

//Subtitles 56 minutes English 1-03-2016

00:00:04:12 00:00:06:08 Okay
00:00:07:18 00:00:10:16 so this is to test the microphone.
00:00:11:07 00:00:13:14 My name is Simon Lamb,
00:00:14:08 00:00:19:08 I'm a scientist. In fact I'm a geologist.
00:00:24:19 00:00:27:10 I'm also a keen amateur cameraman.
00:00:27:10 00:00:31:19 So this is the crew, one cameraman,
00:00:31:19 00:00:37:02 one chap roped in to do the sound | who happened to be walking past the door
00:00:37:11 00:00:41:08 and [umm] looking like a complete idiot.
00:00:47:09 00:00:51:00 Lately I've noticed something | odd happening in the world of science.
00:00:51:09 00:00:56:02 For the first time in my lifetime | scientists are under attack.
00:00:56:04 00:01:01:04 It's junk science and it is a part of a | massive international scientific fraud.
00:01:01:18 00:01:04:19 There is no scientific basis whatsoever.
00:01:04:23 00:01:07:17 This is a fraud and a scam and a hoax.
00:01:07:19 00:01:12:01 This ridiculous nonsense that man-made | CO2 is causing global warming.
00:01:12:03 00:01:17:03 These extremists, these alarmists | are always finding something wrong.
00:01:19:10 00:01:24:10 These extremists and alarmists are, of course, | scientists studying the climate.
00:01:28:09 00:01:30:01 Could these accusations be true?
00:01:30:19 00:01:34:14 Were dishonest climate scientists | bringing all of us into disrepute?
00:01:35:22 00:01:38:14 As a scientist I had to find out.
00:01:38:23 00:01:40:13 I must get my glasses.
00:01:46:24 00:01:51:24 So I decided to make a film about the scientists | at the centre of all this controversy.
00:01:54:11 00:01:58:04 It took me to the ends of the earth | and underneath it.
00:01:58:11 00:01:59:19 So Mark, where are we now?
00:01:59:21 00:02:05:06 We're in a tunnel in the Taylor Glacier | in the Dry Valleys here in Antarctica.
00:02:09:17 00:02:13:04 I've looked in to the future | and travelled back in time.
00:02:14:21 00:02:17:23 I've even been somewhere where | time seemed to stand still.
00:02:19:00 00:02:24:19 We are highlighting in blue those issues | that are within the mandate of the group.
00:02:30:22 00:02:36:21 Who are these climate scientists? | What do they do? What are they saying?
00:02:37:14 00:02:39:12 And do they know what they are talking about?
00:02:40:12 00:02:44:14 Are they searching for the truth, | or are they peddling a lie?
00:03:01:07 00:03:05:03 It so happens that my office at | Victoria University of Wellington
00:03:05:06 00:03:08:03 is just down the corridor from their | Antarctic Research Centre.
00:03:09:16 00:03:14:16 They told me if you want to meet | climate scientists, go to Antarctica.
00:03:18:20 00:03:20:16 The place is swarming with them.
00:03:36:10 00:03:43:10 Thus it was that I found myself | aboard a US Airforce C17 Globemaster
00:03:46:20 00:03:53:24 in a cargo hold full of scientists, | wondering what I'd let myself in for.
00:04:12:23 00:04:16:07 Going the very first time to the ice is | something that you can't really describe.
00:04:16:09 00:04:20:07 It's really a once-in-a-lifetime experience.
00:04:22:23 00:04:29:08 Standing on a sea ice runway in the | middle of this huge continent -
00:04:29:08 00:04:32:13 it's a feeling like landing on the moon, I guess.
00:04:32:19 00:04:34:14 I mean I've never been to the moon obviously,
00:04:34:14 00:04:37:17 but I could imagine the astronauts | would feel a similar way
00:04:41:02 00:04:47:14 But once you are there you just see the beauty - you | see this amazing continent with all its
histories, 52/50
00:04:47:14 00:04:51:18 its secrets and it's right there in | front of you - it's truly amazing.
00:04:57:12 00:05:00:14 The New Zealanders kindly made | room for me at Scott Base.
00:05:03:01 00:05:07:12 This is the permanent base that supports | New Zealand's scientific research in Antarctica,
00:05:09:00 00:05:14:00 research that covers the whole spectrum | of science from physics to biology.
00:05:21:00 00:05:23:20 The base, of course, is named after the leader

