

JOURNEY WITH OCEAN OBSERVERS

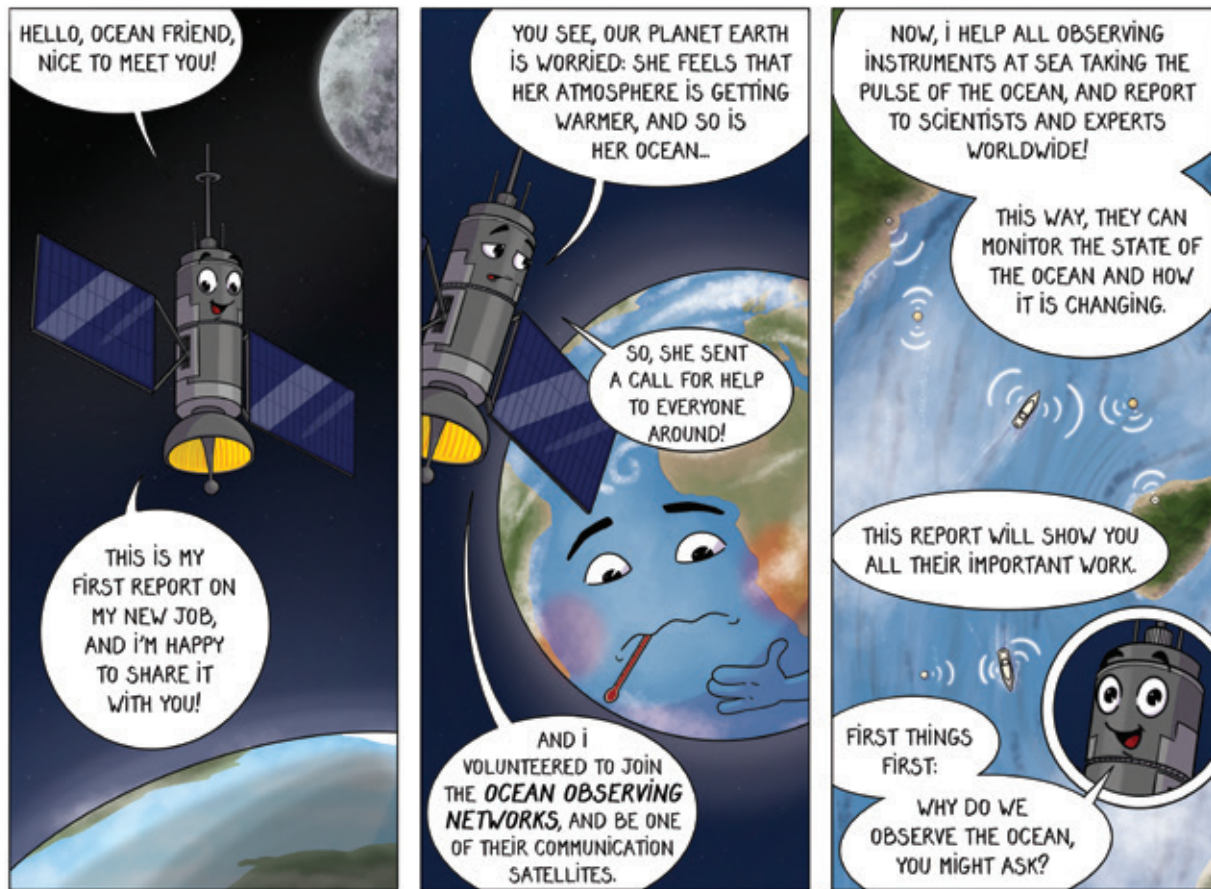


JOURNEY WITH OCEAN OBSERVERS



Discover the thousands
of instruments at sea taking
the pulse of the ocean!

WHY DO WE OBSERVE THE OCEAN?



Because it's vital for our life: the ocean produces **60% of our oxygen** and serves as a source for **food, freshwater, and medicine**. Additionally, 90% of global trade occurs via the ocean, and it plays a crucial role in regulating our **climate**.

You may know that the Earth absorbs energy from the Sun, with some reflected, and retained in the atmosphere by **greenhouse gases** like carbon dioxide (CO₂).

This so-called **greenhouse effect** keeps the Earth's temperature warmer than it would otherwise be, supporting life on our planet. However, human activities, by burning fossil fuels such as using petrol for cars or coal for heating buildings, have been increasing greenhouse gas emissions. These gases act like a blanket wrapped around the Earth, trapping the Sun's heat, and raising temperatures, contributing to **global warming** and **climate change**. Fortunately for us, the ocean helps stabilise Earth's climate, for example by absorbing the excess warmth and CO₂. Can the planet always count on this close friend? This is one of the questions that experts are trying to answer by observing and monitoring the ocean.

Ocean observations also help monitor the **health of ocean ecosystems**, which means how the ocean dwellers are doing, and if their habitats are safe and flourishing. For people living near the coast, the ocean is part of their traditional way of life. They care for the ocean and its biodiversity. For everyone on the planet, it is a source of food, health and travel. Additionally, ocean observations are vital for accurate **weather predictions** and **early warnings** of hazards like tsunamis and storms, saving lives on Earth and ensuring safety at sea.

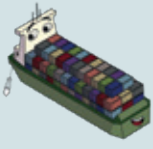
Now, what are my new ocean observing colleagues doing exactly? All these instruments gather **key information about the ocean and the atmosphere** above it. They encompass **autonomous and piloted robots, drifting and fixed buoys, research and merchant ships, sea level gauges, high-frequency radars, and even marine mammals!**



Currently, **9 000 ocean observing instruments at sea** are organised in different but complementary observing networks. On my journey to better know and understand the ocean, I will call on one representative of each network. Follow me to meet the first one!



Hello! I'm the new communication satellite and I'd like to learn more about climate change and how it affects the ocean. Can you help me?



Hi, of course! For starters, I can show you how I monitor variations in the ocean's temperature.



Why do we monitor the temperature in the ocean?

As we have explained before, human activities are altering Earth's natural greenhouse effect, causing **global warming**. This warming affects the ocean, which absorbs much of the extra heat. Even a slight increase in seawater temperature can harm marine life and ecosystems, impacting organisms like fish and corals. The consequences extend beyond the direct impact on marine life. You will discover many of these consequences later!



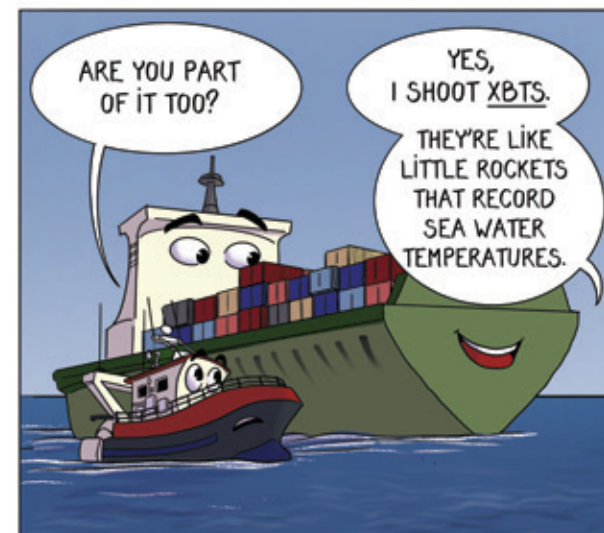
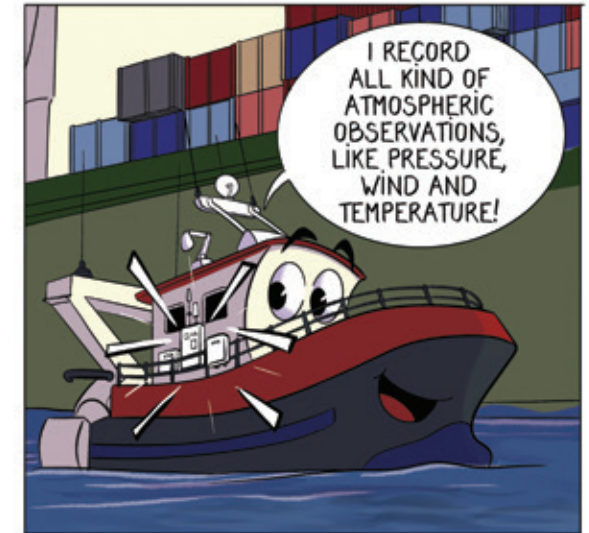
How do ship-based measurements help?

