Myth:

Climate is always changing ... it’s a natural cycle.

Just look at the ice ages!

What does science say?

Flip the page to find out!
It’s true that many natural cycles do influence our climate. In fact, we understand these cycles quite well.

For example:

- Ice ages are caused by cyclical changes in Earth’s orbit.

- El Niño / La Niña cycles are caused by fluctuations in Pacific Ocean surface temperatures.

Because we understand natural cycles well, we can evaluate whether they explain recent warming.

Spoiler alert: the answer is “no”!

Natural cycles cannot fully explain the warming we’ve experienced since the 20th century.
Throughout Earth’s history, climate changes have been driven by changing CO₂ concentrations in the atmosphere. Those fluctuations were natural. What we’re seeing now is also caused by CO₂, but today’s source of CO₂ is not natural.

For example, in the late Permian (250 million years ago), extreme volcanic activity pumped CO₂ into the atmosphere. This caused 6° C of global warming and more than 70% of all species went extinct! Volcanoes still emit CO₂ today, but very little compared to our fossil fuel emissions.

Just as high CO₂ causes warming, lower CO₂ can cause cooling, which happens during ice ages. Ice ages start when Earth moves farther from the sun (due to orbital cycles). But CO₂ dissolves better in colder water, so cooling oceans pull more CO₂ from the atmosphere, which amplifies the cooling.

800,000 yrs of temperature and CO₂ changing together

CO₂ has always driven climate.

Today, CO₂ is mostly increasing due to human activities.

Graph: https://royalsociety.org. Figure by Jeremy Shakun, data from Lüthi et al., 2008 and Jouzel et al., 2007
This myth is a great example of our favorite logical fallacy, the **non-sequitur**

A non-sequitur links two things that are not actually related. Like this cartoon:

![Cartoon Image](https://theconversation.com/its-been-hot-before-faulty-logic-skews-the-climate-debate-23349)

It's true that climate has changed before.

But it doesn't follow that humans are not causing climate change now.
MYTH:

Global warming has stopped!

Actually we are cooling!

What does SCIENCE say? Flip the page to find out!
I was around in the 70's and remember the news media informing me that an ice age was likely to destroy my future hopes.

Well, OK, there was some media coverage like that!

But it reflected a tiny minority of scientific views.

Even in the 70's, only 10% of papers predicted cooling.

As the 70's wore on, warming was clearly favored. In fact, only 7 papers ever argued for cooling.


Claims of cooling rely on cherry-picked data. Short periods of cooling can happen even with an overall warming trend. For example, La Niña cycles and volcanic eruptions will both cause temporary cooling.

To the horror of global warming alarmists, global cooling is here
Peter Ferrara, Forbes Magazine, May 26 2013

Using longer time periods makes it crystal clear that we are NOT cooling.

"If you cherry-pick the time range, you can “demonstrate” flat or cooling trends. But that would be dishonest!"
MYTH:

Climate change won’t be bad.

We love warm weather!

What does SCIENCE say? Flip the page to find out!
SCIENCE says:

Sure, there could be a few upsides to climate change. Fisheries in Greenland might become more productive!¹ The Northwest Passage could open for shipping!²

But these are vastly outweighed by the challenges of a warmer planet. Many are already happening.

Flip through to learn about climate change and:

Wildfires are increasing and wildfire season is getting longer in the Western U.S.

Average number of large wildfires per year
bigger than 1,300 acres
1980-1989 ~140
1990-1999 ~160
2000-2012 ~250

Climate change is driving up temperatures and increasing wildfire risk.

TEMPERATURES ARE RISING
Average annual temperatures in the Western U.S. have increased 1.9°F since 1970.

SNOW MELTS SOONER
Winter snowpack melts up to 4 weeks earlier than in previous decades.

FORESTS ARE DRIER, LONGER
Conditions are primed for wildfires to ignite and spread.

Wildfires are projected to burn more land as temperatures continue to rise.

Projected increase in annual burn area with an additional 1.9°F rise in temperature

By mid-century, temperatures in the Western U.S. are expected to increase even more (2.5°-6.5°F) due to heat-trapping emissions from human activity.

The choices we make today will determine how much temperatures increase this century, how long and damaging wildfire seasons become, and how prepared communities are for the growing risks of wildfires.

