

Demystifying the Science of Climate Change

by debunking climate change denial



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Goals of the talk

- ⌘ What is climate?
- ⌘ What is the scientific evidence for human-caused climate change?
- ⌘ What are the common misconceptions and are they easy to explain?
- ⌘ Help to inform the public about the science behind it all

Defining climate

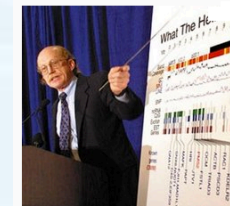
What is climate?

- ⌘ An understanding of the **long-term** (30 yr or longer) variation of weather patterns, including temperature and precipitation
- ⌘ Includes measures of average and “**normal**” weather as well as extremes, or **anomalies**
- ⌘ It includes impacts on other “spheres” - (biosphere, cryosphere, hydrosphere...)

National Science Foundation: Science Hard

NEWS • Science & Technology • Science • Government • ISSUE 45-01 ISSUE 38-21 • Jun 5, 2002

INDIANAPOLIS—The National Science Foundation's annual symposium concluded Monday, with the 1,500 scientists in attendance reaching the consensus that science is hard.



Farian explains the

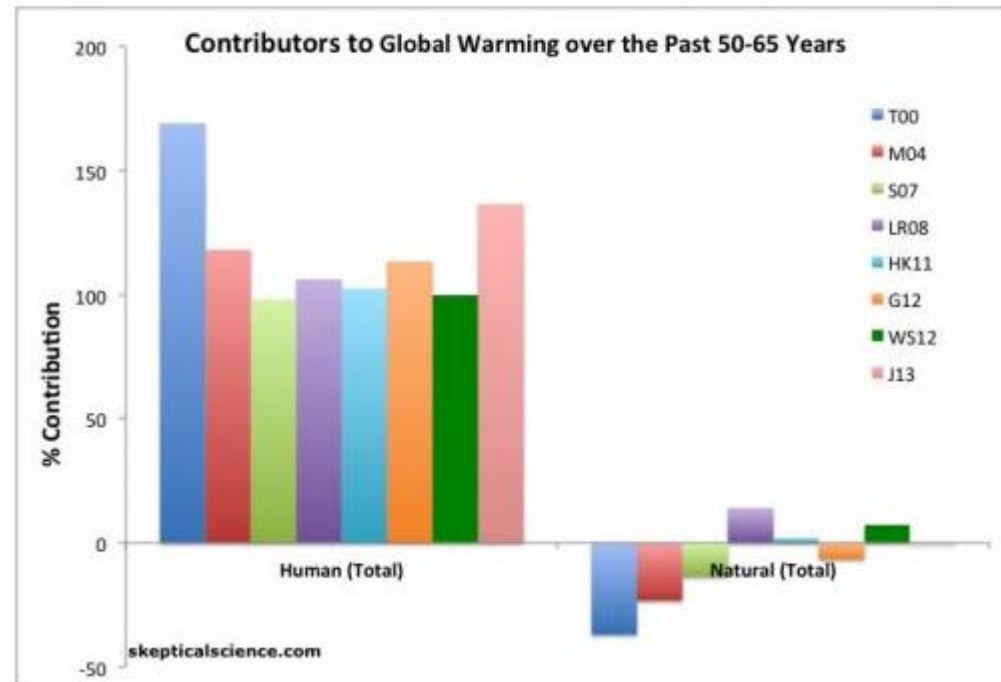
"For centuries, we have embraced the pursuit of scientific knowledge as one of the noblest and worthiest of human endeavors, one leading to the enrichment of mankind both today and for future generations," said keynote speaker and NSF chairman Louis Farian. "However, a breakthrough discovery is challenging our long-held perceptions about our discipline—the discovery that science is really, really hard."

Thanks to onion.com for this...

Defining human-caused climate change

Now we get to the interesting part!

Human vs. Natural Contributions to Global Warming



From John Cook's *Skeptical Science* web site, skepticalscience.com

MOST USED Climate Myths

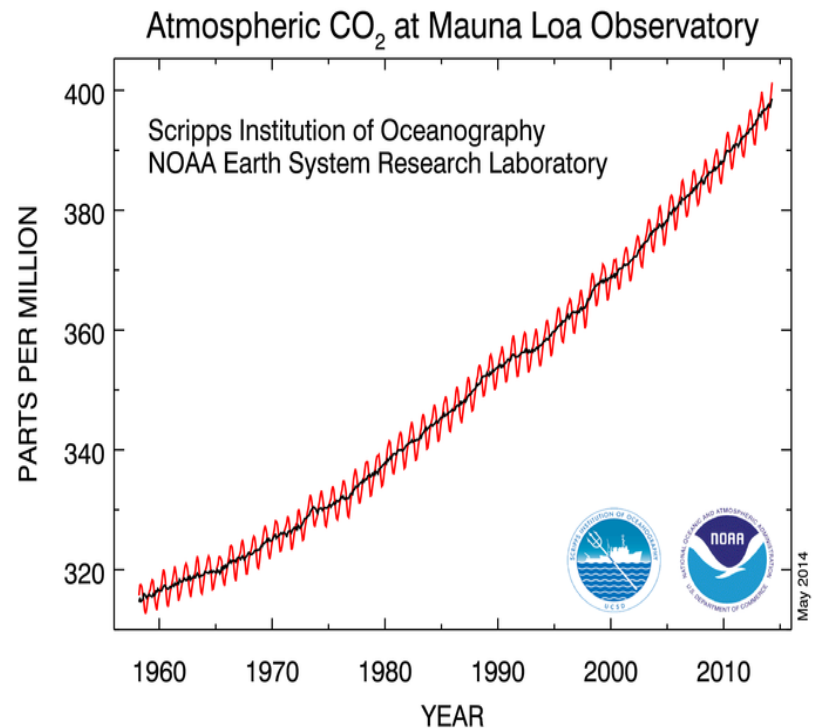
and what the science really says...

