

PART ONE

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Figure 1.1: Padre Island National Seashore. This is what the back side of a barrier island looks like just inches above sea level—very different from the shore side. The barrier island protects the mainland as well as the estuary between the mainland and the barrier island.



June 1, 2010 -- It's Cars, Not Coal, A New Paradigm in Climate Science: The science has changed again. This time, things are really upside down. Who are we supposed to believe? We live, we learn. Science goes on, especially climate science. There is an extreme need for more knowledge about our climate. This has been obvious to the climate scientists for years. The titles in the scholarly journals show just how rapidly climate knowledge is being discovered.

The amount of effort being put into the challenge is possibly greater than any learning event that has ever happened, including things like the Manhattan Project and the Apollo Project. The credibility of the science grows constantly as is shown by a recent paper evaluating over 1,300 climate scientists.

The evaluation found that 97 to 98 percent of climate scientists studied, that supported man-made global warming science, were published more than twice as often in the scholarly journals than were the 2 to 3 percent of climate scientists who did not support man made climate change science.

In 2009, somewhere close to 10,000 times more climate discoveries were made than were made in 1990. Too many of these discoveries showed that earth's climate was changing faster and with greater impacts than our climate scientists had previously realized.

Lord Nicholas Stern, World Bank Chief Economist (2000-2003) and Head of the Government Economic Service for the United Kingdom

during the Blair Administration, wrote (in 2006) what is undeniably the most complete description of the global economic impacts of climate change to date. (700 pages.)

In 2008, just two years later, Lord Stern published an update to his 2006 report. He said that the severity of his previous findings was vindicated by the 2007 Inter-governmental Panel on Climate Change (IPCC) Assessment. He also said "We underestimated the risks ... we underestimated the damage associated with temperature increases ... and we underestimated the probabilities of temperature increases".

In June 2008, Stern said that because climate change is happening faster than predicted, the cost to reduce carbon below dangerous levels would be even higher. Instead of the one percent of global gross domestic product (GDP) per year assumed in 2006, it is now about 2% of GDP."

In just a couple of years, because of new discoveries in climate science, the cost of mitigation has doubled. Are we doing the right things? Can we afford to be doing something that is not as efficient as possible? Do we have time yet to make mistakes? The answers may not be as obvious as we think.

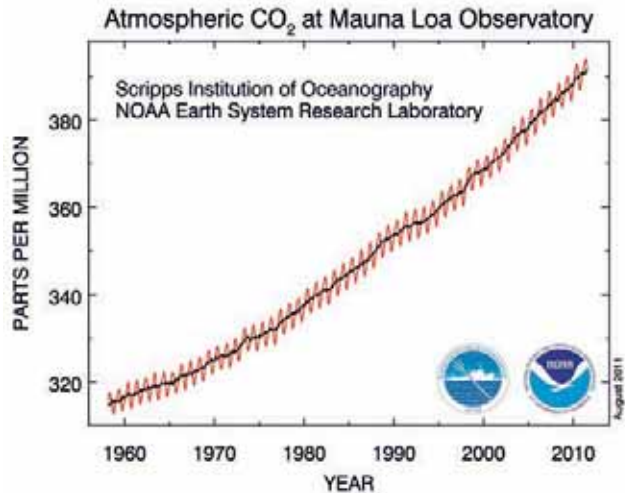


Figure 1.2: The Mauna Loa Volcano in Hawaii has some of the cleanest air on the planet which is perfect for establishing atmospheric CO2 concentrations. The wiggles in the CO2 values (red line) reflect the summer/winter seasons. In the northern hemisphere, where there is far more land than in the south, plants absorb CO2 in summer and organic material decomposes in winter, changing the relative amount of carbon dioxide in the air.

Impacts of Different Economic Sectors on Climate

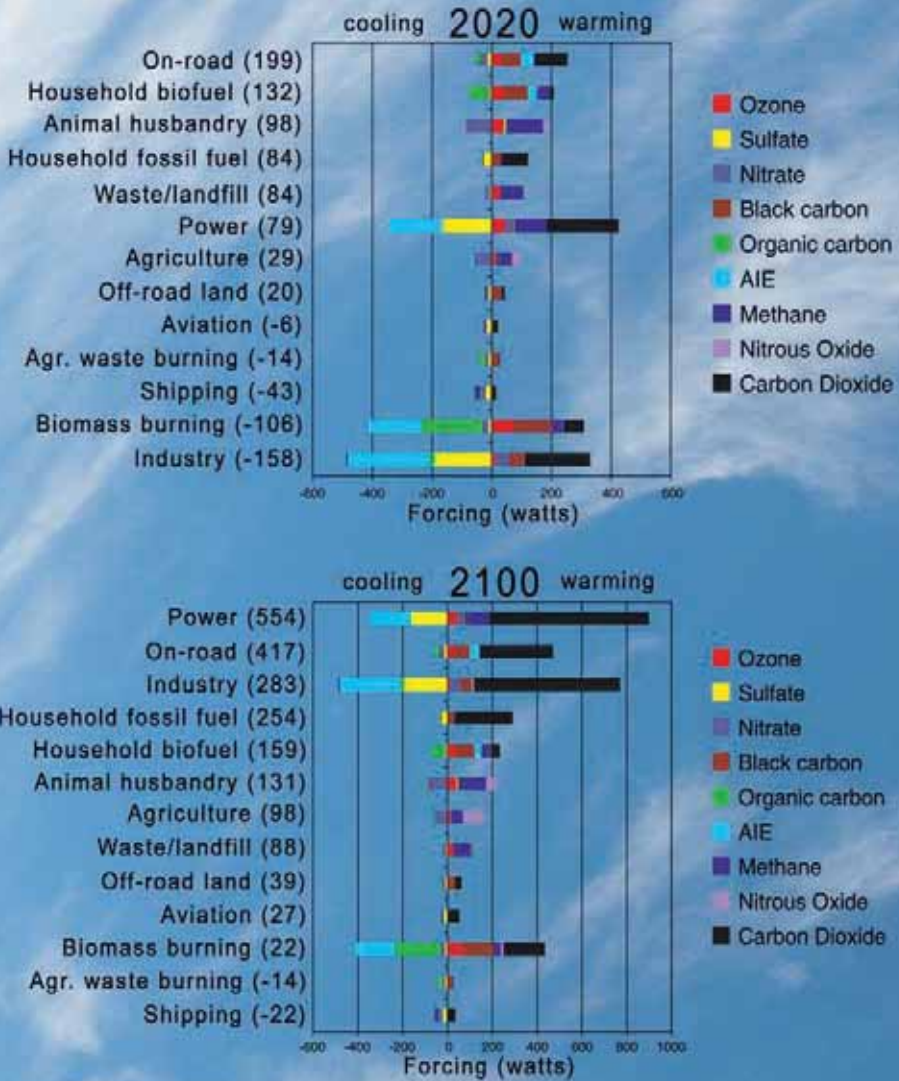


Figure 1.3: Short Term (2020) impacts are different from long term (2100) because aerosols are short lived compared to other greenhouse gases. Change is measured in watts per meter squared since 1750. AIE is aerosol indirect effect. Aerosols fall out of the sky in days, weeks or years and they have chemical reactions that change their characteristics (indirect effects). (Unger 2009)

A paper in the February 23, 2010 edition of the Proceedings of the National Academy of Sciences of the United States of America, written by a team of seven scientists led by NASA's Dr. Nadine Unger, has taken a new view of global warming pollutants that greatly alters our current world of climate change science.

The approach of the team was to define the net change to our climate from any given economic activity, considering both the warming *and* the cooling caused by air pollutants emitted from that specific sector. You see, some pollutants, like the smoke and gases from a volcanic eruption, or the pollutants from coal fired power plants or tropical forest biomass burning, can cool our atmosphere as well as cause it to warm.

We know a lot about greenhouse gases today. This knowledge has been accumulating for more than a century. But greenhouse gases make up only a portion of the pollutants emitted by any given economic sector. Many of the rest of the pollutants (air pollutants) are what are called aerosols.

What is an aerosol? Aerosols are defined as very tiny particles that can basically float (electrostatic attraction) in the air. They are very similar to the stuff that comes out of a spray can. Paint is an aerosol, as is the sticky liquid that makes hairspray work (they are aerosols when they are between the can and whatever surface these materials are being applied to.) Deodorant, air freshener, insecticides, anything that can be sprayed out of a tiny nozzle at high pressure can be made into an aerosol.

Aerosol particles are so small that they do not easily fall to the ground from the force of gravity. Dust and smoke are aerosols, as is salt spray from the ocean and much of what we know of as smog. Aerosols can be both 'light" and "dark". Dark aerosols are somewhat like greenhouse gases. They absorb sunlight and turn it into heat. Light aerosols (referred to as "bright" aerosols in the literature), reflect sunlight harmlessly back into space like ice and snow, resulting in a cooling effect.

