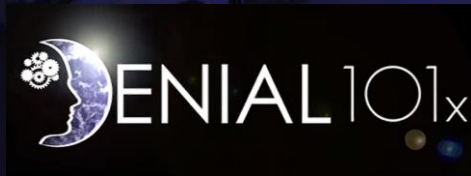


# Fact - Myth - Fallacy

## Compilation of Slides



# 5 CHARACTERISTICS OF SCIENCE DENIAL

F



Fake  
Experts



Magnified  
Minority

L



Logical  
Fallacies



Red  
Herring

I



Impossible  
Expectations



Misrepresentation

C



Cherry  
Picking



Jumping to  
Conclusions

C



Conspiracy  
Theories



False  
Dichotomy

# Some notes about this slide-deck

The slides are based on <http://sks.to/fmf>

The code words on the index page are from here:

<https://skepticalscience.com/shorturls.php>

The shown graphics are just suggestions –  
there may be better ones to suit your purposes

The Fact-Myth-Fallacy texts are just very short explanations

Please use the URL shown at the bottom right of  
each slide for longer explanations

Global  
Warming is  
happening

1998

Cold

Glacier

Greenland

Antarctica

Temp

UHI

Winter

Name

We are  
causing  
Global  
Warming

CO<sub>2</sub>

Volcano

Residence

Thermo

Saturate

Lag

Hotspot

Trace

Sun

Consensus

Past and  
future  
climate  
change

Past

LIA

Past CO<sub>2</sub>

MWP

Model

Hansen1988

Weather

1970s

Iceage

Climate  
change  
impacts

Vapor

Cloud

Species

Bear

Acid

Impacts

Pollutant

Plant

Extreme

# Global Warming is happening

## FACT

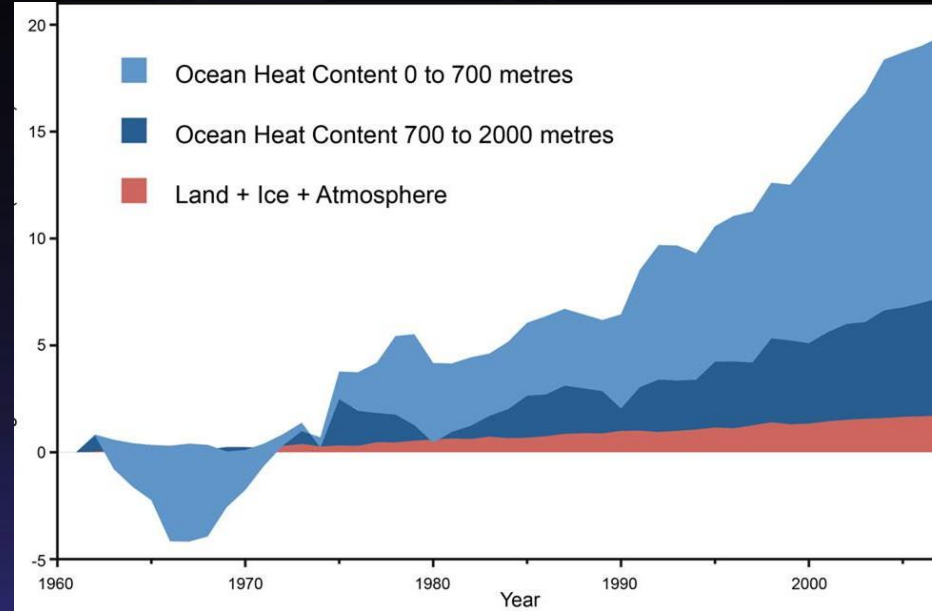
Our planet has continued to build up heat since 1998 - global warming is still happening.

## MYTH

Global warming stopped in 1998.

## FALLACY

Looking at one region or a short period ignores the full picture.



Skeptical Science - <https://skepticalscience.com/graphics.php?g=65>



Cherry-  
picking



<http://sks.to/1998>





# Global Warming is happening

## FACT

Global warming is like rigging the weather dice, making it more likely to get hot days.

## MYTH

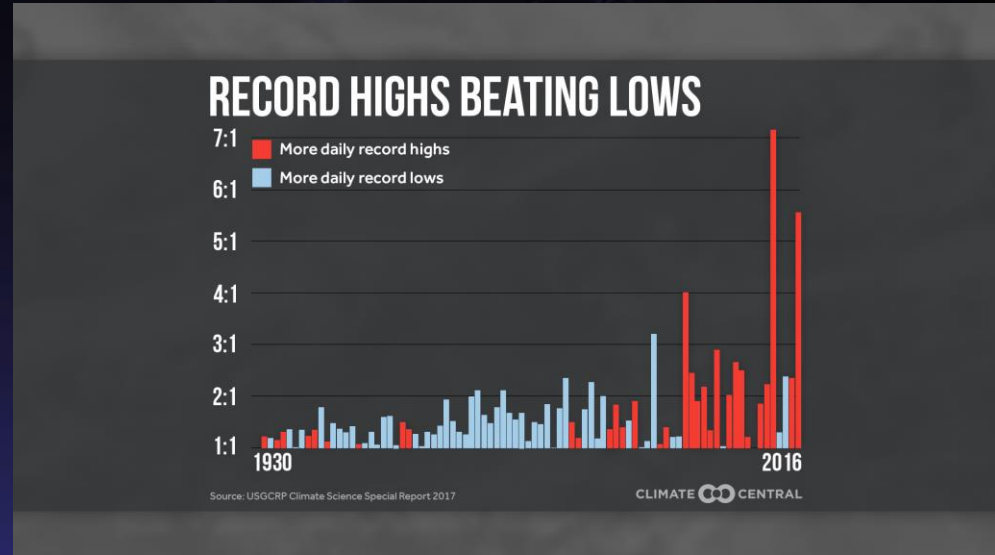
It's cold outside, so global warming must have stopped.

## FALLACY

Global warming doesn't mean no more cold weather, just fewer cold days compared to hot days.



Impossible  
Expectations



Climate Central - <http://www.climatecentral.org/gallery/graphics/daily-record-highs-are-dramatically-outpacing-daily-record-lows>



<http://sks.to/cold>



# Global Warming is happening

## FACT

Overall, glaciers across the globe are shrinking at an accelerating rate, threatening water supplies for millions of people.

## MYTH

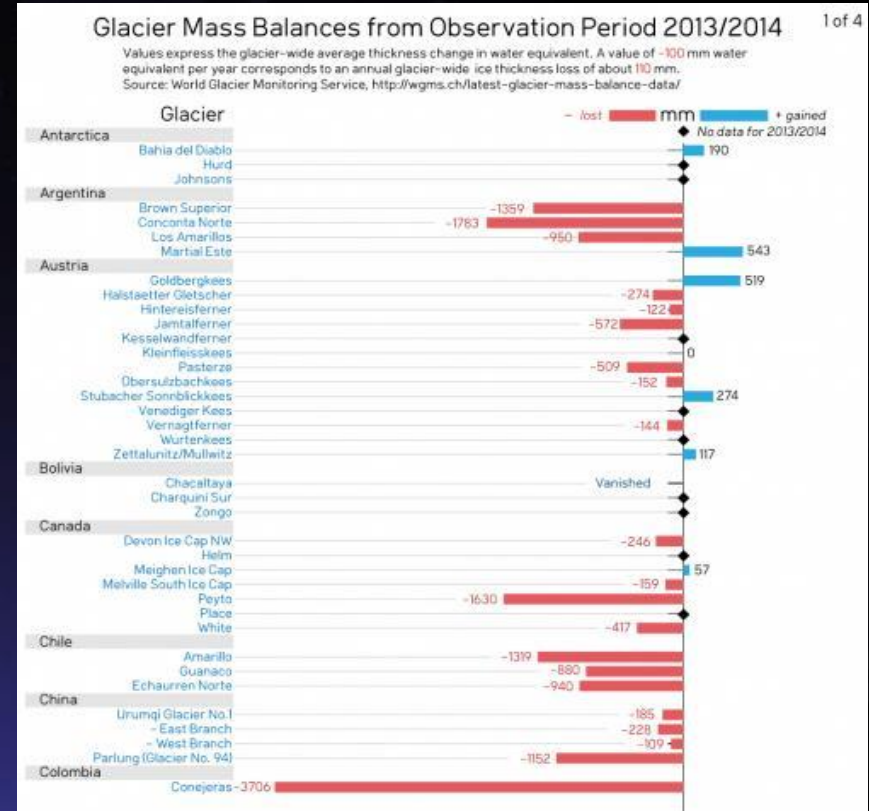
Glaciers around the world are increasing, disproving global warming.

## FALLACY

Picking a handful of growing glaciers ignores the vast majority of glaciers that are shrinking.



Cherry-  
picking



Skeptical Science - <https://skepticalscience.com/graphics.php?g=246>

<http://sks.to/glacier>



# Global Warming is happening

## FACT

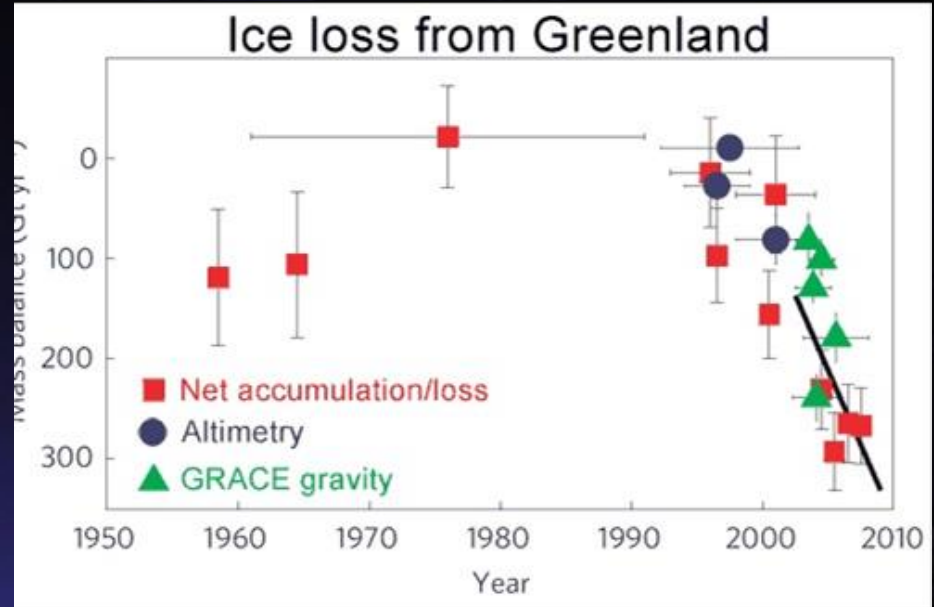
Greenland on the whole is losing ice, at a rate of over 2 Mount Everests worth of ice every year.

