones of Earth: poles, temperate zones, and the intertropical region

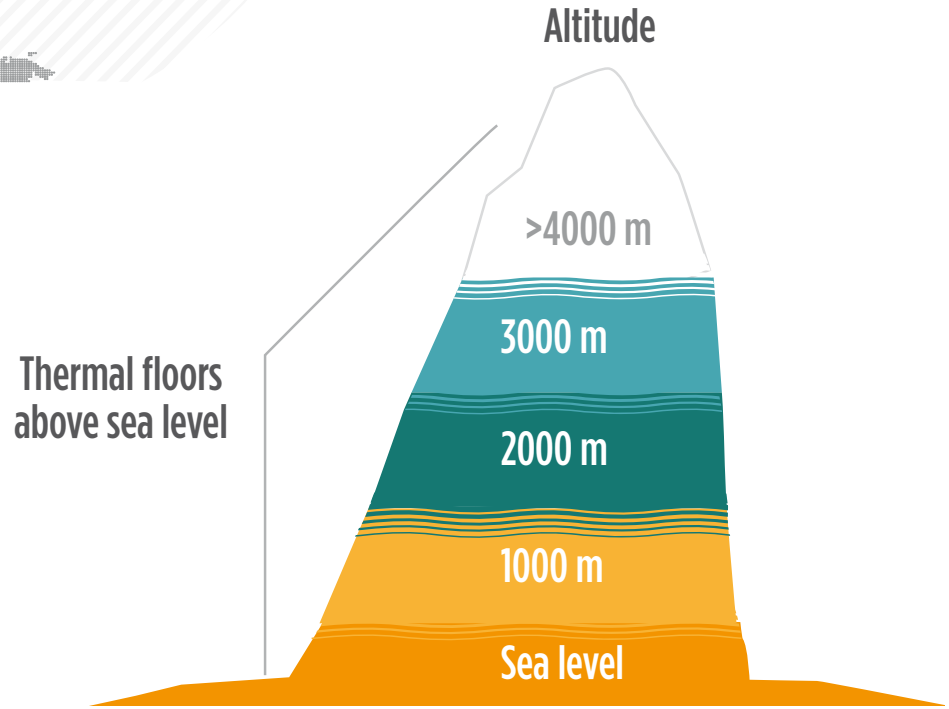


Figure 28. The thermal floors

» Assign one scenario to each group and ask them to answer the following question: Which photograph best represents the climate described? (See figures 29–36.)

Figure 29. Climate photograph 1
Picture by Alegri. www.4freephotos.com

Figure 30. Climate photograph 2
Picture by Alegri. www.4freephotos.com

Figure 31. Climate photograph 3
Picture by Alegri. www.4freephotos.com

Figure 32. Climate photograph 4
Picture by Alegri. www.4freephotos.com

Figure 33. Climate photograph 5
Picture by Alegri. www.4freephotos.com

Figure 34. Climate photograph 6
Picture by Alegri. www.4freephotos.com

Figure 36. Climate photograph 8
Picture by Alegri. www.4freephotos.com

Figure 35. Climate photograph 7
Picture by Alegri. www.4freephotos.com

» Discuss with the students how daily life would be affected by extreme weather changes. Ask the following questions:

- How would your eating habits change if the climate suddenly became cold or hot?
- What changes would you need to make at home if it rained more/less in the region?
- How would you dress differently if the climate became hotter or colder (figure 37)?

Figure 37. Dressing for a hotter or colder climate

- What changes would need to be made to the type of housing in the region? Show students the images in figure 38, or ask them to describe and draw a suitable house for the climate scenario they were given.

Figure 38. Different buildings for different climates

- Which animals could live in that climate? Which animals could not?
- How would the plants change in this new climate?

» After answering the questions, ask each group to present the picture of their climate to the class and to explain their answers.

» Ensure that students understand that climate determines the region's landscape, animals, and plants and affects our dress, food, and housing. It is a major reason for the differences we see in regions with different climates.

» Add that the climate is changing and we must take steps to adapt to the new conditions and ensure our welfare.

Formative assessment

Before proceeding to the next topic, teachers should be sure that:

» Students understand how climate influences culture: clothing, food, housing, and customs

» Students can correctly identify climate variables

» Students can describe the climate of a region

» Students can differentiate between weather and climate

» Students understand that the climate is changing in many regions

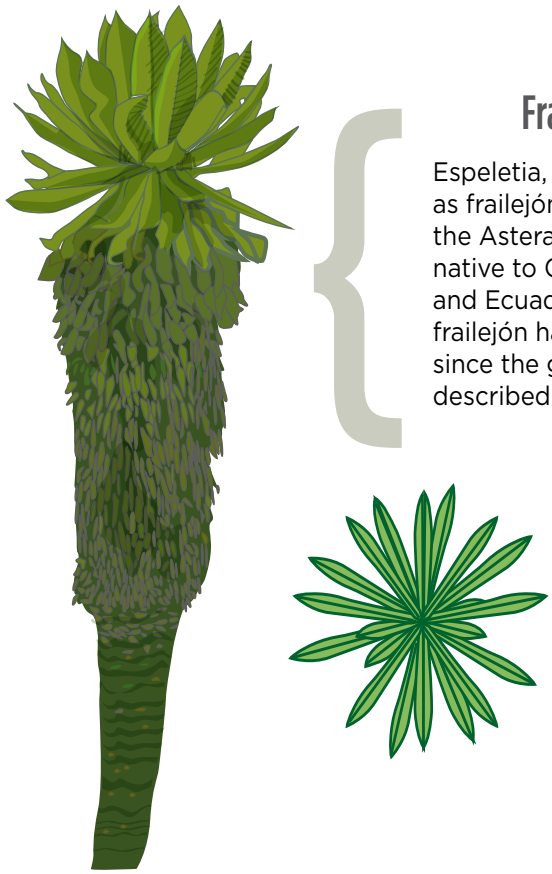
Integration with other subjects

Language: Ask students to write a story about the daily life of a child their age living in a different climate (for example, a very hot and dry region or a very cold, snowy region).

Geography: Using photographs of typical clothing from different countries, ask students to infer the countries' climates. Locate the countries on a map.

Science: Ask students which physical characteristics may help a plant protect itself from the cold (figure 39).

Figure 39. Frailejón



Frailejón

Espeletia, commonly known as frailejón, is a member of the Asteraceae family, which is native to Colombia, Venezuela, and Ecuador. 175 species of frailejón have been identified since the genus was formally described in 1808.

Remember

Climate greatly influences our culture and our lives. Climate change has a direct affects on us.

Tips for the teacher

Local news is a great source of information and reflection for students. For example, search for news on how temperature changes affect local living organisms, such as plants, corals, or bees, and comment on this.

2 Basic lesson plan 2: The atmosphere and climate regulation

General objectives

» Understand the composition of Earth.
» Use our senses to explore the atmosphere.
» Reflect on the interconnectivity of Earth's components.
» Learn where certain greenhouse gases (GHG) come from.

Class activity 1: Earth detectives

Objectives	Time	Place
» Identify the elements that make up Earth » Understand that water, soil, air, and living things are interconnected.	30 minutes	Outdoors

Preparation

Select a local park or green area close to the school. If there are no green areas nearby, the activity can be done on the school premises.

Step by step

» Take students to a nearby green area or park and talk to them about Earth's components: water, air, minerals, and living things. Explain that although these groups can be named separately, they are all interrelated. For example, plants and the soil have water, water and soil have unseen microorganisms, and living things are made up of water.

» Announce that today's mission is: "to find Earth's main components." Emphasize that these are components of the planet, not just the land or ground.
» Have students look around for "evidence" of the components.
» Ask them to work in pairs to find three pieces of evidence or objects that provide clues about Earth's components.
» Work with students to organize the elements into groups representing:
  • Living organisms: plants, fungi, and animals
  • Minerals: stones and soil
  • Water
» Ask the students if they believe that all the main components on Earth are represented in the items they collected. Discuss the crucial component that is missing—it allows us to breathe and is responsible for climate. We may not see it, but we can feel it. This element is the gas that makes up the atmosphere.

Class activity 2: Does the atmosphere really exist?

Objective
Discover that the atmosphere is real and there are many ways to experience it.

Step by step

» Talk to the students about the atmosphere. What is it? What do you know about it? Does it really exist?

» Explain that the purpose of today's class is to find evidence that the atmosphere is real and is everywhere, even at school.

» Divide students in groups to look for the following pieces of evidence:

- An object that can be moved by the wind (such as a seed, a feather, a leaf, a pinwheel, or a kite)
- An activity that lets them feel the air in the atmosphere (such as deep breathing, running fast, opening a window, or standing in the highest part of the school)
- A scent in the air (such as a perfume, the smell from cooking food, incense, or smoke)
- Sounds from a distant place

» Comment on their findings and discuss differences and similarities. Ask them which was easiest: seeing, hearing, smelling, or feeling the atmosphere? Have students record their findings in their notebooks using drawings and keywords.

» Use these observations to discuss the atmosphere with the students. Ask: "When is the atmosphere visible?" The air in the atmosphere can be seen in haze, smoke, clouds, and water vapor, as examples. How else can we prove the atmosphere exists?

Class activity 3: The search for gases that increase the greenhouse effect

Objective	Time	Place
Identify which human activities contribute to increasing GHGs.	2 hours	Classroom

Preparation

Have students bring in newspapers and magazines for cutting out images.

Step by step

» Ask the students to list some human activities, such as driving, farming, doing housework, etc.

» Ask: Do you think human activities can increase greenhouse gases?

» Explain that they will be conducting group research to discover whether various types of human activities produce greenhouse gases.

» Divide the class into four groups.

» Assign one of the topics below to each group and ask students to find relevant pictures in the newspapers and magazines they brought in.