Black carbon and sulfate aerosols are the two biggies that come from everything that burns including coal, oil, natural gas and the wood fires used for cooking in developing nations. Black carbon is a dark

or warming aerosol. Sulfates are bright or cooling aerosols. There are many other aerosols that occur naturally and that are generated from mankind's economic activities and they include nitrogen oxides and volatile organic carbons, as well as organic molecules from algae in the oceans and from trees and other plants on land.

The new science here is that Dr. Unger's team's paper takes all of these warming and cooling effects, adds them up for individual economic sectors, and then ranks them from bad to worse. It also does something else novel. Because different atmospheric pollutants remain in our skies for different lengths of time, the researchers looked at things in the short term (2020) and long term (2100). As we learn, our knowledge changes. We have been learning oodles about the different greenhouse gases in our skies, man-made and natural, for over a century. We also have a lot of new knowledge about the way other things in our atmosphere, such as aerosols, clouds, dust and smoke warm or cool our planet.

One of the big new climate science discoveries is that the life of carbon dioxide in our atmosphere has changed. Our previous understanding of how long CO₂ lasted once emitted was about 100 to 200 years. This is an understanding that has developed over generations as we have learned how the different things in our atmosphere react with CO₂, how they are absorbed by the oceans or respired by vegetation on land, or how they are trapped in soil or ocean sediments.

Now we are finding that all of these things change as our planet itself changes with the warming. On a warmer planet, our oceans absorb less carbon dioxide. Our forests have changed too. While some tropical forests may absorb more CO₂ with warming, much of the temperate and boreal forests of the world are absorbing less carbon dioxide as their stress level increases on a warmer planet. NASA and numerous other researchers have also shown that the carbon dioxide fertilization effect has already worn off as our forests succumb to stress from warming.

As our planet becomes warmer, these changes will become larger. Other things that the scientists have seen happening already will start to play an even larger role in the way our climate changes. Drier soils from ongoing droughts cannot hold as much carbon from decayed organic

material. Extensive peat lands across the world are also drying and have already widely changed into large sources of greenhouse gases. Melting permafrost releases greenhouse gases, under sea frozen methane is venting, ocean primary productivity is falling, and the list goes on.

When the big picture is completely digested, or as completely digested as our knowledge allows today, the 21st century understanding of the life of CO₂ in our sky, based on research from Dr. David Archer at the University of Chicago is as follows: CO₂ lasts for 300 years except for 25 percent that last forever . This is very much different from our previous understanding of the life of CO₂ being 100 to 200 years.

Our knowledge about methane has changed too. When the big picture is recognized, methane has far more impact on our atmosphere than we once thought. Methane reacts differently with different things in the atmosphere at different times. These different reactions tell us the strength of the warming that then occurs. For example, methane decomposes after a dozen or so years, but the decomposition byproducts are CO₂ and ozone, both greenhouse gases. Other substances that are a part of the methane cycle are much more far reaching and include water vapor, volatile organic compounds, sulfur compounds, carbon monoxide, etc.

In the past however, our view was much more basic. We simply compared the warming caused by methane directly to the warming caused by carbon dioxide. Today, we know that the warming from methane, like the lifetime of carbon dioxide, has changed relative to our knowledge of the 20th century. The IPCC Fourth Assessment report listed methane as having a global warming potential (GWP) of 25. That is, methane is a greenhouse gas that is 25 times more powerful than carbon dioxide.

This is basic 20th century knowledge. Even though the IPCC report was published in 2007, most of the knowledge in the report dated to two to five years (or more) prior to 2007. Science takes a lot of time to happen. So our new knowledge considering all of the known reactions and interactions of methane with other atmospheric factors, as published by Dr. Drew Shindell at Columbia University, is that methane is now 34

times more powerful than CO₂. This is more than a third more powerful than we understood just a few years ago.

So it has become obvious to the climate scientists, well at least the atmospheric chemists, that what is really happening in our skies is much different than what we once thought.

Now, back to aerosols. We have learned a lot about aerosols in the 21st century. Aerosols generally cool our atmosphere instead of warming it like greenhouse gases and it turns out that aerosols play big role in what is going on in our sky.

So our team of scientists following Dr. Unger, considers how different economic sectors impact our climate based on the net impact from both warming and cooling pollutants created by those economic sectors. These clever scientists have taken all of this information and put it in this nice little confusing piece of climate science art titled "Figure 6: Impacts of Different Economic Sectors on Climate." The colored bars show the impacts from warming and cooling of different gases and aerosols. Cooling is on the left, warming on the right.

Focus on the top image labeled 2020 where the economic sectors are considered in the short term. "On-road" (which is transportation) ranks highest with a score of 199 watts of warming. This is in great conflict with what we know as the worst offender of greenhouse gas emitters. "Power", better known as dirty coal, has a warming of 79 watts. (Watts of warming is in watts per square meter relative to preindustrial times. This is the same comparison that the IPCC makes.) So transportation warms the planet two and a half times more than coal, in time frames that matter to us humans.

How can this be? The greenhouse gas emissions of dirty coal are certainly the worst of the bunch. This is a well-established fact and is validated by the number one ranking position of "Power" in the long term graphic labeled 2100. However, in the short term it is the cooling impacts of aerosols that make On-road (transportation) the worst offender.

The reason for this new counterintuitive development is that in the past, in considering the climate impacts from a particular economic

sector, we have only considered the impacts of warming from greenhouse gases. The cooling that we realized from the aerosols just was not added in the equation. Could this be a “Duh!” moment for scientists? Well, er, yes and no. Of course there are many researchers out there that have been studying this issue, but the general state of the science does not consider both warming and cooling when looking at individual economic sectors.

We have only recently learned enough about aerosols to really sink our teeth into them when it comes to actually comprehending the big picture, so the climate scientists get a break this time. We are always learning.

Dr. Unger and her team have concluded that our society needs to change its priorities for climate change mitigation. We need to pay more attention to transportation, and maybe not so much to coal. What

Figure 1.4: The Navajo Generating Station in Northwestern Arizona. In a 2009 report by Environment America, “America’s Biggest Polluters,” the Navajo Generating Station is the eighth dirtiest plant in the nation, releasing 20.1 million tons of carbon dioxide in 2007.



you say?! It's not that we should stop our efforts at mitigating for the greenhouse gases emitted by coal; certainly not. But because of the issues with climate change in the short term, policies need to change. Unger's paper states:

The combined direct and indirect effects of aerosols exert a net cooling that may have masked about 50% of the global warming by greenhouse gases.

Air pollutants from coal power generation are half of *all* warming from *all* greenhouse gases. This is a tall statement. Current, as well as historic air pollution control strategies have focused on aerosols because they are bad for human health. This is why we in the western world



Figure 1.5: The dizzying pace of traffic may be second today, only to the fantastic rate of new discoveries in climate science.

no longer have such smog—we have learned to control our aerosol emissions to an extent.

But developing nations are struggling with traditional air pollution control strategies. This is but one of the big reasons why aerosols are hiding a tremendous amount of warming and that our policies towards the climate crisis need to change.

We also understand that tipping points are game changers in our climate challenge. This concept of climate tipping points is the keystone of this new knowledge: Why does the short-term matter more than the long term? If we pass a tipping point, our challenge to keep our climate within the evolutionary limits where our civilization has evolved will suddenly become much more complicated. Climate scientists use the term irreversible for a reason. These tipping points or thresholds can be compared to accidentally tipping a canoe. Everything is fine until the tipping point is crossed, then something radically different happens, especially if one does not know how to swim.

Tipping points, or thresholds, are everywhere: water freezing to ice, rain beginning to fall, flu epidemics, the increase in popularity of the Hula-Hoop phenomena, traffic jams, mercury poisoning, species extinction, fainting, a stampede, a dam failure, the fall of the Berlin Wall, hurricane formation, fruit rotting, fish kills, a thermostat, the collapse of the Saharan grasslands, microphone feedback ...

An example of a climate threshold crossing is Arctic sea ice. This threshold has likely already been crossed. The health of our world's coral reefs has likely crossed a tipping point. Caribou populations, permafrost, and forest health of the Rocky Mountains are all on the candidate list as *likely to have already crossed thresholds*.

In the last 100,000 years, we have experienced approximately 23 major global climate tipping points as our climate flip-flopped through abrupt climate changes. These changes generally happened in tens of years or maybe a hundred years or a little more. Sometimes however, when the forcing on our climate is most extreme (like now) they occurred in less than a decade and possibly even as little as a couple of years. Like a fish kill or a population explosion, things can get out of hand really fast.

The temperature, at least in Greenland, changed 10 to 20 degrees during these 23 events and 5 to 7 degrees across the planet—enough to radically alter most ecosystems on the planet outside of the tropics. These abrupt climate changes basically mark the difference between the depths of the ice ages and temperatures nearly as warm as they are today.

