Key:

I = Interviewer
R = Respondent
Unclear: [unclear + timestamp]
Talking over each other: [over talking]

Welcome to IFLScience The Big Questions, the podcast where we invite the experts to explore the biggest mysteries of science.

Sometimes, in order to predict what might happen in the future, you need to be very familiar with what came before. Predicting how our planet responds to the climate changes brought forward by humans is a difficult job – but so very important. Once approach that we're taking to be better at it is by studying the climate of ages past, and that is done by extracting ancient ice from huge glaciers. We're joined by a special guest to tackle the big question of this episode: What is ancient ice telling us about the future?

I: Can you start by telling me who you are and what you do here at the British Antarctic Survey?

R: Yes, I am Dr Liz Thomas, I lead the Ice Core Research Group here at the British Antarctic Survey.

I: Thank you very much. So, why is it important to drill out ice cores?

R: Ice cores are an amazing archive of how the planet's climate has changed and we can use them by drilling down into an ice sheet, and they're effectively a time capsule because you can extract that information and it tells you how the climate has changed, whether that's looking at temperature changes, but it can also tell you about environmental changes. Things like volcanoes. So, there's actually a huge amount of science that can be done just on looking at small amounts of ice from our ice sheets.

I: That is incredible. How old is the oldest ice that we can get to through these ice cores?

R: So to date, the oldest ice cores that we have ever drilled have gone back just over 800,000 years. So that's a very long core that was drilled called Dome C, it was part of a European collaboration, and various other international partners have also then been drilling deep ice core. And that takes us back about 800,000 years, but the ice in Antarctica, in theory, we know has been there much longer. So, there are places where we know it goes back beyond two and a half million years. So at the moment, we have a big international project aiming to try and do exactly that, try and get beyond our longest ice and get beyond a million years.

I: That is incredible. So, you have this record that spans, for now, hundreds of thousands of years but could soon span millions of years.

R: Exactly.

I: How do you store the ice and how do you prepare for it to be studied?

R: The ice, obviously we need to keep it frozen, and actually that can be fairly problematic. We need to have big storage facilities, freezers, that keep them ideally below about minus 25. So at the moment we have some storage of our freezers here where we have the ice that we're working on at the moment, but because we have an archive of samples we've been collecting for nearly forty yea,rs we actually have to use an off site freezer facility and we work with the food industry and keep our ice in storage alongside the fish fingers and the frozen peas in an off site storage facility.

I: That is awesome. And what can we learn from these ice cores when it comes to the past? How do we find out how the planet was in the past from these ice cores?

R: There's a whole range of different science disciplines, if you like, that are connected to ice core research. One of the most famous ones is we talk about changes in temperature, and with our very long ice core records that we've got at the moment, this shows us how the earth has gone from a very natural climate cycle. So, at the moment we're in the Holocene, which is this relatively warm period, and then 100,000 years ago we were in what we pretty much call an Ice Age. These cycles, we call them glacial cycles and they're quite natural, and the reason that we know that is because we can actually look at something called stable water isotopes. It's a fairly complicated science but effectively water, H_2O, you can have oxygen molecules in their heavy form or you can have them in their light form, and the ratio of heavy to light in the water of the ice core can actually tell you something about the temperature change. So that's a very simplified explanation but this can show us how the temperature has actually varied through time.

I: It's fascinating. But you can also see bubbles, air bubbles within the ice cores. Is that something that can get enough to understand the atmosphere throughout these 100,000 years?

R: Yes exactly. So, as well as what just the water can tell us, the way that the snow falls, if you think about fluffy snow, when it becomes more compacted as it gets squished down into the ice sheet, that air that was sort of fluffy then becomes trapped in these air bubbles. So, what we need to do then is to break open those air bubbles and extract the gases and actually, that can then tell you about really important greenhouse gases, particularly carbon dioxide and methane. We don't need to do very much to the gases, they are just there in those bubbles, so we just break them open and inside a vacuum, extract the gas from in there and it will tell you the exact composition at the time when the snow fell.