© Union of Concerned Scientists 2013. www.ucsusa.org/westernwildfires
Warmer air holds more moisture, making storms more intense:

At the same time, sea levels are rising. That’s partly because glaciers are melting, and partly because water expands as it warms up. This increases coastal flooding:

**The New York Times**

**A Sharp Increase In ‘Sunny Day’ Flooding**

By JONATHAN CORUM  
SEPT. 3, 2016

Global warming and rising seas are increasing the amount of tidal flooding on the Atlantic and Gulf Coasts. Flood levels are different from city to city, but the trends are similar.

**Atlantic City**  
The Jersey Shore was badly damaged by Hurricane Sandy, and fierce fights have erupted about how to rebuild.

**Charleston, S.C.**  
At high tide, water can back up in the old sewers and bubble into the streets. This city is spending more than $200 million on improvements.

Together, more intense storms and sea level rise threaten property, livelihoods, and lives.
Climate change will influence virtually every aspect of human health. This is partly due to things like heat stroke, but also problems like tick-borne disease and food insecurity.

In fact, leading medical journal *The Lancet* has identified climate change as “the biggest global health threat of the 21st century.”

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Crop yields depend on local weather conditions. As temperatures rise, arid regions will experience drought while wet regions get rainier (because warmer air holds more moisture).

How crops respond will depend on the region and the crop.

Projected % change in yield for 2070-2090

The real question is how these changes will influence **food security**. The picture is worrying for unindustrialized nations:
Images of starving polar bears have recently prompted heated online attention.

Research now confirms that dwindling sea ice is preventing polar bears from hunting enough food to meet their caloric needs.¹

But polar bears aren’t alone. A recent study synthesized 20+ years of research linking climate change to extinction risk for all kinds of plants and animals worldwide.

It concluded that 5% to 16% of all species on earth could be threatened if climate change continues unchecked.²

Rosamund Pearce, Carbon Brief, based on data from Urban 2015.

¹Pagano et al. 2018 High-energy, high-fat lifestyle challenges an Arctic apex predator, the polar bear. Science 359 (6375) 568-572
²Urban 2015. Accelerating extinction risk from climate change. Science 348(6234) 571-573
CO₂ doesn’t just stay in the atmosphere. It also dissolves into ocean water, making the oceans acidic.

Clams, snails, crustaceans, and corals build shells out of calcium carbonate. Calcium carbonate is hard to make in acidic water, so some young animals cannot grow properly.

Baby oysters cannot survive in acidic water because their shells cannot grow. This has already forced American shellfish farmers to change their business practices.¹

Shellfish are valuable commodities, and form the base of marine food chains.

Ocean acidification will have a ‘trickle-up’ effect on finfish fisheries and entire marine ecosystems.

¹Barton et al. 2015. Impacts of Coastal Acidification on the Pacific Northwest Shellfish Industry and Adaptation Strategies Implemented in Response. Oceanography 28(2) 146-159
Ocean acidification can prevent corals from building their skeletons. But it also worsens heat stress, which can make coral bleaching worse.

In 2016-2017, **two-thirds** of corals in Australia’s famous Great Barrier Reef **died** due to heat-related stress.¹

Climate change means rising fuel and utility costs, business interruptions due to storms and wildfires, damages to property, increased health care costs, and reduced yields from crops and fisheries. **MOST NATIONS WILL SUFFER REDUCED GDP** by 2100 if no action is taken.

In 2017, the US lost **$306 BILLION** to climate disaster. Sixteen individual events cost **OVER $1 BILLION EACH**.

**U.S. 2017 Billion-Dollar Weather and Climate Disasters**

- North Dakota, South Dakota, and Montana Drought Spring–Fall 2017
- Western Wildfires, California Firestorm Summer–Fall 2017
- California Flooding February 8–22
- Colorado Hail Storm and Central Severe Weather May 8–11
- Minnesota Hail Storm and Upper Midwest Severe Weather June 9–11
- Midwest Tornado Outbreak March 6–8
- Central/Southeast Tornado Outbreak February 28–March 1
- Missouri and Arkansas Flooding and Central Severe Weather April 25–May 7
- Southeast Freeze March 14–16
- Southern Tornado Outbreak and Western Storms January 20–22
- Hurricane Harvey August 25–31
- Hurricane Irma September 6–12
- Hurricane Maria September 19–21

Courtesy of NOAA NCEI

This map denotes the approximate location for each of the 16 billion-dollar weather and climate disasters that impacted the United States during 2017.
MYTH:

There is no scientific consensus!

What does SCIENCE say?