Merchant ships, ferries, fishing vessels, and all sailors can volunteer to observe our ocean, taking measurements of oceanographic and meteorological parameters with onboard and deployed instruments. Some of us take meteorological data, and others, like me, record seawater temperature by launching **eXpendable BathyThermographs (XBTs)**. >>>

An XBT is a probe that records the water temperature in the upper thousand meters of the ocean. XBTs have been launched since the 1960s, providing one of the longest historical records of ocean temperature!

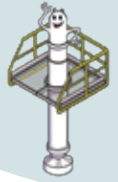


Let's take a step back: **what are the consequences of a warmer ocean on the sea level?** I'd better ask the sea level gauge!

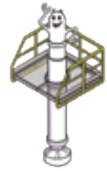




Hello! I've been told that sea level depends on the water temperature. Is it true?



Hi! Yes, it is. But not only. Let me explain...

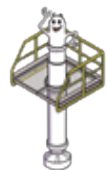


What causes sea level rise?

▶ Warm water takes up more space than cold water. This is because the particles that make up water gain more energy when they're heated, causing them to move around and occupy more space, resulting in the **water's expansion**. This phenomenon accounts for one-third of the global sea level rise.

▶ The other two-thirds come from the **melting of glaciers and polar ice sheets** due to the increase in air temperature. This is what is happening to the ice sheets in Greenland and Antarctica. This meltwater then flows into the ocean, contributing to the overall sea level rise.

Here are two experiments to help you understand



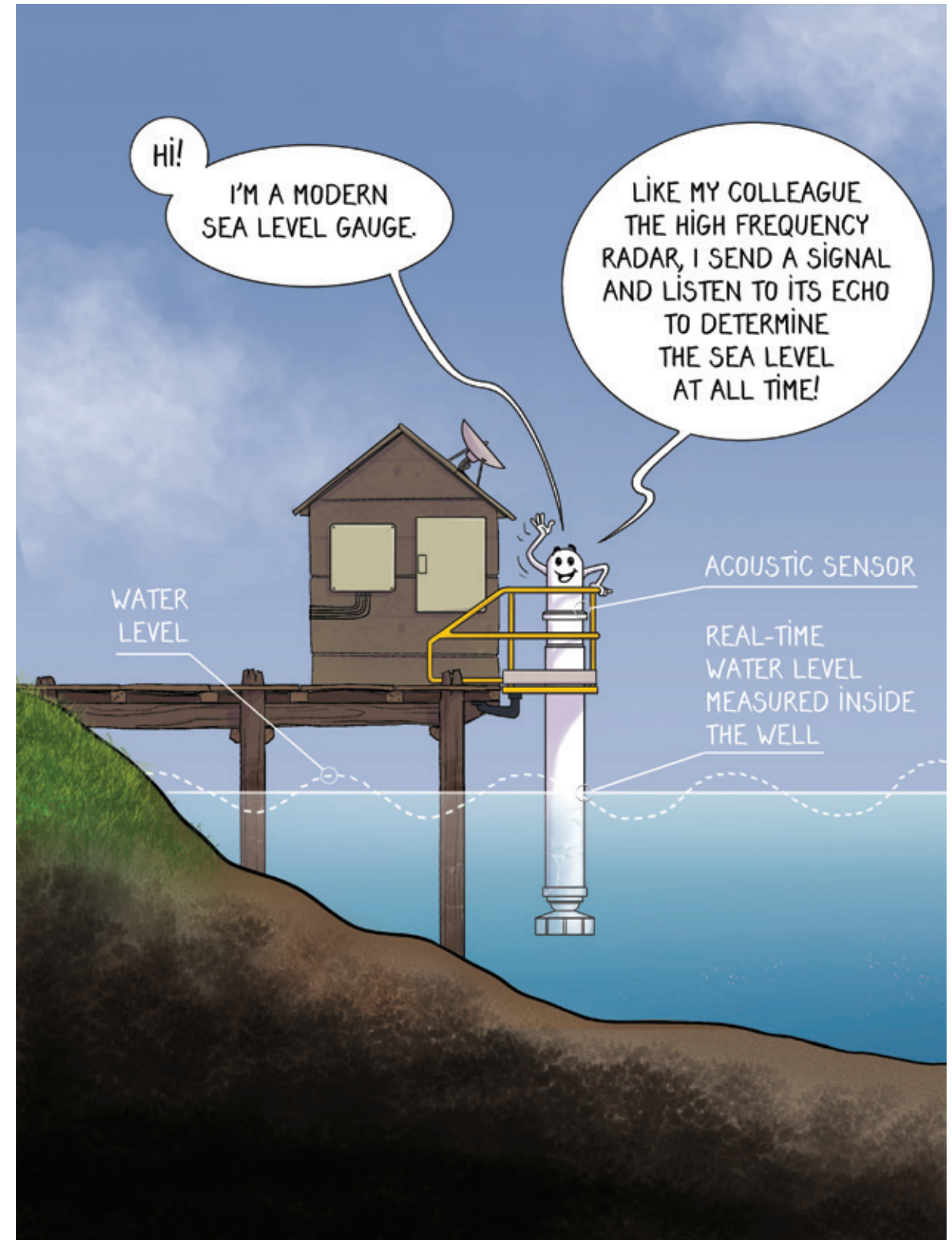
How do sea level gauges help?

In the past, sea level was measured with tide poles or small floating buoys in a tube. Benchmarks on land were used as references to determine sea level relative to the land. Today, **radar technology** is employed on modern sea level gauges for more accurate measurements. >>>

Sea level gauges not only collect crucial data for scientific research into ocean circulation. We also provide tide tables for various purposes, including port operations, fishing, and recreational activities. Moreover, in times of extreme weather events, like storm surges, we can help issue flood warnings.



We have learned that the ocean is getting warmer. Do you think that it is also experiencing **extreme heatwaves**, like heatwaves on land? Maybe my next colleague, the profiling Argo float, knows!





Hello! I'm learning a lot about ocean warming today, and I was wondering if marine heatwaves could happen?

Hi! Yes, they do happen, and it's part of my job to record them.



What are marine heatwaves?

Marine heatwaves are periods of intense, unusually **warm ocean temperatures** which are becoming more frequent, intense, and lasting longer due to **global warming** and **climate change**. These events have disastrous effects on marine ecosystems and vulnerable species. They become stressed, some may die, others move to colder waters, which can impact the food chains. Marine heatwaves can also influence other extreme events on land, such as droughts and heatwaves, and the intensity of tropical cyclones.



How do profiling floats help?

