Our Cooling Climate:

Congressional Testimony , 16th September 2013

1. Do we live in a special time in which the laws of physics and nature are suspended? No we don't. Can we expect relationships between solar activity and the Earth's climate going back hundreds of years to continue for at least another 20 years? As President Obama used to say, and this is some time ago now, "Yes we can." Today I will be telling you a story about climate that is different to many in the public domain. It is a story of continual cooling. Cooling that started from 1998.
2. To put that story into context, we will be asking these five questions – starting with "Has the world warmed?"
3. A good place to answer that question is with global sea ice extent. If the world had warmed, we would expect there to be less ice floating around the poles. This graph shows that the total area of sea ice hasn't changed since 1979 when satellites went up to measure such things. The red line at the bottom is the departure from the 30 year mean, and there hasn't been any departure.
4. That was global sea ice, this is the temperature of the atmosphere over the same period. Once again, things are much the same as they were 34 years ago. And the planet has cooled since the El Nino spike of 1998.
5. This graph is of Antarctic sea ice extent since 1979. It is updated daily at a site called Cryosphere Today. This graph shows that the southern half of the planet has unequivocally cooled.
6. Now let's go back sixty years. This graph shows what temperatures have done in Alaska. From 1949, Alaska had about thirty years of cool temperatures and then thirty years of higher temperatures, separated by the Great Pacific Climate Shift of 1976. This is explained by the Pacific Decadal Oscillation, or PDO for short. The PDO is normally about 30 years long. We have had 30 odd years of positive PDO so we are now due for 30 years of negative PDO again with lower temperatures.
7. Recording daily temperatures became widespread in the US late in the 19th century. What this graph shows is the number of state high temperature records by decade back to the late 19th century. The peak decade for state high temperature records is the 1930s, over 80 years ago.
8. That is corroborated by this graph of the number of days of 100 degree plus temperate recordings at US weather stations for the period 1910 to 2012. Once again, the hottest period was in the 1930s and it has been cooling since.
9. If the world was warming, you would expect there to be less snow. This is a graph of northern hemisphere average snow cover in winter from 1967 to 2013. The last four years have been the snowiest in the satellite record.
10. The planet did warm in the 20th century. Has similar warming happened in the past? Thermometers were invented in the 17th century and records of temperature started to be kept. This graph shows the Central England Temperature record from 1659 – the longest temperature record that we have. A couple of things are worth noting on this graph. One is the association of lower temperatures with the periods of lower solar activity of the Maunder and Dalton Minimums. The second is the temperature rise

from 1695 to the late 1730s. That rise was three times as large and twice as fast as the 0.7 degree rise of the 20th century – all due to natural causes.

11. If we go back 2,000 years, our current warmth has been seen twice before in the Medieval Warm Period and the Roman Warm Period. In that context, our current warmth is not remarkable.
12. If we go back 6,000 years to the Holocene climate optimum, the world was up to a couple of degrees warmer than today and sea level was two metres higher. Since the Holocene optimum, we have been cooling at the rate of a quarter of a degree per thousand years.
13. When I asked at the beginning of this presentation if we lived in a special time, well that is true of the last three million years. We are in an interglacial period of an ice age that started three million years ago and might go on for another 30 million years or so. Interglacials are only 10% of the ice age record. Most of the time it is much cooler than it is now. The name of the interglacial we are in is the Holocene. The previous one is called the Eemian.
14. What I have done in this graph is to get the interglacials from the previous graph and align them on peak temperature to see if that will help us understand how much further the Holocene will last. If the Holocene ends up like the Eemian, then we have up to another three thousand years of Little Ice Age-like conditions. If not, cooling could happen very rapidly from here.
15. All our future glacial periods can be predicted from orbital parameters. This is a portion of a graph produced by an anonymous academic. The hind cast match is very good and what it is predicting is that the peak of the next glacial period will be 55,000 years from now. This is the fate of our planet and mankind will occupy a much smaller portion of its surface.
16. This is a subject that deserves a bit of attention. The greenhouse gasses keep the planet 30 degrees warmer than it would otherwise be if they weren't in the atmosphere. Of that effect, 80% is provided by water vapour, 10% by carbon dioxide and methane, ozone and so on make up the remaining 10%. So the warming provided by carbon dioxide is three degrees. The pre-industrial level of carbon dioxide in the atmosphere was 286 parts per million. Let's round that up to 300 parts per million to make the maths easier. You could be forgiven for thinking that if 300 parts per million produces three degrees of warming, the relationship is that every one hundred parts per million produces a degree of warming. We are adding 2 parts per million to the atmosphere each year which is 100 parts per million every 50 years and at that rate we would fry. But the relationship isn't arithmetic, it is logarithmic. The University of Chicago has an online program called Modtran which allows you to put in an assumed atmospheric carbon dioxide content and it will tell you how much atmospheric heating that produces. So I put in increments of 20 parts per million. Lo and behold, the first 20 parts per million produces half of the heating effect to date. By the time we get to the current level in the atmosphere of 400 parts per million, the heating effect is only 0.1 of a degree per one hundred parts per million. One thing I find quite amusing about the global warming debate is that the carbon dioxide level of the atmosphere is actually dangerously low, not dangerously high. During the glacial periods of our

