STUDENT BOOK

FOLLOW THE GLIDER

DISCOVER THE OCEAN´S SECRETS WITH UNDERWATER GLIDERS

SOCIB Balearic Islands Coastal Observing and Forecasting System
JERICO next
Cefas

Follow the Glider is an educational tool developed by CEFAS (Centre for Environment, Fisheries & Aquaculture Science), IMEDEA (Mediterranean Institute for Advanced Studies, UIB-CSIC), and SOCIB (Balearic Islands Coastal Observation and Forecasting System) as part of the FP7–JERICO European project, and is based on the glider monitoring tool that is avaliable at www.socib.es and has been adapted for student use at http://followtheglider.socib.es/en/

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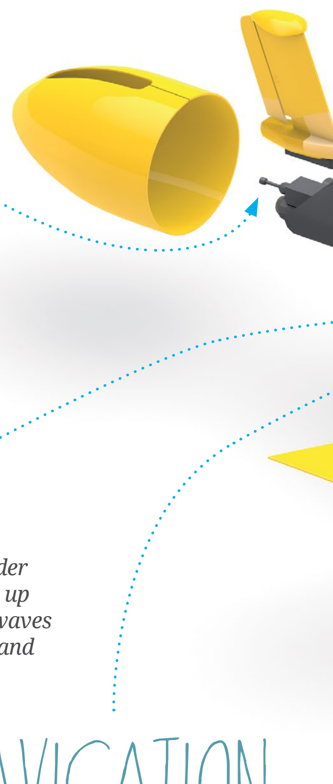
1. WHAT IS A GLIDER*

Underwater gliders are used to observe the seas and the oceans. Scientists place them in the water and the gliders collect interesting data about the temperature, the amount of salt and oxygen in the water, and so forth. They do so by using sensors that measure that information and much more (depth, etc.)

Look, this is what a glider looks like on the inside!



RUDDER*

Steers the glider in a given direction.

ANTENNA

Allows the glider to send data to the lab and receives information to make changes to the mission.

BLADDER

Very close to the antenna. When the glider comes up to the surface the bladder fills up with air. This lifts the glider's tail so that waves don't cover the antenna and it can send and receive data without interference.

NAVIGATION BAY*

This is the part of the processor in charge of the glider's navigation device.

Watch the vídeo

http://followtheglider.socib.es/en/estudiantes/whatisaglider/

** Look up the words with a red asterisk in the glossary*

Interesting info

1. *They use very little energy because they glide; they don't have an engine or propellors.*

2. *They can dive as deep as 1000 metres.*

3. *They can go as fast as 10-20 centimetres per second in vertical motion, but if the currents help them along, they can go up to 1 kilometre an hour.*

4. *They send data to the lab via their antenna which are also used to receive data.*

SCIENCE BAY*

This is the part of the processor in charge of the scientific sensors.

PISTON

Fills up and releases water, making the glider dive or surface. When it fills up, the glider dives. When it empties out, the space fills up with air and the glider floats to the surface.

WINGS

Enable the glider to advance underwater.

SENSORS*

Used to measure water temperature, salt content, chlorophyll, oxygen, the distance from the sea floor, etc.

BATTERIES

Lithium or alkaline batteries, which power the glider. Thebatteries also move back and forth insidethe glider, If they move forwards, they helpit dive. If they move backwards, they helpit to surface.

PROS AND CONS

There are other ways of getting data about the sea. One of them is organising an expedition with several scientists boarding a boat and sailing off for several days, weeks, or even months, to take all kinds of measurements. What are the advantages and disadvantages of using underwater gliders instead of other means, such as boats?

ADVANTAGES

- They work 24 hours a day, 7 days a week.
- They cover large distances.
- They can go on long-term missions.
- They're autonomous, unmanned systems, so you don't need a large number of people on board, as you would on a boat. Therefore, they're much cheaper!
- They can carry several different sensors which measure all kinds of data (temperature, salinity*, chlorophyll*, oxygen and even sounds!)
- They allow us to collect data practically in real-time.

DISADVANTAGES

- They move very slowly.
- They can only dive to 1,000 metres. They can't go any deeper!
- They can't take samples on the spot. They don't have an arm that can take sand or water samples, for example. They can only collect data!
- Their sensors are still quite low-resolution compared to the ones available on boats.
- The technology is very new. They're still in the prototype stage, so things don't always work properly.
- Watch out! Danger! They can run into fishing nets, plastic objects, or collide with the sea floor or boats.

2. HOW DOES IT WORK

How does it surface and dive in the water

1. An underwater glider has a piston. When it wants to dive, it fills the piston up and sinks.
2. When it wants to come back up to the surface, it releases the water from the piston.
3. The space that held the water fills up with air, and that makes the glider rise.
4. It's like an inflatable rubber ring: when it's full of air, it floats, and when it isn't, it sinks.

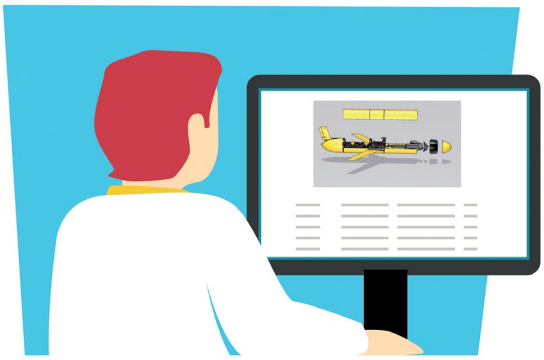
Watch the vídeo

http://followtheglider.socib.es/en/estudiantes/howitworks/

A glider's journey, step by step.

LAB

The scientist decides on the glider's mission and the engineer, who is also the pilot, inputs the data into its operating system: route, deepest dive, how often it will get in touch with the base, what data it will collect and how often, what information to transmit, etc.



LAUNCHING AND NAVIGATING

Once we've put the glider in the water, first it sinks and then it ascends. During the entire mission, it keeps on going up and down like this. As it sinks and surfaces, it collects data. A set of alkaline or lithium batteries provide the power it needs to move. It doesn't have propellers or a motor, so it doesn't use up a lot of energy. So we could ask, "How does it move along?" It does so by using its wings. As the glider goes up and down, the wings convert this to forward motion in the water. If it has to change course*, it uses the rudder attached to its tail.

DATA TRANSMISSION

When the glider comes up to the surface, it connects its antenna, and sends the data it has collected via satellite. If necessary, it receives new orders. Its GPS* helps it find its way, detects whether the currents have set it off course*, and points it in the right direction.

HOW LONG DO THE BATTERIES LAST?

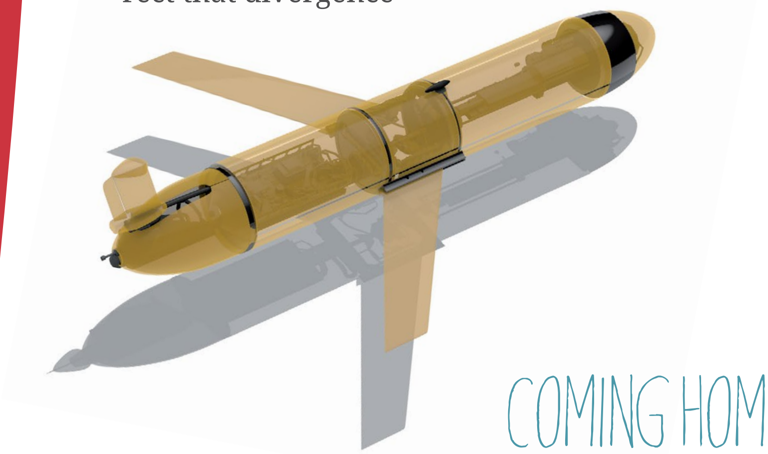
A glider doesn't have a motor. It gets the power it needs from alkaline or lithium batteries and uses as little battery power as a mobile phone.

Battery life depends on...

- The type of battery: lithium batteries last longer.
- The environment: gliding against the current uses more power.
- The mission: if the glider has to dive deep, activate a large number of sensors, or send data many times a day, it uses more power.

What happens if it goes off course*?

Ocean currents can set a glider off course. When it realises what's going on, the glider can correct its "mistake": for example, if it thinks there have been currents heading south, it will head further north to correct that divergence



End of the mission

The mission ends because...

- That was the way it was planned.
- Something very serious happens, like a mechanical failure.
- The batteries run out.
- If a storm is coming, we give the glider the order to dive down, avoid the storm, and wait until it passes to continue its mission. But if there's a long stretch of bad weather ahead we must get the glider back straight away!

COMING HOME

With any luck, the glider will get home on its own, but that may use a lot of battery power, so we have to work it all out well in advance, so the glider doesn't end up stranded.

Sometimes it's worth continuing to collect scientific data even if a glider's batteries have run out. In this case, when the power is all used up, we set out to find the glider, wherever it may be. This isn't always easy!

WE´VE GOT A PROBLEM!

There are many dangers out there while a glider's on a mission:

If any of this happens, we must suspend the mission and rescue the glider!

DANGERS:

Mechanical or software failures.

Collisions with boats, fishing nets, and buoys...

Poor-quality batteries.

Communications failures caused by the glider itself or by the satellites.

Low-density waters that don't allow the glider to get back up to the surface.

Unwanted fellow travelers, such as mollusks or remoras*, that stick onto the glider and stop it from moving forwards.

3. WHAT DOES IT MEASURE

An underwater glider measures different things in the seawater: some are physical (the amount of salt, the temperature) and others are biochemical (the amount of oxygen or chlorophyll in the water).

Physical parameters: salt and temperature

Do you think the amount of salt in the water is the same everywhere in the sea? And that the temperature is the same, too? Well, it isn't!

The water that flows into the Mediterranean from the Atlantic Ocean through the straits of Gibraltar contains less salt. On the other hand, the water in the eastern Mediterranean is saltier. Why do you think that? In the eastern Mediterranean, there's more evaporation, and if more water evaporates, the proportion of salt left in the water is higher.

And why would we want to know about the water's temperature and salt content?

Seawater is not the same on the surface as in the depths. On the surface, it's not very dense. Density depends on salt and temperature, among other things. So when we measure its temperature and salinity, we find out about the changes in the water's density. These changes affect marine currents. If we have that information, we can find out more about how currents move.

We can also find out more about the weather's influence on the sea. For example, if it rains, the surface water cools down. If the weather's very hot, the surface water warms up. This also has an effect on marine currents.

