Topic 3c - Ice and Icebergs

So Sophie, you have a job monitoring icebergs with satellites. Tell me about the icebergs that you monitor.

So to monitor icebergs, here at CLS, as we are expert in satellite, we used two kinds of satellite. And the first one is altimetry satellite and a radar imagery satellite.

So in fact, if we think about the icebergs we monitor, they are in the Antarctic Ocean If you look at the Antarctic, you can see that there is these two seas, the Weddel sea and the Ross sea which are, in fact, the sources of the big, expert iceberg we are able to monitor after... at sea

So the icebergs are produced here and then they move around Antarctica.

Yeah, absolutely. This is like a ramp jump for the iceberg. And after, this is big ones who are going at sea. Only big icebergs are like 100 metres size of iceberg go at sea. And after, we look around and the winds, they drift during all the Antarctica Ocean.

So tell me again where the icebergs travel.

The icebergs travel around the Antarctica, always in the same often sense. At the beginning, very nearest from the coast, they drive towards the west side.

So when they move further away--

When they move further away, after, they change the direction and go to the east.

The iceberg movement is very complicated here. The icebergs are only produced in two places. But the way that they move around the continents is actually really complicated.

Yes. And we monitor only icebergs once they are far from the coast, and the ones that drift on the east side, and they drift until they are totally melt. This iceberg represents a very high risk for navigation and for boats. So thanks to the satellite today were able to detect them and to provide some risk maps for boat and navigation.

So if you're a boat sailing anywhere in this area, you want to know if the icebergs are near you, and that's the data that you can provide.

Yeah, we can provide this kind of data, but we have to know before which kind of boat needs this kind of information, because as the area is very huge, it's difficult, very difficult, to scan every day, at any time, this big area, in fact. So we have to know very which path of the sea we want to scan to produce this kind of maps.

So you've got a huge area around Antarctica. It's got icebergs somewhere in it. Tell me how you find the icebergs.

So to detect the iceberg, today we use two kind of satellite data at CLS. So we use first the altimetry satellite. So we have strong expertise here at CLS, since the first altimetry launch in 1992 with Topex/Posiedon.

So we use all the altimetry satellites since this period, since the Topix/Posiedon And we are able to detect iceberg with that at the beginning, this kind of satellite used to measure the sea level, but we are also able to detect big things at sea like boat and large icebergs, bigger things.

So the satellite is allowing you to measure the height of the sea surface, but if something is sticking up.

Absolutely, we are able to detect it, and this is the way of working.

Altimetry satellite have a repetitive orbit. And so for each mission, the one altimeter are always the same tracks around the Earth. So an altimeter is able to measure the sea level and other big things at sea below its tracks. So if we use the right kind of altimeter, we are able to obtain this kind of grid. So we have information on all these tracks. It's allowed to have global coverage of the Earth at any time, anywhere. The only thing is we are only able to have information below the tracks and not in the middle of them. But it's a quite a good instrument to have information.

So once the satellite travels, it's looking just directly down beneath it.

Yeah, at the nadir.

So you're drawing a line across the planet. And so you can see the sea height as that line, as you go along the line. But you can't colour in everywhere. You have to have lots of lines.

Yes, we need to have a lot of lines. So we need to take into account the delay, the time for satellite to make a total trip around the Earth. And we also have, we are able to use several altimeters. We use all of them to have a very strong coverage of the Earth.

So you have this first system, the altimetry, which is drawing thin lines across the Earth that show you the sea surface height. And that's the first tool for detecting icebergs. Tell me about the second tool.

So the second tool we use is the radar image satellites. So at the opposite of the altimetry satellite to obtain information for the satellite you need to programme them. So, first of all, you need to know where you want to scan to observe the ocean. So the advantage of the satellite is very accurate. But you have information only on the square image about-- five -- an image which is about 500 kilometres by 500 kilometres. We need the specific analyst to interpret the image and find the significant spot on the image, like a boat, like iceberg, and all those kind of things you can see on it.

So here's an example of a SAR. So this is the square like this.

