WHAT IS HAPPENING TO OUR WORLD AND WHY DOES IT MATTER?

KATHARINE HAYHOE
America’s first climate refugees: ALASKA
Frozen ground is melting & eroding

The people of Newtok, AK have already been driven from their homes.

Kivalina may be next.
What is happening to our world?
Doubt regarding the seriousness of global warming is at an all-time high.

Thinking about what is said in the news, in your view is the seriousness of global warming -- [generally exaggerated, generally correct, or is it generally underestimated]?

- % Exaggerated
- % Correct/Underestimated

GALLUP POLL
The Earth is getting warmer ... 

9 of last 10 years warmest on record 
2000s: warmest decade on record
… despite recent claims of “cooling”
It's happening faster and faster

Temperature relative to the 1961-1990 average (°F)

150 yrs
It’s happening faster and faster

Temperature relative to the 1961-1990 average (°F)

150 yrs  100 yrs
It’s happening faster and faster

Temperature relative to the 1961-1990 average (°F)

150 yrs 100 yrs 50 yrs
It’s happening faster and faster

Temperature relative to the 1961-1990 average (°F)

150 yrs  100 yrs  50 yrs  25 yrs
And this is just a fraction of total heating.
Temperature in the US is increasing
Glaciers are melting

Shepard Glacier, Glacier National Park, USA

When the park was created: over 150 glaciers
In 2005: 27 glaciers remaining
Glaciers are melting

The Rhone glacier in the Bernese Oberland, Switzerland
Arctic sea ice is shrinking

- Summer sea ice extent decreased 15-20% over last 40 yrs
- Ice-free summers likely common within 3 decades
Sea level is rising, as ice sheets melt.
Snow is melting earlier in the year
Extreme rainfall becoming more frequent

Increases in average number of days with very heavy precipitation (1958 to 2007)
Ecosystems shifting, as temperatures warm

Where you live today feels like it used to ~200 miles south, just 25 years ago.
Marine species are moving poleward

Each bar represents a family of species
EARLIER SPRING
Lilacs, honeysuckle, and other harbingers of spring are flowering 1-2 weeks earlier in the year.
Our world is changing

SHIFTING CROPS AND PLANTS
Center of blueberry production has shifted northward, from Maine to Quebec.
Our world is changing

EXTREME HEAT
Record high temperatures and heat waves 2x more frequent.
Our world is changing

DROUGHT
Crop losses of $5B per year since 1980s.
Our world is changing

PESTS MOVING NORTH
Less cold days to keep red ants & kudzu at bay
Our world is changing

Responses to warming temperatures seen in more than 25,000 physical and biological systems around the world.
Why is this happening?
Conditions today are unusual in the context of the last 2,000 years …
... the last 6,000 years,
... and even the last 800,000 years.
Changes in the sun can’t explain it
WEATHER: How conditions change from day to day, or even year to year -> unpredictable!
WEATHER: How conditions change from day to day, or even year to year -> unpredictable!

CLIMATE: The long-term average of weather over decades -> very predictable!
There is only one explanation that fits

THE NATURAL GREENHOUSE EFFECT
naturally increases Earth’s temperature by 70°F

THE ENHANCED GREENHOUSE EFFECT
has artificially increased Earth’s temperature by 1.4°F
We produce heat-trapping gases
From our factories, cars, homes, farms
The US is responsible for 30% of past emissions.

Last year, annual emissions from China caught up with those from the US.
How do we know it’s us?
Quantifying the human influence

“Earth with no people”

observations

models
Quantifying the human influence

“Earth with people”

observations

models
Humans are the only explanation.
How will climate change affect us in the future?
What can we expect in the future?

We’re already concerned about this
What can we expect in the future?

But this is what’s coming next.
Future change depends on our choices now.
Summer (JJA) temperature change

Mid-High Emissions

2010-2039

Lower Emissions

2010-2039
Summer (JJA) temperature change

Mid-High Emissions

2010-2039

2040-2069

Lower Emissions

2010-2039

2040-2069
Summer (JJA) temperature change

Mid-High Emissions

2010-2039
2040-2069
2070-2099

Lower Emissions

2010-2039
2040-2069
2070-2099
What does this mean ... for Massachusetts?

Hot and sticky summers:
MD under lower emissions
SC under higher emissions
What does this mean ... for Chicago?

Summers: hot and humid

Winters: warmer, but just as much snow
Days per year over 100°F

1961-1979

Number of Days

- <10
- 20
- 30
- 45
- 60
- 75
- 90
- 105
- >120

Map showing days per year over 100°F for the United States from 1961 to 1979.
Days per year over 100°F

+ 2°C global T
Days per year over 100°F

+ 3.5°C global T

Number of Days

<10  20  30  45  60  75  90  105  >120
What does this mean for ... our health?