- Group 1—Transportation: Cars, trucks, buses, bicycles, and people walking
- Group 2—Energy Production: Coal-powered machines, factory smoke emissions, heating or air conditioning units, and solar panels
- Group 3—Farming: Cows and livestock, burning forests, organic farming, composting, and protected forests
- Group 4—Decomposition of Garbage: Burning garbage, landfills, open dumps, waste separation, and recycling

» Each group should make a poster for their topic with two columns: (i) activities that increase greenhouse gases and

(ii) activities that don't increase greenhouse gases, and paste each picture into the appropriate column.

» At the end, each group will present its poster.

» Explain the types of emissions and where they come from, including:

When we burn fossil fuels to heat our houses and drive cars, buses, and trucks, carbon dioxide (CO_2), a major greenhouse gas is emitted. Livestock farming, agricultural processes, and the decomposition of waste produce methane gas (CH_4). The production and use of fertilizers in agricultural and industrial activities produce nitrous oxide (N_2O). Methane and nitrous oxide gases also increase the greenhouse effect, although to a lesser extent than carbon dioxide.

» Discuss human activities that do not produce greenhouse gases, such as alternate modes of transportation (such as riding bicycles and walking, both of which also promote a healthy lifestyle). Discuss good farming and waste management practices, such as separating garbage and not burning it, avoiding fertilizers, reducing livestock production, and protecting forests.

Tips for the teacher

Ask students to observe the atmosphere at different times of the day and note the cloud cover, movement, color, and density.

Formative assessment

Before proceeding to the next topic, make sure students can:

» Identify Earth's components and understand their importance and some of their interrelationships

» Identify human activities that increase greenhouse gases.

Remember

The atmosphere is an air system that surrounds our planet. It traps some of the sun's energy, which heats Earth, while the rest is reflected back into outer space. As greenhouse gases have increased, more heat from the sun is being "trapped" on Earth. As a result, our planet's temperature is rising.

Integration with other subjects

Language: Write two sentences about the differences between the concepts of *Earth* and *land*. *Earth* refers to the planet and *land* to the ground.

Citizenship: Conduct a survey asking five people the following question: "In your opinion, why is the atmosphere important?"

Suggested reading and viewing

» Brain POP. Videos about the atmosphere, the earth, and the causes and consequences of global warming. www.brainpop.com

Lesson Plans at the Intermediate Level

1 Intermediate lesson plan 1: Variable climate

General objectives

- Reflect on the climate and variations in it.
- Understand how humans influence the climate.
- Analyze how changes in land use and the landscape affect Earth's temperature.
- Analyze temperature as a climate variable and how it is affected by human activities.

Class activity 1: The seasons

Objective	Time	Place
Understand that seasons are caused by Earth's tilt and its orbit around the sun.	1 hour	Classroom

Materials

- World map
- Signs with the names of the four seasons: spring, summer, autumn, and winter
- Rope to depict Earth's orbit around the sun
- Stool or chair without back support
- Flashlight

Preparation

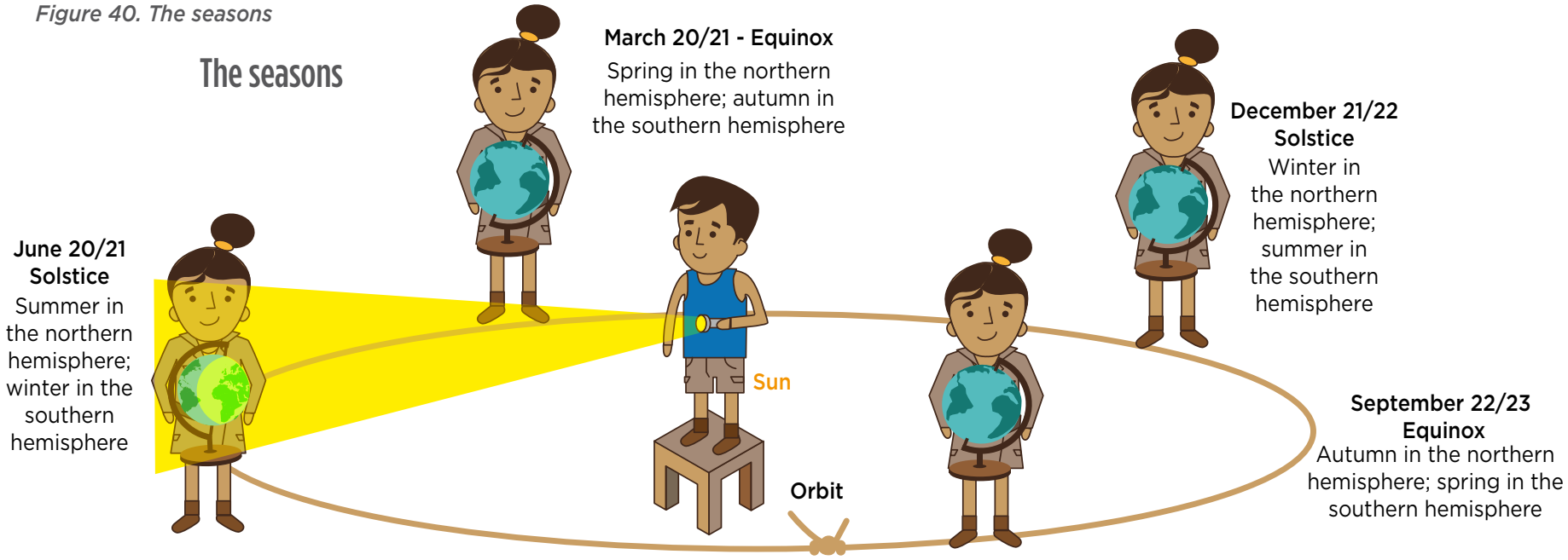
If you don't have a world map, you can paste or draw the continents on a ball or balloon.

Use a large rope to create an elliptical orbit in the classroom and put a chair in the center to represent the sun, as shown in figure 40.

Step by step

- Ask students what they know about the seasons:
  - Do all countries have seasons?
  - In countries with seasons, how many are there during the year? What are they?
  - In regions that don't have seasons, how do the climate and the weather change?
  - What causes the change of seasons?
- Remember that the countries in the intertropical zone do not have marked seasons (spring, summer, autumn, and winter); they have dry periods and rainy periods. The seasons are caused by the tilt of *Earth's axis* and its movement around the sun.
- Point to the equator on the map and show that Earth is divided into two hemispheres: the northern and southern hemispheres. Locate your country and ask the students which hemisphere is it in?
- Explain that Earth moves in two ways: rotation on its axis, which causes day and night, and translation, which refers to its approximately 365-day orbit around the sun.

Figure 40. The seasons



» Ask a student to represent the sun by sitting on a chair in the middle of the "orbit" (the circle made by the rope) and turning on the flashlight.

» Turn off the classroom lights. Show students how day and night occur as Earth rotates counter-clockwise on its axis.

» Walk counter clockwise along the elliptical orbit, showing the path Earth takes during the course of the year.

» Using the image for reference, stand at the position of the summer solstice on the orbit. Show how Earth tilts toward the sun and is lit by the flashlight. Show how some parts of Earth receive more sunlight than others because Earth's axis is not vertical—it tilts toward the sun. Thus, the northern hemisphere receives more direct sunlight than the southern hemisphere.

» Keeping the tilt of Earth intact, walk counter-clockwise along the orbit to the position of the autumnal equinox, as shown in the image. Ask: What season follows summer? (It is autumn in the northern hemisphere and spring in the southern hemisphere). Explain that during this season, temperatures begin to drop in the northern hemisphere and rise in the southern hemisphere.

» Continue along the orbit, maintaining Earth's tilt. Stop at the winter solstice and spring equinox to explain those seasons. Use the image for reference.

» Once the four seasons and translational movement have been explained, turn the lights back on and ask the students to make cards for each of the four seasons.

» If your country does not have seasons, choose a country that does. Stand in Earth's orbit and ask the students to raise the card of the season corresponding to your position. Walk along the orbit and ask the students to show the card for each season as you pass through it.

Class activity 2: Can humans alter the climate?

Objective
Understand the influence of human activity on the climate.

Step by step

» Ask the students if they think that humans can alter the climate.

» Ask students to line up according to their answers, with the students that strongly believe that people can change the climate at one end and those who strongly disbelieve that we can change the climate at the other. Students who are undecided stand in the middle.

» Ask each group to defend their position.

» Conduct a class debate on humans' influence on the climate. Talk about the changes we have seen in recent years and what their parents and grandparents have said about the changes they've experienced.

» Review chapter 1 in the Green School Kit. How do we know Earth's climate has changed? Contrast the students' comments with what scientists have reported.

» Finish by asking students to line up again according to their answers to the question "Can Humans Alter Climate?" Note differences in the students' positions compared to the beginning of the activity. Explain that humans alter the planet's climate by using and changing the land and by producing greenhouse gases that cause global warming.

