

Everything Starts with Water

Principal raindrop:

Dive into the fascinating world of water, explore the magic of the water cycle in nature and find out how it is affected by climate change!

Embark on an exciting journey to unravel the nature secrets and learn new facts about climate change by clicking on the + icon.

Little drops:

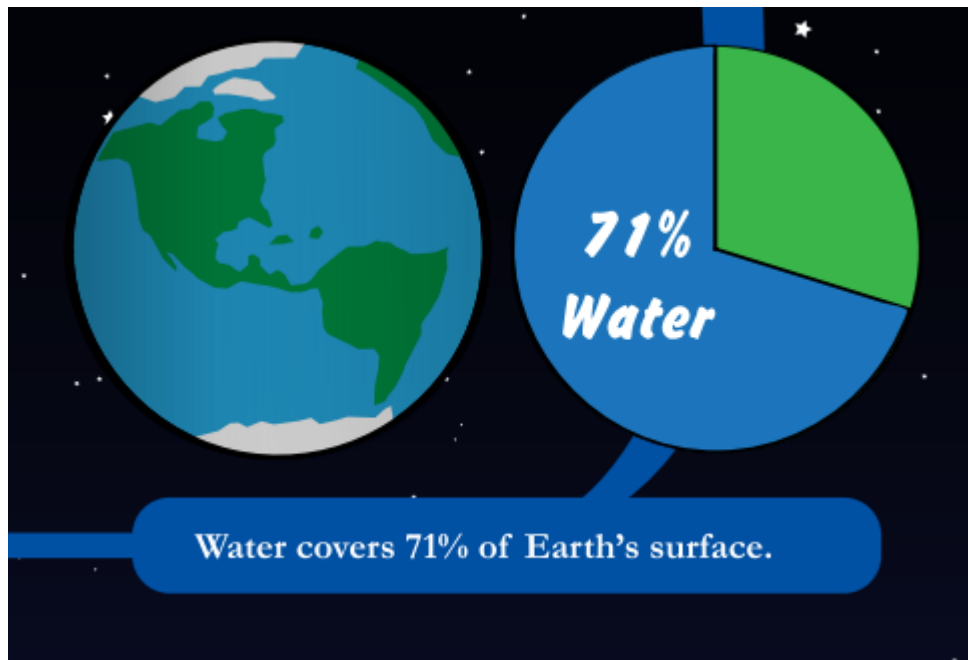
1. Water facts

- **Imagine Earth as a grand, watery kingdom. The story of our planet, especially when it comes to life, is written in the deep blue pages of its oceans. Oceans are like the heartbeats of our world, shaping our home planet and making it uniquely habitable.**



July 10, 2005

- If Earth were a giant puzzle, oceans would cover most of its pieces. In fact, 71% of Earth's surface is covered by oceans. They control Earth's weather and drive the water cycle, which waters our lands and fills the air we breathe.



<https://spaceplace.nasa.gov/water/en/>

- Water is Earth's precious treasure, and we've got lots of it! There are more than 326 million trillion gallons of water on our planet. The oceans hold about 96.5 percent of this watery wealth. Oceans are like Earth's giant reservoirs.
- Despite the abundance of water, only a tiny fraction - less than 3% - is freshwater. And more than 2/3 of this freshwater is trapped in ice caps and glaciers, making it hard for us to use.

Climate change and evaporation

(on cloud) greenhouse effect: Our planet's atmosphere acts like a blanket. It lets sunlight in, which warms the Earth. When we burn fossil fuels like coal and oil for energy, or when we clear land for farms and cities, we release special gases into the

air. These gases, such as carbon dioxide (CO₂), methane, and others, trap extra heat in our atmosphere. It's like adding an extra layer to our cozy blanket. This extra heat can cause our planet to get too warm, leading to problems like melting ice, rising sea levels, and changes in weather patterns.

(on sun) Imagine you have a cup of water sitting outside on a sunny day. As the sun shines, the water in the cup starts to disappear slowly. Where does it go? It's actually turning into something called water vapor, which is like an invisible, lighter form of water. This process of water turning into vapor because of heat is called evaporation. It happens not just in cups, but in oceans, rivers, and even puddles when the sun heats them up.