- 1 Climate's changed before
 - 2 It's the sun
 - 3 It's not bad
 - 4 There is no consensus
 - 5 It's cooling
 - 6 Models are unreliable
 - 7 Temp record is unreliable
 - 8 Animals and plants can adapt
 - 9 It hasn't warmed since 1998
 - 10 Antarctica is gaining ice
- [View All Arguments...](#)

Scientific understanding is evidence-based

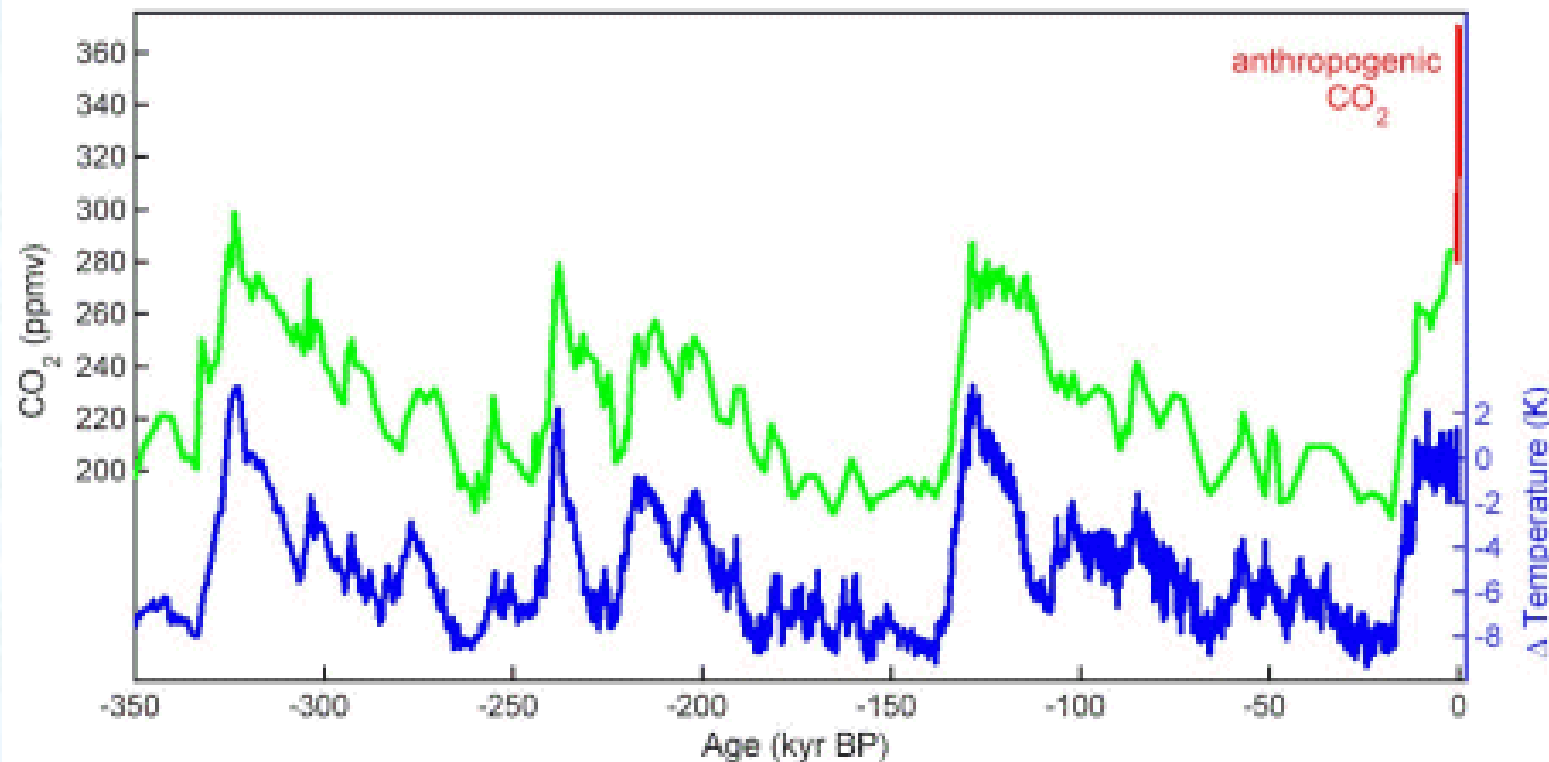
- ⌘ **Physics:** Carbon dioxide (CO_2) absorbs infrared radiation (IR) very efficiently
- ⌘ **Meteorology:** Earth emits and absorbs IR
- ⌘ **Chemistry:** Let's measure CO_2 !
- ⌘ **Biology:** Why does it see-saw every year?
- ⌘ *I wonder what makes it do this?*

Courtesy: NOAA/ESRL and Scripps Inst Oc



Exploring the myths...