Class activity 3: Experiment about influencing temperature

Objective	Time	Place
Analyze how changes in land use and the landscape affect the planet's temperature.	30 minutes for preparation, 30 minutes for follow-up, and 2–3 hours between experiment set-up and data collection.	Classroom and home

Materials

» Alcohol or mercury thermometer (0–100 ºC)

» A satellite image (see supporting materials)

» For each group of four students:

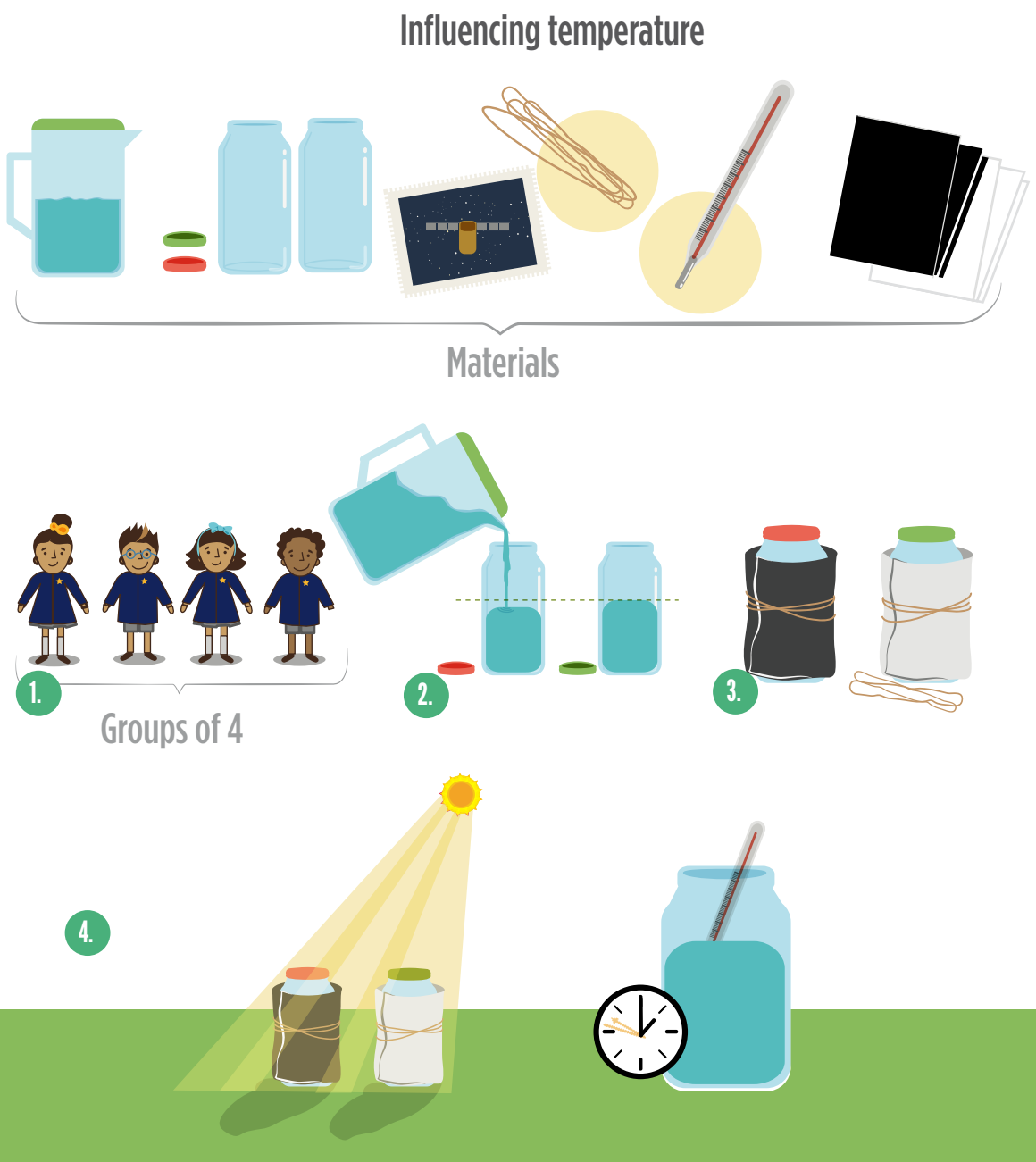
- Container of water
- 2 glass jars with lids
- Rubber bands
- Bond paper
- Dark-colored paper

Step by step

» Talk to the students about changes in the landscape. Ask them to give examples. Ask them to think about changes in land use and to give examples of this. Finally, ask students if they believe that the changes can cause temperature variations.

» Ask students to conduct an experiment in groups of four (figure 41).

Figure 41. Materials to be used to investigate recent climate changes in the region



» Ask students to fill each glass jar with the same amount of water.

» Have them cover one jar with bond paper and another with dark-colored paper, using rubber bands to secure the paper onto each jar.

» Ask them to expose the jars to the sun's rays for a couple of hours and then measure the temperature of the water in each.

» Ask them to write down the data in their notebooks and return the jars to the classroom.

» Ask the following questions:

- Was there a difference in the water temperature in each jar? What could explain this difference?
- Do you believe that the color of the paper covering each jar affected the water temperature?

» Explain that the water in the jar with the dark paper is hotter because dark surfaces absorb more light and heat than do lighter surfaces. Ask: Do you feel warmer when you wear light or dark clothing?

» Display a satellite image of Earth and identify its surfaces. Discuss the colors of these surfaces: forests, seas, glaciers, land without vegetation, and the poles, among others.

» Ask:

- Which surfaces do you think absorb more light and heat?
- What would happen if the poles melted and bare ground replaced their white ice?

Class activity 4: Asking about changes in climate

Objective	Time	Place
Investigate recent climate changes in the region	30 minutes for preparation plus 30 minutes for discussion	Home and classroom

Preparation

Print a copy of the table below for each student.

Step by step

- Ask students to administer a questionnaire to at least three people of different ages (for example, 20, 40, and 70), and then fill out the following table.
- How would you describe the current climate of your region?
- What was the climate like 15 years ago? 50 years ago?
- Have you noticed any changes in temperature, rainfall, winds, or humidity in recent years?
- Do you remember any event or disaster caused by climate in the region in recent years?
- Ask students to analyze and reflect on potential future climate changes, considering the changes that have already occurred. Have students to share their experiences with each other in an informal classroom discussion.

Form for student questionnaire about changes in the climate

	Now	15 years ago	50 years ago
What is the climate of the region like?	Sample response: "There are seasons with a lot of heat and rain throughout the year."	Sample response: "It used to rain heavily in April; it was windiest in August and hottest in June."	Sample response: "We had a very cold climate; most people had to wear coats and hats."
What natural events or climate-related disasters occurred in the region?	Sample response: "At the beginning of the year there were many floods."	Sample response: "La Niña brought a drought and food shortages."	Sample response: "Frost destroyed all the crops."

Formative assessment

Before proceeding to the next topic, make sure students:

» Recognize and can explain climate variability

» Can explain the seasons and their origin

» Understand that human activities cause climate change

Integration with other subjects

Mathematics: Analyze the graphs in the Green School Kit with students.

Civics: Record a community radio report explaining how humans influence the climate and what people can do to reduce negative impacts.

Tips for the teacher

Climate is an exciting topic for class projects. For example, investigate and install a weather station with the students (as shown in figure 42). Set up an outdoor thermometer and a container to collect rainwater at school. Measure the temperature and rainfall throughout the year.

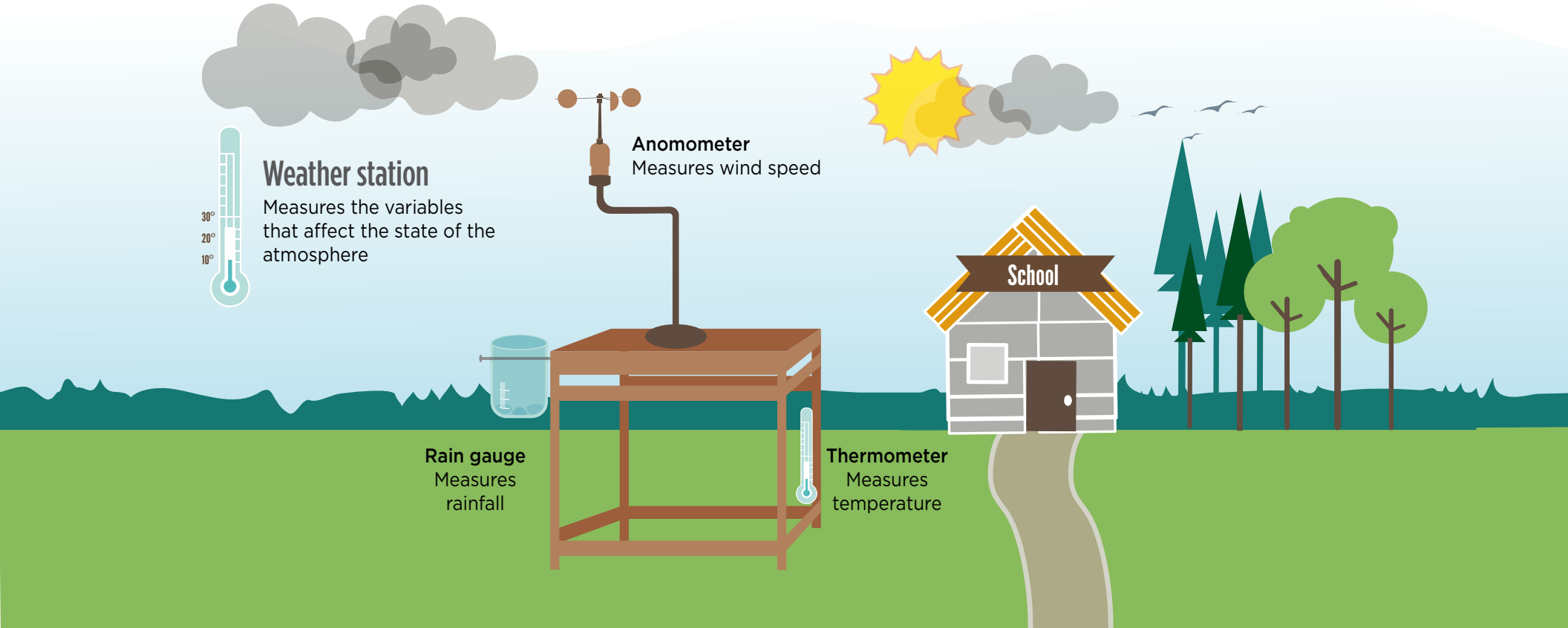
Remember

Our planet is always changing; humans can affect these changes positively or negatively.

Suggested reading and viewing

» "Assessment of the impacts of climate change and Latin America's vulnerability and potential for adaptation." A report from the Intergovernmental Panel on Climate Change. www.ipcc.ch.

Figure 42. Building a school weather station



Intermediate lesson plan 2: The greenhouse effect—What is it and how does it work?

General objectives

- Understand the greenhouse effect.
- Understand the role of greenhouse gases and their relationship to climate change.

Class activity 1: Experiment: Is water vapor a greenhouse gas?