I: I'm assuming, given that it would be easier to get to the ice if it's more recent, the vast majority of ice cores are from the more recent years. What is the more recent year? Is it in terms of a few hundreds, thousands, or is it longer?

R: Any timescale that you want really. So, an ice core, you can go down and drill just a metre's worth of ice, that's till an ice core and that will tell you what happened just within the last year. You're right, most of the ice that we actually have in the archive is much younger than the 800,000 years that I just mentioned but actually, it depends as well on what the science question is. We don't all want to go and drill back a million years. Some of the science that we're really interested in is actually just telling us how has the climate, how has the Antarctic ice sheet, changed over just the last hundred years because you have to remember, for most places in the planet we've got really long weather observations that go back hundreds of years, thousands of years even, whereas for Antarctica, people didn't start going to Antarctica until a hundred years ago and actually in terms of actual, real, instrumental observations, they often didn't start until the late 1950's. So, our understanding of just the very basic "how has the climate changed?" is still unknown. That's why lots of the studies that we do are really trying to look at that very recent period and place it into a longer context. We want to understand, we know that there's load of evidence that's saying that actually places in Antarctica are getting very warm in the last 50 years, but what we want to know and we can only do with an ice core is say, well is that unusual? Is this anthropogenic? Is that human climate change or is that just natural variability? And that's what the ice cores over these shorter time periods are really, really valuable for.

I: Have they been collected on a lot of different places in Antarctica?

R: Yes. We've got a huge range of ice cores from all across the continent, and various different international groups are all working together in order to achieve this. Antarctica is vast. It's very deceptive when you look at it on a map, but actually, the area is huge and so we work on different drilling projects with different people to access as much of the continent as we can, but actually, we really are still only scratching the surface, if you like, because we've got very few records from such a huge continent.

I: I think the last question about the past is, how deep was the 800,000 year…?

R: So, the deepest, the actual amount of ice, it's close to 3 kilometres. It's a huge amount of ice and that obviously takes many, many years in the planning phase but actually when you're drilling, you drill over multiple seasons. Antarctica, unfortunately, is not a hugely hospitable place to work, so we only have a relatively small time window during the summer months when we can actually physically be there and be drilling. Often, for those very deep drilling projects it meant going back year on year, maybe three or four years, to actually reach the bottom. That's the kind of longest records that we have, but actually, there are places where we could drill a thousand metres and it wouldn't cover anywhere near as many years, because it depends on how much snow falls each year. Sometimes you could drill a thousand-metre core and it may only give you a thousand years' worth of data. It depends on your science and what you want to look for.

I: That's fascinating, thank you very much. I think my final question is very much about the future. You are looking at the changes that have happened in Antarctica over both the very recent and also the very not recent past. How are all those data points being used to model what might happen in the future with the unfolding climate crisis?

R: This is what's really important. For me, I have an interest in the climate and how it changed over the long timescales, but actually, as a person, I really want to use as much of that information to help us become better informed about how the climate will change and ideally, make some changes, maybe allow us to mitigate this. What the ice cores are able to do is actually show us how the planet may change and may react in the past. We understand a huge amount about the climate. We understand about smaller weather systems, but it's actually a very big, complex puzzle, and what we try and do is try and fill in those extra puzzle pieces by saying in the past, temperatures may have reached this certain temperature, or they may have been much colder, or sea ice may have been much larger or much smaller. So, those are the kind of information we can provide which then allows the climate models, these are the things that are actually tasks with predicting what's going to happen next, to understand how the planet behaves in a normal, what we would call a natural variability, natural cycles. If it has that as its baseline then it can start running projections further in time. If that baseline data is wrong or missing, then we don't actually know whether what the models are predicting is genuine, it true. So, this is what we provide. It's almost like the calibration, if you like, for how the planet should behave under normal circumstances so that then the climate models can tell us how it may react in the future with all of these non-natural inputs that we are putting in there.

I: Wonderful. Thank you very much for taking the time and talking to us today.

R: You're welcome.

Thank you for listening to The Big Questions. Head over to iflscience.com for the latest and greatest science headlines. The music in this episode is credited to Audioblocks.com. See you next time.

[END OF TRANSCRIPT]