1. The climate has changed before...so why worry?

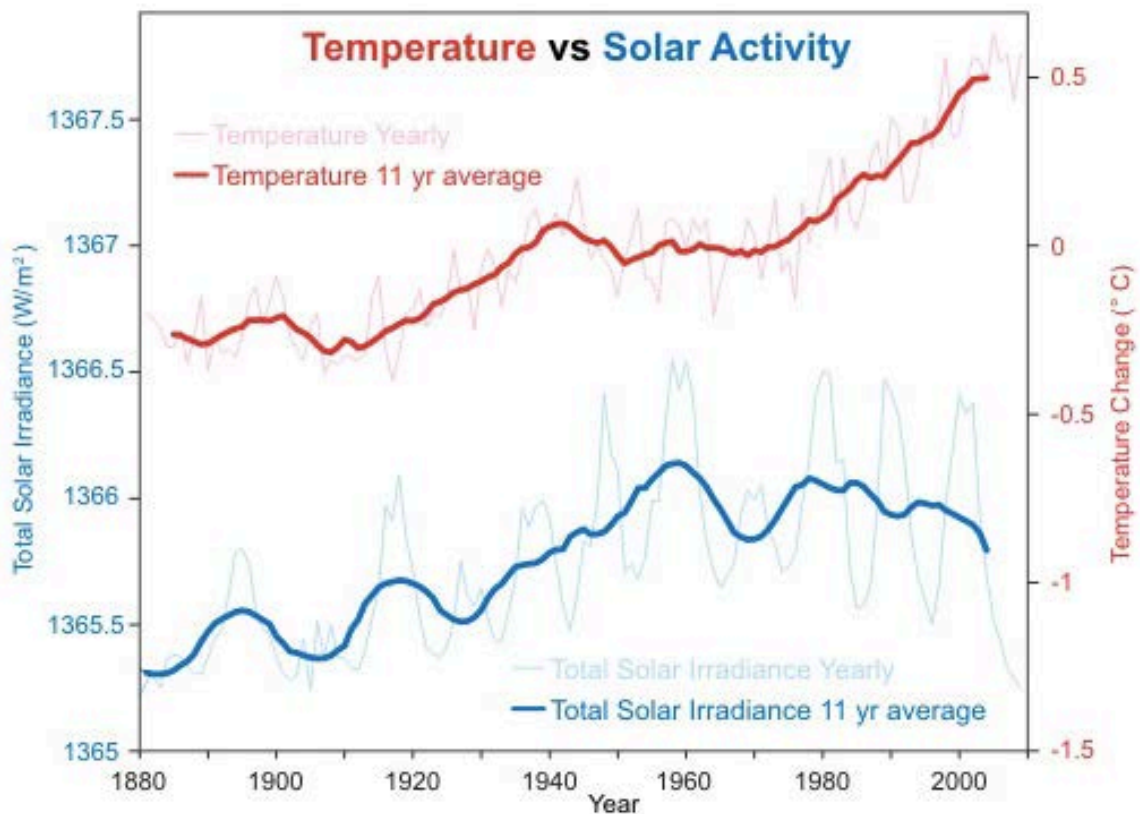


From John Cook's *Skeptical Science* web site, skepticalscience.com

Exploring the myths...

2. Climate change is due to changes in the Sun!

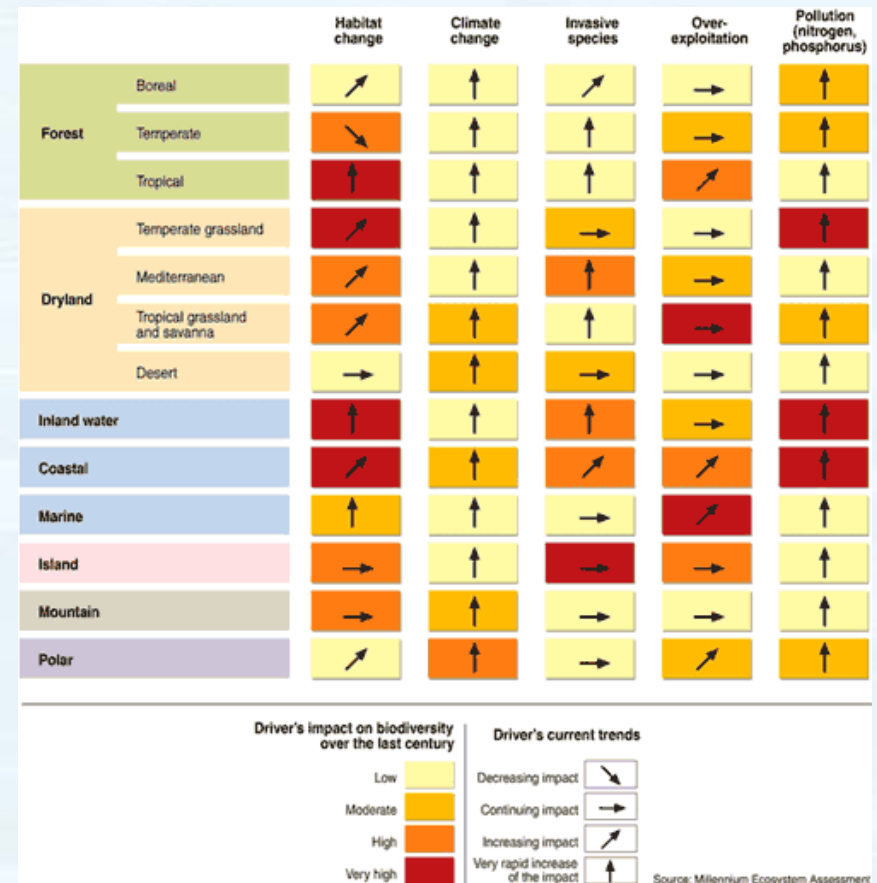
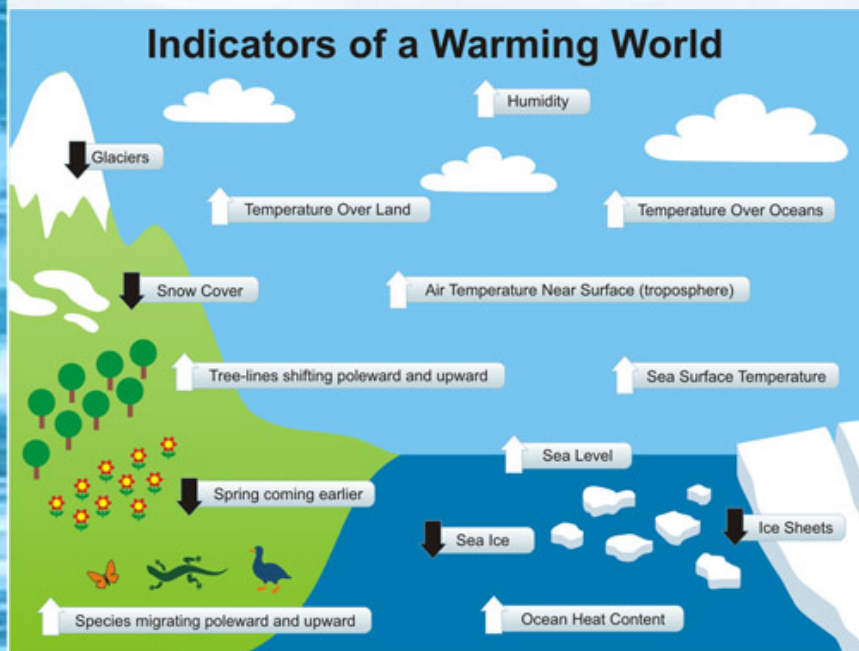
Solar vs Temperature



From John Cook's *Skeptical Science* web site, skepticalscience.com

Exploring the myths...

