Topic 1e - Climate change and the Anthropocene

Tell me a little bit about the balance of the atmosphere and what determines how this is going to evolve over the long term?

OK, well, our atmosphere has never been constant in that sense. It's always been changing because as evolution takes place, you change the types of trees. You change the type of emissions from forests.

You change the number of fires, natural fires taking place. You change also the composition. So the Earth's atmosphere has always been changing. Or if you have suddenly a large meteoratic impact, you create a smog and you killed off the dinosaurs.

So there's always been interaction. It's not constant in that sense. It's what we call a photo stationary state at any given condition.

OK, and as mankind introduces molecules to this system, it changes the surface, which acts as a uptake of carbon dioxide for example. As we reduce the amount of forests, we're obviously changing the sink. OK, so we have sources and we have sinks. And it's this balance between sources and sinks, which ultimately determines the composition of the atmosphere and thereby changes its toxic capacity.

If you might say, well, how toxic it is? It also changes its oxidation capacity. And it impacts on its ability to do what's called radiative forcing, which is essentially the quantification of climate effects. So how much energy is stored in the atmosphere in terms of heat results in the temperature of the surface. How much chemical, toxic, species are produced decides how many people at the end of the day die, what the impact is on the ecosystem, or what the impact is on agriculture.

And tell me a little bit just about speed of change, because if you know, like you say, our atmosphere has lots of processes have changed over eons. But if you had drawn this map even 50 years ago, it would not have looked like this? So there's a difference between long term changes and these very, very rapid changes we're seeing now.

Yeah, well, 100 years ago, you would have seen a little smog in London. Nothing over here in comparison. And you would have seen natural biomass burning to some extent. But the whole-- basically the pollution and the impact of biomass burning by people to change the type of plants that grow, that's changing the ecosystems and changing the type of stuff that's being released and also how much is burned. So mankind's you can see is impacting everywhere.

And also if we change precipitation, you change the amount of methane produced naturally, for example. So there's a whole lot of complicated, what we call, feedbacks, which impact both on chemical composition, chemical composition and climate, and climate and chemical composition. So if you are having warmer, and your Hadley cell, your tropics and growing, which is what we think sort of happening, you're going to increase desertification. So you're going to have more dust coming up here in China.

We have dust. We were just measuring this in emerge. Dust mixing in with pollution, which is a more toxic mix than just the dust on its own or the pollution on its own. It's got a surface that it can chemically transform on. So these are all things which are an impact. And this is going on globally, and not just globally or regionally, this stuff is then being transported around.

And the ozone hole down here is about as far as you can get from humanity, which was created by emissions in the northern hemisphere, you know? Europe is about 30% responsible for the ozone hole.

So we have in the atmosphere and the Earth system, mixtures of processes. Some are very short term. For example, weather changes very quickly. Short term process, which we need to understand to predict numerical weather. But similarly, chemical composition can change quite quickly. We have photochemical ozone episodes.

We have winter episodes of smog. These come somewhere between in Europe, between November and April for winter smog. And somewhere between March and September, in summer smog. And these come at short times. We need to be able to predict them, OK? So that's one aspect of what we're measuring and when we measure the precursors from space. We can say, we're thinking with the weather forecast in a few days time based on these measurements, we're going to have some smog.

The other thing is that we're changing things long term. And the satellites arguably, at the global scale, provide the best evidence base for long term change. And that's really important on issues for example, like climate change. Looking at the greenhouse gases, which are an early warning. And the short term climate pollutants, which are changed. And those are an early warning system of change.

And that's why we need a global Observing System with a key component in space. And having the right set of instruments that provides continuity with innovation, improving measurements. We want comparable measurements, but not with the same instruments.

When you look up into the sky, you look up, especially a day like today, where it's clear and blue, what what's your mental image of what's in the sky?

Well, what I see is a system which is natural, and being modified by mankind. And I see pollution very often because I live in an industrial part of the world. And so when I look at the sky, I think, what's going on in there. When I go walking on the weekend in places which you think are nice and clean, but because you can't smell or see the pollution, you don't realize that you're in it. And I think people don't understand that today, pollution goes from the local to the global scale.

When the solar system formed, which is about five billion years ago, the Earth was created. It was out gassing, and there were a series of atmospheres. And the old atmosphere was actually an atmosphere which was reducing. And the big change came about 3.6 to 4 million years ago, when life started, and there was a thing called the-- well, there is a very large production of oxygen about 2.5 billion years ago, and this changed things.

Because we have an atmosphere on the planet Earth, which is unique in the solar system, possibly unique in the universe. And this is created by a mixture of natural and organic emissions from the Earth's surface and life. And life is producing oxygen, nitrogen, and an awful lot of trace gases. And it's also controlling things like carbon dioxide, which is a very large greenhouse gas.

And so life changed things. And life, we had what you might call the biosphere. And the biosphere was dominating from say, 2.6 billion years ago until arguably, the Industrial Revolution, when man started-- it had been doing already-- big changes since the Neolithic Revolution. But the population basically changed from 4 million to about 1 billion going from the Neolithic revolution, when settlements were first formed in the Middle East. To 1 billion on a mixture of biofuel, wind, water, and early use of coal.

But after going through the Industrial Revolution, we started to exploit fossil fuels in an unforeseen way. And have lots of benefits-- a growing population, a growing standard of living. Unfortunately also, a growing amount of emissions.

So this atmosphere that we're now living in-- it's arguable about when this new geological age, the Anthropocene, began, but basically, let's say for argument's sake, shall we say 1950s, when mankind's impact became very dominant in the post-war period. And population has risen from three to 7.6 billion. 50% of people now live in urban agglomerations or megacities.

And this whole system, which includes massive land use change impacting on what I would now call the agricultural industry-- it's no longer farming in that sense-- mankind is changing its composition. And the atmosphere, and in particular, the trace gases, give us an early warning of change.

A good example of this was the measurement of chlorofluorocarbons compounds, which then the scientific community showed that these are dangerous, and that they are in the stratosphere. They release halogens, which ultimately, destroy in a catalytic cycle, ozone, which is a key part of the atmosphere. Because that is a protective shield which prevents biologically damaging radiation, the so-called UVB, reaching the earth. Otherwise, we would still be living in the ocean. So we need this ozone layer, it's all part of evolution.

So the biosphere was impacting on evolution, and evolution impacting on the atmosphere. But then came man, and now, we're changing, we're modifying this system. In some cases, we're putting chemicals which were never in the atmosphere before, like the chlorofluorocarbons compounds or polyfluoro compounds, the whole host of them. Many of them have very strong greenhouse gases as well as being ozone destroyers. And this system is now controlled by mankind, which is why we think we've now entered the new geological epoch, the Anthropocene.

These are solvable problems. But they are the challenge for the century. The challenge for my grandchildren and their children's children is to resolve our planet's issues. But the big challenge is related to resources. And if we are modifying the resources, which are required by people and the ecosphere to exist, then we're going to have-- we're going to increase conflict. I mean, there are already the discussions of water wars and this sort of problem.

So it's really essential that we work together to control, in a fair-minded way, to create a system which is in a much better sustainable balance than we now have it. And so this is a big issue for politics. And behind that, in order to believe this thing, we need the measurements.

And that's where the scientists have a unique role to play. Because we provide hopefully, objective evidence, which supplies our understanding of the atmosphere, the science of it. The mechanisms by which the air moves around in the atmosphere, transports, that sort of dynamics. And its chemical composition, how it is controlled. And of course, the atmosphere is part of the earth's system, which includes the oceans and land.