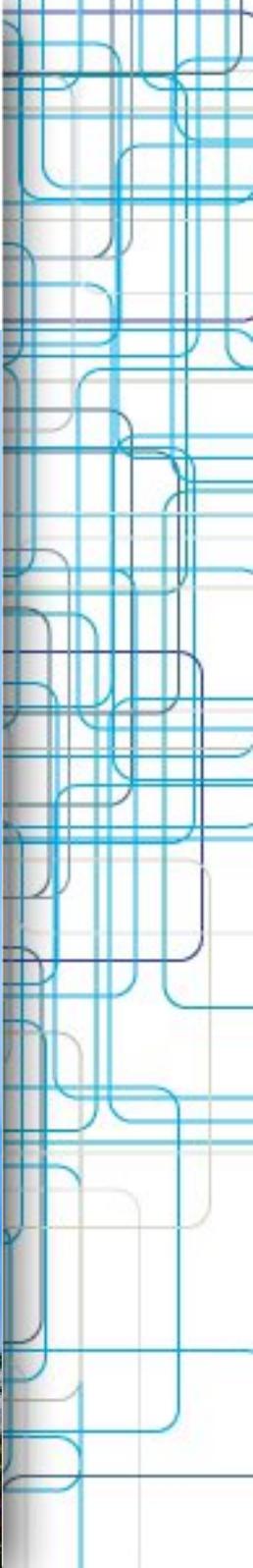


# Introduction To Climate Change

An overview of the environmental challenges we face and how we can work together to be a truly sustainable, global society.



# Lesson 1 Agenda

## Introduction To Climate Change

### Introduction

Overview: Speaker and Students  
Defining Important Terms  
Addressing Skepticism  
Scenarios

### Global Climate Challenges

Effects of *Global Warming*  
*Climate Change* and *Pollution*

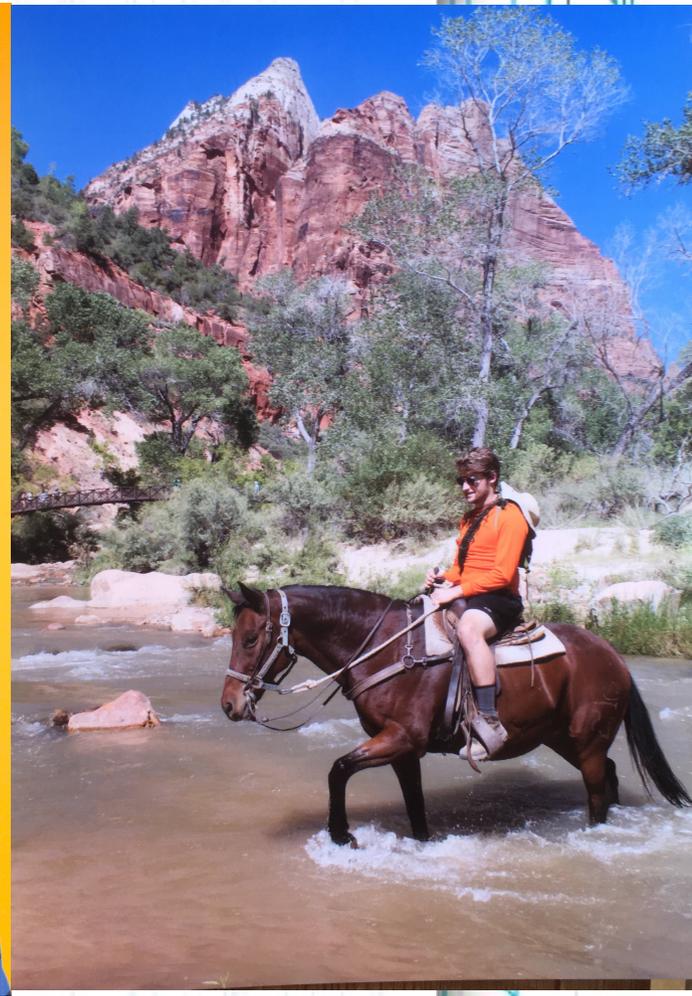
### Q&A Intermission

### Introduction to Sustainability

Solutions to *Climate Change*  
Celebrate The Good!

# About the Presenter

Joshua Kruer, founder of Nature Was Here

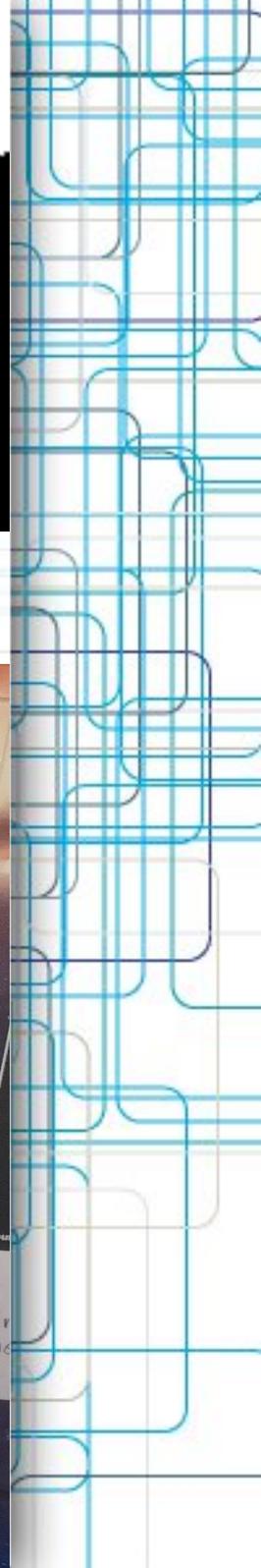
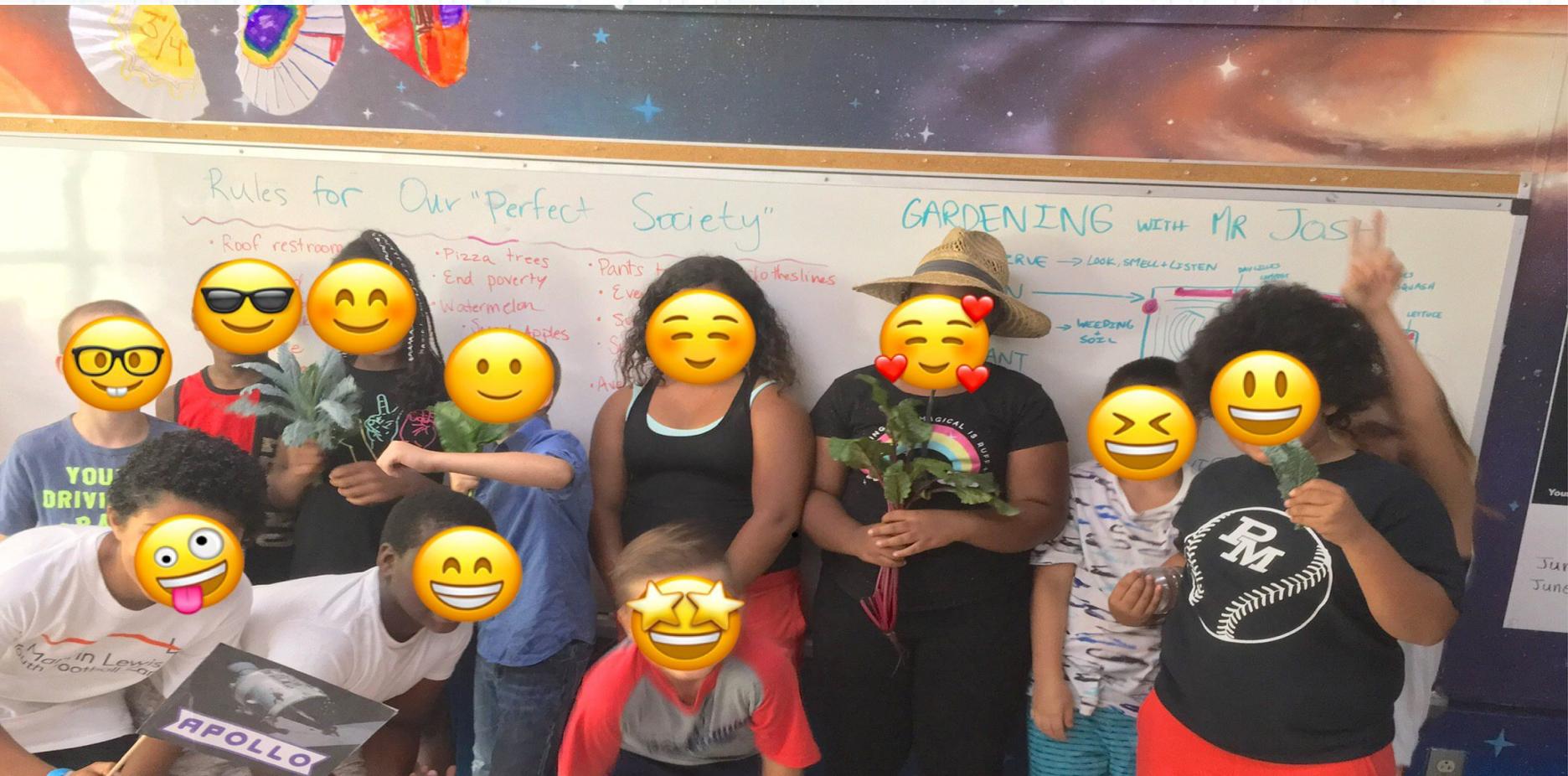




# NATURE - WAS - HERE

Environmental Education - Media - Social Permaculture [NatureWasHere.com](http://NatureWasHere.com)

## Environmental Education (Elementary + High School)

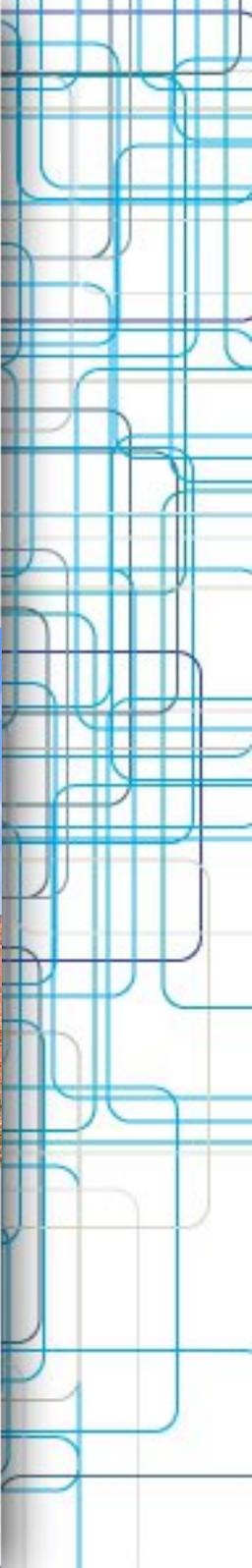




# NATURE - WAS - HERE

Environmental Education - Media - Social Permaculture [NatureWasHere.com](http://NatureWasHere.com)

Media (Music, Poetry, Art/Photography)

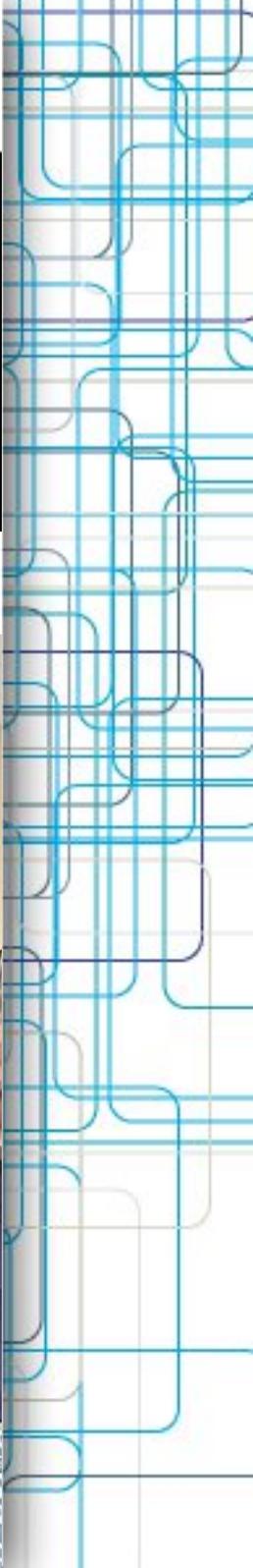




# NATURE - WAS - HERE

Environmental Education - Media - Social Permaculture [NatureWasHere.com](http://NatureWasHere.com)

**Social Permaculture** (Workshops, Potlucks and Public Speaking)



# What Is Climate Change?

- Climate Change** is any significant change to climate which includes seasonal weather patterns
- Climate Change is caused by **Global Warming**, which is the overall rise in global temperatures
- Global Warming is caused by **Greenhouse Gas** emissions, which trap heat in the atmosphere
- the primary sources of Greenhouse Gases are *Carbon Dioxide* from **Fossil Fuels** (coal, oil, etc), as well as *Methane* from cows in Industrial Farms and *Freon* used in Refrigeration and Air Conditioning

**Questions?**

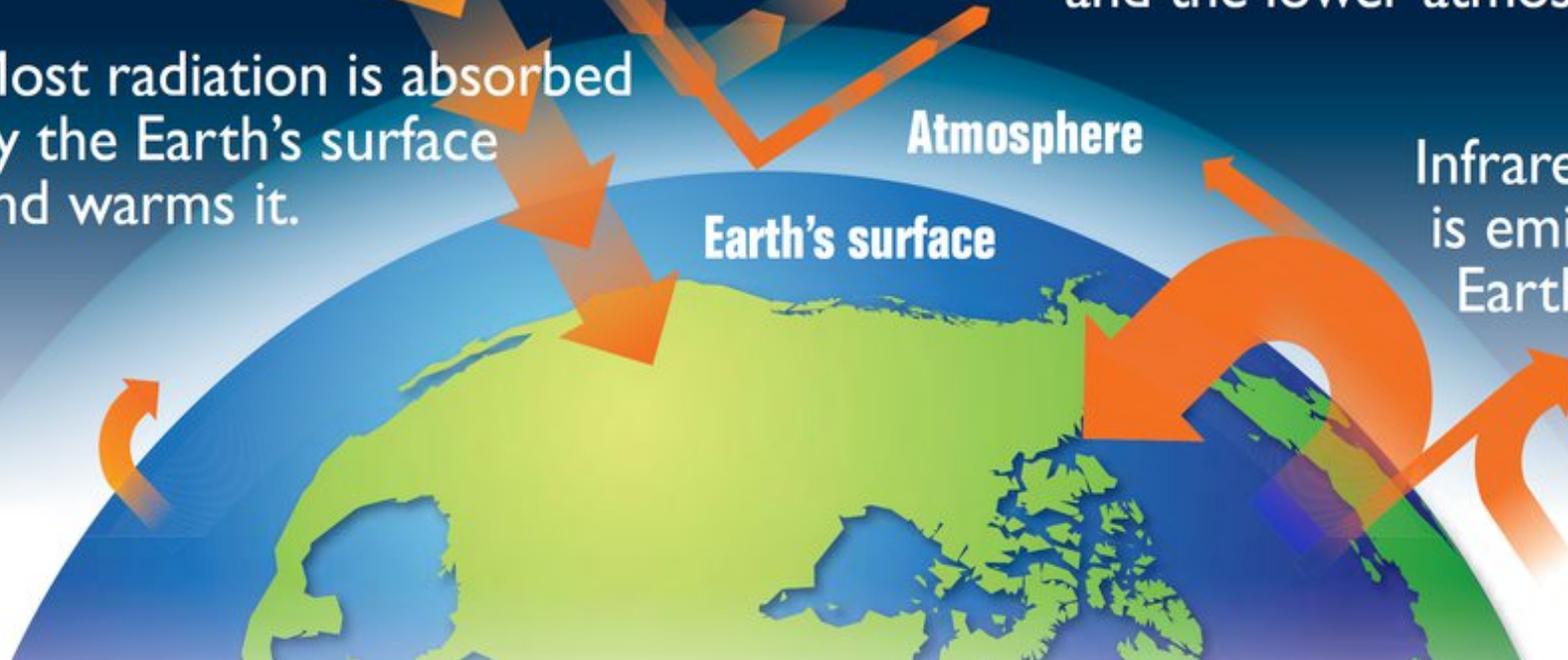
# The Greenhouse Effect

Some solar radiation is reflected by the Earth and the atmosphere.

