Transcript:

AusSMC ONLINE BRIEFING: Ice ain't ice - Antarctic ice in climate change

Friday 12 June 2009

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Thanks very much and good morning everybody.

As Ian mentioned, Antarctic sea ice is a very different form of ice to the ice which accumulates on the Antarctic Continent. In fact, most of the sea ice around Antarctica is less than one year old. And I've just shown this rather pretty picture to start with because it really emphasises the fact that the sea ice is floating on the surface of the ocean. In fact, it is formed by freezing seawater, so it's not fresh. And it's as well as being an integral part of the global climate system, which I'll talk about, it is also very important for many species of marine animals and wild life.

So as I'll show down the side of the ice accumulates algae that provides a food source for krill and many other species in the Antarctic rely on krill as a food source and as you can see from this photo the penguins also use it as a means of escaping from larger predators as well.

If we move on this figure shows about how much sea ice and the sea ice in this is shown by the coloured parts of the map, the white area is the area of the Antarctic Continent itself. The colours there show about how much of the ocean is covered by sea ice in February, or at the end of summer, and if you contrast that with this map, it shows how much of the surface of the ocean is covered by sea ice in the late Spring - which is when sea ice reaches it's maximum extent.

So you can see we have this variation from summer to winter from three to about nineteen million kilometres. And to put that in perspective the area of Australia is about 7.5 million square kilometres. So we're talking about a very, very large area of the southern ocean, which from one to season to the next has this enormous amount of sea ice forming on it.

Now to follow up on something Ian said: because the ice is formed by freezing seawater and because it grows and melts each year, it has no effect on sea level whatsoever. It is however, one of the biggest seasonal changes that we see anywhere on the earth. The amount of snow covered ground in the Northern Hemisphere is one of the few things that has a greater seasonal change and because of this we see big impacts on the way the ocean and the atmosphere interact and on ocean circulation and southern ocean eco systems, which is what I will go on to talk about.

This cartoon shows rather nicely the edge of Antarctica. So this is here where I'm pointing is the Antarctic Continent where it flows down and meets the sea. And we get quite often cold winds blowing off the Antarctic Continent shown here by the red arrows and when those cold winds come into contact with the surface of the ocean, the ocean freezes and forms sea ice. Now that sea ice is actually fresher than the water that it forms from even though the sea ice is not completely fresh a lot of the salt is squeezed out from between the ice crystals as they form and that salt gets put into the upper part of the water column, and because saltier water is heavier it sinks. So you can see shown by these orange arrows how the surface waters of the ocean would start to sink.

Now there's a few complicated processes by which ocean water mass is mixed but basically the salt excluded from the growing sea ice mixes with other water masses and it goes right to the bottom. So we get the heaviest water in the world's oceans accumulates by this mechanism as a result of sea ice formation and you can go right up into the North Atlantic or the North Pacific

Ocean and take samples from the very bottom of those oceans and detect water mass properties that are consistent with what forms by this mechanism around Antarctica.

So it's clearly a very important part of the mechanisms that drive ocean circulation. Now to replace that surface water you can see the pink arrows here showing warmer deep water coming from the mid part of the ocean up to the surface and this is one of the few places in the world where deep water does come to the surface. And that's a very important mechanism by which the ocean is helped to breath in effect because the ocean becomes depleted in oxygen because of the animal and the plant life in there and so when these waters come to the surface they get replenished with oxygen and it helps to overturn the ocean circulation. It helps move heat between the equator and the poles and it helps to maintain the balance of the climate system as we know it.

Now this next figure shows ocean circulation on a much larger scale. The red lines here are an approximation of the surface currents around the globe, the blue lines show the approximate circulation of the deeper currents around the globe and what you can see marked in both the Antarctic and the northern hemisphere polar regions by the mauve circles there, are the areas where this bottom water formation that I talked about in the previous slide is most active and that's driven by sea ice. So you can see that both the input from the Arctic and the Antarctic is really an important mechanism for driving the circulation of the world's oceans.

Now I just also put there that if we see significant changes in the amount of sea ice formation in either hemisphere this could have a commensurate affect on the strength of the ocean currents around the world.

There's also some very important eco system influences as I mentioned in the very first slide. You can see on the bottom of the ice here there's algal communities that grow on the bottom of the ice and in fact by the end of spring and into the summer period the underside of the ice can be almost black because there's such high concentrations of algae growing there and in turn they provide a food source for the krill which you can see swimming at the bottom there. There's also algal communities that grow in the middle of the ice and some that accumulate at the surface and these all form an integral part of the southern ocean eco system and the algae which accumulates in the ice is very important for primary production.

If we move on now there's been a lot of discussion about what's happening to the extent of sea ice, both in the Arctic and the Antarctic. The blue line here shows what has happened to arctic sea ice since 1979 based on satellite records that we have available and there has been a significant decline in the arctic over that period. The red line shows what's been happening in the Antarctic and there's been a lot of activity in the media recently in response to a paper published by John Turner, which suggested there's been a one per cent increase in Antarctic sea ice over the same period. The IPCC reported that there was no statistically significant increase in Antarctic sea ice during the satellite record but this paper has shown that there is a statistically significant increase and that it's about 1% per decade.

So there's been a lot of discussion about why the arctic and the Antarctic may have responded differently. If we look now at the next figure, while we've seen a net increase in Antarctic sea ice there's one per cent per decade, which is a modest increase, we have actually seen much more significant regional differences. You can see here in the Bellinghausen Amundsen Sea area there's this bluey green area to the left of the Antarctic peninsula region which is showing quite a significant decline of the order of tens of percent over the last 20 or 30 years but at the same time over in the Ross Sea in this pink and yellow areas, there's been a significant increase. And what the Turner *et al*. paper reported was that they believed that this was in response to changing surface winds around Antarctica and they used an atmospheric model to turn stratospheric ozone on and off and they found an interesting link between the depletion of ozone in the stratosphere and stronger westerly winds around Antarctica.

Now the hypothesis from that paper was that as stratospheric ozone increases we might see a reversal of that trend and so we may over the next coming decade see the decrease in Antarctic sea ice extend along similar lines to what's been observed in the Arctic. And in fact most model, don't worry about those arrows there actually they've been misplaced unfortunately, but what most models are showing, the IPCC class models, is that we would expect to see a significant decrease in both the thickness and extent of sea ice over the next 50 to 100 years and if you take the ensemble average of most of those predictions they suggest that there would be approximately a one third decline in the amount of sea ice produced around Antarctica each year.

The other point I'd like to make about sea ice is that while we've seen a very slight increase in extent around Antarctica we still can't say very much about whether the thickness is changing. In the Arctic we have the added benefit of military submarine data which has been declassified from the 50s and 60s and which shows that there's been a significant decrease in the thickness of Arctic sea ice. We don't have equivalent data sets for the Antarctic and we are hoping that improved satellite altimetry products along the lines of the instruments that Ian described, will eventually give us the capacity to monitor the thickness of the sea ice as well as the extent.

So just in summary I guess you can read those but sea ice really does form an integral part of the climate system simply because it drives ocean circulation and it therefore redistributes heat between the equator and the poles. It is also an integral part of the habitat for many species of wildlife and as well as the big things that we think about like seals and penguins and whales and it is also very important for krill and for algae and primary product productivity.

I talked in some detail about the one per cent increase that we've seen and the fact that this could be related to strengthening or stronger westerly winds that are related to ozone and that we could in future see a reversal of that trend as ozone in the stratosphere is replenished.

So I think I'll leave it there.

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