00:05:23:21 00:05:26:23 of one of the very first scientific | expeditions to the southern continent.
00:05:34:13 00:05:38:21 Scott's expeditions were very | much science expeditions -
00:05:38:21 00:05:40:13 and of his team more than half were scientists,
00:05:41:13 00:05:48:19 covering a broad spectrum of science from geology | to geography, meteorology and biology.
00:05:49:19 00:05:52:17 Going to the Pole in many ways was | the means of raising the funds.
00:05:52:23 00:05:57:16 It was a sort of a carrot to attract funds | to carry out a scientific expedition.
00:06:06:08 00:06:11:08 We're at Scott's hut from his | second expedition of 1910 to 13.
00:06:12:13 00:06:19:11 Everyone compares today's records with theirs to | see how things have changed - all important
stuff. 48/50
00:06:22:07 00:06:27:02 I admire their fortitude and courage | under just incredible conditions.
00:06:27:09 00:06:30:05 It's hard to imagine the deprivations | they went through.
00:06:35:00 00:06:41:10 Today the only people allowed to live and work in | Antarctica are scientists and their support staff.
00:06:47:13 00:06:51:17 I found the variety and ambition | of the science quite staggering
00:06:52:03 00:06:56:18 and the common thread linking much of the | research was perhaps not surprisingly...
00:06:56:23 00:06:58:12 ice.
00:07:04:17 00:07:12:22 These are ice platelets and almost fresh water.
00:07:12:22 00:07:16:20 and so we think they play a role | in the growth of the sea ice.
00:07:25:24 00:07:29:19 Hey Brad - you ready for the next block? Ready.
00:07:35:24 00:07:44:00 We're looking for microbes that reside in the | ice and that may respire the carbon in the ice
00:07:44:00 00:07:45:08 to form CO2.
00:07:53:19 00:07:56:22 Last year's cores looking at the | younger part of the geological record
00:07:57:10 00:08:01:23 we're able to see a record of advance | and retreat of the ice shelves.
00:08:02:05 00:08:07:05 and now we're in sediments that are getting up | towards 20 million years - 15 to 20 million years
00:08:07:06 00:08:08:23 so it's a much older part of the climate story.
00:08:13:16 00:08:18:16 The Antarctic Peninsula is a perfect example | of a place where sea ice has disappeared
00:08:19:14 00:08:22:05 and so have Adelie penguin populations.
00:08:22:10 00:08:25:01 They really need the sea ice to do well.
00:08:28:08 00:08:34:13 Ice it turns out is not just frozen water | - it's frozen history,
00:08:36:01 00:08:37:18 climate history.
00:08:44:18 00:08:47:16 I knew that climate is just average weather
00:08:48:15 00:08:54:12 and I noticed that an important daily ritual at | Scott Base was the recording of the temperature.
00:08:55:07 00:09:00:14 Current temperature at the moment is minus 7.6°C.
00:09:03:06 00:09:09:04 The maximum temperature since this | time yesterday is minus 6.6°C.
00:09:10:15 00:09:16:00 It's about 50 years - it was 1957 | - that observations started being taken here.
00:09:16:05 00:09:20:01 They were taken every four hours. I'm lucky I | only have to do them every day at 9 o'clock
00:09:20:11 00:09:24:20 But I'm conscious that I don't want to be | the first science technician in 50 years
00:09:24:20 00:09:26:17 to be hung over from the party last night
00:09:26:24 00:09:28:16 and miss the observations.
00:09:29:12 00:09:34:01 And reset this, I better hold on to this | properly. I don't want to let go of it
00:09:34:02 00:09:35:11 and put mercury everywhere.
00:09:36:10 00:09:38:22 It's easy to do that in winter | when you're wearing big gloves.
00:09:41:09 00:09:47:07 There is a 1 degree change in the mean temperature | here at Scott Base in the last 50 years
00:09:47:16 00:09:53:03 and that's reasonably significant in | terms of change over a short period.
00:09:53:17 00:10:00:01 In previous parts of history there's been perhaps | a four degree change every thousand years,
00:10:00:05 00:10:02:15 so one degree over 50 years is quite significant.
00:10:04:02 00:10:07:17 So people have been recording the weather | in Antarctic for about fifty years,
00:10:08:17 00:10:12:19 a hundred, if you include the observations | made by Captain Scott's expedition.
00:10:19:01 00:10:23:16 But on the Evans Piedmont Glacier | I learnt that snow and ice
00:10:23:16 00:10:26:22 have been recording the climate for much longer.
00:10:27:22 00:10:31:11 Well, girls - pick your weapons.

00:10:32:12 00:10:36:07 Because snow is an amazing material, | as it forms in the atmosphere
00:10:36:07 00:10:38:17 and falls down to accumulate here,
00:10:38:17 00:10:43:21 it captures a lot of information on the particular | weather of the day, of the month, the year.
00:10:46:23 00:10:52:02 You can see these wonderful structures here | in the snow, which represent annual layers.
00:10:52:06 00:10:57:06 and so by digging this snow pit we are | going back about 40 years in time.
00:10:59:22 00:11:04:02 When I visited, Nancy Bertler's colleagues | were carefully harvesting snow
00:11:04:12 00:11:07:03 that had fallen over the past few decades.
00:11:07:19 00:11:11:03 A period when we have records of | how the climate was changing.
00:11:12:05 00:11:16:01 At the end of the day what we are | measuring, its chemistry, its isotopes,
00:11:16:01 00:11:20:21 and to understand how the climate | record is preserved in the snow,
00:11:21:07 00:11:23:13 we need to have some time of overlap
00:11:23:13 00:11:27:00 where we can see what the weather did and | what the snow tells us about the weather.
00:11:28:08 00:11:31:23 We use then this knowledge to go back | further in time with the ice core records,
00:11:31:23 00:11:33:16 where we go back many thousands of years,
00:11:35:05 00:11:39:21 but where we don't have the luxury of | having meteorological observations.
00:11:47:04 00:11:50:11 I was intrigued by these ice cores that | Nancy had mentioned,
00:11:51:08 00:11:56:13 and then I was told there was an American-led | team of scientists drilling ice cores
00:11:56:13 00:11:58:24 up on the vast Antarctic polar ice cap.
00:12:01:24 00:12:04:05 So I hitched a ride on a logistics flight
00:12:04:22 00:12:10:10 which took a mere two and a half hours to cover | the same ground Captain Scott struggled over
00:12:10:10 00:12:12:05 for two and a half months.
00:12:25:20 00:12:31:23 Apparently this small team is travelling right across | the Polar Plateau, drilling ice cores as they
went.
00:12:47:06 00:12:52:07 We started about 450km north of here last year,
00:12:52:12 00:12:55:16 but only managed to travel the 450km.
00:12:55:18 00:12:58:22 Typically we travel much | more than 1000 in a season.
00:12:59:20 00:13:04:05 We effectively travel in three different groups. | The first is that red "Pisten Bully".
00:13:04:05 00:13:06:04 - it has a crevice detector on the front.
00:13:08:23 00:13:13:23 - then the second train will have | the kitchen and the accommodations,
00:13:14:13 00:13:18:02 it's dragging experiments looking | down into the ice.
00:13:18:08 00:13:23:08 And then the third train is made up of ice | cores and additional scientific equipment.
00:13:24:20 00:13:29:20 I'm Daniel Dickson. I'm a PhD | student with Paul Mayewski.
00:13:31:18 00:13:38:07 We're trying to understand the climate of | Antarctica for the last 200 to 1000 years
00:13:39:01 00:13:42:15 and I do this by looking at | the chemistry of ice cores.
00:13:44:13 00:13:46:12 These are our two ice core drills
00:13:46:12 00:13:52:13 - one recovers about a 3 inch diameter ice core, | the other about a 2 inch diameter ice core
00:13:53:01 00:13:58:18 and they can go down about 100 to 200 metres, | allowing us to go back 200 to about 1000 years.
00:13:59:13 00:14:04:13 The way this drill works is similar to the way | you would drill a hole in the wall of your house
00:14:05:05 00:14:07:17 but the only difference is our drill bit is hollow,
00:14:08:02 00:14:12:04 and so while we are drilling, the core | is actually captured inside the drill bit.
00:14:12:16 00:14:15:21 Paul will push the core from this end, | and the chips will empty
00:14:18:03 00:14:22:16 - and here comes the core - and there | we have a perfect metre of core.
00:14:23:13 00:14:29:16 We understood from the late 1960s probably until | about 15 years ago, or believed, I should say,
00:14:29:16 00:14:32:12 that Antarctica was a very stable place.
00:14:32:21 00:14:36:20 - giant white cold mass of ice that never changed.
00:14:36:23 00:14:41:04 In the last 15 to 20 years we've learned that | this place is very dynamic.
00:14:42:17 00:14:48:11 This may be a cold spot but climatically | it's a real potential hot spot for change.
00:14:56:01 00:15:01:01 So overall we drilled 1000 metres | - that's almost a decade worth of work.
00:15:02:04 00:15:06:12 So this is our core - we're working on this one.
00:15:08:18 00:15:11:11 It's not the easiest of jobs, | it's a little bit fiddly.

