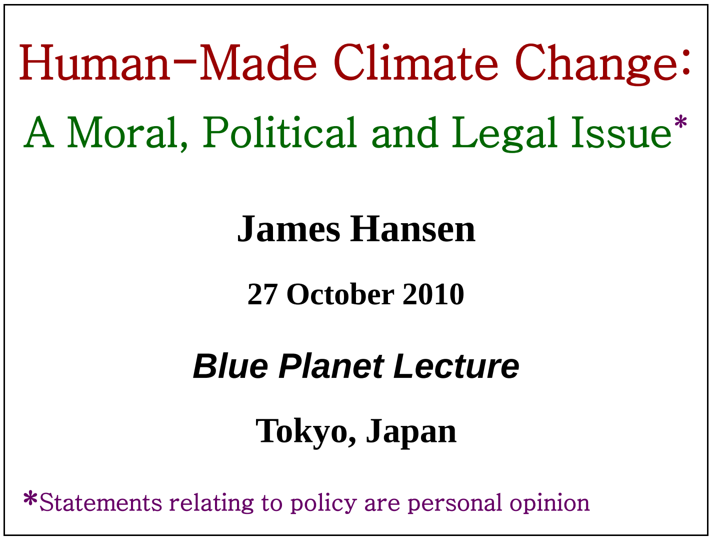
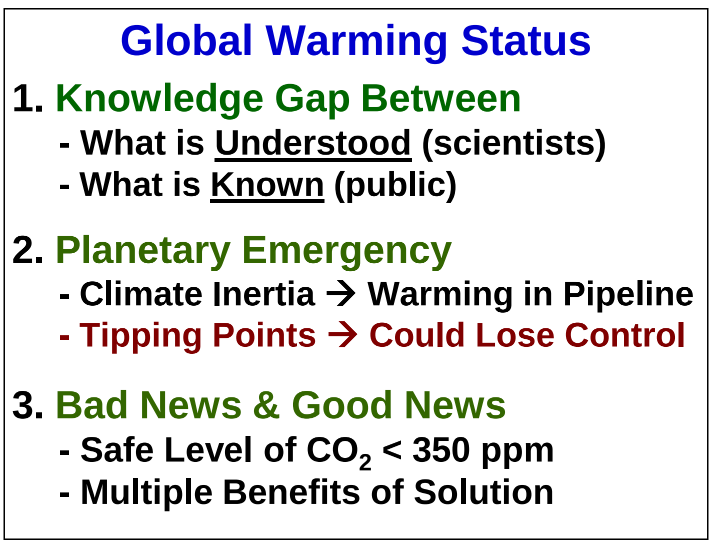
Human-Made Climate Change: A Moral, Political and Legal Issue
Dr. James E. Hansen



#1 Human-made climate change is a moral issue. It pits the rich and the powerful against the young and the unborn, against the defenseless and against nature.

Climate change is a political issue. But politics fails when there is a revolving door between government and the fossil fuel-industrial complex.

Climate change is a legal issue. The judiciary provides the possibility of holding our governments accountable for their duty to protect the public interest.



#2 There is a huge gap between what is understood about global warming, by the relevant scientific community, and what is known about global warming by the people who need to know, the public.

It is difficult for the public to recognize that we have a crisis, because human-made global warming, so far, is small compared to day-to-day weather fluctuations. Yet the fact is: we have an emergency. Because of the great inertia of the ocean, which is four kilometers deep, and the ice sheets, which are two to three kilometers thick, the climate system responds slowly to climate forcings such as increasing greenhouse gases. But this inertia is not our friend, because it increases the danger that we may pass tipping points, beyond which the dynamics of the climate system takes over and rapid changes occur out of humanity's control.

The bad news is that atmospheric carbon dioxide (CO_2) has already reached a dangerous level, having increased from 280 parts per million (ppm) 200 years ago to 389 ppm today. The good news is that it is still possible to get CO_2 back below 350 ppm, if we act promptly, and there would be many benefits of taking the actions that are needed.

Climate Tipping Points

1. Ice Sheet Disintegration

- Ocean Warming → Ice Shelves Melt → Ice Streams Surge → Disintegration

2. Species Extermination

- Shifting Climate Zones, Multiple Stresses, Species Interdependencies

3. Methane Hydrate 'frozen methane'

- In Tundra & On Continental Shelves

- Depends On Ocean & Ice Sheets

#3 The great ice sheets on Greenland and Antarctica provide examples of tipping points, especially the West Antarctic ice sheet, which sits on bedrock below sea level. If an ice sheet is weakened to the point that it begins to collapse, the dynamics of the process takes over. It will be out of our control – we cannot tie a rope around an ice sheet that is two kilometers thick.

Extermination of species is another non-linear problem that can accelerate, because of the interdependencies among species. Multiple stresses may cause enough extinctions that ecosystems collapse.

Methane hydrates are essentially frozen methane. If they begin to disintegrate rapidly, it could become a self-sustaining process.

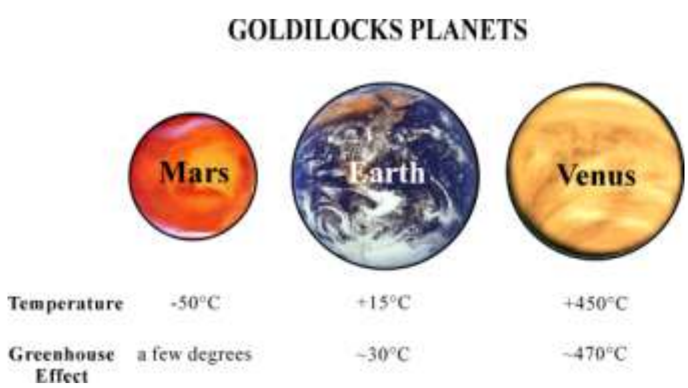
These tipping points all have occurred during Earth's history in conjunction with warming climates. Following mass extinctions new species evolved, but it required hundreds of thousands of years. We will leave a much more desolate planet for future generations, if we destroy many species.

First grandchild, Sophie – at age almost two years

#4 Climate inertia and tipping points give rise to potential intergenerational injustice. Today's adults enjoy the benefits of fossil fuel use, but the impacts will be borne by young people and future generations. Our parents did not know that their actions would affect future generations. We do not have that excuse. We can only feign ignorance. It is called denial.

I showed this photo of our first grandchild in 2000, because newspapers had called me the grandfather of global warming. It was amusing to show that I really was a grandfather.