Some of the infrared radiation passes through the atmosphere. Some is absorbed and re-emitted in all directions by greenhouse gas molecules. The effect of this is to warm the Earth's surface and the lower atmosphere.

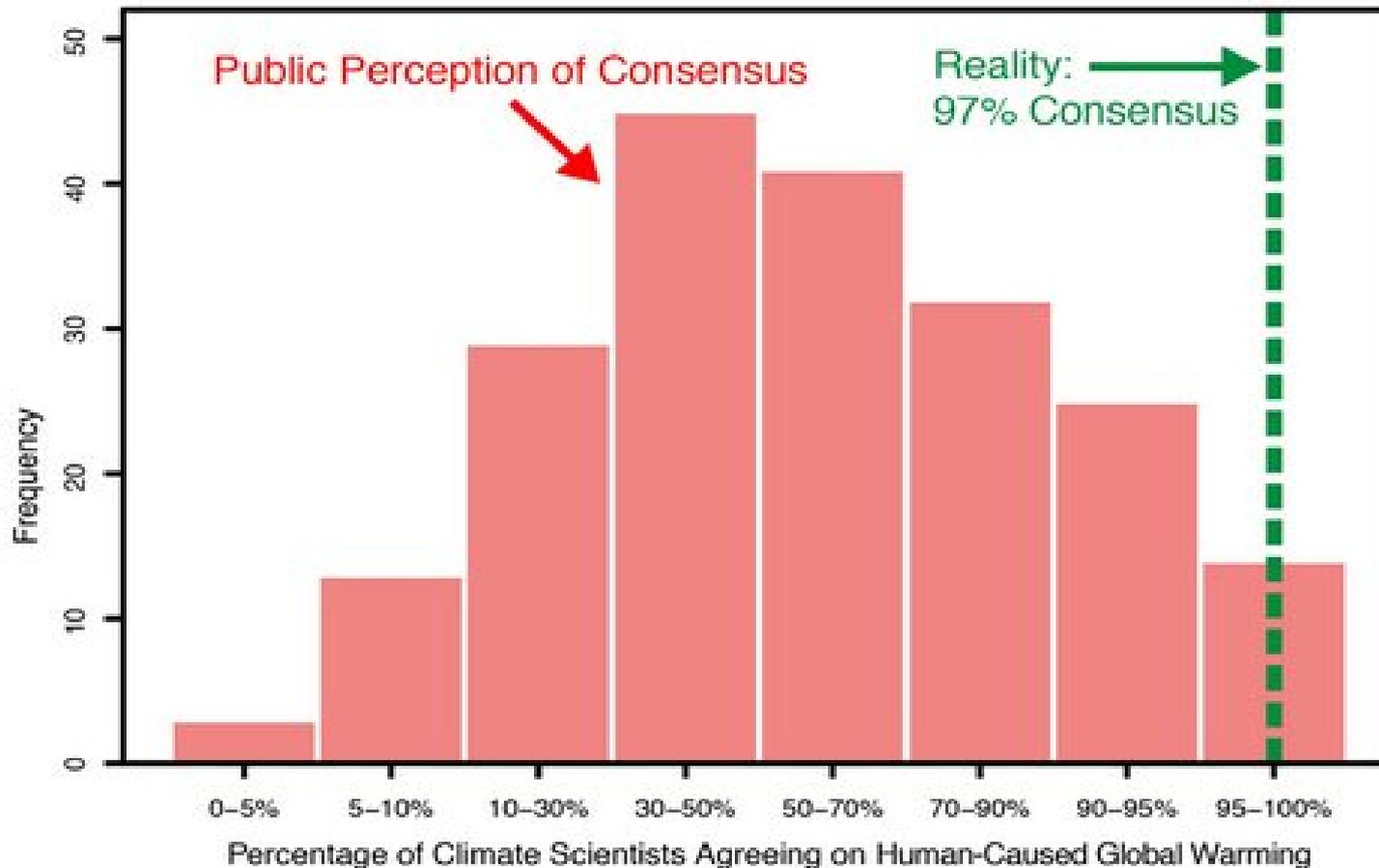
Most radiation is absorbed by the Earth's surface and warms it.

Infrared radiation is emitted by the Earth's surface.



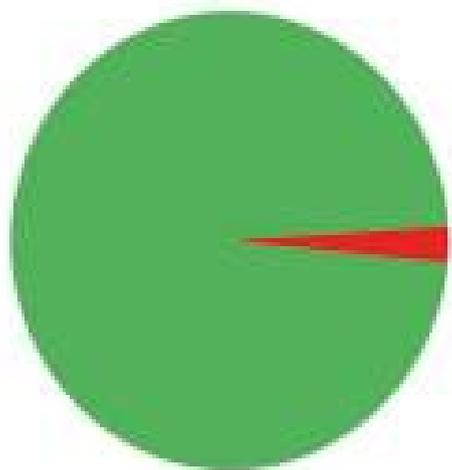
# Public Skepticism

## Misinformation and Propaganda



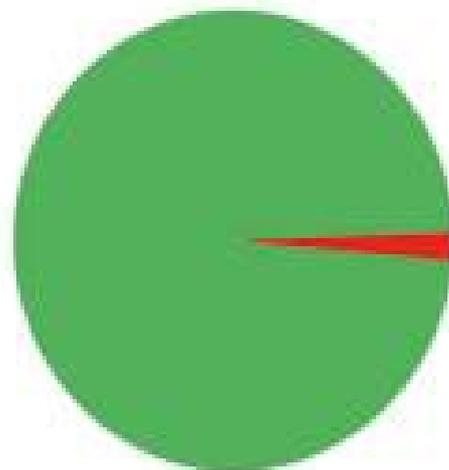
Such false balance has long been the goal of a dedicated misinformation campaign waged by the fossil fuel industry. Just as **one example**, in 1991 Western Fuels Association conducted a \$510,000 campaign whose primary goal was to "*reposition global warming as theory (not fact).*" These vested interests have exploited the media desire to appear "balanced."

# The Scientific Consensus on Climate Change



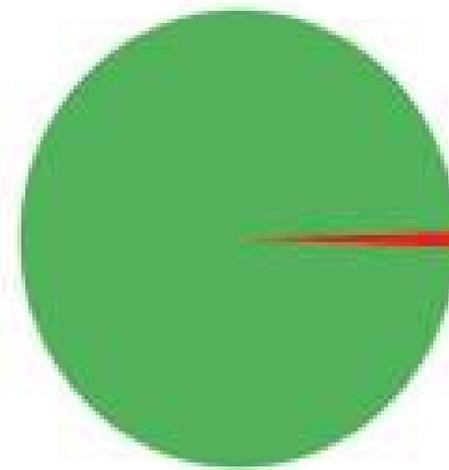
**97%**

Doran and  
Zimmerman 2009  
79 scientists



**97.5%**

Anderegg et al 2010  
908 scientists



**98.5%**

Cook et al 2013  
10,306 scientists

# The Rodney & Otamatea Times

WAITEMATA & KAIPARA GAZETTE.

PRICE—10s per annum in advance

WARKWORTH, WEDNESDAY, AUGUST 14, 1912.

3d. per Copy.

## Science Notes and News.

### COAL CONSUMPTION AFFECT- ING CLIMATE.

The furnaces of the world are now burning about 2,000,000,000 tons of coal a year. When this is burned, uniting with oxygen, it adds about 7,000,000,000 tons of carbon dioxide to the atmosphere yearly. This tends to make the air a more effective blanket for the earth and to raise its temperature. The effect may be considerable in a few centuries.

## The History of Climate Predictions

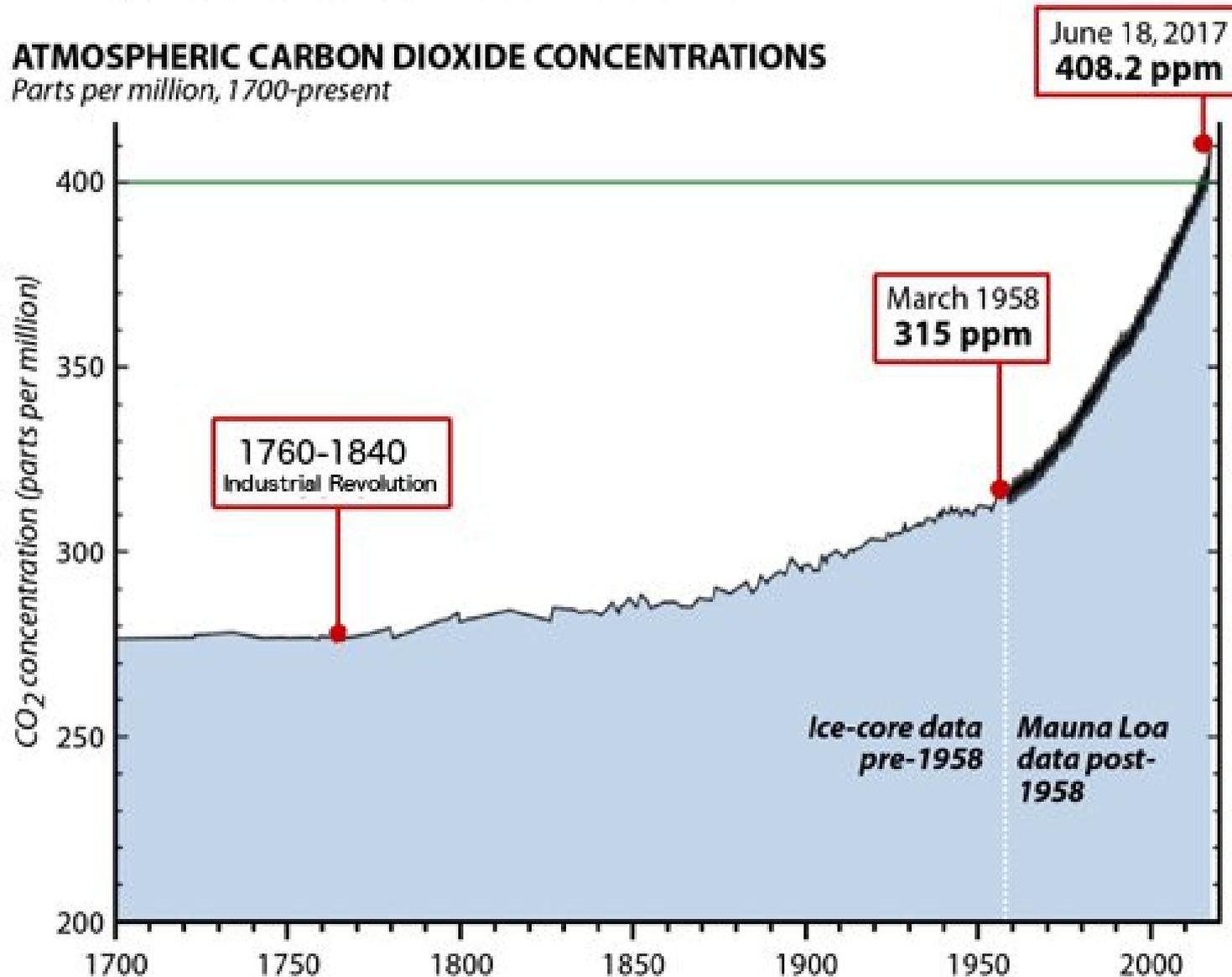
Newspaper article  
from 1912 accurately  
forecasts the  
consequences of  
adding Carbon to the  
atmosphere.

# CO<sub>2</sub> Levels Are Rising

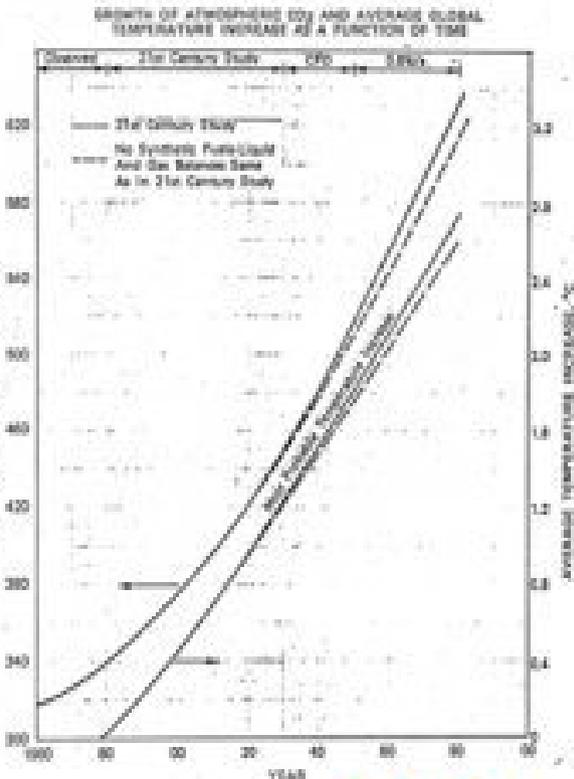
Carbon dioxide concentrations in the atmosphere have been rising since the Industrial Revolution. The chart shows evidence from ice cores before 1958 and daily measurements taken in Hawaii after 1958.