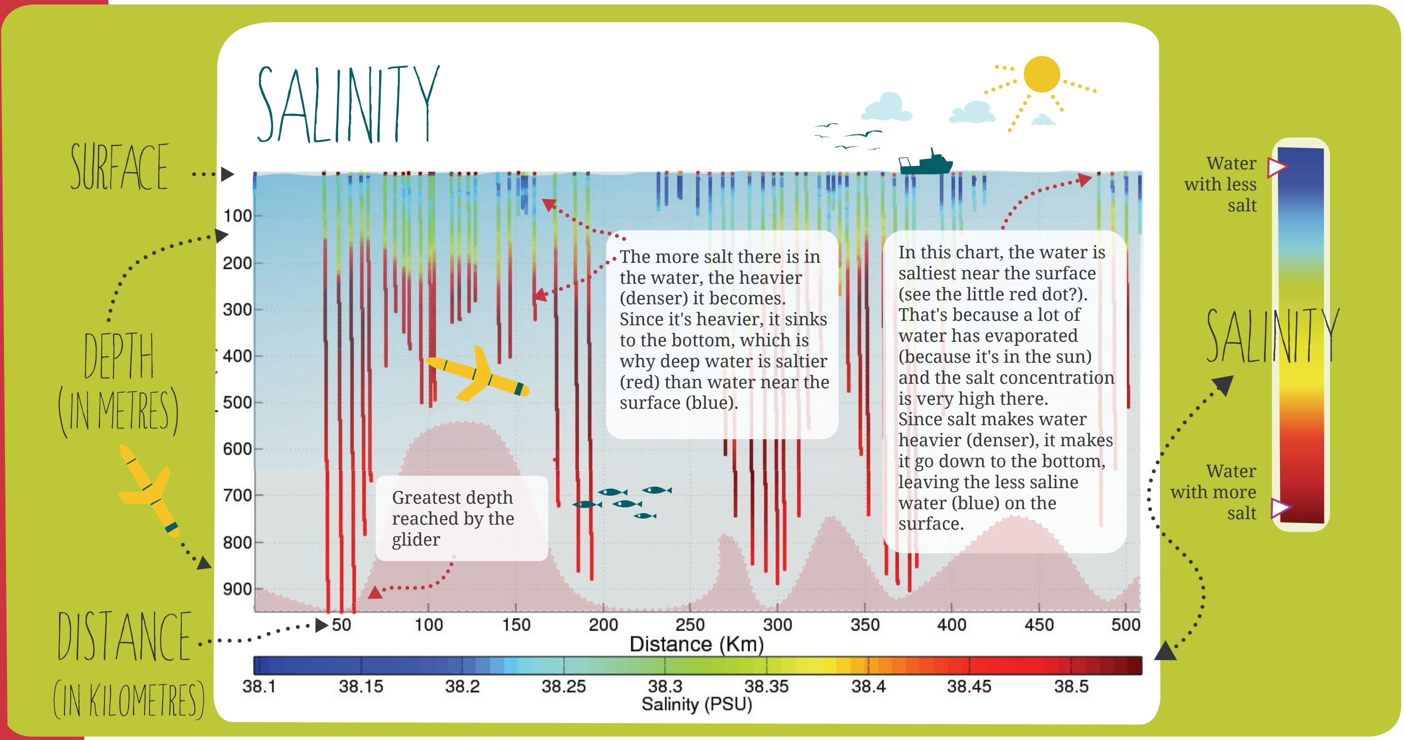
Biochemical parameters*: oxygen and chlorophyll

The oxygen and chlorophyll* in seawater are very important for marine ecosystems. Oxygen is what most animals and plants need to survive. Chlorophyll helps us to know how much phytoplankton is in the water. Phytoplankton are small organisms (like tiny algae) that photosynthesise and contain chlorophyll. So, if there's a lot of chlorophyll in the water, it means there's lots of phytoplankton. Do you think that's important? Definitely, because so much marine life feeds on phytoplankton! Phytoplankton also absorb large amounts of C02, they're like a forest in the sea, the "ocean's lungs."

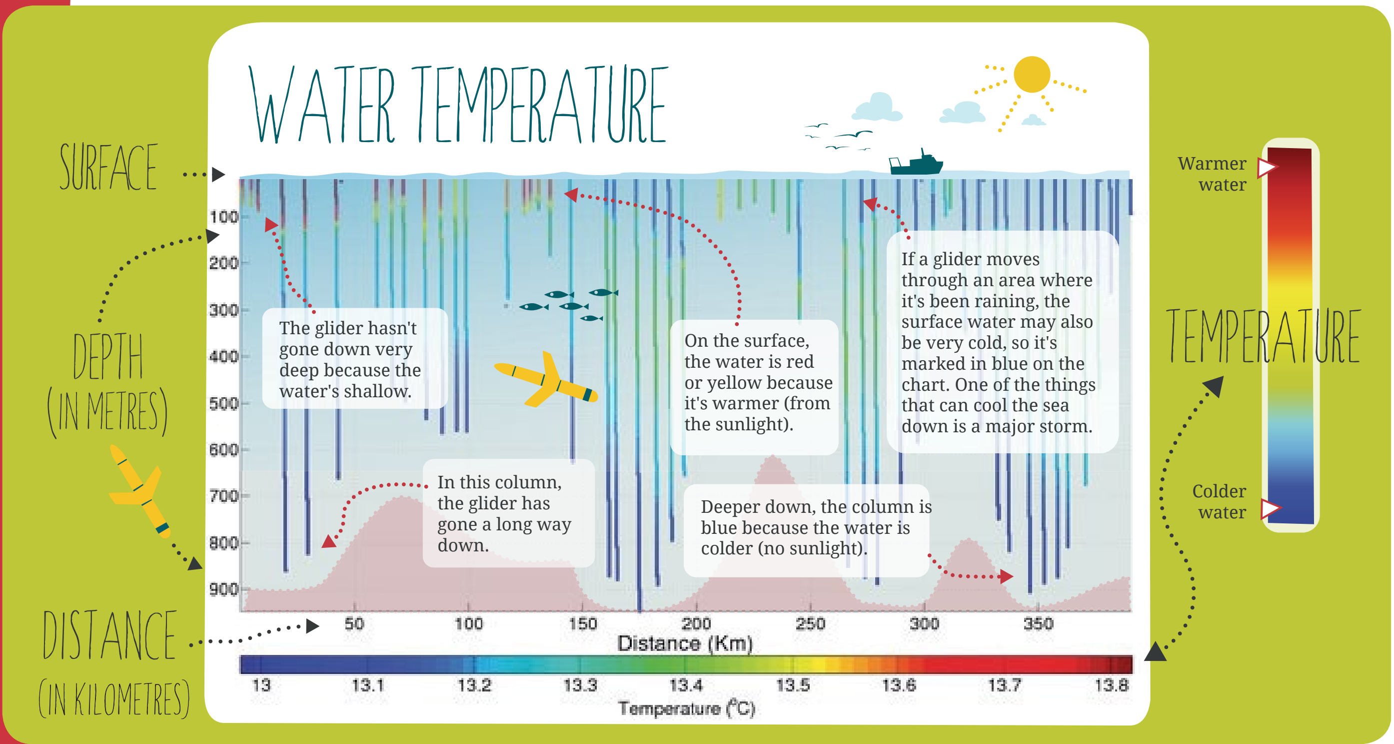
** Look up the words with a red asterisk in the glossary*

How do we read the data we receive from a glider?

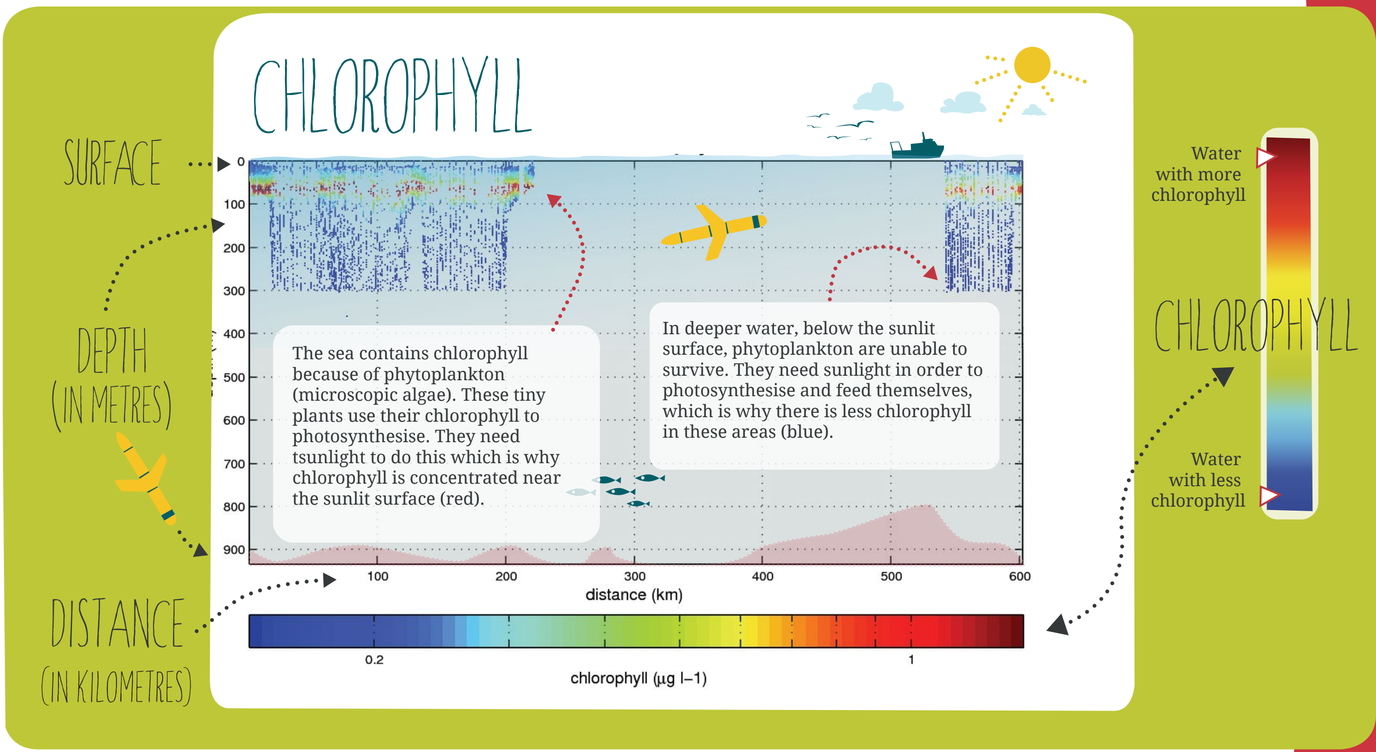
We use the data we receive from a glider to put together charts. They seem hard to read, but it's actually easier than you think.



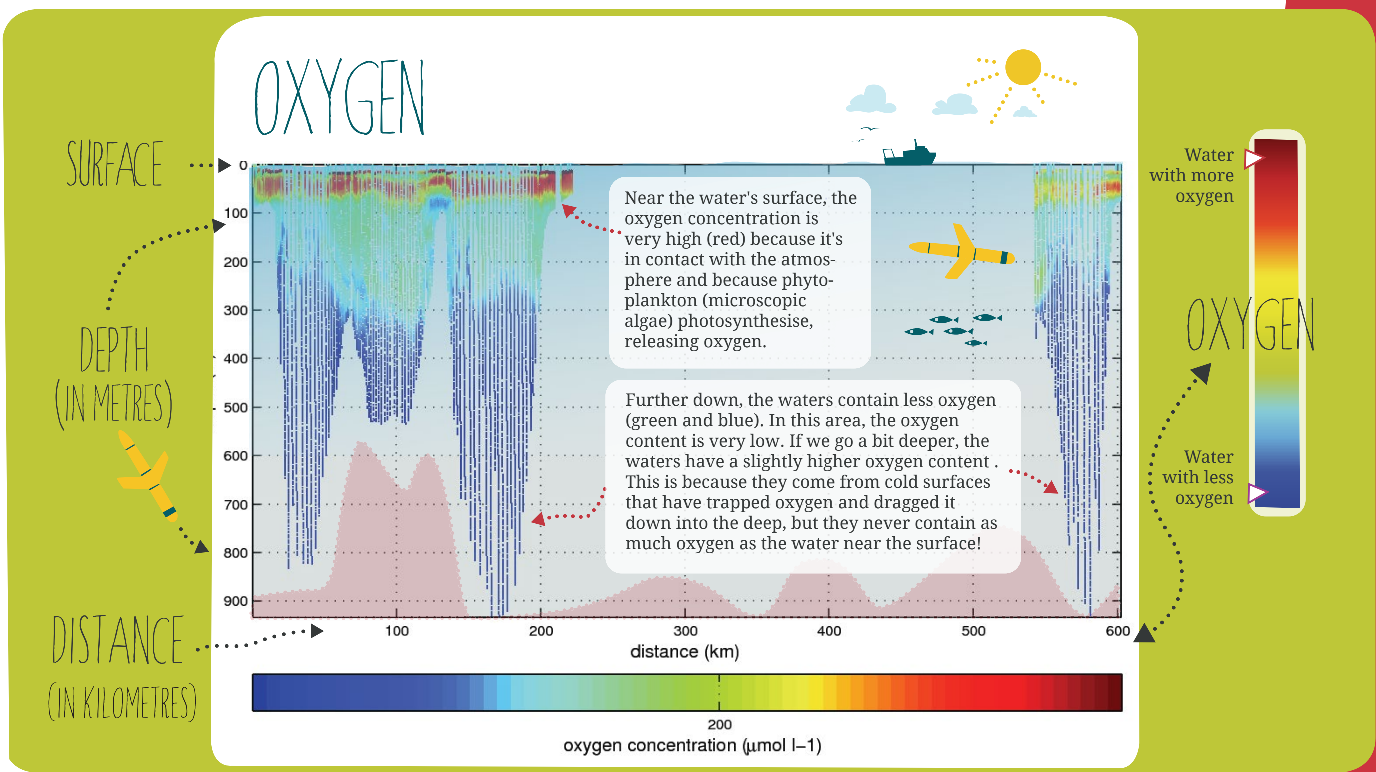
This is a chart showing the sea's temperature: each column shows the glider's course over several kilometres. Some columns are deeper than others. That's because the glider doesn't always reach the same depth. Do you know why? It's because the sea floor isn't flat. Sometimes there are underwater mountains and the glider can't go any deeper - it would crash into the seabed.