## MYTH

Greenland ice sheet is thickening in the middle so it must be gaining mass.

## FALLACY

Looking at the whole ice sheet shows it's thickening in the middle but ice loss at the edges is accelerating.



Estimated Greenland Ice Sheet mass balance changes since 1950 using three different methods (Jiang 2010)



Cherry-picking



<http://sks.to/greenland>





# Global Warming is happening

## FACT

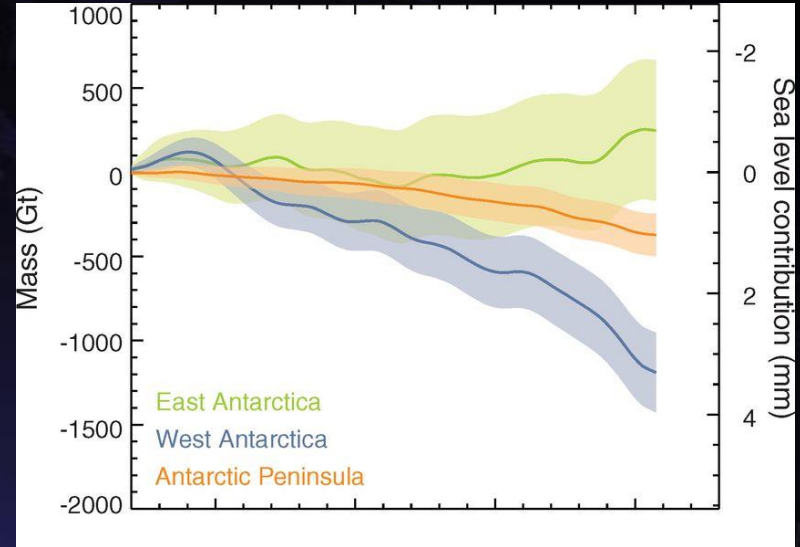
The West Antarctic ice sheet is losing hundreds of billions of tonnes of ice every year, making it a major contributor to global sea level rise.

## MYTH

Antarctic sea ice is on the increase and casts doubt on global warming.

## FALLACY

A number of factors may contribute to the increase in sea ice - but in no way does it change the fact that climate change is happening.



Estimates of total Antarctic land ice changes and approximate sea level contributions using a combination of different measurement techniques (Shepherd, 2012).



Over-

simplification



<http://sks.to/antarctica>



# Global Warming is happening

## FACT

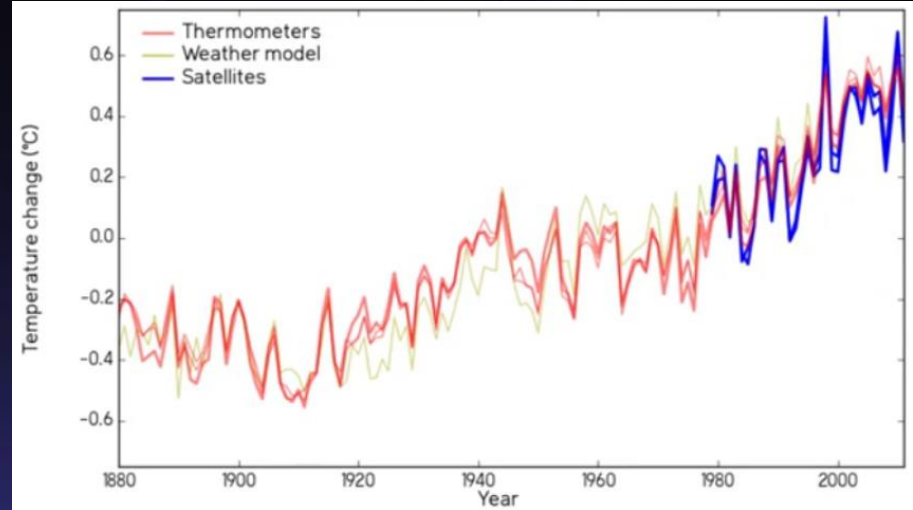
We can measure temperature in many ways and they all say the same thing - our planet is warming.

## MYTH

The thermometer record is unreliable.

## FALLACY

Just because measurements have uncertainties doesn't mean it's unknowable. The uncertainty is smaller than measured global warming.



Denial101x - 2.4.1. - <https://youtu.be/YKQiyBkt4Vs>



Jumping to  
conclusions



<http://sks.to/temp>



# Global Warming is happening

## FACT

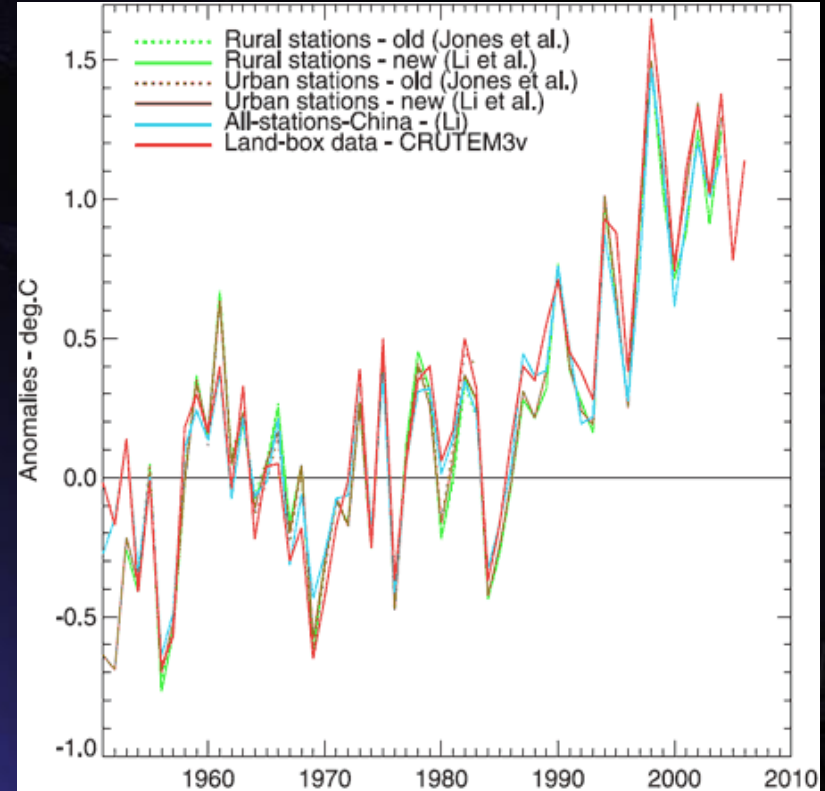
Urban heat has had minimal effect on the climate record, with much warming happening where there is little urban development.

## MYTH

Urban development is responsible for much of global warming over the last century.

## FALLACY

Just because urban heat might affect the climate record doesn't mean it does. Scientists have confirmed it has negligible effect.



Jumping to  
conclusions



<http://sks.to/uhi>



# Global Warming is happening

## FACT

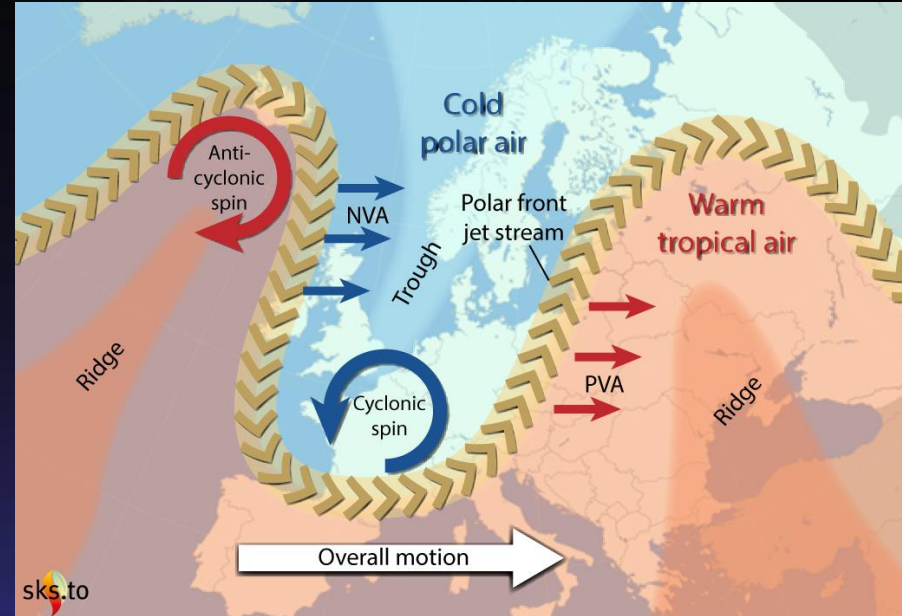
Slowing jet stream is causing Arctic cold air to leak down into Europe and North America, like an open fridge leaking cold air into the kitchen.

## MYTH

Record cold winters disprove global warming.

## FALLACY

A cold winter doesn't disprove global warming, you need to look at the big picture.