![Bar graph showing the number of heat-related deaths per year from ~1975 to ~2085. The graph includes observed data and scenarios with lower and higher emissions.](image)

- **Observed**
- **Lower emission scenario**
- **Higher emission scenario**

* Deaths per 6 million people (Current population of the Chicago Metropolitan Area)
GREAT LAKES

Levels depend on balance between precipitation and evaporation

Warmer temperatures increase evaporation

... for our lakes?

![Graph showing change in lake level over time for different Great Lakes.](chart.png)
... for our water resources?

Percentage change in March-April-May precipitation for 2080-2099 compared to 1961-1979.
... for our energy?
... for our energy?
Half of California’s water comes from mountain snow.

70-90% of that could be gone before the end of the century.
... for snow cover in the Northeast?
… for winter tourism?
Salmon can be found where average air temperature is less than about 70°F (shown in blue).
... for frozen ground in the Arctic?

Seward Peninsula, under moderate warming
... for ecosystems in the eastern US?
... for our agriculture?
Area that would be underwater with a 3 foot sea level rise.
… for our cities?

Landmarks
A. West Side Highway
B. Battery Park
C. Brooklyn-Battery Tunnel
D. South Ferry Subway Station
E. Ferry Terminals
F. Franklin D. Roosevelt Drive
G. Wall Street
H. South Street Seaport

NEW YORK CITY
and even entire nations?

Tuvalu, South Pacific
Climate change will alter the character of every region in the U.S.
In 2000: 150,000 deaths per year
In 2009: 300,000 deaths per year
300 million already at risk from climate change
What can we do about it?
What if I think climate change is a crock?

By reducing our reliance on coal, gas, and oil, and looking to clean, renewable sources for our energy, we would:

- Clean up our air and water
- Reduce our dependence on foreign oil
- Invest in our own economy and our people
- Preserve our limited natural resources for future generations
We have 3 choices:

“We basically have three choices: mitigation, adaptation, and suffering. We’re going to do some of each. The question is what the mix is going to be. The more mitigation we do, the less adaptation will be required and the less suffering there will be.”

John Holdren
President’s Science Advisor; Harvard University
Resource 1

Global Climate Change Impacts in the United States

What climate change means for the places we care about …

PDF & educational materials free online at:

www.globalchange.gov/usimpacts
Resource 2

A Climate for Change

Global Warming Facts for Faith-Based Decisions

Why climate change is happening, and how it is affecting our world …

Free online e-book at:
www.katharinehayhoe.com
Grade 10 Climate Change Unit

Nelson Education

Basic climate science for high school students

Free online ebook available at:

www.nelson.com/scienceperspectives/10/uniflip2/unitD/
Solar activity & climate: is the sun causing global warming?

The skeptic argument...

"Over the past few hundred years, there has been a steady increase in the numbers of sunspots, at the time when the Earth has been getting warmer. The data suggests solar activity is influencing the global climate causing the world to get warmer." (BBC)

What the science says...

In the last 35 years of global warming, the sun has shown a slight cooling trend. Sun and climate have been going in opposite directions.
2. Prepare for what we can’t avoid

Conserve the resources we have

Protect ourselves from what we can
3. Reduce our own impact

stop using this

start using this

Each US household replacing 1 light bulb = taking 1,000,000 cars off the road (+$30 savings per bulb)
4. Support fundamental change

Renewable energy gives us clean air and water, and home-grown energy sources that will never run out. So, why not?
Change is happening

1992 UN Framework Convention on Climate Change
167 nations agree to reduce heat-trapping gas emissions, to prevent dangerous human interference with climate system.
Change is possible.
THE END

FOR MORE INFORMATION

WWW.KATHARINEHAYHOE.COM
WWW.GLOBALCHANGE.GOV/USIMPACTS
Maybe it’s just the urban heat island effect.

Where people live

Where it’s warming fastest
Aren’t scientists always disagreeing?

Warming of the climate system is now evident from observations. Most of the increase is very likely (>90%) due to the observed increase in heat-trapping gas concentrations due to human activities [including burning fossil fuels].

Climatic change is being brought about by human-induced increases in the concentration of atmospheric carbon dioxide, primarily through the processes of combustion [burning] of fossil fuels.
Warming of the climate system is now evident from observations. Most of the increase is very likely (>90%) due to the observed increase in heat-trapping gas concentrations due to human activities [including burning fossil fuels].

The United Nations Intergovernmental Panel on Climate Change, 2007

Climatic change is being brought about by human-induced increases in the concentration of atmospheric carbon dioxide, primarily through the processes of combustion [burning] of fossil fuels.

“The Artificial Production of Carbon Dioxide and Its Influence on Temperature”

Guy Callendar, 1938
Didn’t those stolen emails disprove it?

- Everything discussed in the stolen emails had been published in the scientific literature for years
- 3 independent records of global temperature from NASA, NOAA, and Japan show same warming trends
- 26,000 physical and biological systems reflect same warming trends

BOTTOM LINE: A few personal emails have no impact on overall understanding that human activity is driving dangerous levels of global warming.
“Natural” thermometer records