And just for the record, the snowball earth and the Venus Syndrome are both the results of even more extreme climate tipping points. We have experienced snowball earth several times on this planet. Most climate tipping points are reversible however. This is the good news. The bad news is that naturally, the time frames involve thousands, tens of thousands and hundreds of thousands of years. Mankind may be able to reverse tipping points far more rapidly than this, or maybe not, we simply do not know yet. The Venus Syndrome however, where our atmosphere and our oceans evaporate into space because of runaway warming, is an irreversible tipping point, to say the least. This scenario is poorly represented in the climate models because when business as usual emissions continue beyond the 21st century, the models tend to “blow-up.”

A quote from another of Unger’s papers, this one from June 2010 in *Environmental Science and Technology*, titled “Short-lived non-CO2 pollutants and climate policy,” puts tipping points into an uncommonly used frame of reference for an academic publication:

Concerns about anthropogenic forcing of the climate system beyond an irreversible tipping point coupled to the important role that the non-CO2 effects play in global climate change, urgently call for the development of new metrics that would appropriately quantify the non-CO2 effects relative to CO2.

Publishing the word “urgently” in an academic journal is an act that is seldom performed in scientific writing. Most climate scientists do understand that we are close to climate thresholds if we have not already initiated them (Arctic sea ice.) The “urgent” viewpoint of Dr. Unger is

certainly not an uncommon sentiment among climate scientists—it is only uncommon in publication.

We know that the Greenland and Antarctic ice sheets have what are called dynamical ice sheet disintegration tipping points, that methane



Figure 1.6: It is hard to imagine that clean burning oil and its refined products are so much more important in the climate change conversation than are coal fired power plants. This is another of the all-too-common counterintuitive things that we are constantly learning about climate change.

clathrates have melt thresholds, that our oceans have a threshold for CO₂ absorption called the saturation point, that marine organisms have a point where ocean acidity increases can kill because of carbon dioxide absorption.

We know that rainforests have thresholds beyond which they collapse. As I speak even, we have likely passed a threshold where a native pine beetle pandemic in North America that has significantly impacted more than 64 million acres in the Rockies, likely killing well

over a billion trees. This attack is unprecedented and climate scientists and forest professionals see no reason why this pandemic will not continue across the North American continent.

So, once again, why are we concerned with the short term? Reason number two: because the long term is about slow climate things happening. Tipping points and threshold crossings though are generally *not* slow.

It is not only likely, but very likely that in the next 90 to 100 years we are going to learn how to deal with atmospheric carbon dioxide in a relatively efficient way. This will make it “easy” to get that extra carbon dioxide out of our atmosphere. This is a “slow thing” relative to climate tipping points. It will take time to bring our climate under control.

But if we cross a major threshold(s) in the meantime, the task will become immeasurably harder because we will have lost functionality in one or more earth systems. These earth systems provide valuable life support for our planet. Without them, life becomes much harder, or impossible.

For example: Ocean primary productivity is really important to our planet. This ecosystem service consists of all of those single and multi-celled ocean organisms that contain carbon (as all life forms do.) As these organisms die they settle to the ocean floor and sequester their carbon dioxide (long-term storage.) Reducing the population of these organisms affects the ability of our oceans to store carbon as well as create oxygen.

Primary productivity in our oceans has decreased 40 percent in the last 50 years across 8 out of 10 oceans. Most ecosystems have thresholds where they go into decline, then further thresholds where they cease to function.

This example of “ecosystem services” that our planet provides is one we can no longer take for granted. Our innocent pollution of our atmosphere with greenhouse gases will put life on this planet in jeopardy unless we take responsibility for our actions. Understanding the new knowledge about climate change impacts of different economic sectors and using this knowledge to the greatest extent feasible is paramount.

So now we have this new knowledge. The extra smoke and sulfates, those bright aerosols, and the different reactions that they have in our skies, and even the ways that clouds respond to these aerosols, make the net short-term warming from coal about two and a half times less than the warming caused by emissions from transportation. Gas and diesel are simply much cleaner than coal, so they are responsible for more warming. They produce less smoke and sulfates which, in total, cools our planet less.

The smoke and aerosols from burning dirty coal counter-balance much of the warming from the carbon dioxide emitted by dirty coal in what could be the greatest policy blunder of the climate change challenge. What we have previously understood as the most important climate change economic sector—power generation from dirty coal—in time frames that matter, is actually nowhere near as important as transportation.

What then, is the meaning of this new knowledge? It means we have to change the way we think about mitigating for climate change. We have to reprioritize our strategies to maximize our efforts in the short run.

This is not a “personal” reprioritization. This climate policy paradigm is fundamental at the highest level. It is international in scope. It impacts everything that we know about mitigating for climate change.

We cannot stop trying to reduce greenhouse gases; they still accumulate over time and compound the warming. But the long-term is not our priority concern. We have tipping points that must be considered. Dirty coal is not the most important climate change challenge any longer.

We have to focus on the most efficient means of limiting global warming to minimize the risks from tipping points. Just to be clear, we cannot simply ignore carbon dioxide emitted from coal. But the game is now more complicated. The highest priority strategies need to involve the global economic sectors responsible for the most warming in the short term. This new prioritization needs to be addressed with the greatest amount of resources. Currently, coal is being addressed

with the greatest amount of resources. Following this path will lead to a much greater actual warming than if we focused more strongly on transportation.

Even more important may be the risks posed by reducing aerosol pollutants through the reduction of energy produced from coal. The U.S. and much of the developed world did this in the 1970s. The developing world is in the same position with regards to smog and other pollution created by coal that the developed world was in the '70s. These developing nations are very concerned about the health impacts of this air pollution on their citizens and are aggressively working to reduce these pollutants.

What are the ramifications of the developing world removing the cooling mask from their relatively uncontrolled coal emissions? How much of the hidden warming will be revealed with their new air pollution control regulations? What will be the effects on tipping points, and how are we supposed to address agriculture and biomass burning?

We do not know all of the answers yet, we are still learning. We do know that some serious work must be done on the direction of the policies that we are pursuing in this great atmospheric chemistry experiment that we call climate change.

And always remember, we have found ourselves in this situation innocently. There is no need for blame or guilt unless we fail to act responsibly on the knowledge that we have learned, and the knowledge that we continue to learn.

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A Google Scholar search for "climate change" in the title for the year 2009 returned 70,100 hits. This is a highly unscientific revelation, but useful for comparison. See the article above (Anderegg 2010) in the magazine Science for a discussion relevant to scholarly searches using the Google Scholar Database.

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June 9, 2010 -- Vegetation Shifting Around the World:

Researchers have found that vegetation has been gradually moving towards the poles, towards the equator, and up the sides of mountains in response to warming and reduced precipitation. The report was prepared by a team from the University of California, Berkeley and an ecologist from the USDA Forest Service. The paper, published in *Global Ecology and Biogeography*, evaluated 1,955 reports and data sources.

Their work included only long-term shifts in the wild, where climate change caused vegetation to migrate to more favorable conditions. They did not include instances where forestry practices, agriculture or increasing urbanization created changes in ecosystems that resulted in vegetation changes.

Their work purposely looked at the big picture, in what is known as 'biome shift' among ecologists. A biome is simply any given set of plants and animals that occupies any given area. For example, a sand dune



Figure 1.7: Padre Island National Seashore, about 35 miles south of the Four-wheel Drive Only sign. If this coastal ecosystem was picked up and moved to the northern Texas coastline, just 200 miles away, it would be a radically different place because the plants and animals on the southern coast have not evolved with freezing temperatures that occur on the north coast.

ecosystem on the central coast of Texas Gulf of Mexico represents a very specific type of biome. This beach and dune is a little different from the very similar beach and dune vegetation and animals on the southern Texas coast, and a little different still from the same ecosystem on the northern Texas coast. These three ecosystems, although very similar, actually represent three different biomes with some very specific and distinct differences in plants and animals that live in each one. If we picked up the South Texas sand dune community and moved it to the northern Texas coast, a number of characteristic plants would freeze during winters possibly resulting in their extinction, likely resulting in

a change in the whole ecosystem because the insects and other wildlife that depended on those now extinct plants would also have to change their evolutionary adaptation. In other words, leave or die.

Fifteen cases of vegetation shift were identified from the authors' evaluation from studies across the globe. Lead author Patrick Gonzales says in the press release, "This is the first global view of observed biome shifts due to climate change ... It's not just a case of one or two plant species moving to another area. To change the biome of an ecosystem, a whole suite of plants must change." Gonzales' team found that the average temperatures significantly increased on 76 percent of the global sites they studied. The greatest general warming was in the higher latitudes of the northern hemisphere.

The press release gives examples of biome shifts that occurred, including: "woodlands giving way to grasslands in the African Sahel, and scrublands encroaching onto tundra in the Arctic." Arctic biome changes are particularly troublesome because plants sticking up above the snow absorb a lot more heat than does snow.

