Before I begin, I would just like to be clear about the terminology, because sometimes we are not quite clear on what we are thinking about, when we are thinking about adaptation and mitigation. So mitigation is a reduction of greenhouse gasses in the atmosphere in order to try and reduce the concentrations. It’s a way of avoiding the threat of climate change. Adaptation is actually dealing with climate change after it’s happened, and the impacts of climate change. So in a sense you could say that adaptation denotes failure, because you wouldn’t have to adapt if you’ve managed to mitigate all your emissions away. Nevertheless, the bottom line is that for us sitting here today, and for our country and for the people who come after us, it’s going to have to be a package of adaptation and mitigation measures which will be necessary to deal with climate change.

I am going to talk today about climate change which is forced by human activities. So I am not interested in climate change which is caused by solar variability or by the onset and retreat of glaciers. I am interested in climate change which we are causing through our activities. So just to set the scene, some people think that climate change is a bit of a Johnny Come Lately, it’s something that we’ve only just been thinking about over the past few years, and the corollary of that is that the scientists have conjured it up from nowhere in order to get their hands on the money. That’s not quite fair. Climate change has been around for a very long time as a concept, as an idea. We have to go all the way back to Arrhenius who in 1895 first set out in a paper the idea that by increasing emissions of certain gasses into the atmosphere we might be able to have an impact on climate. He was very much to the forefront of the science, and it went very quiet after that. Nobody really took up his idea, and there was much more research around ice ages. And there was a low link between people thinking about climate and people looking up landscapes. So as people studied U-shaped valleys and murrains [02:41], back at the laboratory people were thinking more around the onset and retreat of glaciers in the very long term. But when we got up to the period between 1938 and 1964, then Guy Callender who was a British scientist came along, and he began also to pick up the ideas of Arrhenius and carry them on a little bit further. He thought that warming would be beneficial. I don’t know that we’d entirely agree with him today, depending on where we live, but nevertheless he had a clear idea of the threat that was posed, or the risk that was posed by man-made or human induced climate change.

Neither Arrhenius nor Callender have the benefit of the high speed computers that we have today. And it’s really as we had that facility to process very large amounts of data very rapidly that we have really been able to push forward the science of climate change. And there are really two pieces of evidence that I would like to show you now which really do demonstrate for us the reality of the climate change threat. This is the first one. It shows you the observed land and sea temperatures record which goes back to 1850. It’s compiled from many thousands of records over land and by collection of temperature
records by ships at sea. And it comes up to the present day and in various laboratories around the world it is updated each year. So this is the most recent one, which is complete up to the end of 2009, and it shows pretty clearly that since 1850s when the industrial revolution in the Northern hemisphere really got under way temperatures have been gradually increasing with something of an acceleration since the 1960s. And the total warming on the global scale over that record is on the order of just under a degree Celsius.

The second piece of evidence is the computers being used to model how climate will change out into the future. And broadly speaking, those computer models show us that over the period of the 21st century if we continue to release greenhouse gasses at the scale that we are doing at the present day, then by the time we double those concentration amounts in the atmosphere temperatures will have increased by between 1.5 degrees and 4.5 degrees Celsius. It’s an interesting figure, that is an interesting range because it’s been about constant for the last 20 years. So although in that period of 20 years there’s been a huge increase in the sophistication and speed of the computers that we have available to us and the models that we run to capture climate change, nevertheless, that range of warming for the doubling of CO$_2$ in the atmosphere remains broadly constant. And it’s interesting that Arrhenius and Callender both got it not badly wrong considering that they were at the back of the envelope period of calculation. Arrhenius has estimate for the warming due to the doubling of CO$_2$ is between five and six degrees, and Callender’s estimate was two degrees.