This is a chlorophyll chart, showing how much chlorophyll is in the water. The water with more chlorophyll is shown in red and the water with less chlorophyll is in blue.



This is an oxygen concentration chart, showing how much oxygen is in the water. The water with more oxygen is shown in red and the water with less oxygen is green and blue.



4 WHAT IS IT FOR

We're used to seeing how weather works, with its high and low pressure areas, its storms and so on. Things are very similar in the sea and it's important to know how currents and eddies work in order to come up with forecasting models. These models enable us to do things such as:

- Know in what direction an oil spill is going to move. If we know where it's heading, we can try to contain it so that it does the least possible damage to the environment.
- Know how the oceans are reacting to climate change.
- Know how severe winter storms affect the sea. These extreme phenomena can have an impact on marine ecosystems.
- In the future, gliders will have more advanced sensors that will allow us to measure nitrites, nitrates, pH, alkalinity, etc. This will allow us to take better care of our Marine Protected Areas, among other things*.

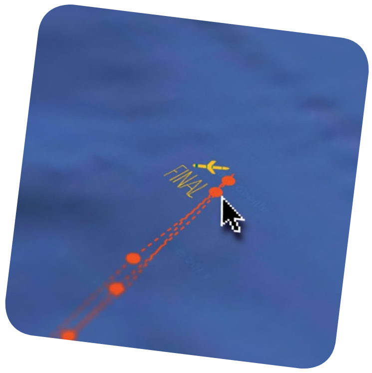
The www.followtheglider.com Gliders

The gliders you see on this website are the ones we use in the area around the Balearic Islands. This area is an important crossroads between the waters of the Gulf of Leon, to the north, and the Alboran Sea to the south. The channels of Ibiza and Mallorca let in water with lower salinity coming from the Atlantic Ocean, which mixes with saltier water coming from the currents of the northern Mediterranean Sea. The crossing of these currents makes the waters much richer in nutrients, with a high concentration of larvae from many species, such as bluefin tuna.

We need to find out how it all works so we can preserve this wealth. That's what gliders are for. Before they existed, scientists went out on boats several times a year to take measurements. In winter, bad weather made it harder and considerably more expensive. Now, using gliders, we have much more information that has helped us find out that changes in the main currents happen faster than we had imagined.

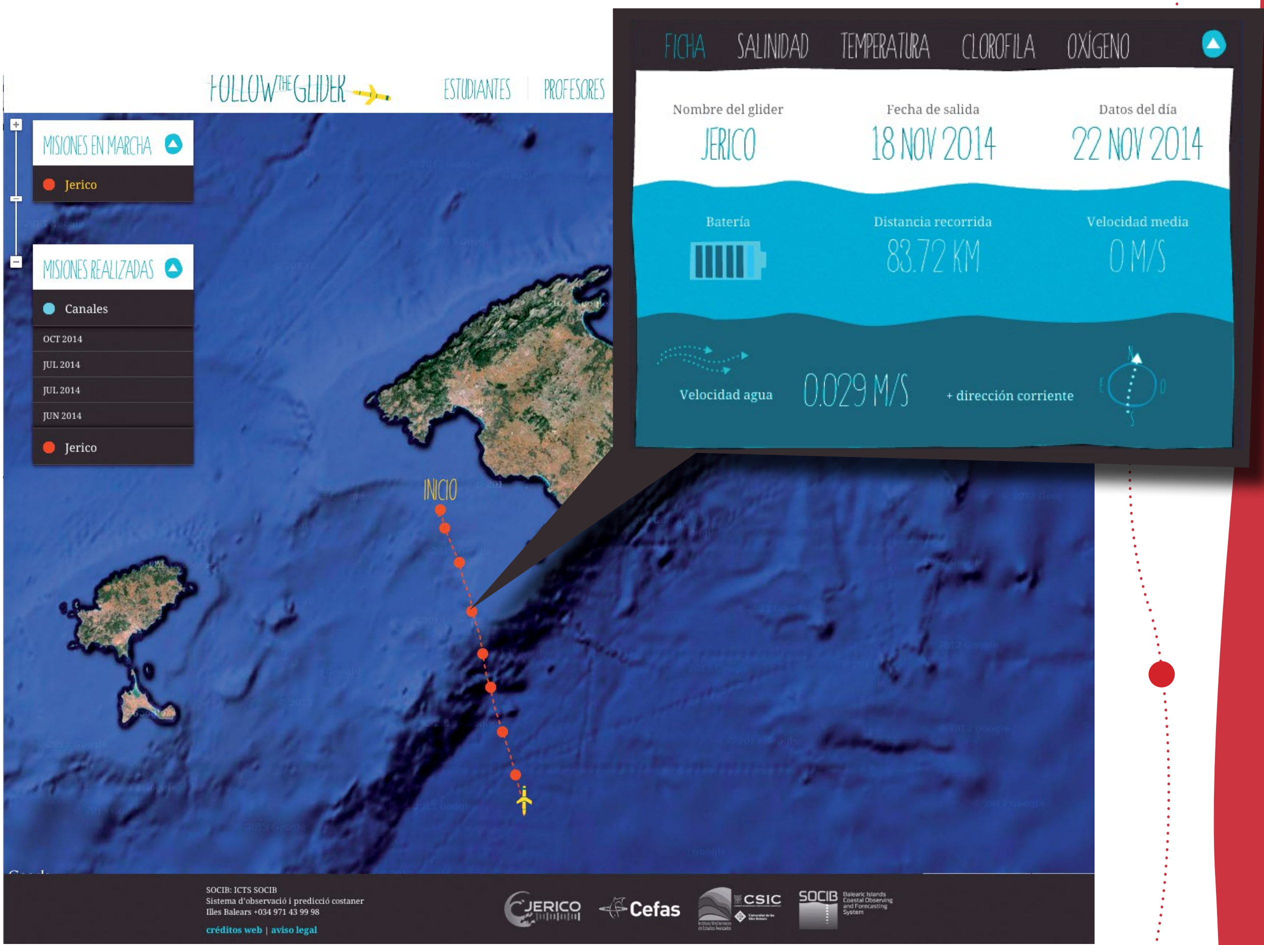
** Look up the words with a red asterisk in the glossary*

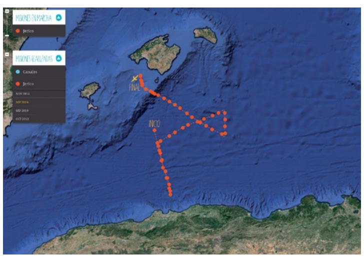
5 EXPLORE THE OCEAN

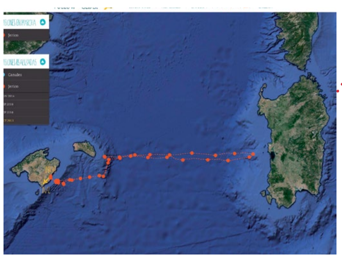


WHERE ARE OUR GLIDERS SAILING TODAY?

FOLLOW THEM AT WWW.FOLLOWTHEGLIDER.COM

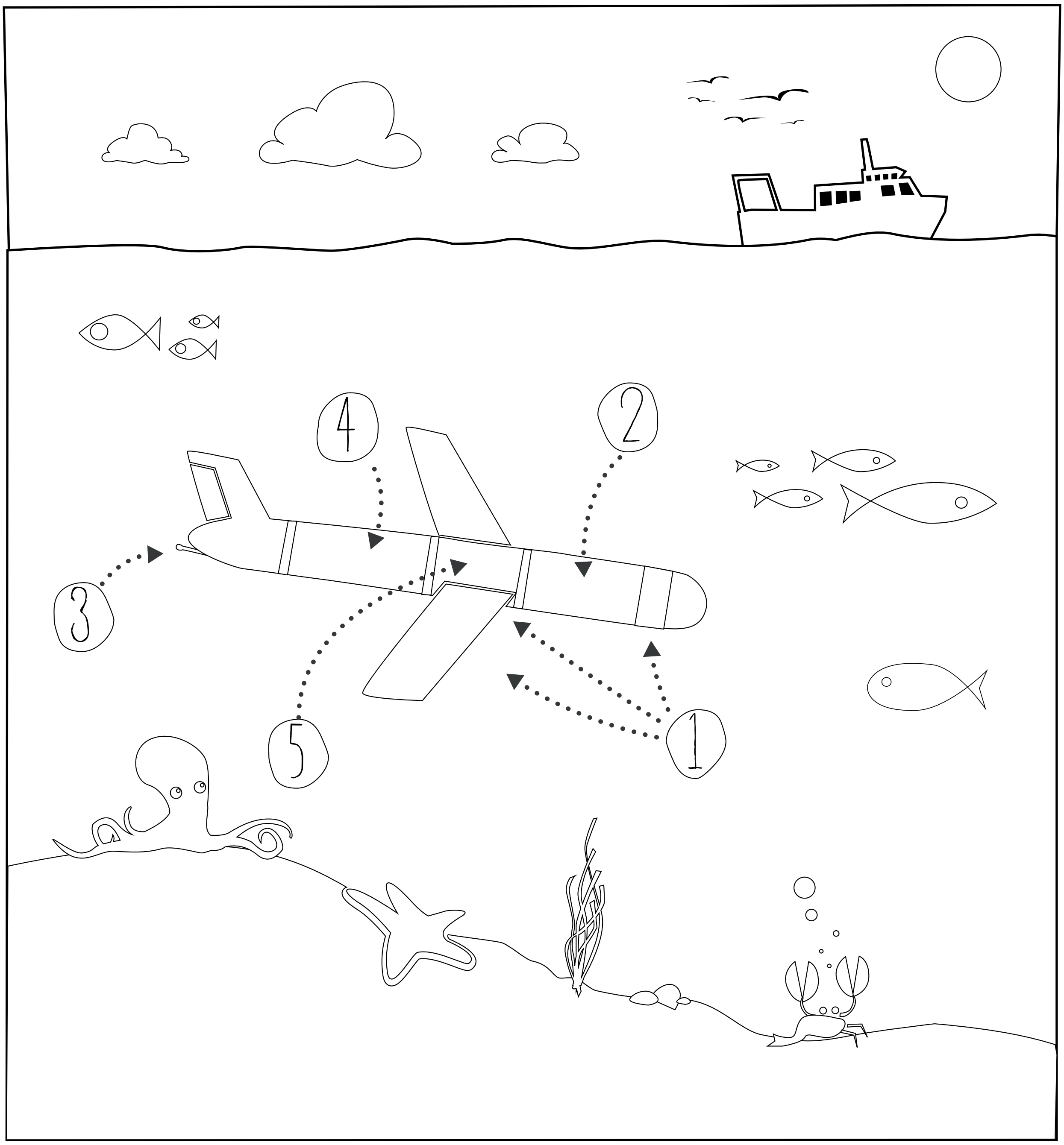






1 ACTIVITY

Discover a glider and follow it



◯	**Piston**
◯	**Antenna**
◯	**Navigation bay**
◯	**Scientific bay**
◯	**Sensors**

1. Colour the glider and label its parts.
2. Choose one of the gliders that are on the "Explore" map and follow its course day by day.
   What do you see?
   How does the water temperature change?
   What about the salt in the water?
   What clues do the chlorophyll and oxygen data give you?