Objective	Time	Place
Identify GHGs and their effect on the temperature.	30 minutes	Classroom

Materials

- 2 transparent heat-resistant containers
- Hot water
- 2 alcohol or mercury thermometers (scale from 0 to 100°C)
- 1 lid
- Temperature recording chart

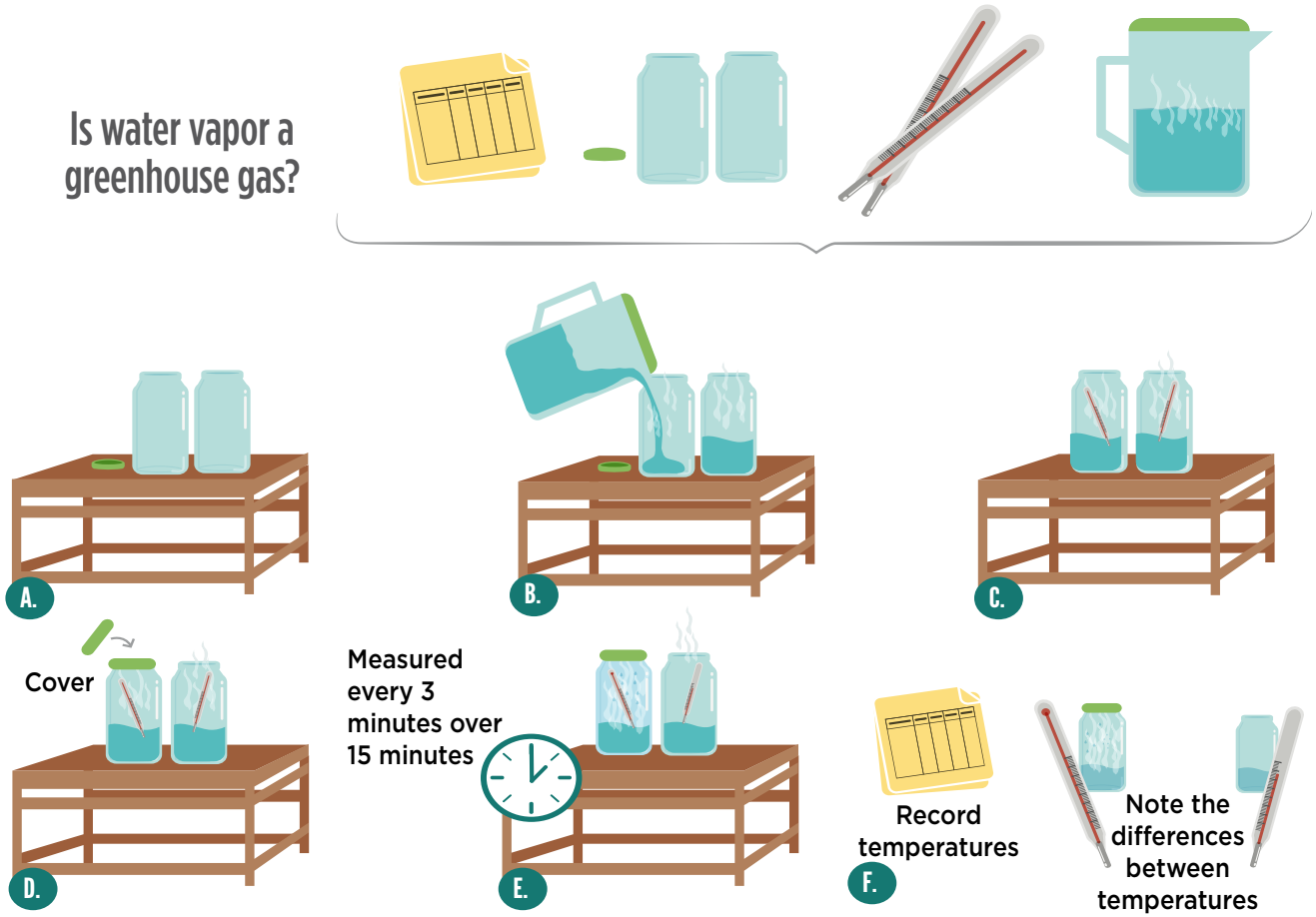
Preparation

- Print a temperature record chart for each student.
- Arrange the classroom for the experiment.
- Heat the water.

Step by step (figure 43)

- Discuss GHGs with students. What are they? What do they do? What happens when we burn fuels that increase GHGs?
- Place two heat-resistant jars on a table or desk.
- Add the same amount of hot water to each jar.
- Insert a thermometer into each jar.
- Cover one jar with a lid. Leave the other jar uncovered.
- Measure the temperature every three minutes for 15 minutes and ask students to complete the temperature record chart. They should have five entries per jar.
- Note any differences in temperature between the two jars.

Figure 43. Is water vapor a greenhouse gas?



» Ask students to answer the following questions:
  - What is the highest temperature?
  - What is the lowest temperature?
  - Which container has higher temperatures?
  - What differences were found between the two containers?
  - What was the temperature in each container?
  - What happened to the water vapor in each container?

» Explain that the water vapor stayed in the jar with the lid, "trapping" heat and keeping the water hotter than in the uncovered jar. This is what greenhouse gases do in the atmosphere. They retain heat, causing Earth's temperature to rise.

Temperature record chart

Temperature in °C	T1	T2	T3	T4	T5
Covered container					
Uncovered container					

Class activity 2: Building a greenhouse

Objective	Time	Place
Understand the greenhouse effect	Two and a half hours	Classroom

Materials (for each group) (figure 44)

» Adhesive tape
» Recyclable cardboard boxes
» Scissors
» Two transparent plastic bags
» Soil
» Water
» Thermometer for measuring air temperature

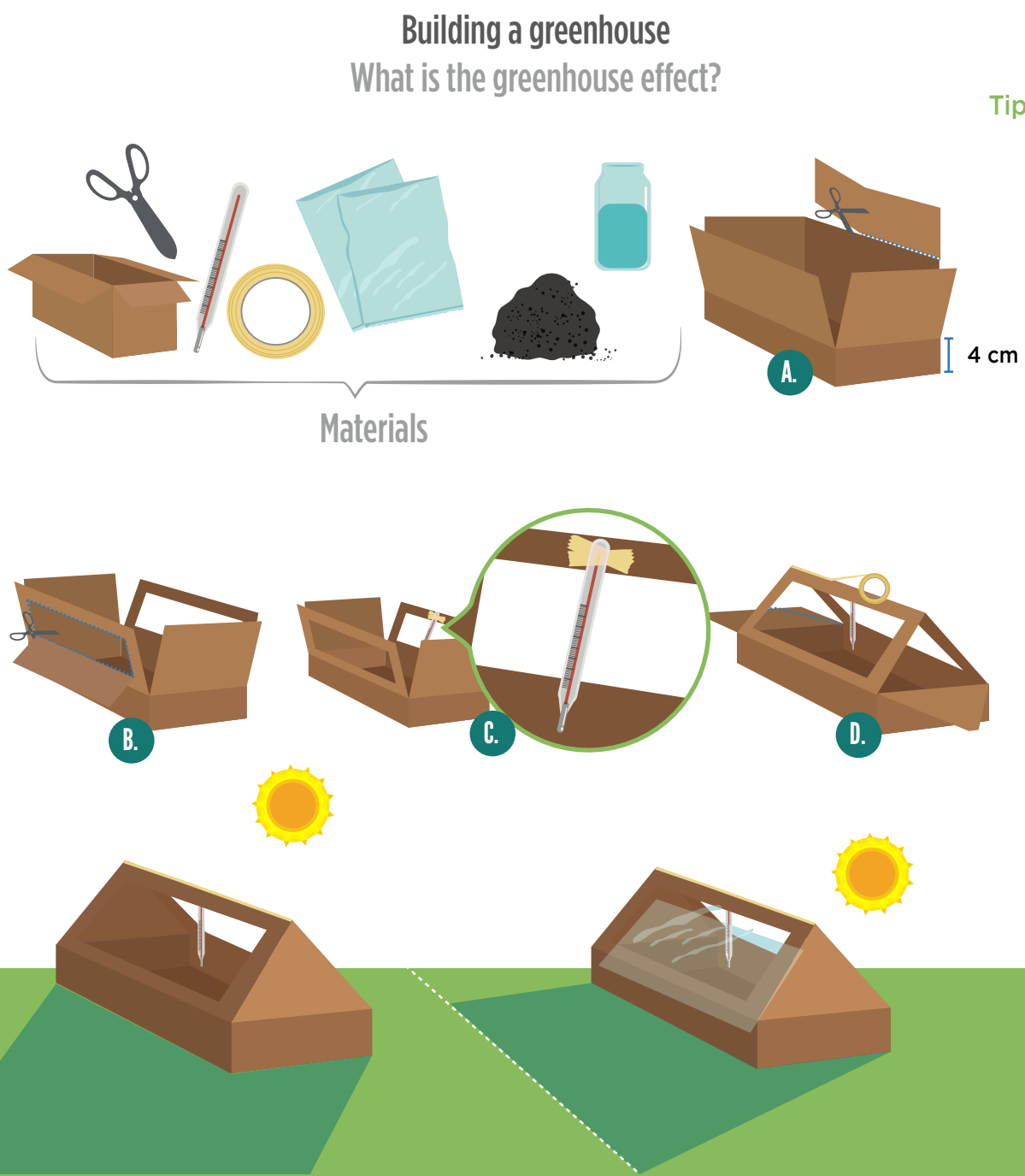
Preparation

Watch the video entitled "What's the Greenhouse Effect Really About?" found at at www.iadb.org/riseup

Step by step

» Ask: Do you know what a greenhouse is?
» Ask the students to describe one.
» Show the students a picture of a greenhouse.
» Describe how greenhouses trap heat from the sun, which makes plants grow faster and more uniformly and protects them from the effects of drastic weather changes. Emphasize the temperature differences inside and outside the greenhouse.
» Ask: How does the greenhouse keep in heat?
» Have students make their own greenhouses in pairs or groups, as follows:
  • Cut the top flaps off the box. Cut most of the way down the corners, but leave approximately four cm (1.6 in.) of each corner uncut for stability.
  • Cut out large rectangle from the two largest sides, leaving a 2 cm (0.79 in.) "Frame," as shown.
  • Tape a thermometer on one frame so you can see its reading.
  • Tape the two framed sides together to make the greenhouse's "roof" and cut the smaller sides to fit the new shape.
» Ask students to place their uncovered greenhouses in the sunlight and take a temperature reading in 30 minutes.
» Explain to the students that the cuts in the sides of the rectangles allow heat to freely enter and leave the box. This is the reason that the temperature does not change.
» Now ask students to affix the transparent bags over the rectangular openings in your "roof" before placing the greenhouse back under the sun. Wait 30 minutes and take another temperature reading.
» Reflect on the temperature difference.
» Ask students the following questions:
  • How is what is happening on planet Earth similar to what happened with the greenhouses you built?
  • How did the temperature of the greenhouse change when it was covered with plastic bags?