Skeptical Science: <https://skepticalscience.com/graphics.php?g=98>



Jumping to  
conclusions



<http://sks.to/winter>





# Global Warming is happening

## FACT

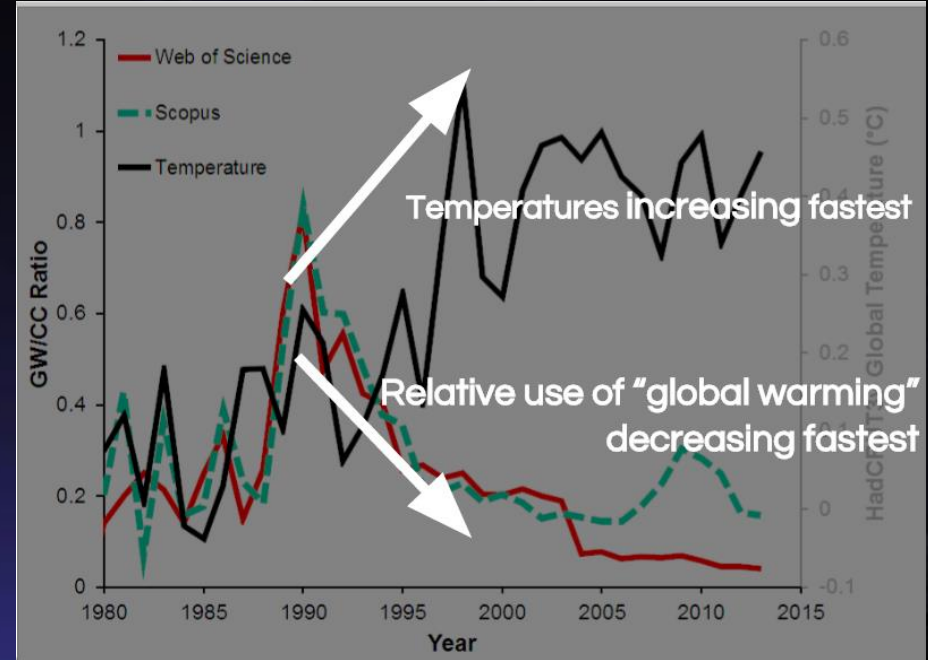
Climate change and global warming have both been used for decades.

## MYTH

They changed name from 'global warming' to 'climate change'.

## FALLACY

They didn't change the name (let alone in connection with temperature changes!)



Denial101x – 2.4.4.1



Misrepresentation



<http://sks.to/name>





# We are causing global warming

## FACT

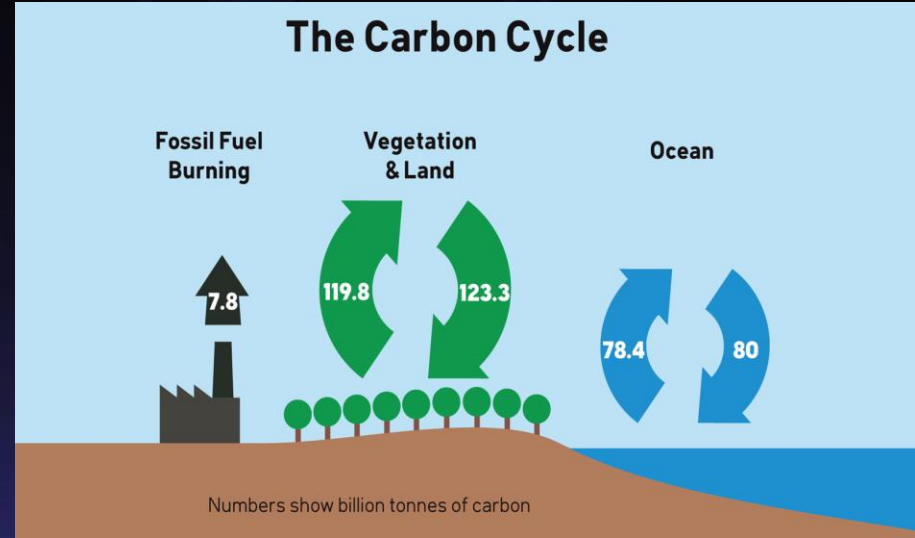
For thousands of years, our atmosphere has been in balance. Humans have upset the balance.

## MYTH

Human CO<sub>2</sub> emissions are tiny compared to natural CO<sub>2</sub> emissions so our influence is negligible.

## FALLACY

Considers only natural CO<sub>2</sub> emissions and ignores natural CO<sub>2</sub> sinks.



Denial101x – 3.2.1.1



Over-

simplification



<http://sks.to/co2>



# We are causing global warming

## FACT

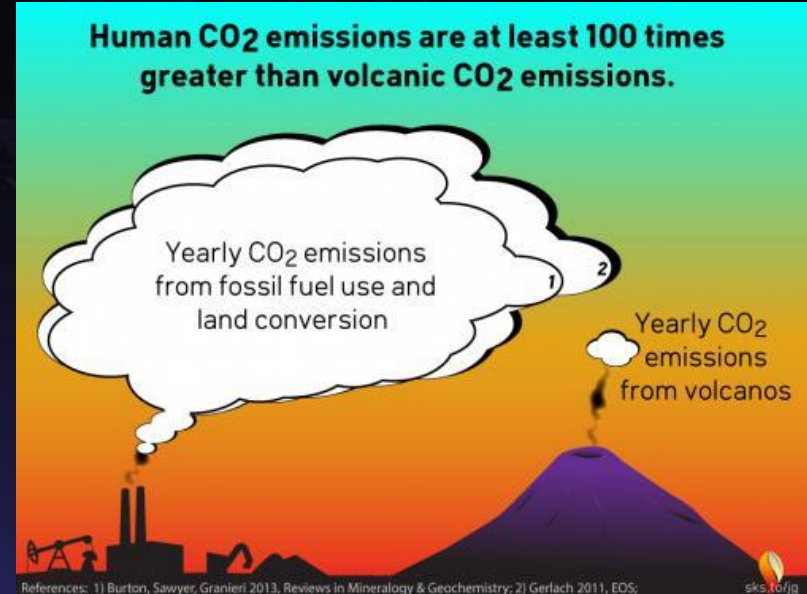
Human emissions are responsible for all of the increase in CO<sub>2</sub> in the air over the past two centuries.

## MYTH

Volcanoes produce more CO<sub>2</sub> than humans.

## FALLACY

Volcanoes do produce CO<sub>2</sub>, but over recent centuries the amounts are too small to account for the observed changes in the air.



Skeptical Science - <https://skepticalscience.com/graphics.php?g=28>



Jumping to  
conclusions



<http://sks.to/volcano>



# We are causing global warming

## FACT

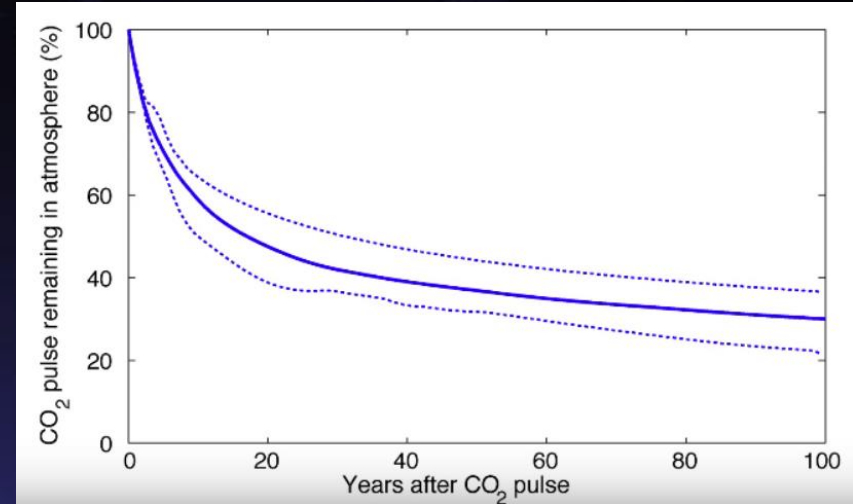
If we stopped emitting CO<sub>2</sub>, it would take thousands of years for the atmosphere to return to pre-industrial levels.

## MYTH

CO<sub>2</sub> has a residence time of only 4 years so CO<sub>2</sub> levels would fall quickly if we stopped emitting.

## FALLACY

How quickly a CO<sub>2</sub> molecule moves around the climate system is different to how long it takes CO<sub>2</sub> level to return back to normal.



Denial101x – 3.2.3.1



<http://sks.to/residence>



Over-  
simplification

# We are causing global warming

## FACT

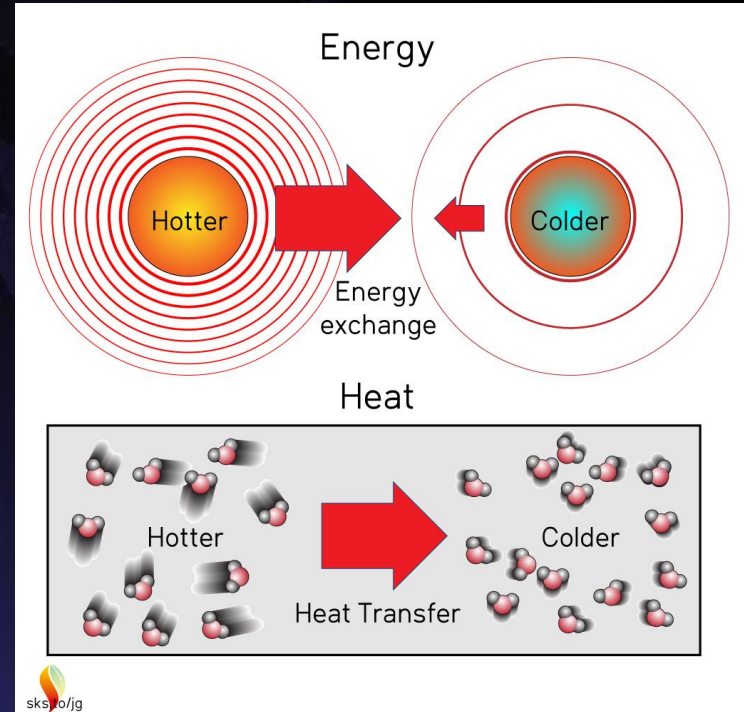
Greenhouse gases are like a blanket. They trap heat, sending it back down to Earth where we measure it.

## MYTH

Greenhouse effect violates the 2nd law of thermodynamics.

## FALLACY

2nd law talks about net flow of energy and doesn't forbid some flow from cool to hot.