You're a glider pilot and have to make a few decisions.

1. Do you have to put fuel in the glider before it leaves?

* Before you answer, look at the "Setup and Programming" micro-video that you will find at www.followtheglider.com, under Teachers/Additional material.

* You can also look at the "How it works" section in the STUDENT BOOK and on the website.

a. No, you don't. The glider doesn't need fuel because it glides and uses batteries.
b. Yes, it needs fuel so it can surface and dive in the sea..

2. The glider has gone off course. What should you do?

* Before you answer, watch the "Monitoring" micro-video that you will find at www.followtheglider.com, under Teachers/Additional material.

* You can also look at the "How it works" section in the STUDENT BOOK and on the website.

a. Just let it keep on going.
b. Send it new data so it can get back on the right course.
c. Bring it back before it gets lost.

3. The glider is very far from home. It's collecting really interesting data, but it's almost out of battery power. What are your options?

a. It's probably not a big deal. Keep on going.
b. Dive down deep and wait until the storm passes.
c. Come home, it's really dangerous!

4. A storm is approaching. What orders should you send to the glider?

a. It's probably not a big deal. Keep on going.
b. Dive down deep and wait until the storm passes.
c. Come home, it's really dangerous!

5. The glider's motor has broken down. What should you do?

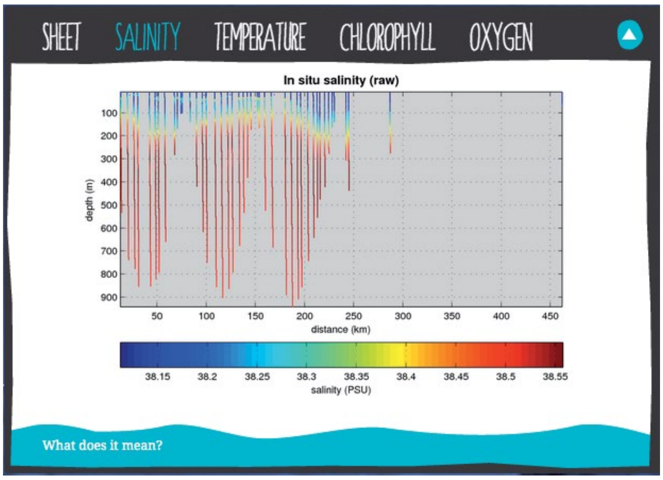
*** Look at the diagram showing the parts of a glider in the "What is a glider?" section in the STUDENT BOOK and on the website.**

a. Send a mechanic out to repair it.
b. That's impossible. Gliders don't have motors; they glide!

6. The glider has sent you this graph showing the salt in the water. Point out where the following are.

*** Before you answer, look at the "Data Analysis" micro-video that you will find at www.followtheglider.com, under Teachers/Additional material.**

*** Check out the information about interpreting graphs and charts in the "What it measures" section in the STUDENT BOOK and on the website.**



a. The surface water.
b. The bottom of the sea.
c. The saltiest water.
d. The least salty water.

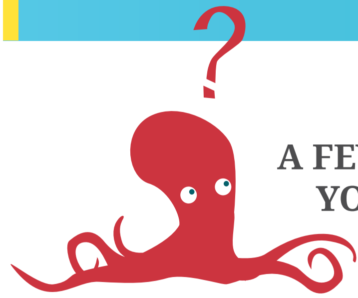
7. The glider is moving along on very warm surface water. Suddenly, it starts raining hard. What do you think will happen?

a. The water on the surface will cool down.
b. The water on the surface will stay just as warm.

8. The sea can be a very dangerous place for a glider. What dangers do you think it can encounter when it's on a mission?

*** Before you answer, watch the "Rescue" micro-video that you will find at www.followtheglider.com, under Teachers/Additional material.**

9. What do you think gliders are for?



A FEW THINGS YOU SHOULD KNOW BEFORE YOU CONTINUE WITH THE ACTIVITIES

How does a glider move if it doesn't have a motor?

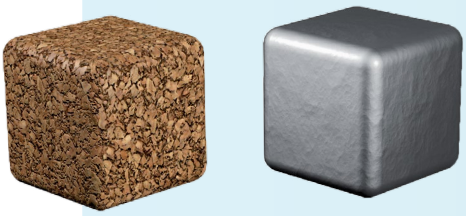
Gliders are very energy efficient, because they use small changes in buoyancy to move

up and down in the water without the need for a motor or fuel. The submarine has a piston, and when it wants to dive, the piston lets seawater into the glider. This increases its density, so it sinks. The wings on its sides enable it to glide ahead like a plane. When the glider wants to go up to the surface, the piston pushes out the seawater, the glider's density decreases, and it rises.

Watch the video you'll find at www.followtheglider.com, under "How it works."

What is density?

Density refers to how much mass there is in a ce-rtain volume. Even if two objects are the same size, if one has more mass than the other, it will be denser. For example, lead is denser than cork.



How is density related to buoyancy?

Buoyancy is an object's ability to float in a liquid. One object will float above another one if it is less dense. The density of lead is 11.35g/cm3; it is 0.24g/cm3 for cork, and 1g/cm3 for water. Therefore, cork will float on water, but lead will not.

What is the density of seawater?

The density of seawater varies according to its salinity and its tempera-ture. Seawater is denser than freshwater; the saltier the water, the denser it is. Temperature also has an effect on density: cold water is denser than warm water. This determines ocean circulations, which is the movement of masses of water within the ocean.

Salinity

Surface salinity depends primarily on evaporation and rainfall. In tropical zones, where evaporation is greater than rainfall, seawater is very salty on the surface. However, in coastal areas near the mouths of rivers, salinity is lower. At the North and South Poles, when the ice melts during the summer season, salinity is also very low.

Temperature

The water temperature depends on the amount of heat absorbed from solar radiation and the amount of heat released from the sea to the atmosphere.

How does a glider move through water without a propeller?
Let's find out with the following experiment

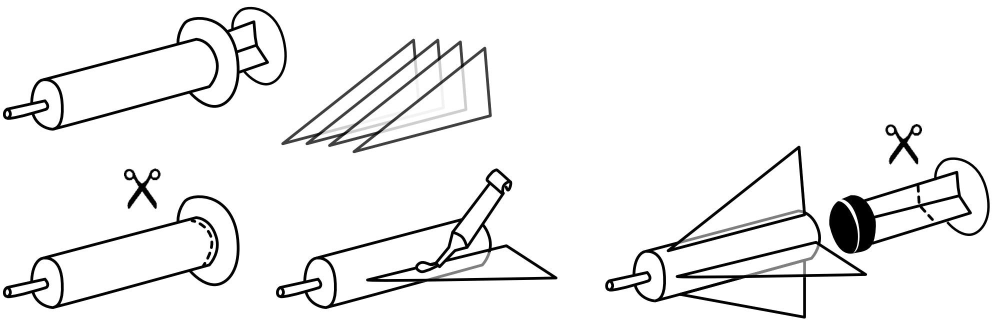
We are going to build a glider to see how changes in density make it move down and how wings make it glide ahead in the water.

Read the previous explanations about density, salinity, temperature, and buoyancy as they relate to gliders.

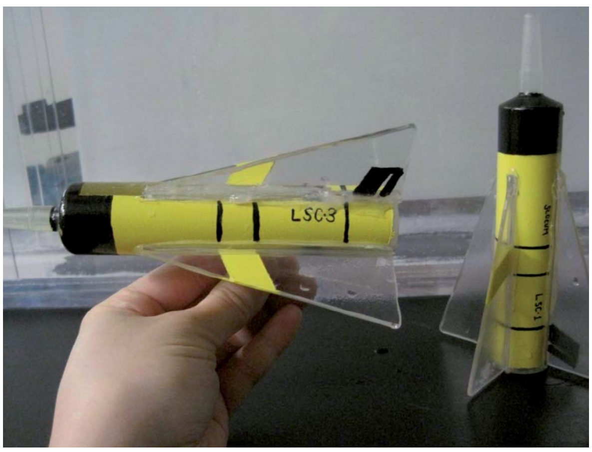
MATERIALS REQUIRED

A large fish tank filled with fresh water, coarse salt, kitchen scales, two 60cc syringes, Perspex, scissors, saw, hot glue (or other strong glue), black and yellow electrical tape, and one large measuring cup.

CONSTRUCTION



1. First, cut the plunger of the syringe so it is about 2.5 cm long.
2. Cut off any of the excess plastic at the back of the syringe. This modified syringe will form the body of the model glider.
3. Next, form the glider wings by cutting 4 Perspex triangular shapes that are 10 to 11.5 cm long and 3 cm high. Although real ocean gliders only have two wings, for stability this model needs four wings.



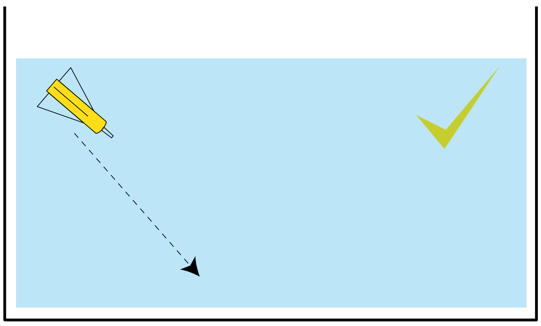
4. Glue the wings to the syringe body at 90º angles positioned at north, south, east, and west. It is important to make sure that the wings are straight on the tube lengthwise, and as close as possible to a right angle on the syringe.
5. Lastly, use black and yellow electrical tape to "paint" the syringe and make it look like a real glider.

Activity written by Kate Florio, Liberty Science Center

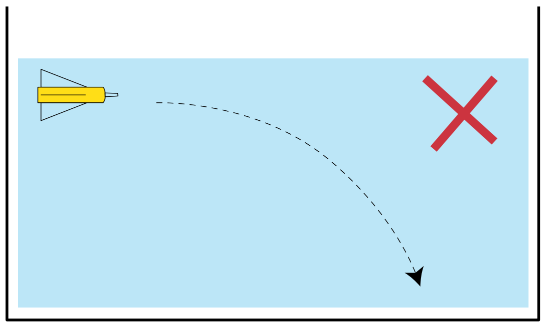
EXPERIMENT

1. Fill the fish tank with fresh water to about ten centimetres from the top.
2. Fill the large measuring cup about halfway with fresh water. Add a handful or two of salt and stir well. The salt should be coarse-grained and additive-free.
3. Use the syringe to fill one of the gliders you built with the saltwater mixture. Hold it upright and press up on the plunger with your finger to remove any air bubbles.
4. Take another one of the gliders you built, either empty or with a small amount of water inside it.
5. Test fly the gliders by placing them horizontal in the tank (at the surface if it is water filled or near the bottom if empty/air filled) and giving a slight forward push before you release them. The glider should sink nose first, not tail first.