current ice age, the level got as low as 180 parts per million. Plant growth shuts down at 150 parts per million. Several times in the last three million years, life above sea level came within 30 parts per million of extinction due to a lack of carbon dioxide. The more we can increase the atmospheric concentration of carbon dioxide, the safer life on Earth will be.

17. This graph shows the heating contribution of the first 20 parts per million, then the rest up to the pre-industrial level, the 0.1 degree contribution from anthropogenic global warming to date and the maximum effect if we dig up all the rocks we might economically burn and burn them. The total anthropogenic effect to the end of time might be 0.4 of a degree over a couple of hundred years. This would be lost in the noise of the climate system.
18. What I have done in this graph is take the heating effect shown on the second-last graph and make it cumulative. Global warming as promoted by its believers relies upon a little bit of carbon dioxide warming causing more water vapour being taken up in the atmosphere which causes more warming in turn and the whole effect compounds away. They have claimed that the temperature of the planet might rise up to six degrees by the end of this century. This graph attempts to show how that might work. At our current carbon dioxide level, we should already have seen two degrees of warming for this to hold. What the warmers also believe is that global warming starts exactly from the pre-industrial level – not before, not after, but exactly at the pre-industrial level. It is a bizarre thing to attempt to believe, or want to believe.
19. This graph shows world coal production from 1981 with a projection out to 2050. The United States burns about a billion tonnes a year in power generation. European consumption fell away with the collapse of communism. The opposite effect happened in China and they are now burning about four times as much as the United States.
20. And this graph shows a five hundred year slice of mankind's fossil fuel production. The steep rise will be followed by a fall almost as steep.
21. This graph shows the outline from the previous graph with the Mauna Loa record of atmospheric carbon dioxide level superimposed in black. You can see on that graph the effect of the Mt Pinatubo volcanic eruption causing the ocean surface to cool and absorb more carbon dioxide and the effect of the 1998 El Nino. What this means is that we are only a couple of decades off from peak addition of carbon dioxide to the atmosphere and then almost all of that wonderful aerial fertiliser will be absorbed by the deep oceans over the next thousand years or so and mankind won't ever see it again.
22. The advocates of global warming alarmism claim that even if the atmosphere isn't going to heat up, carbon dioxide will make the oceans more acidic and then all the fish and other slimy things in the sea are going to die. To put that claim in perspective, this is a photo of a coral reef growing over a volcanic vent on Dobu Island in New Guinea. The white streams of bubbles you see are pure carbon dioxide. The corals are healthy and there are fish swimming around. The water in this lagoon has a pH of 7.3. Above a pH of seven is basic and ocean water is normally 8.1. Even in the most extreme environment of carbon dioxide addition, it doesn't kill anything.

23. We won't waste any more time on things that aren't a problem. Let's get on to what really drives climate. What stops the Earth from looking like Pluto is energy from the Sun and the amount of energy we get from the Sun does vary in cycles. What this graph shows is the sunspot cycle record from 1749 when the numbering of solar cycles started. Solar cycles are normally 11 years long and can be as short as 9 years and as long as 18 years. We are currently near the peak of solar cycle 24. The Dalton Minimum was two weak solar cycles, five and six, which was associated with colder weather around the planet. The Little Ice Age ended in 1900 and the warmth of the 20th Century that has got some people hot and bothered was associated with some very large solar cycles. There is one prediction so far of the strength of the next solar cycle – Solar Cycle 25. That is an estimate of seven by Livingston and Penn, two researchers at the National Solar Observatory.
24. This is a graph of solar activity back to over 8,000 years ago. The Sun was more activity in the second half of the 20th century than at an time in the previous 8,000 years. It is little wonder that the planet warmed, but we can be more precise than that.
25. Time is short and so we will cut to the chase. While there is a correlation between the amplitude of a solar cycle and atmospheric temperature over that cycle, there is a stronger correlation between the length of a solar cycle and temperature over the following solar cycle. This observation was published by two Danish researchers, Friis-Christensen and Lassen, in 1991. In 1996, two researchers at the Armagh observatory in Northern Ireland applied that theory to the two hundred year temperature record at Armagh. This is figure 5 from their paper. The x axis shows solar cycle length increasing to the right and the y axis shows the average temperature over the following solar cycle. As you can see, there is very little scatter about their line of best fit which means that this graph is a very good predictive tool. If you know solar cycle length, you can predict the average temperature over the following solar cycle. So on top of their graph, I put on Solar Cycle 22 which was 9.6 years long and ended in May1996 and Solar Cycle 23 which was 12.5 years long and ended in December 2008. The fact that Solar Cycle 23 was three years longer than Solar Cycle 22 means that Armagh in Northern Ireland will be 1.4 degrees colder, on average, over Solar Cycle 24, which is what we are in at the moment.
26. I have applied that predictive tool to a number of other temperature records. This graph shows Hanover, New Hampshire which has a steeper relationship of 0.73 degrees per year of solar cycle length. Hanover, which is a good proxy for the Corn Belt, is going to be two degrees colder.
27. A few years ago, an astrophysicist at Oslo University, Jan-Erik Solheim, decided to apply my methodology to the Norwegian temperature record. This map is from an article he published in a Norwegian science magazine. It shows the relationship between solar cycle length and temperature for a number of Norwegian weather stations. Bergen is shown in detail. A decline of 1.5 degrees is forecast – similar to the prediction for Armagh.
28. In 2012, Solheim and his co-authors followed that up with a paper crediting me with the development of this climate prediction methodology. This is a very important