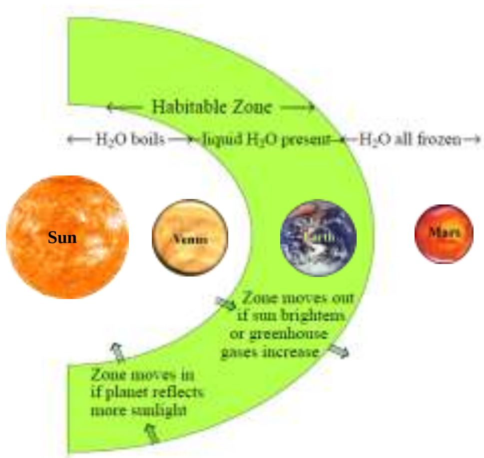
After I testified to Congress in the 1980s I had decided to stick to research and leave public communication to others. But by 2004 we had two grandchildren and the gap between what was understood about the science and what was known by the public had become huge. I decided to give one carefully prepared public talk in 2004.



Venus is closer to sun than Earth is, but cloud-covered Venus absorbs only 25% of incident sunlight, while Earth absorbs 70%. Venus is warmer because it has a thick carbon dioxide atmosphere causing a greenhouse effect of several hundred degrees.

#5 The talk was titled "Dangerous anthropogenic interference: a discussion of humanity's Faustian climate bargain and the payments coming due." I began with this chart comparing Mars, Earth and Venus. Mars has a thin atmosphere of carbon dioxide, Earth an intermediate amount, and Venus has a very thick carbon dioxide atmosphere. The greenhouse effect of carbon dioxide – the fact that it allows sunlight to penetrate to the planetary surface, but partially traps the planet's infrared (heat) radiation – causes each planet to be warmer than it would otherwise be, given the amount of sunlight that it absorbs – Mars by a few degrees, Earth by a few tens of degrees, and Venus by several hundred degrees.

Mars is too cold – its water is all frozen. Venus is too hot – the water has boiled into the atmosphere. Earth is just right for life to exist.



When the solar system formed, the sun was 30% dimmer than today and Venus had an ocean. As the sun brightened, a runaway greenhouse effect caused the Venus ocean to boil away.

At times when Earth was younger, the sun brighter, and atmospheric CO_2 less, Earth froze over ("snowball Earth").

Earth is in the sweet spot today.

#6 The habitable zone around a star is the zone where liquid water can exist on a planet. Our sun is an ordinary star, "burning" hydrogen in its core, producing helium by nuclear fusion, slowly getting brighter. When the solar system was young the sun was 30 percent dimmer than today and the habitable zone was closer to the sun. Venus was cool enough to have an ocean. Earth was near the cold limit of the habitable zone. On several occasions Earth froze all the way to the equator. The most recent "snowball Earth" occurred about 700 million years ago.

As the sun brightened, Venus experienced a runaway greenhouse effect. The ocean evaporated, boiling into the atmosphere. Carbon dioxide baked from the Venus crust into the atmosphere. There is no going-back. Venus is permanently outside the habitable zone, locked forever in a hellish greenhouse with a surface hot enough to melt lead.

Earth is now near the middle of the habitable zone. Earth can never freeze over again. The sun is now too bright and humans have added greenhouse gases to the atmosphere. A runaway greenhouse effect will not occur naturally on Earth for several billion years. But if we burn all fossil fuels, including tar sands and oil shale, it is conceivable that we will hasten a runaway greenhouse effect.

How will climate change this century? It depends. It depends mainly on how much carbon dioxide humans put into the atmosphere.

Basis of Understanding

1. **Earth's Paleoclimate History**
2. **On-Going Global Observations**
3. **Climate Models/Theory**

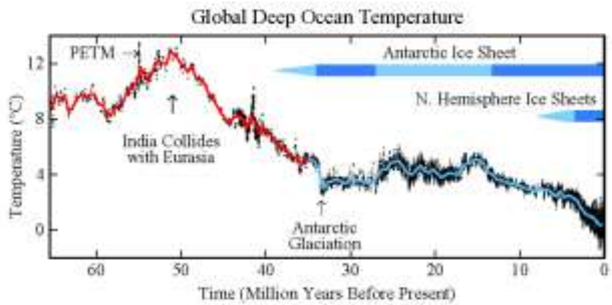
#7 Our understanding of climate change is based most of all on Earth's history – how the climate responded in the past to changing boundary conditions such as atmospheric composition and surface properties. Ongoing global observations are also valuable, showing how climate is responding to rapid changes of atmospheric composition. Climate models and theory are helpful in interpreting what is happening and they are needed to predict future changes.

Why be concerned about human-made climate change?

There have been huge climate changes during Earth's history!

It is arrogant to think that humans can control climate or that we know enough to say that today's climate is the best one for the planet.

#8 Why should we be concerned about human-made climate change? There have been huge climate changes in the past. Is today's climate the best one? These are reasonable questions. Indeed, they were statements made on National Public Radio in 2008 by my then boss's, boss's, boss's boss, the NASA Administrator. Earth's climate history helps answer such questions.



50 million years ago (50 MYA) Earth was ice-free.

Atmospheric CO_2 amount was of the order of 1000 ppm 50 MYA.

Atmospheric CO_2 imbalance due to plate tectonics ~ 10^{-4} ppm per year.

#9 This is the deep ocean temperature over the past 65 million years. Fifty million years ago Earth was so warm that there were alligators in Alaska – the Arctic was tropical-like. There were no ice sheets and sea level was about 75 meters (250 feet) higher than today. Earth cooled over the past 50 million years. About 34 million years ago it became cool enough for an ice sheet to form on Antarctica. What caused the great warmth in the first half of this Cenozoic Era, and why did Earth then become cooler?

Cenozoic Era

End of Cretaceous (65 My BP) Present Day

Global Climate Forcings

External (solar irradiance): +1 W/m²

Surface (continent locations): ~1 W/m²

Atmosphere (CO_2 changes): > 10 W/m²

#10 The climate change was due mainly to change of atmospheric carbon dioxide (CO_2). Climate forcings, perturbations of the planet's energy balance, must be due to changes of the energy coming into the planet, changes within the atmosphere, or changes on the surface. The sun's luminosity increased 0.4 percent over this era, which is a forcing of 1 watt per square meter. The continents at the beginning of the Cenozoic were already close to their present latitudes, so the surface forcing was only about 1 watt. But atmospheric CO_2 varied from as little as 170 ppm to more than 1000 ppm, a forcing of more than 10 watts per square meter.