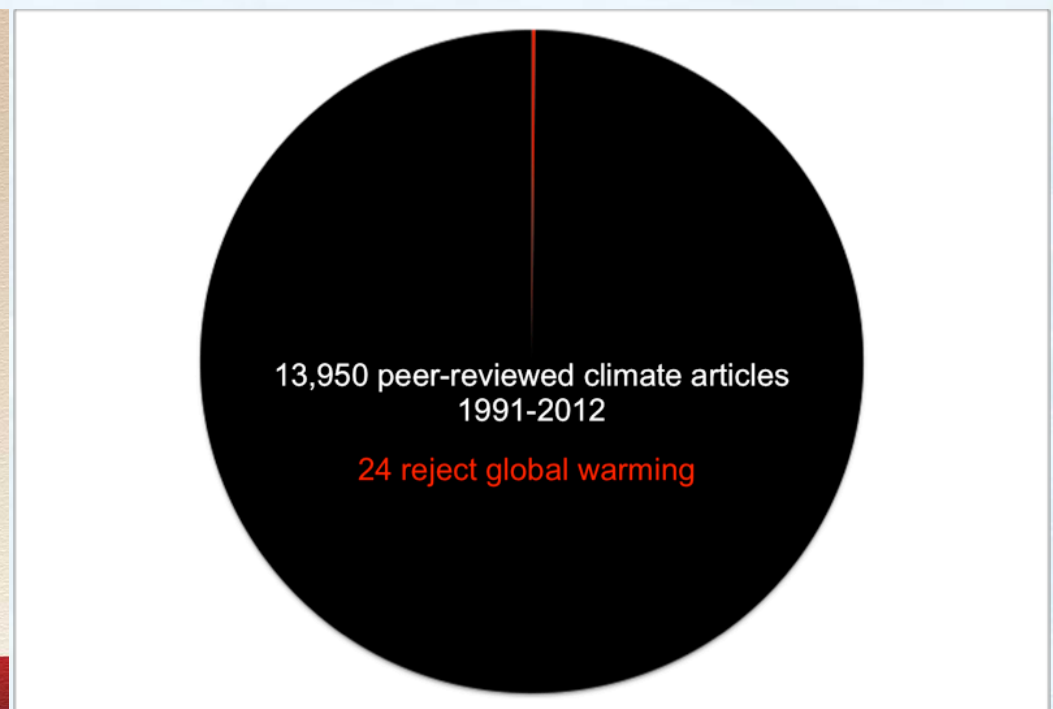
3. Climate change is not bad!



From John Cook's *Skeptical Science* web site, skepticalscience.com

Exploring the myths...

4. There is no consensus. Why, 31,000 scientists can't be wrong, ... can they?



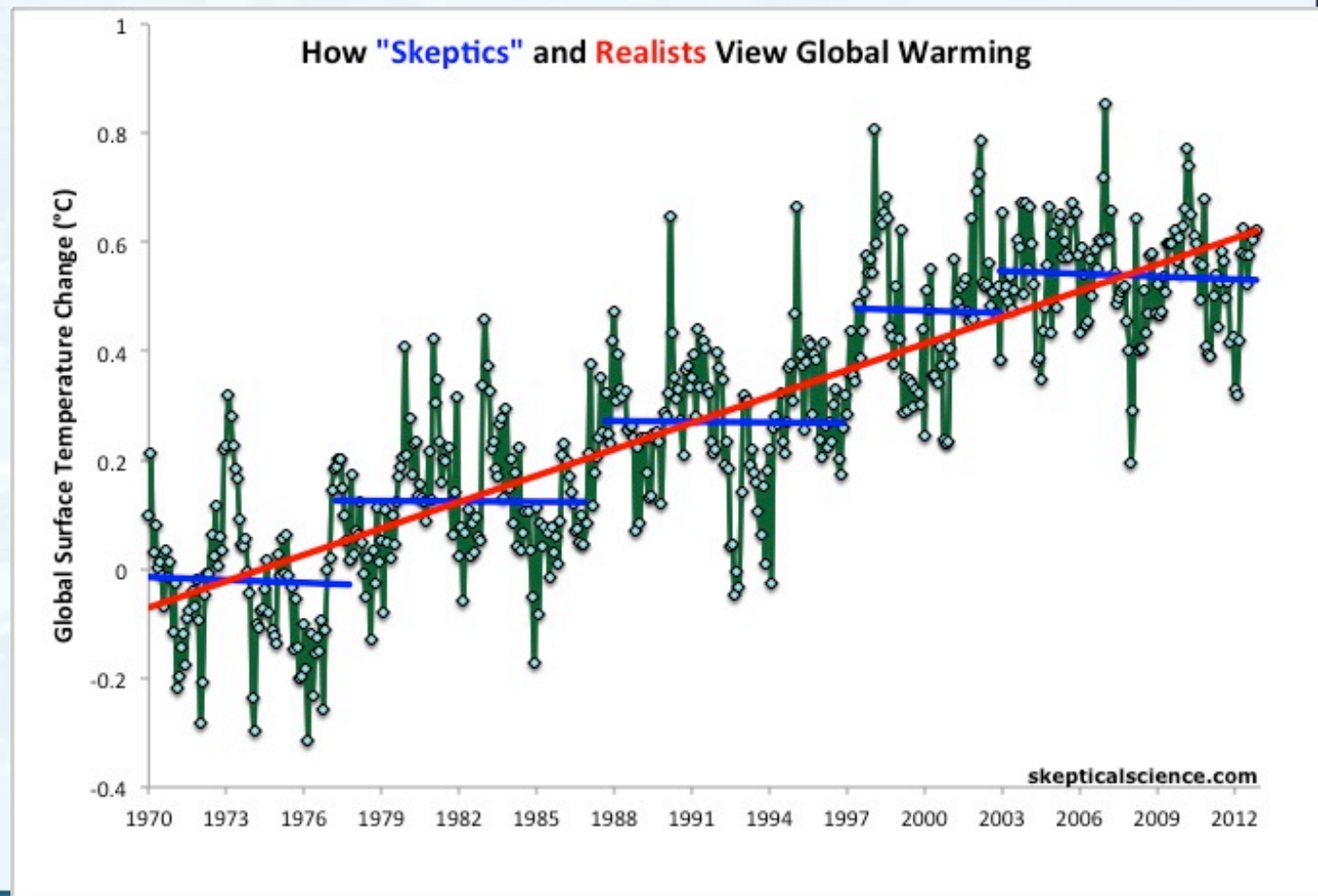
From John Cook's *Skeptical Science* web site, skepticalscience.com

Exploring the myths...