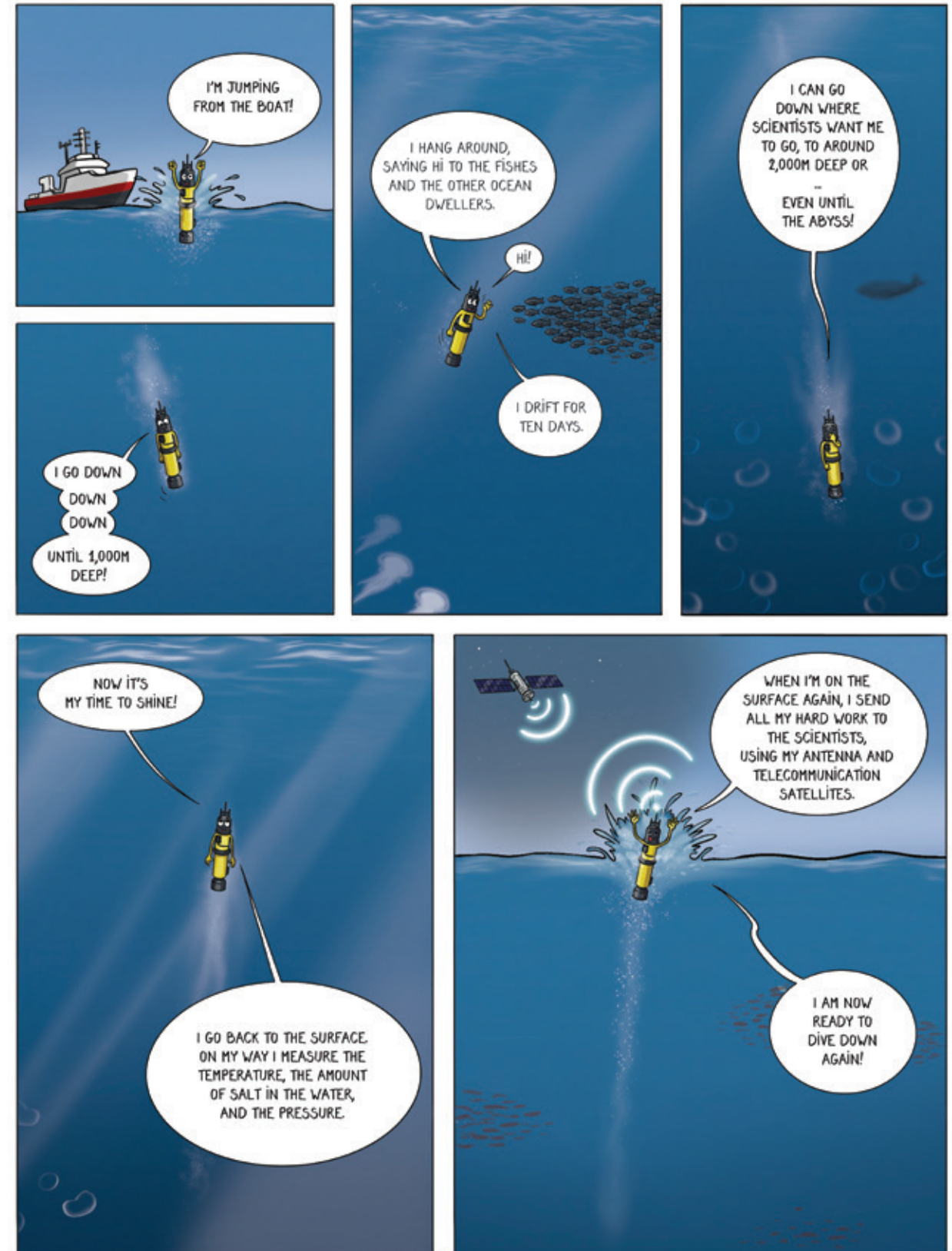
Today, about 4000 profiling floats, like me, called Argo floats, record observations of seawater temperature, salinity and pressure along vertical lines, called profiles. Together with other instruments at sea and observing satellites, we help scientists track marine heatwaves with high accuracy.

I'm a regular float, but in the last few years, oceanographers and engineers have also developed:

- the **Deep float**, which can dive down to 4000 and 6000 m;
- the **Biogeochemical float**, measuring for example the concentration of oxygen in the ocean water, chlorophyll, nitrates, and other biological, geological or chemical ocean properties.



Why do we need to monitor oxygen in the ocean?
Uh oh, is there a problem with oxygen? I'll call the research vessel next to enquire about that!





Hello! Can you explain why it's important to check the concentration of oxygen in the ocean? Is the ocean in trouble?



Well, yes, it is. There is some concern, especially for ecosystems and marine life. You see...



Is the ocean losing oxygen?

Ocean observations have shown that the ocean has lost about 2% of its oxygen since the 1950s. It is in part due to **global warming**: a warmer ocean holds less oxygen and marine organisms have higher oxygen needs when water is warming. Today, scientists have models showing that the ocean will lose between 3% and 4% of its oxygen by 2100. This process is known as **ocean deoxygenation**. The problem is that it's hard work to breathe under the sea, since a given volume of seawater contains much less oxygen than the same volume of air. So, even a small oxygen decrease is very distressing for marine life. Keeping an eye on oxygen levels and understanding the oxygen cycle in the ocean is very important to monitor ocean health.



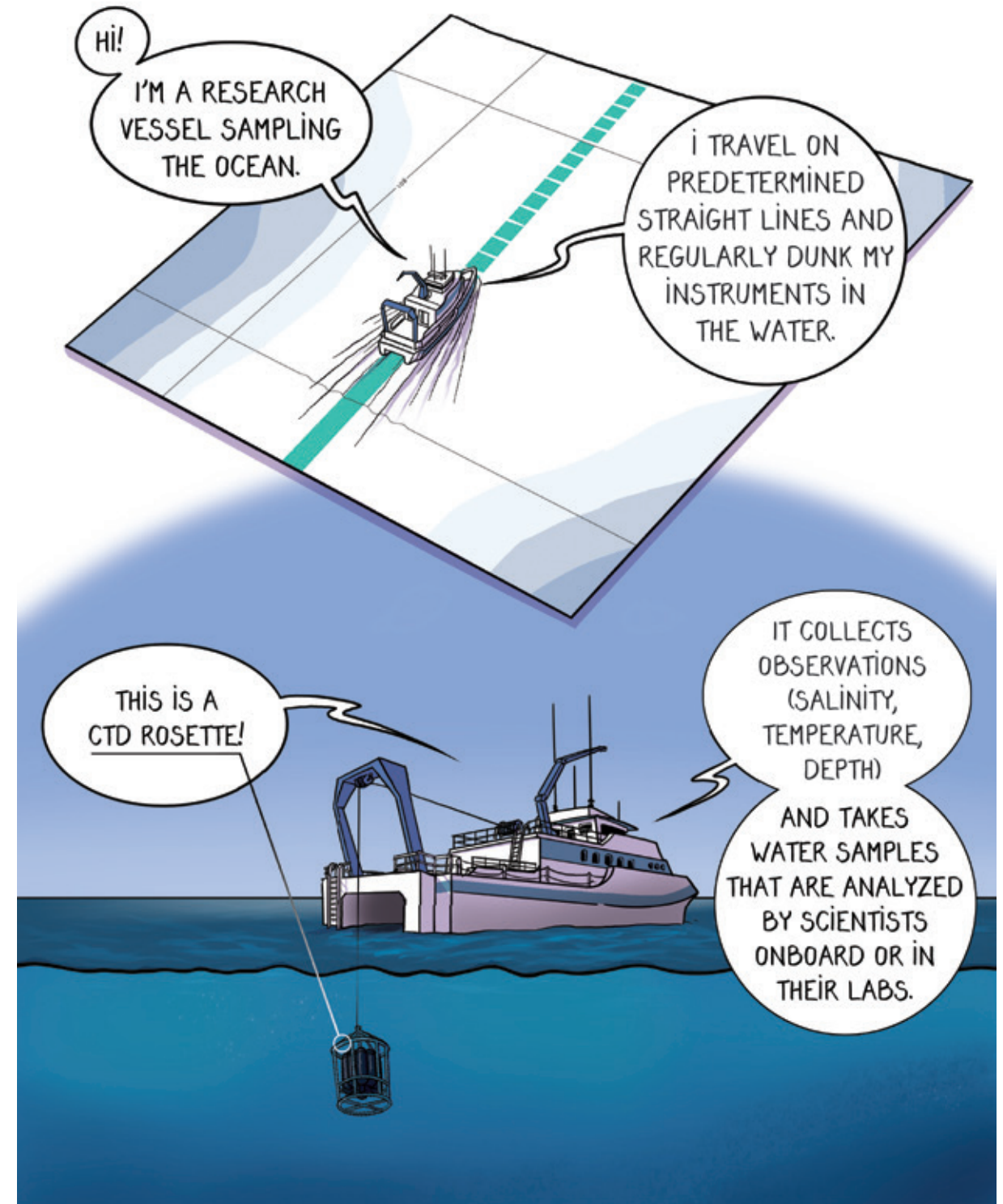
How do research vessels help?

My job is to carry out ocean observing missions to collect high-quality measurements of physical, chemical and biological information over the full water column. Research vessels like me are part of the GO-SHIP programme. Every ten years, we sample the same trajectories spread out in the global ocean. >>>

By carrying the best set of sensors and a qualified team of scientists onboard, we collect and provide very accurate **reference observations** on the distribution and changes in the quantity of heat, salinity, nutrients, and of course oxygen. We can also measure ocean carbon content and provide information on ocean acidity.