And here on this image you can see the little spot, yellow spot. This is iceberg detection. Here, this is South Georgia.

Yeah. Near the capital. The small thing you can observe on it are smaller iceberg, or some type of small island. We don't see the difference if you are not an expert. So you need to have a CLS written expert to analyse this kind of image and to produce for us the content.

So we have three things working together. We have the altimetry satellites. We have the SAR satellites, and we also have a human analyst who can pick out the patterns.

For both satellites, in fact we need also for the altimetry a specialist. We interpret the signal on altimetry in a specific way. Because iceberg detection with altimetry is not the normal usage of the altimetry satellite. So we have a specific process for that. As for the radar image satellite, we have a specific expert for analysing the image and they're able to qualify each spot, if the spot are icebergs or boats or other piece of land.

So you take the images from the satellites, you do your data analysis. And what happens to that data? What do you produce afterwards?

So we used this kind of iceberg detection specifically at CLS to better manage the navigation risk at sea during the sailing race. The idea for these kind of race, we provide iceberg risk built in for the navigation. For that, we use two satellites, two kind of satellites. We described them before. As the ocean, the Antarctica ocean is very, very big, very huge. Each observation we are able to obtain is very valuable, very precious. So to conserve this information in the time, we inject them in our model to forecast the trajectory, but also the melt and the split of each iceberg in a statistical way. The idea is to provide built in with two or three days in the future to have a general risk situation for the navigation for the iceberg.

So you look at the way the icebergs have moved over the past few days, and then you use a computer model to forecast where they are likely to move, and then you can give that information to the race organisers, so they can plan their race safely.

Absolutely. Typically, this is a kind of iceberg risk built in that we had produced for the race management. Here on the screen you can see for instance, the radar images, the little snowflakes on the yellow and the round and red square are the risk area. And the skippers boat have to avoid this area typically. Here you can see also, the trajectory, the simulation of the iceberg movement for several months and how the they go around the Antarctica and develop.

So this is real data from lots of icebergs as you can see what icebergs have done in the past, and there's a pattern. And you can learn that pattern and use that to forecast.

Yes we tried it, but it's very difficult because, you know, Earth, it's natural. So since 2008, we work on iceberg detection with satellite. We did this activity almost every year since 2008 and the thing is there is not natural tendency each winter, each summer. It's not the same thing. One winter you can have a lot of icebergs at sea and situation very risky, for as I said, in races. And sometimes there is nothing at sea and there is not very correlation today between for instance a year with Nino or not etcetera. It's difficult a lot today to observe a real balance, defined a risk regarding these kinds of winter or this kind of year.

So because the icebergs are doing something different every year, you really need the satellite seeing what they're doing now.

Typically entering a race we scan before the race, with the altimetry, all the area to see to have the first guess of the situation of the year. After, when the race is started, we scan always in front of the leader to make--

To make them safe. So you have a map.

So on this one, we don't see the radar image, but we see this is the map of the last Volvo ocean race. So the pink line is the line above which the boat is not allowed to go below, because on this line the situation is too dangerous for them. You can see also the little snowflakes on the same orange and red square on the screen, you can see that the pink line is a boat on this square. The idea is to communicate to risk management oftenly and to update the information twice, three times per week during the race. To move if needed the pink lines and to improve the situation of the race.

So this is real time forecasting.

Absolutely. During the race it's real time forecasting every day.

A lot of work.

Because in fact, when you programme a radar image, you know when she's done a lot to the ground segment we want to analyse it quickly. As soon as we receive it, so it could be at any time.

So if you're a boat sailing around here. And you are just to the north of this line. You really want to know whether the danger line has moved. And this is what the satellites can tell you.

Yeah. Absolutely, we can use the satellite to update the line, which is in general defined as a risk management at the beginning of the race, this line is defined by a first scan of the ocean before the departure of the race. And during the race, we update it regularly with the observation we made with the satellites, radar image and altimetry satellites. And we update also this information thanks to our drift model, because as we discussed about it, observation we have been by satellites are put in our original model to extend the information in the future.