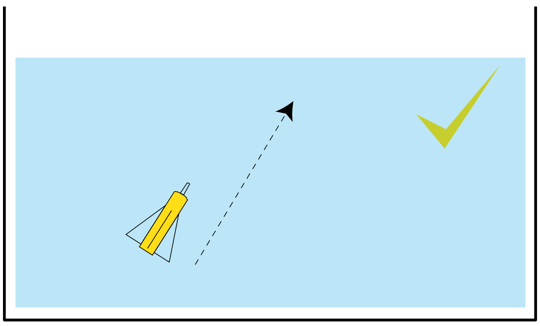
Diving should look like this:



And not this:



Surfacing should look like this:



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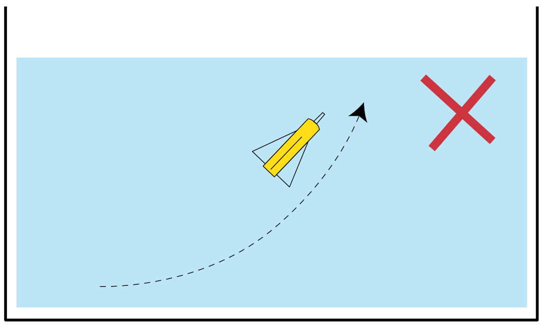


6. Which of the gliders has a higher density?

4 ACTIVITY

The amazing story of the floating egg and the coloured ice cubes

Read the previous explanations about density, salinity, temperature, and buoyancy before performing the following experiments.

1 THE EGG THAT FLOATS... OR DOESN'T

MATERIALS

Two large, clear glasses, salt, water, and two raw eggs.

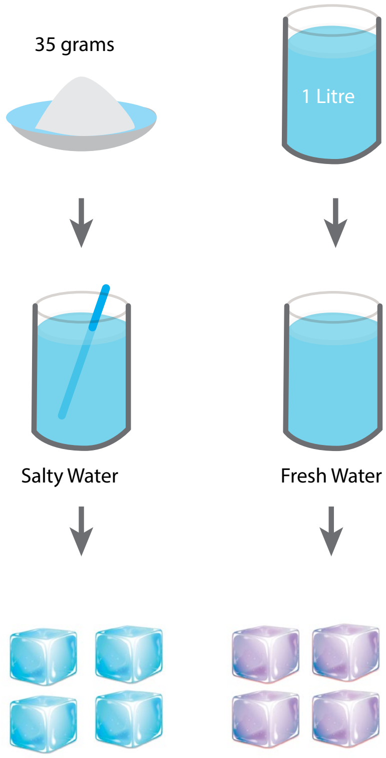
EXPERIMENT

1. Fill a large, clear glass with tap water and place an egg in it. What happens?
2. Fill another identical glass with tap water and add a good amount of salt. Stir it in. Place an egg in the glass. What happens?
3. Why does one egg float and the other one sink?
4. Why is saltwater denser than fresh water? Look for the answer online.
5. How do you think this affects the glider?

If you have time, you can take the experiment one step further following this video: http://youtu.be/VAevsIHDnhQ

Watch the vídeo

2. THE COLOURED ICE CUBES



Make ice cubes the day before. Pour water coloured using the food colouring into one half of the tray. Using a different colour, pour very salty water into the other half of the tray (35 grams of salt per one liter of water, which is the average amount of salt in seawater).

MATERIALS

Fish tank or large, deep glass container, water, ice cubes made by the teacher with water, salt, and food colouring.

EXPERIMENT

1. Fill the fish tank with tap water. Allow the water a minute or two to settle.
2. Gently add one cube of each color into the water. Before you do it, come up with a working hypothesis - What do you think will happen when you add the ice cubes?
3. Describe and explain what happens.
4. What ice cubes sink faster? Which sink slower? Why?

5 ACTIVITY The water layer trick

How does seawater mix? Is seawater the same everywhere? Let's find out with an experiment.

Stratification

In the ocean, masses of water form layers according to their densities. This is what we refer to as the water column, from where the glider collects data. In areas of open ocean, the water column usually has three different layers:

1) At the top there is a layer of warm, less dense water.

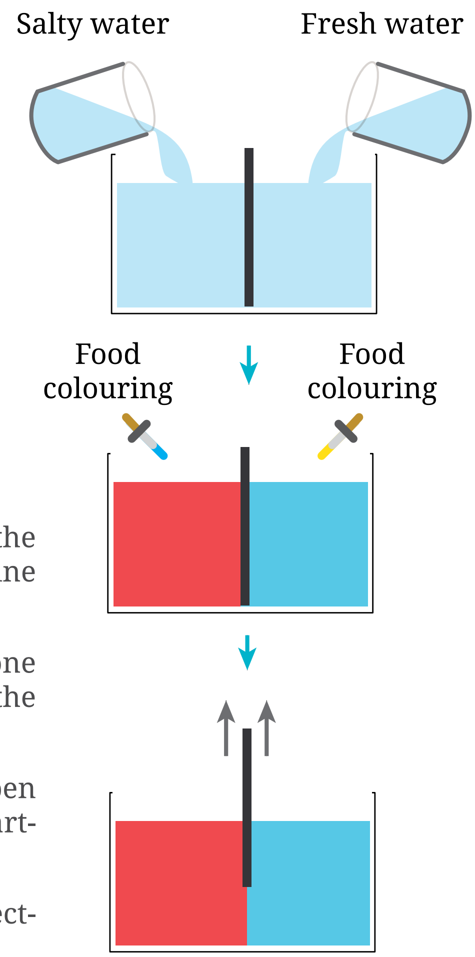
2) Next, there is a thermocline: an area where the water cools down and its density quickly increases with depth.

3) Lastly, there is a deep layer of denser, colder water, whose density increases with depth.

In the open ocean, the difference in density depends on temperature above all. However, in coastal areas near the mouths of rivers and in polar regions where ice forms or melts, salinity is very important for determining water density and stratification.

MATERIAL

- Rectangular fish tank with a divider panel
- Bottle of water with dissolved salt (about 75 grams of salt dissolved in 1 litre of water)
- Food colouring in two different colours
- Ice
- Measuring cups



EXPERIMENT

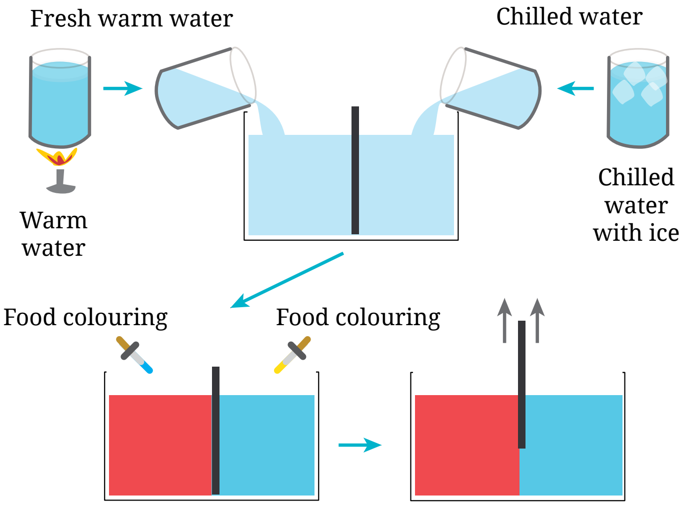
EXPERIMENT 1

1. Fill the measuring cup with tap water.
2. Pour that tap water into one of the compartments in the divided tank. Pour the contents of the bottle with the saline solution into the other compartment.
3. Add a few drops of food colouring of one colour in one compartment and a few drops of another colour into the other compartment.
4. Generate a hypothesis: What do you think will happen when you remove the divider between the two compartments? Why? Which water is denser?
5. Remove the divider. What happens? Is it what you expected?

EXPERIMENT 2

We are going to repeat the experiment, but instead of using fresh water and saltwater, we will use cold water and warm water..

1. Pour warm water into one compartment and chilled water into the other one.
2. Put a few drops of food colouring of one colour in one compartment and a few drops of another colour in the other compartment.
3. Come up with a hypothesis: What do you think will happen when you remove the divider between the two compartments? Why? Which water is denser?
4. Remove the divider. What happens? Is it what you expected?



The Ibiza Channel

There are places in the ocean where large masses of water come together, with different densities, temperatures, and salinities. This has consequences for the entire ecosystem and ocean climate in that location. One of those special places is the Ibiza Channel. Water masses from the Atlantic and the Mediterranean meet there, with the changes in density associated with temperature and salinity. Have a look at the following articles and you will see how the data provided by gliders help us learn how this confluence of waters works and what consequences it has for some animal species, such as the Atlantic bluefin tuna.

http://www.diariodeibiza.es/diario-verano/2013/01/04/biza-grifo-mediterraneo/597012.html

http://www.diariodeibiza.es/diario-verano/2013/01/04/atunes-encuentran-balears-calor-necesitan-desovar/597014.html

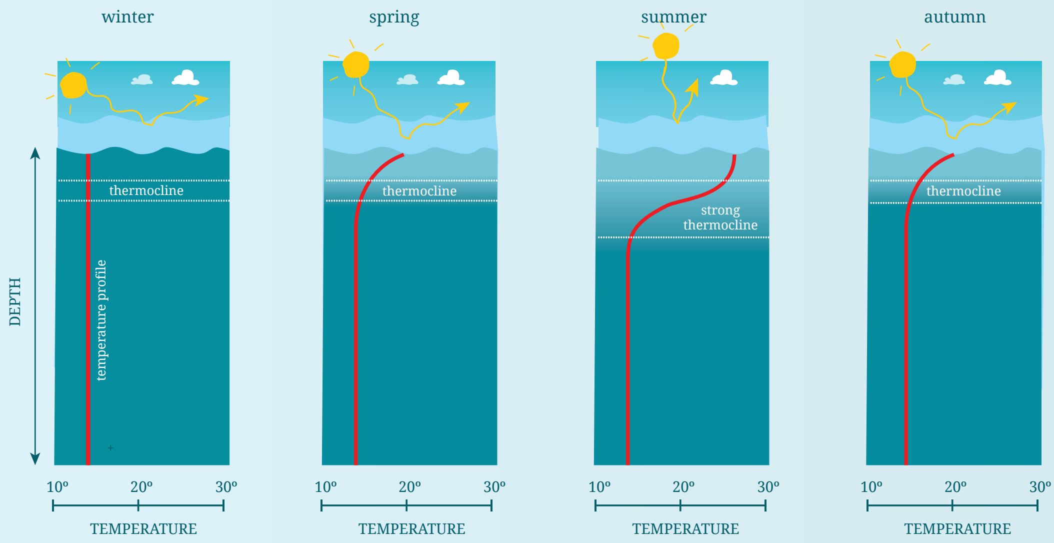
6 ACTIVITY

The Thermocline: a transition zone

Masses of water with different densities don't mix, but what happens in the area where they meet?

The Thermocline

Waters with different densities don't mix. They only do so if they're affected by powerful external events, such as major storms. When the sun is very strong, the temperature on the ocean's surface rises sharply. However, this temperature doesn't reach the deepest water, which is colder (cold water is denser, so it sinks). Between the two layers, we find an area that separates both masses of water: that is the thermocline. When there is a big storm or a strong wind, the water is choppy, and the masses of water mix again in the surface. Look at how the thermocline works in the Mediterranean Sea throughout the year:



Create your own thermocline

Have you done the experiment in Activity 5? If so, remember the layer that appeared between the denser and the less dense water: that was the thermocline.