The amount of CO_2 naturally in the atmosphere-ocean system depends on the balance between the source and sink of CO_2. The balance changes over time, depending mainly on continental drift. The source of CO_2 is volcanic eruptions, which occur as moving continents subduct the ocean floor. The metamorphosis of carbonates on the ocean floor into denser rocks, due to high pressure and temperature as the continent rides over the ocean floor, releases CO_2 via volcanoes. The main sink of atmospheric CO_2 is the weathering process as sediments are carried by rivers to the ocean and deposited as carbonates on the ocean floor.

Between 60 and 50 million years ago atmospheric CO_2 increased rapidly because India was moving at high speed, about 20 centimeters per year, through the Tethys (Indian) Ocean, which had long been the depocenter for major rivers and thus had a carbonate-rich ocean floor. When India crashed into Asia, pushing up the Himalayas and Tibetan Plateau, this source of CO_2 diminished and the weathering sink increased. So atmospheric CO_2 decreased and the planet cooled over the past 50 million years.

Summary: Cenozoic Era

1. Dominant Forcing: Natural ΔCO_2

- **Rate ~100 ppm/My (0.0001 ppm/year)**
- **Human-made rate today: ~2 ppm/year**

Humans Overwhelm Slow Geologic Changes

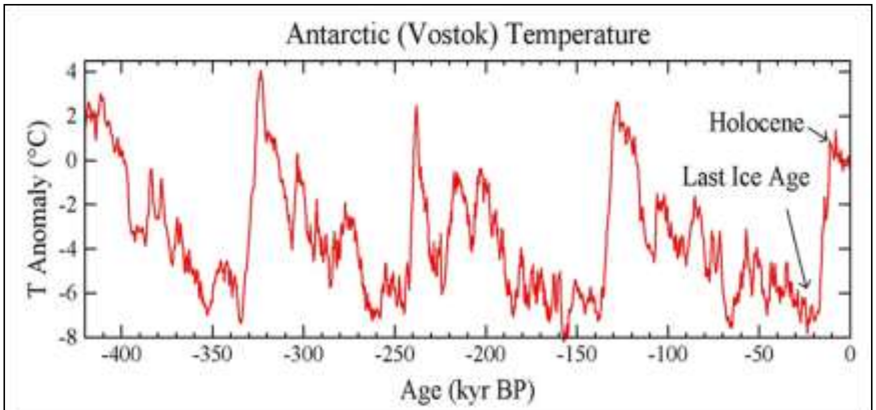
2. Climate Sensitivity High

- **Antarctic ice forms if CO_2 < ~450 ppm**
- **Ice sheet formation reversible**

Humans Could Produce "A Different Planet"

#11 The lesson from the Cenozoic is that the amount of CO_2 in the atmosphere-ocean system changes naturally via exchange with the Earth's crust. The imbalance between the source and sink of CO_2 yields a change of atmospheric CO_2 of the order of 100 ppm in one million years, or 1 ten-thousandths of a ppm per year. Humans are now increasing atmospheric CO_2 by about 2 ppm per year, 10,000 times faster than the natural geological change.

The Cenozoic also allows us to estimate that an ice sheet began to form on Antarctica when CO_2 had declined to about 450 ppm. Some scientists estimate a higher amount of CO_2 at the transition. But it is clear that burning all the fossil fuels would produce enough CO_2 to head Earth back toward the ice-free state, a different planet than the one that humans know.



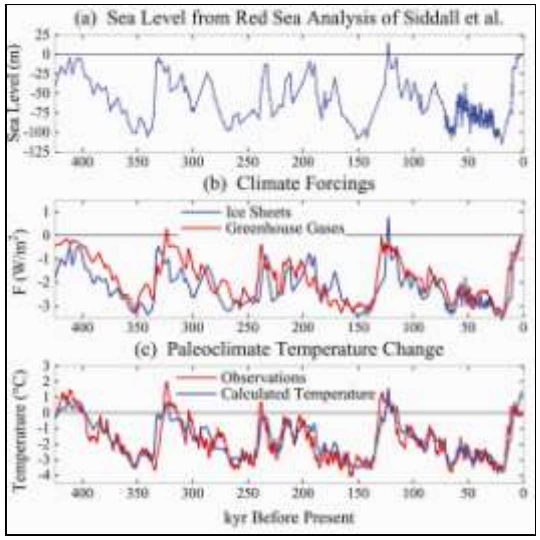
Earth's history provides important information on global warming.

Recorded human history occurs within the Holocene warm period.

#12 Climate also fluctuates on shorter time scales, as shown by this record of Antarctic temperature for the past 400,000 years. Civilization developed during the Holocene, the relatively stable warm period, now almost 12,000 years long. During the last ice age New York was under a kilometer of ice and sea level was 350 feet lower.

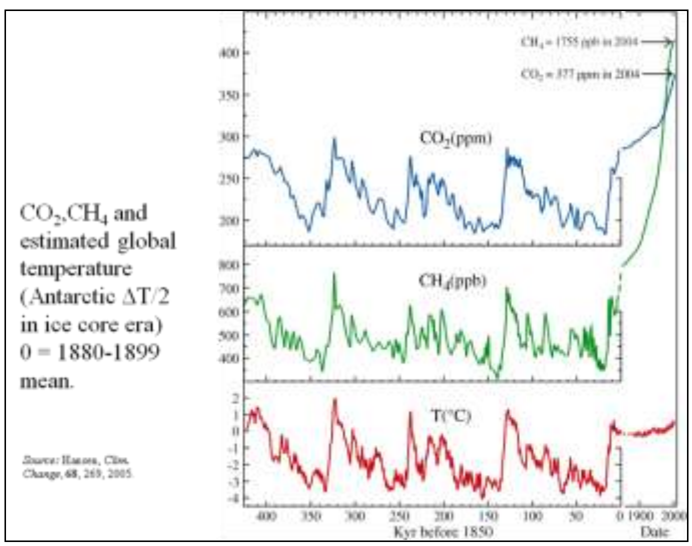
The glacial to interglacial climate swings are caused by perturbations of Earth's orbit. As Jupiter, Saturn and Venus tug at our planet, Earth's spin axis tilts successively slightly more toward or away from the sun. Also Earth's orbit becomes more or less eccentric. These changes alter the amount of sunlight striking the ice sheets in the summer.

As ice sheets melt they expose a darker surface that absorbs more sunlight, causing Earth to become slightly warmer. The warming ocean releases CO_2 to the atmosphere and the greenhouse effect of this CO_2 causes additional warming. Changing ice sheet size and changing atmospheric CO_2 are slow feedbacks that amplify the climate change.