## ATMOSPHERIC CARBON DIOXIDE CONCENTRATIONS

Parts per million, 1700-present



# Climate Predictions From An Unlikely Source...



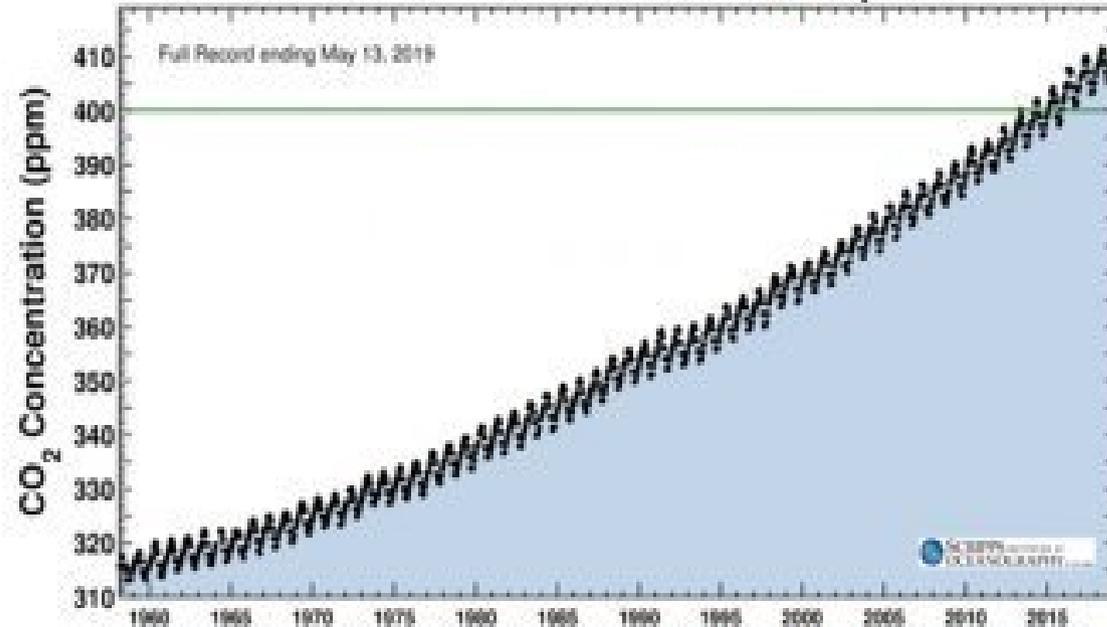
**EXXON: 1982**

Latest CO<sub>2</sub> reading

May 13, 2019

**415.50 ppm**

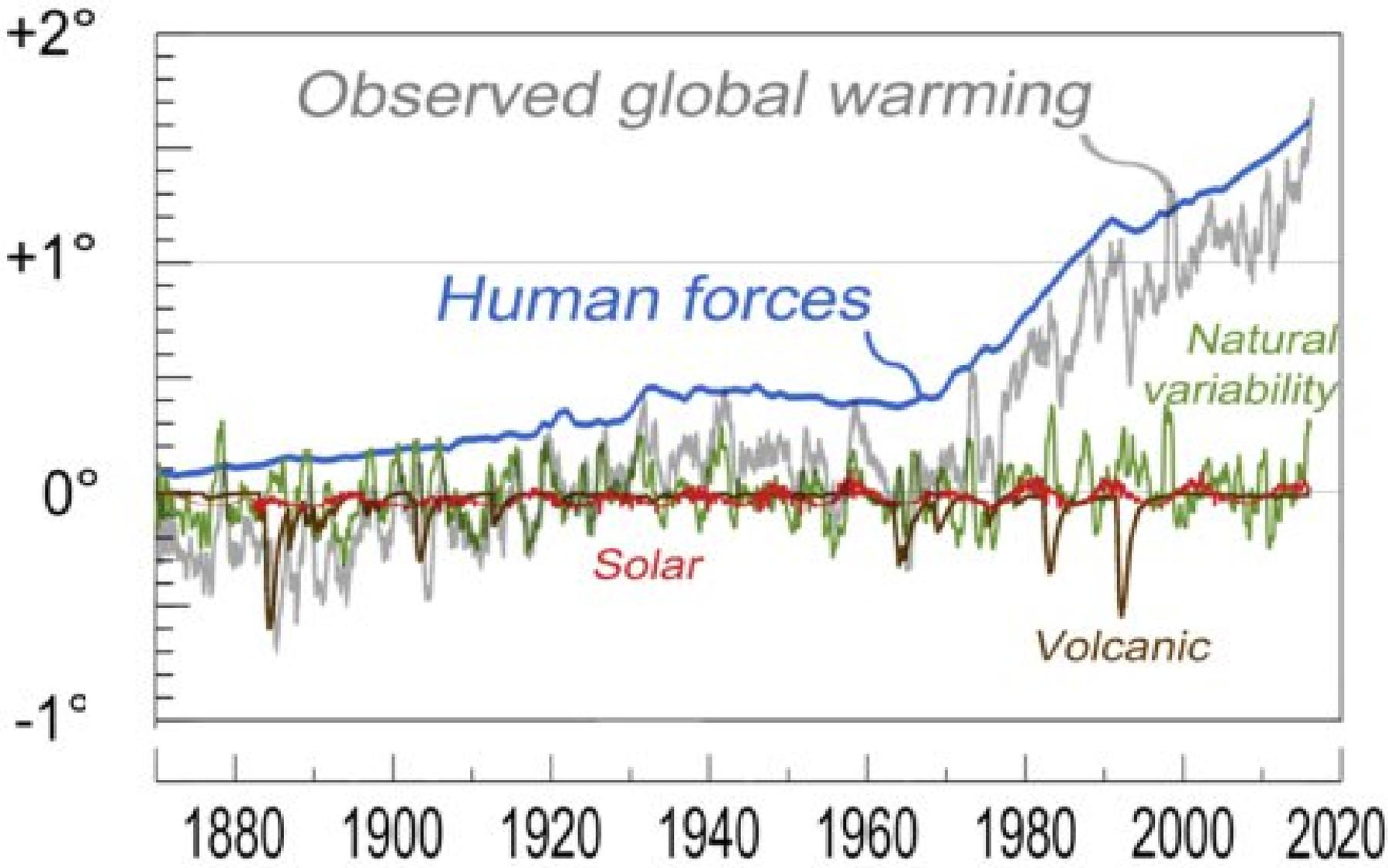
Carbon dioxide concentration at Mauna Loa Observatory



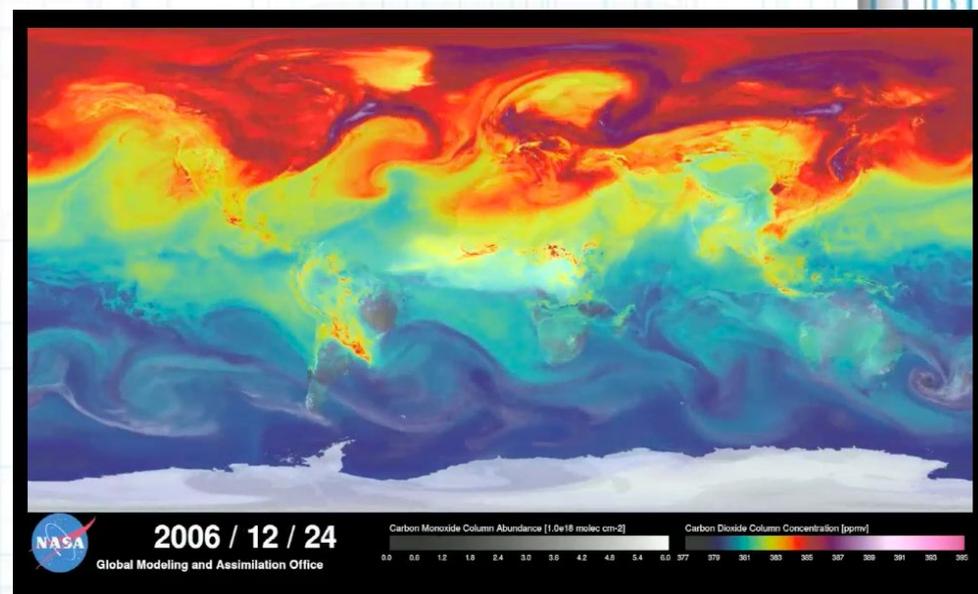
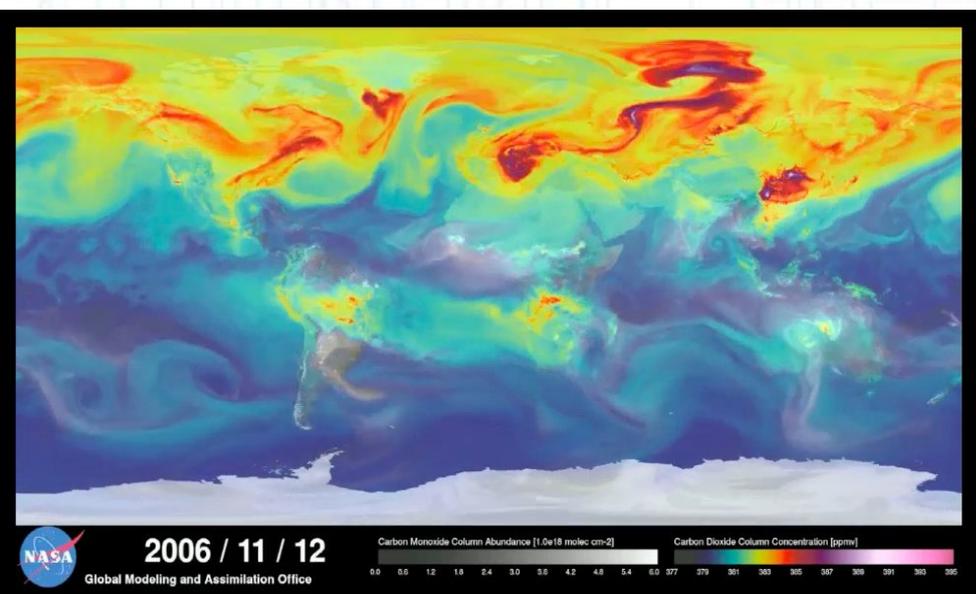
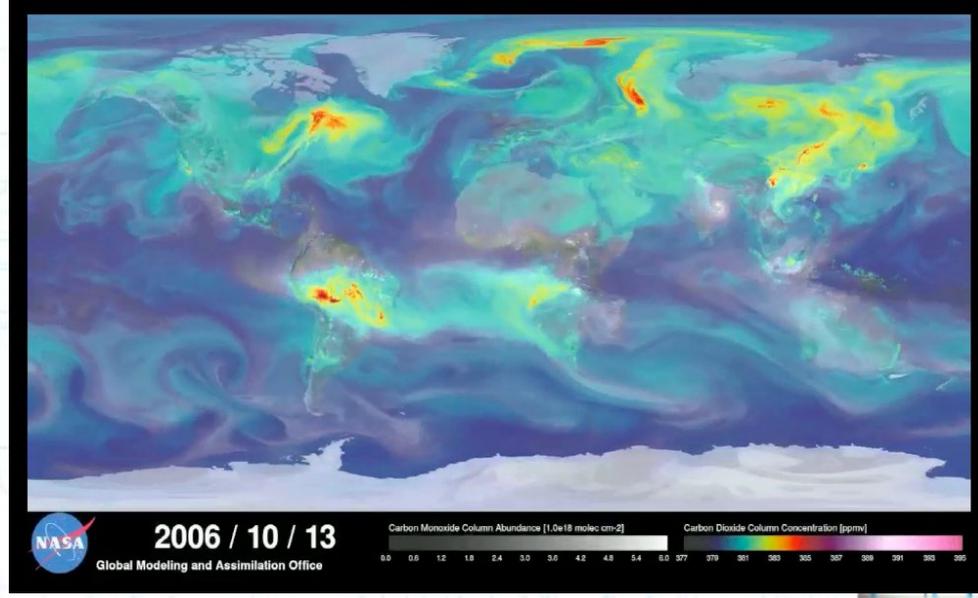
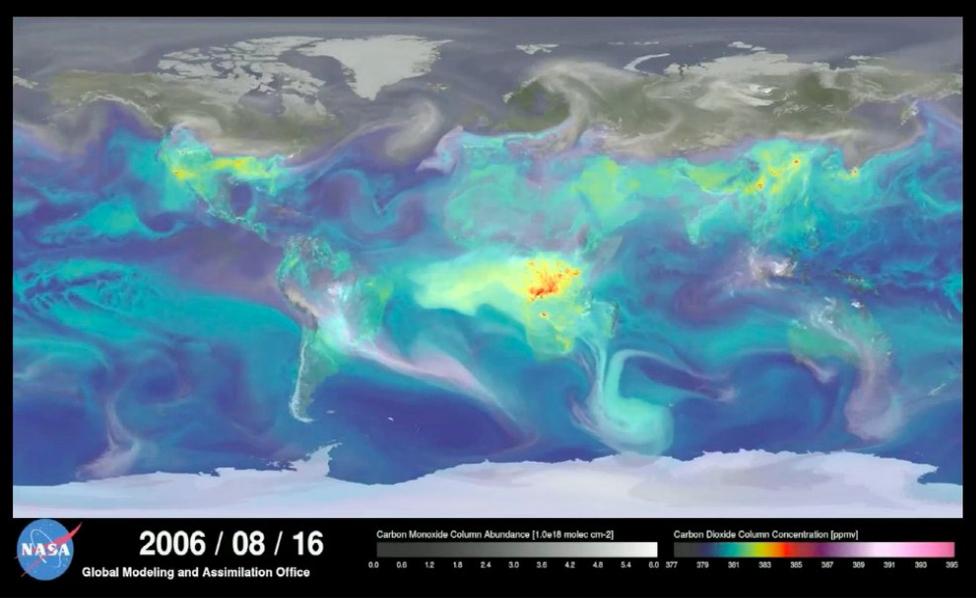
**EARTH: 2019**

A previously unpublished, internal study conducted by Exxon Mobile, the largest oil company in the world accurately predicted current warming trends in 1982.