5. The climate is actually cooling...

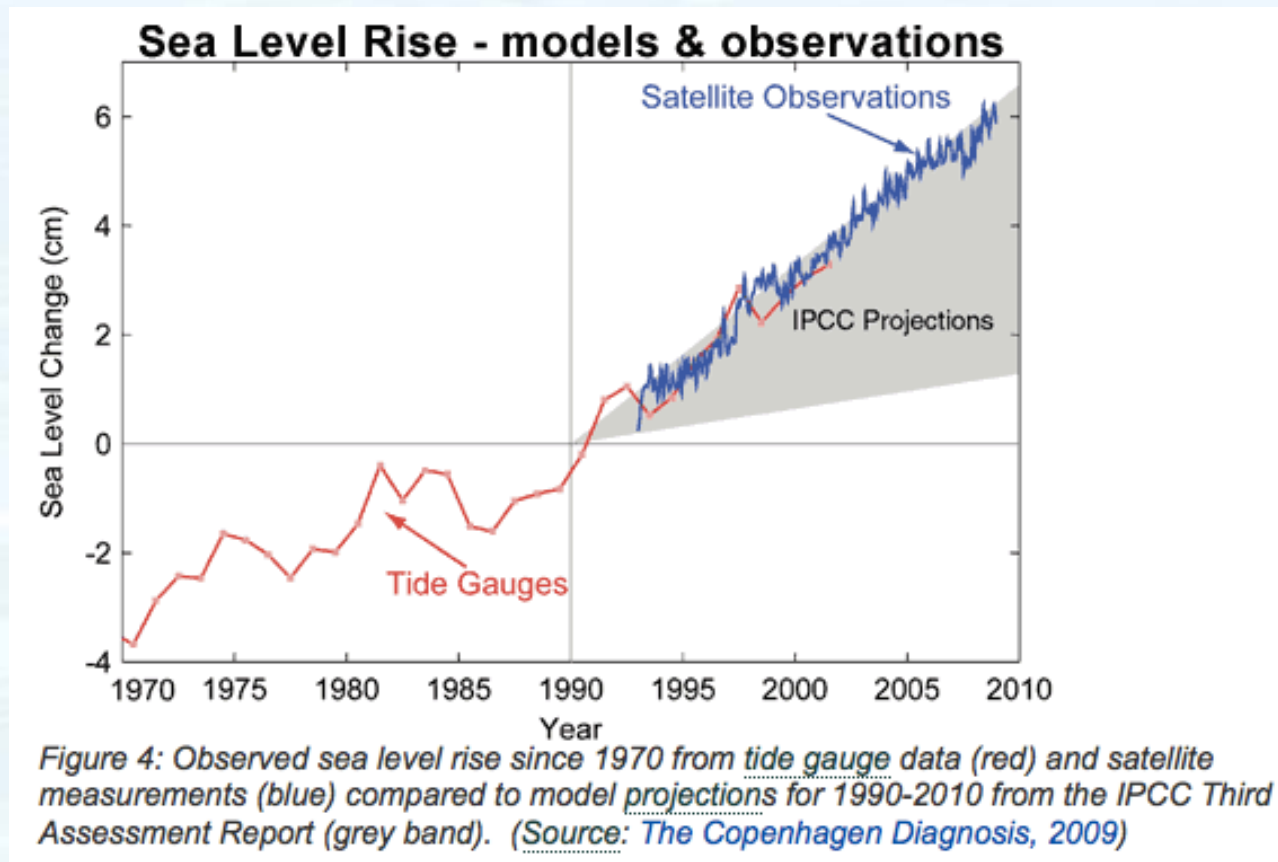
Cherry-picking time periods leads to false conclusions about trends (note *none* are ≥ 30 yr)

From John Cook's
Skeptical Science web
site, skepticalscience.com



Exploring the myths...

6. Models are unreliable – you can't even predict the weather a few days from now with any accuracy!



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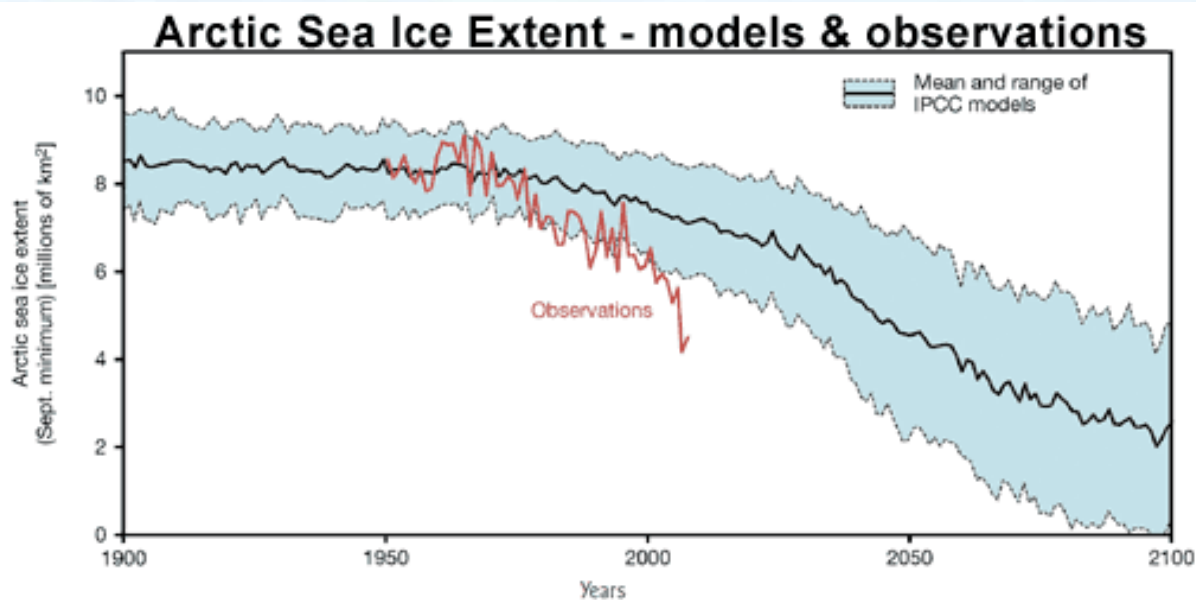
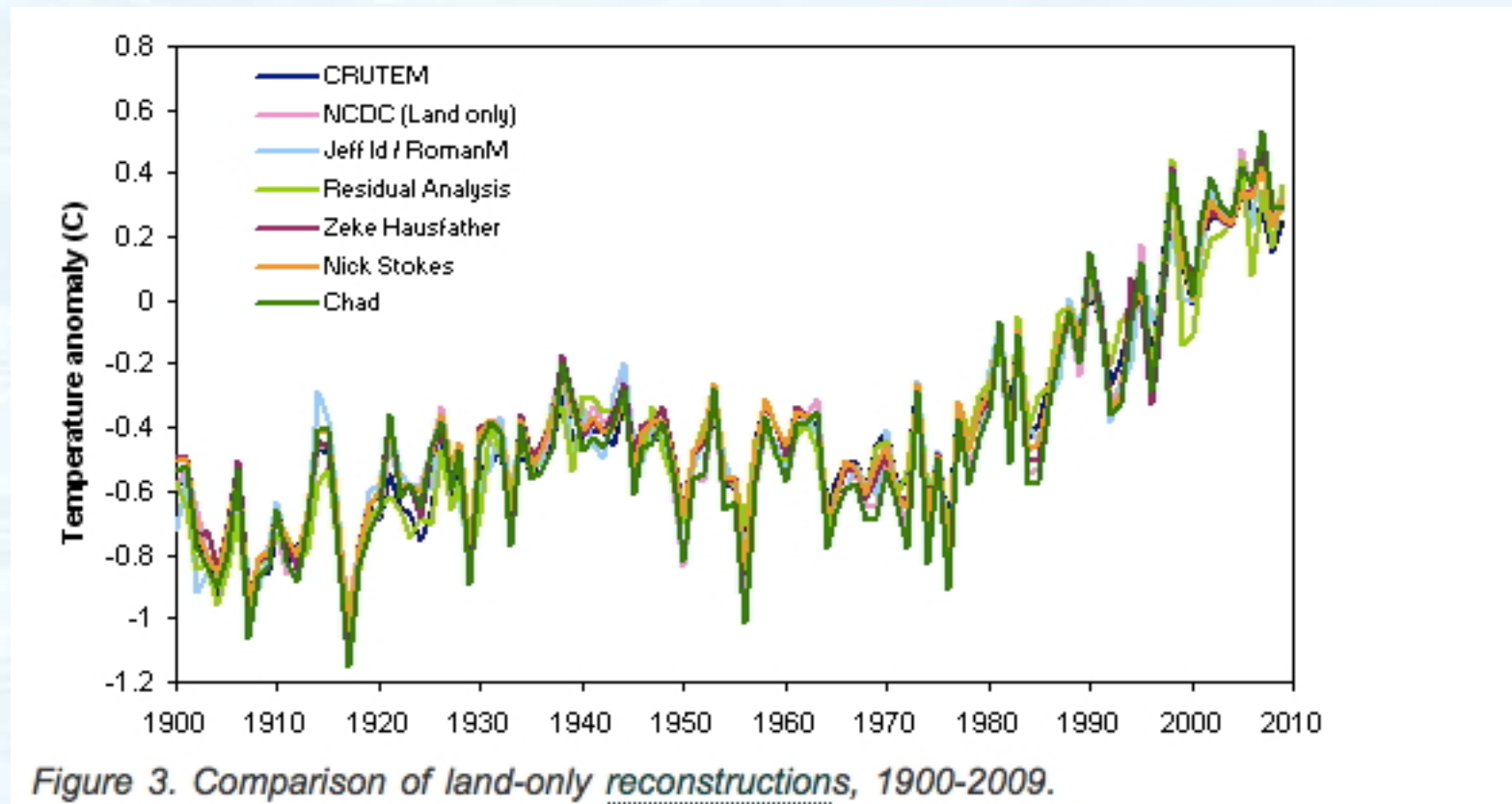