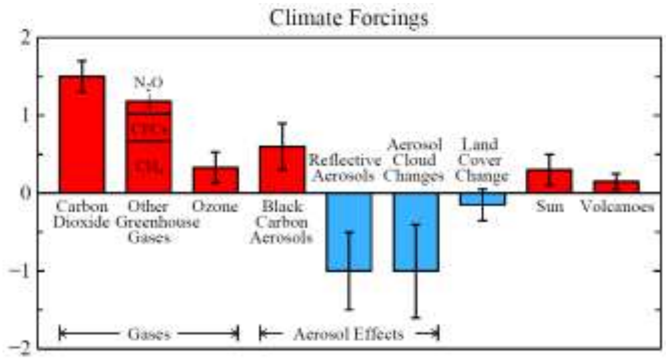


#13 Indeed, these feedbacks cause almost the entire temperature change. The sea level record in the top curve tells us how large the ice sheets were. Greenhouse gas amount is known from bubbles of air trapped in the Antarctic ice sheet as snow piled up.

Multiplying the ice sheet plus greenhouse gas forcings by a climate sensitivity of ¾ degrees Celsius for each watt of forcing yields good agreement with the actual climate change, as shown by the lower curves. This empirical climate sensitivity includes all fast feedback processes such as changes of water vapor, clouds, sea ice and aerosols – and it is much more accurate than can be obtained from climate models. The climate sensitivity for a specified greenhouse gas change becomes twice as large if we wait long enough for ice sheets to respond.



#14 The climate sensitivity and response time of the climate system are important, because humans have caused greenhouse gases to increase in the past century far outside the range of the past several million years, as shown by the expanded time scale on the right. Earth has begun to warm, as shown by the lower curve, but much of the warming is still in the pipeline, due to the long climate response time.



Change of climate forcings in W/m^2 between 1750 and 2000.
[from Hansen *et al.* *"Efficacy of Climate Forcings" J. Geophys. Res.* (2005)]

#15 To understand modern climate change we must know all climate forcings, that is, perturbations to Earth's energy balance. Greenhouse gases are accurately measured – they cause a large positive (warming) forcing. Human-made fine particles in the air (aerosols) reflect sunlight and thus cause cooling, but it is very uncertain, because it is not measured. Natural forcings, due to the sun and volcanoes, are probably larger now than in the eighteenth century, when the sun is believed to have been slightly dimmer and volcanic eruptions were greater. But the natural forcings are small compared to present human-made forcings.

The net climate forcing is probably between +1 and +2 watts per square meter. Carbon dioxide is the largest forcing, and as time goes on it will be more and more dominant because of its long lifetime in the atmosphere.

#16 In my University of Iowa talk in 2004 I used this photo of my daughter's children to discuss climate forcing. Sophie explains that the net forcing is about 2 watts, equivalent to two tiny light bulbs over each square meter of Earth's surface. But Connor could only count 1 watt. Connor may be right. We are not measuring aerosol forcing well enough to know for sure.

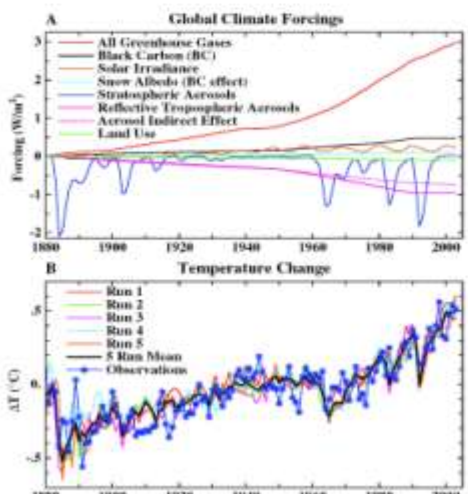
Sophie and Connor at ages 9 and 4.

#17 So I went back to Sophie and Connor a few years later, when they were older and wiser. I asked them "what is the net climate forcing?" They said that they don't know. Well, we can't blame them if we adults fail to make the measurements.

But my grandchildren were useful in another way. They forced me to keep speaking out. I decided that I didn't want my grandchildren in the future to say "Opa understood what was happening, but he never made it clear."

(A) Forcings used to drive climate simulations.

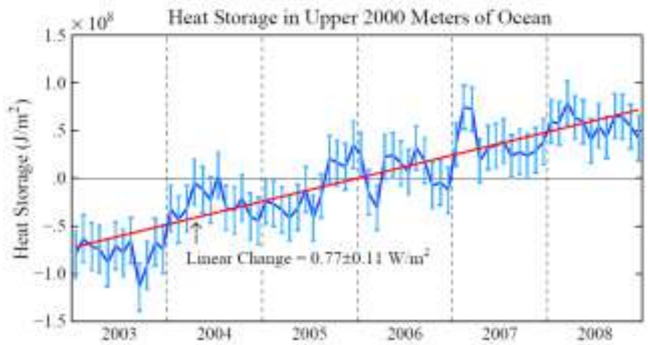
(B) Simulated and observed surface temperature change.



Source: Earth's energy imbalance: Confirmation and implications. *Science* **308**, 1431, 2005.

#18 The upper graph shows estimates of changing climate forcings over the past century. Greenhouse gas forcing becomes increasingly dominant. Aerosol forcing is very uncertain, because it is not well measured.

If we use these forcings in a climate model with equilibrium sensitivity ¾°C per watt of forcing, we find good agreement with observed global temperature, as shown in the lower graph. This agreement could be partly accidental: if we used a model with greater sensitivity and a smaller climate forcing, or vice versa, we might also get agreement. However, the model's sensitivity agrees with the fast-feedback climate sensitivity implied by paleoclimate data.



Heat storage in upper 2000 meters of ocean during 2003-2008 based on ARGO data.
Knowledge of Earth's energy imbalance is improving rapidly as ARGO data lengthens.
Data must be averaged over a decade because of El Nino/La Nina and solar variability.
Energy imbalance is smoking gun for human-made increasing greenhouse effect.