Figure 44. Building a greenhouse



Tips for the teacher

» Try repeating the exercise with the following variations and discuss similarities with human activities.
- Place stones, water, or an empty tin can inside the greenhouse.
- Paint the sides of the greenhouse with different colors.
- Place a plant inside.
- Place a second plastic sheet on the windows.

» Show students the video on the greenhouse effect and climate change.

» Discuss:
- What was the main message of the video?
- How do greenhouse gases affect the health of the planet?
- What actions (represented by the thick coverings) can affect the health of the planet?

Class activity 3: Playing with the greenhouse effect

Objectives	Time	Place
» Understand the role of greenhouse gases and their relationship to climate change. » Identify some greenhouse gases and their origins.	30 minutes	Outdoors

Materials

» A hoop

Preparation

Find a large open area in the schoolyard

Step by step

» Divide students into two groups: A and B (figure 45). Group A will represent Earth's atmosphere by forming a circle. Group B will be divided into two groups: B1: solar energy (heat and light) and B2: greenhouse gases (methane, carbon dioxide, and water vapor).

» Place a hoop in the center of the circle (Group A). The hoop represents plants.

» Explain that group B1 (solar energy) students will travel through the atmosphere to the plants, carrying out photosynthesis. The Group B1 students will enter the circle one at a time, touch the hoop, and then exit the circle in pairs. They will repeat this pattern for three minutes. Tell the students to count how many times they touch the hoop as they do the exercise. Ask the students to keep track of how many times they touch the hoop and record their answers.

» Repeat step 4, but this time pause every 30 seconds and announce one of the following scenarios (add a new scenario every 30 seconds):

- Increase in the number of cars. All the students representing CO2 molecules (Group B2) should enter the atmosphere by joining the circle.
- Cities grow and people throw away more trash, filling the landfills. Students representing methane molecules (Group B2) should enter the atmosphere by joining the circle.
- Forests shrink and rivers and streams evaporate faster. Students representing water vapor molecules (Group B2) should enter the atmosphere by joining the circle.

» Students should now have a hard time getting past each other in the circle.

» Ask students inside the circle to try to leave it in pairs after touching the hoop, as they did in the first round.

» After three minutes, ask how many times they touched the hoop. Compare their responses with those of the first round.

» Discuss: The students in Group B1 had a hard time leaving the atmosphere when it was full of greenhouse gases. Why? Because while they had no problem entering the atmosphere, so many GHGs got in their way and kept them from leaving after they reflected off Earth's surface.

» Ask: If the gases left the same way they entered (individually instead of in pairs), would there be a greenhouse effect? Note that the greenhouse effect also occurs because solar energy changes frequency as it reflects off Earth.

Formative assessment

Before proceeding to the next topic, make sure students can:

» Explain the greenhouse effect in their own words.

» Name greenhouse gases and their origins.

Integration with other subjects

Mathematics: Using their greenhouse temperature data, ask students to graph temperatures over certain period of time.

Civics: Have students to identify sources of greenhouse gases in their town and design a campaign to reduce emissions

Remember

» Some human activities produce greenhouse gases such as CO2, water vapor or methane, which are released into the atmosphere "trap" heat, raising Earth's temperature.

» Even a small increase in Earth's temperature has big effects and changes the climate worldwide.

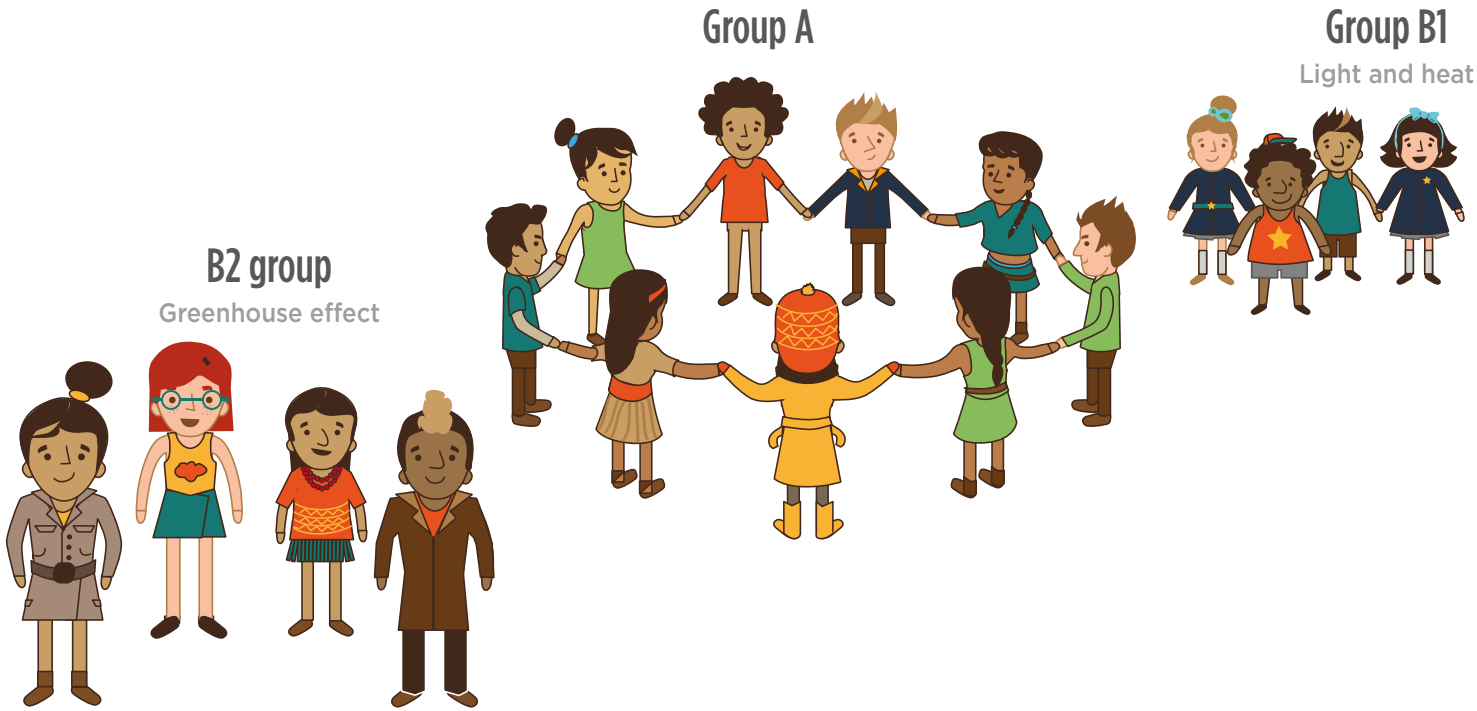
Tips for the teacher

Real-life scenarios empower students to find ways to reverse climate change. The World Wildlife Federation (WWF), wwf.panda.org, "Witnesses of Climate Change" program is one good resource for this. You and the students can also build off these scenarios to create your own stories.

Suggested reading and viewing

» *Tunza,* magazine. *Tunza* is a children's magazine from the United Nations Environment Program. Volume 5, number 1, is entitled "Melt Down." It contains articles and data on the effects of climate change on the melting poles. www.unep.org.

Figure 45. Forming groups to play with the greenhouse effect



Lesson Plans at the Advanced Level

1

Advanced lesson plan 1
Climate change and global environmental change

General objective

» Understand how climate change alters the behaviors and lives of living things.

Class activity 1: Differences in the distribution of sunlight

Objective	Time	Place
Understand why the sun warms various living things on the planet in different ways.	45 minutes	Classroom

Materials

» World map
» Map of your country or region, a globe, or spherical object
» Electric lamp or flashlight
» Projector for or copies of the maps

Preparation

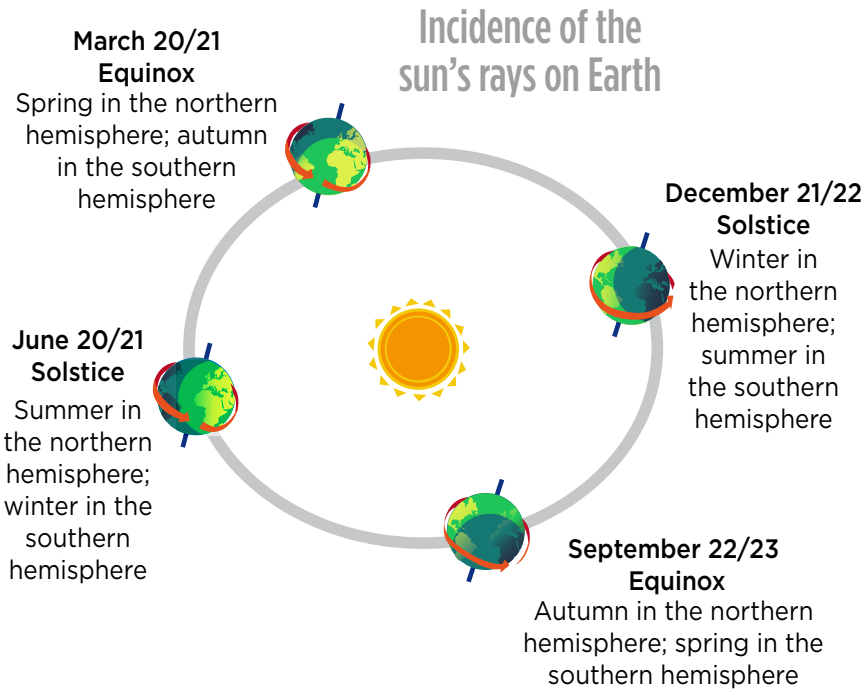
» Review background materials here and below.
» Practice the experiment ahead of time by yourself to find the best lamp or flashlight to use.
» Make sure there is an electrical outlet available for the lamp.
» Appoint a student or colleague to assist you in organizing the experiment.