# History of Forces Affecting Global Temperature



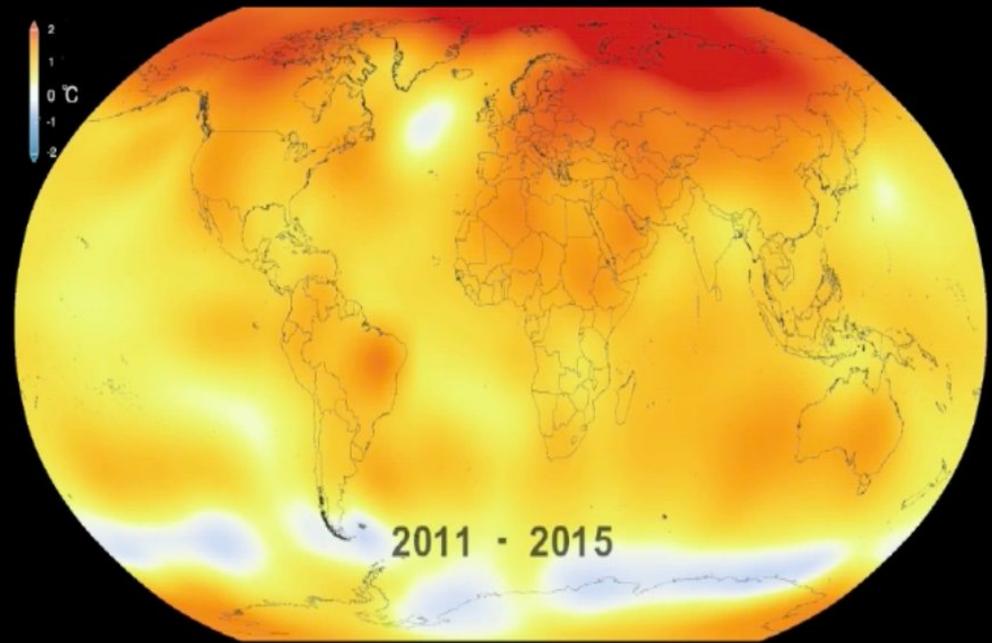
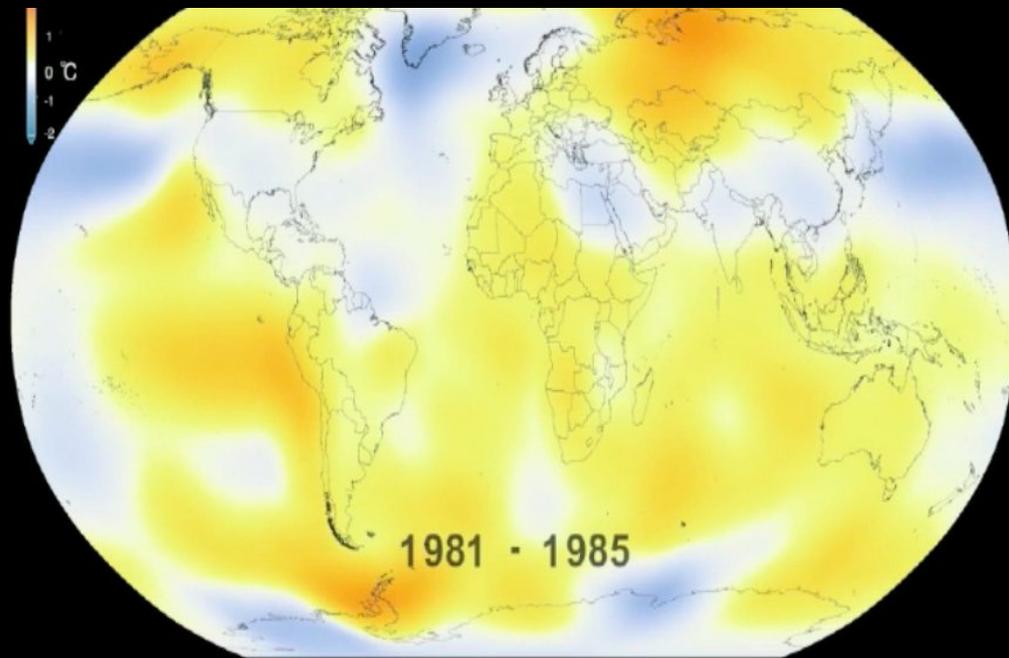
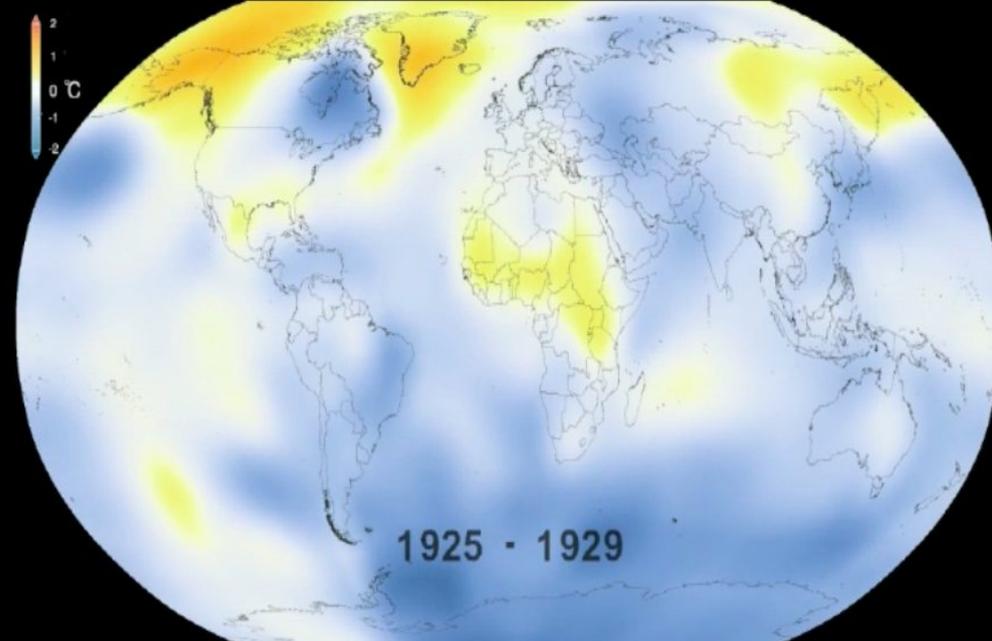
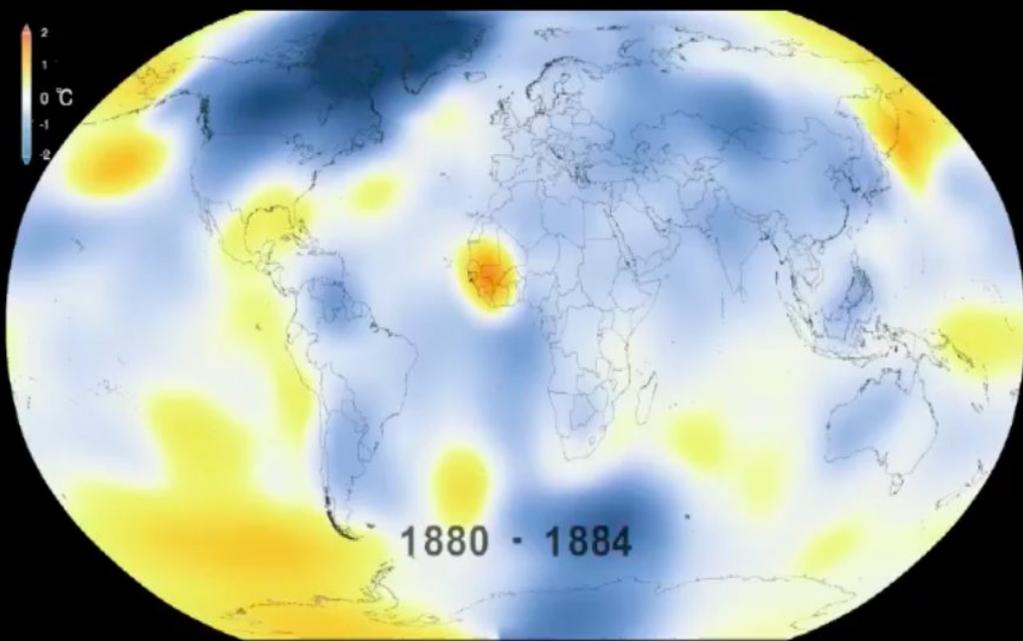
Adapted from U.S. Global Change Research Program (USGCRP)  
Climate Science Special Report: Fourth National Climate Assessment (NCA4), Volume I, Chapter 3, Fig. 3.3. (2017)  
Natural variability includes El Niño / Southern Oscillation



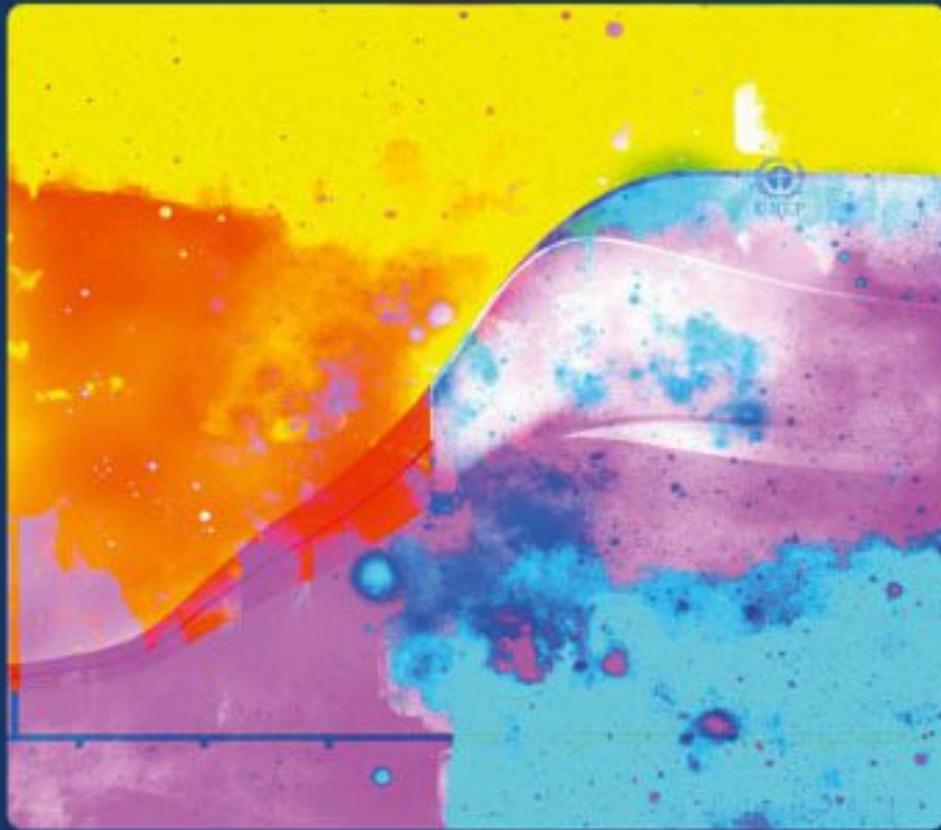
## Global Atmospheric Carbon

Current Atmospheric Carbon = **440ppm+**

Pre-Industrial average (past 400,000 years) = **180-280ppm**



**Global Average Temperature 1885 – 2015**



ipcc

INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE



## Global Warming of 1.5 °C

An IPCC special report on the impacts of global warming of 1.5 °C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty.

## Intergovernmental Panel on Climate Change

IPCC is an international authority, with scientists from over 60 countries, using established, peer-reviewed research. Referenced by many, including films like *An Inconvenient Sequel*. Trust the Science!

# To keep to 1.5°C

CO<sub>2</sub> emissions would have to decline by

**45%** before **2030**



renewable energy will need to supply

**70-80%** of power by **2050**



We must limit Global Warming to 1.5 degrees to mitigate worst effects of Climate Change.

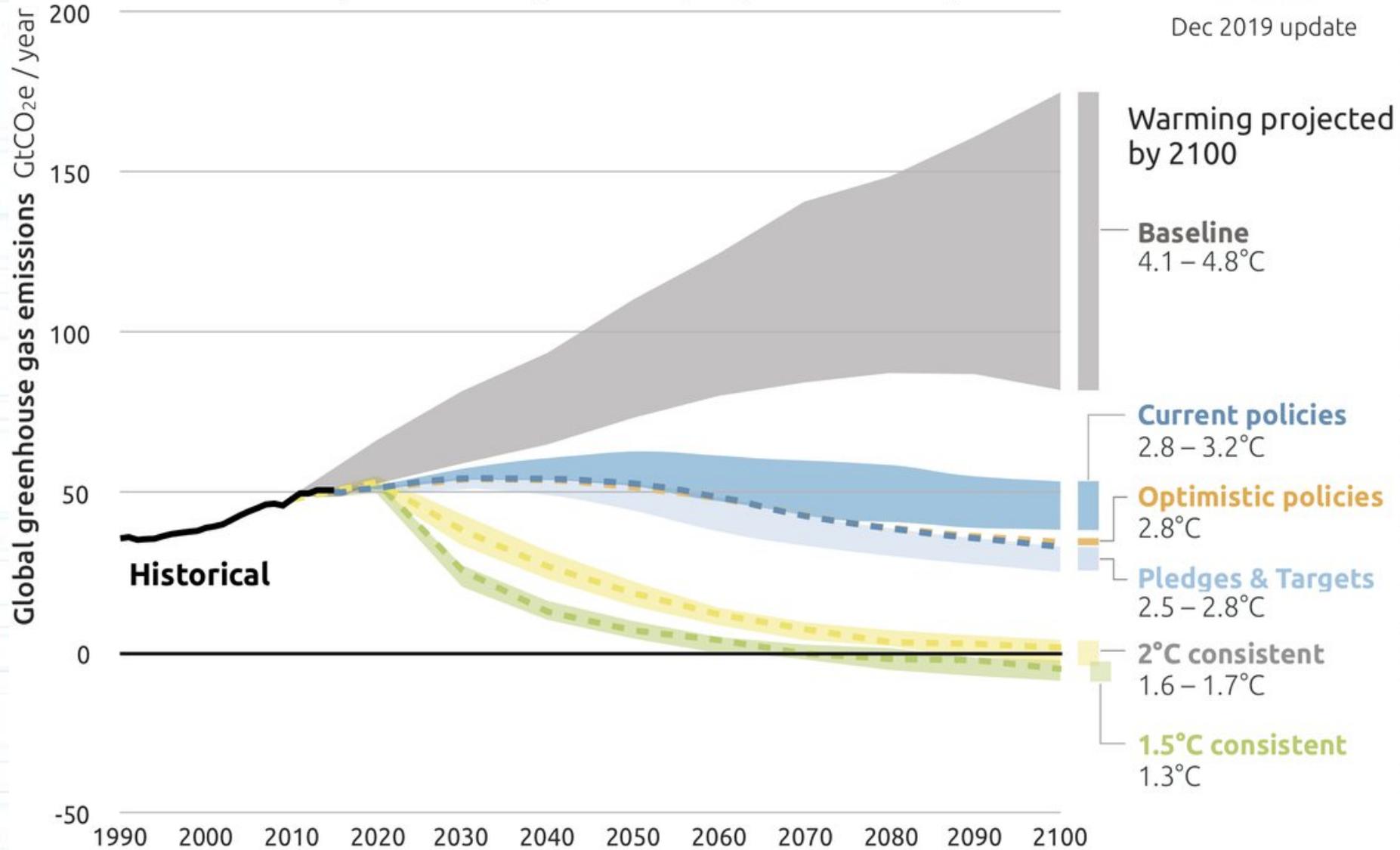
IPCC uses lower estimates, which are possibly too conservative, so the reality may be more imminent.