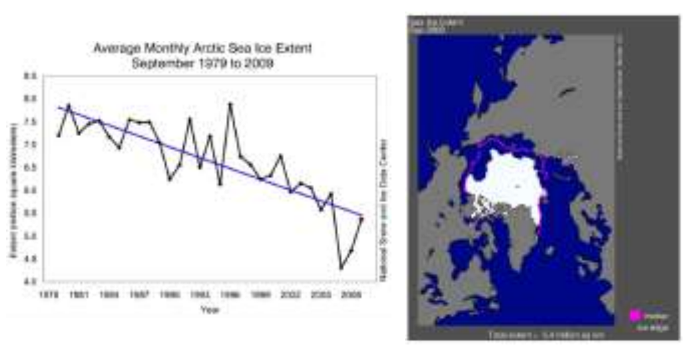
Data source: von Schuckmann *et al. J. Geophys. Res.* **114**, C09007, 2009, doi:10.1029/2008JC005237.

#19 The most fundamental check of the physics is the planet's energy imbalance. We anticipate that the planet is out of balance, more energy coming in than emitted to space. That imbalance is the signature of the greenhouse effect, the smoking gun that can confirm climate change is being driven by a forcing. Imbalance is expected because greenhouse gases reduce the planet's heat radiation to space.

How can we measure Earth's energy imbalance? Small amounts of energy go into warming the atmosphere, melting ice, and warming the upper tens of meters of the ground, but most of the excess energy must go into the ocean, which has enormous heat capacity. Measuring the ocean's heat content accurately has been a great challenge, but the data are improving as more than 2000 ARGO floats have been distributed around the world ocean. Each float regularly yoyos an instrument package to a depth as great as 2000 meters.

The best data, covering the past six years, indicate that the planet is out of energy balance by at least ½ watt per square meter. These data are for the time of minimum solar irradiance in the 10-12 year solar cycle. Our climate model yields an imbalance of ¾ of a watt averaged over the solar cycle. I expect we will find close agreement with the model as the observations extend over the full solar cycle and the entire ocean. The data already show that the planet is out of energy balance, confirming the expected effect of human-made greenhouse gases.

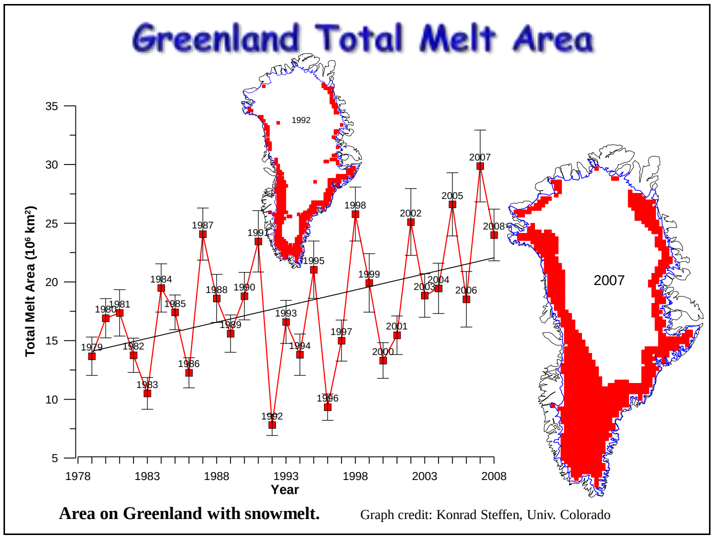
Arctic sea ice area at warm season minimum.



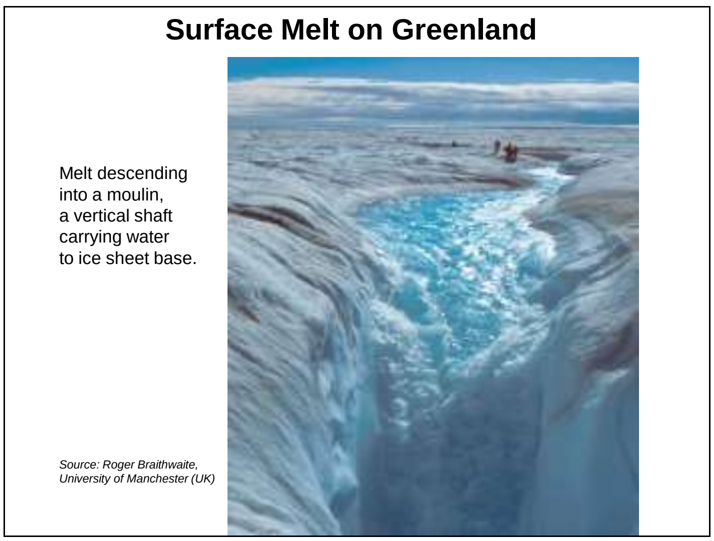
September sea ice extent based on satellite microwave observations.

Data source: National Snow and Ice Data Center

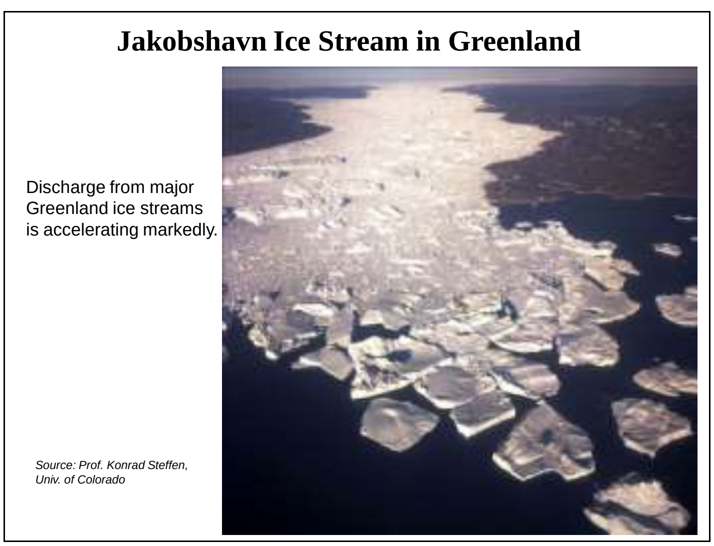
#20 Global observations reveal effects of Earth's energy imbalance. The area of Arctic sea ice began to be measured by satellites in the late 1970s. The area of sea ice at the end of the melt season has decreased about 30 percent. There are large year-to-year fluctuations because of weather variations that affect the wind direction and ocean currents. But, because of the planet's energy imbalance, the area of sea ice will continue to decrease on decadal time scales. Unless we restore the planet's energy balance, we can expect to lose all late-summer sea ice within the next few decades.



#21 The area on Greenland that has summer snow melt, shown in red, fluctuates from year-to-year, depending on the weather. But the melt area has increased about 50 percent over the past few decades.