Figure 5: Comparison of observed September minimum Arctic sea ice extent through 2008 (red line) with IPCC AR4 model projections. The solid black line shows the mean of the 13 models, and dashed black lines show the range of the model results. The 2009 minimum was calculated at 5.10 million km², the third lowest year on record and still well below the IPCC worst case scenario. (Source: *Copenhagen Diagnosis*, 2009)

From John Cook's *Skeptical Science* web site, skepticalscience.com

Exploring the myths...

7. The temperature data are unreliable, see?



From John Cook's *Skeptical Science* web site, skepticalscience.com

Exploring the myths...

8. Animals and plants can just adapt (after, all, they have before).

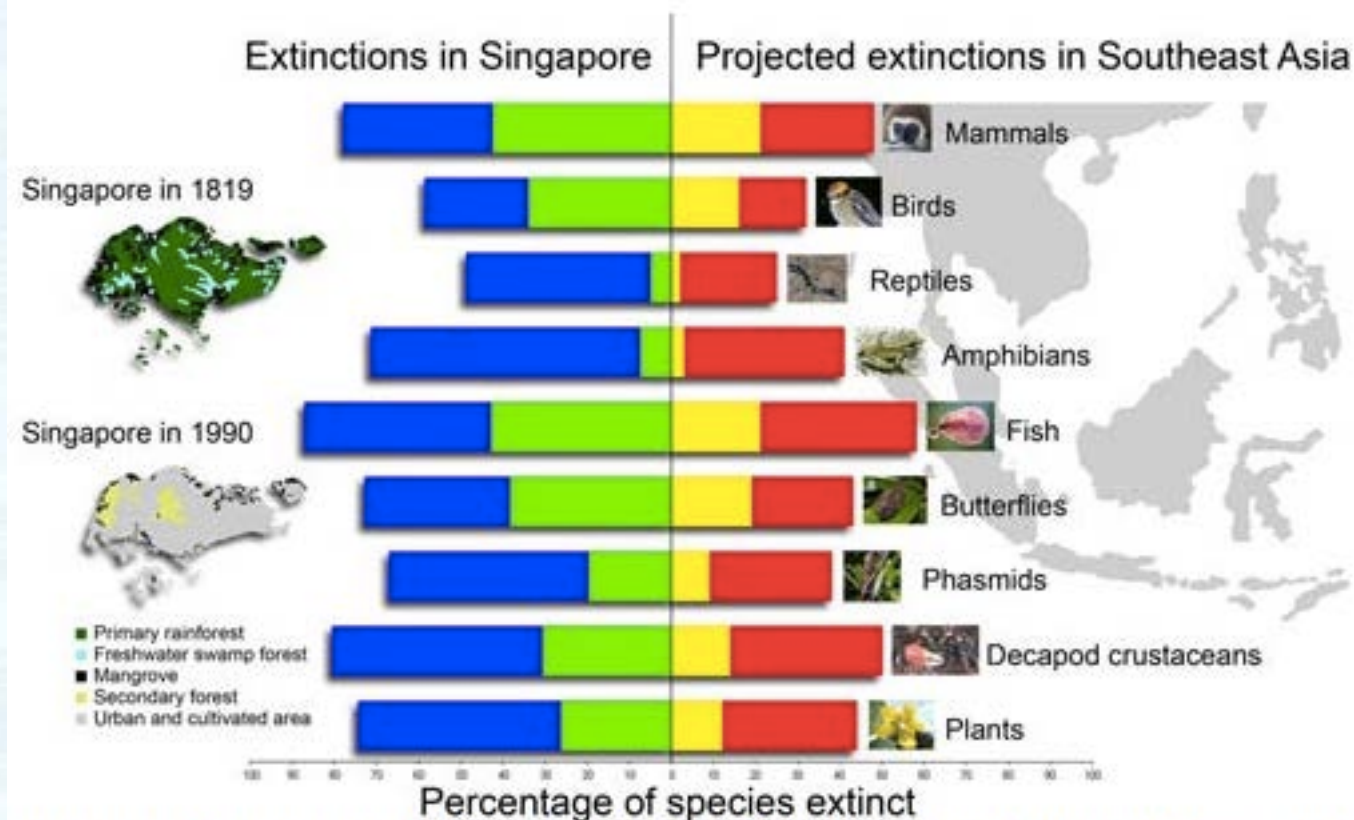
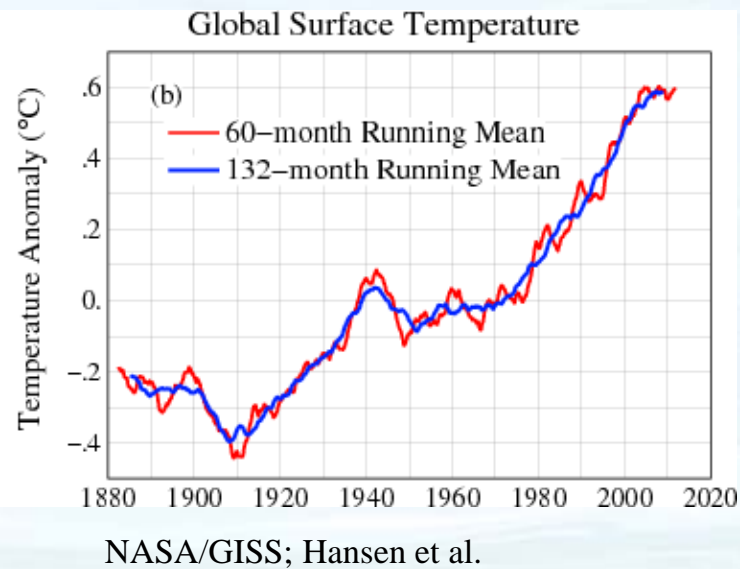


