The Case for Anthropogenic Warming

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Is the globe warming?
What determines the Earth’s temperature?
What is the role of human activity?
How big is the problem?

Anthropogenic Warming

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The Great Greenland Thaw: July 2012


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Arctic Sea Ice Reaches New Low: August 2012


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Drought in the Midwest

http://www.mcclatchydc.com/2012/07/10/155668/midwest-drought-may-spark-food.html

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Global Mean Temperature

Technical Summary, IPCC AR4, p.37

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Jan-Jul Global Surface Mean Temp Anomalies

https://www.ncdc.noaa.gov/sotc/service/global/glob/201501-201507.gif

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Lake Vostok

http://www.gsfc.nasa.gov/via/a000000/a000500/a000996/index.html

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Lake Vostok

http://www.nst.gov/cover/srga-media/images/lake_vostok_int_0.jpg

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Core Samples


Antarctic Temperature Data

http://svs.gsfc.nasa.gov/vis/a000000/a000900/a000996/index.html

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Antarctic Temperature Data

Petit, et al., Nature 399 (June 3 1999), pp.429-436

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Ocean Sediment Cores

http://eo.ucar.edu/staff/rrussell/climate/paleoclimate/sediment_proxy_records.html

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Benthic $\delta^{18}O$ Data


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Is the globe warming? 
Yes, but, from a geologic perspective, not so much.

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Heat Balance

$$\sigma T^4 - (1 - \alpha)S = \text{solar incoming (visible)}$$

where $T$ = surface temperature (Kelvin)
$S$ = solar influx (W/m$^2$)
$\alpha$ = albedo (reflectivity)
$\sigma$ = the Stefan-Boltzmann constant

For current values, $T = 255K \approx 18^\circ C - 452$

Why isn’t the Earth a Snowball?
Greenhouse gases (CO$_2$, H$_2$O, CH$_4$) are transparent to visible light, but opaque to infrared light. The energy from the sun passes through the atmosphere and heats the surface. The surface radiates energy at a lower temperature (infrared), which is absorbed by the atmosphere.

Who discovered the greenhouse effect?


Why isn’t the Earth a Snowball?

The Greenhouse Effect!


Heat Balance

Historical Overview of Climate Change Science, IPCC AR4, p.96
http://www.ipcc-wg1.ucar.edu/wg1/summary/009_ch01.pdf

http://svs.gsfc.nasa.gov/vis/a000000/a000900/a000996/index.html

Remember Lake Vostok?

http://svs.gsfc.nasa.gov/vis/a000000/a000900/a000996/index.html
Anthropogenic Warming

Antarctic Temperature Data

Petit, et al., Nature 399 (June 3 1999), pp.429-436

Anthropogenic Warming

Atmospheric CO₂ (Vostok data)

Petit, et al., Nature 399 (June 3 1999), pp.429-436

Anthropogenic Warming

Atmospheric CO₂ & Temperature (Vostok data)

Pam Martin, University of Chicago, 2010

Vostok Data

Current conditions are well outside the range recorded in the ice core data.
Extrapolate linear regression to 400 ppm CO₂.