# 2100 WARMING PROJECTIONS

Emissions and expected warming based on pledges and current policies



Dec 2019 update



Modeling possible climate scenarios based on current policies and target goals.

# Consequences of Climate Change

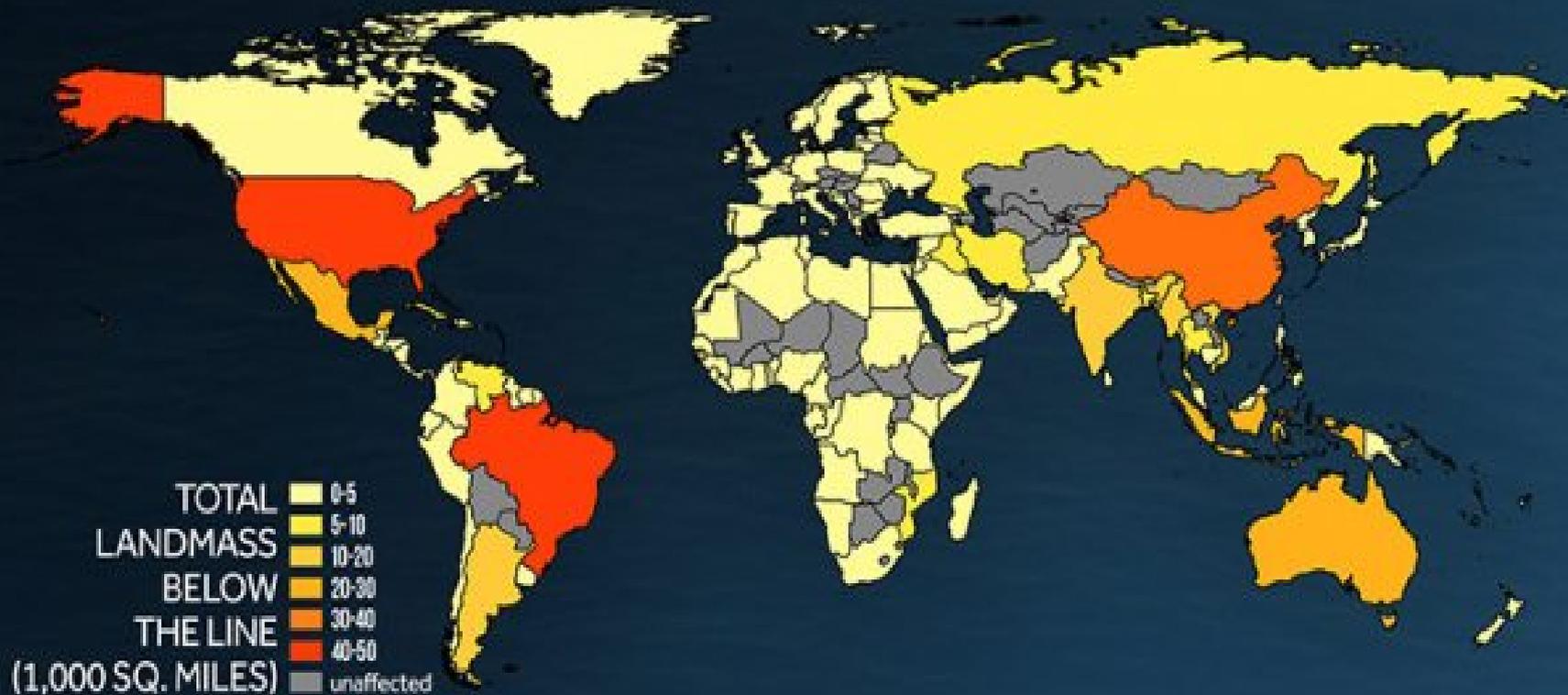
As Global temperatures rise, climate patterns are disrupted. This effect is seen as extreme Weather phenomena: larger and more frequent storms, drought and floods.

Climate Change is also becomes evident as we see more forest fires, rising sea levels and even pandemics.



# Rising Sea Levels

## 6 METER SEA LEVEL RISE Land at Risk with 2°C of Warming



# Droughts and Floods

## Cities with the 10 highest annual flood costs by 2050

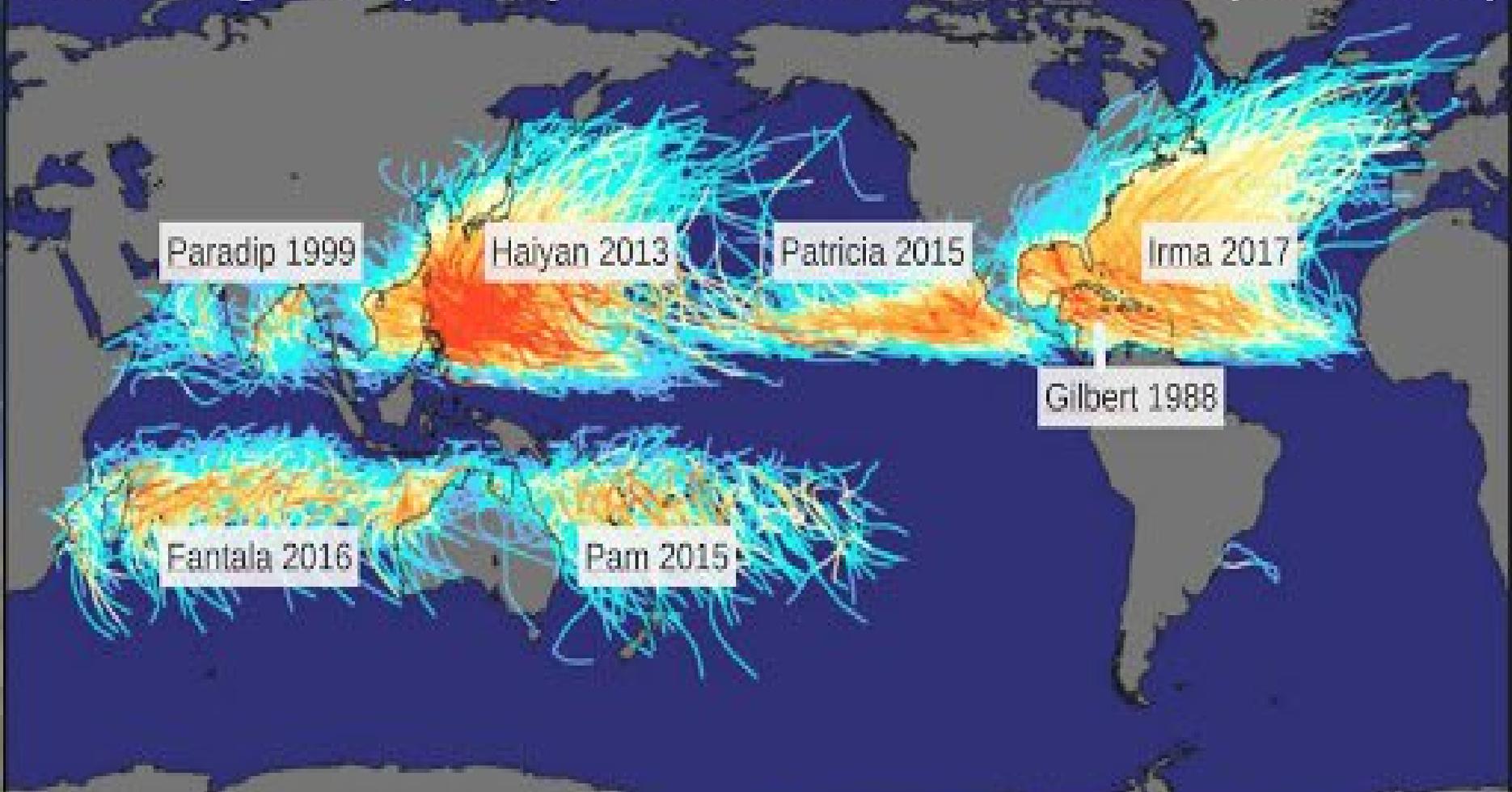


### RUNNERS-UP



# Extreme Weather Events

The strongest tropical cyclones in the satellite record (since 1979)



Data from Velden C, Olander T, Herndon D, & Kossin JP, *Mon. Weather Rev.* 2017

Background: map of historical tropical cyclone tracks, by Robert Rohde

Do not be daunted by the  
enormity of the world's grief.  
Act justly now. Love mercy now.  
Walk humbly now. You are not  
obligated to complete the work,  
but neither are you free to  
abandon it.



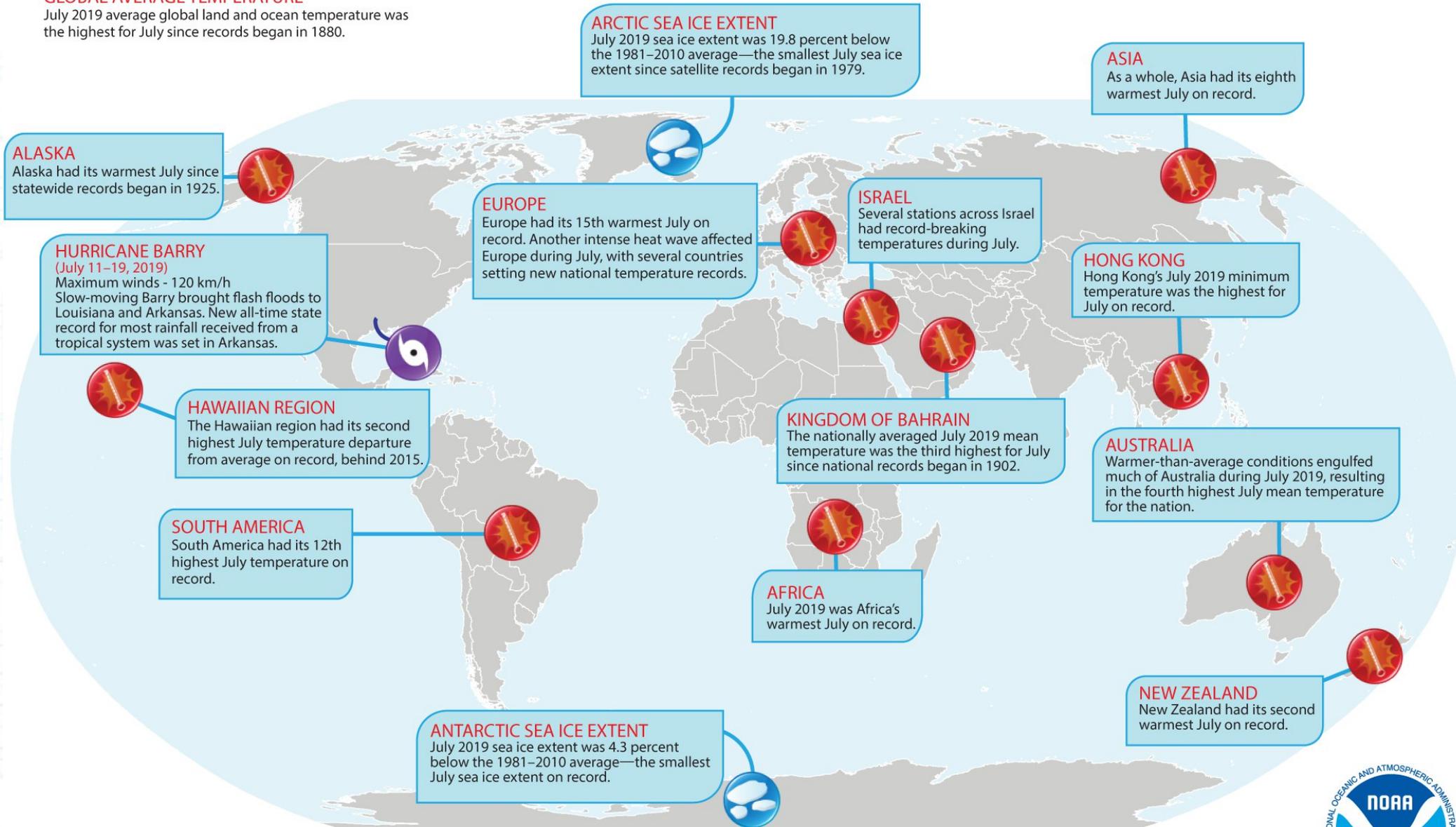
(Attributed to Rabbi Tarfon  
and the Talmud)



# Selected Significant Climate Anomalies and Events July 2019

## GLOBAL AVERAGE TEMPERATURE

July 2019 average global land and ocean temperature was the highest for July since records began in 1880.



Please Note: Material provided in this map was compiled from NOAA's State of the Climate Reports. For more information please visit: <http://www.ncdc.noaa.gov/sotc>



# Selected Significant Climate Anomalies and Events October 2019

## GLOBAL AVERAGE TEMPERATURE

October 2019 average global land and ocean temperature was the second highest for October since records began in 1880.

## ARCTIC SEA ICE EXTENT

October 2019 sea ice extent was 32.2 percent below the 1981–2010 average—the smallest October sea ice extent since satellite records began in 1979. The 10 smallest October Arctic sea ice extents have occurred since 2007.

## CONTIGUOUS U.S.

While much of the western half of the contiguous U.S. had cooler-than-average temperatures, the southeast, mid-Atlantic, and the Ohio Valley had warmer-than-average conditions. Overall, this was the coldest October since 2009 for the contiguous U.S.

## EUROPE

Europe had its third warmest October on record.

## ASIA

As a whole, Asia had its fourth warmest October on record.

## KINGDOM OF BAHRAIN

Bahrain had its highest mean, minimum, and maximum October temperatures on record.

## HAWAIIAN REGION

The Hawaiian region temperature departure for October 2019 tied with 2015 as the second highest October temperature on record, behind 1968.

## CARIBBEAN REGION

October 2019 was the Caribbean's third warmest October on record, behind 2016 and 2015.

## SOUTH AMERICA

South America had its seventh highest October temperature on record.

## ANTARCTIC SEA ICE EXTENT

October 2019 sea ice extent was 1.4 percent below the 1981–2010 average—the 10th smallest October sea ice extent on record.

## CYCLONE KYARR

(October 24–31, 2019)  
Maximum winds - 240 km/h  
Kyarr was the first super cyclone in the Arabian Sea since Cyclone Gonu in June 2007.

## TYPHOON HAGIBIS

(October 4–20, 2019)  
Maximum winds - 260 km/h  
Typhoon Hagibis was one of the most rapidly intensifying tropical cyclones on record in the region. Hagibis brought record-breaking rainfall and caused widespread damage to parts of Japan.

## AUSTRALIA

Warm and dry conditions plagued much of Australia during October 2019, resulting in the third warmest and fifth driest October on record.

Please Note: Material provided in this map was compiled from NOAA's State of the Climate Reports. For more information please visit: <http://www.ncdc.noaa.gov/sotc>



# Selected Significant Climate Anomalies and Events: December 2019

## GLOBAL AVERAGE TEMPERATURE

December 2019 average global land and ocean temperature was the second highest for December since records began in 1880.

