Topic 3f – GHG monitoring and identifying sources

At least for some products, like CO or CO2, which last quite a long time and the distribution is quite homorganic, so quite often we cannot see the sources, where the CO is coming from, for example. For example, there exists some new studies how do to improve the situation and how we can see the sources, what is the real source of the CO2, for example. But for several species, this is very difficult questions. I hope that in future, with new instruments like Tropomi and Sentinel-5, the situation improves, then because the spatial resolution is much better then. So we doesn't, for example, need to collect data over one year to see the sources, what we are doing now. We can use data from one day, for example.

Tell me a little bit first about why it's important that we measure carbon dioxide.

Well, of course we want to know what's the level of carbon dioxide in the atmosphere, but what we actually are really after, we want to know what are the sources and sinks of carbon dioxide. So the surface, where does it get emitted and where does it let it go?

And carbon dioxide is an interesting gas to monitor from space because there are both natural sources-- there are huge natural sources and sinks, and then there's what humans are doing. Tell me about the difference between those two and what they are, where they come from.

Well, natural sources you can see, for example, this kind of seasonal cycle of CO2. So when plants and trees start growing, we see that they take CO2 from the atmosphere, whereas if you look at, for example, anthropogenic sources, they kind of emit all the time the CO2 to the atmosphere. And then there are, of course, other sources like biomass burning is one big emission source for CO2.

There's an increasing effort to go and, especially because of the Paris Agreement, to monitor carbon dioxide. How is that changing over time? Take us through what's happening now and what will happen in the future.

Actually, before Paris Agreement, people were mostly studying biospheric fluxes, but now because of Paris Agreement and the general importance, for example, European Space Agency is currently planning their anthropogenic CO2 mission.

And so there's new satellites. I think Sentinel-5 and Sentinel-7, is that right? What will they do?

Well, Sentinel-5 and the Sentinel-5b, they measure carbon monoxide and methane, which are-- well, methane is a very important greenhouse gas, too, in addition to CO2. But Sentinel-7 will most likely be an anthropogenic carbon dioxide mission. And the idea, for example, is that the measurement would be kind of more targeted to the anthropogenic sources.

And how important is the international cooperation on this? Because there's a lot different countries measuring these things.

Yeah. For example, at the moment, we have one CO2 measuring satellite from NASA and one from Japan. But, for example, at the moment Europe doesn't have its own CO2 mission. Europe will have a big role in the future, especially in this anthropogenic side.

Let's look at the animation here behind us. What are we looking at?

These are the measurements of NASA's carbon dioxide mission OCO-2. And while you can see this is a two-week period that we see these very narrow tracks that their satellite this measuring CO2 in the atmosphere.

As the satellite goes, around it draws a different line--

Yeah. Yeah. And this is how many measurements we have in two weeks' time. And now it's in the wintertime, so we can actually see that there are not that many measurements in the Northern Hemisphere or Europe.

And why do we not get winter measurements in Europe?

Because the satellite measures backscattered solar light, so we only get good measurements during summertime.

And we can see there's all kinds of-- there's lots of detail in this data. But there's this huge seasonal cycle. The Northern Hemisphere and the Southern Hemisphere behave differently when it comes to carbon dioxide.

Yeah. Most of the landmass is actually in the Northern Hemisphere, so that's the main driver for the CO2 seasonal cycle in the atmosphere. So we see this huge effect that we call draw down. During wintertime, the CO2 kind of builds up in the atmosphere, as we can see right now.

So in the Northern Hemisphere where the plants are, there's a very strong cycle of carbon dioxide goes up in the winter and down the summer, but it's less strong in the south?

Yeah. It's much less strong. There still, you can see from the satellite measurement, the seasonal cycle, but it's less strong, yes.

So that's the natural cycle. Tell me a little bit about the monitoring of anthropogenic sources on top of that. How accurate is it? How much data do you have? Can you-- how can you tell?

Yeah. Well, it's actually very difficult because we have lots of data, but the CO2 background, what we have is, globally, for example, about 400 parts per million. But what we can see, for example, from individual cities or power plants are less than 1% or 1%. So a couple of PPMs. So it's very difficult to look at those individual sources.

So how do you separate them out?

There are a couple of different approaches. One is to look at the individual tracks and see if the satellite has flown over, for example, individual power plants, and then we get kind of a gradient that, oh, here was the plume from the power plant. And the other approach is that you collect this data, for example, for one year, and then kind of look what kind of patterns do you have in the map? So we calculate CO2 anomalies and then kind of try to detect what's can we see in those anomalies? And in many cases, for example, anthropogenic sources that emit CO2 all the time, they get visible in the maps.

Let's talk a little bit about carbon monitoring, just because that is the big story on planet Earth at the moment. What's the future of carbon monitoring look like? What's coming up down the line?

What we're doing in the Copernicus program is also a great deal of carbon monitoring, and actually, in the near future, we're moving more and more to that. There'll be a carbon dioxide monitoring service similar to the atmosphere monitoring service that we have, and, in fact, there will be a satellite mission which will be dedicated to observing CO2, as well. And this will be the Sentinel-7 mission, and that's due to be launched in the next five to 10 years.

And is there also a contribution. Specifically on carbon monitoring. From countries like China, for example. Are there other international partners who are going to join Copernicus in this endeavor?

So lots of different countries are building their own programs for monitoring the quality of the air and the environment, and these programs will be very complementary to each other. Copernicus will remain a European Union program, but it will take information from wherever it's available for better understanding global air pollution.

So the good thing here is that there's a lot of cooperation in science, and this is such a big problem. But people are working together.

This is a problem that affects everybody, that everybody's pollution at some point is going to affect somebody else. And this has been the basis of things since the Clean Air Act, with the policies on transboundary air pollution, scientists and governments working together to really understand the issue, monitor the issue, and then come up with appropriate solutions.