Acidity? Is that another problem caused by climate change? Let's ask my next colleague, the interdisciplinary mooring!





Hello! I've heard that we need to monitor acidity in the ocean. Can you tell us about it and how it's linked to climate change?



Hi! Of course, I can! Let's talk a little about chemistry...



How is the ocean becoming more acidic?

As we have already seen, human activities release large amounts of **CO₂** into the atmosphere. A significant portion of this dissolves in seawater, forming carbonic acid. A series of chemical reactions increase **ocean acidity**. These changes have dangerous consequences for marine life and ecosystems. Marine organisms like crabs, mussels and corals use minerals to build their shells and skeletons. Acidity makes these building blocks less available, endangering each organism's growth and well-being. To measure acidity, scientists use a scale called **pH**, from 0 to 14. Ocean waters normally have a pH of around 8 but this is becoming lower, so the water is more acidic.



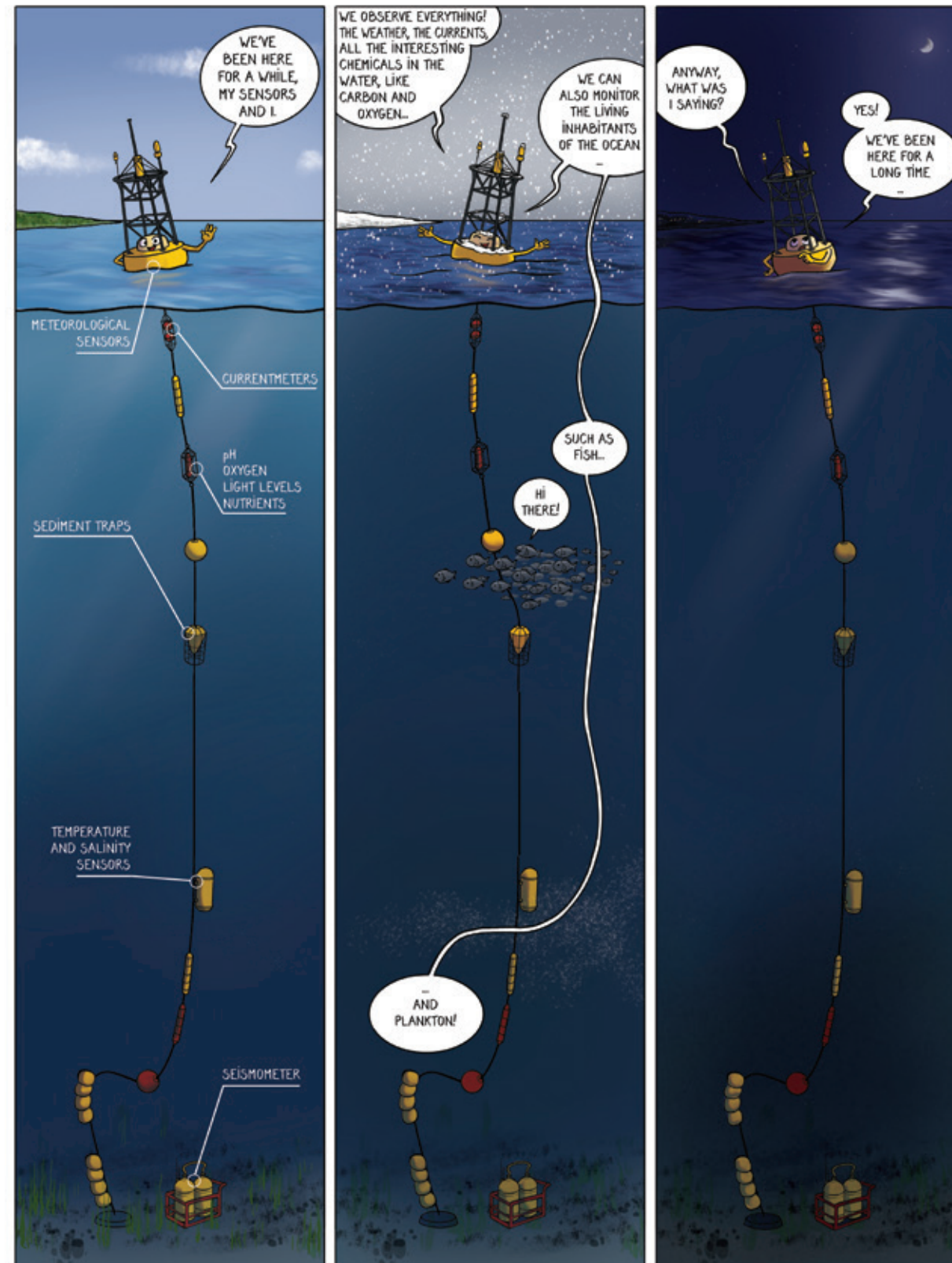
How do interdisciplinary moorings help?

We are stable platforms on which oceanographers and meteorologists can install many different instruments. One of these measures the pH in the water, to monitor ocean acidification. >>>

We are anchored to the sea floor, several thousands of meters deep. We stay in place for many years, between maintenance visits, which helps understand **ocean changes over long periods of time**.



Oxygen, ocean carbon... isn't there another important characteristic of seawater we haven't heard of yet? Let's ask our next colleague about **salinity**!





Hello! It seems you are also new to the network. Do you by any chance measure salinity? Can you tell us more about it?



Hello! You are right. The instrument on my head does it.



Why is measuring ocean salinity important?

► Freshwater is always flowing into and out of the sea through rain, rivers, evaporation and icecap melting, through the **freshwater cycle**.

Monitoring salinity helps understand how freshwater, vital for all life on Earth, moves between the air, the land and the ocean.

► Cold water is denser than warm water, and water with high salinity is denser than water with low salinity. The ocean is always moving in reaction to changes in **water density**. For example, near Greenland and Norway, some of the seawater freezes, leaving salt behind. The cold, salty water sinks to the ocean floor. This water, the North Atlantic Deep Water, is one of the driving forces of the **great conveyor belt**, a giant ocean current which transfers heat and salt around the globe.