Flip the page to find out!
What % of scientists do YOU think AGREE on climate change?

Write down your guess!
THE “CONSSENSUS GAP”

THE PUBLIC THINK...
55% OF CLIMATE SCIENTISTS AGREE ON GLOBAL WARMING

IN REALITY...
97% OF CLIMATE SCIENTISTS 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.
Scientists agree on climate change

97% Doran and Zimmerman 2009
79 scientists

The famous number from a survey of 79 scientists

97.5% Anderegg et al 2010
908 scientists

98.5% Cook et al 2013
10,306 scientists

This survey was over ONE HUNDRED TIMES BIGGER!

Compare: Americans who agree that smoking causes lung cancer
Gallup Poll, 2013

91%
Many studies have surveyed scientists to quantify their position on climate change. These are summarized below.

Each circle shows a different study. Symbols are color-coded by the type of group that was surveyed. Groups are arranged from left to right by increasing expertise in climate science.

97% of ALL scientists agree that humans are causing global warming.

But it’s much higher among scientists with climate expertise.

Data from Cook et al. 2016 Consensus on consensus: a synthesis of consensus estimates on human-caused global warming
Environmental Research Letters 11 048002
Graphic modified from skepticalscience.com
Only 91% of Americans agree that cigarette smoking causes lung cancer. Does that mean there’s no consensus?

When the smoking-cancer link was first suggested in 1912, the answer wasn’t obvious. It took years of research to conclusively demonstrate the link.

By the early 1950s, the data were so strong that cancer researchers stopped debating. At that point, the scientific consensus was established.

Doctors in other specialties took time to catch up. In 1960, only 33% of all American doctors thought that smoking definitely caused cancer.¹ But today, virtually all doctors would agree.

Of course, the tobacco industry continued to sow confusion for several decades! They sponsored their own “research” and hyped up “disagreement” among experts.

Energy companies today use similar tactics to sow confusion about climate change.²

What % of scientists do *YOU* think AGREE on climate change?

Write down your guess!
What % of scientists do YOU think AGREE on climate change?

Write down your guess!
MYTH: It’s a Hoax!

- Climate-gate!
- China!
- Emails!

What does SCIENCE say? Flip the page to find out!
The more people involved in a conspiracy, the more likely that someone will give it away.

Oxford scientist David Grimes used information about real conspiracy theories (like the Tuskegee Syphilis Experiment, and the NSA spying that Edward Snowden exposed) to predict how long a conspiracy could survive, given the number of people involved.¹

Today, there are well over 400,000 people in the climate science community worldwide.

Grimes’ model predicts that a conspiracy of this magnitude could not survive beyond 4 years.

Climate change has been a scientific consensus for nearly 75 years, and the basic science goes back even farther.

Can all those people be that good at keeping secrets?

Science is not a conspiracy

Some groups that deny climate reality have accused a few climate scientists of fraud.

The accusations rest on email exchanges that sound bad when taken out of context.

Multiple independent investigations have cleared the accused of any wrongdoing.

The evidence for climate change comes from thousands of studies conducted by tens of thousands of scientists in dozens of nations over nearly a century.

Even if we discarded the data from those who were accused, the evidence for climate change would remain overwhelming.

Next page: anatomy of an accusation
Climategate: Debunked

The “evidence”:

“...I’ve just completed Mike’s Nature trick of adding in the real temps to each series for the last 20 years (ie from 1981 onwards) and from 1961 for Keith’s to hide the decline...”

- from a 1999 email by CRU scientist Phil Jones

Accusation: Temps are actually cooling, and these bozos used a TRICK to HIDE it.

The reality:

‘Trick’ can also mean ‘a clever way to solve a problem’. Here, Phil was discussing a problem that was irritating, but not serious.

To understand Phil’s problem, you’ll need to know that there are two ways of finding temperature:

1. Direct measurements with a thermometer.
   • Accurate, but limited to the last ~150 yrs

2. Proxies can reconstruct past temperature by measuring things that correlate with temperature.
   • Examples: tree ring widths, isotopes in ice cores, etc.
   • Proxies can only estimate temperature, which is why we never rely on just one.
   • When multiple proxies agree, we can draw confident conclusions.

Flip to continue
Here was Phil’s problem:

After 1950, the tree ring proxy shows declining temps, even though thermometers show increasing temps. The tree ring proxy is clearly wrong since 1950. This is no secret, it’s very well-known, and illustrates why we need multiple proxies.