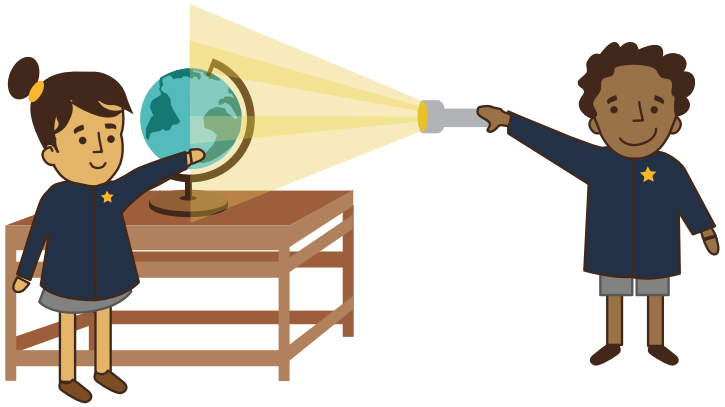
Step by step

» Bring in or project a world map. If possible, also show a map of your country or region. (Check the school library.) Ask students to point to their town on the map. They will begin to study Earth's climate from that location.
» Ask: Is the sun's heat distributed equally across the planet? Why or why not?
» Have students use their answers to formulate a hypothesis about the distribution of solar energy on the planet.
» Start by asking the group to describe the shape of the planet and use a globe, ball, or other spherical object to illustrate their description.
» Show how Earth's shape makes solar power distribution unequal across the planet. More heat reaches the tropics than the poles. Make sure that students know the geographical location of the poles and the countries in the tropical zones.
» Shine a lamp or flashlight on any spherical object. Keep the light in a fixed position relative to the sphere and ask students to touch the sphere and feel the temperature differences between the middle of the sphere and its top and bottom.
» Have students discuss the similarities of the sun's effect on different geographical areas.
» Describe the tilt of Earth's axis and the orbit it follows on its journey around the sun (figure 46). Explain how the Earth's

tilt affects the amount of solar energy every part of Earth receives as it travels along its orbit, which causes seasonal climate changes. Each hemisphere receives less sunlight during the winter and more during the summer. Use the image in figure 46 to explain this:

Figure 46. Incidence of the sun's rays on Earth





Class activity 2: Reflecting on the seasons

Objective	Time	Place
Understand the characteristics of Earth's seasons.	30 minutes	Classroom

Materials

- 4 pieces of cardboard
- 8 markers of various colors
- Tape

Preparation

- Locate a room where you can show students a video.
- Watch the video entitled "What's the Difference between a Meteorologist and a Climatologist?" found at www.iadb.org/riseup.
- Set up a table and chairs in every corner of the classroom for student group meetings. Each table should have one piece of cardboard and two different colored markers.
- Ask students to research the characteristics of the four seasons north and south of the equator, emphasizing changes to living things, temperature, and rainfall.
- Prepare posters on the seasons of your region.

Step by step

- Hang one poster for each season in your region in corners of the classroom. For tropical climates, hang summer and winter posters showing rainy and dry periods.
- Ask: Who prefers summer/the dry season (for countries without clearly defined seasons). Ask those students to move to the table by that poster. Repeat this question for the other three seasons (or for the rainy season in

countries without marked seasons), until each student has joined a group. Redistribute the students more evenly if one of the seasons has many more of the students.

» Ask students to discuss the following questions in their groups and prepare to present their conclusions to the class.
  - What is the average temperature in their season? The average precipitation (including rain, drizzle, snow, sleet, and hail)?
  - What does the landscape look like (trees, fields, rivers, ocean, sky)?
  - What ecosystems characterize the region?
  - Is there any variation in the fauna and flora during this season? Are there any animals that appear or disappear during this time of the year? Does any fruit ripen?
  - Do you believe the seasons are important in the lives of human beings?
  - How does this season affect your daily life?
  - Imagine that a given season or the dry or rainy period does not last as long as expected. What would be the effects or impacts on the planet's life forms?
  - Would it disrupt transportation systems or would they still function normally?
  - Would food harvests be affected?
» After 10 minutes, ask each group to select a person to present their conclusions to the class. Groups can draw or write on the cardboard to illustrate key points.
» Allow each group about five minutes for their presentation.
» Allow students to ask questions and offer comments after each presentation.
» Share the climate video with your students.
» Ask: What happens in countries far away from (or close to) the equators, where the seasons are more (or not as) noticeable? Let students express their opinions about life in those countries and seasonal changes in the weather and in daily life.

Class activity 3: Understanding La Niña and El Niño

Objective	Time	Place
Understand the La Niña and El Niño phenomena and analyze their impact on life in Latin America and the Caribbean.	1 hour	Home and classroom

Preparation

» Review "The El Niño and La Niña Phenomena: Climate variability or climate change?"
» Watch the video on the El Niño and La Niña phenomena found at www.iadb.org/riseup and allow students to ask questions.
» Research the social, political, cultural, environmental, and economic effects of these phenomena.

Step by step

» For homework, ask your students to write an essay on the effects of El Niño and La Niña on daily life in Latin America and what humans can do to minimize them.
» Collect the essays for grading and then randomly ask the following questions during class:
  - What are the effects of these phenomena in Latin America? Which countries are most affected? Which are least affected?
  - What do these phenomena mean for the fishing industry?
  - What do they mean for infrastructure?
  - What do they mean for agriculture?
  - What do they mean for the daily life of citizens?
  - What are the social, environmental, economic, cultural, and political effects?

- Do you believe these phenomena are part of climate variability or climate change?
- How can we cope with the effects of El Niño and La Niña? Is it possible to avoid disasters?

Class activity 4: Climate change and global environmental change

Objective	Time	Place
Understand the impact of climate change and global environmental change on living things.	3 hours	Classroom with a projector and a computer

Materials

» Computer with Internet access or a video beam projector

» Video: "Can the planet suffer from indigestion?" found at www.iadb.org/riseup

Preparation

» Read "Climate Change and Global Change" in the introduction to this set of lesson plans.

» Watch the video, "Can the planet suffer from indigestion?"

Step by step

» Ask: Do you believe that climate change is affecting life on Earth? How? (Make sure students go beyond environmental changes and address secondary effects on humans, health, food, security, and so on).

» Ask and discuss: Have your parents or grandparents ever said that the seasons are different now, compared to they way they used to be? Or that the landscape has changed? Or that bodies of water that used to exist in your area no longer do?

» Have students form a hypothesis to explain the changes based on comments about the current state of the ecosystem.

» Discuss the greenhouse effect, the increase in greenhouse gases, and their effects on life. Show the video, "Can the planet suffer from indigestion?"

» Divide the class into 10 groups and ask each group to research one of the topics below prior to the next class. Students should prepare a 10-minute presentation using PowerPoint, photos, drawings, a collage, or a story or narrative that can be acted out.

» Presentation topics:

- Influence of burning fossil fuels on climate change.
- Influence of livestock on climate change.
- Influence of mining on climate change.
- Influence of solid waste management on climate change.
- Effects of climate change on rivers and seas.
- Effects of climate change on wildlife.
- Effects of climate change on flora.
- Effects of climate change on humans.
- Impact of clean energy on climate change.
- How can humans adapt to climate change?

» During the next class, have the groups give their presentation according to the order of the list above.

» After each presentation, allow five minutes for students to ask questions or to make comments.

» Each group should designate a representative for a committee to summarize the basic findings and share the students' overall conclusions with the school community..

» Ask students to create posters demonstrating things human beings can do to reduce their impact on the planet. Hang the posters on prominent bulletin boards in the school.

Formative assessment

Before moving on to the next topic, it is important that students understand the following concepts:

» The atmosphere is an air system that surrounds our planet and absorbs some of the sun's heat, which warms Earth. This is called the greenhouse effect.

» Due to Earth's shape and tilt, the sun's rays are unevenly distributed on the planet.

» The greenhouse effect has increased. Today, greenhouse gases are trapping more of the sun's heat, causing global warming.

» Many human activities influence climate change because they produce greenhouse gas emissions, including cutting down forests and mismanagement of solid waste, among many others.

» Climate change affects all life forms on the planet.

» Thermal expansion refers to the increase in volume that occurs when ice melts. When applied to ice at the poles, melting will cause sea levels to rise and will lead to flooding.

Integration with other subjects

Social Studies: Research social problems in Latin America and the Caribbean that affect climate change.

Science: Research community food adaptations as a result of climate change.

Physics: Use the Thermal Expansion Experiment to calculate the thermal expansion coefficient for solids or metals, or to calculate volumes.

Math: Calculate solar radiation emissions, the distance between Earth and the sun, the sun's altitude, the length of one day, and so on.

Remember

» The atmosphere is an air system that surrounds our planet and absorbs some of the sun's heat, which warms Earth. The atmosphere contains greenhouse gases such as water vapor (H_2O), methane (CH_4) and carbon dioxide (CO_2). These gases trap the sun's heat and keep Earth's temperature at about 15°C, a temperature ideal for life.

» Greenhouse gases, particularly CO_2, come from burning fossil fuels such as gas, oil, and coal; pesticides and fertilizers; decomposing trash; and animal digestion (in the form of methane).