paper which I don't expect to be mentioned in the IPCC report coming out late this month.

29. One benefit from the global warming hoax is that it attracted the attention of scientists from outside the climate science field. We got to work and telescoped what possibly might have taken 30 years to discover into about five years. So instead of blundering into the cooling that is coming, we now have some forewarning. My generation has known a warm, giving Sun but the next will suffer a Sun that is less giving, and the Earth will be less fruitful. Just how less fruitful is what we are now going to examine over the next few slides. This is a graph from Solheim and his group which predicts a temperature decline of 0.9 degrees over the next ten years. All the warming of the 20th century will be reversed and we will return to conditions of the mid-19th century.
30. This graph shows Dombaas in southern Norway which has a 1.5 degree decline in store for it.
31. This is the prediction for the island of Svalbard up near the Arctic Circle which will have a 6 degree decline in winter.
32. Livingstone and Penn have provided a prediction of the amplitude of Solar Cycle 25 of seven, which would make it the weakest solar cycle for over 300 years. Another researcher at the National Solar Observatory, Dr Richard Altrock, produced this graphic which enables the length of Solar Cycle 24 to be calculated, which is a more important parameter. What this graph shows is the green corona emissions of the Sun back to the early 1970s. It shows the progression of solar cycles 21, 22 and 23 and 24 up to a couple of years ago. Solar Cycle 24 is 40% slower than the average of the previous two cycles and thus will be 40% longer. That means that it will be 17 years long – much longer than Solar Cycle 23. In turn that means that Solar Cycle 25 will be much colder again.
33. So using these three tools – a prediction of Solar Cycle 24 length, the solar cycle length-temperature relationship and the logarithmic heating effect of carbon dioxide – we can now predict climate out to 2040.
34. Applying that to Hanover, New Hampshire, we get a return to temperatures of the mid-19th century in the near term and a plunge to the lows of the 17th century a couple of decades out. This has implications for agriculture.
35. We have seen these sort of temperature declines in the instrumental record. This is the Central England Temperature again. The temperature spike down in the last decade of the 17th century killed a third of the population of Finland. We know it was solar-driven as there is a big spike in cosmogenic isotopes in ice cores from that period.
36. This graph shows Solar Cycle 24, the cycle we are currently in, over the records for Solar Cycles 5 and 6 of the Dalton Minimum. So far we are tracking Solar Cycle 5 pretty closely.
37. And the cooling to date has been in line with our prediction. The Central England Temperature has declined by about a degree over the last ten years.
38. One thing I am proud of is helping other researchers to get their work published. This is a graph produced by an electrical engineer in Ohio by the name of Ed Fix. The solar cycle record, shown in green, reminded Ed Fix of the ideal spring relationship in engineering. So he downloaded the orbital data of the planets from a NASA website

and produced a model predicting solar activity, which is the red line. The hind cast match is very good which gives us confidence about what it is predicting. And that is weak solar activity for the next 30 years or so.