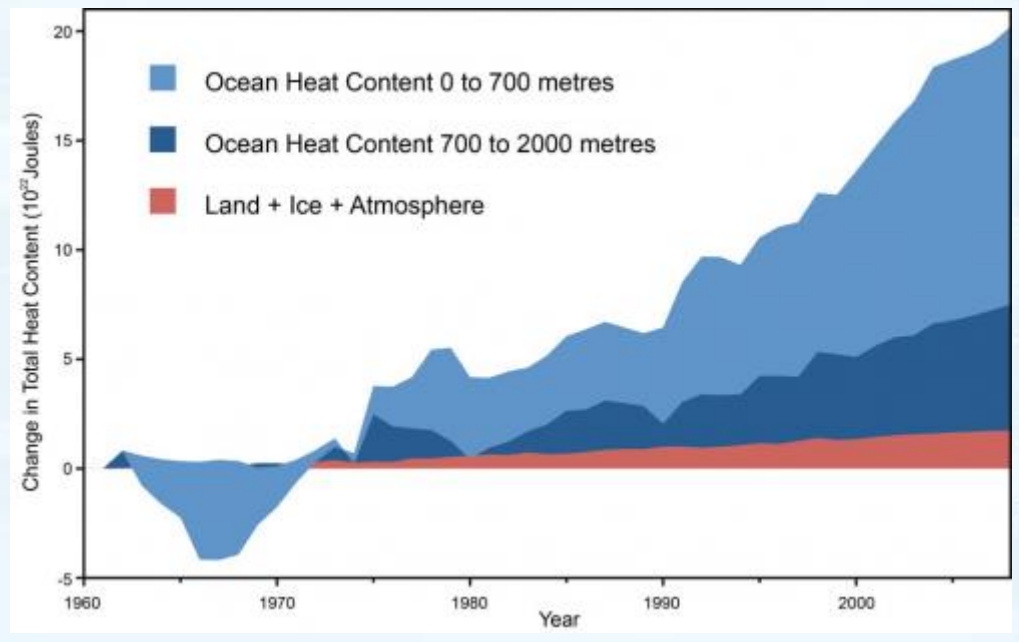
Figure 1: Southeast Asian extinctions projected due to habitat loss (source: Sodhi, N. S., Koh, L. P., Brook, B. W. & Ng, P. K. L. 2004)

Exploring the myths...

