**Topic 4f - Part 1 - Practical Products – Predicting impact from aerosols, dust and fires**

[MUSIC PLAYING] So Mark, we've been talking about the many, many things that are in the atmosphere. And they're all there because something puts them there. And some of the things that put them there are more noticeable than others. And we've got some data here on wildfires. So tell me how a wildfire can contribute to what's in the atmosphere.

Yeah, so as you say, we're relying on a surface boundary condition or an emission flux of some sort at the surface. And if that's anthropogenic, it's coming from a city, or a power plant, or traffic, or shipping, as you can see, with NO2. But then there are also other more natural sources, such as dust storms, but also wildfires.

Now wildfires are a little bit more complicated, because they can have natural sources caused by lightning and dry temperatures. But sometimes, they're often caused by human activity as well. So wildfires, what we mean by "wildfire" is vegetation fire in the wild land environment.

And depending on what kind of vegetation that is-- whether it's forests, or grasslands, or peat lands-- depends on the material that's actually emitted into the atmosphere. Typically, we're always getting some kind of carbon gas and aerosol. And the quantities of those depend on the type of environment that is being burnt.

So the thing is that we all know from burning candles and small campfires that it's when things burn inefficiently that you get lots of stuff left over. You get soot and ash. And that's what we're talking about. You don't necessarily know what it is, because you don't know what was happening where it was burning.

That's right. And what we're looking at here is an animation of carbon monoxide, which is very much a product of that incomplete combustion. And carbon monoxide has a very long photochemical lifetime in the atmosphere. So you can really track where it goes when it's emitted by a fire, to see what the longer distance downwind impacts of that smoke might be.

So how long does it last in the atmosphere?

Lifetimes for carbon monoxide is typically 30 to 40 days before it is oxidized through reaction with OH, typically. And what we're seeing here is this animation of carbon monoxide from our forecast model over South America throughout the month of January, 2017. And generally, what we see over the Amazon and elsewhere is these green and yellow colors, which are the moderate concentrations that you might expect. But then later on in January, and we'll see when it appears in red, there were these big fires in Chile, which were associated with very bad drought conditions. And we can then see that this plume of smoke really goes out over the Pacific, and can be transported quite a considerable distance.

It's a huge, huge plume when it gets going, isn't it? And wildfires-- we hear about the big ones, in California most commonly. But wildfires are actually quite common, aren't they? You get them in lots of places.

So wildfires are indeed very common. This is a map which is showing the location of all the satellite-observed fires during the year of 2017. So as you say, over in North America, we really expect in Canada to see a lot of fires, in the Amazon, in tropical Africa, and also in parts of Siberia during the summer months. And what this map is showing is that there are very clear patterns to where the fires occur. But there's a lot of variability as to the time when those fires are burning within an actual fire season, as well.

And these are observations. This is real data.

This is all based on observations from satellites, which are measuring the location of active fires in near real time.

And so there's very strong patterns here. And it's not necessarily unexpected. You would expect wildfires in hot, dry places. But when they occur, which is sporadic-- it's not necessarily predictable-- you get these extra gases put into the atmosphere. And that potentially has implications for health and for weather. Why would someone want to know about this?

Well, like you say, in terms of an air quality impact which could affect human health. With the CAMS system, we have that information about the distribution of the gases and where they're transported to. And we also make use of this information. So we have a map like this every day that's updated daily based on the latest observations. And that information is going in at the surface level of our model to really drive the potential pollution events, and then the potential advection of that pollution away from the source region to places where it could affect human populations.

And there's a lot of potential for this for integrating with other things. So I was living in California during the wildfires of 2007. And even back then, people in their neighborhood had a picture.

And they had things they were observing. And if you put all the things that people observe-- if there's a big fire causing problems like that, and you have both the satellite data showing where the emissions are going what the weather is doing, you have people taking pictures-- if you add all that together, there's a huge amount of data out there. But if you make it into one thing, then that's really powerful.

Then it would be very powerful, indeed. Yeah. So there are some moves by the WMO to create haze warning sensors, which would then take predictions of the environmental conditions for whether the fire is likely to occur, and then actually data like this, which is the actual occurrence of active fires, and then also the smoke modeling and the chemical modeling of the emissions to see where that goes and where that affects air quality in different places.

And we think of air quality, especially for wildfires, in terms of its impact on humans. But you also get wildfires and ash where there are no humans, don't you?

That's right. So there's a good example in boreal Canada and in Siberia. These are places which have very, very common occurrences of very large wildfires during the summer months. And these are large areas where there isn't much in habitation.

And what we've seen is that, particularly last year-- so this is an image taken from August of 2017, where there were these very large fires over the Northwest Territories of Canada. And these fires were big enough that actually, a lot of smoke was advected directly into the high Arctic and crossing over the North Pole, as well as coming down across the North Atlantic into Europe, where it affected European air quality.

And we think of the Arctic, especially in the summer, we think of the air being very, very clean. And yet what this shows is that these events do kind of break the wall. These particles can get into the Arctic, and potentially change the weather and the ecosystems here, as well.

Yes, so there's a number of things that can potentially occur. It's worth pointing out that over the years we have the CAMS data for, this is a reasonably rare occurrence, that is the scale of it. But there's a number of things that happen that can affect the radiation budget in the Arctic, plus also deposition of black carbon and soot onto the ice sheets. Whether that's sea ice or the ice sheets in Greenland, it can then actually lead to accelerated melting and warming of the atmosphere.

And that's because the ash tends to be dark. And so when it sits on the white ice, it absorbs a bit extra heat from the sun, so it heats up a little bit more, just because something black and it's sometimes soot it could be ash has just fallen out onto the surface.

That's right, yes. And indeed, there are records in the snow pack and ice cores which show the occurrence of these events in the past history. And this is one of the advantages of having our CAMS system being global, is that we can really-- we really have the data which could eventually be quantifiable to how much that might affect the climate system in these pristine, remote environments.

And of course, it all links up, doesn't it? Because things happen down here in the mid latitudes. Things like ash may get carried north. But actually the weather in the Arctic also affects us, as well. Someone on the High Street here might not care about whether there's ash over the North Pole. Actually, the weather patterns up here and understanding them does feedback down. It does affect us.

That's right. And perturbing the atmospheric composition in this part of the world can affect the radiation balance, which in turn affects the synoptic scale meteorology, which can affect how the weather behaves at the mid latitudes, as well.

And if someone has an interest in this type of data, how can they get access to it? What does CAMS produce that could help people?

So CAMS produces maps very similar to the one that we saw. And this is a measurement of the fire intensity. But then it's also converted into estimates of how much trace gases are emitted into the atmosphere. And that's the product that we provide through our fire products. And those data are all available through the CAMS Data Catalog, and through the archive that we have on that data.

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