Skeptical Science - <https://skepticalscience.com/graphics.php?g=304>



Misrepresentation



<http://sks.to/thermo>





# We are causing global warming

## FACT

Emitting more CO<sub>2</sub> means more heat is being trapped higher up in the atmosphere where the air is thinner.

## MYTH

The greenhouse effect is saturated so adding more CO<sub>2</sub> won't affect it.

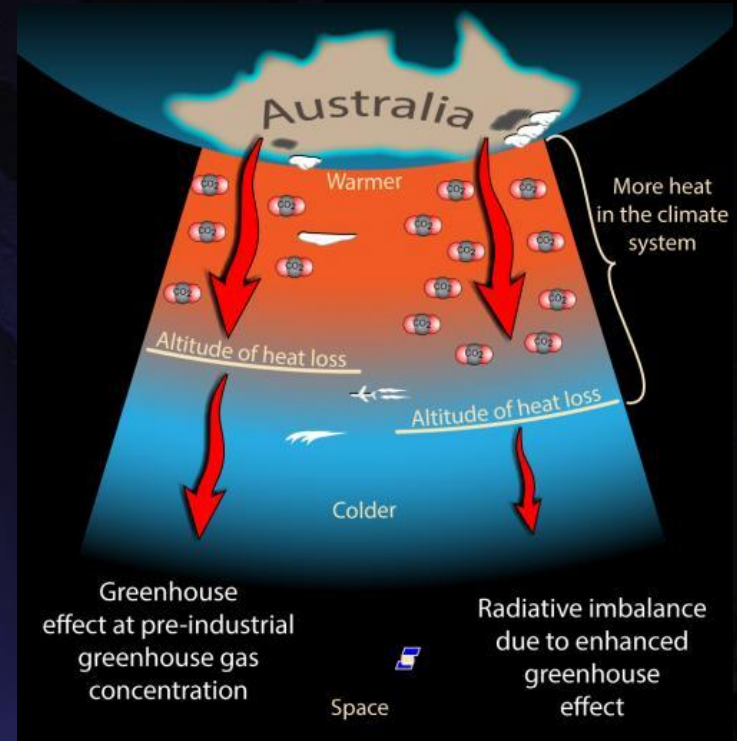
## FALLACY

Considers the atmosphere as a single layer when it's multiple layers.



Over-

simplification



Skeptical Science: <https://skepticalscience.com/graphics.php?g=104>

<http://sks.to/saturate>





# We are causing global warming

## FACT

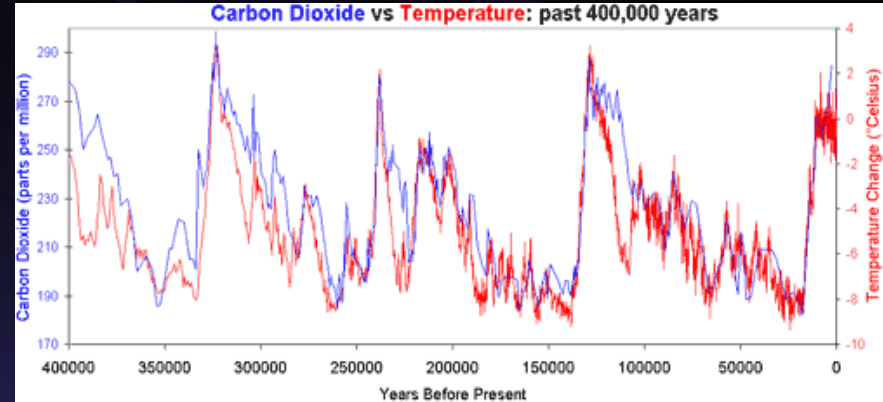
Ice cores tell us warming causes the ocean to emit more CO<sub>2</sub>. Combined with greenhouse effect, this is a reinforcing feedback.

## MYTH

CO<sub>2</sub> lagging temperature means greenhouse effect is minimal.

## FALLACY

It's not one or the other but both. CO<sub>2</sub> causes warming and warming causes CO<sub>2</sub> to rise.



Vostok Antarctic ice core records for carbon dioxide concentration (Petit 2000) and temperature change (Barnola 2003)



False  
Dichotomy



<http://sks.to/lag>



# We are causing global warming

## FACT

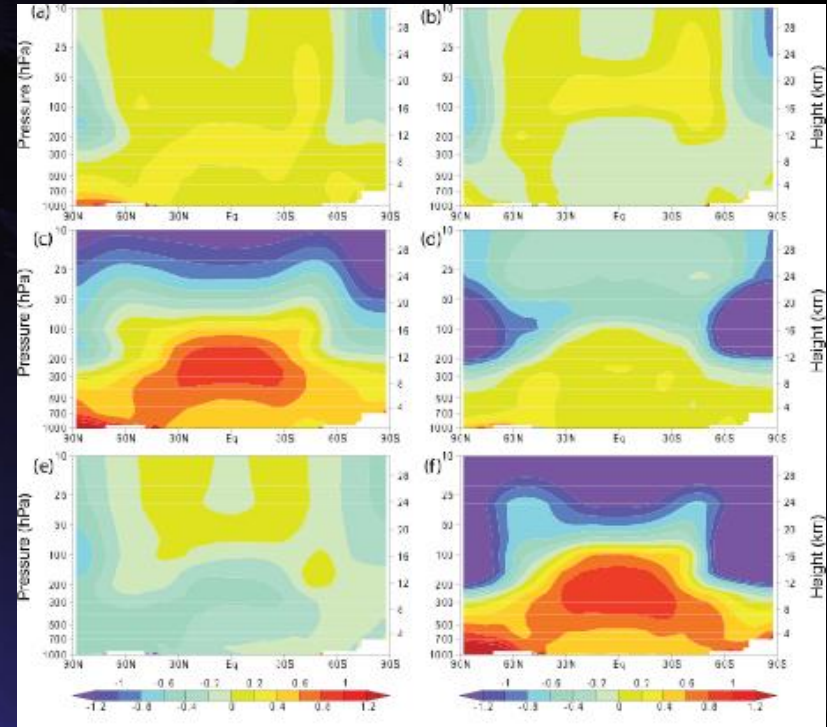
One human fingerprint is a cooling upper atmosphere with a warming lower atmosphere. Satellites have measured this pattern.

## MYTH

One fingerprint of human-caused global warming is the tropospheric hot spot which hasn't been observed.

## FALLACY

A hot spot should appear for any type of surface warming so is not linked uniquely to greenhouse warming.



Atmospheric temperature change from 1890 to 1990 from (a) solar forcing, (b) volcanoes, (c) greenhouse gases, (d) ozone, (e) sulfate aerosols and (f) sum of all forcing (IPCC AR4)



Red  
Herring



<http://sks.to/hotspot>



# We are causing global warming

## FACT

Satellites measure the warming effect from CO<sub>2</sub>. The increased greenhouse effect is an observed reality. It was predicted before it could be measured.

## MYTH

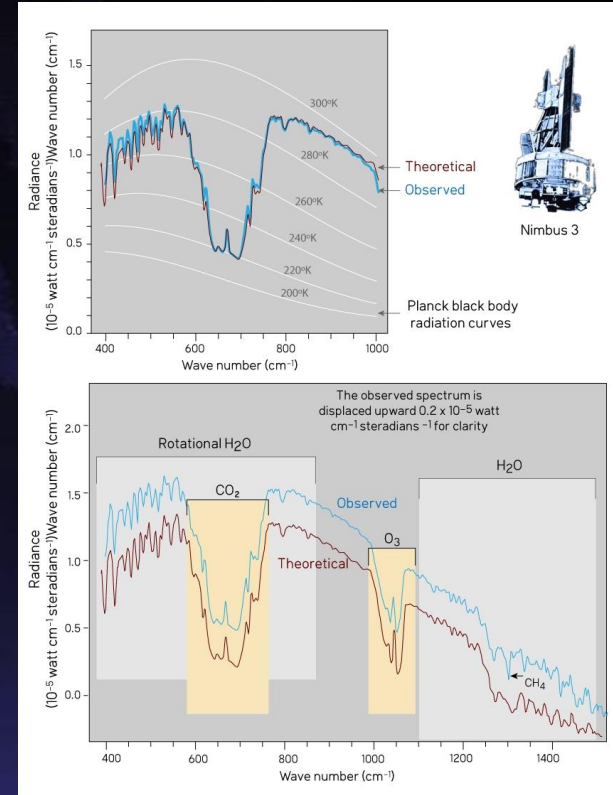
CO<sub>2</sub> is a trace gas so it's warming effect is minimal.

## FALLACY

The fact that CO<sub>2</sub> is a trace gas is irrelevant to whether it can impact climate. Trace amounts of substances can have a strong effect.



Red  
Herring



Skeptical Science - <https://skepticalscience.com/graphics.php?g307>

<http://sks.to/trace>



# We are causing global warming

## FACT

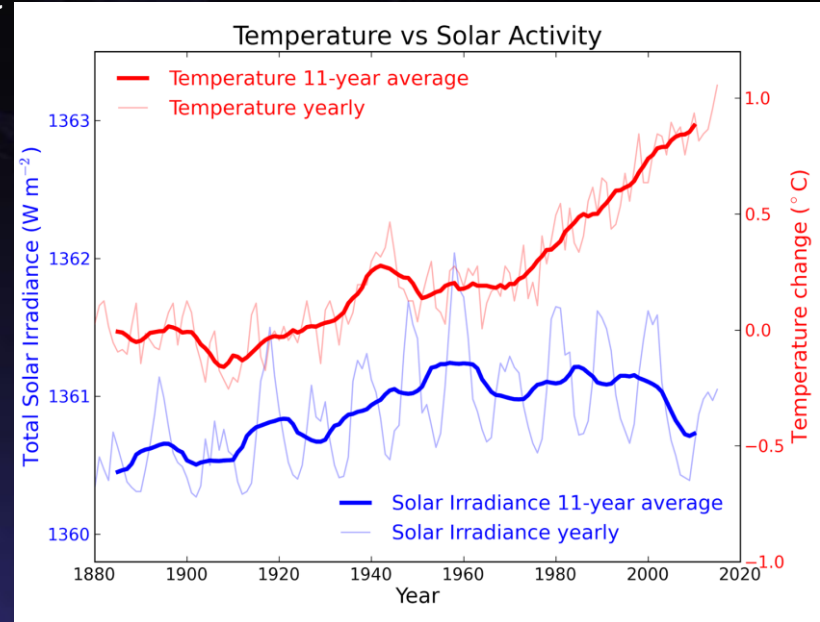
The Sun has been getting colder for the last 30 years as the Earth has been warming. Sun and climate are moving in opposite directions.