39. Another research who predicted weak solar activity was Clilverd in 2003 based on low frequency oscillations in the solar record. Despite the relationship between solar activity and climate, these predictions have been neglected to date.
40. Of course there is a correlation between sea level rise and solar activity. What this graph shows is rate of sea level rise in blue and the solar cycles in red for the years 1909 to 1999. There is a particularly good correlation in the period 1948 to 1987 when solar activity was rising strongly.
41. That relationship is 0.045 mm of sea level rise or fall per unit of sunspot number. The break-over point is a sunspot count of 40 – above that sea level rises and below that it falls.
42. If we apply that relationship to the solar record back to 1646, we get this graph. According to this graph, sea level should have peaked in 2003 and is now falling.
43. Let's compare that to the official record of the satellite era provided by the University of Colorado. According to them, sea level is rising and rising and we are all going to drown.
44. But this graph from a paper in 2008 gives the game away. The lower line is the raw data and the upper line is their adjusted data. They adjusted for isostatic rebound which is a parameter they dreamt up in order to get the result they needed.
45. Let's compare that to a tide guage record. This is from an island in Sydney Harbour for the period 1915 to 2009. Sea level has been rising, though it is off from its peak in 2003. But the rate of rise is more leisurely at two inches per century.
46. The cooling being predicted is going to have significant economic effects, particularly on agriculture. This is a map of Canada from the last time there was appreciable cooling back in the 1970s. The dashed line is the theoretical thermal limit for growing wheat. The heavy black line is what that would shrink to if temperature fell one degree centigrade. A two degree fall wouldn't allow the Canadian wheat crop to ripen before the first frost. I believe that Canadian agriculture will go back to trapping beavers as they did in the 17th century.
47. Similarly from a paper in 1980, this map shows how far the Corn Belt would shift if temperature rose or fell one degree centigrade. It is 144 km per degree.
48. At that rate and given the temperature decline in prospect for Solar Cycle 25, the Corn Belt would shift to the Sun Belt.
49. And it has happened before in the United States. This is a map of the Corn Belt region showing the northern limit of Indian corn growing during the Medieval Warm Period from 1000 to 1250 AD and what that shifted to during the depths of the Little Ice Age between 1350 and 1550 AD. The shift was up to 320 km.
50. How that works is shown by this example from the modern temperature record. Whitestown is just northeast of Indianapolis. The growth of corn is measured in Growing Degree Days or GDD for short. A normal crop takes 2500 GDD to ripen. What this graph shows is the progression of individual years for the period 1901 to

1910 in blue and 2001 o 2010 in red. If conditions returned to what they were 100 years ago, the Corn Belt would be able to grow about 15% less grain.

51. I wasn't the first person to predict that we are entering a severely cool period. My search of the literature points to the CIA being first. I would like to draw your attention to the last sentence which says that the Earth over the last 50 to 60 years has enjoyed the best agricultural climate since the eleventh century. What we have come to consider normal is instead abnormally good and we will revert to conditions somewhat worse.
52. This is the cover of that report which was found in the Library of London.
53. The next researcher to predict a cold period was the eminent UK climatologist Hubert Lamb in 1978. He found a 200 year period in wind direction in London and shifted the line 200 years forward. This was in a report for the German Navy which wanted to find out why the sea conditions in the North Sea had changed.
54. This is a prediction from two US researchers, Libby and Pandolfi, in 1979 and takes the prize for accuracy and distance. They got the small detail of the rise up to 2000 right. Their forecast of a cooling of up to four degrees Fahrenheit is similar to what I am predicting.
55. This is a graph produced by Finnish forestry researchers in 2007. They are predicting the biggest cold period for five hundred years.
56. It can get worse than what I and others before me have predicted in terms of solar-driven cooling. One this graph, note the 0.7 degree cooling in 1992 caused by the eruption of Mt Pinatubo in the Philippines. If we get a cold period overprinted by a major volcanic eruption then we will get an 1816-type crop failure event.
57. The severe cold of 1816, when the Thames froze over in central London, was caused by Mt Tambora in Indonesia exploding the previous year. Grain prices rose and the Swiss ate their cats and dogs and horses.
58. And sometimes severe cooling comes out of the blue without any apparent solar or volcanic event associated with it. The blue line on this graph is the Central England Temperature record from 1715 to 1745 showing the three degree centigrade drop into 1740. The crop failures associated with that spike down killed 20% of the population of Ireland. On top of that is the recent record from 1990 to 2012 which shows a similarity in the shape of the record. If climate repeats, then we have two years to go to a severe whacking and no inkling that it is coming.
59. These are my recommendations for advancing the science of climate and being prepared for what is going to happen. Libby and Pandolfi showed how accurate and prescient good tree ring research can be. It would be good to update their work. Similarly, Ed Fix's model could be further refined. We should also be modelling the coming volatility in grain production.
60. In summary, carbon dioxide's heating effect is minuscule and everything would be better with more of it in the atmosphere. But there is still plenty to worry about because we are at the beginning of a severe cold period. Thank you for your attention.

David Archibald
September 16, 2013