If you haven't done the experiment, watch this video and you'll see where the thermocline is:

Watch the vídeo

http://youtu.be/RXTc-kHQN2U

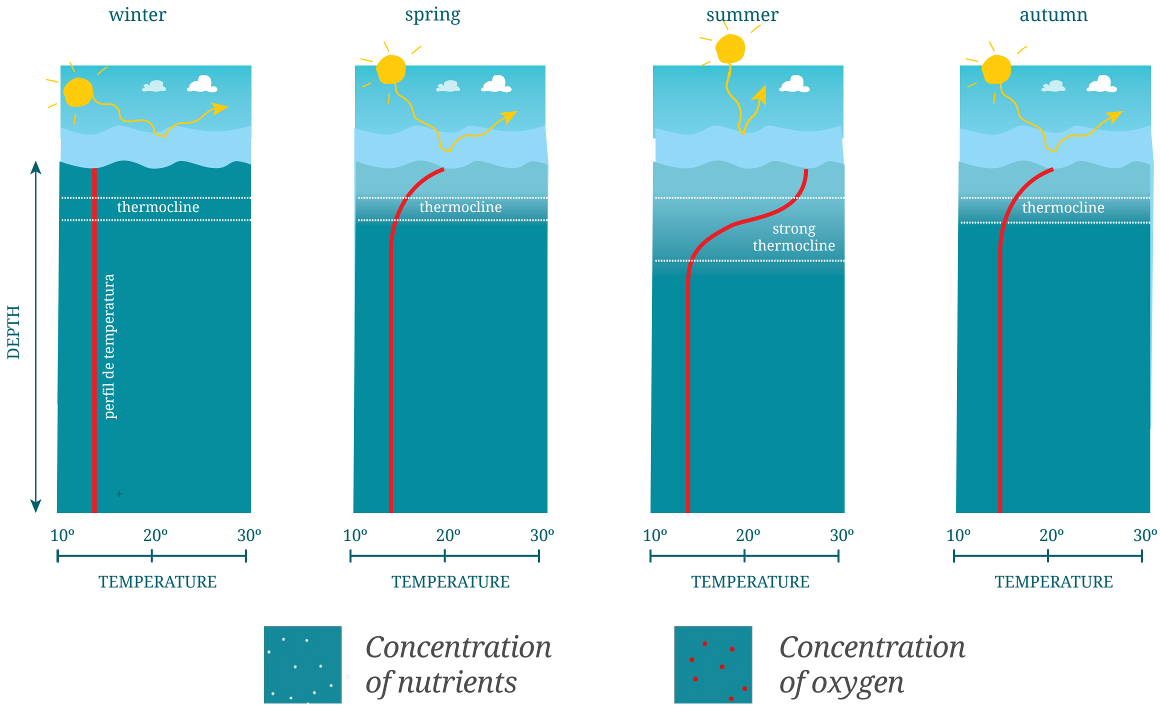
Read the previous explanations about density, temperature, and buoyancy, as well as the information about stratification in Activity 5.

1. If the water near the surface is very warm and the deep water is very cold, what time of year do you think it is? What will the thermocline be like? Why?

2. Why do we say that the thermocline is a transition zone?

3. How do storms affect the ocean?

4. Look at the following graph. How would you interpret what happens in the summer?



5. The data provided by gliders enable us to study the thermocline. Visit http://follow-theglider.socib.es/explorar/. Choose one of the missions, click on one of the dots on its course, and then select Temperature. Point out where the thermocline is located in this graph.

How can gliders help us learn about marine ecosystems?

Gliders can't collect samples of water that we can analyse in the lab, nor algae, nor sand from the ocean floor. However, they can supply us with certain data that enable us to draw conclusions about plankton. Plankton are a source of food for many living organisms, so if we analyse the data properly, we can calculate how healthy a marine ecosystem is.

What are Plankton?

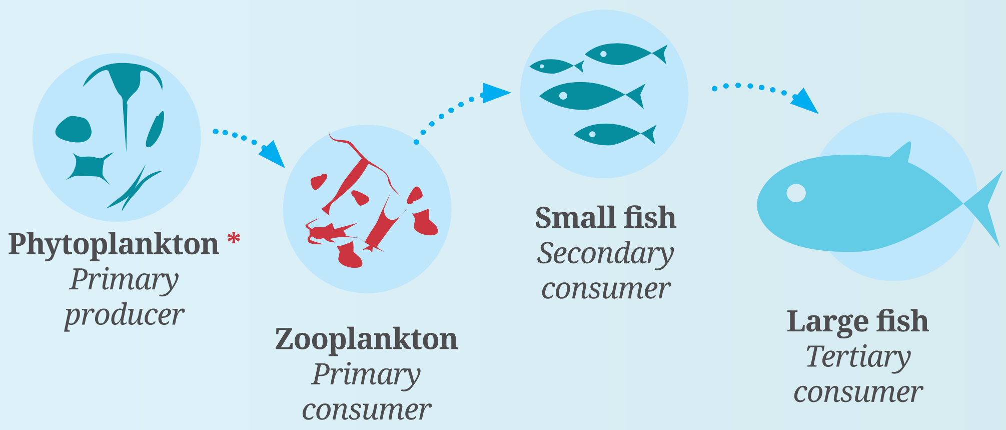
Plankton are aquatic plant and animal organisms, most of which are very small, even microscopic, that drift in the water.

Phytoplankton*

Phytoplankton are the kind of organisms that perform photosynthesis*. Most are microscopic algae. They stay near the surface of the ocean to receive sunlight, which is essential for them to photosynthesise and transform light into food. To trap the energy from sunlight, they need chlorophyll, and in doing so, they release oxygen. Gliders are capable of collecting data about chlorophyll and oxygen content, and therefore can tell us whether there are more or less phytoplankton in an area. Phytoplankton organisms are considered to be primary producers, and are a food source for very small organisms a well as for some very large ones, such as whales.

Zooplankton

Zooplankton are very small or microscopic animals that live in the ocean. They do not only live near the surface, like phytoplankton; they spread out across all the different layers. They are referred to as primary consumers, because they feed on primary producers, in other words, on phytoplankton. Small fish are secondary consumers because they feed on zooplankton. The larger fish, known as tertiary consumers, eat the smaller fish. This is the food chain, and it involves a huge energy transfer that begins with sunlight being turned into food.

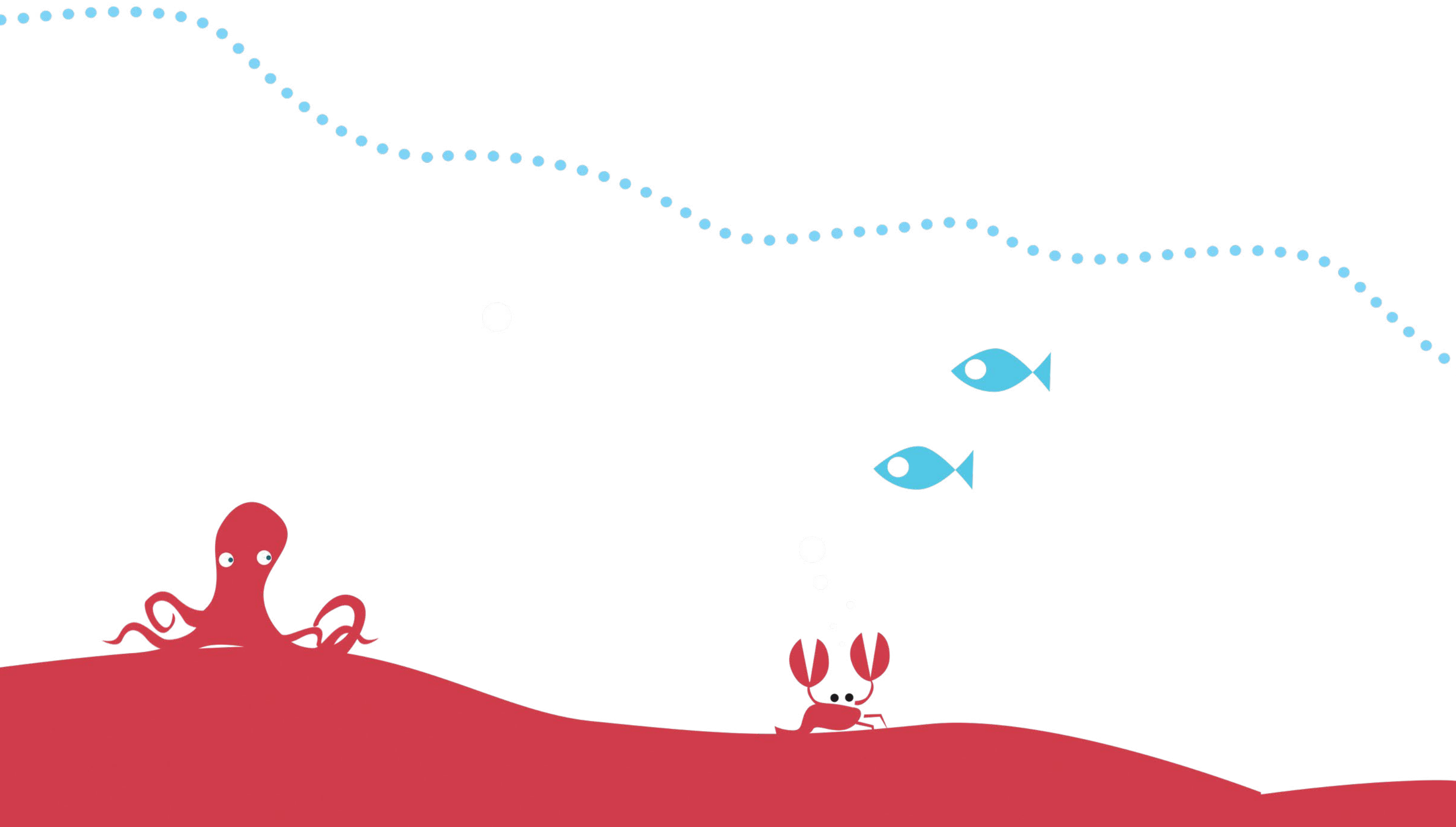


Carbon Sequestration

When phytoplankton perform photosynthesis, they capture CO_2 and release oxygen. 50% of the oxygen in the atmosphere is the result of this process.

** Look in up the words with a red asterisk in the glossary*

1. At first glance, what kind of data would lead you to believe that there is a high concentration of phytoplankton in a given area of the ocean?
2. Why are phytoplankton considered primary producers?
3. Why are phytoplankton referred to as “the ocean’s lungs”? What consequences does this have?
4. Why do you think the organisms that form phytoplankton are so light?
5. Visit www.followtheglider.com and click on Explore. Choose a mission and look at the chlorophyll and oxygen graphs. Based on these data, say where you think the highest concentration of phytoplankton will be.
6. How can gliders help us protect plankton?
7. What would happen if a boat spills oil in the ocean? What consequences would it have for the food chain?
8. Do you think that pollution and ozone depletion may have an effect on phytoplankton? Why?



8 ACTIVITY The fisherman

How can gliders help us learn about marine ecosystems?

Can a glider help us find out in where there the greatest concentration of fish will be?

The microscopic plants that make up phytoplankton need sunlight, nutrients, carbon dioxide, and water to grow. There is a lot of water and carbon dioxide in the ocean, but there is not always sunlight and nutrients. These two factors–sunlight and nutrients–determine the abundance of phytoplankton. Near the surface there is more sunlight, but nutrients are more abundant in the cold, deep waters near the ocean floor. How do phytoplankton manage to get both?