00:15:11:20 00:15:16:20 We set it onto a continuous melter, | which is pretty much just like a hot plate.
00:15:17:12 00:15:22:12 It melts the ice core layer by layer | back through time.
00:15:23:08 00:15:28:10 As the water is produced, it is pumped by | these pumps into these various tubes,
00:15:28:10 00:15:33:10 and this allows us to do analyses of all sorts of | things that are contained in these ice cores.
00:15:38:07 00:15:42:00 We are looking for properties of the water | that tell us about the temperature.
00:15:42:05 00:15:46:00 We are looking for dust as an indicator | of wind strength,
00:15:46:00 00:15:50:17 and where this air mass might come from | that precipitated this snow.
00:15:53:00 00:15:57:18 And so by studying how much of these | various components is in the ice,
00:15:57:18 00:16:01:06 we get a feel for what the climate was like | when the snow fell.
00:16:03:22 00:16:10:02 But what really fascinated me is that the ice cores | allow us to relate changes in past climate
00:16:10:07 00:16:14:04 to changes in the composition of | the ancient atmosphere.
00:16:14:15 00:16:20:09 In the ice cores there are little bubbles that contain | a real sample of the atmosphere through time.
00:16:20:14 00:16:24:00 We can release that air and measure | the greenhouse gases.
00:16:24:07 00:16:28:06 You could almost say we're taking the DNA | of the atmosphere.
00:16:29:17 00:16:35:09 Nancy and her colleagues are just one of | many scientific groups examining ice cores.
00:16:36:19 00:16:42:09 I found a lot of the original scientific papers | on the web going back over 30 years.
00:16:42:20 00:16:46:21 All the cores seem to tell the same story,
00:16:47:03 00:16:53:01 a regular pattern of cooling and warming | as the planet passes in and out of ice ages.
00:16:56:06 00:16:59:04 Yes, so we've got this remarkable record | in the ice cores,
00:16:59:21 00:17:06:10 and we see these very regular, but quite dramatic | shifts going from warm to cold, warm to cold,
00:17:06:10 00:17:07:14 warm to cold, warm to cold.
00:17:07:14 00:17:11:04 These are the glacial interglacial cycles | happening every 100, 000 years.
00:17:11:08 00:17:18:12 But what's so striking is the way that CO2 levels | show exactly the same pattern as temperature.
00:17:19:11 00:17:23:24 It's probably the best correlation in any | natural data set that I've ever seen.
00:17:25:05 00:17:28:08 The greenhouse gases also show | the same pattern
00:17:28:15 00:17:31:20 so when CO2 goes up temperature goes up,
00:17:31:20 00:17:34:13 and vice versa, when CO2 goes down | the temperature goes down,
00:17:34:13 00:17:39:05 and for all intents and purposes it looks like | they are totally locked together in step.
00:17:40:02 00:17:42:19 And it really is a remarkable piece of science.
00:17:42:23 00:17:45:14 It's revolutionised the way we think | about the climate system.
00:17:51:09 00:17:55:05 This discovery, that going back | hundreds of thousands of years,
00:17:55:05 00:17:58:23 there's a link between CO2 in | the atmosphere and temperature,
00:17:59:17 00:18:03:12 must be one of the most important things | to come out of Antarctic science.
00:18:09:04 00:18:14:08 But to me this correlation was still not proof | of the central claim of climate scientists -
00:18:16:10 00:18:21:21 that changing levels of CO2 are actually | causing the changing temperatures.
00:18:26:09 00:18:31:09 I realised I needed to know a lot more | about what CO2 does in the atmosphere
00:18:31:19 00:18:33:13 and why it's called a greenhouse gas.
00:18:35:11 00:18:37:11 It was time to talk to physicists.
00:18:41:04 00:18:46:04 We're going to try to go through in this tutorial | basically what controls the climate of the earth.
00:18:47:12 00:18:50:13 But I was rather taken aback at what they said.
00:18:50:15 00:18:54:19 The question of whether or not greenhouse | gases are causing global warming is
00:18:54:19 00:18:56:22 completely uninteresting to a physicist
00:18:56:22 00:18:58:16 Of course they are causing global warming.
00:18:59:18 00:19:06:00 It turns out that the theory of global warming, the | greenhouse effect, was worked out some time
ago.
00:19:06:16 00:19:12:16 If all we knew was that greenhouse gas levels were | going up and supposing we didn't have any
record
00:19:12:16 00:19:20:04 of temperatures over the last 50 years, we would | still expect as physicists the world to be warming.
00:19:20:11 00:19:25:12 Really what we're talking about is not so different | from the warming effect that you get from
00:19:25:12 00:19:27:23 adding fibreglass insulation to your house.
00:19:28:13 00:19:32:11 You've got a big chunky amount of | shortwave energy coming in from the sun.