(on steam?) Increased evaporation means more water is going up into the atmosphere, potentially leading to drier conditions on land. This can affect the availability of freshwater for us and for plants and animals. Evaporated water eventually comes back down as rain. Climate change can lead to imbalances in the water cycle, causing some places to experience heavy rainfall (leading to floods) while others might face droughts due to reduced rainfall. Changes in evaporation patterns can also affect natural habitats and ecosystems. Plants, animals, and even people who depend on regular rainfall patterns for agriculture might face challenges.

Condensation

(on cloud) When warm, moist air rises and meets the cold air high up, it cools down. The moisture in the air condenses to form tiny water droplets or ice crystals, which come together to form clouds. When the Earth warms up, it affects the atmosphere too. Warmer air can hold more moisture. So, there's more water vapor in the air. When this warm, moist air rises and cools down, there's a lot more moisture to condense into clouds and raindrops. This means some places might experience heavier rainfall and more intense storms. On the other hand, warmer air can also lead to more evaporation, where water on the ground or in rivers and lakes turns into water vapor. So, while some areas might get more rain, other places might become drier due to increased evaporation.

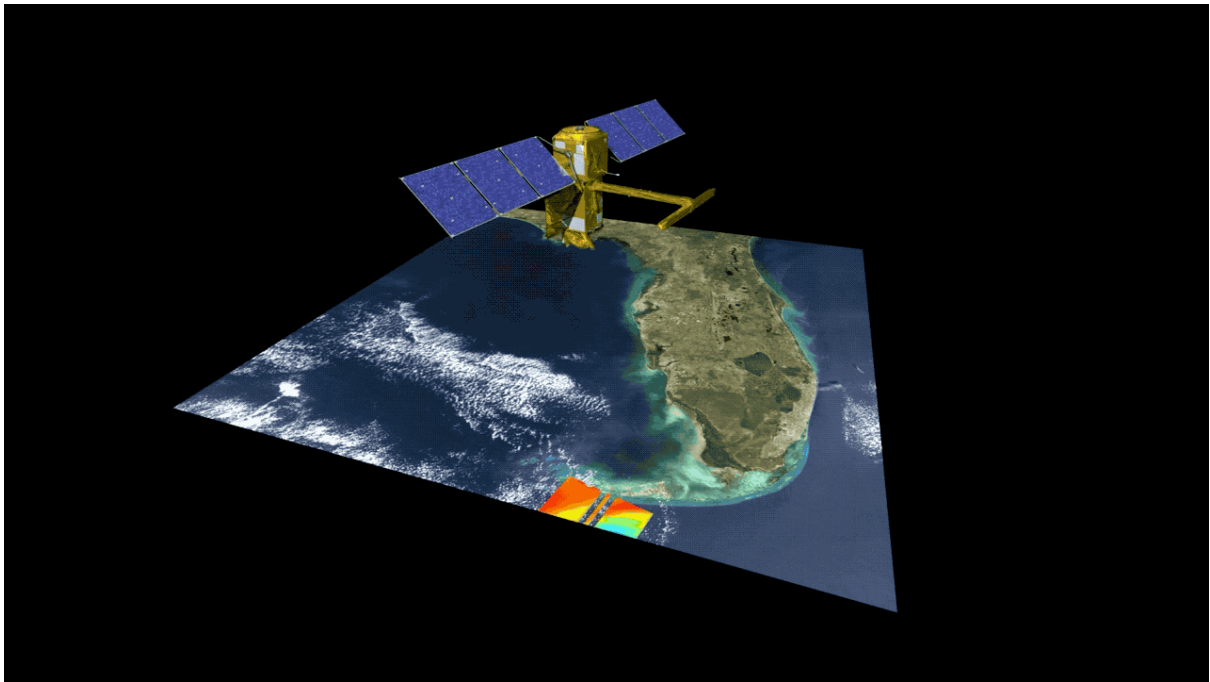
(on wind) If these temperature differences change significantly, it can alter wind directions and speeds. Cyclones, hurricanes, and typhoons form over warm ocean waters. Climate change can lead to warmer sea surface temperatures, providing more heat energy to fuel these storms. Warmer waters can lead to the intensification of tropical storms into hurricanes or typhoons.