Gliders provide us with graphs that help us find out where in the ocean these two factors converge, and where phytoplankton proliferate. Where phytoplankton is found, there is food for many organisms, and therefore you can assume that more species will be present in that area.

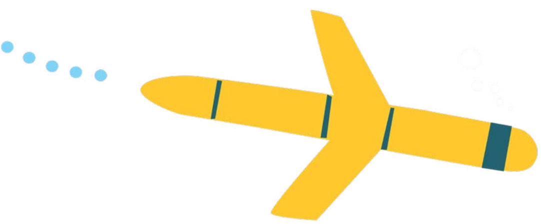
Review the information about density, temperature, salinity, stratification, and phytoplankton provided in the previous pages.

You are learning to be a fisherman and you need to find out where the fish are. You don't know that much about fishing, but you do have a few very interesting graphs you got from a glider, showing the water temperature and the amount of chlorophyll. Answer the following questions to reach conclusions that will help you achieve your goal.

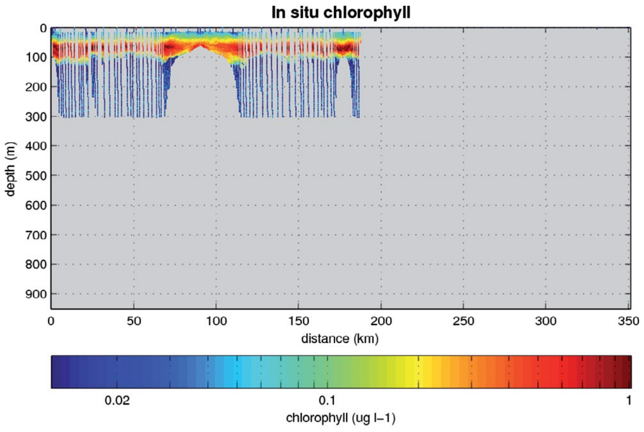
. What are phytoplankton and what is their role in the food chain?

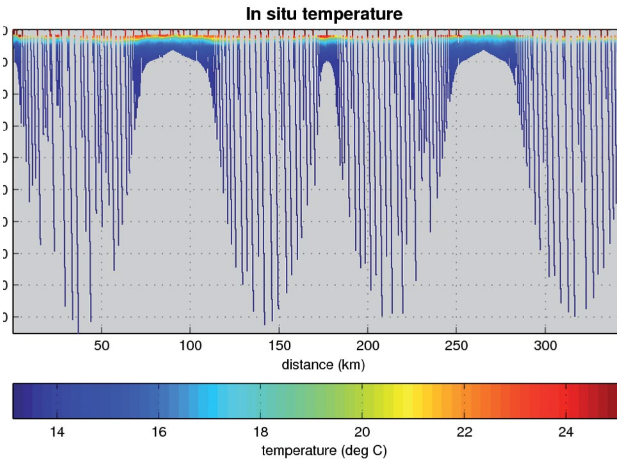
2. Based on your answer to the previous question, come up with a hypothesis that will enable you to locate shoals of fish. Consider the different factors that may have an effect on the proliferation of phytoplankton.

3. Can a glider give us information about phytoplankton?

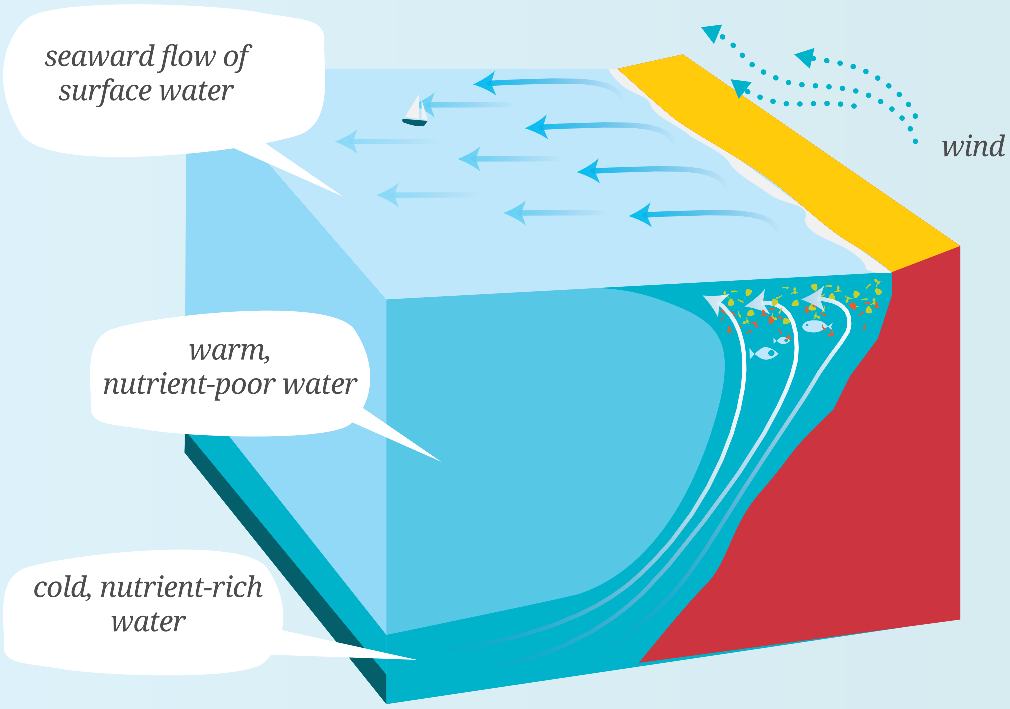


4. It is July. The glider is on a mission in the Mediterranean Sea, in the Ibiza Channel. It has sent us the following temperature and chlorophyll graphs. Observe and discuss the relationship between the two. Where does the surface water nearest to the light meet with the deep, nutrient-rich water?





Upwelling occurs when cold, dense, deep, nutrient-rich water flows up to the surface. Why does this water rise from the bottom? One of the causes is the wind on the surface of the ocean. When it blows on the surface, it creates a frictional force which, jointly with the Coriolis effect, makes the water from the surface clockwise (anti-clockwise in the Southern Hemisphere). As it moves, this water is replaced by water from deeper layers, causing an upwelling. This causes an increase in phytoplankton, which benefit from the large amount of nutrients in the rising water.



Gyres and eddies, as well as **storms**, also contribute to breaking the thermocline and making nutrients rise to the surface, contributing to the proliferation of phytoplankton. Remember that in Activity 6 we said that the thermocline acted as a barrier between cold, deep, nutrient-rich water and the warmer water near the surface with fewer nutrients. If a storm or a eddy breaks the thermocline, the deep, nutrient-rich water is able to flow upward.

This also occurs at global level. At the Poles, when ice forms, the surface water becomes very salty, and therefore denser. This makes it sink down. This downward motion in turn causes an upwelling of deep, nutrient-rich water elsewhere. Look at the following map: the pink and blue areas are where the surface water sinks. Then the deep cold water flows into other areas and wells up to the surface, shown in light green. This causes an upwelling, with a large amount of nutrients rising to the surface.

5. Do you think sailing in choppy waters is good for fishing?

6. Do you think that the green areas in the map would be good for fishing?

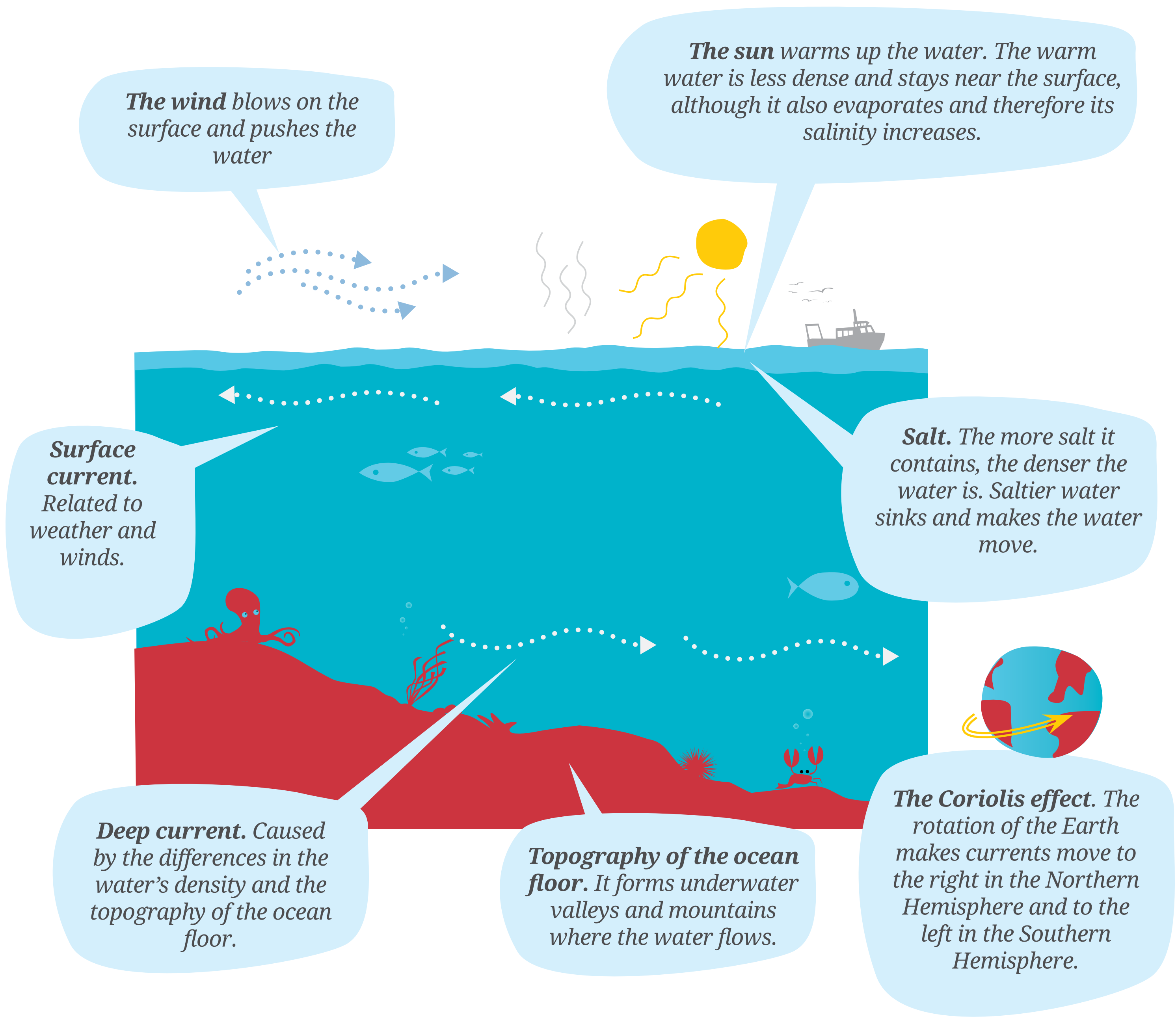
** Look up the words with a red asterisk in the glossary*

9 ACTIVITY

And yet it moves

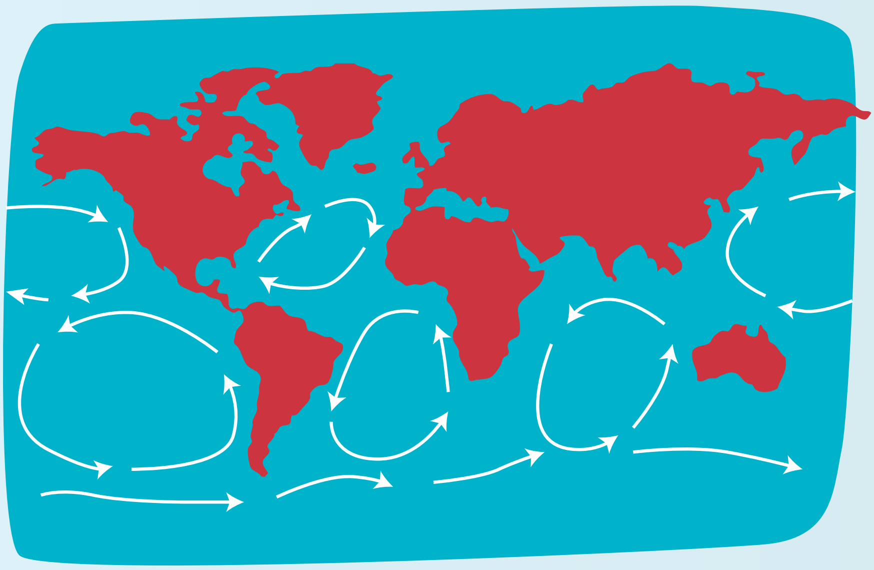
One of our gliders has drifted off the course it was supposed to follow. Why did this happen? What dragged it off?