00:19:33:09 00:19:38:17 If we want to understand the climate, or | particularly the surface temperature of a planet
00:19:38:24 00:19:43:01 you first have to understand something about | the connection between temperature and energy.
00:19:43:05 00:19:49:01 Temperature is loosely speaking a measure | of the energy content of something.
00:19:49:01 00:19:51:13 Something that is hotter actually | has more energy inside it.
00:19:53:19 00:19:57:11 In order to determine the temperature | you need to know something about
00:19:57:11 00:20:00:12 the rate at which energy goes in, and | the rate at which energy goes out.
00:20:10:03 00:20:16:04 In 1827 it was recognised that the energy | source that maintains the earth's temperature
00:20:16:06 00:20:21:16 is not energy coming up from the interior of | the planet, but the sunlight that's absorbed.
00:20:21:19 00:20:27:06 And so if you kept absorbing all the sunlight | and you kept accumulating energy,
00:20:27:21 00:20:31:00 then the planet would just heat up, | and heat up, and heat up,
00:20:31:00 00:20:34:02 and the temperature would grow | without bound until we melted.
00:20:40:00 00:20:43:11 So the other part of the equation that | determines the temperature of a planet
00:20:43:23 00:20:46:07 is the rate at which you lose energy.
00:20:46:07 00:20:52:03 Here the key insight was that the hotter | a body gets the more rapidly it loses energy.
00:20:52:05 00:20:58:22 You're receiving energy at more or less a fixed rate | from the sun. Then temperature builds up and
up.
00:20:59:01 00:21:02:17 The hotter it gets the more rapidly | you lose energy to space,
00:21:04:15 00:21:10:12 and then, bang, when what goes out equals what | comes in, that's your equilibrium temperature.
00:21:14:20 00:21:17:14 Though on reflection it's obvious, | I was still struck
00:21:17:14 00:21:23:20 by the fact that to avoid burning up | the earth must constantly lose energy to space.
00:21:23:20 00:21:26:24 Given that outer space is essentially a vacuum
00:21:27:03 00:21:31:22 the only way that a planet can lose energy, | the only thing that exits from the planet,
00:21:31:22 00:21:34:10 is light radiation, electromagnetic radiation
00:21:34:14 00:21:40:06 and light I mean broadly construed, | so there is light that we can't see - infrared.
00:21:45:03 00:21:48:18 You can actually feel the effect | of infrared energy from the earth.
00:21:48:23 00:21:54:10 If you go out on a clear night in the winter, | and you hold your hand above the ground
00:21:54:12 00:21:59:02 you can actually feel that the bottom | of your hand feels warmer than the top.
00:21:59:20 00:22:03:04 And that's the flux of infrared energy | escaping from the earth.
00:22:04:19 00:22:08:20 The reason I said it had to be a cold night in winter | is because those are some of the few
conditions 53/47
00:22:08:20 00:22:14:06 in which you actually do get radiation | escaping from the surface of the earth directly.
00:22:14:08 00:22:21:09 On most days under most conditions | the atmosphere is far too thick,
00:22:21:09 00:22:26:09 far too opaque for this infrared radiation | to escape directly to space.
00:22:26:21 00:22:29:05 And this is the thing that | people have to understand
00:22:29:05 00:22:33:03 - the atmosphere looks completely different in the infrared.
00:22:33:03 00:22:38:13 If we were wearing goggles that only | allowed us to see in the wavelengths
00:22:38:13 00:22:42:10 that the earth uses to shed energy to space,
00:22:42:10 00:22:47:10 we wouldn't be able to see very far. We'd barely be | able to see 200 yards to that college over
there.
00:22:51:00 00:22:53:09 Most of the atmosphere is nitrogen and oxygen,
00:22:53:09 00:22:58:14 I mean 80% of it is nitrogen, and nitrogen doesn't | really absorb infrared radiation very well
00:22:58:14 00:23:00:14 - it doesn't absorb heat very well at all.
00:23:01:03 00:23:07:21 So anything like CO₂, which is a different type of | molecule - it has a different shape essentially
00:23:08:00 00:23:11:05 - is much, much better at absorbing heat
00:23:11:05 00:23:15:16 specifically at the wavelengths, | the parts of the colours of the spectrum,
00:23:15:16 00:23:18:05 where the earth itself is re-emitting that heat.
00:23:21:05 00:23:25:23 OK, what I am going to do is I'm going to puff | some CO₂ from this fire extinguisher into the beam
00:23:25:23 00:23:27:13 between the sun and the instrument,
00:23:27:13 00:23:30:22 and see what effect that has | on the absorption. Here we go.
00:23:31:01 00:23:32:18 We'll see what that does.
00:23:33:07 00:23:36:07 So here we've got the two spectra | that we measured from outside

00:23:36:09 00:23:43:07 - the black curve underneath is what happened | after we puffed CO₂ from the fire extinguisher,
00:23:43:11 00:23:49:10 and here you can see the strong | absorption feature due to CO₂.
00:23:50:07 00:23:53:18 This shows why CO₂ is such a good greenhouse gas,
00:23:54:00 00:24:00:09 because it has such strong infrared absorption | where the earth is re-emitting heat from the sun.
00:24:02:19 00:24:06:20 But the higher up you go, the more tenuous | the atmosphere gets, and the thinner it is,
00:24:06:20 00:24:10:12 so there's less greenhouse gas there | just because there's less gas of any sort.
00:24:10:12 00:24:13:20 And so there's always some level where | the atmosphere finally becomes thin enough
00:24:13:21 00:24:16:12 that the radiation can escape to space -
00:24:17:01 00:24:19:08 and that is called the radiating level.
00:24:28:05 00:24:32:02 I've been doing this twice a day | for the last 40 years.
00:24:32:13 00:24:34:08 Do you enjoy doing this?
00:24:34:14 00:24:40:08 It's fascinating. You never can tell what you're | going to get on your flight, and it's always different.
00:24:43:24 00:24:51:12 As you're going up in a balloon, you're in effect | rising through the mist, and escaping slowly
00:24:51:14 00:24:55:12 from the greenhouse blanket that | envelopes the surface of the earth,
00:24:56:24 00:25:00:07 and when you get to around 5000 metres, | you've reached that critical altitude where
00:25:00:08 00:25:04:11 energy can begin to escape to space.
00:25:07:00 00:25:09:16 And that level is colder than the ground
00:25:10:11 00:25:14:04 because the higher up you go, up to | a certain point, the colder it gets,
00:25:14:22 00:25:17:24 and that is called the radiating | temperature of the planet.
00:25:19:03 00:25:24:16 OK, the temperature plot we have here | starts at the surface at about 18 degrees
00:25:24:16 00:25:28:16 - at about 10,000 feet we go | through the freezing level.
00:25:28:24 00:25:38:09 You can see the temperature decrease up to this | point here, about 12 km, which is the
Tropopause.
00:25:42:13 00:25:47:13 And then I'll be back here at midnight | tonight, and do it all over again.
00:25:54:07 00:25:58:18 That difference between the radiating temperature, | which you can measure from satellites and
confirm
00:25:58:20 00:26:03:22 - that difference between the radiating temperature | and the surface temperature is accounted for
by
00:26:03:22 00:26:05:07 greenhouse gases.
00:26:05:16 00:26:14:10 If you looked at the planet from space, it would | look as if the planet had a temperature of -18°C.
00:26:15:14 00:26:19:07 That's the temperature we would | actually have if we had no atmosphere.
00:26:19:09 00:26:27:04 But in fact we have a blanket of | greenhouse gases surrounding the earth.
00:26:27:08 00:26:32:08 What you see from space is the top of that blanket, | which - just like a real blanket
00:26:32:10 00:26:37:10 - can be much colder than the bottom. | So where we are underneath this blanket
00:26:37:13 00:26:41:11 is a nice comfortable 15 degrees on average.
00:26:42:08 00:26:48:08 No matter how much greenhouse gas we add | to the atmosphere, we will not change the
00:26:48:08 00:26:50:03 radiating temperature of the planet
00:26:50:09 00:26:55:09 because the radiating temperature is determined | by the requirements of energy balance.
00:26:55:22 00:27:01:02 So if the earth is radiating at a temperature of | minus 20 Celsius today, in round numbers,
00:27:01:20 00:27:09:10 then even after adding a lot of CO₂ to the atmosphere | it will still, once it comes into balance,
00:27:09:10 00:27:11:14 be radiating at minus 20
00:27:12:15 00:27:17:20 When we add CO₂ to the atmosphere we are not | primarily changing the radiating temperature -
00:27:17:20 00:27:20:16 we're changing the radiating altitude.
00:27:21:20 00:27:29:13 When we raise greenhouse gas levels, you make | the fog thicker, and the mist rises slightly,
00:27:30:04 00:27:36:09 and where you are, energy can no longer escape. | So you have to go a little bit higher.
00:27:39:02 00:27:42:14 The more greenhouse gas you stuff in the | atmosphere, the higher you have to go
00:27:42:14 00:27:48:05 before the atmosphere is thin enough to | let the infrared radiation escape to space.
00:27:50:04 00:27:54:24 So the atmosphere is radiating to space | from a higher altitude than it used to,
00:27:55:01 00:28:06:01 so that the temperature at the radiating level which | is still -20, remains at -20. But that occurs
higher.
00:28:06:14 00:28:13:12 And since the rate at which temperature increases | as you go deeper in the atmosphere is fixed,