Here are two experiments to help you understand

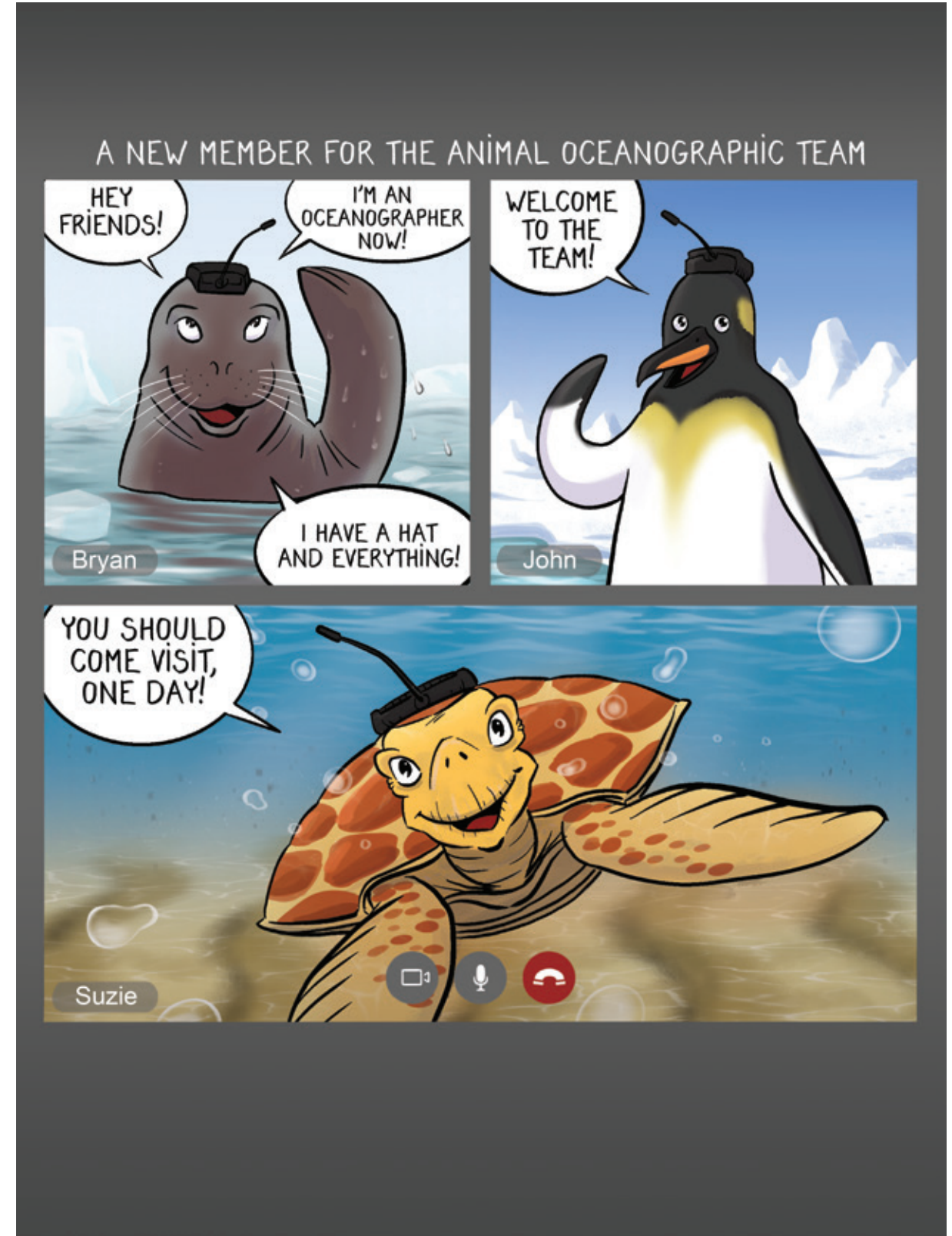


How do animal oceanographers help?

We help scientists to collect physical ocean data like temperature and salinity, but they can also learn about our **habits** and the **ecosystems** we live in. Seals, like me, are popular and helpful animal oceanographers because we are easy to catch and manipulate – scientists take care not to hurt us – and we often live in **undersampled places**, such as the polar regions. Other species that come to the surface to breathe and talk to you, my satellite friend, are also part of our network, like penguins, sea turtles and sharks. >>>



We've learned a lot about the water column, but what happens above the sea surface? Who can tell us about **marine weather**, for example? Let's ask the drifting buoy!





Hello! What's the weather at sea like today?



Hi! Be careful! The weather conditions will not remain calm in the next few hours. Let me tell you how I know that...



How do we provide accurate marine weather forecasts?

The information gathered by most of the instruments at sea helps scientists to improve marine weather forecasts. As we have seen, some provide ocean data over the water column, others like me, help to monitor the sea surface, where the air meets the sea. By measuring atmospheric pressure (using barometric pressure sensors), air and sea temperature, for example, we contribute to **weather bulletins issued in real time**.

Even though our weather forecasting skills keep getting better, extreme weather events still inflict damage on ships, cargo, and even people. It is thus very important to keep gathering information and improve our models to ensure safety at sea!

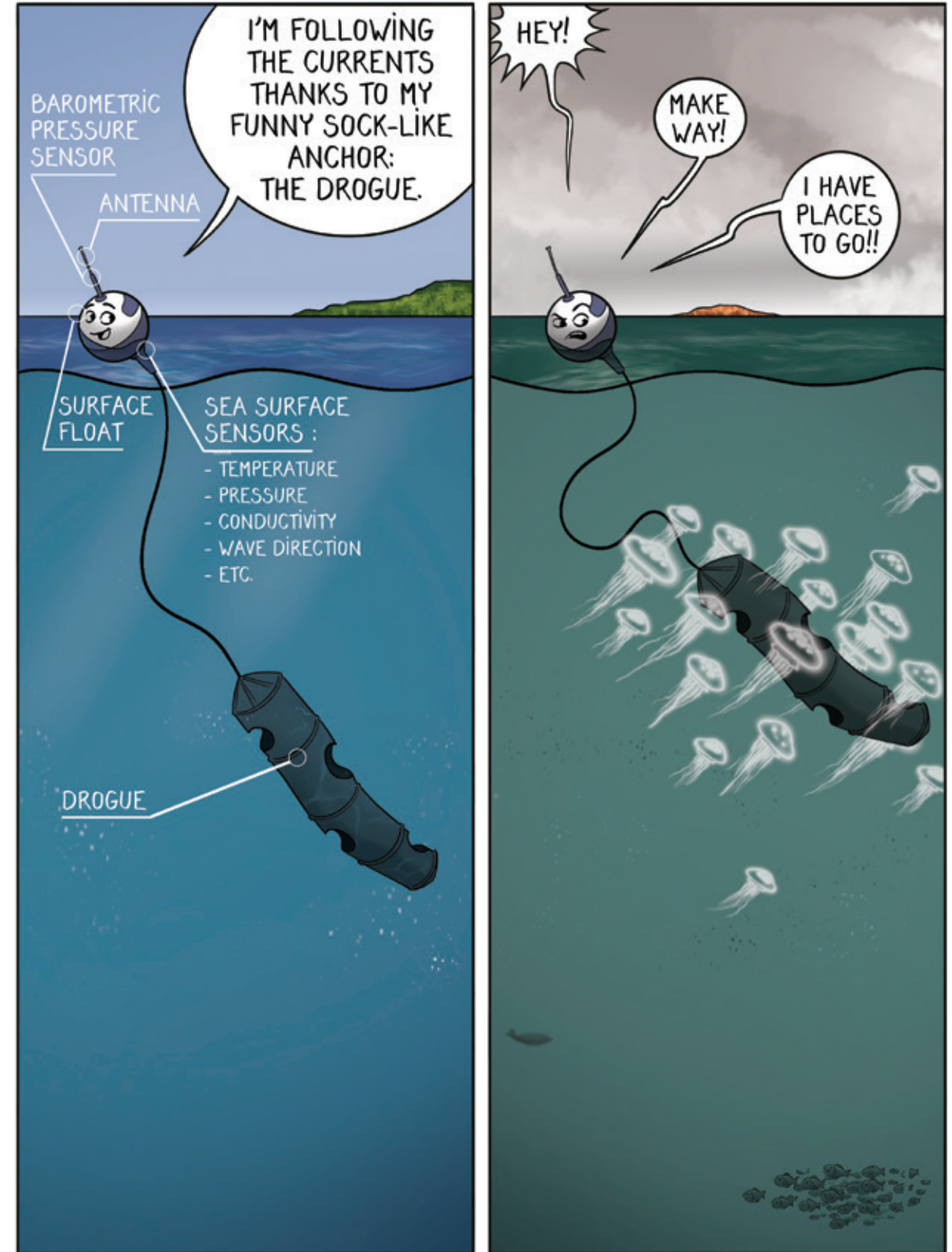


How do drifting buoys help?

We carry several instruments on our hull to measure various parameters like atmospheric and sea surface pressure, sea surface temperature and salinity. I have an anchor – called a **drogue** – drifting below the surface, so that I follow the **water circulation** and not the wind. We all have satellite communication equipment to transmit our ocean data and our position in real-time. >>>



I know that sometimes **the weather becomes extremely dangerous**. Our most fearless colleague, the glider, may have some stories to share!

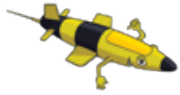




Hello! Is it true you can swim into giant hurricanes?



Yes, it's true! I have an exciting life! Let me tell you more about hurricanes...



How do we predict hurricane intensity?

► **Giant, spiralling tropical storms** with winds of at least 119 kilometers an hour are called **hurricanes** when they develop over the North Atlantic, central and eastern North Pacific, **cyclones** when they form over the South Pacific and Indian Ocean, and **typhoons** when they develop in the Northwest Pacific.

► Hurricane intensity mainly depends on the **heat content** of the ocean. So, if a hurricane passes over a water mass that is really cold, some of the heat can be drawn out of the hurricane, which weakens the hurricane. If the hurricane goes over a body of water that is warmer than the hurricane itself, it can absorb heat out of the ocean and this energy will strengthen the hurricane.