How climate change affects the oceans?

1.5 SWOT

- NASA is like a team of super scientists and astronauts who explore space! They have a special mission called SWOT. Now, SWOT is not a superhero, but it stands for something really cool: Surface Water and Ocean Topography.
- Think of surface water as all the water you can see, like in rivers, lakes, and oceans. It's the water that's on the surface of the Earth.
- Topography means the shape of the land. So, ocean topography is like understanding the bumps and dips at the bottom of the oceans. It's a bit like exploring the hills and valleys, but deep down under the sea!
- NASA's mission, SWOT, is like a super space gadget that helps them study water on Earth. It's a satellite (which is like a really fancy space robot) that orbits our planet. From way up high, it can see how much water there is in different places and how the land underwater is shaped.
- Imagine you have a big bowl of jelly, and you want to know how wobbly it is in different places. SWOT helps scientists understand how much water is in different parts of the world and how the shape of oceans and rivers change over time. This helps them learn about floods, droughts, and how the Earth is changing because of things like climate change.

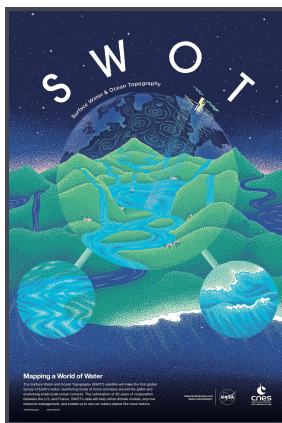
<https://www.youtube.com/watch?v=2oKYXKKf28g&t=1s>



Source: NASA/JPL-Caltech

Published: January 19, 2022

This animation shows the collection of data over the state of Florida, which is rich with rivers, lakes, and wetlands.



(center)Climate change impacts oceans, leading to rising temperatures, melting polar ice, and ocean acidification. Warming waters threaten marine life, while melting ice contributes to rising sea levels, endangering coastal regions. Acidification harms coral reefs and shellfish. Altered ocean currents disrupt ecosystems, affecting weather patterns. Mitigating climate change is vital to preserving the oceans' health and the diverse life they support.

(on coral)Climate change leads to rising global temperatures. This warming extends to the oceans, causing them to heat up. Warmer waters can harm marine life, including coral reefs, which are sensitive to temperature changes. It can also disrupt the habitats of many marine species.

(bubble one)The warming atmosphere causes polar ice caps and glaciers to melt. This adds more water to the oceans, causing sea levels to rise. Rising sea levels threaten coastal communities and can lead to erosion, flooding, and even the disappearance of small islands.

Precipitation

GPM

Have you ever wondered how raindrops form and why some places get more rain than others? NASA created the Global Precipitation Measurement mission. GPM is like a super rain detector from space which helps scientists understand rainfall patterns, from small rains to big storms and typhoons and also can help us understand how climate change is affecting weather.

GPM uses instruments and sensors to measure raindrops from space, their size and intensity and it creates maps that show how much rain is falling all around the globe.

It improves the knowledge about the water cycle and it helps monitoring and predicting the tropical cyclones and other tropical events. GPM also improves agricultural forecasting and helps monitoring freshwater resources.