## MYTH

The sun is causing global warming.

## FALLACY

Ignores human fingerprints and recent period where sun and climate move in opposite directions.



Skeptical Science - <https://skepticalscience.com/graphics.php?g=5>



Cherry-  
picking



<http://sks.to/sun>





# Consensus

## FACT

Between 90 and 100 % of climate experts agree that we are mostly responsible for current global warming.

## MYTH

More than 31,000 scientists disagree with the consensus.

## FALLACY

The myth relies on fake experts and a magnified minority. Just about 0.1 % of signees are actively publishing climate scientists while most of them work in other areas.

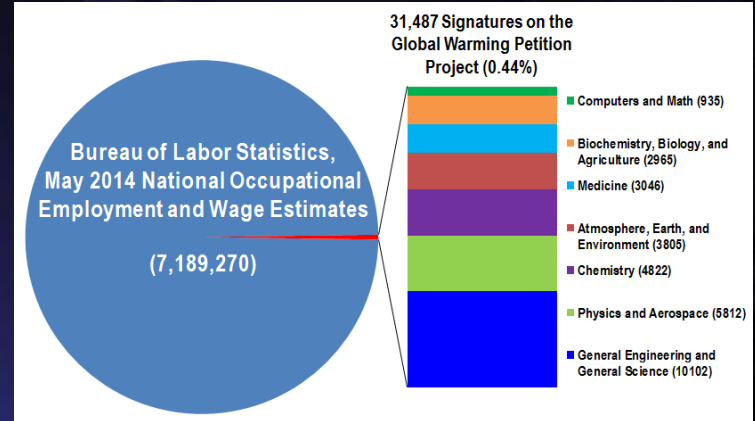
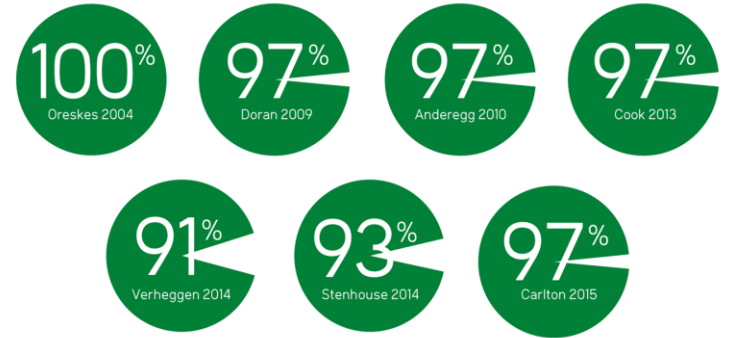


Fake  
Experts



Magnified  
Minority

Studies into scientific agreement on human-caused global warming



Brian Angliss – Scholars & Rogues (2015)

<http://sks.to/consensus>





# Past and future climate change

## FACT

Past climate change tells us climate is sensitive to the warming effect of  $\text{CO}_2$ .

## MYTH

Natural climate change in the past implies current climate change is also natural.

## FALLACY

Past climate change actually sends the opposite message than what the myth concludes.

*Humans have died naturally in the past...*

*...so this death must be natural!*



Jumping to  
conclusions



<http://sksto/past>



# Past and future climate change

## FACT

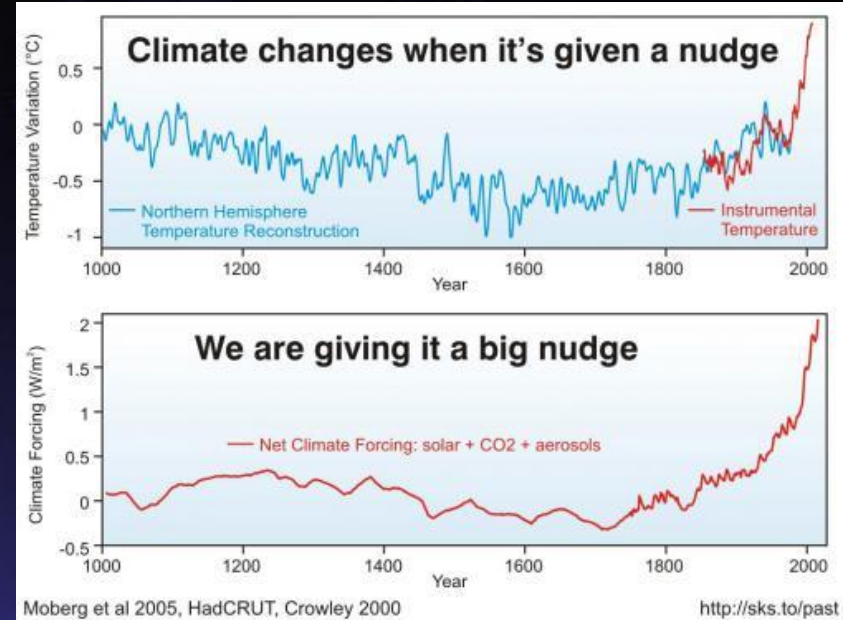
Natural influences that ended the Little Ice Age have been swamped by recent human activity.

## MYTH

Current warming is just the continuation of natural recovery from the Little Ice Age.

## FALLACY

The natural factors that ended the Little Ice Age are no longer significant.



Skeptical Science - <https://skepticalscience.com/graphics.php?g=40>



Red  
Herring



<http://sks.to/lia>



# Past and future climate change

## FACT

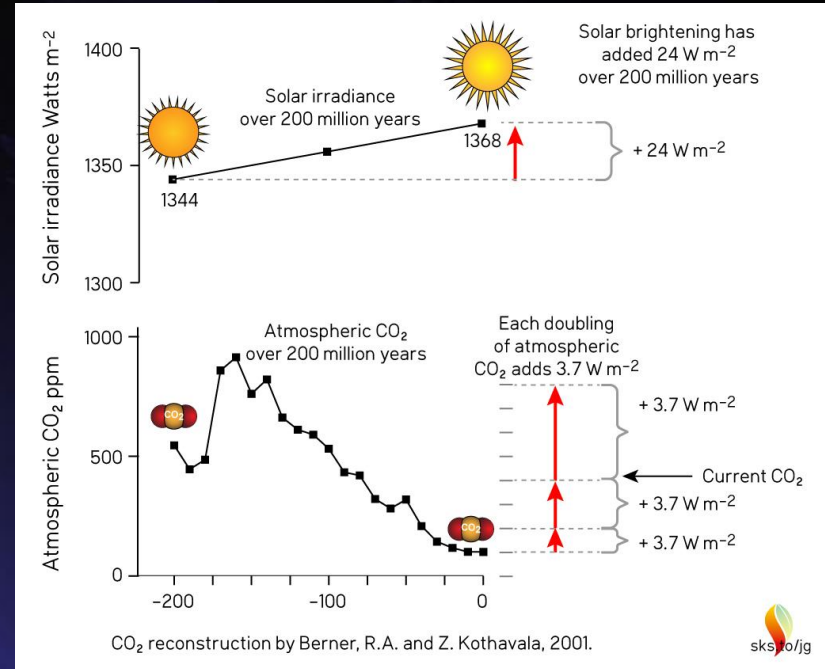
In the past when the sun was cooler, CO<sub>2</sub> was higher. The two roughly balanced each other. We are now raising CO<sub>2</sub> levels with a warmer sun.

## MYTH

CO<sub>2</sub> was higher in the past but the world didn't boil away so the greenhouse effect is weak.

## FALLACY

Ignores the role of the sun which was cooler in the past.



Skeptical Science - <https://skepticalscience.com/graphics.php?g=303>



Cherry-  
picking



<http://sks.to/pastco2>



# Past and future climate change

## FACT

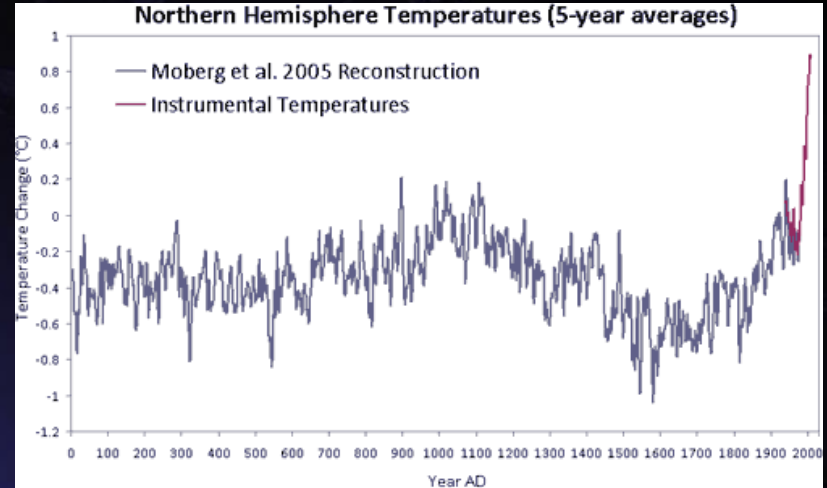
While the Medieval Warm Period saw unusually warm temperatures in some regions, globally the planet was cooler than now.

## MYTH

The Medieval Warm Period was warmer than current conditions. This implies recent warming is not unusual and must be natural.

## FALLACY

For average temperature over wide regions, the hot regions were cancelled out by other cool regions.



Northern Hemisphere Temperature Reconstruction by Moberg et al. (2005) shown in blue, Instrumental Temperatures from NASA shown in Red.



Cherry-  
picking



<http://sks.to/mwp>





# Past and future climate change

## FACT

Models are based on fundamental physical principles.