The press release continues, "The dieback of trees and shrubs in the Sahel leaves less wood for houses and cooking, while the contraction of Arctic tundra reduces habitat for caribou and other wildlife ... Globally, vegetation shifts are disrupting ecosystems, reducing habitat for endangered species, and altering the forests that supply water and other services to many people ... Scientists had not quantified this risk before ... We developed a simple classification system that natural resource management agencies can use to identify regions in greatest need of attention and planning. We have worked with the U.S.D.A. Forest Service and the U.S. Fish and Wildlife Service to explore the application of our results to adaptation of natural resource management ... It is also useful to identify places of higher vulnerability, because agencies will need to consider adaptation measures for vulnerable ecosystems ... Some shifts in vegetation could increase fuel for wildfires, for example, so prescribed burning may be necessary to reduce the risk of catastrophic fires."

This poignant note from the press release is not to be omitted: "Approximately one billion people now live in areas that are highly to

very highly vulnerable to future vegetation shifts ... Ecosystems provide important services to people, so we must reduce the emissions that cause climate change, then adapt to major changes that might occur."

In a related story from ABC station KGO-TV in San Francisco, reporter Wayne Freedman writes about the Farallones National Marine Sanctuary and two recent climate change impacts reports. The ABC report quotes Dr. Sydeman, "We can expect changes more in accordance with a tropical environment," The report shows that climate change is happening now in the Farallones sanctuary. Water temperatures have risen five degrees Fahrenheit in 30 years. Normally a relatively cold water ecosystem, warm water species are increasing, and cold water species decreasing. Sydeman says "It's mixed. There are winners and losers. If you're a salmon, you're losing in this battle ... If we continue to emit greenhouse gasses, half the state is vulnerable to shifts in the future."

Another report sponsored by the Marine Sanctuaries Advisory Council lists the following impacts already observed or soon expected to occur:

- Observed increase in sea level (100 year record: San Francisco Bay),
- Expected increase in coastal erosion associated with changes in sea level and storm waves,
- Observed decrease in spring runoff of freshwater: San Francisco Bay because of a decreased Sierra snowpack,
- Observed increase in precipitation variability (drier dry years, wetter wet years)
- Observed increase in surface ocean temperature offshore of the continental shelf (50 year record),
- Observed increase in winds driving coastal upwelling of nutrient-rich waters and associated observed decrease in surface ocean temperature over the continental shelf (30 year record),
- Observed increase in extreme weather events (winds, waves, storms),

- Expected decrease in seawater pH, due to uptake of CO₂ by the ocean,
- Observed northward shift of key species (including Humboldt squid, volcano barnacle, gray whales, bottlenose dolphins).

The ABC report concludes:

Dr. Patrick Gonzales from UC Berkeley said that with less rain in Southern California, we can expect more brush and forest fires. More worrisome is that pine trees may disappear from parts of the Sierra. They play a crucial role in retaining water for the spring run-off, which fills rivers, lakes, reservoirs and comes through your tap. "... it's the trees on land that soak up water and feed reservoirs. Some of these shifts are reducing trees on the land. They're dying out," Gonzales said. According to scientists, change is normal and constant, but change this fast is more than a little frightening.

University of California Berkeley Press Release: <http://newscenter.berkeley.edu/2010/06/04/climate/>

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June 10, 2010 -- Climate Change is Ten Times Faster than Predicted:

How much ancient plant matter had to be buried millions of years ago to produce one gallon of gas? It takes 196,000 pounds of plants to produce a gallon of gasoline. This is some 40 acres of plants, roots, stalks and leaves—just to go 20 miles in the average car. It is incredible how much

buried sunshine, how many fossilized photons it takes to make up a little bit of oil.

Dr. Jeff Dukes published the paper from which these numbers are taken back in 2003 in the journal *Climatic Change*. This ancient solar energy is normally emitted back into the environment over tens of millions of years. Mankind therefore is literally releasing this carbon tens of thousands of times faster than it is naturally released.

Since 1983 Dr. James Hansen has been the Director of the NASA Goddard Institute for Space Studies (GISS). GISS is the United States' foremost climate modeling agency. Hansen, who National Public Radio suggests is "almost universally regarded as the preeminent climate scientist of our time", says that mankind is causing the carbon dioxide concentration in our atmosphere to increase 10,000 times faster than at any time in the last 65 million years—since the giant asteroid struck the Yucatan Peninsula and the dinosaurs went extinct.

A paper in *Nature* by Dr. Richard Zeebe (University of Hawaii) has upped this ante. His findings show that atmospheric concentrations of CO₂ are changing 14,000 times faster than the long-term average for the last 610 million years. This time period represents Earth's history since there were green plants on land.

Dr. Dennis Darby (Old Dominion University) says, in a paper published in 2008 in *Paleoceanography*, that Arctic sea ice has not been absent in the Arctic in the summer season in 14 million years. This can be seen in Arctic ocean sediment cores where sea ice, once grounded to shore, breaks away, melts, and deposits the soil from shore across the ocean.

Dr. Wieslaw Maslowski is an Arctic sea ice scientist at the U.S. Naval Postgraduate School. He is the scientist in charge of the U.S. Navy's Polar Ice Prediction System (PIPS). Maslowski has been predicting, since 2003, that the Arctic will see ice free conditions in summer between 2011 and 2016. Carbon dioxide levels in our atmosphere today are as high as they have been in 15 million years, says Dr. Aradhna Tripathi of UCLA and Cambridge University, in a paper published in the journal *Science* in 2009.

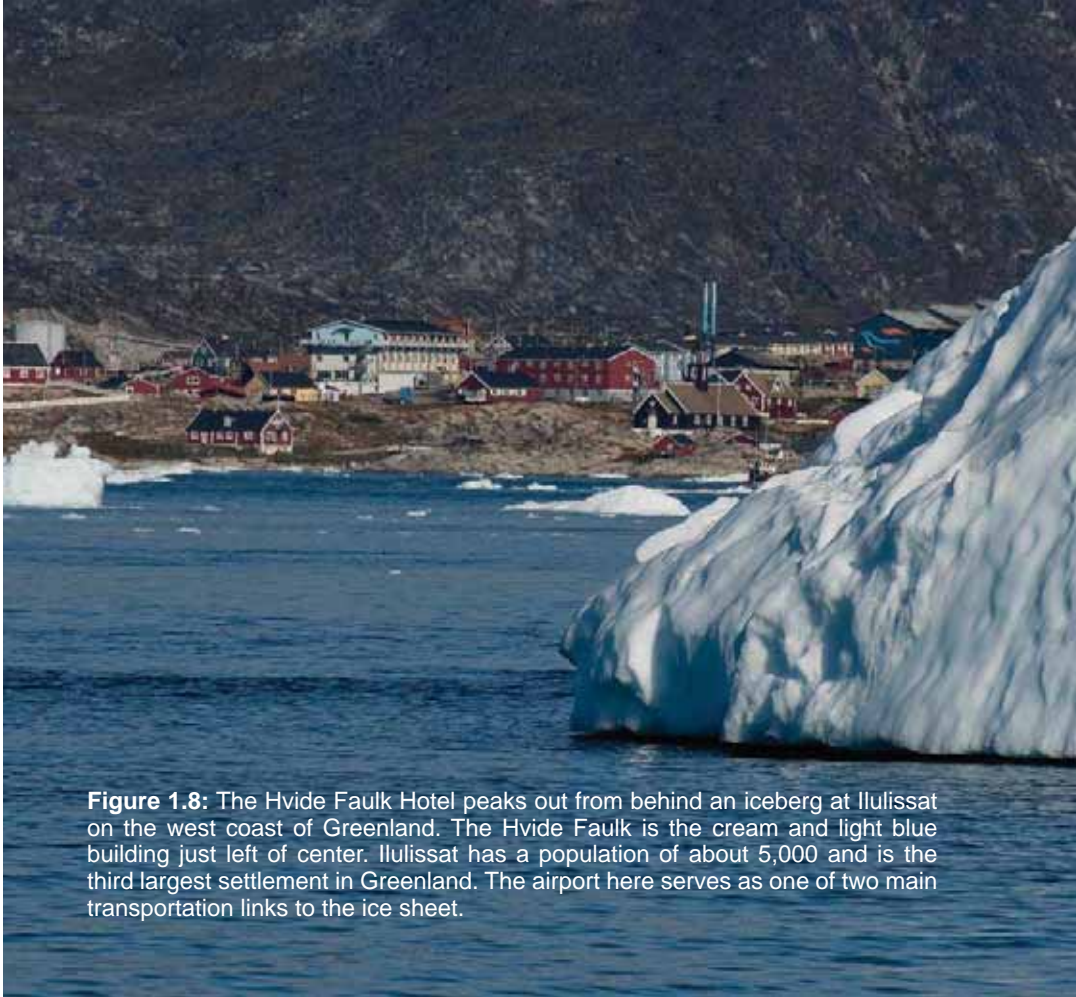


Figure 1.8: The Hvide Faulk Hotel peaks out from behind an iceberg at Ilulissat on the west coast of Greenland. The Hvide Faulk is the cream and light blue building just left of center. Ilulissat has a population of about 5,000 and is the third largest settlement in Greenland. The airport here serves as one of two main transportation links to the ice sheet.