## ARCTIC SEA ICE EXTENT

December 2019 Arctic sea ice extent was 6.9 percent below the 1981–2010 average—tying with 2006 as the fifth smallest December sea ice extent since satellite records began in 1979.

## CONTIGUOUS UNITED STATES

Warmer-than-average conditions engulfed much of the contiguous U.S. during December, resulting in the sixth warmest December on record.

## EUROPE

Europe had its second warmest December on record, behind 2015. Spain and France had a top-five warm December.

## ASIA

While much of western and central Asia had warmer-than-average temperatures, parts of eastern and southern Asia had near- to cooler-than-average temperatures. Overall, Asia's December 2019 temperature departure from average was the eighth highest for December on record.

## TYPHOON PHANFONE

(December 19–29, 2019)  
Maximum winds: 175 km/h  
Phanfone made landfall in the Philippines on December 25, bringing strong winds and heavy rain to the region.

## HAWAIIAN REGION

The Hawaiian region temperature departure from average for December 2019 was the highest for December on record.

## CARIBBEAN REGION

December 2019 was the Caribbean's fifth warmest December on record.

## SOUTH AMERICA

South America had its third highest December temperature departure from average on record.

## AFRICA

Africa had its third warmest December on record.

## AUSTRALIA

Australia was record warm and record dry during December. The national accumulated Forest Fire Danger Index was the highest for any month on record.

## ANTARCTIC SEA ICE EXTENT

December 2019 Antarctic sea ice extent was 10.7 percent below the 1981–2010 average—the fifth smallest December sea ice extent on record.

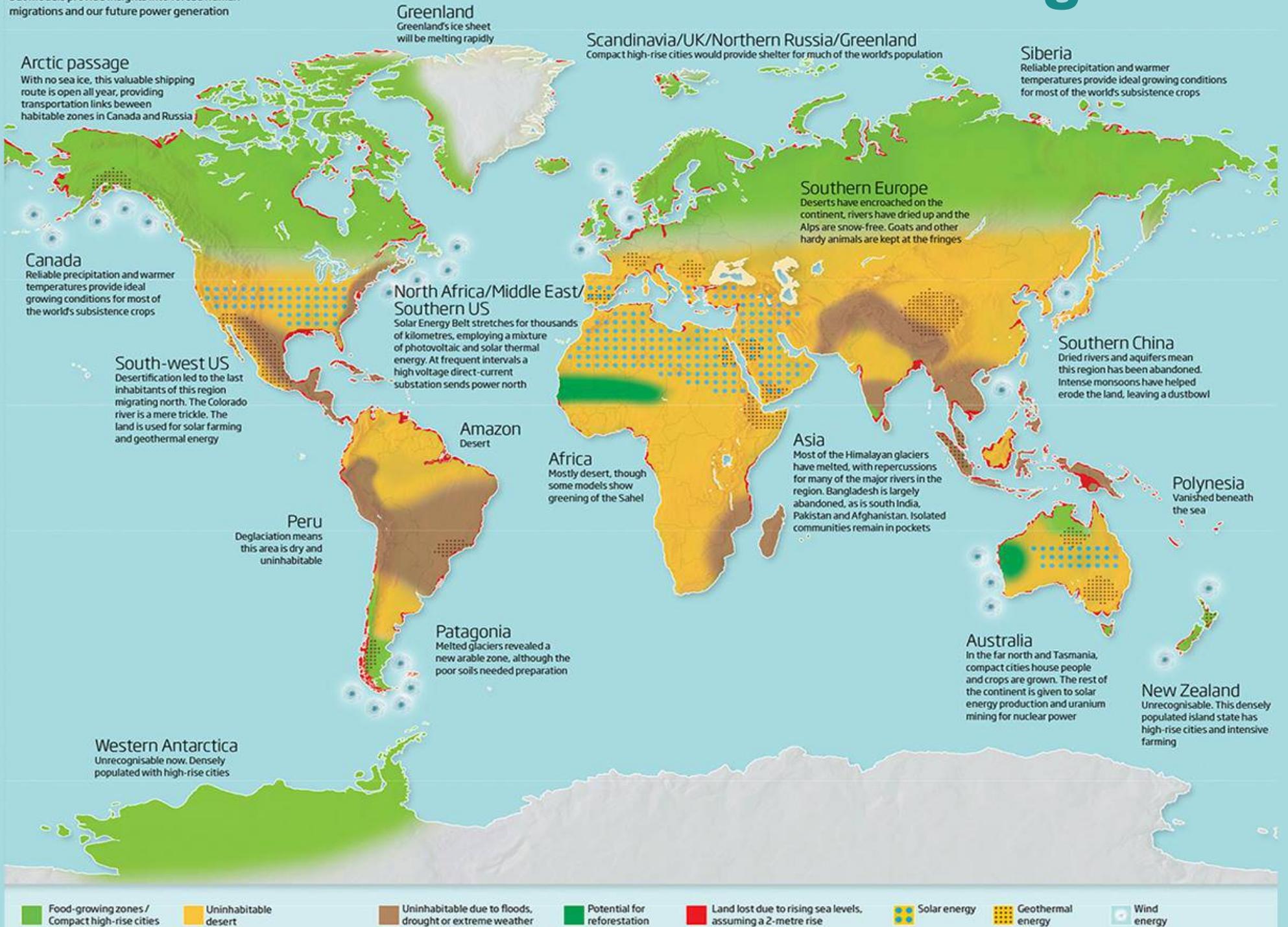
Please note: Material provided in this map was compiled from NOAA's State of the Climate Reports. For more information please visit: <http://www.ncdc.noaa.gov/sotc>



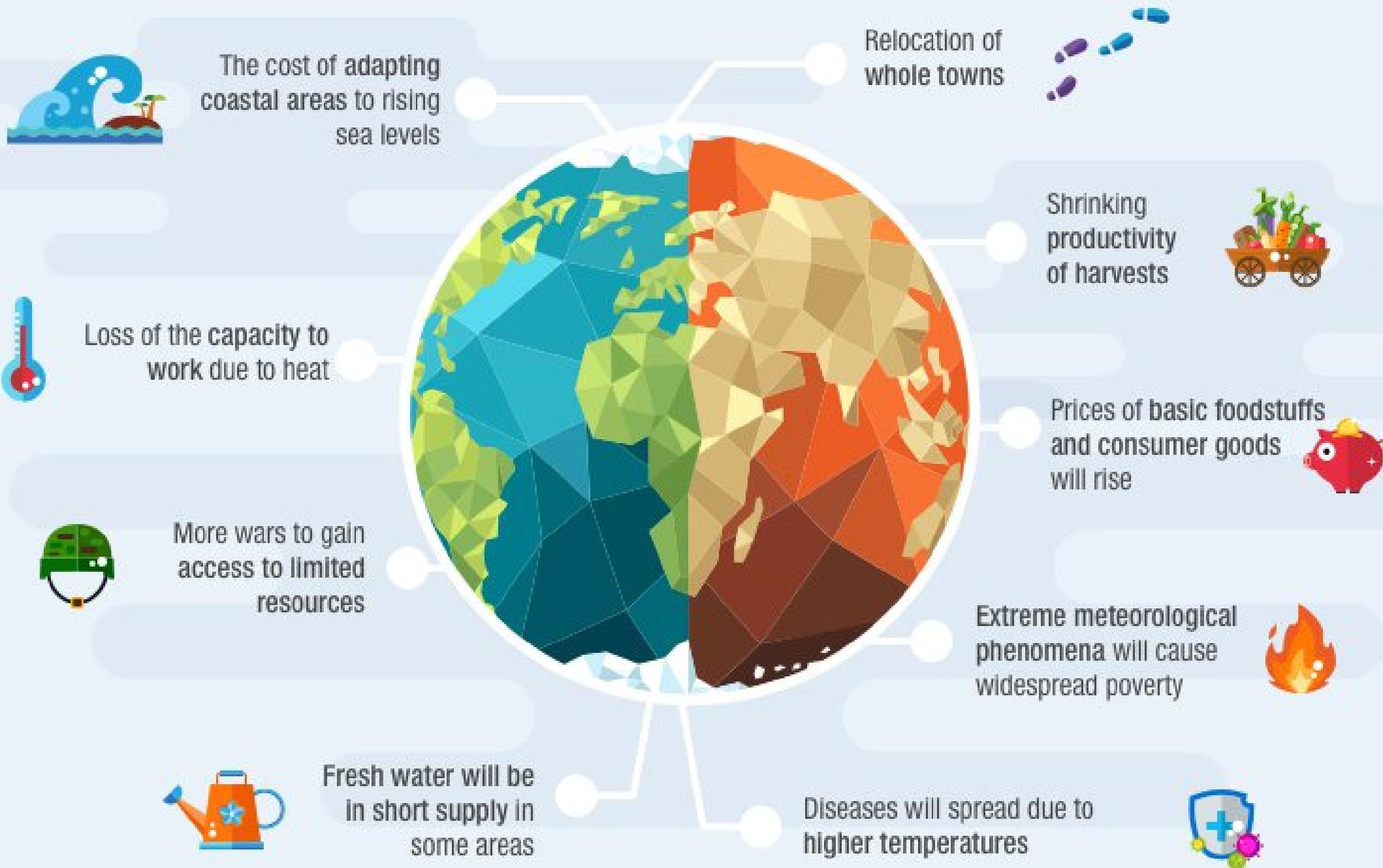
# The world: 4°C warmer

No one knows exactly what this world will look like, but models provide insights into forced human migrations and our future power generation

# Climate Refugees



# Effects of Climate Change, in Summary:



# Climate Change and Pollution

Greenhouse Gases are the primary cause of Global Warming, which is driving Climate Change, but are just one type of pollution. Other types of pollution that affect Climate include: water, soil, noise, light and other air pollution. Pollution and other effects of human activity will be detailed in following presentations.



# Why There Is Hope!

**We have the knowledge!** Climate Change is well-documented and the data is readily available.

**We have the technology!** Scientists have already identified the most effective solutions and we have the technology to implement these solutions. Global Warming is reversible!

**We have the power!** People across the globe are waking up to the reality of our situation and recognizing our collective power as global citizens. Ultimately, every action is a vote that matters.

# Introduction to Sustainability

Living more sustainably *is* the path to solving climate change. To be more sustainable is to intentionally generate less waste, use less fossil fuels, and other practices, therefore lowering our carbon footprint and ecological footprint, thereby slowing global warming and solving climate change

Reduce energy consumption and invest in cleaner energy production.  
Protect, manage and restore natural systems.

## Natural climate solutions: cost-effective, scalable and viable

We must cut 30 gigatons a year of carbon emissions by 2030 if we are to keep global temperature increase well below 2 degrees Celsius. Nature can reduce more than one-third of the emissions to meet this goal if countries invest in carbon-storing forests, grasslands, wetlands and farmlands.



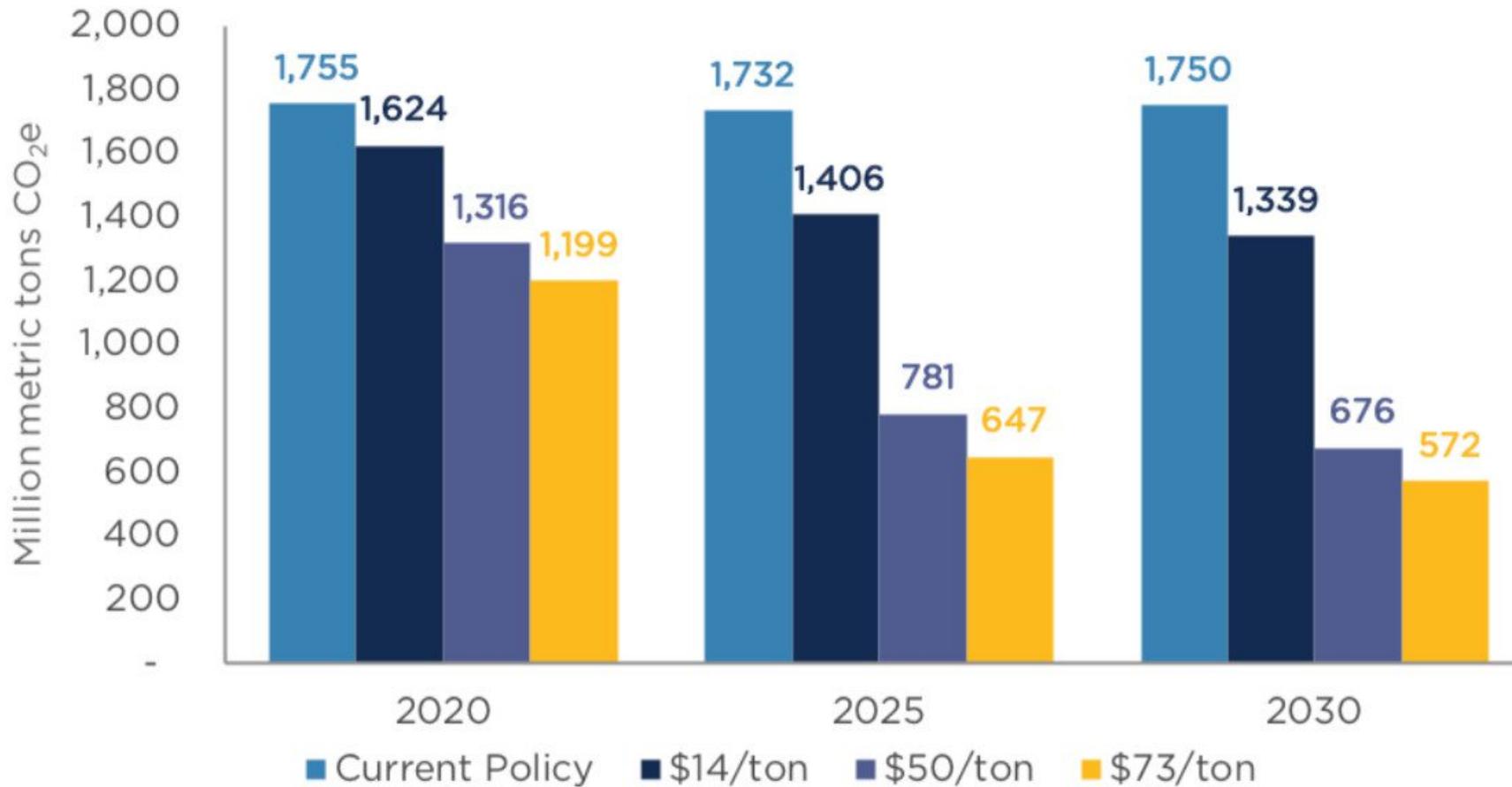
# Renewable Energy



Renewable energy is energy produced from sources that do not deplete or can be replenished within a human's life time. The most common examples include wind, solar, geothermal, biomass, and hydropower. This is in contrast to non-renewable sources such as fossil fuels.