In the next video are images from GPM Core Observatory satellite of the recent Typhoon Mawar, a powerful recent storm that happened on May 25, 2023.

insert GPM video

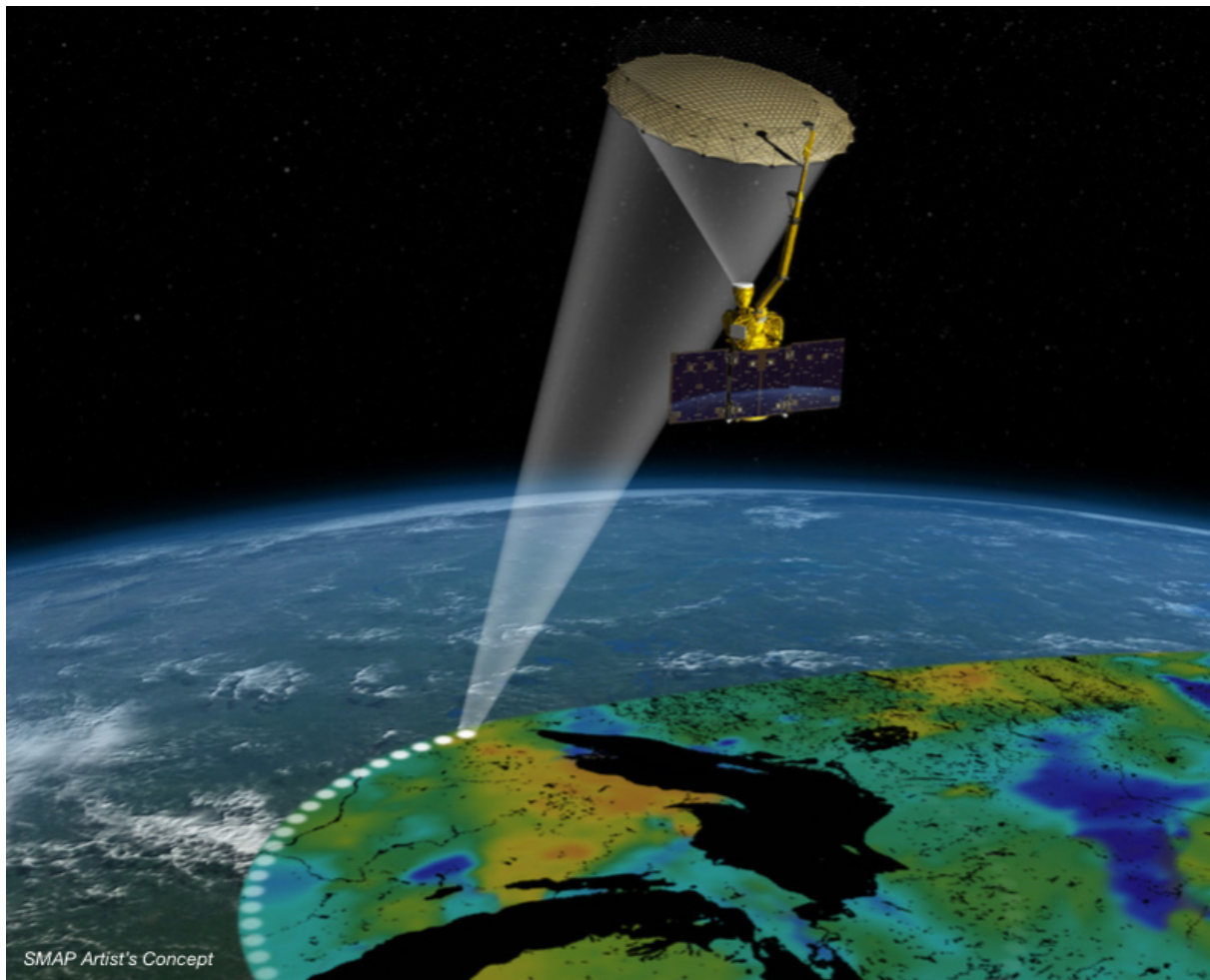
<https://gpm.nasa.gov/applications/weather/news/gpm-captures-typhoon-mawar>

SMAP

SMAP- Soil Moisture Active Passive mission is a radar sent by NASA to space which studies the moisture in our planet soil.

Soil moisture tells us how wet or dry the soil is, this information is very important in the agriculture domain, farmers need to know when to water their crops.