He used thermometer data to correct the problematic post-1950 tree ring data. Here’s the result:

Was this “clean-up” necessary or good? Arguably, no. They could have just shown the raw proxy data, and all their conclusions would have been the same.

Did they make a bad decision? Arguably

Does it alter the overwhelming evidence for climate change? No

Was this a conspiracy? No
SCIENCE is not a conspiracy

Also, 97% is a low estimate. It’s more like 99%. See our de-MYTH-ification of “There is no scientific consensus!”
DE-MYTHIFYING CLIMATE CHANGE

THE #1 MYTH

NONSENSE!
We can do this!

It’s too hard!

TOP 12 SOLUTIONS
& GIGATONS CO₂ REDUCED BY 2050

1. Refrigerant Management ↓89.7 Gt
2. Wind Turbines ↓84.6 Gt
3. Reduced Food Waste ↓70.5 Gt
4. Plant-Rich Diet ↓66.1 Gt
5. Tropical Forests ↓61.2 Gt
6. Educating Girls ↓51.5 Gt
7. Family Planning ↓51.5 Gt
8. Solar Farms ↓36.9 Gt
9. Silvopasture ↓31.2 Gt
10. Rooftop Solar ↓24.6 Gt
11. Regenerative Agriculture ↓23.2 Gt
12. Temperate Forests ↓22.6 Gt

Source: Project Drawdown, drawdown.org

FLIP THE PAGE TO LEARN MORE!
Globally, wind can meet our annual energy needs 40 times over\textsuperscript{1}... 

...and the sun could do so \textit{hundreds} of times over.\textsuperscript{2}

**US renewable energy is growing \textit{rapidly}\textsuperscript{3}**

<table>
<thead>
<tr>
<th>Overall rank</th>
<th>Solution</th>
<th>↓Gt CO\textsubscript{2} by 2050</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Wind Turbines (Onshore)</td>
<td>84.6</td>
</tr>
<tr>
<td>8</td>
<td>Solar Farms</td>
<td>36.9</td>
</tr>
<tr>
<td>10</td>
<td>Rooftop Solar</td>
<td>24.6</td>
</tr>
<tr>
<td>18</td>
<td>Geothermal</td>
<td>16.6</td>
</tr>
<tr>
<td>20</td>
<td>Nuclear</td>
<td>16.09</td>
</tr>
<tr>
<td>21</td>
<td>Wind Turbines (Offshore)</td>
<td>14.1</td>
</tr>
</tbody>
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Food waste

The US wastes 30-40% of all food we produce. Rotting food produces methane, a greenhouse gas more potent than CO₂. Preventing waste at every stage of production, distribution, & consumption can have big effects.

### WHO’S WASTING THE MOST FOOD?

Anywhere food is grown, sold, or eaten, food is wasted. However, consumers are definitely the biggest source of food waste.

<table>
<thead>
<tr>
<th>Overall rank</th>
<th>Solution</th>
<th>↓Gt CO₂ by 2050</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.</td>
<td>Reduce Food Waste</td>
<td>70.5</td>
</tr>
<tr>
<td>4.</td>
<td>Adopt a Plant-Rich Diet</td>
<td>66.1</td>
</tr>
<tr>
<td>60.</td>
<td>Composting</td>
<td>2.3</td>
</tr>
</tbody>
</table>

Source: USDA
**AGRICULTURE**

**Silvopasture** means grazing livestock among trees

Silvopasture can increase CO₂ storage, nutrient cycling, timber yield, and animal health.

Drawdown ranks silvopasture as a **top 10 solution**, with >31 Gt of CO₂ reducing power.

**Regenerative Agriculture** refers to practices that keep carbon in the soil. These improve soil condition, increase yields, and transform soil from a CO₂ source to a CO₂ sink, with >23 Gt of CO₂ reducing power.

**Pillars of Regenerative Agriculture**

1. Minimize soil disturbance
2. Keep soil covered
3. Rotate crops

US Farmers are increasing regenerative practices

- no-till farming: ↑ 8%
- cover crop use: ↑ 49%

(from 2012-2017)
THE WORLD’S LEADING RESOURCE FOR CLIMATE SOLUTIONS.

View the solutions

Drawdown.org

NEW YORK TIMES BESTSELLER

DRAWDOWN
THE MOST COMPREHENSIVE PLAN EVER PROPOSED TO REVERSE GLOBAL WARMING
EDITED BY PAUL HAWKEN