00:28:13:18 00:28:18:04 but you're starting at that -20 from higher up, | by the time you extrapolate to the ground,
00:28:18:04 00:28:19:18 you wind up with a higher temperature.
00:28:30:23 00:28:36:11 On average, temperature goes down about 6 | degrees with each kilometre that you go up,
00:28:36:23 00:28:39:15 And so, we can ask the question:
00:28:39:16 00:28:44:03 how much higher do we have to push that level | in order to get a two degree warming at the
surface?45/52
00:28:45:11 00:28:50:11 Well, to get a 6 degree warming you would push | that radiating level up by 1 km.
00:28:50:21 00:28:57:03 To get a two degree warming at the surface I need | only push it up a third that much, roughly 300 m
00:28:58:20 00:29:03:20 It takes relatively little increase in the | infrared murkiness of the atmosphere
00:29:04:12 00:29:10:19 to change the altitude at which infrared | escapes to space by a mere 300 metres.
00:29:12:14 00:29:18:05 And that's part of why the climate is so | sensitive to greenhouse gas concentrations.
00:29:23:16 00:29:28:16 So the link between temperature and | CO2 was basic physics,
00:29:30:09 00:29:33:07 ideas that had been around for over 100 years.
00:29:36:18 00:29:40:18 But are global temperatures really rising | in the way these ideas would suggest?
00:29:47:00 00:29:54:00 Working out an average temperature for the | whole planet is obviously not a simple matter.
00:29:55:23 00:29:58:24 But a little bit of research | on the internet soon revealed
00:29:59:01 00:30:04:00 that there are in fact three different scientific | groups that have undertaken the task.
00:30:06:03 00:30:12:02 The groups are independent of each other, and their | estimates of global average temperatures
differ slightly, 51/57
00:30:13:03 00:30:16:02 but overall they reach very similar conclusions.
00:30:18:10 00:30:25:10 I went to meet Professor Phil Jones, who leads the | British effort based at the University of East
Anglia. 50/55
00:30:26:14 00:30:29:18 Phil's office took me rather by surprise.
00:30:30:07 00:30:35:07 It was crammed with scientific publications | and there was barely room to film
00:30:35:24 00:30:38:06 but Phil seemed quite at home here.
00:30:41:00 00:30:45:02 Most climate information we have access to, not | just for temperature but for other variables too,
00:30:45:07 00:30:48:14 is collected for weather forecasting purposes.
00:30:48:16 00:30:50:19 So the primary use is weather forecasts.
00:30:50:19 00:30:54:05 You can think of climate as a | second hand user of weather data.
00:30:55:05 00:31:00:19 Phil has also collected weather data like this | going back in time more than a century.
00:31:00:23 00:31:07:08 This is the book from Scott's expedition | to the Antarctic for the 1909 to 1911 period,
00:31:08:01 00:31:14:21 so it contains all the temperature, pressure, | snowfall and other weather measurements taken
00:31:15:12 00:31:21:16 both at the bases along on the coast and on | his ill-fated expedition to the South Pole.
00:31:24:03 00:31:27:03 So there's one of the Russian yearbooks for 1847.
00:31:28:19 00:31:35:06 And this one contains daily data and monthly data | from various places across Russia.
00:31:36:00 00:31:42:02 and it tells us temperature, and the pressure | every hour, the daily rainfall totals,
00:31:42:14 00:31:49:01 So, again we've gone through these and digitised | the data, and all this goes into our database.
00:31:52:06 00:31:55:20 There are one or two coolish decades | in the second half of the 19th century
00:31:55:20 00:31:57:10 and one or two slightly warmer decades,
00:31:57:10 00:32:00:04 but there's no real overall trend in temperature
00:32:00:05 00:32:05:05 on longer-than-decade time scales | until you get to the 1910s.
00:32:10:14 00:32:18:09 Then you have quite a dramatic warming | from the late 1910s to the middle of the 1940s,
00:32:19:02 00:32:24:02 which is more marked in the Arctic region | than in other regions of the world.
00:32:25:07 00:32:30:07 And after that time the temperatures | cooled slightly to the late 1970s,
00:32:30:10 00:32:32:18 and they've warmed very dramatically since.
00:32:36:18 00:32:45:01 And the top ten warmest years are all from | 1997 through to 2008 with the exception of 1999.
00:32:46:18 00:32:52:04 Temperature records show that over the past few | decades the region that'd warmed fastest on
earth
00:32:52:04 00:32:53:16 was the Arctic.
00:33:00:11 00:33:03:22 I wanted to find out what the people who | live there had experienced
00:33:04:11 00:33:08:08 so I jumped at the chance to visit northern Norway.

00:33:23:03 00:33:28:03 Exactly how long the Sami people had been here | seems to be a matter of debate.

00:33:31:00 00:33:34:18 The Sami has been reindeer herders | very very long time

00:33:35:11 00:33:43:08 - some scientists say 400 year, and of course it | is several thousand of year, not only 400 years.

00:33:45:18 00:33:50:10 All their culture, their identity and so on, | is connected to reindeer husbandry.

00:33:50:21 00:33:59:22 Of course it is very close we live to the environment | and also it's a way of life to live with

00:34:00:08 00:34:07:08 all the changes in the environment. As you know | in Arctic we have a lot of changes in the climate.