I'll not repeat myself any longer and get to the point. The examples are virtually endless. I recently talked with one of the scientists that I interviewed in Greenland in 2007. I had found a previously forgotten quote that appeared to be from him (in my old notes from the trip), and I wanted to confirm what he had said. The quote was "Climate change is proceeding ten times faster than we (the climate scientists) had predicted." The scientist that made this quote is Dr. Konrad Steffen, Director of the Cooperative Institute for Research in Environmental Sciences (CIRES) at the University of Colorado, Boulder. When he returned my email he said he was sitting in the same hotel where I had interviewed him (the Hvide Faulk in Ilulissat, Greenland).

He had just completed a month-long field session at Camp Swiss, up on the ice sheet. Dr. Steffen founded Camp Swiss in 1990. This is one of those very important ice stations in Greenland that keeps us in touch with climate change in a region where it is likely changing faster than almost anywhere else on the planet. His email confirmed that he remembered our interview, and me; and that indeed, he had made this quote and that climate change was in his opinion progressing ten times faster than predicted.

For nearly two decades I have been analyzing academic papers on climate science that talk about climate changes that are one, two or even three orders of magnitude faster than have occurred in millions of years. (One order of magnitude is ten times faster, two is 100 times faster, three is 1,000 times, etc.) I have become jaded as to the significance of the concept of "Ten times faster", so I resort to analogy to understand the true meaning. Understanding that climate change is progressing ten times faster than predicted takes on an entirely different light when put into perspective. "Ten times faster" then becomes a chillingly profound statement. How much faster is ten times faster? What if the average human life happened ten times faster than normal?

If our human lives evolved ten times faster than normal, our average life expectancy of 77.7 years (77 years and 9 months) would be condensed down to 7 years and 9 ¼ months. In this abbreviated world—this ten times faster world—we would graduate from high school at the age of 21 months, become middle-aged at 5 years and retire at 6 years and 6 months. Another analogy? If the speed limit on our highways were ten times faster, we would be traveling at the speed of sound. Another? If Austin's average number of days per year that the temperature exceeds 100 degrees increases by ten times, Austin will be hotter than the Sonoran Desert Research Station (the one with the giant saguaro cactus located in Arizona) that averages 87 days of 100 degree plus heat per year.

The IPCC, which represents six years of work by over 2,500 climate scientists from 130 countries, is the basis for the consensus predictions of climate change that are understood by the world today. Reaching agreement on the predictions made by this many specialists in any

given field have an extremely high likelihood of being significantly conservative. Think what it would be like getting 2,500 politicians to agree on a global political platform... The platform that is eventually agreed upon is the most basic, simple and fundamental knowledge in the field—that everyone can agree upon. This is what the IPCC report represents. The predictions of the IPCC are basically what Dr. Steffen says are being eclipsed at a rate that is ten times faster than the scientific consensus had previously understood.

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Conrad Steffen, Director of CIRES: <http://cires.colorado.edu/>

James Hansen Director of NASA Goddard Institute for Space Studies, Bjerknes Lecture, American Geophysical Union, December 2008. http://www.columbia.edu/~jeh1/2008/AGUBjerknes_20081217.pdf

Hansen et. al., *Target Atmospheric CO2 Where should humanity aim?*, Open Atmospheric Science Journal, August 2008. http://pubs.giss.nasa.gov/abstracts/2008/Hansen_et_al.html

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Maslowski: Freshnor Consortium, *The Freshwater Budget of the Nordic Seas* (conference). http://freshnor.dmi.dk/handout_freshnor.pdf

CO2 concentration is as high any time in 15 million years: Tripathi, et. al., *Coupling of CO2 and Ice Sheet Stability Over Major Climate Transitions of the Last 20 million years*, Science Express October 8, 2009. <http://www.seas.harvard.edu/climate/seminars/pdfs/tripati.etal.sci.2009.pdf>

June 21, 2010 -- Carbon Dioxide Concentrations in the Ancient Hothouse Much Lower Than Previously Assumed:

The further along we move into the 21st century, the more astonishing the climate discoveries become. New discoveries show that atmospheric CO2 in ancient times was only one third as high as we thought. What

Figure 1.9: Tree kill from drought in Central Texas. In Austin, in the last three years, we have seen two droughts that were so extreme that the inflows to our Highland Lakes fell below the drought of record, which in our area was the drought of the 1950s. This is the third drought that has been in the extreme category, or worse—the exceptional category—in the last seven years in our region.



once was a huge consensus in climate science that understood that atmospheric CO₂ was, at its highest, at any time on earth, around 3,000 ppm, has been stood on its head in a way that has serious fundamental implications for the risks associated with climate change.

For a long time now we have understood that the CO₂ concentration of our atmosphere on Earth—when it was anything more than dirt, volcanoes and oceans with one celled plants—was between 2,000 ppm and 3,000 ppm. This knowledge came from various places. The new work comes from dirt. Soil carbon can serve as an atmospheric carbon dioxide indicator, similar to the tiny shells of plankton that help us understand climate change within the last tens of millions of years. Dirt can tell us about hundreds of millions of years of atmospheric carbon dioxide.

This work out of the University of Texas at Austin tells us that atmospheric CO₂, during the last 400 million years, specifically during the Mesozoic (the warmest period on Earth since there were green

plants on land) was no more than 1,000 ppm. Breeker's paper tells us the following about his work looking at soil carbon:

Large fluctuations in atmospheric CO2 did not characterize ancient climates and past greenhouse climates were accompanied by CO2 concentrations similar to those projected for A.D. 2100.

Worst-case carbon dioxide concentrations predicted for the year 2100 will match the highest CO2 concentrations on Earth seen since there has been any more than 1.5 percent oxygen in our atmosphere. But, this is not the widely held popular understanding, nor is it anything yet acknowledged by the IPCC. This paper was published in January 2010, the IPCC quit taking papers for the 2007 report in 2005. Before this discovery, it was widely accepted that back in the days of the dinosaurs CO2 had maxed out somewhere between 2,000 and 3,000 ppm.

If this were the case, then our projected year 2100 worst-case scenario of 1,000 ppm would only be one-half to one-third as high as it was in ancient greenhouse times. Instead, our projected 1,000 ppm CO2 concentration will be as high as anything seen on Earth *since there were green plants on land*. This means we are much, much closer to the edge than we previously understood.

Breecker, et. al., *Atmospheric CO2 concentrations during ancient greenhouse climates were similar to those predicted for A.D. 2100*, Proceedings of the National Academy of Sciences of the United States of America, January 12, 2010. <http://www.pnas.org/content/107/2/576>

July 8, 2010 -- In Western North America, The Worst Drought Since 1951 Will be Repeated Three to Five Times by 2030:

As unbelievable as this seems, in Austin, Texas, in the last three years, we have seen two droughts that were so extreme that the inflows to our Highland Lakes fell below the drought of record, which in our area was the drought of the 1950s.

This is the third drought that has been in the extreme category, or worse—the exceptional category—within the last seven years. Trees are dying across the region. In some places the forest devastation has

killed more than half of the trees in the forest. It is devastating to see this happen in your own neighborhood. I have been filming the pine beetle pandemic in the Rockies for five years now and what I am seeing around Austin is beginning to be really bad.

One of the authors of this study says: “Frankly, I was expecting that we’d see large temperature increases later this century with higher greenhouse gas levels and global warming . . . I did not expect to see anything this large within the next three decades. This was definitely a surprise.”

Even more surprising, the modeling in this work looked at the A1B scenario which falls along the lines of one of the middle of the road future predictions. This scenario sees our society making emissions reductions associated with common sense efficiency gains as well as including an balanced mix of fossil fuel and non fossil fuel energy sources. This scenario is often described as the “likely” scenario. The IPCC says the earth will warm by 1.8 degrees C by 2039 (3.6 degrees F). Now the surprising part; the extensive increases in heat waves and extreme temperatures in this modeling do not reflect that fact that right now, CO₂ concentrations are increasing as rapidly, or even more rapidly, than the worst-case scenario considered by the IPCC.

Most of the climate studies today are being performed with IPCC model scenarios, this study included. The IPCC model scenarios are significantly conservative as has been shown by the current impacts of climate change consistently happening faster and with more extreme impacts, than the IPCC models had predicted along the “likely” scenarios lines.

