Topic 1b - Part 2: Copernicus, CAMS and Global Networks - The role of satellites in CAMS

We're surrounded by air down here on Earth, and even though it's right here, we can't see what's in it. So if it's hard for us to see what's in it here, why, on Earth, would you try monitoring it from space?

We go into space because what we get then is a full global picture of not just the chemical constituents, but we also see the clouds, and we see smoke and pollution plumes, for example. Dust storms is another good example. But by going into space, we know we can manipulate parts of the electromagnetic spectrum to be able to actually see the signals from the molecules from different species as they're being affected around the world. We can see those from the Earth's surface as well, but we only see them at a particular location, a particular time. But with a satellite, we can actually orbit the Earth and get a complete global picture of what's going on.

So what's fascinating about this is that you're using light. You're using lots of wavelengths of light, both within the visible spectrum and outside. But the atmosphere is mostly invisible to us, so why does it work? What can you do with light from a satellite that we can't see here on Earth?

So the light that's seen by a satellite is dependent on how the molecules in the air are behaving. So in the infrared, we're seeing the vibrations of molecules that are releasing energy that's coming out of the top of the atmosphere as heat, and that's the signal that's actually measured by these satellites. By measuring those signals in the laboratory and knowing what the composition of the gas is, we can then use that information to calculate what the contribution of that gas is to what is actually measured by the satellite, and then that gives us the distribution globally of ozone or whatever other pollutant that we're interested in.

Tell me about the Copernicus Atmosphere Monitoring Service, which you are a part of. What's it do?

So we run the Copernicus Atmosphere Monitoring Service here at the European Centre for Medium-Range Weather Forecasting. And a nice way to think of it is that we're doing for atmospheric composition what weather forecasting does for precipitation and temperature, except instead of those parameters, we're looking at pollution from different sources, we're looking at the ozone layer, for example, we're looking at dust storms, we're looking at fires, and we're looking at how that pollution then is moved from the source region across a region and across the globe as well. The analogy with the weather forecast is a very good example and, indeed, what we do within the Copernicus Atmosphere Monitoring Service is we're using this weather forecast model into which we've added chemical tendencies and different chemical species so that they run alongside the weather parameters and we can forecast them in much the same way.

So there's a huge system here because, first of all, you've got lots of satellites up above the atmosphere, and then dealing with all of that data is very complicated. Run me through the path of what happens to the data until it becomes useful to a person on the ground.

So typically what a satellite is measuring, it's not actually measuring ozone or a particular chemical species but rather it's measuring this radiations, as we already mentioned. And that information is what is relayed to the ground through various ground segments and they then go to satellite processing, data processing centers, where then they turn that into something more meaningful. So they're applying computer algorithms, which take in that information about how the light interacts with different molecules of different species, and then turning that into an estimate of the quantity of that chemical species. And that's the data that we actually use in our system to do the forecasting.

And then you're producing tools which you can use-- an individual like me-- could use like a weather forecast. So you're sort of coordinating the data so it looks like something meaningful. Tell me a little bit about that.

Yeah, exactly. So part of getting uses for this kind of data is to make it into a form which is understandable and which you can look at and get out what the message of the image is. So everybody's familiar with looking at weather forecasts on the news or in the newspaper or on the internet, and we can produce similar kinds of maps which then show the distribution of pollution plumes and how those things are changing over time. What we're also doing in the Copernicus program as a whole is to provide free open access data to anybody that wants to use it, and that's true of the Atmosphere Monitoring Service data as well, and that includes all the parameters that we're estimating based on the satellite data.

So the point of your part of the system is that you take the satellite data that's got this information, you turn it into something that people can make sense of, and then you make it openly available.

Yeah.

Because it's a big teamwork effort to get to that point, isn't it? This is an EU project. These are EU satellites. And so it takes the contributions of a lot of countries to get to this stage of having this weather forecast.

Exactly. And it's taken the best part of ten years to get to this stage where we can actually run this now as an operational service. And that's because we are in this golden age of Earth observation data, and this is true for atmospheric composition, where there are some satellites that we're still using now which have been in orbit since the late 1990s and throughout the 2000s. And the effort for getting those instruments flying and producing that data is huge and it's a huge international effort that includes not just people from the European Union, but also scientists at NASA, and NOAA, and elsewhere around the world.

When Copernicus started, it was an idea. So it was quite difficult to convince people about an idea. But now that we have seven satellites flying and concrete products, it's more easy to explain, in particular to policymakers, the importance of what we are doing.

Let's maybe focus on the fact that we launch satellites, it's Sentinel-5P, that is a precursor, and the entity is really looking into the atmospheric quality. Already we have brilliant pictures from this that can show us some atmospheric emissions and atmospheric compositions. And from there, it's nice to see pictures to policymakers in order to make them understand what does the main challenges that are happening in Europe, as a first, but even more globally. It's a challenge, and we have many people working around us, so the Commission is managing this program, European Space Agency is developing the satellites, but then ECMWF is running the service and EUMETSAT is also contributing through the operation of the satellites.

And in particular, in the future, Sentinel 4 and 5 will come in the, let's say, in the range 2020, 2021, in order to complement our sentinels constellation and to provide us even with more capacities. And with all capacities flying, I think that people are really starting to understand what we are really doing. We have the capacity now also to deliver regular bulletins to explain what is the quality of the air. So really, something tangible, not just dreams, but really something operational and true.

Copernicus is more than one satellite. Just tell me a little bit about the satellites you've got and what's coming up.

So we use satellite information from a wide range of different sources. Some of these are NASA's satellites. Some of these are European satellites. The Copernicus program itself has this so-called hardware components, which is the sentinel satellites. There are six of those, and those are measuring a wide range of environmental variables.

There are three that are of particular interest to CAMS, which are the sentinel 5 precursor, which was launched late last year and is measuring quite high resolution trace gases, and then in the future, there will be the sentinel 5 but also sentinel 4, which is a geostationary platform which stays at the same place over the Earth's surface and measures at much higher time resolution over Europe, as it will be in this case.

So there's a group of satellites that are all working to measure, measuring slightly different things, and you're taking the data from all of them and building it into one way of looking at the atmosphere.

Yeah. And that's the advantage of the system that we have. We use process of data assimilation to take information from a lot of different sources, from different satellites, which are measuring slightly different things in slightly different ways. Integrating all that information into our forecasting model means that we can really get extra value added information from those datasets.