Right. So that just sets the background for you. I was just going to say a little bit about the international negotiations which are going on as we speak, really. It’s a continual process of negotiations on the international scale to try and arrive at a way to deal with the threat of climate change. So that means that I have to talk to you about something like the UN, something called the UN Frameworks Convention on Climate Change. And this was the body which first saw the light of day in 1992 at the Rio Sustainability Summit, but actually came into being in 1994. And its job is to gather together the governments of the world periodically and to get them to discuss what they are going to do in order to reduce their emissions of greenhouse gasses, and also what they are going to do to adapt to the climate change that they failed to avoid. And in particular, how the rich countries are going to help the poor countries to adapt to climate change.

The principal tool that the Framework Convention has is the Kyoto Protocol. And this sets binding commitments around climate change for governments. It was first adopted in Kyoto in December 1997, and entered into force in February 2005. That happens when the sufficient number of governments signed, and it went into force when Russia signed the Kyoto Protocol. Australia was one of the later signatories, it signed in December 2007. The map on the right shows you in green the countries which have signed or are close to signing, and the red countries are the ones which don’t have an intention of signing at the present time. The first commitment period for the Kyoto Protocol ends in 2012, and that’s causing some difficulties as I will describe to you now.
So the Framework Convention on Climate Change holds an annual meeting called the Conference of the Parties in order to talk around what’s to be done, and the 15th meeting was held in Copenhagen in December 2009, and I am sure you’ve all heard about it, but it’s important to note that it was just one in a series of annual meetings. The next one will be in Mexico in December this year. The role of Copenhagen was to put in place a successor of the Kyoto Protocol which expires in 2012, and to develop a road map to achieve a successor. And the meeting essentially failed, and it left the international process in a state of limbo from which it has not yet emerged.

Why did it fail? Well, the Framework Convention on Climate Change is built around the standard international process of one country, one vote. If you come from Vanuatu you get one vote, and if you come from Russia you get one vote. The big emitters, both now and in the future, and there is a list of those on the right – those are the countries which are the seven biggest emitters of greenhouse gasses, the percentage figures show you the proportion of global emissions for which they are responsible. So China now contributes slightly over 16% of global emissions. The big emitters now are no longer prepared to accept external mandatory imposition of reductions in greenhouse gasses and external policing of their capacity and their achievement around limiting emissions. When I talk about the big emitters, I am talking, and sometimes people talk about the BRIC countries, which are Brazil, Russia, India and China, together with the United States, or the BSIC countries, people also talk about, which is Brazil, South Africa, India and China, and also together with the United States. This is also an interesting map for Australians, and it shows greenhouse gas emissions per capita. As you probably know, Australia now has the largest per capita emissions of greenhouse gasses. It looks slightly less grim from where we are sitting at the present time if we look at the total emissions, which is what really counts, how much you put out, and it’s also how much you are going to put out in the future. So this shows you CO₂ emissions through fossil fuel burning, the total, and you can see why the BRIC countries and the BSIC countries, they are the ones that really matter around emissions. They are the big emitters and particularly in case of China and India, they are going to be the big ones out into the future as both their populations and their standards of living increase.

I said that Copenhagen was a failure. Well, what happened, there was, at the very end the countries got together so that it wasn’t a complete washout, and produced a document called the Copenhagen Accord. But this is around voluntary pledges of emission reductions. So in the Copenhagen Accord countries can pledge reductions which they self-policing. It isn’t enough. There’s no doubt about that. And the reason why it came into force as I said, is because the big emitters were no longer prepared to be told what to do by the UN FCCC and by small countries like the Pacific islands or much of Africa or parts of Latin America. Nevertheless, since Copenhagen took place in December, countries have been making pledges through the Copenhagen Accord about the size of emission reductions that they are prepared to deliver, and it isn’t enough. Even if the countries actually met the pledges that they’ve made, it is highly unlikely to avoid dangerous climate change, where dangerous climate change is widely accepted as being warming which exceeds globally two degrees Celsius.
So the bottom line is, it’s not enough to mitigate, you have to adapt as well.