Figure 1.12 shows actual CO₂ emissions are higher than the IPCC A1FI scenario (the red line). The A1FI (FI stands for Fossil Intensive and is often wrongly stated as A1F1) scenario follows the path that our society is on today. It is a fossil fuel intensive path with only efficiency gains made by common sense to increase profits. The A1FI is the highest emission scenario that the IPCC considers. In effect, this is the worst-case scenario. Actual CO₂ concentrations, from data from both major sources in the climate community (the black lines) are higher than the

IPCC Model Scenarios vs. Actual Emissions

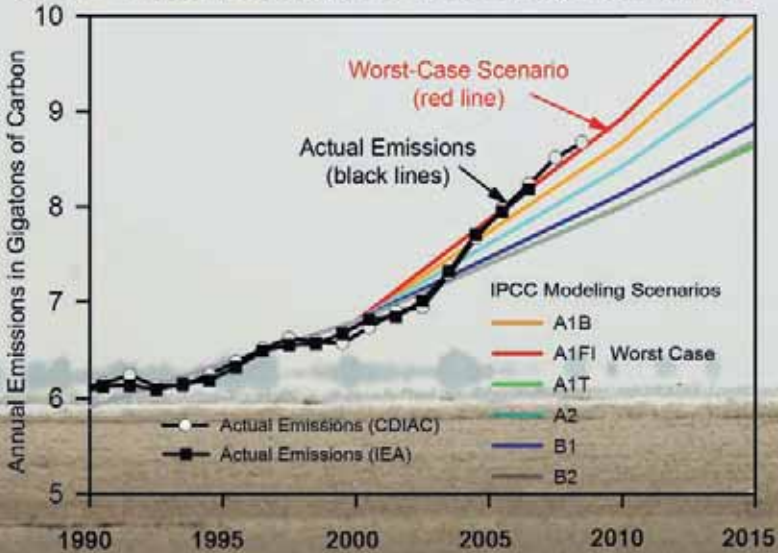


Figure 1.10: Observed global fossil-fuel and industrial CO₂ emissions compared with averages of 6 scenario groups from the IPCC Special Report on Emissions Scenarios (colored lines). The Carbon Dioxide Information and Analysis Center (CDIAC) and the International Energy Agency provided the current observations of CO₂ emissions. The latest update was obtained from www.globalcarbonproject.org. Sources: *Synthesis Report, Climate Change, Global Risks, Challenges and Decisions*, Climate Change Congress, International Alliance of Research Universities, University of Copenhagen, March 2009. Raupach and Canadell, *Carbon and the Anthropocene*, Current Opinion in Environmental Sustainability, August 2010.

A1FI worst-case scenario. In other words, our global greenhouse gas emissions are worse than anything the modelers have considered up to this point.

What does this mean? In the short term, and especially with the way that greenhouse gas regulations are going on Earth today, this trend will continue. And by the short term, I mean climatologically. This short term would be for at least the next couple of decades or more. Remember, the time frame for climate discussions, which is the amount of time that it takes for something to happen with climate, including emissions mitigations effects, is measured in multiple decades.

Looking at Diffenbaugh and Ashfaq's paper in *Geophysical Research Letters*, they say that the hottest season that occurred between 1951 and 1999 will recur three to four times between 2010 and 2020. The frequency of these heat waves will increase through the 2020 to 2030 decade—happening eight times in the American West and four times in the East.

Based on their work, Diffenbaugh and Ashfaq tell us: "The possibility that intensification of hot extremes could result from relatively small increases in greenhouse gas concentrations suggests that constraining global warming to 2°C [3.6°F] may not be sufficient to avoid dangerous climate change." That the 2 degree threshold is so widely accepted in policy work considering climate change, this discovery (like so many recently) is very important.

Most alarming though, as I brought out earlier, the authors stick to the old science. They use the A1B scenario which we have significantly left behind.

The paper ends "The response to a given greenhouse gas stabilization target is likely to be greater than to the equivalent

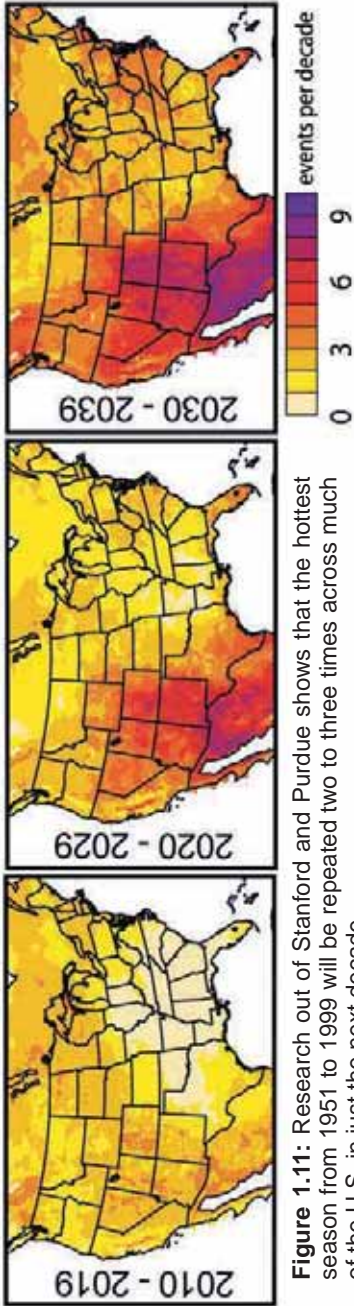


Figure 1.11: Research out of Stanford and Purdue shows that the hottest season from 1951 to 1999 will be repeated two to three times across much of the U.S. in just the next decade.

concentrations within the [modeling] tested here. Although accurate decadal-scale climate prediction represents a significant challenge, the intensification of hot extremes reported here suggests that constraining global warming to 2°C [3.6°F] above pre-industrial conditions may not be sufficient to avoid dangerous climate change.”

Diffenbaugh and Ashfaq, Intensification of hot extremes in the United States, Geophysical Research Letters, July 2010. http://www.stanford.edu/~omramom/Diffenbaugh_GRL_10.pdf

CO2 emissions are worse than the worst-case scenario developed by the IPCC: Synthesis Report, Climate Change, Global Risks, Challenges and Decisions, Climate Change Congress, International Alliance of Research Universities, University of Copenhagen, March 2009. <http://climatecongress.ku.dk/pdf/synthesisreport>

Raupach, et. al., Global and regional drivers of accelerating CO2 emissions, PNAS, April 2007. <http://www.pnas.org/content/104/24/10288.full.pdf+html>

IPCC Special Report on Emissions Scenarios: <http://www.ipcc.ch/ipccreports/sres/emission/index.htm>

July 15, 2010 -- Increasing Antarctic Sea Ice on A Warmer Planet:

Arctic sea ice coverage was 10.6 percent below the 1979-2000 average coverage, the lowest June coverage since records began in 1979. This was also the 19th consecutive June with below-average Arctic sea ice coverage.

But look—Antarctica’s sea ice in June was 8.3 percent above the 1979-2000 average, which made it the largest June coverage on record! How did we get the smallest Arctic, and the largest Antarctic sea ice coverage records ever during the same month? Especially with global warming already increasing the sea surface temperatures in the Antarctic?

As counter-intuitive as it sounds, climate change is the answer of course. We have finally locked down the main reasons that Antarctica’s sea ice has been growing. This counterintuitive task has taken a decade and we have found that one of the reasons has to do with the ozone hole, which is not a cause of climate change at all. Or is it?

The ozone hole was caused by chlorofluorocarbons (CFCs) released into the atmosphere because our advanced civilization has found that these compounds are very good at being refrigerants, aerosol propellants and solvents (among other things.) They escape into the atmosphere

very easily through evaporation and before the 1990s, their vapors, or the release of these “CFCs” and other chemicals were not regulated. The CFSs get into the upper atmosphere (the stratosphere) and destroy our protective ozone layer. The ozone depleting chemicals get concentrated at the poles and temperatures at the South Pole are cold enough for these complicated atmospheric chemical and photochemical (involving light) reactions to happen. This also occasionally happens at the North Pole.

Luckily for us, we discovered the ozone hole before it took over the earth and we saved mankind by strictly limiting the use of ozone depleting chemicals, or did we? The Montreal Protocol went into force in 1989. This international treaty to regulate ozone depleting chemicals

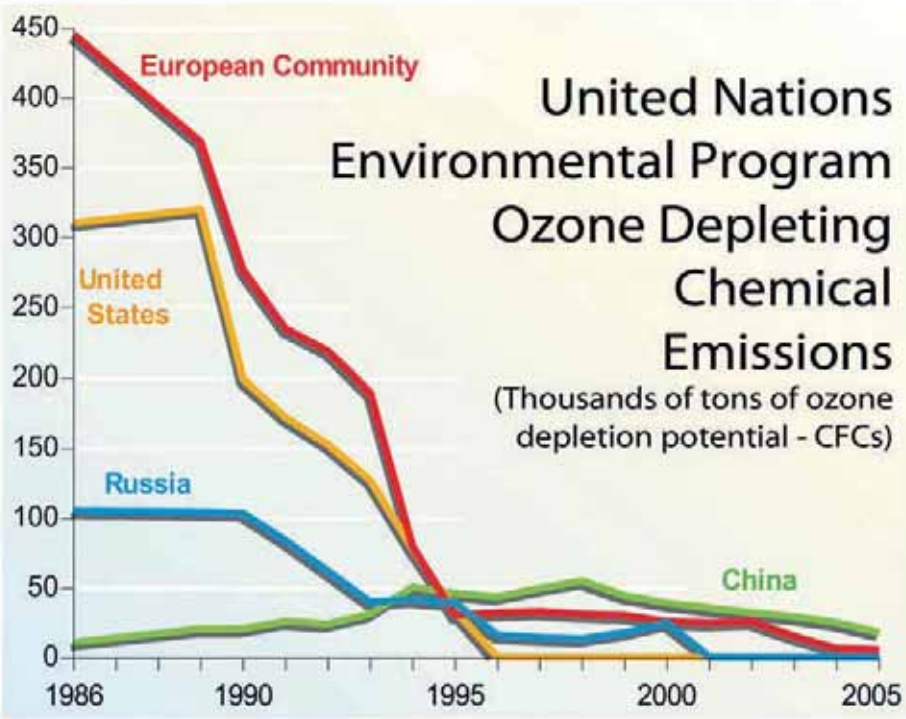


Figure 1.12: When Humankind has the will, there is a way. We reduced the emissions of ozone depleting chemicals in an exceptionally radical way in less than a decade, likely saving the world from immense hardships.