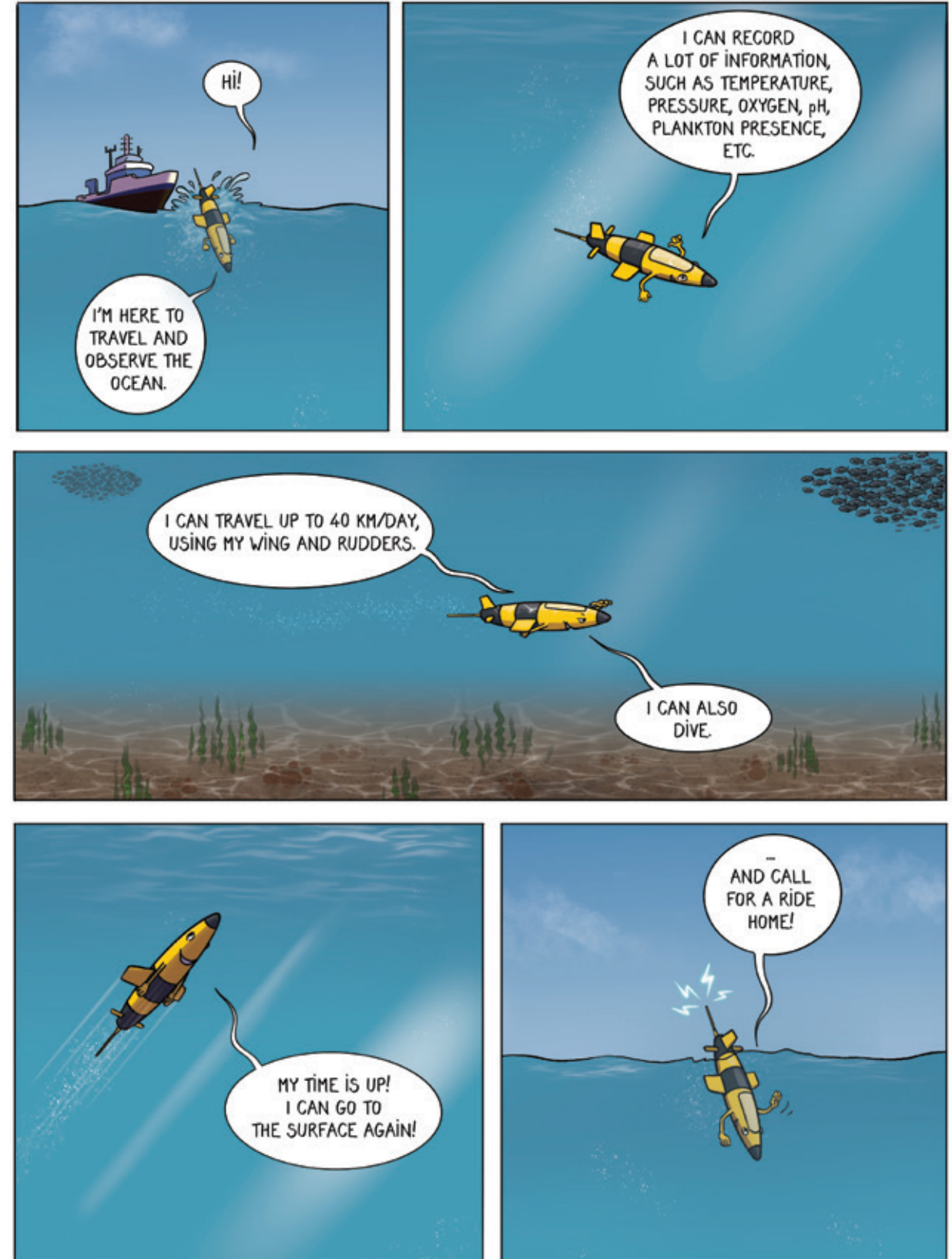
How do autonomous gliders help?

Gliders, by measuring ocean temperatures, look out for the heat content below and in front of the storm. This helps the researchers and forecasters understand the ocean conditions ahead of the storm, the conditions where it will pass over, and what is going on right under the storm.

I'm an autonomous underwater vehicle. I can be deployed near a hurricane and then piloted to get close to its center, where I can dive and provide real-time ocean temperature and salinity data to support hurricane forecasting. This is exciting indeed, but to be honest, I like being deployed in calmer waters and gathering many other ocean observations, to monitor **ocean acidification** and **deoxygenation**, **plankton** and **fish stocks**. >>>



We can observe marine weather in real-time, but can we do the same with local currents? Let's call our vigil on shore, the radar!





Hello! Oh, you look busy, is everything ok?

Right now, I'm on high alert, an oil spill just occurred. Watch out!



How can we look out for oil spills?

Oil spills in the ocean come from boats, oil rigs or pipelines. Oil spills threaten marine life as oil is toxic and animals who end up swallowing it can become sick and more vulnerable.

Unfortunately, a lot of **pollution** ends up in the ocean. Humans also release chemicals and waste into the ocean, posing threats to the marine environment.



How do high-frequency radars help?

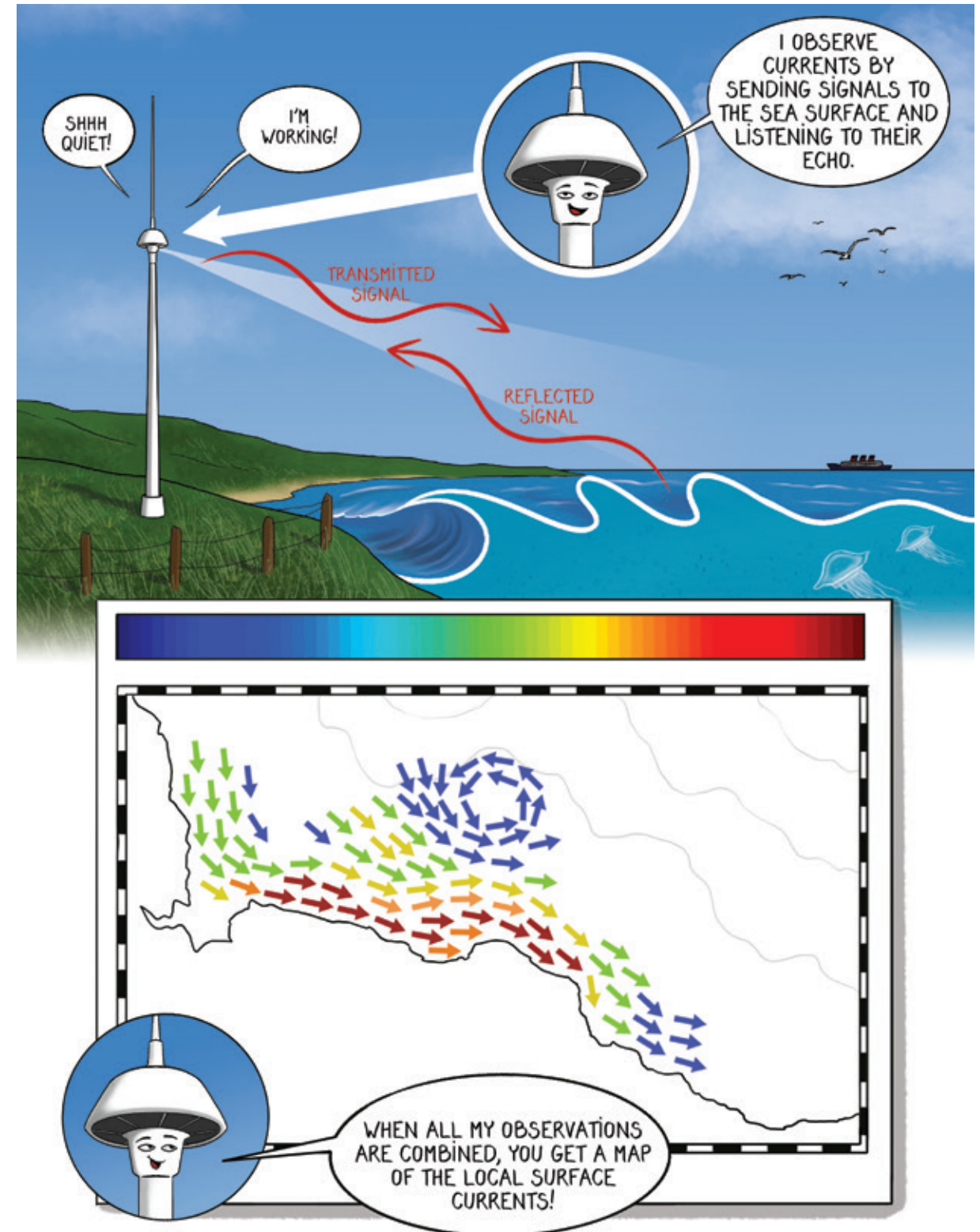
By providing real-time information on the **speed and direction of surface ocean currents**, we help to predict where oil spills flow in the ocean.