So I just want to say a little bit then about the disasters that have been taking place through July and August. I am sure you’ve all been reading about them in the newspapers. They are linked to unusual patterns in the jet stream which is a high altitude stream of air around the Northern hemisphere, which normally moves in a fairly low wave height manner around the Northern hemisphere, but through much of July and in to August it has assumed this very steep pattern of wave, and a pattern which is locked into place in a very unusual pattern. And this is brought to Russia Northerly moving warm air which has produced extremely high temperatures. July was the hottest on record for Moscow, and July also saw the hottest ever Moscow day of 37.2 degrees. And those high temperatures went on for many weeks and produced very dreadful wildfires that they have experienced. Pakistan, on the other hand, because of the interaction of jet stream with the monsoon has seen very large amounts of rain, typically 255 mm at the station which is reported on here in 12 days compared with a normal monthly value of 17.4 mm.

Scientists are now beginning to think about whether or not this is a signal of global warming. They are always very cautious in the language that they use, and the typical statement that you’ll find from scientists in the literature is that it is entirely consistent with global warming, which perhaps isn’t particularly helpful. It’s interesting that this came out of the Telegraph, which is an extremely conservative newspaper in the UK, and which has always been sceptical about climate change, but just this week, this is their weekly summary which I can buy at the airport in Australia, which came out with this headline: Clear Evidence of Global Warming, which is completely atypical of the Telegraph and really does represent a complete turn about in their ideas about global warming.

So. I’ve said a little bit about the international scene. Well, what about Australia? Well, Australia went through this kind of extremes, just in the way that Australia very often leads with respect to climate change impacts, which isn’t always where you want to be. In January and February 2009 Australia went through a series of coincident events – the heat wave in Melbourne, bush fires in Victoria, severe flooding in Northern Queensland, and then an outbreak of dengue fever in Northern Queensland also. Just to give you the example of the heat wave, this shows you the temperature record for Melbourne city through the end of January and the beginning of February 2009, and you can see that temperatures for four days in that period exceeded 40 degrees Celsius, but also remained extremely warm at night, so there was no possibility for people really to recover at night, just to remain persistently hot over a series of days. And this had an effect on the mortality rate in Melbourne, so the orange line at the top of the graph shows you the temperature record between the 26th of January and the 1st of February, the blue line shows you the average mortality rate for that period over a period of years, and the red line shows you the actual mortality over the period 26/01/09 to 01/02/09. You can see how the mortality rate rises as the temperatures rise and stay hot, and as soon as it starts to cool, the mortality rate with the lag of one day begins to fall. It’s very clear, the relationship between the death rate and the temperature. So what happened as a result of the Melbourne heat wave in 2009? Well I estimate 374 premature deaths. The
ambulance services were very stressed, they got 1600 calls per day, double the normal rate, there were power blackouts affecting half a million households, and the train services, around a quarter of services had to be cancelled because of the buckling of rails, or because of failures in the air conditioning systems. The direct financial loss is estimated at $100 million, and the indirect, between $400 and $500 million, so half a billion dollars worth of damage. In the Queensland floods, the damage is estimated at $234 million, but the psychological effect on the communities and the sustainability of those communities, their ability to hold people to live there begins to come into question when you have this kind of flooding which puts places under water for more than a month, when you get rid of one event and then another one comes along, so there is a repetition of events during like the January-February period, they were dealing with flood levels in places between 11 and 12 metres. And the thing that you can comment on about those floodings is firstly how few deaths there were compared with the heat wave event in Melbourne, but also I think how little news coverage there was about that event in the national press compared to the coverage around the Melbourne heat wave.

So if we just look at what happened to the climate of Australia, if you plot out the annual total rainfall, the trend over time, this shows you the map for the period 1900 to 2008, and that looks fairly pale, which indicates it's not much of a change. But if you then begin to focus down, so here’s the period 1950 to 2008, you can see that then there is a clear drying trend over Eastern and South West Australia, and a tendency towards wetting becoming more rainfall over the Kimberly region and the Pilbara up in the North West. And if you come in even closer to the present day, so this is a trend, a change in rainfall over the period 1970 to 2008, that dichotomy between the East and the South West of Australia on the one hand, and North West Australia becoming wetter on the other hand becomes even clearer. What’s interesting about these maps is that they are consistent with what climate models which have been forced by the greenhouse gas changes, they are consistent with the predictions of those models made out into the future. So if you force your models with greenhouse gas emissions, they also will show these special patterns. So then scientists are beginning to wonder whether in fact this special pattern is in any way related to long term climate changes caused by human effects, increased release of greenhouse gasses.