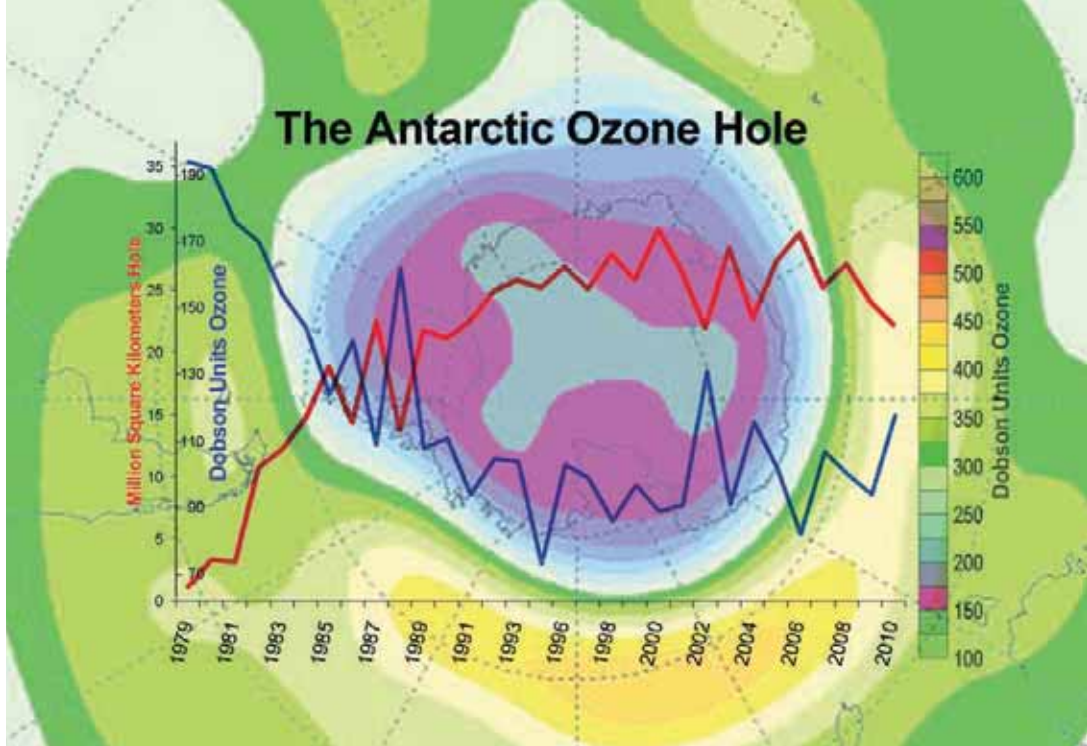


Figure 1.13: This scary graphic that takes a little concentration to see what's going on. The pink bulls eye is the ozone hole superimposed over the outline of Antarctica in gray. This is about how large it has been since 1993 or so. The red line is the size of the hole in square kilometers and the blue line is the average ozone concentration over Antarctica. What this shows is that while ozone depleting chemical emissions have been radically reduced (Figure 17), the size of the ozone hole has remained about the same. This means that a threshold was crossed where Earth's natural mechanisms regulating ozone in the atmosphere has been compromised. Data sources: NOAA and NASA.

quickly created a very large drop in emissions. The ozone hole however, did not shrink. It remains virtually the same size today as it was during the peak of the ozone depleting chemical crisis. I will get to the reason why in a moment but first I have some more explaining to do.

This ozone depletion stuff is some of the most complicated climate science I have run across and it has taken me years to get a grasp of what is actually happening. I realize it is uber geeky but hang in there for a few more paragraphs.

All of this ozone hole chemistry is happening in the stratosphere above 50,000 feet (a little lower at the poles.) Ozone is a greenhouse gas



Figure 1.14: Nacreous clouds, also known as polar stratospheric clouds or mother of pearl clouds can form at 50,000 to 80,000 feet, far above normal clouds. They are so high that they catch the sun's rays long after sunset. Their chemical composition, that includes nitrous and sulfuric acids, causes the sun's rays to refract differently from normal clouds revealing these fantastic displays of color. Source: NASA image from Antarctica.

that captures warmth and keeps it on Earth through the greenhouse effect. So ozone does act as a greenhouse gas and the ozone hole, which reduces atmospheric ozone in the stratosphere, creates cooling not warming at high altitude. In the lower atmosphere, ozone does warm, but it also plays a big role in the formation of smog that generally cools the atmosphere. So in the lower atmosphere these effects somewhat cancel each other out.

To understand why ozone depletion increases winds around Antarctica, we have to understand the processes that destroy ozone. In the Antarctic winter, when temperature is the coldest, nacreous clouds containing chlorine and nitrous acid, very high in the atmosphere, that

can be colder than -100 degrees F, start a chain reaction with ozone depleting chemicals. (What? We have nitrous acid and chlorine clouds on Earth? Yes we do.) The ozone destroying reaction is started when the sun returns in early spring and hits the super-cooled nacreous clouds. This is called a photochemical reaction and yes, it is very cool geeky-wise, as it is something much more commonly found on planets like Saturn

The photochemical reactions involving the nitrous acid and chlorine change ozone molecules to regular gaseous oxygen. (Ozone is O_3 – a molecule with three atoms of oxygen instead of the normal O_2 that has two atoms of oxygen.) This is where ozone disappears and the ozone hole forms. The hole is at its largest in the Antarctic spring in the Northern Hemisphere autumn.

So this is how we created our ozone hole. Now why is the ozone hole not shrinking if we have brought our ozone deleting chemicals emissions under control? Greenhouse gases (of all kinds) are predominantly found in the lower atmosphere, below the stratosphere. These gases trap warmth and keep it from reaching the stratosphere. This makes the stratosphere cool. The cooling gets greater as the greenhouse gas concentration of our atmosphere increases and more warmth is trapped lower. The cooler stratosphere then has the ability to destroy more ozone in the super-cold ozone depleting chemical reactions with the chlorine and nitrous acid clouds.

Another complicating factor involves what are called hydroxyl compounds. This group of chemicals occurs naturally and can be thought of as our atmosphere's cleaning crew. They are involved in a lot of reactions including neutralizing ozone depleting chemicals. All of the extra ozone depleting chemicals and their leftovers have depleted hydroxyl concentrations so that the ability of our atmosphere to clean itself has been compromised.

All of these complicated chemical reactions involving ozone have been shown to happen in the supercomputer models for a long time. Now we are seeing it happen for real. We are definitely not out of the woods yet with the ozone depleting chemicals crisis.

So, global warming warms the lower atmosphere and makes the upper atmosphere colder. This enhances the loss of ozone at the poles, so even though we have drastically reduced our ozone depleting chemical emissions, the ozone hole is not really shrinking. This temperature difference between the upper and lower atmosphere results in “weather” that has more energy. In this case it means more wind. In other words, the ozone hole energizes the jet stream. The windier jet stream then transfers some of its energy down low to the lower atmosphere. This creates the windier Antarctic that we are seeing today.

The high plateau of East Antarctica throws a kink in the jet stream flow around the pole. This creates stronger winds in some areas and these areas then get the sea ice blown off of them regularly. These ice-free areas form polynyas, a Russian word for “ice free area.” Polynyas are “sea ice nurseries.” More polynyas mean more sea ice can form. More wind means the ice is spread out more, creating a larger area of coverage. Remember the Arctic – more sea ice coverage does not necessarily mean that there is more ice, but can easily mean that there is more wind.

The reasons that there are record levels of sea ice in the Antarctic do not stop here. Like I said before, this is really crazy stuff. Warmer temperatures, increased melt, and increased ice discharge (icebergs) from the ice sheet have all combined to increase the amount of fresh water in the Great Southern Ocean around Antarctica.