## MYTH

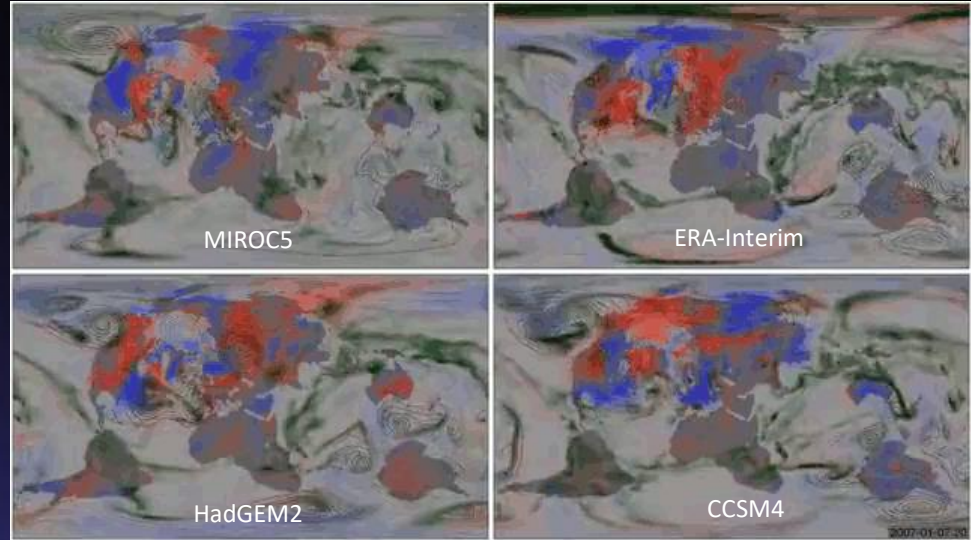
Models are unreliable.

## FALLACY

No model is perfect but they are useful tools that can reproduce the past and provide insights into the future.



Impossible  
Expectations



One of these panels shows observed weather (as estimated by Era-Interim); the other three weather simulated by three different climate models (HadGEM2, CCSM4, and MIROC5) - which is which? Click to find out!  
Video from Philip Brohan - <https://vimeo.com/213117747>





# Past and future climate change

## FACT

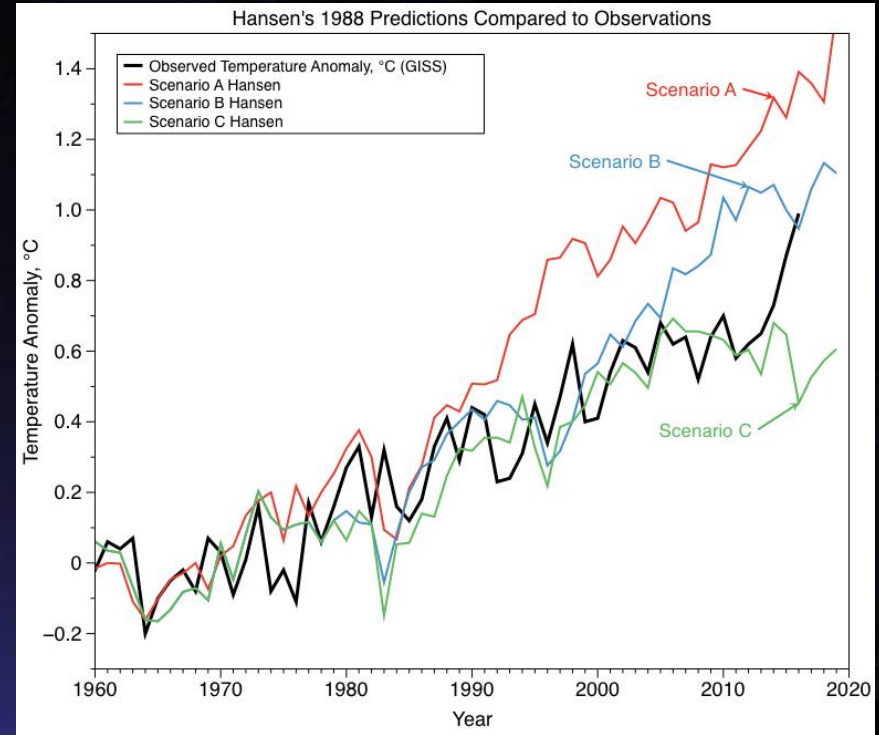
Models have made a number of successful predictions.

## MYTH

Models predictions have failed, making them unreliable.

## FALLACY

Climate models have had great success at predicting long-term effects like greenhouse warming.



Impossible  
Expectations



# Past and future climate change

## FACT

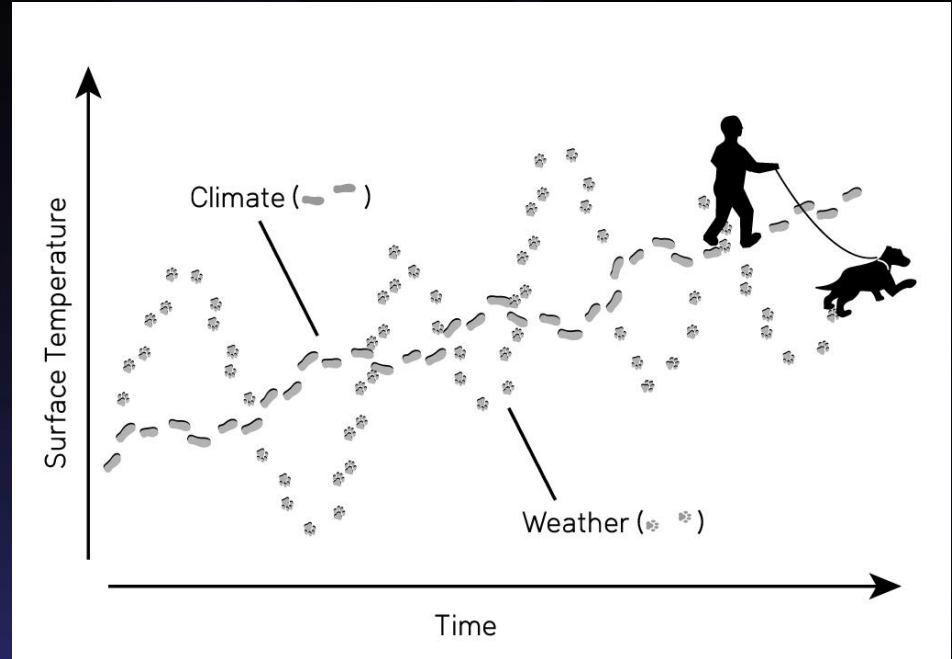
Climate models simulate climate which is weather averaged over time.

## MYTH

Scientists can't even predict weather.

## FALLACY

Confusing weather with climate distracts from the fact that short-term predictions have little relevance to long-term climate predictions.



Skeptical Science - <https://skepticalscience.com/graphics.php?g=308>



Red  
Herring



<http://sks.to/weather>



# Past and future climate change

## FACT

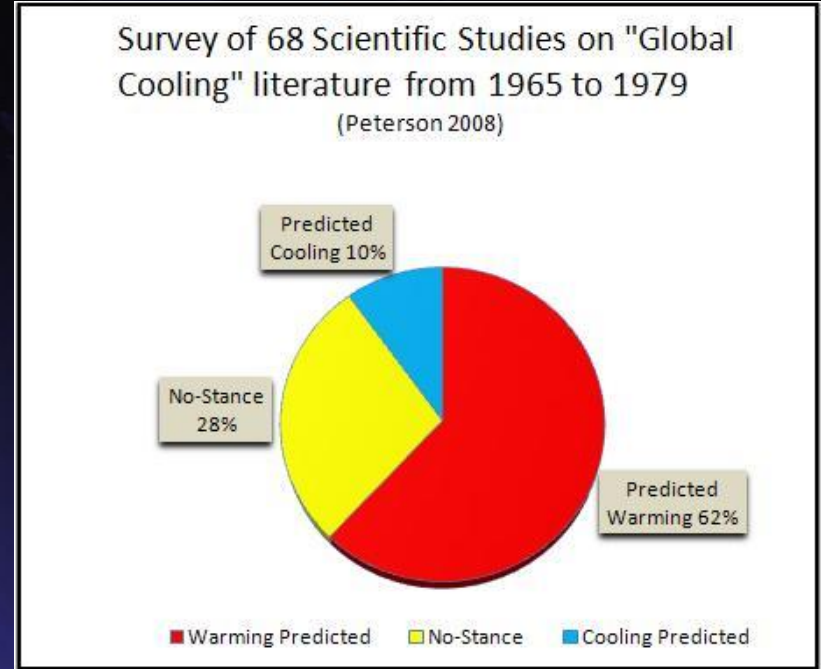
In the 1970s, the majority of climate papers were predicting warming.

## MYTH

In the 1970s, climate scientists were predicting an ice age.

## FALLACY

Confuses mainstream media reports with scientific papers which overwhelmingly pointed towards warming.



Misrepresentation



# Past and future climate change

## FACT

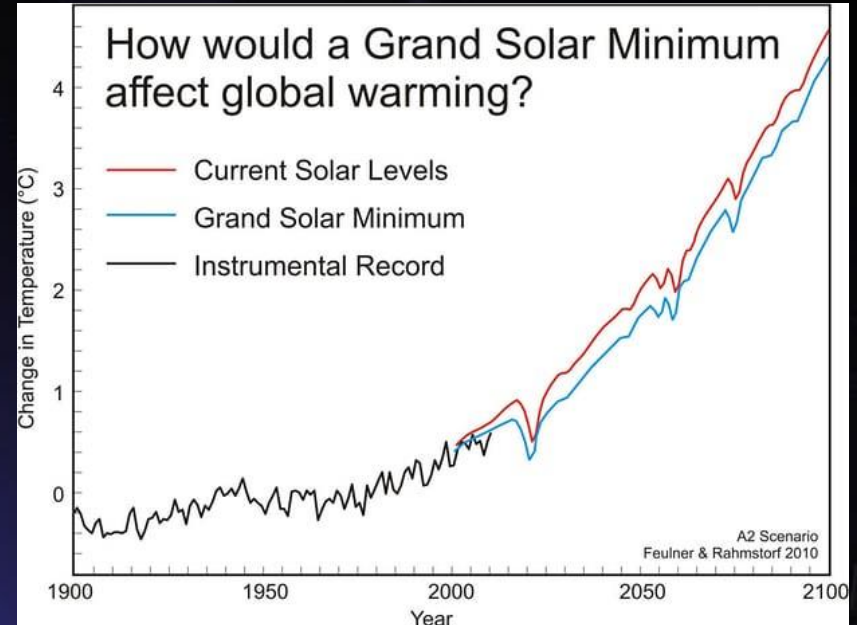
Even if the sun fell to Maunder Minimum levels, it would only delay global warming by a decade.