» Some of the effects of climate change include:

- Higher temperatures
- Extreme temperatures and increased climate variability
- Droughts and floods
- Melting poles and snowy peaks
- Increased ocean acidity— oceans absorb large amounts of CO_2 from the atmosphere.
- Warmer oceans
- Increased ocean water levels

Suggested reading and viewing

» Climate change starter's guide for education planners and practitioners from UNESCO and the United Nations Environment Program (2011). Search for "starter's guide" at www.unep.org.

» The student's guide to global climate change from the U.S. Environmental Protection Agency explains in a simple way the effects of climate change and its impact on ecosystems, animals, and plants. www.epa.gov.

2 Advanced lesson plan 2: Climate change affects us!

General objectives

- Understand that climate change affects communities.
- Identify actions to reduce climate change and its impacts.
- Consider adaptations to climate change

Class activity 1: How do we adapt?

Objective	Time	Place
Understand that we must adapt to climate change to protect our communities and that we can do things to reduce climate change and its impact.	5 hours	Classroom/room with a projector, computer, and Internet access

Materials

- Newspaper article on Isaac Held from El Tiempo
- Cardboard and corrugated board
- Sticks
- Tempera paints
- Colored pencils
- Magazines
- Markers, brushes and other art materials

Preparation

- Read the article on the next page, and watch the video "Are you risk averse?" found at www.iadb.org/riseup
- Reserve several hours to share students' projects with the rest of the school.

Step by step

- Ask: Do we need to adapt to climate change? Why?
- Read the definition of adaptation to climate change to the students: Decisions and actions aimed at strengthening the capacity of the land (including ecosystems, communities, and institutions) to withstand the adverse effects of climate change without trauma, and taking advantage of any favorable effects. An example of structural adaptations is building levees or walls to protect people from rising seas or rivers. Examples of nonstructural (or soft) adaptations are policies that prevent construction in areas vulnerable to rising sea or river levels planting vegetables that can withstand excessive conditions, such as a lack of rain, and developing strategies to help farmers cope with climate changes.
- Ask: What climate change adaptation measures are already in place today? Discuss both structural and nonstructural adaptations, and their advantages and disadvantages for the environment and communities. Research and discuss other examples beyond those mentioned.
- Have students watch the video "Are you risk averse?"
- Ask: How do the ideas in this video fit with the classroom discussion? What additional ideas did they learn about?
- Divide the class into five groups and give each a copy of the following article.

El Tiempo

Bogotá - Friday, January 12, 2012 Weather

The Predictions of the Einstein of Climate Change, *El Tiempo* (Bogotá), January 2012

"Colombia? With the passage of time it will become an increasingly rainy country. We believe the effects of water will become more intense." In less than five minutes of conversation, this was the first prediction from Isaac Held, a researcher at the Geophysical Fluid Dynamics Laboratory of the National Oceanic and Atmospheric Administration (NOAA, Princeton, New Jersey).

The second was another bombshell. "But parts of Argentina, Uruguay, Chile, Spain and other Euro-Mediterranean countries like Italy, part of France, Greece, Turkey and Croatia, for example, will become drier."

Evoking the style of an elementary school teacher and leaving no room for misunderstanding, Held summarizes his prediction in even simpler words: "With the help of the wind and its constant variations, wetlands will become wetter and dry lands drier, that is what we have been able to calculate."

Furthermore, the regions along the equator (the Caribbean) will be more prone to storms and hurricanes, necessitating radical changes to the control of agriculture and flooding. In Canada and Scandinavia, rainfall is expected to rise 5–10 percent for each degree Celsius of warming while North Africa will suffer water shortages.

Held's predictions include great extremes and relativity—it's no wonder he has been dubbed the Einstein of climate change. But there is actually a different reason for his nickname. Held altered the way we see this global phenomenon, which had previously been explained only as an increase in temperatures due to the emission of carbon dioxide and other gases resulting from the use of fossil fuels.

Held has opened new avenues of work by incorporating the role water plays in the evolution of these climate changes and by studying the movement of liquid in the atmosphere and the influence of water vapor as another protagonist of the greenhouse effect, "whose existence and abundance is another reaction to global warming."

Held just won the Frontiers of Knowledge Award from the BBVA Foundation of Spain, perhaps one of the most important awards in the world for his unusual approach.

Held is not a high-profile researcher and his face may not be familiar to most people, but those who know him say that the award was well deserved, based on his more than 30 years of research. "His work is not only relevant,

but of the utmost importance for making decisions," says Bjorn Stevens, director of the Max Planck Institute for Meteorology (Germany).

Held himself is modest. "I didn't even know I was a candidate," he said, even though his studies have helped explain many processes behind the existence of different climatic zones.

"The amount of water in the atmosphere causes some areas to be wetter than others. As temperatures rise, the amount of water vapor also increases, and this increases the temperature even more. It produces a type of feedback effect."

Held never misses an opportunity to say that if it were not for water vapor (and CO_2), life would be a utopia and Earth's temperature would never exceed 15 degrees Celsius.

"An excess of anything can become a threat."

For example, he explains that if nothing is done to reduce CO_2 emissions in the Mediterranean, temperatures may rise about 3 degrees in the coming century, and rainfall will decline by 10–15 percent per degree Celsius of temperature increase.

Held often speaks of moments and transcendental changes, perhaps because his life has been so full of them. His parents met in Auschwitz, one of Nazi Germany's concentration camps during World War II. Held was born in 1948, in a refugee camp in Ulm, a German city on the banks of the Danube.

When he was four, his family immigrated to the United States. Two years later, his father died and Held was left in the care of his mother. He choose to study theoretical physics at a time when the Vietnam War protests were raging. "It was very difficult to concentrate on my studies," he says. Still, he read any scientific document that fell into his hands, including a 1972 study titled "Man's Impact on the Climate," which was one of the first analyses of humans' role in increasing greenhouse gas emissions and their effects on the atmosphere.

From that point on, Held saw the climate problem as "a really important challenge for society." After graduating with a degree in Physics from New York State University and earning a PhD in Atmospheric and Ocean Sciences from Princeton University, Held went to work at the National Oceanic and Atmospheric Administration (NOAA), where he works to this day.

Although his work focuses on science, Held says that part of challenge is to effect changes in climate policy. "Our role is to provide the evidence needed for governments to act."

Held does not attempt to judge the success or failure of global negotiations, such as those recently held in Durban (South Africa), but he does dare to suggest that a consensus must be arrived at soon. "I am not a politician and I cannot discuss the issue, but I can say that we are facing a huge challenge. Decisions are needed; we need to change our energy sources, and this is a major economic problem. Studying and discovering the mysteries of climate change is the biggest challenge in all of science." One of the first to celebrate Held's award was the Scientific Committee on Antarctic Research (SCAR), which summarized his work as an exhibition demonstrating as never before that the planet is a system with complex interconnections. One of the committee's spokesmen concluded:

"The atmosphere and the ocean are the major distributors of the world's energy, and Held has helped us understand how this process works."

» Ask: what can you conclude from the article you just read?

» Relate the conclusions with the concept and importance of adaptation to climate change.

» Ask: According to the article, what weather can we expect in our region in the coming years? Do you think the weather will change? Ask the students to provide examples of the types of changes they foresee.

» Divide students into groups of three and ask them to develop community outreach projects. Discuss ideas for actions that can be taken to adapt to climate change. Potential topics include:

- Ideas for homes in flood-prone areas.
- Ideas for using the weather to our advantage, such as developing sustainable construction criteria or bioclimatic construction of housing, schools, and offices.
- Ideas for saving water and how doing so benefits adaptation.
- Ideas for saving energy and how doing so benefits adaptation.
- Promoting greater respect for water sources.
- Advancing preparations for tropical storms, hurricanes, and heavy rains.
- Ideas for living in times of drought.
- Dietary changes to reduce or adapt to climate change.
- Others ideas suggested by students.

» Tell students they will present their work to the entire school community, including parents. Make up written invitations to send out in advance.

» Ask students to work on the ideas in their groups, at home, and in the library.

» Set aside classroom time for students to work on their projects and provide any needed guidance. Refer to the Green School Kit for useful information.

» Ask students to create posters inviting the community to the presentation 1–2 weeks in advance of the event.

» Ask students to invite their parents and siblings to the presentation.

» On the day of the presentation, set up exhibition tables for each group and arrange them by topic. As visitors walk through the tables, groups should provide explanations of adaptation and describe their projects.

Class activity 2: A climate for learning—learning for the climate

Objective	Time	Place
Understand the importance of teamwork and communication in addressing climate change.	1 hour	Classroom suitable for projection

Materials

» Video: “Greening Your School” from the video library at www.iadb.org/riseup

» A projector and a computer

Preparation

Watch the video before showing it to students.

Step by step

» Show students the video, “Greening Your School.”

» Ask: What main argument did the story use to get the community to act?

» Ask: What were the most important ideas in the video? What were its essential messages?

» Ask: Has your school ever faced a situation similar to the one in the story?

» Ask: If you were a teacher at the school in the story, what other ideas would you suggest to turn the crisis into an opportunity for learning and long-term positive change?

» Ask: Should schools wait for a disaster to strike before engaging teachers, students, parents, and the community in a discussion about policy changes?

» Have students write stories from their own perspective and propose a plan to transform their own school in a way that can be immediately implemented. This can be done as a homework assignment.

» Present the best stories and proposals at an exhibition and via informative media (such as a blog, bulletin board, or public presentation). Send them to the school principal and other decision-makers and encourage them to think about the problems and potential solutions.

» Discuss the importance of teamwork and communication in the community for addressing climate change and its consequences.

Tips for the teacher

» Encourage students to be creative in choosing their story format: an article, a play, a comic book, a story, etc. If students love to act, let them prepare a script and act out their story.

» To learn about school issues, risks, and vulnerabilities, have students question other teachers and administrators.

» The Green School Kit's chapter on Risks at School has in-depth tools for determining risk.

Formative assessment

» Propose ways to adapt to climate change.

» Propose ways to prepare for climate and environmental changes.