Lots of fresh water inserted into a salt water environment quickly results in a layer of the less dense fresh water forming on top of the more dense salt water. This does two things: First—fresher water freezes at a higher temperature than saltier water by as much as several degrees (Normal sea water freezes at about 28.4 degrees F.) Next, the layer of fresh water serves as an insulator keeping the warmth of the main ocean currents away from the cold sea ice allowing more ice to form faster.

There is even more to this story: Antarctic temperatures have not dropped as the radical climate skeptics would have us believe. They have warmed. The warming is not as much as the world average, nor near as much as the Arctic, but they have not dropped. This reduced amount of

warming in the Antarctic compared to the rest of the world is completely supported by the climate models. The ocean around Antarctica warms very slowly, moderating Antarctica's warming trends—whereas, the Arctic is surrounded by land, which accelerates warming.

Warmer ocean temperatures (all over) have increased evaporation (in open water areas.) This increases moisture in the air, which increases precipitation. More snow and rain over the ocean decrease the salinity of the surface ocean waters similarly to melting ice and melting icebergs, and ice discharge from glaciers in Antarctica has increased to about the level that we are seeing in Greenland. The extra icebergs melt quickly and further decrease the salinity of Antarctic Ocean surface water, further enhancing sea ice formation.

The final thing happens after sea ice has formed. More sea ice decreases the amount of mixing of surface waters by the wind because once the surface freezes the wind cannot move the water around, so even though the polynyas create more sea ice because of the open water in the polynyas, many more areas do not see this open water and sea ice decreases mixing, keeping that layer of less salty water from mixing with the waters below. The less salty water of course freezes at a higher temperate.

This paradoxical behavior is like what we have seen in the northeastern U.S. and parts of Europe over the last several winters with the big snowstorms. As counterintuitive as it may seem, climate change can set into motion very complicated patterns of weather across global regions that would not be the first thing that we would expect to happen; or the second thing, or the third . . . The authors of the Antarctic sea ice paper also caution us that their modeling shows that this trend is highly and rapidly reversible with only a little more warming, and that this has all been modeled for many years now.

Turner. et. al., Non-annular atmospheric circulation change induced by stratospheric ozone depletion and its role in increasing Antarctic sea ice, Geophysical Research Letters, April 2009. <http://ruby.fgc.edu/courses/twimberley/EnviroPhilo/Turner.pdf>

Liu and Curry, Accelerated warming of the Southern Ocean and its impact on the hydrologic cycle and sea ice, PNAS, August 10, 2010. <http://www.pnas.org/content/early/2010/08/09/1003336107>

July 24, 2010 -- Expert Credibility in Climate Change:

I am going to repeat a bit of my ongoing discussion about how vast the scientific consensus is. Not because it will persuade you about anything—you've made it this far in this book, so you obviously do not think climate change is bunk. I repeat this to add some thoughts about the media and give you the impression of how important this is to the issue as a whole.

This paper out of Stanford titled "*Expert credibility in climate change*," shows us that between 97 and 98 percent of nearly 1,400 climate scientists publications reviewed, published by climate the climate scientists who are *most actively* publishing findings in their field, support the human-caused climate change consensus. Out of the two to three percent that do not support the consensus, 80 percent have published fewer than 20 papers. The consensus crowd includes only 10 percent of scientists who have published fewer than 20 papers. (See also entry for October 8.) The conclusion of the paper tells us a little about the unfairness of the media

and the harm that can be innocently caused through ignorance:

Despite media tendencies to present both sides in [climate change] debates, which can contribute to continued public misunderstanding regarding [climate change], not all climate researchers are equal in scientific credibility and expertise in the climate system.

A significant amount of blame for the continuing public misunderstanding



can be attributed to the media. This has been innocent, but ignorant behavior on their part. Our society has demanded that journalists, reporters, and all the rest, be fair. This public sentiment was echoed in a rule by the Federal Communications Commission in 1949 called the Fairness Doctrine. This rule required that media coverage of public issues be fair. It said that



broadcasters were to provide coverage of controversial news and public affairs when appropriate and that they were to provide reasonable opportunities for the presentation of contrasting viewpoints. The Fairness Doctrine was abolished by President Reagan in 1987. Then there was the Equal Time Rule, established in 1927 and recodified in 1934. It was a rule addressing political issues only, intended to provide an equivalent opportunity to any opposing political candidates who request it.

These two rules help define ethics, and the morally appropriate way to behave on television and radio. It is only fair that both sides of the story be heard, that those with different beliefs be given appropriate time to demonstrate their position accordingly. We as a society understand these ethical and moral rights and generally we uphold them to the utmost degree.



But there is a big challenge associated with climate change, or science of any kind really. Most public issues in the past deal with beliefs and issues. Climate change is not about beliefs and issues. Beliefs change over time as the public's perception of an issue changes with things like: racial issues, alcohol consumption, workers rights, child labor laws, women's suffrage, slavery, right to life, appropriate religious beliefs, separation of church and state, the right to bear arms, nuclear power, national healthcare, etc., etc. Climate facts change based on evidence.

Climate change is about science. Science has no morals. There are ethics involved in science, but they are the ethics of the industry of science, not the perceived appropriateness of an issue like "the right to life." Issues can be debated based upon beliefs. There are no "beliefs" in science, only facts.

So right away, you see that there is a fundamental problem here with the way our society is treating climate change. We are treating it like it is another belief; something that can be judged through morally appropriate behavior. Of course, it is nothing of the sort. One can no

more judge that a data set is invalid based on morals any more than one can judge another's ethics by the color of his or her skin.

The media are no different than anybody else when it comes to climate science. They do not understand that the credibility of the "skeptical



Expert credibility in climate change

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Contributed by Stephen H. Schneider, April 9, 2010 (sent for review December 22, 2009)

Although preliminary estimates from published literature and expert surveys suggest striking agreement among climate scientists on the tenets of anthropogenic climate change (ACC), the American public expresses substantial doubt about both the anthropogenic cause and the level of scientific agreement underpinning ACC. A broad analysis of the climate scientist community itself, the distribution of credibility of dissenting researchers relative to agreeing researchers, and the level of agreement among top climate experts has not been conducted and would inform future ACC discussions. Here, we use an extensive dataset of 1,372 climate researchers and their publication and citation data to show that (i) 97–98% of the climate researchers most actively publishing in the field support the tenets of ACC outlined by the Intergovernmental Panel on Climate Change, and (ii) the relative climate expertise and scientific prominence of the researchers unconvinced of ACC are substantially below that of the convinced researchers.

climate change skeptics and on researchers that have public statements concerning climate change. We then imposed a minimum threshold on researchers that have public statements concerning climate change. We then imposed a minimum threshold on researchers that have public statements concerning climate change.

We compiled a database of authorship of scientific multisignatory statements about climate change. We tallied the number of climate change papers authored or coauthored by each researcher. We then imposed a minimum threshold on researchers that have public statements concerning climate change. We then imposed a minimum threshold on researchers that have public statements concerning climate change.

Figure 3.13: The abstract from Anderegg et al., in the Proceedings of the National Academy of Sciences of the United States of America.

ones" is low or in many cases completely nonexistent. The media only understands that the public trusts them to be fair, and that the rules say that to be fair they must provide equal time to the opposition. ("The Rules" today being mostly ethical considerations of the media industry.) But the rules were written for issues-based discussions, not science based discussions. Climate change is not a controversial issue. It is a sobering issue, a fearful issue, and dangerous issue, but it is not controversial. Ninety-seven to ninety-eight percent of scientists agree, so where is the controversy in such an extraordinarily large majority?

Nevertheless, the media continues to “give equal time.” Even though the credible scientists tell us that there are critical flipping points in our climate that we may pass at anytime, an embarrassingly small number of ‘Skeptics’ have hijacked the climate change plane. The media is not completely to blame of course. The skeptical propagandists have been egging the media on. The Kontrarians’ anti-press releases follow nearly every major climate science breakthrough: down playing, denying and obfuscating.

The media then, not knowing that they do not have enough knowledge to be able to tell the rabbit crap from the real science, prints the rabbit crap religiously, “because it is only fair.”

Now I come to the same old sour question: “What the in the world do we do about this?” The answer is still; Tell your friends. Ask people in line at the supermarket if you can ask them a question about climate change. My latest standard question is “Quick!, What is the first thing that pops in to you mind when I say climate change?” This will start a conversation. This is the first step.

Anderegg, et. al., *Expert credibility in climate change*, Proceedings of the National Academy of Sciences of the United States of America, April 2010. <http://www.pnas.org/content/early/2010/06/04/1003187107.full.pdf+html>



Figure 1.15: The “ukaliq”, or arctic hare, is four times the size of our lower latitude cottontail rabbit that most of us are familiar with. The arctic hare is native to the tundra regions of Greenland and the northernmost parts of North America. It changes color to white during the winter so it can be camouflaged against the snow to protect it mostly from Arctic wolves. During the summer months the body and head changes to a brownish gray on some individuals, while others (like these) remain white year-long. National Geographic says they can run at speeds up to 40 mph.