00:34:13:24 00:34:22:14 Trees are growing in the tundra. | It's bad because trees, they kill lichen.

00:34:23:16 00:34:30:09 The reindeer don't like it - and of course it's | also covered with more snow, when it is wind.

00:34:31:14 00:34:34:22 So the snow will be very hard.

00:34:50:21 00:34:56:18 I asked Uvlla Henrich about climate - how he feels | it has been. He feels it has been a big change.

00:34:59:09 00:35:09:06 Earlier, it was very common with long periods | - already in December, January, February

00:35:09:06 00:35:13:16 with temperatures between 35 to 40 below Celsius,

00:35:14:02 00:35:22:06 and now it's very common with rain in December. In the | last ten years they have really noticed

00:35:26:09 00:35:31:07 changing. 54/49

00:35:31:21 00:35:35:16 By now I felt I had seen a lot of evidence | that the earth is actually warming,

00:35:36:02 00:35:37:17 and that rising levels of CO2 | a part of the explanation,

00:35:38:12 00:35:43:22 if not the whole thing.

00:35:44:22 00:35:48:02 But everything I'd learnt so far was about | the past. What about the future?

00:35:48:02 00:35:50:16 I knew scientists were making predictions | about global temperatures

00:35:52:14 00:35:54:24 at the end of this century and beyond.

00:36:04:24 00:36:08:13 Could they really be so confident?

00:36:09:12 00:36:15:17 Two thirds of the earth is covered by water

00:36:15:24 00:36:20:03 so it's what happens to the oceans that will | determine the future of the world's climate.

00:36:21:02 00:36:25:09 The ocean stores an enormous amount of heat.

00:36:25:22 00:36:31:20 In order to warm the planet we ultimately | have to warm the whole ocean

00:36:38:07 00:36:41:12 and to warm the whole ocean is an enormous thing.

00:36:42:00 00:36:47:23 So what is happening to the world's oceans?

00:36:47:23 00:36:50:16 With a slightly sinking stomach, I accepted | an invitation to join the RV Tangaroa,

00:36:51:08 00:36:53:24 New Zealand's deep water research vessel,

00:36:57:10 00:37:01:20 on a cruise to the Southern Ocean.

00:37:01:20 00:37:03:04 I am sure I'm preaching to the choir here | - anybody who's sailed in the Southern Ocean has

00:37:04:01 00:37:10:22 felt its turbulence.

00:37:14:04 00:37:17:13 For any yachtsman sailing around-the-world yacht | races, the big bogie is always the Southern

00:37:17:15 00:37:24:11 Ocean.

00:37:25:01 00:37:30:01 Oceanography covers a whole range of disciplines.

00:37:30:23 00:37:34:11 so you have to have some knowledge of chemistry, | of the climate, of the geology, and of the

00:37:37:11 00:37:41:00 biology 48/51

00:37:45:13 00:37:49:23 So, there's a whole range of things in the back of | your mind when you go to sea.

00:37:49:23 00:37:51:24 But I do get seasick and that's the fact of life.

00:37:53:19 00:38:01:03 As soon as that ship leaves | port we're in business.

00:38:10:19 00:38:12:20 Because we're running 24 hours a day, | we have one team doing 12 hours,

00:38:12:22 00:38:21:14 the other team doing the second 12 hours.

00:38:22:16 00:38:28:12 When we reach the first of our scheduled survey | points, I like to say "All hell breaks loose".

00:38:29:00 00:38:31:03 We take lots of water samples,

00:38:36:16 00:38:43:04 and we are constantly recording the depth of the | ocean, along with surface water temperature.

00:38:43:07 00:38:46:00 Temperature is fairly constant down to about 3 | 0-40 metres. Then it slowly starts dropping off,

00:38:47:04 00:38:51:17 and the deeper we get the lower the temperature.

00:38:53:16 00:39:00:16 We have a range of instruments: current meters, | temperature loggers, sediment traps,

00:38:53:16 00:39:00:16 instruments for measuring CO2 in the water.

00:38:47:04 00:38:51:17 This is the.. probably close to the | 20th time we have visited this site.

00:38:53:16 00:39:00:16 There is really no other way to get a time series | of measurements from the depths of the ocean.

00:39:01:06 00:39:05:05 So we're turning it around, | replacing the instruments,
00:39:05:07 00:39:08:04 and we'll be leaving it again | now for another eight months.
00:39:10:09 00:39:15:20 I love my work, I suppose I shouldn't say, | but I've been doing this for almost 20 years,
00:39:16:01 00:39:22:22 and I really enjoy coming out to sea. | It's what makes being an academic fun.
00:39:25:09 00:39:28:16 You cannot do the science without | knowing where your samples come from.
00:39:28:18 00:39:30:23 You can ask people to bring you home samples,
00:39:31:00 00:39:35:21 but if you don't actually see | where things are coming from.
00:39:36:04 00:39:38:12 It's easy to miss the subtleties | in what you're looking at.
00:39:47:10 00:39:51:21 The warming, which initially affects the | atmosphere and the near-surface ocean,
00:39:51:21 00:39:55:11 is slowly penetrating down into the ocean depths
00:39:55:16 00:40:01:12 The ocean is acting as a brake on the surface warming. | It's holding surface temperatures down.
00:40:01:21 00:40:03:24 The planet hasn't caught up | with what we've already done,
00:40:04:17 00:40:11:17 so emissions in the past mean that we're going to | see further warming through the century anyway.
00:40:12:16 00:40:19:08 So we shouldn't expect the climate change that | we've seen so far to be all we're committed to
00:40:19:21 00:40:22:03 as a result of the greenhouse gas | emissions we've made so far.
00:40:22:08 00:40:28:00 In fact it's probably.. maybe over half, but probably | only around two thirds, of what we're committed
to. 53/51
00:40:38:12 00:40:44:03 My time at sea made it clear that | predicting the future of the climate
00:40:44:03 00:40:46:04 was not just a matter of | understanding the atmosphere.
00:40:48:13 00:40:55:23 Somehow, we needed to incorporate what happens in | other parts of our world, particularly the
oceans.
00:40:58:16 00:41:05:16 So I arranged to meet some scientists who were | trying to do just that, using computers.
00:41:26:00 00:41:32:18 We can do the experiment with the earth only once | but a computer can simulate it thousands of
times.
00:41:36:04 00:41:41:21 We want to simulate the oceans, atmosphere, | biosphere, and all the interconnections in between,
00:41:41:23 00:41:48:12 and that's why it takes so long, even on | these powerful computers, weeks and months
00:41:48:12 00:41:51:03 to project the climate for | a couple of hundred years.
00:41:53:13 00:41:57:11 Back when this science was | relatively young, in the 1980s,
00:41:57:11 00:42:00:16 they predicted the warming we should expect
00:42:00:18 00:42:04:15 to be associated with the rate of increase in | greenhouse gases that we've observed.
00:42:04:17 00:42:09:16 and they predicted it to be 1 to | 2/10's of a degree per decade,
00:42:09:16 00:42:13:00 and that's exactly what we've seen since that time.
00:42:13:05 00:42:20:16 So this was a 20 year weather forecast that | appears to have been remarkably successful.
00:42:23:14 00:42:30:12 The big question the models are designed to answer | is how sensitive is climate to this warming,
00:42:30:23 00:42:34:18 the so-called forcing of increased CO2.
00:42:36:01 00:42:41:02 The answer the models suggest is that | if we double the level of CO2
00:42:41:02 00:42:45:18 the world will warm by 3 degrees Celsius, | or thereabouts.
00:42:46:09 00:42:49:09 But if we continue as we are doing,
00:42:49:16 00:42:54:16 by the end of the century CO2 may well be | four times higher than pre-industrial levels,
00:42:55:18 00:43:01:21 implying a world of 6 degrees Celsius | (11 degrees Fahrenheit) warmer.
00:43:04:21 00:43:08:19 But can the models be trusted so far from experience?
00:43:09:05 00:43:12:12 Have they really got the climate sensitivity right?
00:43:14:01 00:43:20:00 This is Matt Huber, a paleoclimatologist | from Purdue University, Indiana.
00:43:20:09 00:43:24:15 A lot of people are sceptical of climate models | and it's very good to be sceptical of them.
00:43:25:10 00:43:35:06 But here's a question. If you push the model toward | a warmer world, is the model too sensitive?
00:43:35:08 00:43:39:05 You push it a little bit, and the model | goes crazy, and it gets way too warm.
00:43:39:21 00:43:45:21 Or if you push the model it doesn't budge nearly | as much as it should, and just moves a little bit.
00:43:50:07 00:43:56:23 You can look at the past 100 years to try and infer | what the true value of climate sensitivity should
be. 51/53
00:43:57:12 00:44:05:11 Right now we don't know whether that value is | 1 degree of global climate change per doubling
00:44:05:11 00:44:10:14 of CO2 concentrations, or 5 degrees of | warming per doubling of CO2.

