Topic 4f – Part 2: Practical products - Aerosol forecasting

So as you said, there's lots of information about how hazy the atmosphere is here, but it doesn't tell you what's making up the haze. What sorts of things might go into it?

So we look at different species. We look at five main species, which is sea salt, desert dust, organic matter, black carbon, and sulfates. So that's the aerosols we're really interested in and that we use in our forecast to pass on to the general public.

Well, if we go across to here, this is one of our forecasts. And it's the forecast from the Hurricane Ophelia.

So this is the same-- so on that day, you got this satellite data, which is incomplete.

Yes, yeah.

And this is the result after you've done the data assimilation and run the model.

Exactly, yeah.

This is what comes out the other end.

Exactly that, yes. So here, you can really get an idea of the different species that we look at. So for example, this is desert dust coming across from the Sahara.

So you can see it's blowing this way.

You can really see, yes. So this is where our model comes into its forte, because this is the winds that are blowing it. So it's picking up the dust from here, blowing it out across the Atlantic, and you can see it turning around and coming back up and across Europe.

So this was what made the sky go red for us.

Not quite. So you can also see, coming in here, you've got Ophelia, the hurricane itself. And that sea salt blowing, being lifted up, and blowing across--

So this is when the wind blows across the ocean surface, lots of spray.

Exactly.

And that sends the salt particles.

Yeah, that sea salt gets picked up.

And you can see that from-- effectively, that's the sort of thing you can detect from space, that salt?

So you will see it in the aerosol optical depth. But unfortunately, when the high winds are there-- you've got a storm or something like this coming across--

You can't see it.

You can't see it because there's cloud there. So this is coming from our model. But around that, we might have observations where there is clear sky. And that will inform us of how well we're doing, not perhaps on the exact location, but in the vicinity of that. So we can use that information to inform our model.

So we can see-- so Ophelia here. So this is sea salt.

Yeah, that's sea salt going up and across there. But also what really stands out and you can see very dramatically is this is smoke from fires. So these were the forest fires in Portugal that were very bad at that time. And because the hurricane's zooming across, it's lifting up the smoke from the fires, and that's going across the UK as well.

So we've got three types of aerosol here. We've got the desert dust here. We've got the sea spray coming up here. And then we've got stuff coming from the fire.

Exactly, yes.

And now you can separate them out.

Yes, yeah. And it's very important for us, as people in the UK, what type of aerosol actually was causing those orange skies. If it's the smoke from the fire, then that's something that affects our air quality and what we breathe that's very small particles. So if we're breathing that in, then that's actually going to give us a very bad air quality index, and we're going to suffer.

The desert dust perhaps is more important for solar panels, things like that, our cars. We'll see that being deposited. And that can interrupt energy levels from solar panels, but that won't perhaps have such an impact on our health. So it's quite important for us as people down here what actually those aerosols that were coming across are.

And so one of the things that CAMS does is create things like this and then make them available. So the idea is that people can look at it and make these decisions.

Absolutely, yes. So if we want to go and have a look over here, this is one of our forecasts. So

here, you can see that this is aerosol optical depth again. So this is not a specific species. This is the total number of all our species.

So this is looking down through the atmosphere--

Exactly.

--how much stuff is in that column there.

Yes, yeah. So it's very similar to the observations. But this now, you can see there's not those gaps that you've got in the observations. Now you've got a much fuller picture.

But we can still identify some of what we think is probably causing that in this picture because you can see here the effect of the sea salt across all southern oceans here. We don't have much smoke. We don't have much pollution, basically. So all of this down here is the sea salt. And then you've got the pollution visible up here.

So this isn't Ophelia anymore. This is actually this week's forecast.

This is right now, yes. So it starts from today. It goes out for the next five days, and it gives us an idea.

We can also do individual species. So if you were interested in desert dust if you ran a solar farm, you could actually go on here and see what the forecast is for the next five days, and see whether you might have issues or not.

So we're in there somewhere.

Yes, yes.

So what we've got in the next five days is a little-- there is a little collection of something coming over us.

Yes.

So how would we notice that? What do we do with that information?

Well, for this, this looks like it's probably going to be sea salt. So perhaps that's not going to bother us too much in practical terms. But what you might notice is sometimes you'll have big plumes of desert dust coming up here, and that's something we could take notice of.

You might have pollution plumes coming across from parts of Europe that we might want to take notice of. So we can use the information to really actually help people on the ground

with how they should respond to events.

And all of this is open data. I mean, you took the data and you processed it, and you created something new, which represents our best understanding of the atmosphere. And then this is available for people to use. So how can they get at it?

Absolutely. They just need to go on the website. And then from the website, you can navigate to charts just like these and use that data. And you can also download the actual raw data.

If they're very enthusiastic.

Yeah, yeah. If you're really interested, then you can just get literally data files that go into making up these plots.

Your role really in this is making sure that we can trust what comes out the other end. There's a lot of checking that goes on, and constant revision, almost tweaking, to make sure that this is the best understanding we have.

Absolutely. So my role is generally to take those observations and look at how we can make the best use of those observations, how we can look at the errors that might be in them, the errors in our model, and incorporate the two together to be the most accurate forecasts we can.

But also, a lot of validation work goes on by our team as well. And that might be used to improve the model. There might be places where we know the model isn't as good. And we can use these forecasts and validate them against other observations we have at that time to really improve our forecasts.

And if you were to look maybe 10 or 15 years into the future and look at how all these models are going, what's the thing that you would like to see the most or that you would be most excited by, are the data input or the output? What's the thing that you would love to happen or be happening in 15 years' time?

For me-- and this gets more technical in terms of how we actually use that data. But it would be really good-- at the moment, we can't make most effective use of observations of different species. We have just this total aerosol content that we're using in our model.

For me, what would be really value-added was if we could start making use of different aerosol species types-- so to have observations of dust that we could incorporate in our system. There's a huge amount of work that needs to go on before we can start to do that, but that's what we look towards in the future and what we'd like to be able to do.

And how about using the data now? There is so much data that's being recorded that even

now, you're not actually using all of it.

Yeah. So some of the new satellites that have been launched very recently, Sentinel-5p, the resolution of that data is extraordinary. It's really, really high.

But the resolution of our model is not that high. So we have to do things with the observations. So we have to do things where we combine observations and average observations to be able to use them most effectively in the model.

What would be really good, at some point in the future, with enough computer power, would be to increase the resolution of our model. But you're looking at a global model on multiple levels going up through the atmosphere. So to increase the resolution is a huge amount of computing power. It's a huge amount of data storage. So these things only become possible as the computers improve.

But in principle, you've got the data now. So we might understand our atmosphere today better in 10 years' time.

Yes, yes. Exactly that, yeah.