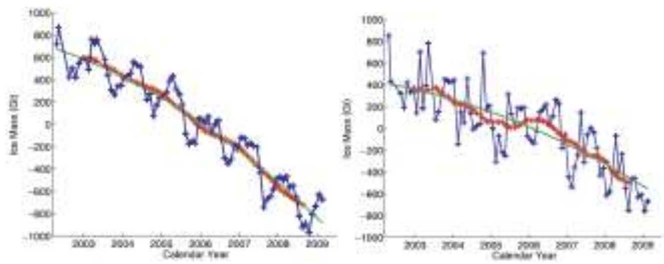


#22 Meltwater runs to a low spot on the ice sheet and burrows a hole, a vertical shaft that goes all the way to the base of the ice sheet. This water lubricates the base of the ice sheet.



#23 Increased meltwater is one of the processes speeding up discharge of giant icebergs to the ocean. The net effect was once uncertain, because global warming also increases the amount of water vapor in the air, so snowfall over the center of the ice sheet is increasing.

Gravity Satellite Ice Sheet Mass Measurements



Greenland Ice Sheet **Antarctic Ice Sheet**

Source: Velicogna, I. *Geophys. Res. Lett.*, **36**, L19503, doi:10.1029/2009GL040222, 2009.

#24 But beginning in 2002 the gravity satellite, GRACE, began making measurements of the Earth's gravitational field with such high precision that we can measure the change of ice sheet mass. The Greenland ice sheet gets heavier in the winter as snowfall piles up and loses mass in the melting season. But overall Greenland is now losing more than 200 cubic kilometers of ice per year. Antarctica is losing more than 100 cubic kilometers per year. The data suggest that the rate of mass loss may be increasing.

Pier on Lake Mead

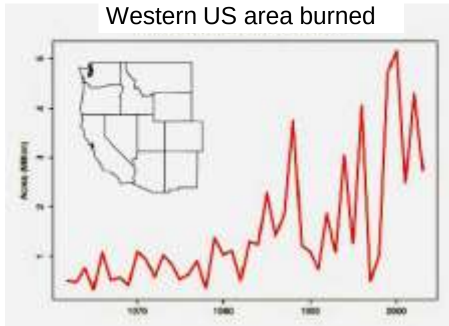
Subtropics are expected to expand with global warming.
Observations show, on average, 4 degrees of latitude expansion.

#25 Another expected effect of global warming is expansion of subtropical dry regions. The overturning circulation, rising air in the tropics with subsidence in the subtropics, which gives rise to the dry subtropics, is expected to expand poleward as the planet warms. Observations show that expansion by four degrees of latitude, averaged over all longitudes, has occurred already.

The expanding subtropics affects the southern United States, the Mediterranean region, and Australia, for example. It is one of the reasons that Lake Mead and Lake Powell are only half full.

Fires Are Increasing World-Wide

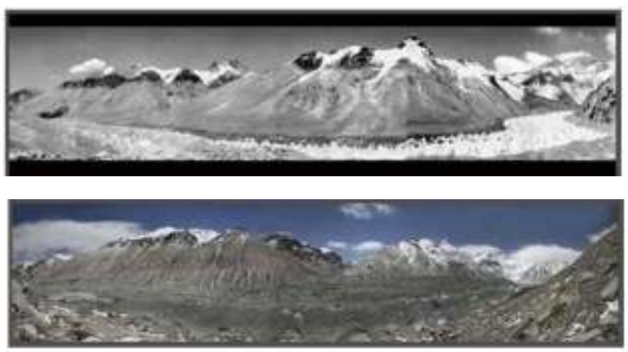
Wildfires in Western US have increased 4-fold in 30 years.



Source: Westerling et al. 2006

#26 The expanding subtropics is also one of the reasons for the increase in fires in the western United States, Greece and Australia. With the changing climate the fires burn hotter, making it more difficult for forests to recover.

Himalayan (Rongbuk) Glacier



Rongbuk, the largest glacier on Mount Everest's northern slopes, in 1968 (top) and 2007.
Glaciers are receding rapidly world-wide, including the Rockies, Andes, Alps, Himalayas.
Glaciers provide freshwater to rivers throughout the dry season and reduce spring flooding.

#27 Another impact of global warming is the world-wide recession of mountain glaciers. Glaciers are receding in the Rocky Mountains, the Andes, the Alps, the Himalayas. Glacier National Park in the United States will need a new name within 25 years, because it will have no glaciers if greenhouse gases continue to increase.

Loss of glaciers has a practical impact, because in the driest months more than half of the water in major rivers, such as the Indus and Brahmaputra, is provided by glacier melt water. Without glaciers, floods from spring snowmelt will be greater and rivers will tend to run dry in the driest months.

Stresses on Coral Reefs

Coral Reef off Fiji

(Photo credit: Kevin Roland)

#28 Coral reefs are the rainforests of the ocean, home to more than a quarter of ocean species. Coral reefs are under stress for several reasons. Two of the most important stresses are the warming waters and ocean acidification. Warming can cause coral bleaching and death as the coral expel their symbiotic algae. The ocean becomes relatively more acid as it takes up carbon dioxide, which is a problem for animals with carbonate shells or skeletons – if the water becomes too acid it can dissolve carbonates.

Assessment of Target CO_2

Phenomenon	Target CO_2 (ppm)
1. Arctic Sea Ice	300-350
2. Ice Sheets/Sea Level	300-350
3. Shifting Climatic Zones	300-350
4. Alpine Water Supplies	300-350
5. Avoid Ocean Acidification	300-350

→ Initial Target CO_2 = 350* ppm

***assumes CH_4, O_3, Black Soot decrease**

#29 Such phenomena help us assess the atmospheric carbon dioxide amount required to maintain life on our planet as we know it. Each of these phenomena, including their responses to current levels of atmospheric CO_2, lead to the conclusion that the target atmospheric CO_2 amount that we must aim for is less than the current amount, which is 389 ppm in 2010.

The best, most quantitative, assessment is the need to restore planetary energy balance. Stabilizing climate, stopping global warming, requires restoration of Earth's energy balance – as long as there is more energy coming in than going out, the planet will keep getting warmer. The present imbalance is at least ½ watt per square meter. A ½ watt increase of thermal emission to space can be achieved by reducing atmospheric CO_2 by 35-40 ppm.

The optimum CO_2 may be somewhat less than 350 ppm, especially if there are future reductions in atmospheric aerosols. However, adjustments of other forcings such as methane and black soot can help balance such effects.