00:44:11:20 00:44:16:06 The paleoclimate record is providing a | lot of really useful insights into
00:44:16:06 00:44:20:03 which of those numbers is closer | to the truth - is it 1 or is it 5?
00:44:22:00 00:44:27:06 So what I've done in my research and what | others have done in my field of research
00:44:27:06 00:44:29:11 is look at past periods of global warming
00:44:29:11 00:44:34:17 as a way of understanding the ways in which | models produce warmer climates
00:44:34:19 00:44:39:16 - also the degree to which they reproduce | the magnitude and pattern of warming correctly
00:44:39:16 00:44:41:18 based on comparison with paleoclimate data.
00:44:43:20 00:44:47:22 Here's the amazing thing. This is the world | as it was in the Eocene 50 million years ago.
00:44:48:14 00:44:51:01 There were crocodiles near the North Pole
00:44:51:19 00:44:56:19 and also fossils of tortoises and | a whole variety of subtropical plants.
00:44:56:20 00:45:01:20 This was clearly a subtropical swamp environment | during the warmest periods in the Eocene,
00:45:01:22 00:45:04:13 more like the coast of Florida | than the North Pole is today.
00:45:07:11 00:45:13:10 That the climates have changed so dramatically in | the past is the strongest evidence for the reality.
00:45:13:12 00:45:18:24 The correctness of our understanding of climate | sensitivity in terms of principles of energy balance.
00:45:19:01 00:45:25:06 If you had a situation where the climate just | remained rock solid for the past billion years,
00:45:25:24 00:45:32:13 then you would have a strong argument that | some stabilising feedback was keeping climate stable
00:45:32:24 00:45:41:16 But we do know that 55 million years ago the | climate was substantially warmer than it is today.
00:45:42:09 00:45:46:11 There was no ice essentially anywhere | on the planet - no permanent ice
00:45:46:15 00:45:51:21 and we know that the only thing - the | only lever - we have over climate
00:45:52:07 00:45:57:07 that can cause that kind of change is the | green-house gas composition, a change in the CO2.
00:45:57:08 00:46:01:14 We even know to some extent what the | greenhouse gas concentrations were.
00:46:03:13 00:46:09:09 So there are a variety of techniques for | estimating the past atmospheric CO2 concentrations
00:46:09:11 00:46:18:10 but the one that I find the most convincing is a | mineral that forms only under high CO2 conditions
00:46:18:21 00:46:25:01 and that mineral "nahcolite" is actually known | to have been forming 50 million years ago
00:46:25:02 00:46:27:08 and not subsequently after that.
00:46:30:07 00:46:39:03 If you set the models up with the conditions as they | were 50 million years ago, including higher
CO2, 52/49
00:46:39:03 00:46:44:13 the modelled temperatures are distinctly warmer | than climates produced by the models for today
00:46:45:08 00:46:47:03 - but they are not warm enough.
00:46:48:11 00:46:55:13 And that indicates that the models tend to be | not sensitive enough to forcing due to CO2.
00:46:59:24 00:47:05:09 That's what the paleoclimate record indicates | - that sensitivity is more towards the high end,
00:47:05:13 00:47:12:18 4 or 5 degrees of warming per doubling | of CO2 as opposed to 1 or 2 degrees.
00:47:14:05 00:47:18:18 So if anything the climate models may | underestimate the future pace of global warming.
00:47:19:15 00:47:25:14 It seems likely that over the next decade or two | climate change will begin to accelerate.
00:47:26:15 00:47:32:23 To find out what that might mean for the | planet, I took one last trip back in time.
00:47:38:17 00:47:46:00 I found what I needed sitting on the sea ice | in the middle of McMurdo Sound in Antarctica.
00:47:47:00 00:47:49:05 ANDRILL.
00:48:03:16 00:48:05:18 We made a hole 84m deep,
00:48:05:20 00:48:08:09 then we lowered our pipe through the ice shelf
00:48:08:11 00:48:12:22 and a further 850 metres down to the sea floor.
00:48:18:20 00:48:22:19 And from there we drilled | back in time 14 million years
00:48:22:23 00:48:25:01 through sedimentary layers of rock.
00:48:25:18 00:48:27:16 When we got to the bottom of the hole
00:48:27:20 00:48:30:23 we had drilled 1284 metres of core.
00:48:38:00 00:48:42:04 We bring up these layers core barrel | by core barrel, very laborious.
00:48:43:08 00:48:48:08 All this information is absolutely vital | to reconstructing a picture
00:48:48:14 00:48:50:06 of what our planet looked like
00:48:50:06 00:48:55:06 at a time which is probably a very good | example of where we're heading to.
00:48:58:04 00:49:04:14 The rock cores are a treasure trove of information | about past conditions in the Ross Sea.
00:49:05:01 00:49:08:05 What actually came out of that hole had | our eyes out on organ stops.