Although the ocean sometimes looks as if it were calm, it's always on the move. The glider has gone off course because of the ocean currents.



Surface Ocean Currents

Surface ocean currents move 10% of the oceans' water and move in the top 400 metres of the water column. They are usually moved by winds, creating a large-scale circulation system formed by five major ocean gyres. Due to the rotation of the Earth, everything that moves on the surface shifts towards the right in the Northern Hemisphere and towards the left in the Southern Hemisphere. Therefore, in the north, gyres turn clockwise, and in the south, anti-clockwise. Look at the map of ocean gyres.



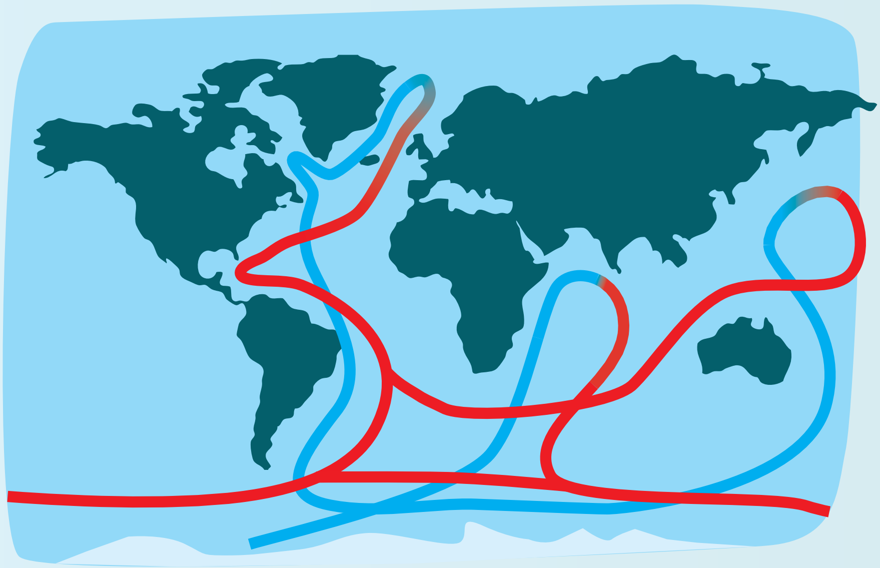
1 The wind plays a part in creating surface currents. Let's find out how with an experiment. Gather into groups of four.

1. Fill a rectangular container with water (for example, a roasting tin).
2. Each of the four students will stand at one corner of the container
3. Sprinkle black pepper onto the water in one of the corners.
4. Each student takes a straw and blows gently onto the water, towards the left. Each student blows towards his or her left.

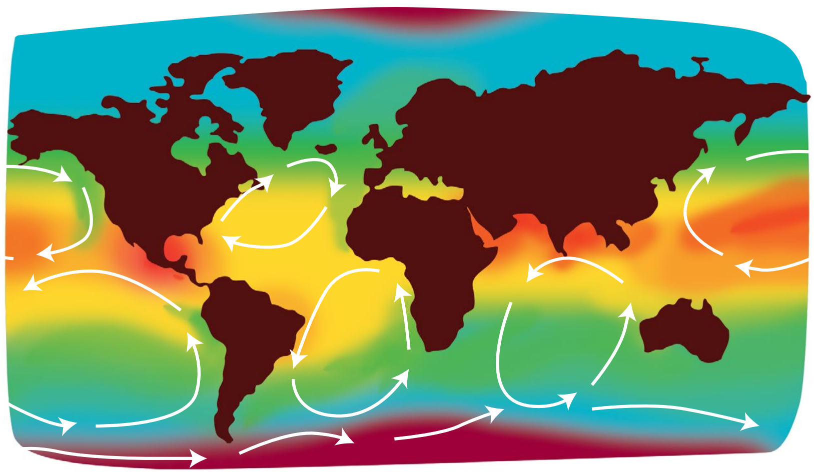
What happens? How do you relate it to what happens in the ocean?

Deep Currents

Deep currents move 90% of the water in the ocean. Both salinity and temperature affect ocean circulation. The water that is denser (because it is colder or saltier) sinks, allowing its place on the surface to be replaced by less dense water. At the Poles, when ice forms, the water becomes less salty and therefore more dense. The water that sinks in the Arctic flows along the bottom of the ocean towards the Antarctic. There it splits and wells up again in the Indian Ocean and in the Pacific. On the ocean surface, the wind pushes the water toward the north Atlantic, where it sinks again. Have a look at this map of the Great Ocean Conveyor.



2. Ocean currents move a lot of water and energy in the form of heat, and therefore they have an influence on the distribution of temperature around the planet. Have a look at the following map. The colours represent the water temperature: red for warm and blue for cold. How do you interpret it?



3. What would happen if these currents stopped moving and the warm water from the Equator did not reach the Poles, or the cold water from the Poles did not flow towards the Equator as it does now? Why could that happen? Come up with a hypothesis.

4. How can gliders help us face this danger?

10 ACTIVITY A fabulous team

The glider

Find out about the team that makes the SOCIB gliders' missions possible.

To find out who is in charge of all the stages in a glider's operation, watch the following micro-videos, which you will find at www.followtheglider.com, under Teachers/Additional material.

1 Who decides where the glider goes? Look at the Planning video. What do you think about this job? Why do you think it is important?

2. How do you prepare a glider before you put it in the water? Watch the Setup & Programming video. Do you think it's complicated?

3. How do you think you launch a glider into the water? Watch the Launching a Glider into the Sea video. Would you be able to do it?

4. The glider is already sending data via satellite. Watch the Monitoring video. Try to do the same thing by going to www.followtheglider.com and clicking Explore.

5. We have the data that the glider has sent us. Now what? Watch the Data Analysis video. How important do you think this job is?

6. We have to go recover the glider! Watch the Rescovery video. What is the most interesting part of this job?

7. Which of these jobs would you like best? Do you think they're fun? Are they Interesting? What would you have to study to end up doing one of these jobs?

More than Gliders

SOCIB doesn't only work with gliders. It also works with other technologies to obtain data that enable us to gain new insight into our seas and oceans, and develop predictive models such as those for weather forecasts, etc. The data provided by gliders make it easier to control oil spills, protect marine resources, guarantee marine safety, etc. Visit the SOCIB website at www.socib.es and find out what the following elements are used for:

	Coastal HF radar		*Coastal research vessel*
	Surface drifters		*Fixed stations*
	Satellite		*Data center*

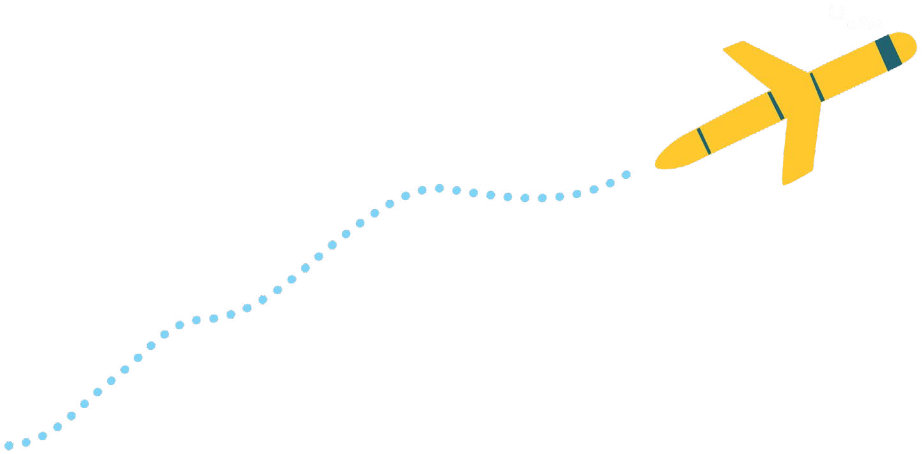
How is all this research useful?

For example, gaining new insight into the sea can help us prevent the effects of the meteotsunamis known as rissagues in Menorca. Watch the following video to find out what they are

http://www.socib.es/index.php?seccion=multimedia#current_video_title

Watch the vídeo

In what other ways do you think having so much information about the ocean is useful?



GLOSSARY

Biochemical parameters: biological and chemical variables that the glider measures during a mission, such as oxygen, chlorophyll, and turbidity.

Chlorophyll: the pigment in green plants and certain bacteria that is involved in photosynthesis.

Course: direction.

Cyclone: an atmospheric disturbance that causes strong winds.

Glider: a small autonomous submarine used for observing ocean. These devices use wings and changes in flotation to achieve propulsion based on gliding, which uses very little energy.

GPS: the acronym for Global Positioning System, which uses satellites to find a person or an object's exact location in the world, with an accuracy of a few centimetres.

High-pressure area: an atmospheric disturbance that usually brings clear weather (Anticyclone).

Marine current: moving waters in a sea or an ocean.

Marine Protected Area: a marine area specially designated for the protection and maintenance of its biological diversity and its natural and cultural resources.

Navigation bay: the part of the glider's processor in charge of the glider navigation.

Photosynthesis: a process involved in the development of green plants and algae. These organisms use their chlorophyll to trap the energy they receive from sunlight, together with carbon dioxide from the air and the water. Photosynthesis enables plants to make their own food. In addition, plants produce oxygen as a byproduct of photosynthesis.

Phytoplankton: marine plankton, made up primarily of plant organisms such as microscopic algae.

Physical parameters: physical variables that the glider measures during a mission, such as salinity, temperature, and water conductivity.

Plankton: tiny animal and plant organisms that drift in the water.

Remora: a species of fish, also known as suckerfish, which attaches itself to floating objects and large marine animals. In ancient times, people believed that remoras had the power to stop ships.

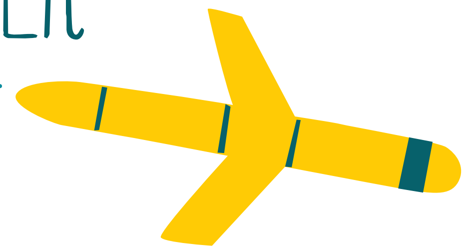
Rudder: the part used to steer a boat (or in this case, a glider) in a given direction.

Salinity: the amount of salt in seawater.

Science bay: the part of a glider's processor in charge of the scientific sensors.

Sensor: a device that detects something external (temperature, pressure, etc.) and transmits that information.

FOLLOW THE GLIDER



SOCIB Balearic Islands Coastal Observing and Forecasting System

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