Governments can rely on us to focus on the threatened zones and start cleaning up. We also support search and rescue operations, marine shipping navigation, monitoring and tracking harmful algal blooms and coastal water quality monitoring. We can also record the height and direction of the waves, the number of waves in a minute, or the wind direction. >>>

Radar is an acronym for **radio detection and ranging**. It is a system that uses radio signals for finding the exact position of something.



It seems we are able to monitor various kinds of **hazards**, can we also monitor **tsunamis**? Let's ask our last colleague, the moored buoy!





Hello! Can you tell us about your role in the ocean observing team?



I'm part of the moored buoys team and our data help to forecast tsunamis and issue early warnings.



Why do we need early warnings for tsunami waves?

▶ Tsunami waves occur when there is an underwater earthquake, landslide or volcanic eruption. They mostly happen in the Pacific and Indian Ocean. They are a **fast-moving series of waves** that can cause a lot of damage and put people in danger, that's why early warnings are crucial for saving lives.

▶ Early warnings are not limited to tsunami waves. The World Meteorological Organization has launched the **Early Warning for All** initiative, "to ensure that everyone on Earth is protected from hazardous weather, water, or climate events through early warning systems by the end of 2027."

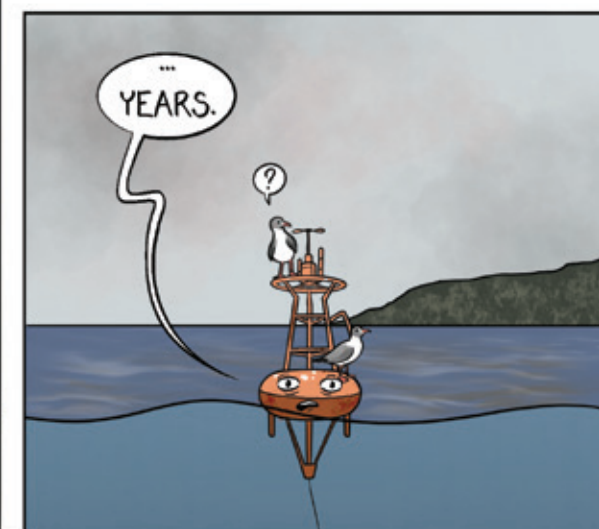
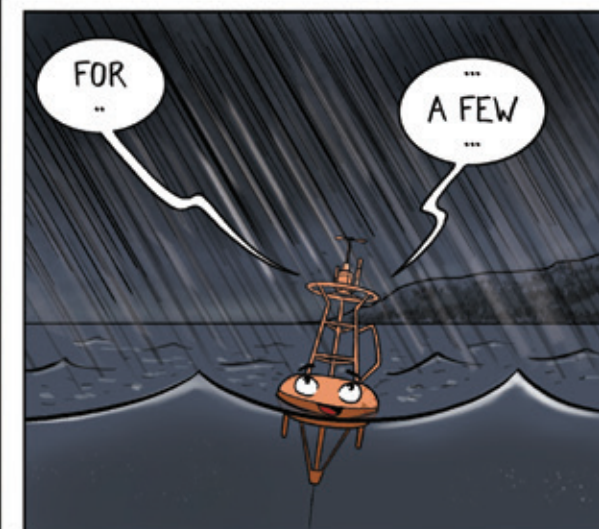
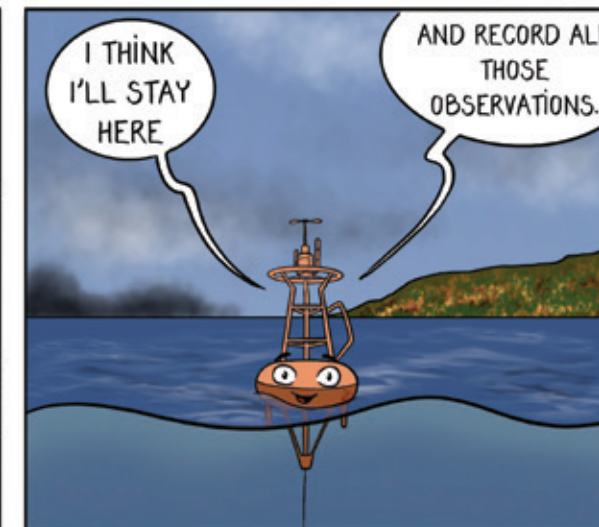
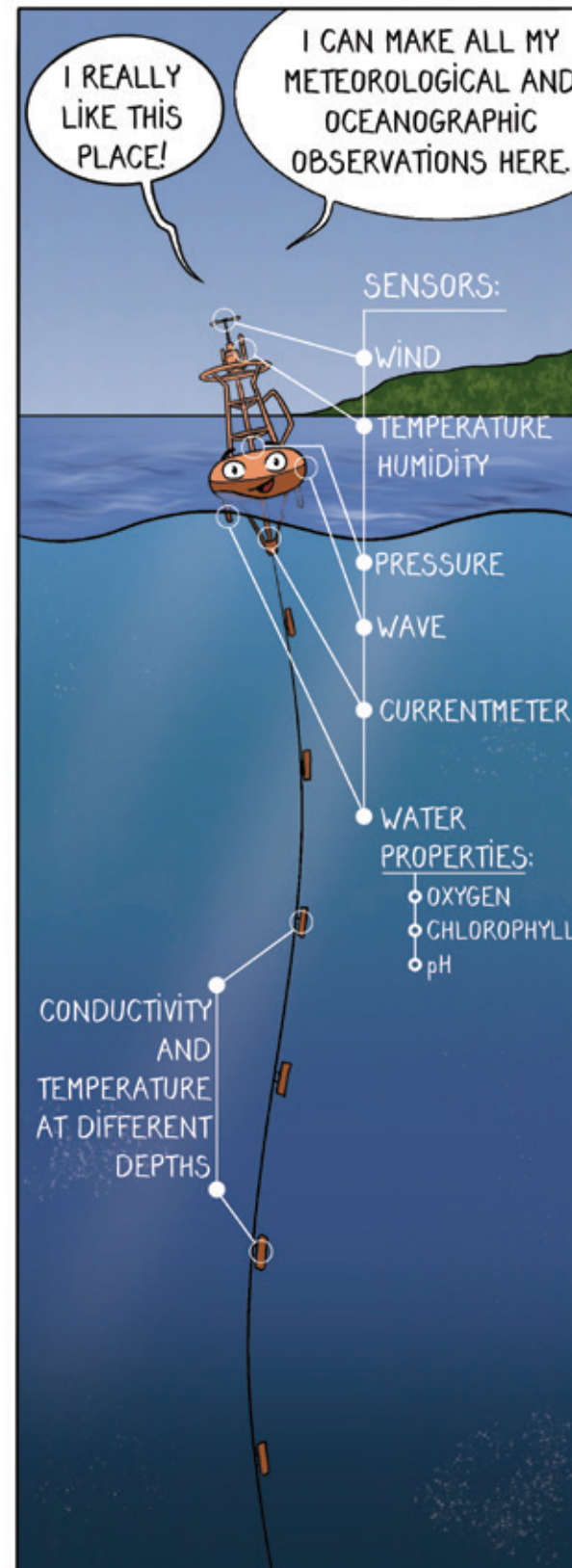


How do moored buoys help?