SMAP's most prominent feature is its spinning antenna which is like the "eye" of the instrument. The antenna works like a flashlight which flies over the Earth's surfaces and makes measurements of the soil moisture, generating large amounts of data stored in the spacecraft computer memory.



source: <https://smap.jpl.nasa.gov/resources/76/smap-launch-press-kit/>

2. What Is Climate Change?

Climate change is a change in the usual weather found in a place. This could be a change in how much rain a place usually gets in a year. Or it could be a change in a place's usual temperature for a month or season. Weather can change in just a few hours. Climate takes hundreds or even millions of years to change.

What Is Causing Earth's Climate to Change?

Many things can cause the climate to change all on its own. Earth's distance from the sun can change. The sun can send out more or less energy. Oceans can change. When a volcano erupts, it can change our climate.

How can humans change climate?

People drive cars. People heat and cool their houses. People cook food. All those things take energy. One way we get energy is by burning coal, oil and gas. Burning these things puts gases into the air. The gases cause the air to heat up. This can change the climate of a place. It also can change Earth's climate.

+ Greenhouse Effect:

https://climate.nasa.gov/system/video_items/126_Greenhouse_effect_revised_HD_English.m4v

- + Four Major Gases That Contribute to the Greenhouse Effect: Carbon Dioxide, Methane, Nitrous Oxide, Chlorofluorocarbons (CFCs)
- + Another Gas That Contributes to the Greenhouse Effect: Water Vapor
- + Over the last century, burning of fossil fuels like coal and oil has increased the concentration of atmospheric carbon dioxide (CO₂). This increase happens because the coal or oil burning process combines carbon with oxygen in the air to make CO₂. To a lesser extent, clearing of land for agriculture, industry, and other human activities has increased concentrations of greenhouse gases. The industrial activities that our modern civilization depends upon have raised atmospheric carbon dioxide levels by nearly 50% since 1750.
- +

Evidence of climate change:

1. Global Temperature Is Rising
 - a. **Slider** Global Temperature Picture Slider 1884-2022
2. The Ocean Is Getting Warmer
 - a. The ocean covers about 70% of Earth's surface. So, it's not surprising that it plays a large part in Earth's environment. As Earth warms, water in the ocean soaks up energy (heat) and distributes it more evenly across the planet. The ocean also absorbs carbon dioxide from Earth's atmosphere. The additional heat and carbon dioxide in the ocean can change the environment for the many plants and animals that live there. Earth stores 90% of the extra energy in the ocean.
 - b. How does the ocean soak up CO₂?
 Fish and other animals in the ocean breathe oxygen and give off carbon dioxide (CO₂), just like land animals. Ocean plants take in the carbon dioxide and produce oxygen, just like land plants. The ocean is great at absorbing CO₂ from the air.
 However, a lot of CO₂ comes from human activities, too. For example, exhaust from cars, planes, and factories put extra carbon dioxide into our air. Too much carbon dioxide in the air is a problem, as it causes the Earth to trap more heat. The ocean absorbs about one-quarter of the CO₂ that humans create when we burn fossil fuels (oil, coal, and natural gas).
 - c. **challenge:** It's hard to care about something you cannot see, so make CO₂ visual with this cool classroom activity that uses vinegar and baking soda to blow up a balloon. You can use this physical model as an icebreaker to

introduce the harmful effects of too much carbon dioxide.:

<https://www.kcedventures.com/chemistry-experiments-for-kids-with-co2/>

3. The Ice Sheets Are Shrinking

- a. link to NASA website to see how the climate change affected glaciers, sea ice, and continental ice sheets worldwide:

<https://climate.nasa.gov/interactives/global-ice-viewer#/>

- b. *Melting sea ice could raise sea level by several meters?* True/ **False =>**

Melting sea ice cannot significantly raise global sea level since the ice is already floating (think of an ice cube melting in a glass full of water, which doesn't raise the water level). However, the melting of sea ice floating in salt water does cause a slight rise in sea levels due to salinity effects (if all the floating ice everywhere were to melt, global sea levels would rise about 4 centimeters). Ice lost from glaciers and ice sheets, which form on land, does add water to Earth's oceans when it melts and does contribute to sea level rise.:

<https://www.jpl.nasa.gov/edu/teach/activity/whats-causing-sea-level-rise-land-ice-vs-sea-ice/>

4. Glaciers Are Retreating

- a. link to NASA website to see how the climate change affected glaciers, sea ice, and continental ice sheets worldwide:

<https://climate.nasa.gov/interactives/global-ice-viewer#/>

- b. **(FF)** *During the last ice age, glaciers covered almost one-third of all the land.*

What percentage of the land is covered by glacial ice today?: Ten to 11 percent of the land is covered by ice today. The vast majority of Earth's ice is found in Antarctica. It has an ice sheet more than 1.8 kilometers (1.1 miles) thick on average, and can be more than 4 kilometers (2.5 miles) thick in some places.

- c. **(FF)** *Which is the only continent on Earth with currently no glaciers?:*

Australia. There are no glaciers on mainland Australia today. However, during the last glacial ice age, which ended 10,000 years ago, Mount Kosciuszko had a small glacier and Tasmania had many glaciers. The South Island of New Zealand still has thousands of glaciers.

5. Snow Cover Is Decreasing

- a. Snow coverage slider: **Slider**

https://earthobservatory.nasa.gov/global-maps/MOD10C1_M_SNOW

6. Sea Level Is Rising

- a. **Slider** <https://climate.nasa.gov/interactives/climate-time-machine>

7. Arctic Sea Ice Is Declining

- a. **Slider** Arctic Sea decreasing:

<https://climate.nasa.gov/vital-signs/arctic-sea-ice/>

- b. The animated map below shows the minimum size of the Arctic sea ice measured each year since 1979, based on satellite observations. The 2012 sea ice extent is the lowest in the satellite record.

- c. link to NASA website to see how the climate change affected glaciers, sea ice, and continental ice sheets worldwide:
<https://climate.nasa.gov/interactives/global-ice-viewer#/>
- 8. Extreme Events Are Increasing In Frequency
 - a. ? enumeram + poza cu fiecare eveniment extrem (explicare in punctul urmator): uragane,...
- 9. Ocean Acidification Is Increasing
 - a. Easy def: Ocean acidification is a change in the properties of ocean water that can be harmful for plants and animals. Scientists have observed that the ocean is becoming more acidic as its water absorbs carbon dioxide from the atmosphere.
 - b. Since the beginning of the Industrial Revolution, the acidity of surface ocean waters has increased by about 30%. This increase is due to humans emitting more carbon dioxide into the atmosphere and hence more being absorbed into the ocean.
 - c. How does climate change affect coral reefs?:
<https://oceanservice.noaa.gov/facts/coralreef-climate.jpg>
 - d. **Game:** Coral bleaching: <https://climatekids.nasa.gov/coral-bleaching/>

Future effects of global climate change in the United States:

In mijloc: Earth Will Continue to Warm and the Effects Will Be Profound: The potential future effects of global climate change include more frequent wildfires, longer periods of drought in some regions, and an increase in the wind intensity and rainfall from tropical cyclones

- 1. Hurricanes Will Become Stronger and More Intense
 - a. Scientists project that hurricane-associated storm intensity and rainfall rates will increase as the climate continues to warm. Moreover, as sea level continues to rise, the severity of storm surges will escalate, exacerbating flooding caused by heavy rainfall, leading to heightened damage.
 - b. Due to global warming, global climate models predict hurricanes will likely cause more intense rainfall and have an increased coastal flood risk due to higher storm surge caused by rising seas. Additionally, the

global frequency of storms may decrease or remain unchanged, but hurricanes that form are more likely to become intense.

c. imagine?:

<https://media2.giphy.com/media/Zmc6wnh167ujCzUyRk/giphy.gif>

2. More Droughts and Heat Waves

a. According to the most recent National Climate Assessment, droughts in the Southwest and heat waves (periods of abnormally hot weather lasting days to weeks) are projected to become more intense, and cold waves less intense and less frequent.