» Propose ways to share information on climate change with the community.

» Understand how learning about the environment and climate change improves human behavior and our chances for survival.

» Recognize the need to engage the community when responding to an emergency or climate change threat.

» Recognize the importance of communication in adapting to climate change.

» Understand that you must know the area and region where you live to effectively prevent or respond to an event caused by climate change.

Here is an example of a student assessment activity: Assume the role of trainer and community leader. Plan educational workshops for the community on issues around climate change, global change, and climate change adaptation and reduction. List the topics you will address in each area in the table below.

Area	Topics	Requirements (equipment, materials, participants, and classrooms)
Climate change		
Global change		
Adaptation to climate change		
Climate change reduction		

Integration with other subjects

Climate change adaptation and community collaboration are cross-cutting issues that present opportunities to prepare for emergency or threatening situations. Every teacher should watch the video "Greening Your School" and hold a ten-minute class discussion about potential risks, threats, or crises facing the community or school, as well as proposed solutions. Use simulations and potential scenarios to help students visualize adaptations to change.

Remember

- During most of the Holocene era, conditions on Earth allowed for human development: relatively constant temperatures, available drinking water, and minor variations in climate.
- Now, due to our dependence on fossil fuels, industrialized agriculture and high consumption levels, human activity is damaging the systems that keep Earth in balance.
- Some scholars claim that we are entering a new geological age, called the Anthropocene age, in which human activity affects the environment through pollution, alterations to the natural landscape, changes in atmospheric composition, and concentrated urban populations, causing irreversible environmental changes and creating a less suitable environment for human development.
- Due to climate change, some countries will become wetter and others drier.
- Wind variations will make the wetlands wetter and dry lands drier.
- Thermal sensation is the way the body "registers" temperature changes. Our bodies are biologically and culturally adapted to a range of temperatures. When these ranges are exceeded without time for us to adapt, our bodies enter into a crisis state. Some organisms are even less capable of adapting to temperature changes than humans.
- Adaptation to climate change can be defined as "decisions and actions aimed at strengthening the capacity of the land to withstand the adverse effects of climate change without trauma and to take advantage of any favorable effects."
- Adaptation is essential for preventing disasters.
- Teamwork makes us less vulnerable to risks and helps prevent disasters.

Suggested reading and viewing

- Module 9 of the Green School Kit deals with managing risk. You will find it at www.iadb.org/riseup.

3 Advanced lesson plan 3: Climate agreements

General objective

» Learn about some of the agreements and pacts between governments to protect the climate.

Class activity 1: Debate on climate change

Objective	Time	Place
Examine how partnerships between governments and communities can lead to public policies for reducing climate change.	3 hours	Auditorium or classroom with good lighting and sound

Preparation

Review the "Climate Change and Global Change" activity from Lesson Plan 1 with your students. In that activity, students reflected on the impact of human activities on climate change. Based on the presentations created for that activity, divide students into four groups and ask them to prepare for a debate aimed at drafting a public policy. Encourage your students to learn about climate agreements during the past 10 years.

The first group represents the government; the second group represents big business (including the oil, mining, livestock, plastics, and transportation industries); the third group represents small farmers, fishermen, and rural residents; and the fourth group represents climate change experts. The goal is to formulate a public environmental policy. What elements should it contain? What commitments should each group make? Allow the groups one week to prepare their initial presentations, arguments, and general policy frameworks, reflecting their group's perspective. Reserve an auditorium or a large room with a podium.

Step by step

» Give your students suitable time to prepare for the debate and allow some time for groups to meet during class, if possible. Group members must know their arguments and research and reflect on the topic before facing the other groups.

» Set up four large tables in the debate room.

» Give students a few general rules for the debate, which should include:

- Each group will have seven minutes for introductions and a general statement.
- Arguments against the positions of the other groups may take the form of a series of rebuttals or questions. Each group will have the opportunity to ask two questions or present a rebuttal for each of the other teams. This phase will last at most 20 minutes.
- Counterargument preparation: Each group will have 10 minutes to prepare counterarguments and answers.
- Presentation of counterarguments: Five minutes per group.
- Conclusions: Four minutes per group.

- A committee should be selected to draw general conclusions, giving equal consideration to the interests of all the parties, with the goal of reaching agreement on actions to reduce climate change. This committee will have 10 minutes to write down its conclusions—i.e., the public policy.
- The teacher will determine a winner, based on the following criteria: clarity of concepts, analytical skills, debating skills, and inductive capacity.

Tips for the teacher

» Invite other classes or members of the school community, including parents, to watch the debate.

» Have the audience ask questions or vote for the winner.

» Encourage students to present precise, clear arguments and to avoid having a discussion without offering arguments.

» Use awards to encourage friendly competition.

Class activity 2: Calculate your ecological footprint—an interactive game

Objective	Time	Place
Calculate your ecological footprint	1 hour	Computer lab or classroom with computers

Materials

» Internet access

» Computers

» Bulletin board to display the footprint results

» Camera to record student performances.

Preparation

Play the game "Test your sustainability" that you can find at www.iadb.org/riseup. Ensure that the classroom where the students are working has electricity and Internet access.

Interpretation of the results:

» If your score was between 0 and 60, your footprint on Earth is very small. Great job!

» If you scored between 61 and 100, you can do a little better, but you definitely deserve recognition.

» If you scored between 101 and 150, try to do better. You can do it!

» If you scored between 151 and 200, you are seriously affecting the planet. It's time to reflect and change!

Step by step

» Invite your students to play the game "Test your sustainability". Tell them that if they want to be part of the solution, they should start by calculating their ecological footprint. This will help them understand how many resources they consume and how to make better choices.

» After students calculate their footprints, divide them into groups of five to discuss their results and the actions they can take to reduce their impact. Ask the groups to share their most creative ideas for reducing their footprint.

» If your school is in a rural or forested area or in a community with a below-average ecological footprint, give an example of a person who consumes a lot of resources. This will give students something to compare their behavior to, and will foster a discussion about how different lifestyles impact the climate.

» Ask: Do you think developed countries should have greater commitments to reduce GHG emissions? Why?

» List the students' ideas and conclusions. Remind them of industrial use of nonrenewable energy and concentrations of housing, transportation, food, and solid waste in urban areas.

Class activity 3: My footprint in a time capsule

Objective	Time
Encourage your students to make a commitment to reduce their ecological footprint.	15 minutes

Preparation

Have sheets of recycled paper and envelopes for each of your students. Familiarize yourself with the site www.footprint.org and locate the calculator that best fits your country.

Step by step

» Ask: What do you do at home to reduce your carbon footprint? Talk about things they already do, such as recycling, reusing, separating garbage, and reusing shower water.

» Have students visit www.footprint.org and find the carbon footprint calculator for your country.

» Talk with the students about the importance of their talking with their families about this issue and assign the following homework: Gather your family together and calculate your family's ecological footprint.

» Discuss how families can work together to reduce their carbon footprint.

» For the next class, ask students to bring in a document signed by each of their family members with their commitments for reducing their carbon footprint.

» In a few weeks, ask students to give a progress report on their family's efforts at reducing their ecological footprint. Remind the students to continually reinforce positive attitudes about the environment when they are at home.

Tips for the teacher

» Students must feel empowered in order to convey information to their communities. Remind them that the work they do in class is helpful to their family, town, city, and country.

» Encourage students to share the environmental calculator with others to help them find ways to reduce their environmental impact and make positive lifestyle changes.

Formative assessment

Before moving on to the next topic, ensure that students understand the following points:

» The ecological or environmental footprint is the impact of human activity on the environment. The environmental impact is negative when it hurts the structure and function of ecosystems and positive when it improves their integrity and biodiversity.

» We all have an ecological footprint that we can reduce by making better choices regarding the transportation we use, the food we eat, the water and fuel we consume, and they way we handle our waste, among others.

Integration with other subjects

Science: Have students research and analyze the countries with the largest ecological footprints.

Language: Have students write essays about the importance of taking action to reduce climate change.

Mathematics: Use the ecological footprint calculation to produce statistical tables. Have students make bar charts showing the footprints of different countries.

Remember

» Human activity affects the environment and can either accelerate or reduce climate change.

» The ecological footprint measures our impact on the planet. It allows us to see whether or not the resources we use every day are renewable. It also helps us see how we can make better choices.

Suggested reading and viewing

- The UN Development Programme's community on climate has information on climate change and its consequences, drawing from the results of the 2011 Durban Conference. www.undpcc.org.
- "The future we want" is a report of United Nations deliberations on sustainability and the environment. www.un.org/es/sustainablefuture/.
- The Global Footprint Network explains the "ecological footprint" and its importance in protecting the planet's resources at www.footprintnetwork.org. The "footprint calculator" measures our access to nature, the resources we use, and who uses what. It has ecological and carbon calculators for various levels of society: individuals, companies, cities, farms, and nations.
- World Wildlife Fund's "ecological footprint calculator" can be found at www.wwf.panda.org
- Worldometers provides updated and free global statistics at www.worldometers.info/es.
- Al Gore's *Our Choice: A Plan to Solve the Climate Crisis* (2009) contains photos and graphics that help the reader understand climate change and its consequences. Since publishing his first book (*An Inconvenient Truth*), Nobel Peace Prize winner and former U.S. Vice President Al Gore has organized 30 "Solutions Summits" at which world experts in agriculture, neuroscience, economics, and information technology get together to discuss responses to climate change.
- The most recent report of the Intergovernmental Panel on Climate Change: IPCC. 2014. *Climate Change 2014: Synthesis Report.* Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Geneva, Switzerland, 151 pp. www.ipcc.ch.
- Publications on climate change from the UN Food and Agriculture Organization. www.fao.org.


Rise Up
Against Climate Change

2016

Our Climate Is Changing

Lesson Plans for Children and Youth

Emma Näslund-Hadley, María Clara Ramos, Juan Paredes, Ángela Bolivar, and Gustavo Wilches-Chaux

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Rise Up Against Climate Change!

A school-centered educational initiative of the Inter-American Development Bank