The Scarlet Knight's Trans-Atlantic Challenge

· A ROBOT'S EXPLORATION OF THE UNKNOWN OCEAN ·

Common questions about theTrans-Atlantic Glider

How does an underwater glider "fly" ?
Most underwater vehicles, like submarines, use a spinning propeller to move around in the water. Propeller driven vehicles are fast, but they also require a lot of energy to maintain their speed. Smaller vehicles like the glider only carry enough battery power to drive a propeller for a few days at most.

Instead, underwater gliders move around by changing their buoyancy, that is they change their density such that they alternate between more dense and less dense than the surrounding ocean water. This change in buoyancy causes the glider to rise and sink in the ocean. The glider changes its density by moving a small piston forward and back that increases and decreases its volume. You may remember that you can calculate the density of an object by taking its mass and dividing that by the object's volume. Since the mass of the glider remains constant, all we need to do is change its volume. A small change in volume (about a half cup of water) is all the glider needs to change its density enough to rise and sink in the ocean.
As the glider goes up and down, its wings give it a forward motion just like the wings on an airplane glider, which is why these robots are also called gliders. But airplane gliders can only "glide" as they fall downwards due to gravity. Underwater gliders can glide forward both as they rise and fall.

Why is it called a Slocum Glider?
The Slocum glider was named after Joshua Slocum, the first man to sail around the world on his own. Like Captain Slocum, gliders are designed to explore the oceans on their own. They may one day follow in Slocum's footsteps, but first they have to make it across an ocean. You can read more about Joshua Slocum's journey in his book "Sailing Alone Around the World."

How deep does a glider go?
An average glider usually flies between 5 meters and 100 meters (15 to 300 feet) below the ocean's surface. However, Scarlet Knight has a unique feature which is the integration of a new pump which allows the glider to dive to twice the depth of an average glider: 200 meters (600 feet). It uses a pressure sensor to measure how deep it is, similar to how an altitude sensor tells an airplane pilot how far above the ground he/she is.

How much does a glider weigh?
The glider weighs 60.6 kilograms (or 134 pounds). Because this mission will require a lot of battery power to make it across the entire Atlantic, batteries comprise almost 40% of the glider's weight (23.8 kilograms).
The glider has a volume of 59.1 liters (about 15 gallons), and thus its density (which is calculated as mass divided by volume) is 1,025 grams/liter. This is close to the average density of the North Atlantic Ocean.

How big is a glider?
Scarlet Knight is 93 inches in length. Most of the gliders flown by Rutgers are 84 inches, but we custom built Scarlet Knight and stretched its payload bay so we could fit more batteries inside.
How will we recover the glider?
Because gliders are so small, they can easily be launched and recovered by a small boat and a two-person team. We have several partners in Europe who are anxiously awaiting the arrival of Scarlet Knight, and are ready and willing to sail out to sea to pick it up when it arrives. All Scarlet Knight has to do is sail itself within a hundred or so kilometers of the coast of Europe.

What data does it collect?
Scarlet Knight is currently carrying sensors to measure the temperature, salinity and depth of the water as it sails through the ocean. Ocean modelers will use this data to calculate the density and currents of the North Atlantic Ocean. Very little is known about the ocean beneath the surface layer that can be seen by satellites and passing cargo vessels. The data collected by the glider will help scientists better understand and model the ocean, which eventually will provide them with better data to answer questions regarding fish stocks and the interaction of the ocean with the global climate system.

Underwater gliders can often also carry sensors to measure chlorophyll, sediment, the presence of red tide organisms (which cause harmful algal blooms), and can even track acoustic transmitters placed in fish. But all these sensors require a lot of energy and so are not included on Scarlet Knight's mission.

Why are there large gaps in the data plots?
During previous missions, we have configured gliders to continuously record data every 2 seconds. For this mission we are only sampling the ocean once a day for one hour. This means we will be getting 2 profiles a day so there is less data to transmit over the satellite communications channel, which cuts down on power use.

Is Scarlet Knight different from other gliders?
Yes, in order to cross the Atlantic we had to make several modifications to Scarlet Knight. The largest challenge was to make sure the glider would have enough battery power to make it across. Step one was to cram the glider full of batteries by extending the length of the glider and removing extraneous equipment and sensors. After that, technicians modified the software to make the glider as efficient as possible. Sensors are only on for limited amounts of time and satellite transmissions are kept to a minimum. Scarlet Knight also contains a new Digifin tail that is more robust and provides more efficient control of the glider's direction. Finally, because this is such a historic mission, Scarlet Knight received a fresh coat of paint, contains numerous stickers of project supports and a package of letters inside to be opened on the other end.

How does the glider call home?
The glider uses a satellite modem to call home from anywhere in the world. In fact, it uses the same satellite phones you often see far-flung news reporters using.
The glider can be programmed to call home as frequent as the pilots feel is necessary. Because the glider relies on GPS for its location, it must surface every few hours to make sure it's headed in the right direction. Generally, we have the glider surface and call home every 6 hours.
How do we control the glider?
Each day, pilots at Rutgers (many of them undergraduate students) look a variety of maps to determine where the ocean currents are most favorable for the glider. Much of this data is viewed

in Google Earth. Pilots then choose the path that will maximize the glider's speed and save these coordinates in a file for later transmission to the glider.
When the glider calls home, it uploads the data it collected and then checks its mailbox to see if the glider pilots have new instructions for it. After that it hangs up and continues on its mission "“ diving and rising again to the surface every few minutes "“ for a few more hours until its timer goes off and it calls home again to repeat the process.

How long can Scarlet Knight fly?
We estimate Scarlet Knight has enough battery power to fly anywhere from 250 days to one year in the ocean. We're doing as much as we can to conserve power early on in the mission in case we need it later. We're also trying to fly the glider smartly, using ocean currents to propel us towards Europe.

To watch a cool animation of the flight of the Scarlet Knight, go to:
http://rucool.marine.rutgers.edu/atlantic/about_gliders.html