b. All seasons are projected to continue to get hotter. By the end of this century, if we continue emitting greenhouse gases at our current rate, extreme heat events that used to occur only once in 20 years are expected to occur every year. Image credit: NOAA

c. imagine?:

<https://media.tenor.com/EdCQEpwBqDkAAAAM/heat-heat-wave.gif>

3. Longer Wildfire Season

a. Globally, fire weather seasons have lengthened. Drought remains the dominant driver of fire emissions, but recently there has been increased fire activity in some tropical and temperate regions due to warmer temperatures that increase vegetation flammability. The northern boreal zone (Earth's northernmost forests) near the Arctic is also experiencing larger and more frequent fires, and this may increase under a warmer climate.

4. Changes in Precipitation Patterns

a. Scientists have predicted that droughts and floods will become more frequent and severe as our planet warms and climate changes.

5. Frost-Free Season (and Growing Season) will Lengthen

What Can You Do to Help?

You can help by:

- using less energy and water
- turn off lights and TVs when you leave a room
- turn off the water when brushing your teeth
- planting trees.
- learning about Earth. The more you know about Earth, the more you can help solve climate problems.

Fun facts:

What is the main difference between the Arctic (North Pole) and the Antarctic (South Pole)? The Arctic is an ocean surrounded by continents; the Antarctic is a continent surrounded by an ocean. The Arctic consists of the Arctic Ocean covered by sea ice, which is surrounded by treeless permafrost (permanently frozen land). That land includes parts of Russia, Canada and the island of Greenland. Antarctica is a vast continent covered in a layer of snow and ice 2 km thick on average, which is surrounded by the Antarctic Ocean.

What is Sea ice? Sea ice starts out as frozen sea water. It forms once the temperature of the water's surface drops below its freezing point. For salty ocean water, that's about 29°F (-2°C). (The salt impurities make the freezing point lower than that of pure water.) In contrast, icebergs, glaciers and ice shelves are made from freshwater, which comes from precipitation on land and other sources. Because it makes it seem like sea ice is frozen seawater, with all the salt retained. As sea ice ages it rejects the salt, with the oldest sea ice being essentially pure water.

What proportion of the world's freshwater is stored in glaciers and ice caps?

The salty oceans contain more than 97 percent of all water on Earth, making freshwater relatively scarce. **A bit over 69 percent** of Earth's freshwater is held in ice caps and glaciers. The rest resides in lakes (27 percent), swamps (3 percent) and rivers (less than 1 percent).

What are ice sheets and which one is losing the most ice every year?:

Ice sheets are large glaciers that cover much of Greenland and Antarctica. Mountain glaciers, smaller than ice sheets, flow from high alpine areas. Even though Antarctica holds the majority of Earth's ice, Greenland, which contains only 10 percent, loses the most ice every year. If all 2.9 million cubic kilometers (0.7 million cubic miles) of Greenland's ice sheet were to melt, it would cause sea level to rise by 7.2 meters (23.6 feet).

What is the normal temperature range for ocean surface water?: -2 to 35°C.

Very cold and very salty water sinks to become deep water in Earth's polar regions, while warm water tends to remain on the surface in tropical waters. Fresh water freezes at 0°C, but sea water freezes at colder temperatures because it contains salt.

Is El Niño is the result of global warming?: No. El Niño is a natural Earth system phenomenon and is not directly associated with, or caused by, global warming. El Niño, marked by episodes of warm water in the eastern Pacific, is associated with regional and global changes in precipitation and ocean circulation patterns and has been occurring for hundreds of years or more. **However, climate change might be influencing its frequency and intensity.**

How long does it take a drop of water to travel through the water cycle?:

It depends on the path the droplet takes. Water can take many paths as it travels around the planet. For example, water is in the atmosphere for just 8 to ten days, but it can stay in the soil for 1 to 2 months and as seasonal snow for 2 to 6 months.

Water can remain locked into a glacier as ice for 20 to 100 years, in the oceans for 3,000 years or stored away as deep groundwater for 10,000 years. An epic journey!