



Climate Change Evidence & Causes

What is Climate?

- Refers to the average environmental conditions (i.e. temperature, precipitation, extreme events) in a given location over many years
- “Climate is what you expect, weather is what you get”
- Climate is not expected to change

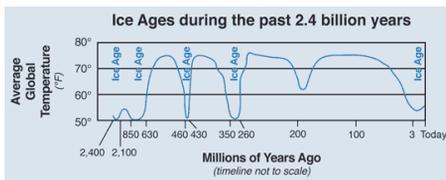
Is the Climate Changing?

Is the Climate Changing?

- Yes!
...But Earth's climate is always changing!

Is the Climate Changing?

- Throughout its 4.5 billion year history, Earth's climate has alternated between periods of warmth and relative cold, each lasting for tens to hundreds of millions of years.



Is the Climate Changing?

- But...the current rate of change is unprecedented! And it is human-induced!



Climate Change: How Do We Know?

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- Scientists study past climate by analyzing rocks, fossils, pollen grains, tree rings, and ice.



- They use remote sensing data.
- They compare historical to current data and analyze statistical models.



Climate Change: How Do We Know?

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- All of this data is combined in internationally respected reports:

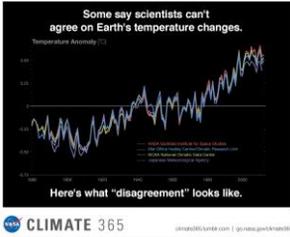
- IPCC Fifth Assessment – Intergovernmental Panel on Climate Change
- Climate Change Evidence & Causes (Royal Society and the US National Academy of Sciences)



Temperature Records

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- Clearer evidence for climate change comes from worldwide temperature records.
- Data shows that the global average surface temperature has increased by 0.8°C since 1900.



- What's more...



NASA's analysis of the last 132 years of global temperatures shows a consistent long-term warming trend.

CLIMATE 365 [climate365.tumblr.com](http://climate.nasa.gov) | go.nasa.gov/climate365

<http://climate.nasa.gov/vital-signs/global-temperature/>

Ice Cores

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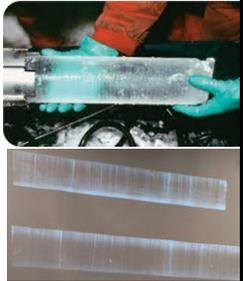
- Samples from ice fields show layers created by snowfall, which alternate with summer deposits of pollen and dust.
 - These provide physical timelines of glacial cycles.
- Air bubbles in the ice provide a direct measurement of atmospheric carbon dioxide (CO₂) levels at the time the ice was laid down.



Ice Cores

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- Measurements from ice cores show that atmospheric CO₂ increased by about 40% from 1800 to 2012.
- Isotope analysis of the carbon also show that this increase is due to human activities, not natural cycles.



Atmospheric carbon dioxide is at its highest level in human history.



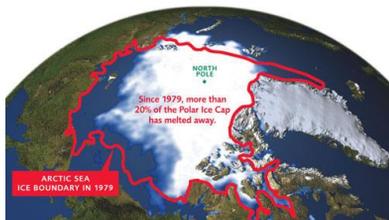
Ice Sheets

- The Greenland and Antarctic ice sheets have decreased in mass.



Ice Sheets

- Both the extent and thickness of Arctic sea ice has declined rapidly over the last several decades.

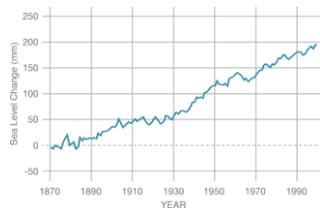


Glaciers

- Glaciers are retreating almost everywhere around the world.



Sea Levels



- Global sea level rose about 17 centimeters in the last century. The rate in the last decade, however, is nearly double that of the last century.

Sea Levels

- Inflow of water occurs from melting land ice, coupled with thermal expansion, or the increase in volume of water as it warms.



As the ocean level rises, it will impact coastal cities.

Other Evidence

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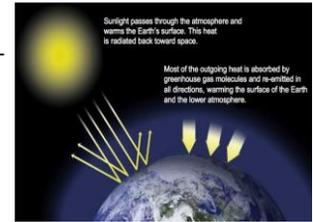
- Shifting climate patterns of El Nino and La Nina events
- Ocean warming and acidification
- Increased strength and frequency of hurricanes and other extreme events



Climate Change: Causes

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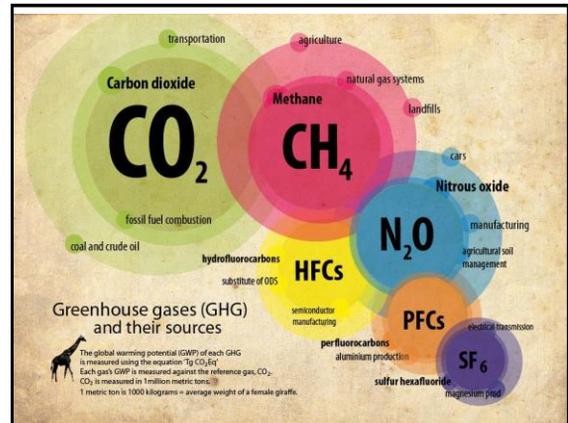
- Most climate scientists agree the main cause of the current global warming is human expansion of the "greenhouse effect".
- The greenhouse effect – A layer of gases act as a thermal blanket for the Earth, absorbing heat and warming the surface to a life-supporting average of 15°C.



Climate Change: Causes

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- Human activities are changing the natural greenhouse.
- Over the last century the burning of fossil fuels has increased the concentration of atmospheric carbon dioxide and nitrogen oxides.
- Deforestation, agricultural practices, decomposition of landfills, and other human activities have also increased these concentrations, as well as those of other greenhouse gases (methane, CFCs).



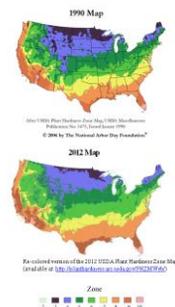
Climate Change: Effects

- More frequent wildfires
- Longer periods of drought and/or increased intensity of tropical storms depending on location



Climate Change: Effects

- Frost-free season (and growing season) will lengthen
- Arctic likely to become ice-free
- Sea level will rise 1-4 feet by 2100



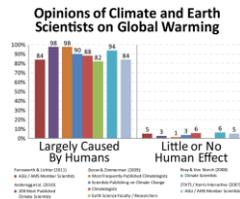
Are Scientists Sure We Caused It?

- A survey was taken in 2004 of 928 abstracts of peer-reviewed papers relating to climate change.

➤ None disagreed with the IPCC conclusions.

- A different survey was taken in 2009 of 3,146 Earth Scientists

➤ 97% agree with the IPCC conclusions.



Are Scientists Sure We Caused It?

- The evidence for this is found within the different isotopes of one of the atoms released by burning fossil fuels, carbon.
- No other point in the data record shows ratios similar to what is currently in the atmosphere.
- This points to human created, or anthropogenic greenhouse gas emissions, as a major contributor to global warming.