## MYTH

We're heading into another ice age because of the cooling sun.

## FALLACY

Overstating the role of solar activity on climate - it actually has had little effect.



Skeptical Science - <https://skepticalscience.com/graphics.php?g=21>



Misrepresentation



<http://sks.to/iceage>





# Climate change impacts

## FACT

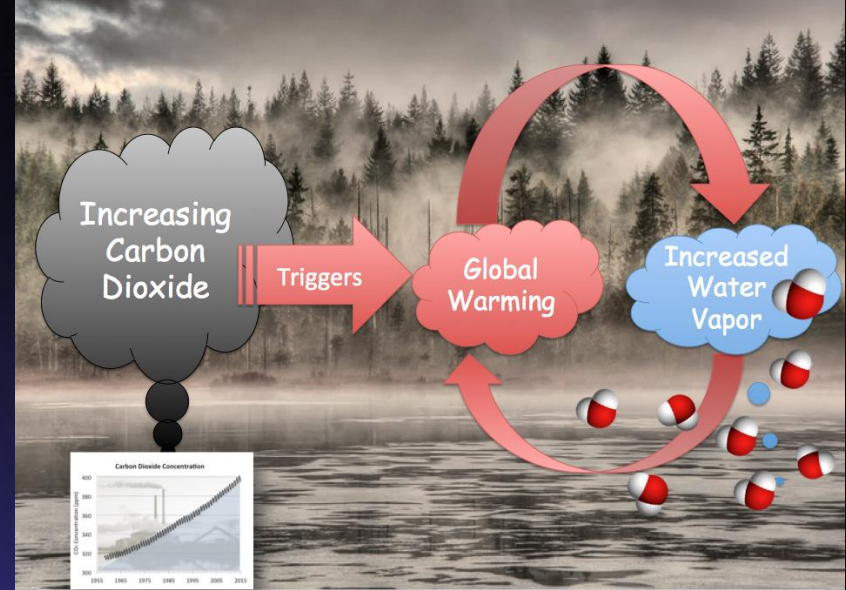
The amount of water vapor in the air depends on temperature. Warming causes water vapor to rise, which causes further warming: a reinforcing feedback.

## MYTH

Water vapor is the strongest greenhouse gas.

## FALLACY

The fact that water vapor is a strong greenhouse gas means it amplifies the warming from greenhouse gases.



Denial101x - 5.2.2 - Water Vapor



Red  
Herring



<http://sks.to/vapor>



# Climate change impacts

## FACT

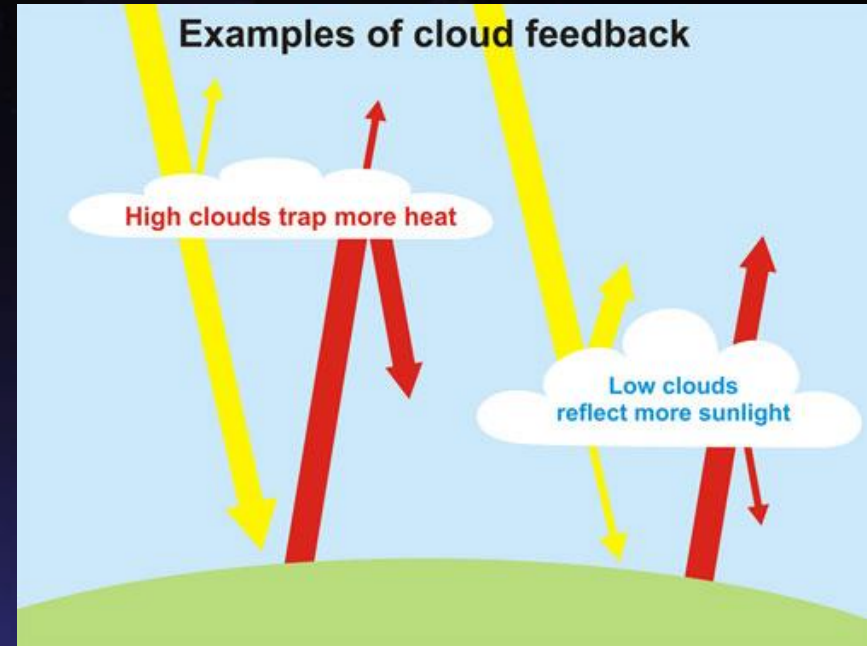
Clouds provide a reinforcing feedback but the effect isn't strong. Clouds play a minor role in climate sensitivity

## MYTH

Clouds provide negative feedback

## FALLACY

Acting as if clouds only have a cooling effect ignores that they can also warm.



Skeptical Science - <https://skepticalscience.com/graphics.php?g=21>



Over-

simplification



# Climate change impacts

## FACT

Mass extinctions happen when climate changes too fast for species to adapt. Currently species are going extinct at similar rates to past mass extinctions.

## MYTH

Species can adapt to climate change.

## FALLACY

Just because species can adapt to some climate change doesn't mean they can adjust to the rapid climate change happening now.

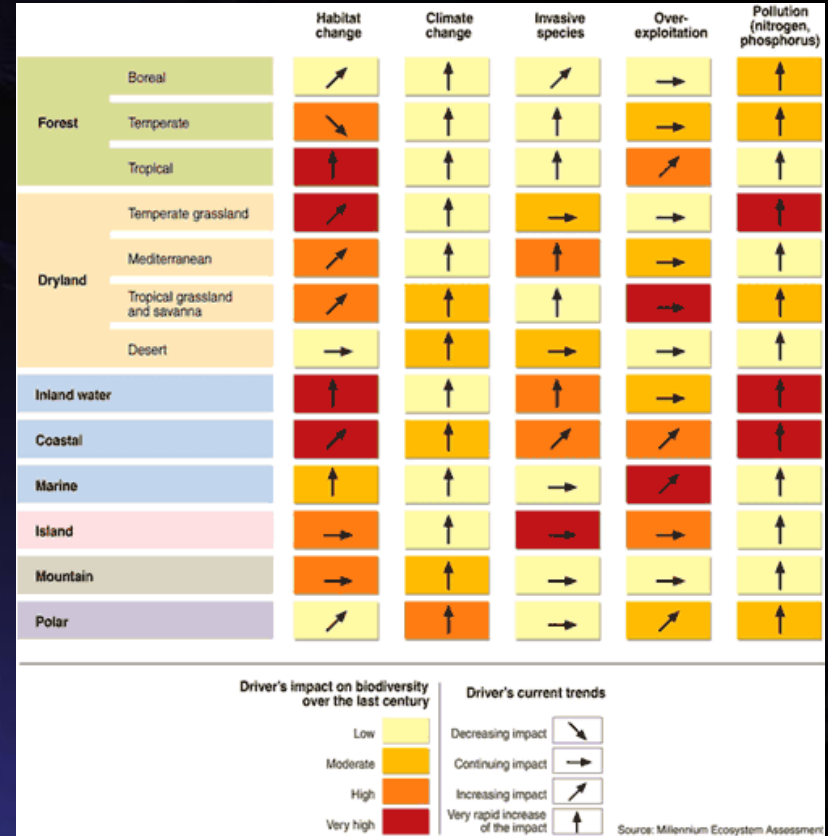


Figure from the [Millennium Ecosystem Assessment](http://www.millenniumassessment.org/)

# Climate change impacts

## FACT

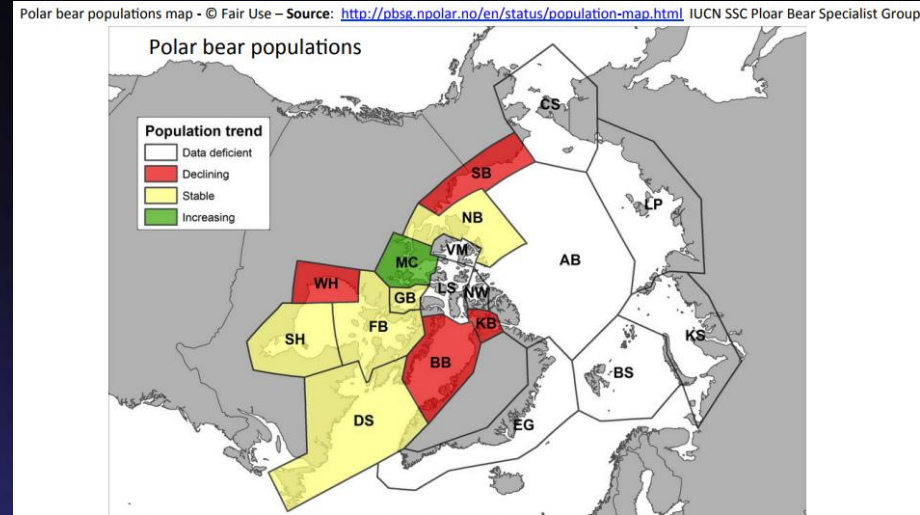
Polar bears need sea ice to hunt so the shrinking of Arctic sea ice is endangering their populations.

## MYTH

Polar bear numbers have increased so they're in no danger from global warming.

## FALLACY

One threat (hunting) has been removed but replaced with an increasing threat (melting sea ice).