Whether or not it’s caused by human induced climate change, of course the fact remains that we have to adapt, even at the present day, to these changing rainfall patterns. You do find for example that the agricultural authorities in Australia are beginning to think around what has to be done, whether you have to be thinking about moving parts of your agriculture up into the North West, or whether you have to be thinking about stopping growing certain kinds of crops in the areas that are becoming drier.

If we look out into the future, then, what are we trying to adapt to? Well, this slide tries to show you what we think is going to happen in Australia in the future, and the size of the font tells you how certain we are about that change happening. So we are very confident that into the future there will be an increased frequency and severity of heat waves over Australia, and we are also very confident that there will be rising sea levels. But for other things around droughts and more intense cyclones and storms, we think that
might happen but we are less certain, and we think that there will be a change in the intensity in rainfall events, but we are even less certain about that. So it’s just a way of thinking around what’s going to happen into the future, and how confident we are. I am grateful to CSIRO for this slide. It just shows you, given what I’ve just shown you in the preceding slide about how we think climate will change into the future, what the impacts are likely to be, and what it is we are going to have to adapt to. So, increased water security problems, less water in the Murray Darling basin, greater risks from coastal flooding as sea level rises, and significant loss of biodiversity, threat for example to the Great Barrier Reef through warming leading to bleaching and damage to corals. Also, a greater risk to major infrastructure, more heat related deaths particularly amongst the elderly, and reduced production in agriculture and forestry in the South and East of Australia.

We can think around impacts. We can also think around those parts of Australia which are particularly vulnerable to climate change, and this is the map taken from the Intergovernmental Panel on Climate Change assessment for 2007, and these are the areas that they’ve picked out. They’ve picked out South Western Australia, the Murray Darling basin, alpine zones, Southern Queensland, the Queensland wet tropics and Kakadu, being areas that are particularly vulnerable to climate change. And NCAR, the national climate change adaptation research facility were just starting a set of projects to look at the limits to adaptation in some of these vulnerable hot spots. So there are questions around whether or not you would be able to adapt to the impacts of climate change in these places, or whether the impacts will be so severe that it will exceed our capacity to adapt, and we will move, the climate change will move us beyond the limits to adaptation.

So finally, my final messages from this talk are, one is, and I think this is an important and not yet emerging area of research, but it’s something that we really do need to think about, we tend to think about impacts of climate change as being in situ. So we think about the Kakadu as being vulnerable to climate change, we think about South West Australia being vulnerable to climate change. And we think it’s so, or we consider it to be vulnerable because of the way in which the climate will change at that place. But of course we are a globalised society now, and we are vulnerable here in Australia to what will happen in other countries. And we don’t think enough around that. And I think it needs to be an area of research which should be developed extensively. And you can see examples of it. For example, Russia which I think is the third largest wheat exporter in the world, as a result of the drought and the extreme heat which I described to you earlier, has banned wheat exports until the 31st of December. That’s already having an impact on the global price of wheat, and how that’s going to play out between now and the 31st of December isn’t clear, but it’s going to be a very interesting case study of how things may be in the future, as drought becomes more common globally and the responses of governments to the threat of drought challenge us globally, here in Australia, Europe and North America.

The second of my messages is, you very often hear people saying, well we can’t term it a human climate change because we don’t know really precisely what’s going to happen. But here is a quote from another very sceptical publication. The Economist has always
taken an extremely sceptical position around climate change, but on 20th March 2010 it said, “action on climate is justified not because the science is certain, but precisely because it is not.” And I absolutely agree with the Economist, which is probably the first time ever on the subject of climate change.

End of recording