00:49:08:06 00:49:16:02 We were just staring at this core and seeing | these dramatic changes from full-on glacial conditions.
00:49:16:03 00:49:22:08 then going up through half a metre of core | we were into green algal blooms.
00:49:23:01 00:49:25:04 And the characteristics of many of these blooms
00:49:25:08 00:49:28:22 indicate temperatures were 2 to 3 to 4 | degrees warmer than they were today.
00:49:30:05 00:49:40:19 We are building a picture of a very different Ross | Sea and West Antarctica during past warm periods.
00:49:49:15 00:49:59:20 It's a cautionary tale to be able to look back and | realise that only under slightly higher CO2 values
00:49:59:20 00:50:06:05 these elements are incredibly sensitive - the West | Antarctic ice sheet is a very sensitive feature.
00:50:07:17 00:50:12:18 You don't have to do a lot to destabilise it, | and we are doing a lot right now.
00:50:12:21 00:50:14:24 We just haven't seen the consequences.
00:50:18:21 00:50:22:23 If the temperatures of the ocean increase | by up to five degrees
00:50:24:06 00:50:27:15 the West Antarctic ice sheet will collapse, | it will disappear.
00:50:27:18 00:50:30:13 and sea level will be at least five metres higher -
00:50:30:23 00:50:33:19 and I'd guess we'd have to assume | Greenland would be gone as well,
00:50:33:19 00:50:36:00 so ten metres higher.
00:50:37:16 00:50:47:00 Over the next 100 years we'll be pushing CO2 up to | levels last seen around 45 or 50 million years ago, 50/51
00:50:47:09 00:50:53:01 when there was no ice at either Pole, and | crocodiles were swimming off Greenland's coast.
00:50:56:08 00:51:00:19 Where we're headed into the future, we have an | idea where we may go by looking back at the past.
00:51:01:16 00:51:05:20 If you looked across here five million | years ago, you would see no ice in the sea,
00:51:05:24 00:51:10:10 you'd see not so much ice on the hills. | You might see green over there.
00:51:11:14 00:51:15:05 Going back 15 million years ago you'd see | a whole different biota down here.
00:51:15:05 00:51:19:22 You'd probably see porpoise and dolphins | swimming out there rather than killer whales.
00:51:23:08 00:51:29:18 It seems we are on course to take | our planet back millions of years.
00:51:31:06 00:51:37:21 It's unlikely that much of the natural | world we know will survive the transition.
00:51:39:20 00:51:44:04 What will happen to human society | is impossible to say.
00:51:44:24 00:51:52:12 I look at my kids and I look at the way people behave | - mostly people are pretty adaptable, resilient, 53/49
00:51:52:14 00:51:57:20 and so I don't worry that we are going | to all get killed by this thing.
00:51:58:13 00:52:08:13 I do worry that our children will not thank us for the | headache we'll give them if we stay on this path, 54/49
00:52:09:10 00:52:13:08 because if we don't get out of this, | they will have to.
00:52:14:02 00:52:20:23 And every decade we postpone doing | anything about global warming
00:52:21:00 00:52:27:16 is another 100 billion tonnes or | so of carbon into the atmosphere,
00:52:27:21 00:52:35:16 and we are that much closer to the sort of climate | where we can't predict where warming will stop.
00:52:44:05 00:52:51:08 If sensitivity to CO2 variations is something | like four or five degrees per doubling,
00:52:51:10 00:53:00:02 that means we actually need to reduce human | emissions of CO2 to zero in the next 50 years,
00:53:00:24 00:53:10:11 a far more radical kind of policy than most | politicians and governments are talking about.
00:53:10:20 00:53:16:14 It's quite important to realise that | if we want to stabilise the climate,
00:53:16:14 00:53:22:12 there is no way other than to aim for | zero CO2 emissions in the long term.
00:53:24:19 00:53:31:13 Today the main effort to manage CO2 emissions | is the UN Convention on Climate Change.
00:53:31:23 00:53:40:19 I hereby declare open the third meeting of the | ad hoc [LTCA] Working Group under the Convention.
00:53:40:23 00:53:45:18 Thank you, Chair, Distinguished Delegates. | The objective of the convention requires
00:53:45:18 00:53:50:17 keeping global warming as far as possible | below 2 degrees
00:53:51:09 00:53:59:10 It was obvious to me that getting the whole world to | agree on CO2 emissions is proving depressingly difficult 52/56
00:54:00:23 00:54:05:12 But what finally cheered me up was the | experience that I'd had with climate scientists
00:54:05:20 00:54:07:16 learning about their science.
00:54:11:06 00:54:14:22 Over three years I'd met dozens | and dozens of scientists.
00:54:16:03 00:54:18:15 I was convinced that they had not been lying.

00:54:18:19 00:54:21:09 There is no hoax.

00:54:21:17 00:54:24:17 In fact I was impressed by | the breadth of the subject,
00:54:25:02 00:54:32:08 how carefully the scientists went about collecting | their data, scrutinizing all possible sources of
error, 50/55
00:54:32:24 00:54:36:24 and how open-minded they were | about their conclusions.

00:54:38:20 00:54:41:06 This was science at its best
00:54:41:14 00:54:44:14 and it has given us a great gift,
00:54:44:10 00:54:49:00 the ability to look in to our future and shape it.

00:54:50:06 00:54:55:06 The sooner that we begin to reduce our impact | on the climate system the better off we are.
00:54:55:16 00:55:01:07 That said, I think we have the opportunity for an | exciting future. We understand there's a problem,
00:55:01:07 00:55:08:24 we understand the direction that we're going, | and we need fixes that are going to be valuable.
00:55:09:00 00:55:15:02 Often I go and talk to school groups, and I come | away wondering whether I've just scared them.
00:55:15:20 00:55:22:16 I think it's important to tell them - Don't be afraid | - here's something that we're going to get
through, 54/51
00:55:22:16 00:55:28:16 But for you kids, take it seriously. Don't be | alarmed or afraid, but join in this effort.
00:55:29:05 00:55:37:05 Become the best scientists or engineers you can | - and let's solve this problem.