Climate Change: From Global to New York Scale

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HELP CLOSE THE CONSENSUS GAP

THE PUBLIC PERCEPTION

45%
THINK THERE IS SCIENTIFIC AGREEMENT ON GLOBAL WARMING

THE SCIENTIFIC AGREEMENT

97%
OF CLIMATE SCIENTISTS ACTUALLY AGREE ON GLOBAL WARMING

When people don’t realize there’s a scientific consensus, they’re less likely to support climate action. This underscores the importance of closing the consensus gap.

TheConsensusProject.com
Isaac Cordal sculpture depicting politicians discussing global warming
Understanding Climate Change
Greenhouse Effect 101

Glass panes allow shortwave radiation to pass

Longwave radiation is trapped
Greenhouse Effect 101

The Greenhouse Effect

Some sunlight that hits the earth is reflected. Some becomes heat.

CO₂ and other gases in the atmosphere trap heat, keeping the earth warm.
Greenhouse Effect 101

In the absence of greenhouse gases, Earth’s average temperature would be: 

-18°C!!!
Greenhouse Effect 101

In the absence of greenhouse gases Earth’s average temperature would be:

\[ \sim 0^\circ F !!! \]
Jean Baptiste Joseph Fourier
1827: Recognized warming effect of greenhouse gases
John Tyndall
1864: Measures IR absorption by CO2
Svante Arrhenius

1896: Doubling of CO2 will warm Earth’s surface by 4°C
Charles Keeling
1957: starts atmospheric CO2 measurements on Mauna Loa
The Carbon Cycle

Atmospheric CO$_2$ at Mauna Loa Observatory

Scripps Institution of Oceanography
NOAA Earth System Research Laboratory

PARTS PER MILLION
320 340 360 380 400

YEAR

NOAA Earth System Research Lab
Detection of our increasing carbon emissions – one of the most important scientific breakthroughs of the past 150 years
Aren’t these variations in CO2 and Temperature just part of a natural cycle?
Carbon Dioxide Concentrations

- 2100 High emission scenario
- 2100 Low emission scenario

2017: 405 ppm
What was climate like in the past and how will climate change in the future?

Proxy Reconstructions
- Esper et al. [2002]
- Mann and Jones [2003]
- Moberg et al. [2005]
- Hegerl et al. [2006]

Borehole Temperatures
- Huang et al. [2000]

Borehole + Surface Air Temperature Observations
- Harris and Chapman [2001]

IPCC Projections
- A2
- A1B
- B1
- C3

Glacier Lengths
- Oerlemans [2005]

Temperature Anomaly (°C)

Year

1000 1200 1400 1600 1800 2000

1.1 °C

Instrumental Record

Chapman & Davis, 2010
Temperature anomalies

Source: NASA GISS
The year 2016 – warmest year on record

GISTEMP Annual Mean 2016
Baseline 1951-1980

2016:
0.99°C / 1.8°F above 1951-80 average

Warmest year of NASA GISTEMP record

February 1985 was the last time globally averaged temperature fell below the 20th century average for a given month. So if you are younger than 32 yrs…

NOAA/NASA Global Analysis, Jan. 2017
Are there serious impacts associated with global warming?
Many components of the climate system that would be expected to change in a warming world exhibit trends consistent with warming.
Arctic sea-ice is declining rapidly
We are losing sea-ice equivalent to twice the size of Alaska (12%) every decade.

http://nsidc.org/arcticseaicenews/
Greenland mass balance from GRACE

Mean mass loss in Greenland 2003-2014: 265 Gt / yr

Loss is accelerating:

Record mass loss in summer (JJA) of 2012: 627 Gt

Blue symbols denote April values for reference

State of Climate in 2015, BAMS, Supplement 97(8), 2016
Observations of glacier retreat

Glacier Espejo, Pico Bolivar (5002 m) Venezuela

< 2 km$^2$ of ice left in Venezuela

1910  1988  2008
How much has sea level gone up in the 20th century?

Current global sea level rise: 3.5 mm/yr

Total change over this period: ~7.9 inches
Observed Changes in the US and North East
Observed Sea Level Rise in New York City
Observed U.S. Temperature Change

1991-2011 minus 1901-1960

US National Climate Change Assessment (2013)
“New York is on the move”

Yellow: path under low emission scenario

Red: path under high emission scenario

→ late this century residents in New York might experience a summer climate similar to today's summer climate in Georgia

US Global Change Research Program, 2009
Drying the Southwest

Weather systems that bring rain are becoming more rare

Percent change in precipitation per decade (1980-2010)

Extreme precipitation events have increased in the northeast

% change in heavy precipitation events 1958 - 2012

Flooding and Hurricane Irene
Losses due to Extreme Weather

- Global losses due to increasing frequency and intensity of extreme weather events have been increasing with time.
  - Part of this increase likely due to climate change, but how much is uncertain.
  - Part of this increase is due to increasing population (i.e., more people in harms way).

*Insured losses (billions of $) due to extreme weather events (green, blue, and orange bars). Source: Munich RE.*
And then this happened in 2017...

Record rains and flooding in N. California damaged the Oroville Dam.

A massive hailstorm struck the Denver metro area and was the costliest hailstorm ever to hit Colorado.
And then this happened in 2017...

Hurricane Harvey produced record amounts of rainfall and inundated SW Texas.

Hurricane Irma was the second most intense hurricane ever observed in the N Atlantic Ocean.

Hurricane Maria devastated all of Puerto Rico.
And then this happened in 2017...

Severe drought affected Montana, N Dakota, and S Dakota.

The Tubbs Fire, driven by high winds and dry conditions, burnt down many houses in Santa Rosa, CA.
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Rainfall Forecast for Sunday in the North East!
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4-6 Inches!!!
Number of days when $T_{\text{max}} > 100^\circ \text{ F}$

Recent Past, 1961-1979

Lower Emissions Scenario$^91$, 2080-2099

Higher Emissions Scenario$^91$, 2080-2099

US Global Change Research Program [2014]
1-20yr events now are projected to become more likely by the end of the 21st Century. In NE: Low-emissions: \(\sim 2 \times\) more likely, High-emissions: \(\sim 4 \times\) more likely.
The Climate Change Challenge

‘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,
Former President, American Association for the Advancement of Science
now Director of the White House Office of Science and Technology Policy (OSTP)
The US commitment to reduce greenhouse gases (COP 21 in Paris)

All major economies were asked to submit post-2020 emission reduction targets to UN by April 2015:

**USA:** cut emissions by 26-28% below 2005 levels by 2025 (~4% below 1990 levels)

**Canada:** cut emissions by 30% below 2005 levels by 2030

**EU:** cut emissions by 40% below 1990 levels by 2030

**Switzerland:** cut emissions by 20% below 1990 levels by 2020

**Australia:** cut emissions by 5% below 2000 levels by 2020

**China:** peak emissions by 2030

**India:** reduce GDP-based emission intensity by 33-35% below 2005 levels
THANK YOU
EXTRA SLIDES
Climate Change policies (from Rio to Kyoto and Paris)
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How do we know humans caused the observed warming?
Models with both natural and anthropogenic forcings can reproduce the observed global temperature changes.
A climate model including only natural forcings (solar + volcanic aerosol) does not explain the temporal change in global mean temperature.
- 126 Sites
- Spaced ~19 miles apart
- Reports every 5 minutes