Many models of buoys exist, varying in size and shape, and carrying different sensors. My colleagues, the tsunami buoys, have a pressure sensor anchored to the sea floor and a surface buoy. The sensor on the seafloor measures the change in the seawater's height above it. This **water height** is communicated to the surface buoy and then relayed via satellite to the tsunami warning centre. Other kind of moored buoys exist, for example, tropical buoys like me are deployed near the tropics in the Pacific, Atlantic and Indian Ocean, and coastal buoys along the shores of North America, Europe, India, East Asia, and Australia. >>>



Well, I think I'm caught up! We should organise a big party to celebrate our collective efforts and raise awareness about the state of our ocean and planet. Let's inspire positive change and work together to find sound solutions for the protection and sustainable management of our ocean, to ensure the preservation of our planet and the well-being of humankind!



WE'RE ALL IN THIS, STRONGER TOGETHER

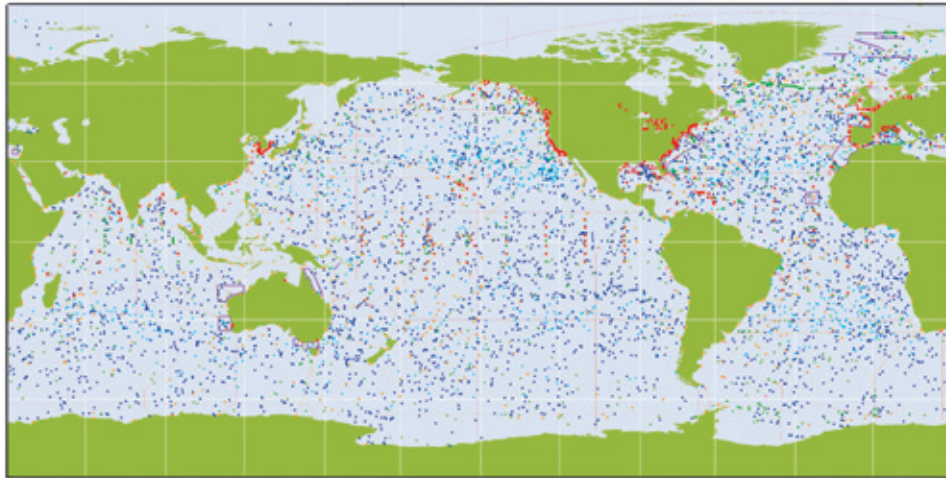
We have decided to have our party on June 8. Why? Because it's **World Ocean Day!** The perfect day to plan an event about the ocean!

But first, we must all meet up. No small feat, since there are so many of us and we are spread out in every ocean!

Did you realise that **ocean observing instruments are patrolling everywhere?!** Let's have a look at the map...

Discover our Global Ocean Observing System

Here we are! About 9 000 ocean observing instruments scattered in all parts of the ocean. All these instruments at sea are helping scientists and experts all around the world to better understand and preserve our ocean.



Mobile systems <ul style="list-style-type: none"> Core floats - Argo Deep floats - Argo Biogeochemical floats - Argo Underwater glider - OceanGlider Drifting buoys - DBCP Polar buoys - DBCP Animal Borne Sensors 	Fixed systems <ul style="list-style-type: none"> Moored buoys - DBCP Tide gauges - DBCP Offshore platforms - DBCP Ocean reference stations - OceanSITES Sea level gauges - GLASS High Frequency radars 	Ship based measurements <ul style="list-style-type: none"> Moored weather station - SOT/WOS Automated weather station - SOT/WOS Biological measurements - SOT/WOAP Reference lines Expendable Bathy/thermographs - SOT/SOOP Rapid hydrography - GO-SHIP
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Generated by ocean-obs.org, 2023-11-06
Adapted for Ocean Observers

Here is our family picture for World Ocean Day!

We always work as a team to take the pulse of the ocean. Each of us can carry out various types of missions, making different ocean observations like those listed below, among many others. This way, we complement each other to provide all the information scientists and experts need.

Want to find out more about our missions?



Flash this code!



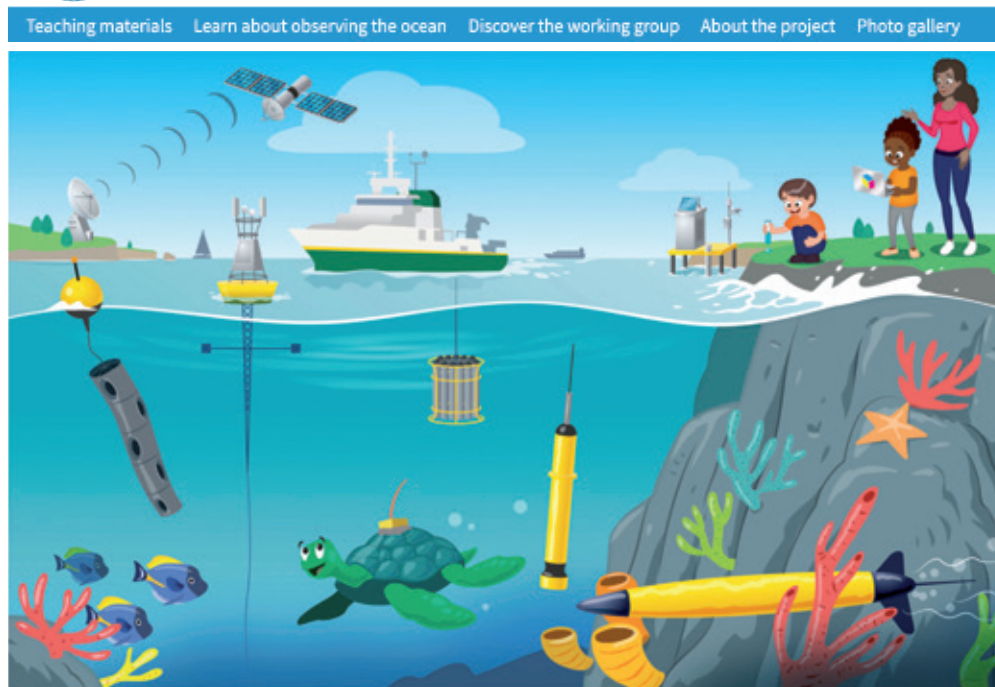
THE OCEAN OBSERVERS INITIATIVE

▶ Discover the Ocean Observers community and website



Ocean Observers
Sharing international marine science educational resources

oceanobservers.org



The Ocean Observers initiative brings together ocean scientists, teachers, students, marine communicators, and all people who are willing to **share marine science educational resources and experiences**, and work towards establishing new international collaborative activities.

The Ocean Observers website is an **open-access ocean observation learning platform**. It hosts resources mainly in English. Some of them are also available in other languages such as Spanish, Catalan, French, German, Italian and Portuguese. The teaching materials comprise a lot of **on-hands experiments**, easily done at home or at school, with videos and illustrations.

▶ Here are a few examples of the teaching resources you can find. Dive in, there are plenty more!

	How to understand and model tides Individual activity Duration: 1 hour Type of activity: writing, modelization Language: English Networks: GLOSS		Identify the ocean observing networks Individual activity Duration: 10 min Type of activity: online or downloadable game Language: English Networks: OceanGliders, AniBOS, DBC buoys, GO-SHIP, Argo floats, OceanSITES, GLOSS
	How do Argo floats observe the oceans? Individual activity Duration: 1 hour Type of activity: online quiz Language: English Networks: Argo floats		Experiment how an Argo float moves [video] Individual or group activity Duration: 40 min Type of activity: experiment Language: English Networks: Argo floats
	Sea Science series with Mark Langtry [videos] Individual or group activity Duration: viewing 4 x 10 min Type of activity: documentary, experiments Language: English Networks: all networks		

▶ Do you want to join the team and help out?
You are very welcome!

- ▶ You can contribute by showing respect for the ocean, taking care of it, and you can consider participating in events like World Ocean Day!
- ▶ You can study to become an oceanographer. Every flavour exists: biologist, chemist, physicist... all of these can be applied to the ocean!
- ▶ You can tell everyone around you what you have learned about the ocean, and if you want to know more, you can visit the Ocean Observers platform www.oceanobservers.org and take part in the initiative.



This book is part of the Ocean Observers initiative oceanobservers.org

The Ocean Observers initiative is jointly led by **OceanOPS** - a joint center of the World Meteorological Organization and the Intergovernmental Oceanographic Commission of UNESCO which monitors and supports the implementation of the Global Ocean Observing System - and **Euro-Argo ERIC** which coordinates the European contribution to the Argo Programme.

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Ocean Observers, 2023

