Topic 4c - Part 2 - Ocean Colour and Models

In the context of what it means for an ecosystem, tell me about the relationship between ocean color and the ecosystem.

OK, so the ecosystem of the ocean is full of life and particulates and another material. And that has an influence on the way light behaves once it enters the ocean and then comes out. And that is simply the ocean colour. It can be measured from boats, it can be measured from satellites.

But what we do is we use the colour of the ocean to make inferences or detect changes in the ecosystem that's present.

How do you build an understanding of that.

So we have to go out and take a lot of in situ measurements of what's going on. So you have a property that you might be interested in, whether it's the growth of the algae, how fast they grow, or what species are growing. So you go out, you take measurements that might give you information on the differences between the algae that are present. Or how fast they are doubling in a bloom situation.

And sometimes the measurements are made out in the ocean. Sometimes you bring samples back to the lab and measure them here. And then there are some things that we can measure without actually going out and taking a sample. So once you've proven a remote sensing technology, then you can use that to make observations without having to go out in the field.

Tell me about an ecosystem model.

So ecosystem models are trying to have a numerical representation of what is going on in the ocean. So you might have algae in that model and they might have a numerical representation of how they take on nutrients. So the nutrients, obviously, will have to be in the model. Then you might have light coming in from the surface and attenuating the depth.

You might have a seabed and some interaction going on in there. And basically, all those fluxes and exchanges. And then you can also take your little parcel of water, put it next to another one. And you can have exchanges between those. And then through that, we can really represent a full ocean ecosystem.

So there's all these separate bits of scientific understanding about how species interact with each other, how they interact with their environment, how things change when the sun comes up. And you build all those bits of understanding into one mathematical model. And you can run it, so it's like a flight simulator for a part of the ocean.

Yeah. And the hope is that if we have the models running correctly, then what we can also do is change the input. So we can see what happens if it gets warmer, what happens if we dump a load of sewage into the ocean and the phytoplankton to respond to that. So once you have a model set up and seems to be reproducing what you observe, you can start to push it with something else.

Lots of things that go into an ecosystem model like that, like lights and temperature for example-- the things that you can get some data about from satellites. So tell me about how remote sensing and ecosystem model can work together.

So you can use the remote sensing information in two ways. One, you can use it to validate the model, check the model-- especially if you have a long time series. So there's been, for example, the climate change initiative has developed a number of long time series of satellite data. And then if you have 10 years of information, you can see if your model is performing well over a long time period and matching your observations.

And also, what you can do is take the remote sensing data and use it in the model. So then you say, OK, well we have a model that requires some inputs on temperature and light, but we're going to use the remote sensing biomass-- the algae-- as detected and put that into the model. And also you can have models where, for each step of the model, you check it against the observation. And you correct it. So those models kind of optimise themselves or learn as you go along.

So you have this mathematical representation of a part of the ocean. You've got satellite data that's feeding into it so that you can check against it. Once your ecosystem model has run for a bit, what happens to that information? Who can use that data?

The hope is that information and the results from these sorts of models can inform us on areas that are vulnerable that might be around the coastline. Areas that we might have to protect, areas that might be able to sustain, for example, more fishing than there is going on.

But I guess, really, in the end, it should feed into policy and management. I mean, the coastal zone requires a huge amount of management. It's got tourism going on, there's a lot of fishing that goes on in the coastal zone. You have tourism as well. And you have to balance all of these important factors. So the policy really requires information on where more management and less management is needed.

So pick an example, a fishery for example. Now, fish are not something that you can see from a satellites most of the time. They're definitely in the ocean and we care about fish because we eat them and lots of things rely on them. So if you want to manage a fishery, how does an ecosystem that relies on these things like light and ocean colour and temperature-- these quite nebulous things-- How does that impact where you fish over here or over here.

The models and the observations can show you persistent features a lot of the time or you might have regions of the ocean that have a lot of things like fronts. So fronts are where you have strong gradients in temperature on nutrients in the ocean. And often along those fronts, you get blooms of phytoplankton. And that supports a large amount of higher life. So zooplankton and fish.

So often, you can observe the fronts or look in the models for regions where fronts are very dominant or prominent. And then you might say, OK, this is an area that can support a large fishery.

The habitats in the ocean aren't stationary like a forest, that constantly shifting around. But these models are able to capture some of that shifting and actually predict it. So you have a much better basis for policy in that case.

Yeah. And also, it's not necessarily about saying exactly that a front might be at this point in the ocean. But you might say that recurrently, every year, at some point from June to July, there is significant growth in this region.

And also, the models might allow you to say whether the factors that you can observe in January or February are related to the timing of a bloom. So then you can say is there going to be lots of algae and fish in June or July or May. So you can then look at correlations and predictions from earlier observations in the year until later year.

It's a very intricate dance of all these tiny, tiny organisms in the ocean. You've got all these environmental parameters-- some of which you can observe from a satellite and some of which you can't. And you've got all these different regions of oceans, which have different properties and different depths. And you can sort of build all this in. And a model is our best understanding of what's going on and yet, it's still such a complicated thing, isn't it?

The hope is that we are continually improving our models. I mean, any model really is our best representation, but it won't be perfect. And so we strive to create the best model. And that's why the test of any model is, can it explain the observations.

If it can explain the observations, then we really have to test, as well, whether it's explaining for the right reasons. And that gives us an insight into the functioning of the ecosystem.

And the satellites are a different way of observing, so they're important because that's a different set of observations that the models have to match up to.

Yeah. So the in situ measurements are often very precise and really important. And those, again, they used to validate the remote sensing observations, as well. But the remote sensing gives you a really broad picture. So on a clear day, you might see what's happening all the way from here to France across the channel in one picture.