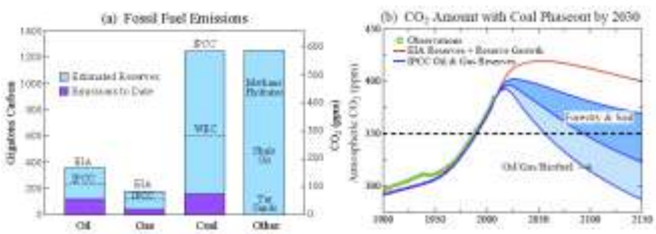
Target CO_2:

< 350 ppm

To preserve creation, the planet on which civilization developed

#30 For policy purposes all we need to know for the foreseeable future is that the CO_2 target must be "<350 ppm", if we wish to preserve creation, the planet on which civilization developed. Bill McKibben and the young people who form the backbone of the organization 350.org have done a remarkable job of publicizing the need for this target. They have succeeded in getting more than 100 nations to agree to this target.

Fossil Fuel Reservoirs & CO_2 Scenarios



Scenarios assume no "Other" = Tar Sands, Oil Shale, Methane Hydrates

Coal phase-out by 2030 → peak CO_2 ~400-425 ppm, depending on oil/gas.

Faster return below 350 ppm requires additional actions

Source: Hansen *et al.*, Target atmospheric CO_2: where should humanity aim? *Open Atmos. Sci. J.*, **2**, 217-231, 2008.

#31 What is the practical implication of the "<350 ppm" target? This chart shows the amount of carbon in fossil fuel reservoirs, dark purple areas being the portion that has already been burned and released into the air. There is a range of estimates for the remaining reserves, which depend in part on whether we will go after "every last drop".

In order to stop growth of atmospheric CO_2 and return to a level below 350 ppm, we must phase out coal emissions rapidly and leave most of the "other" fossil fuels, the unconventional fuels such as tar sands, in the ground. In that case atmospheric CO_2 could peak at a value between 400 and 425 ppm, depending upon how much of the remaining oil and gas we exploit.

If we do not go after every last drop of oil and gas, it will be possible to get CO_2 back below 350 ppm within several decades, provided that we also adopt improved agricultural and forestry practices that cause more CO_2 to be stored in the vegetation and soil.

<350 ppm is Possible, But…

Essential Requirements

1. **Quick Coal Phase-Out Necessary**
   All coal emissions halted in 20 years
2. **No Unconventional Fossil Fuels**
   Tar sands, Oil shale, Methane hydrates
3. **Don't Pursue Last Drops of Oil**
   Polar regions, Deep ocean, Pristine land

#32 So it is possible to achieve the 350 ppm CO_2 target, but there are three essential actions. First, coal emissions need to be phased out rapidly. Second, the unconventional fossil fuels should be left in the ground. Third, we should not pursue every last drop of oil and gas.

In other words, we must move on to the clean energy future now, rather than using all the remaining fossil fuels.

What's Really Happening

1. **Tar Sands Agreement with Canada**
   Pipeline planned to transport oil
2. **New Coal-fired Power Plants**
   Rationalized by 'Clean Coal' mirage
3. **Mountaintop Removal Continues**
   Diminishes wind potential of mountains
4. **Oil & Gas Extraction Expands**
   Arctic, offshore, public lands

#33 But what is really happening? The United States has signed an agreement with Canada for a pipeline to carry tar sands oil to Texas. New coal plants are being built all around the world, some being financed by the World Bank. Environmentally destructive mountaintop removal continues. Oil is pursued in pristine places. The environmentally destructive practice of shale fracturing is being developed and implemented to find the last bits of gas.

Global Action Status

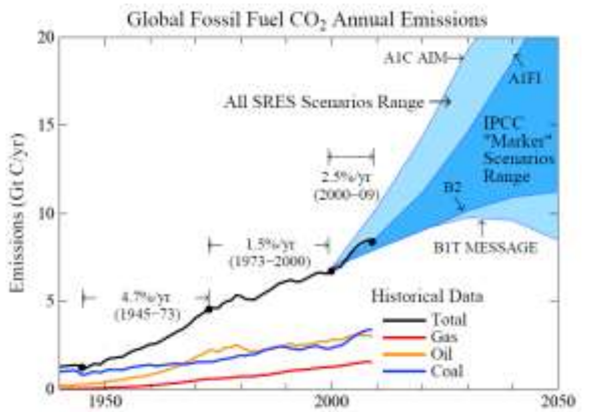
1. Huge Gap: Rhetoric & Reality
- **Rhetoric: Planet in Peril**
- **Policies: Small Perturbation to BAU**

2. Greenwash/Disinformation Winning
- **Appeasement of Fossil Interests**
- **Still Waiting for a Winston Churchill**

3. Kyoto & Copenhagen Failures
- **Kyoto → accelerating emissions**
- **Copenhagen → still "cap-&-trade"**

#34 There is a huge gap between government rhetoric and policy reality. Leaders say that we have a "planet in peril", yet their proposed policies barely differ from business-as-usual.
Greenwash is plentiful, but the leaders follow a path of appeasement of fossil fuel special interests. There is no Winston Churchill willing to stand up and tell the truth about what is needed.

International agreements are jury-rigged to allow continued business-as-usual. For example, the World Bank is allowed to finance new higher efficiency coal plants in developing countries and count these as a "clean development mechanism", which allows dirty plants in developed countries to continue. Total CO_2 emissions actually increase. The science requirement is that the coal be left in the ground, because fossil fuel CO_2 stays in the atmosphere-ocean system for millennia. It does not help to burn it more efficiently.



Global fossil fuel carbon dioxide emissions accelerated after Kyoto Protocol.

Date sources: Marland et al. (U.S. Dept. Energy, Oak Ridge and extended with BP Statistical Review of World Energy.)

#35 CO_2 emissions were increasing 1.5 percent per year prior to the Kyoto Protocol. Subsequently emissions have increased 2.5 percent per year, even with the recent economic downturn.

Problem & Solution

1. Fossil Fuels are Cheapest Energy
- **Subsidized & Do Not Pay Costs**
- **Solution: Rising Price on Carbon**

2. Regulations also Required
- **Efficiency of Vehicles, Buildings,e.g.**
- **Carbon Price Provides Enforcement**

3. Technology Development Needed
- **Driven by Certainty of Carbon Price**
- **Government Role Limited**

#36 Fossil fuel use continues to increase because fossil fuels are the cheapest energy. It is as certain as the law of gravity: as long as fossil fuels are the cheapest energy their use will continue. Fossil fuels are cheapest in part because they are subsidized, but mainly because they are not made to pay their cost to society – caused by their impact on human health, on the environment, and on the future of young people.