# Carbon Pricing

**Figure 4:** Electric power GHG emissions, 2020-2030 (Million metric tons CO<sub>2</sub>e)



Economists have long suggested that raising the cost of burning coal, oil and gas can be a cost-effective way to curb emissions. But, in practice, most countries have found it politically difficult to set prices that are high enough to spur truly deep reductions.

<https://www.nytimes.com/interactive/2019/04/02/climate/pricing-carbon-emissions.html>

# Renewables and Carbon Tax

Figure 1. Support/opposition to a carbon tax<sup>a</sup>

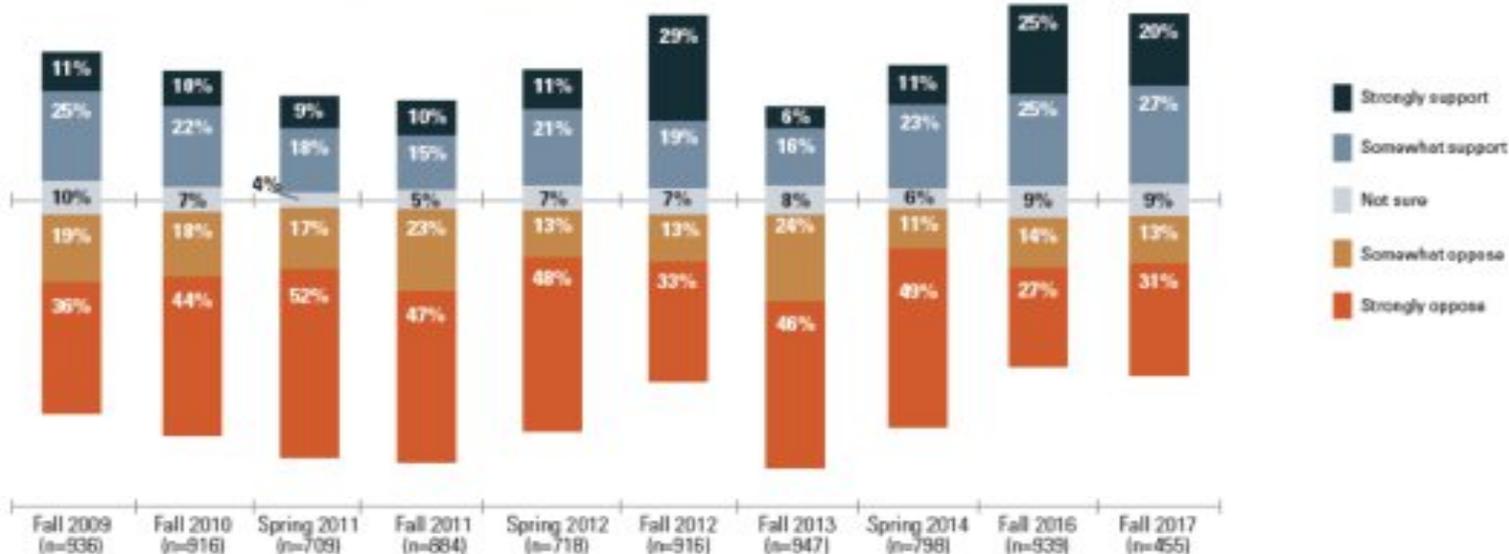
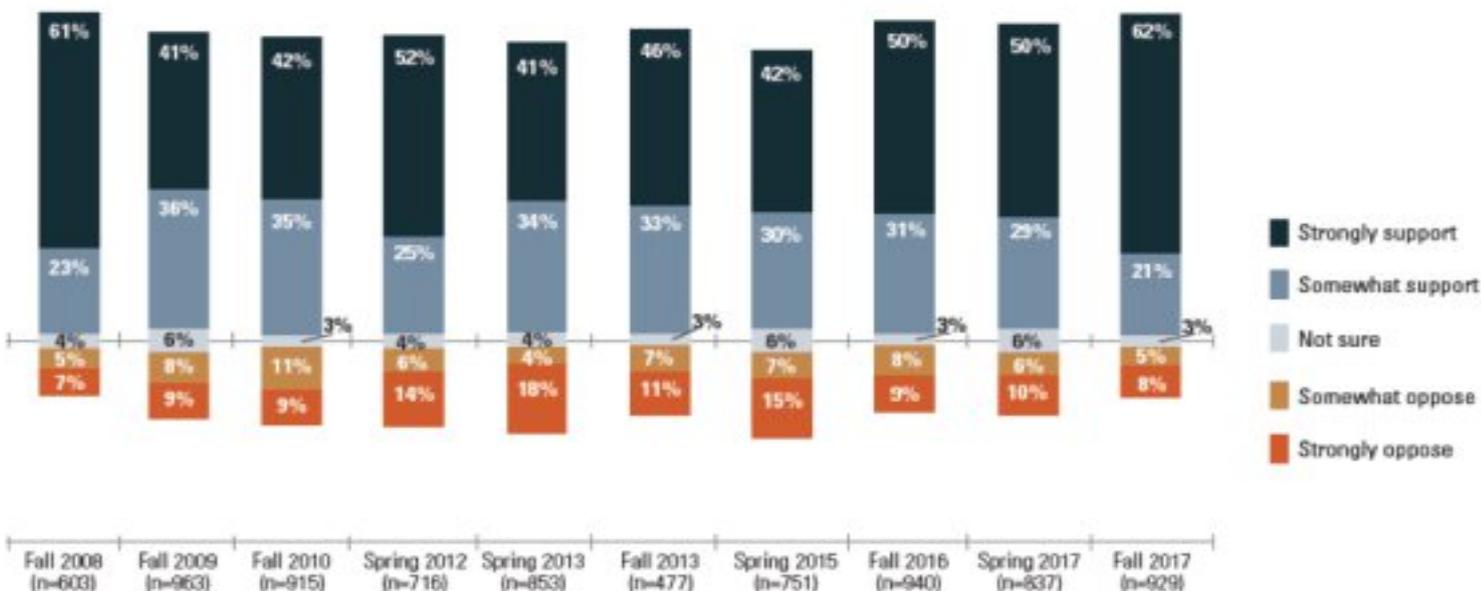


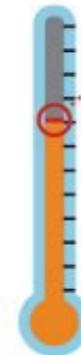
Figure 1. Support/opposition to states requiring increased use of renewable energy<sup>a</sup>



Source: Fall 2008 – Fall 2017 NSEE waves. Survey data tables for all NSEE waves are available at <http://closup.umich.edu/national-surveys-on-energy-and-environment/>

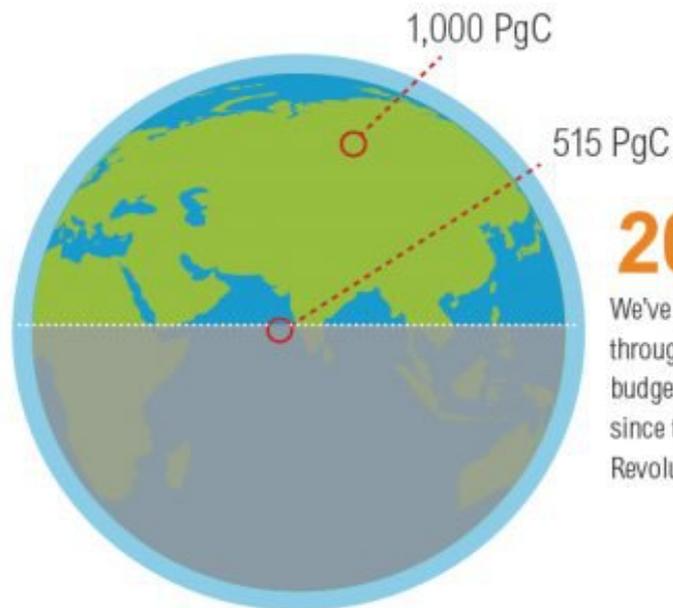
# WHAT IS THE CARBON BUDGET?

The carbon budget is the estimated amount of carbon dioxide the world can emit while still having a likely chance of limiting global temperature rise to 2°C above pre-industrial levels. The international scientific community estimates this budget to be 1 trillion tonnes of carbon (1,000 PgC).



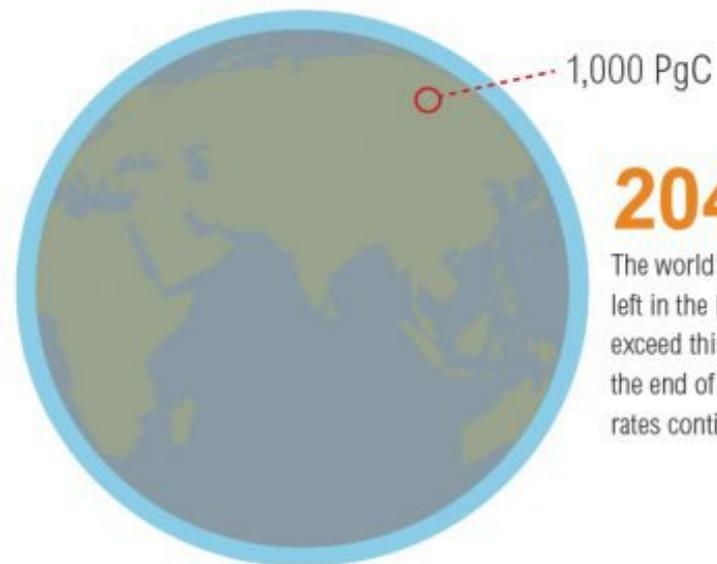
**2°C**

The 2°C target has been adopted by the countries within the United Nations Framework Convention on Climate Change (UNFCCC).



**2011**

We've already burned through 52 percent of the budget, emitting 515 PgC since the Industrial Revolution (1861–1880).



**2045**

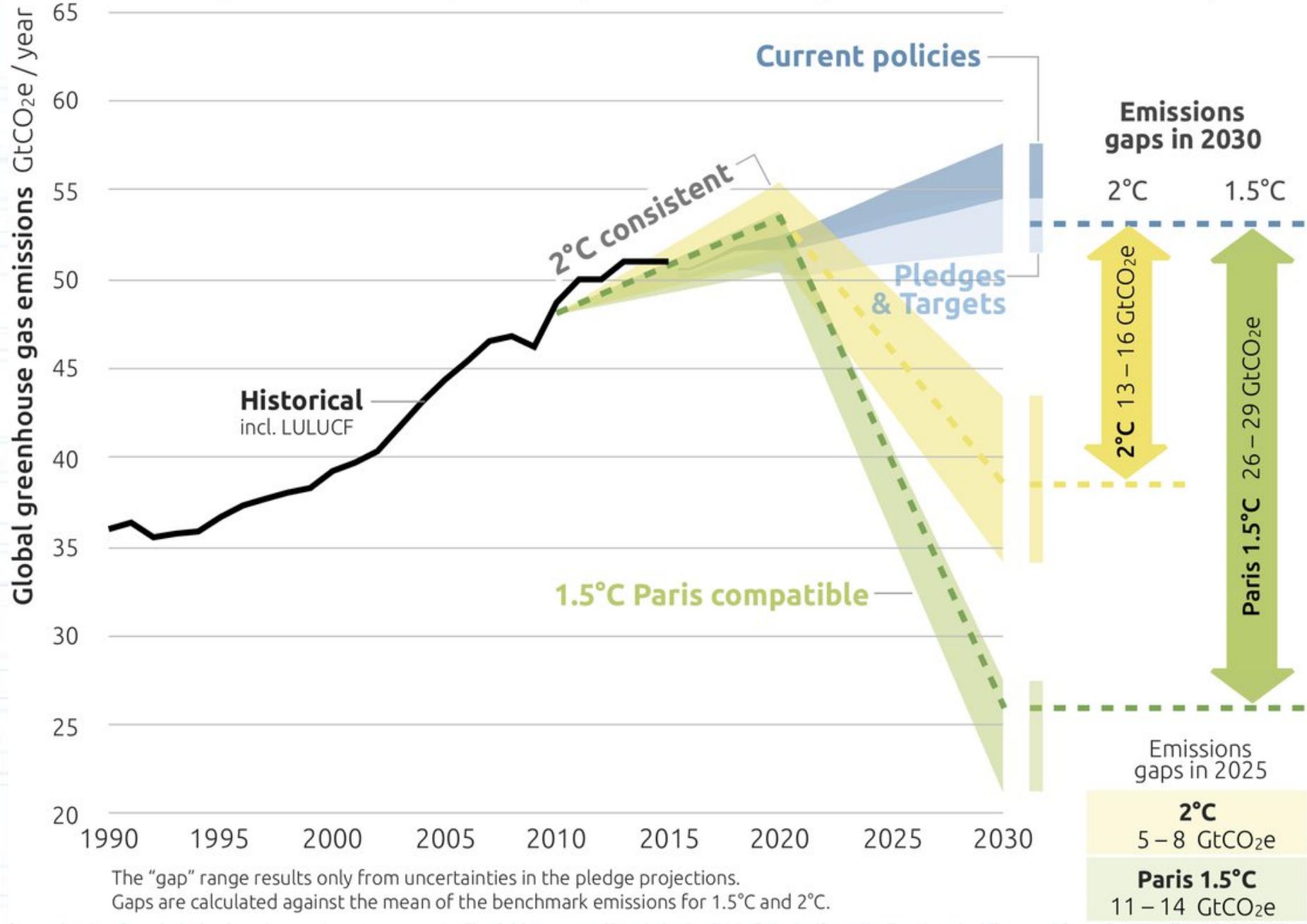
The world has only 485 PgC left in the budget. We'll exceed this amount before the end of 2045 if emissions rates continue unabated.