Over-  
simplification





# Climate change impacts

## FACT

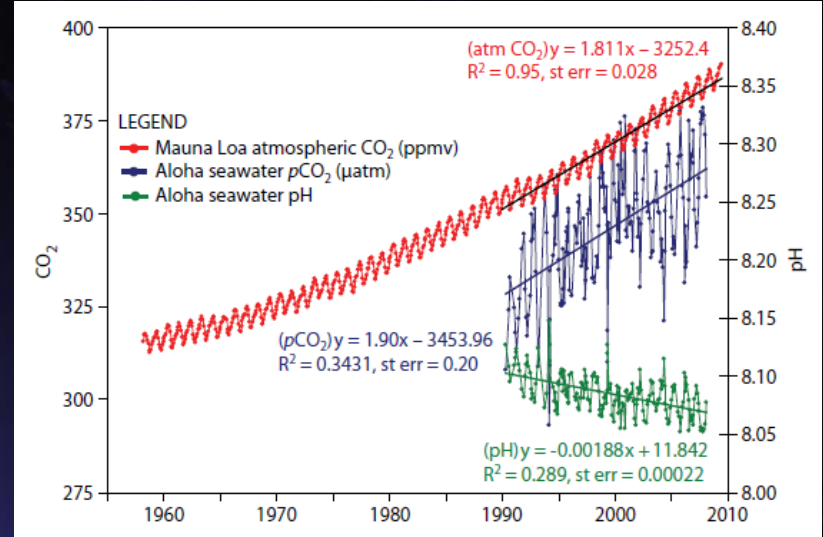
Ocean acidity has increased 30% and poses serious threats to coral reefs that are also threatened by warming oceans and bleaching.

## MYTH

Ocean acidification isn't serious.

## FALLACY

Ocean acidification means oceans are decreasing in pH so they are getting more acidic, even if they are not actually acid.



Annual variations in atmospheric CO<sub>2</sub>, oceanic CO<sub>2</sub>, and ocean surface pH. Strong trend lines for rising CO<sub>2</sub> and falling pH.



Misrepresentation



# Climate change impacts

## FACT

Climate change is having negative impacts on all parts of society.

## MYTH

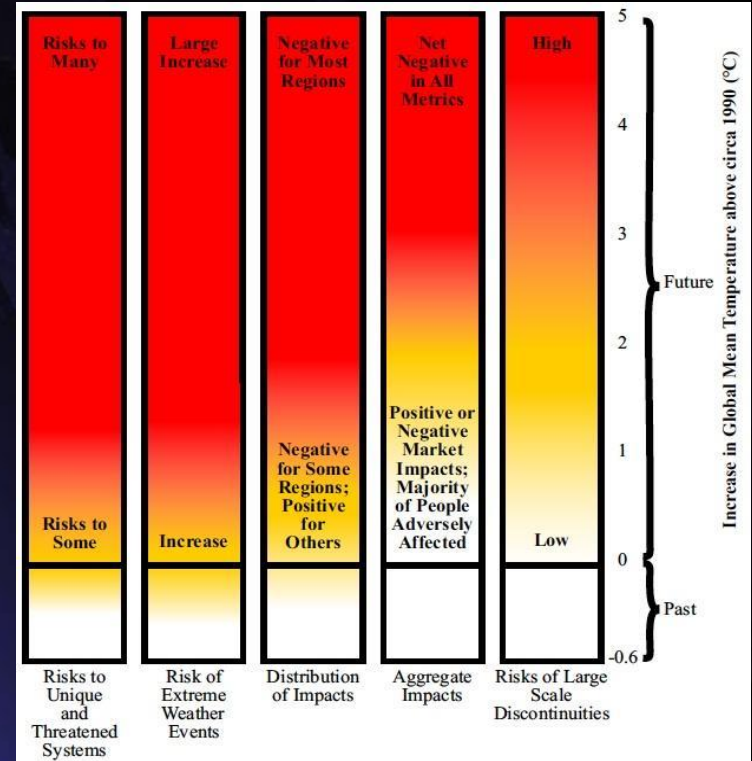
Global warming is good.

## FALLACY

This focuses on a few good impacts of global warming but ignores the overwhelming number of bad impacts.



Cherry-picking



"Burning embers" from IPCC AR5 WGII 2013

<http://sks.to/impacts>



# Climate change impacts

## FACT

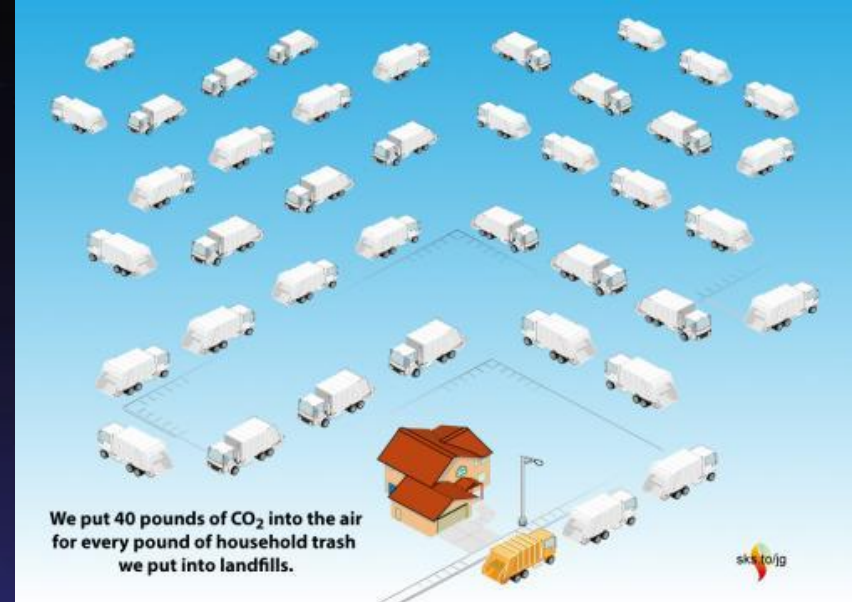
A pollutant is any substance that disrupts the environment - CO<sub>2</sub> does that by trapping heat.

## MYTH

CO<sub>2</sub> is not a pollutant.

## FALLACY

Quibbling over technical definitions of pollutant is a distraction from the realities of the negative impacts of global warming.



Skeptical Science - <https://skepticalscience.com/graphics.php?g=21>



Red  
Herring



<http://sks.to/pollutant>



# Climate change impacts

## FACT

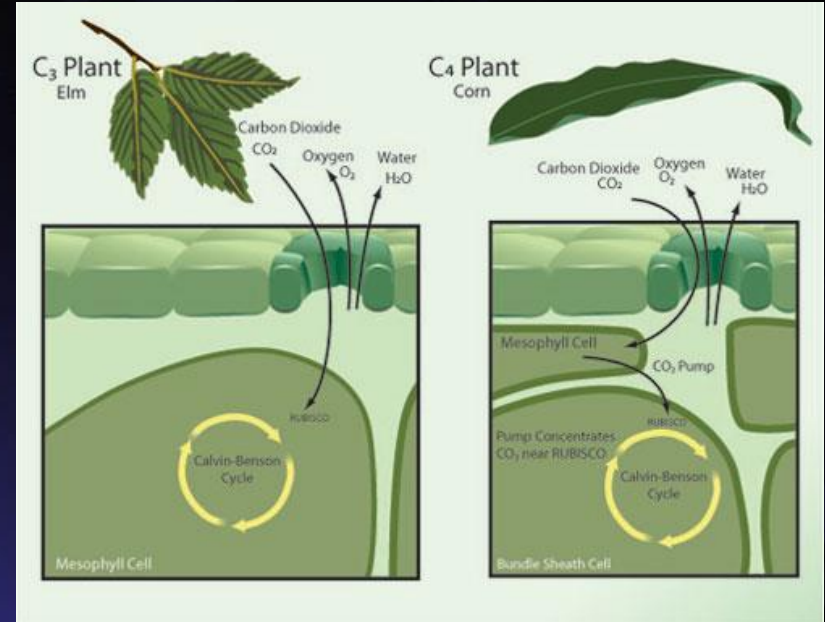
Climate change impacts agriculture through extreme weather: heat stress and flooding.

## MYTH

CO<sub>2</sub> is plant food.

## FALLACY

CO<sub>2</sub> fertilisation is just one factor affecting plant growth. The full picture shows that negative impacts outweigh benefits.



A simplified diagram contrasting C<sub>3</sub> vs. C<sub>4</sub> plant photosynthesis.  
From [Nature Magazine](http://nature.com).



Over-

simplification



<http://sks.to/plant>





# Climate change impacts

## FACT

Risk from extreme weather is increasing, albeit some forms of extreme weather are more confidently linked to global warming than others.

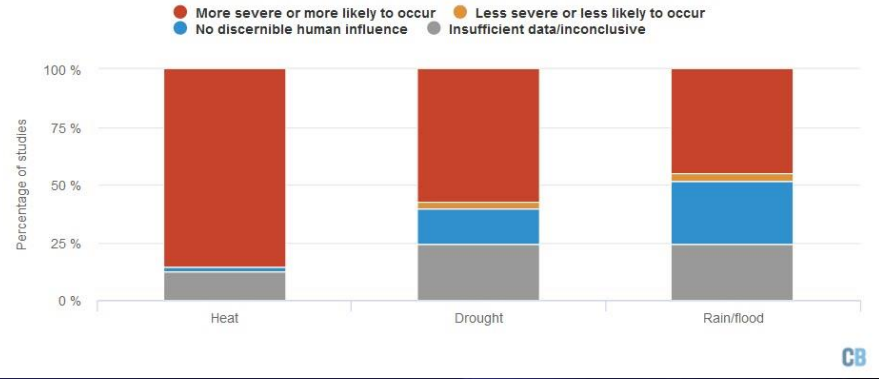
## MYTH

Extreme weather not linked to global warming.

## FALLACY

Just because extreme weather happened in the past doesn't mean climate change isn't having an influence now.

Human influence on most-studied types of extreme weather



Mapped: How climate change affects extreme weather around the world  
<https://www.carbonbrief.org/mapped-how-climate-change-affects-extreme-weather-around-the-world>



Jumping to  
conclusions



<http://sks.to/extreme>



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MOOC - <http://sks.to/denial101x>