The solution is obvious: remove subsidies and put a rising price on carbon – a fee collected domestically from the fossil fuel companies at the mine or port of entry.

Of course efficiency regulations are also needed, as is technology development – but the success of these depends on having a rising carbon price.

Fee & Green Check (Dividend)

1. Fee Applied at First Sale/Port of Entry
Covers all Oil, Gas, Coal → No Leakage

2. Fee Specified: No Speculation, No Volatility
No Wall Street Millionaires at Public Expense

3. Other Merits
Only Potentially Global Approach
Simple, Honest, Can be Implemented Quickly
Market Chooses Technology Winners
Most Efficient & Largest Carbon Reductions

#37 The public will accept a substantial rising carbon fee only if the money is distributed to the public. Put the money in the hands of consumers and let the market place choose technology winners. Those citizens who do not use their resources to reduce their carbon emissions will soon be paying more in increased energy prices than they get in their green check.

A carbon fee or tax is the only viable global approach. It requires mainly that the United States and China agree upon a carbon price. Europe and Japan would surely then consent. Any country not agreeing would have a duty placed on its products made with help of fossil fuels.

Cap-and-Trade Flaws

1. **Designed for Banks & Fossil Interests**
   Impossible to exclude big money
2. **Price Volatility**
   Discourages clean energy investments
3. **Ineffectual**
   Real carbon reductions small
4. **Cannot be made global**
   China/India will not (& should not) accept caps

#38 Cap-and-trade, in contrast, is favored by big banks and fossil fuel interests. In a multi-trillion dollar carbon market it is impossible to avoid bank involvement. Their highly skilled, secretive, trading units would make billions, without providing any added value.

Cap-and-trade is proven to be ineffectual in reducing emissions and it cannot be made global. India and China would never accept caps on their economies, nor should they.

Fee & Green Check Addresses

1. **Economy: Stimulates It**
   Puts Money in Public's Hands– A Lot!
2. **Energy: Fossil Fuel Addiction**
   Stimulates Innovation – Fastest Route to Clean Energy Future
3. **Climate**
   Only Internationally Viable Approach - - Zero Chance of China/India Accepting a Cap
   Would Result in Most Coal & Unconventional Fossil Fuels, and some Oil, left in the Ground

#39 Fee-and-green-check puts money in the public's hands, a lot of money, stimulating the economy and stimulating innovation. It is the fastest route to a clean energy future. It would quickly bring mountaintop removal and tar sands development to an end – it may be the only way to do that, surely the least painful way.

Lauren Emma (age 2½ days) and Jake (age 2½ years)

<u>#40</u> Back to the basic issue: stabilizing climate is a matter of intergenerational justice. Jake, my son's first child, recently was excited to have a baby sister, who was 2½ days old in this photo. My parents lived about 90 years, so Jake and Lauren Emma are likely to be around most of this century and feel the full force of climate change.

Lauren Emma (age 2½ days) and Jake (age 2½ years)

<u>#41</u> Jake likes to protect his baby sister, even though she is sometimes a nuisance. Jake is a gentle giant, for his age. If you believe long extrapolations, the charts suggest that he may be almost 2 meters tall eventually. But here is the problem: protecting Lauren Emma may be out of Jake's control, no matter how big and strong he is.

Today we have pushed the planet close to tipping points. Ice is melting in the Arctic, on Greenland and Antarctica, and on mountain glaciers worldwide. Many species are stressed by environmental destruction and climate change. If fossil fuel emissions continue unabated, sea level rise and species extinction will accelerate out of humanity's control. Increasing temperature and atmospheric water vapor will magnify climate extremes, both droughts and floods, and the storms of our grandchildren will be much more devastating.

Intergenerational Justice

Jefferson to Madison: …self-evident that "Earth belongs in usufruct to the living"*

Native People: obligation to 7th generation

Most Religions: duty to preserve creation

Governments (with fossil interests): we set emissions at whatever level we choose

Public: when will it become involved?

*Legal right to use something belonging to another

#42 Such intergenerational injustice is foreign to all nations, cultures and religions. Yet we are saddled with governments who do nothing effective. They think they can set emissions at whatever level they choose, and they choose it with the help of the fossil fuel industry.

This situation is likely to continue until the public demands that governments do their job. But prospects for pressure from the public have been diminished by an effective campaign to discredit science by those who prefer business-as-usual.

Notes of Optimism

1. China

Enormous investments in carbon-free energy (solar, wind, nuclear power)

2. Legal Approach

Judicial branch less influenced by fossil fuel money (than executive and legislative branchs)

#43 Yet I see two reasons for some optimism. First, China seems capable of making rational decisions and taking action. China has several incentives to move as rapidly as practical into clean energies: (1) their high levels of local air and water pollution, (2) the fact that they will suffer more from global warming than most nations, and (3) the economic advantage that they can gain by being out front in clean energy technologies. Indeed, China is aggressively investing in clean energy technologies.

Will this action by China stimulate the United States and other nations to get moving? Maybe. But, because of the undue influence of money in Washington and other capitals, I believe it is essential to involve the judicial branch of governments. As in the case of civil rights, achievement of justice probably requires people standing up for their rights and courts enforcing them.

Atmospheric Trust Litigation*

1. **Atmosphere is a public trust asset**

   Governments have fiduciary obligation to manage asset – it is not political discretion

2. **Courts can enforce via injunction**

   Require carbon accounting, with schedule specified by science

3. **Force governments at all levels**

* Wood, M., Atmospheric Trust Litigation, in *Adjudicating Climate Change: Sub-National, National, and Supra-National Approaches* (William C.G. Burns & Hari M. Osofsky, eds.) (2009, Cambridge University Press

#44 Legal scholars point out that governments have a fiduciary responsibility to manage the atmospheric trust. The executive and legislative branches of our governments are turning a deaf ear to the science, but the courts have the ability to require the government to make emission reductions that the science shows to be necessary. Stabilizing climate is a matter of intergenerational justice that can be enforced.

Young people, and older people who support them, must unite in demanding an effective approach that preserves our planet. I look forward to working with young people and their supporters in developing the scientific and legal case for young people and the planet.

To the young people I say: Stand up for your rights. Demand that the government take the actions needed to assure a future for you and your children. To the old people I say: we are not too old to fight. Let us gird up our loins and prepare to fight on the side of young people for protection of the world that they will inherit.