# 2030 EMISSIONS GAPS

CAT projections and resulting emissions gaps in meeting the 1.5°C Paris Agreement goal vs 2°C Cancún goal



Dec 2019 update

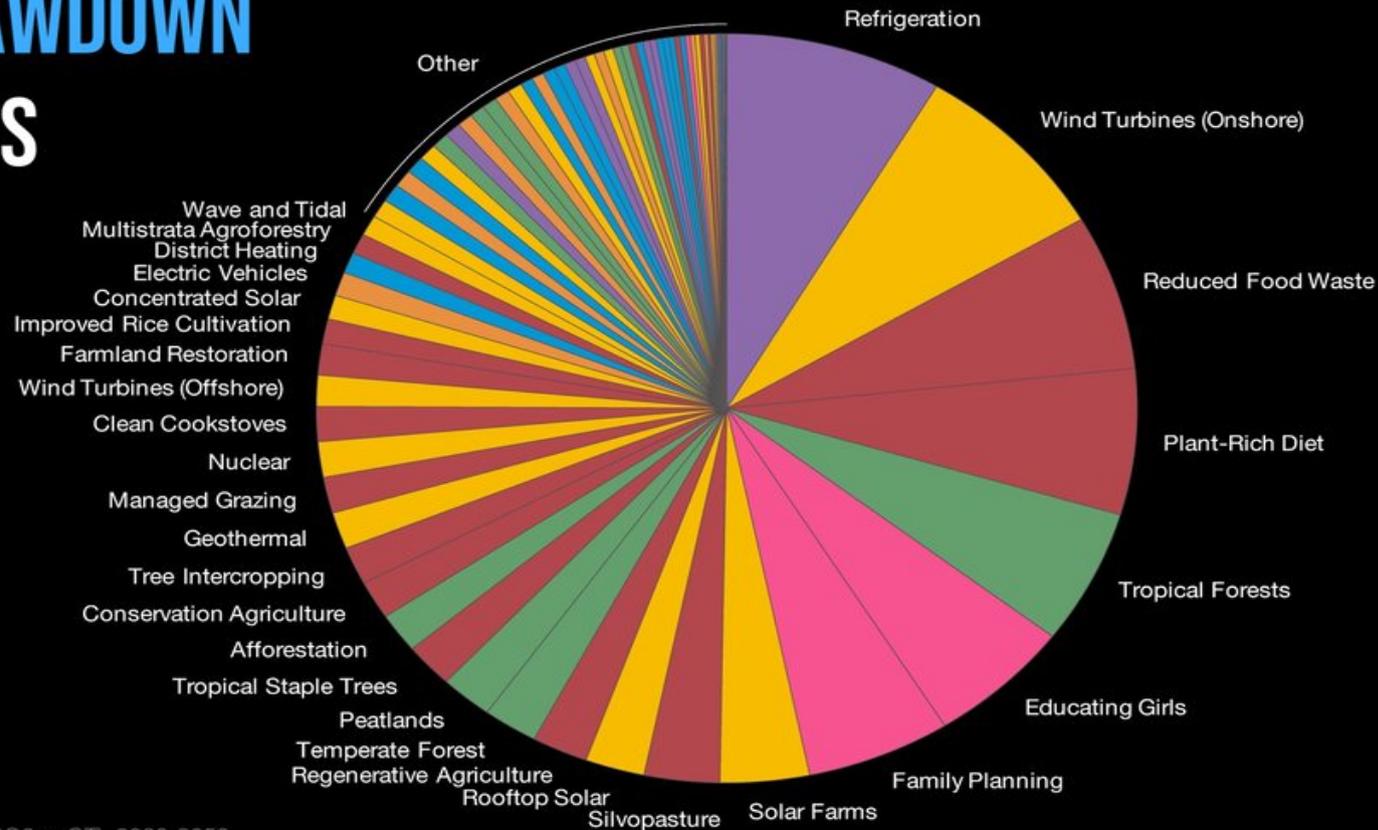




# Top Solutions to Solve the Climate Crisis

## PROJECT DRAWDOWN 80 SOLUTIONS

**CO<sub>2</sub>-EQ: 1,035 GT**  
**COST: \$29.6T**  
**SAVINGS: \$74.4T**



Ranked by potential emissions reduction (CO<sub>2</sub>eq GT), 2020-2050, as modeled in Project Drawdown's Plausible Scenario (2017).

Proper recycling of refrigerants like freon, onshore wind power, reducing food waste and a plant-rich diet are the top climate solutions.

# Celebrate Good News!

## India plants 66 million trees in 12 hours in record-breaking bid to meet Paris Agreement promise

Posted 4 Jul 2017, 3:33pm

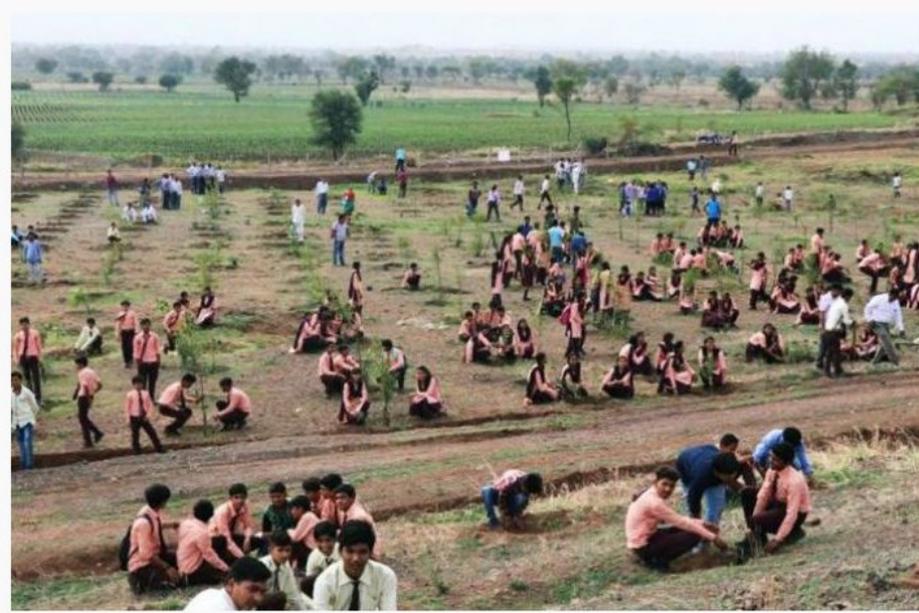
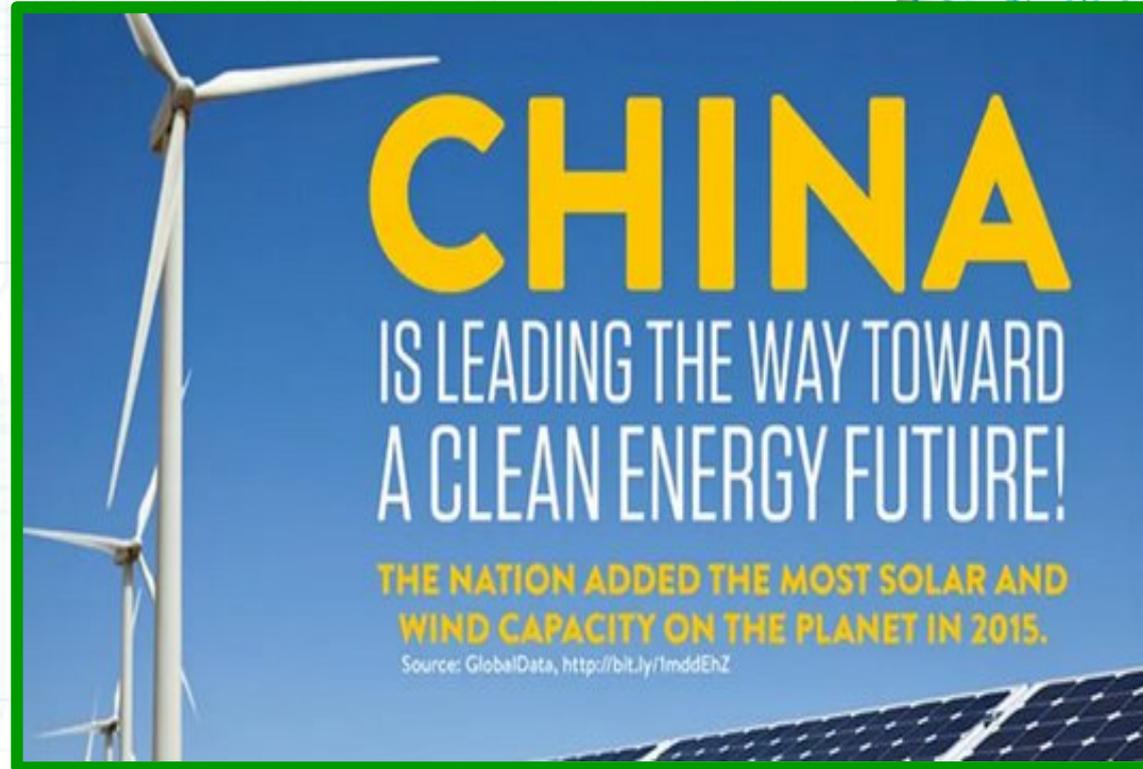


PHOTO: More than 1.5 million volunteers worked along the Narmada River to set the new record. (Twitter: Shivraj Singh Chouhan)



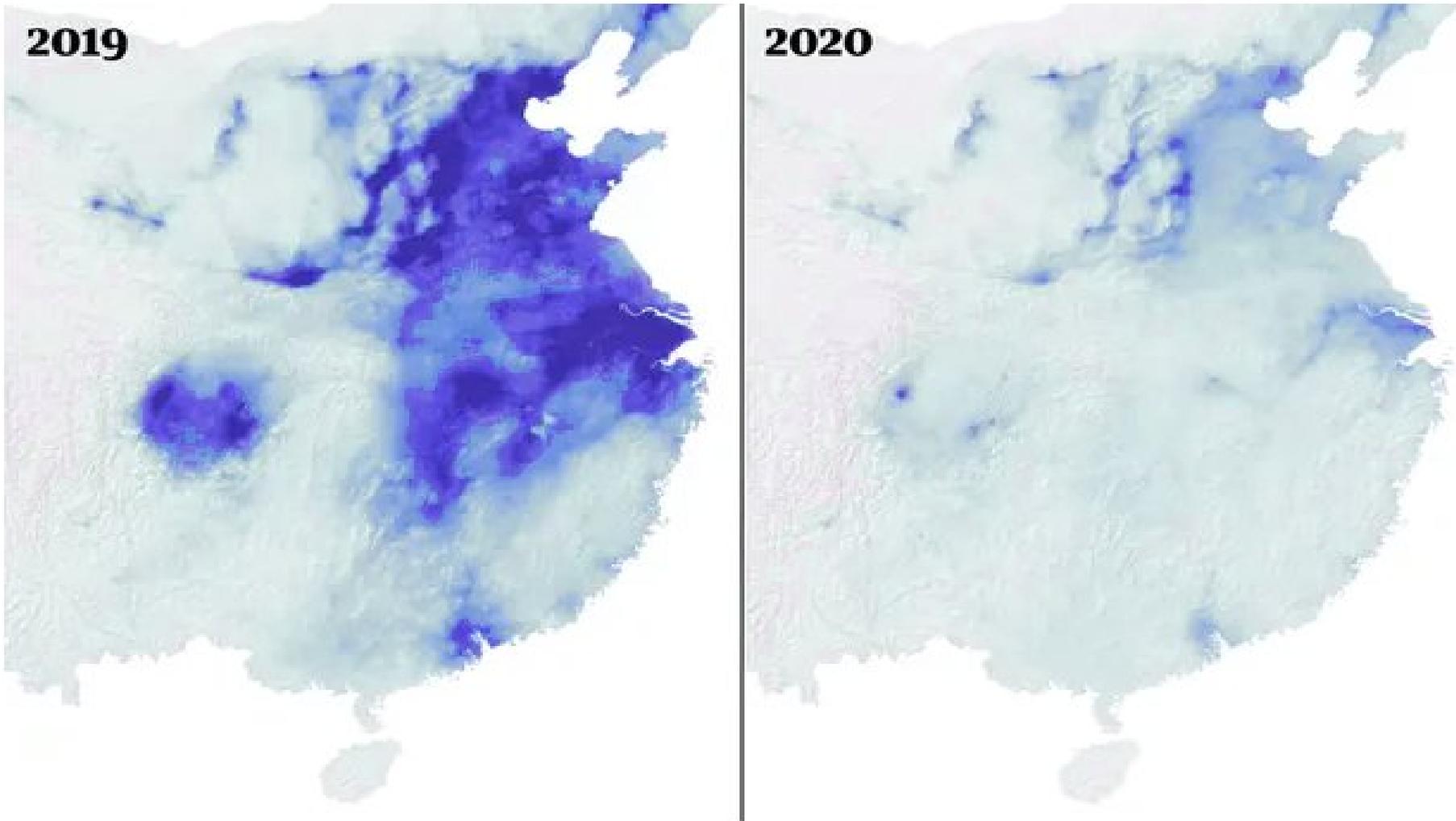
## US coal consumption drops to lowest level since 1979

By ELLEN KNICKMEYER and MATTHEW DALY December 4, 2018



...and more!

# What happens when we slow down...

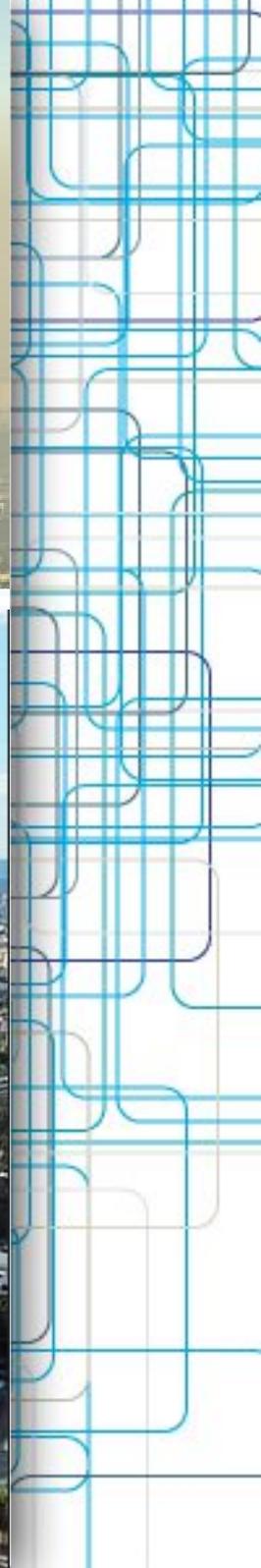


▲ Pollution levels in China in 2019, left, and 2020. Photograph: Guardian Visuals / ESA satellite data

Pollution levels dropped by as much as 40% in some regions of the world since the lockdown in early 2020.



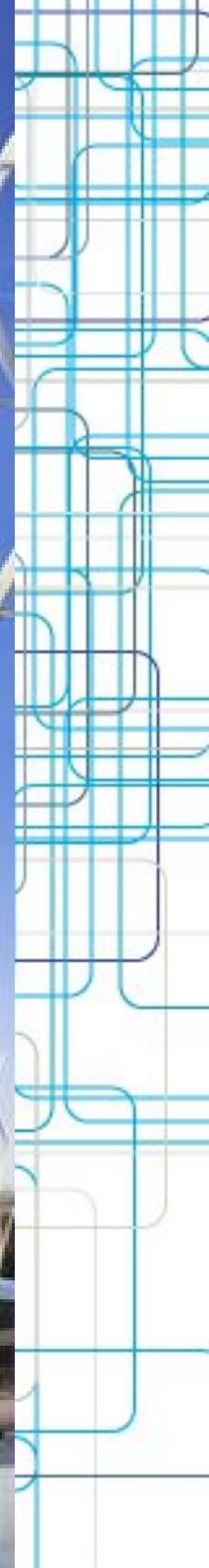
...clear skies in Los Angeles, CA 2020





A better world is possible...

Use your imagination and focus on a goal...







# Resources and Further Reading



- A.C.E. Alliance for Climate Education
- Project Drawdown: Solutions
- Extinction Rebellion (EU)
- Sunrise Movement (US)
- The Venus Project