9. The climate stopped warming in 1998.

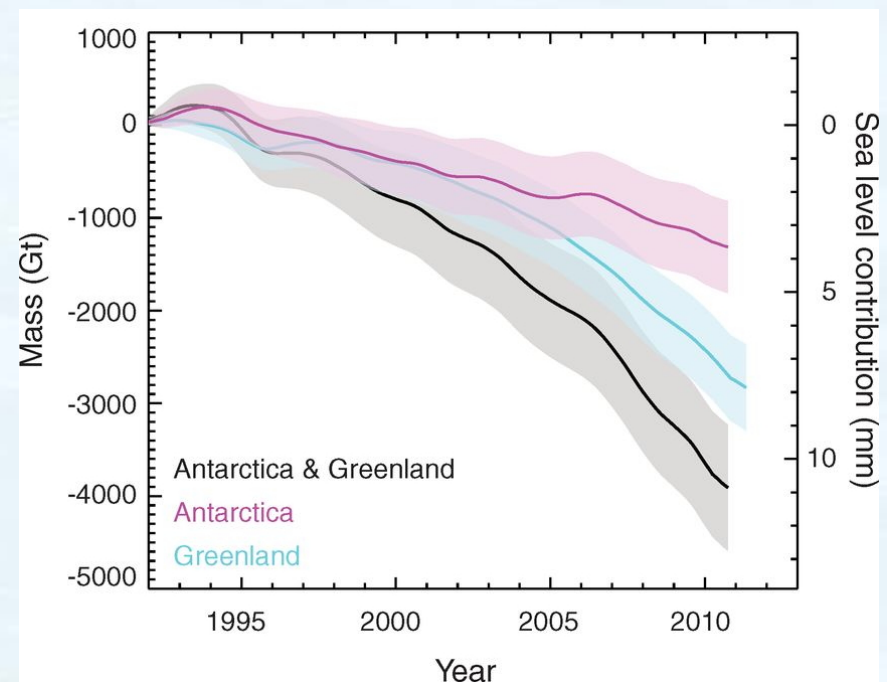
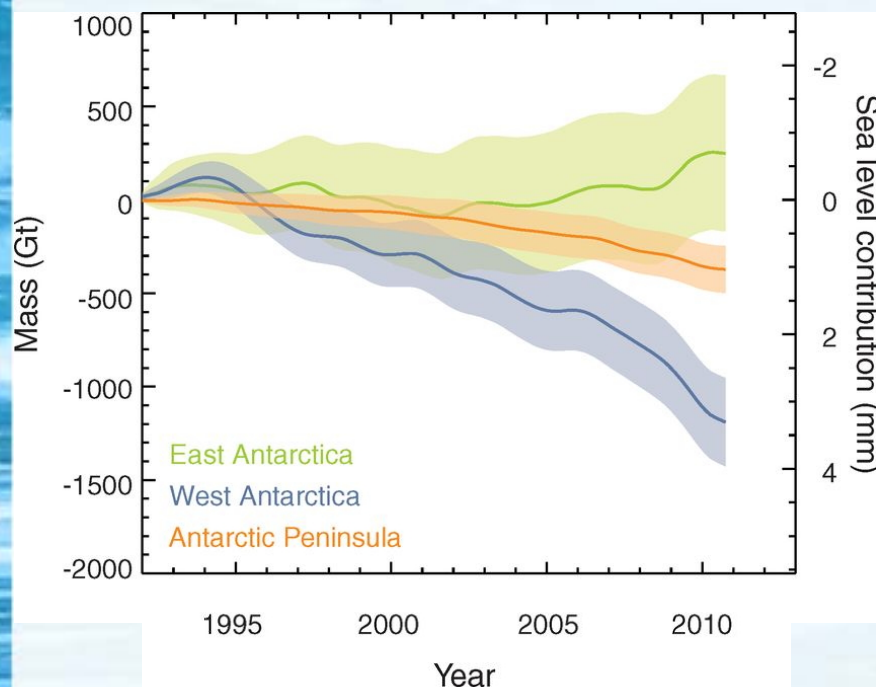


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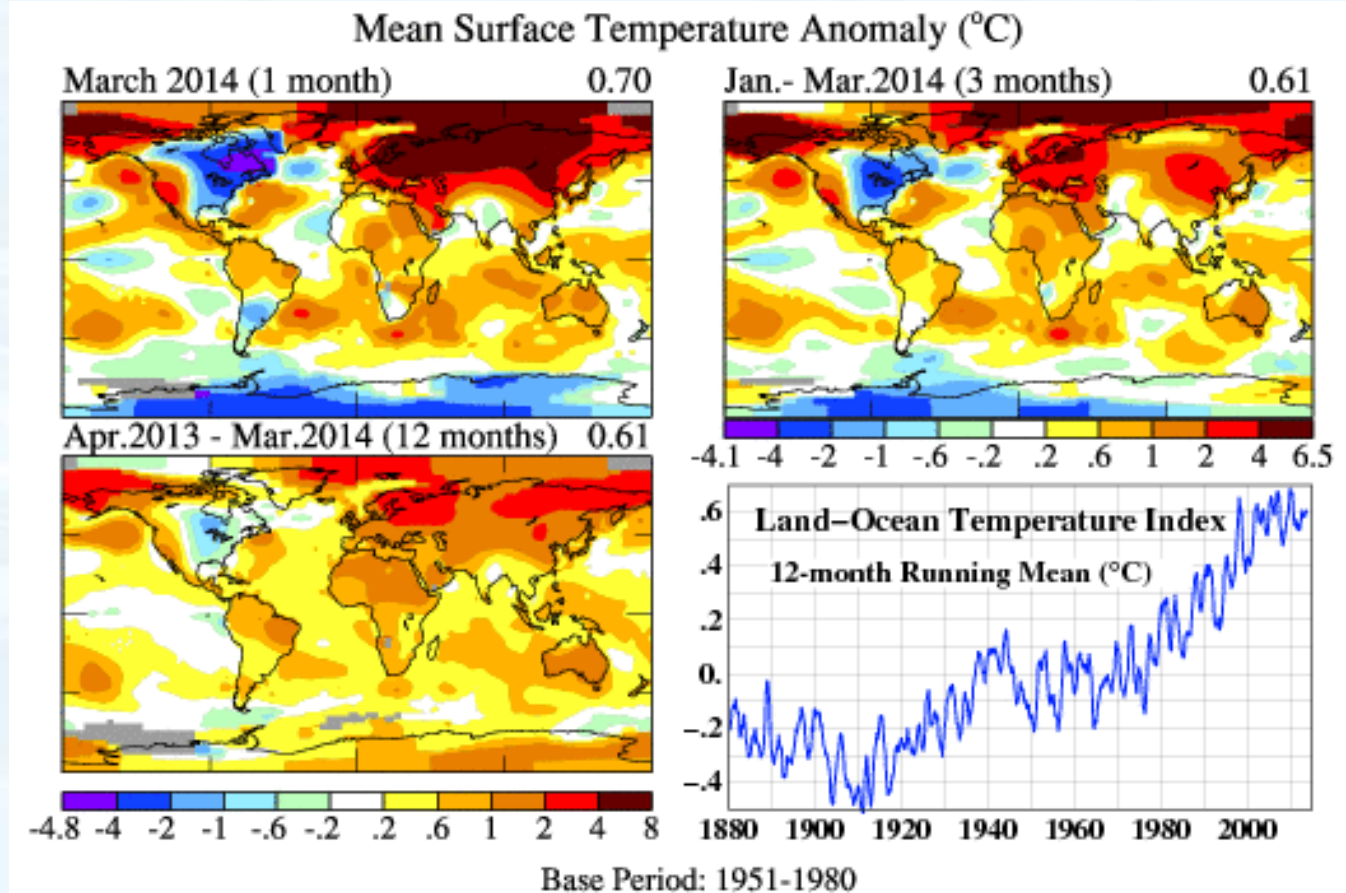
10. So if it is getting so warm, how come Antarctica is gaining so much ice, huh?



From John Cook's *Skeptical Science* web site, skepticalscience.com

I'll add one myself

11. How can there be global warming going on when it was so cold last winter, eh?



NASA/GISS

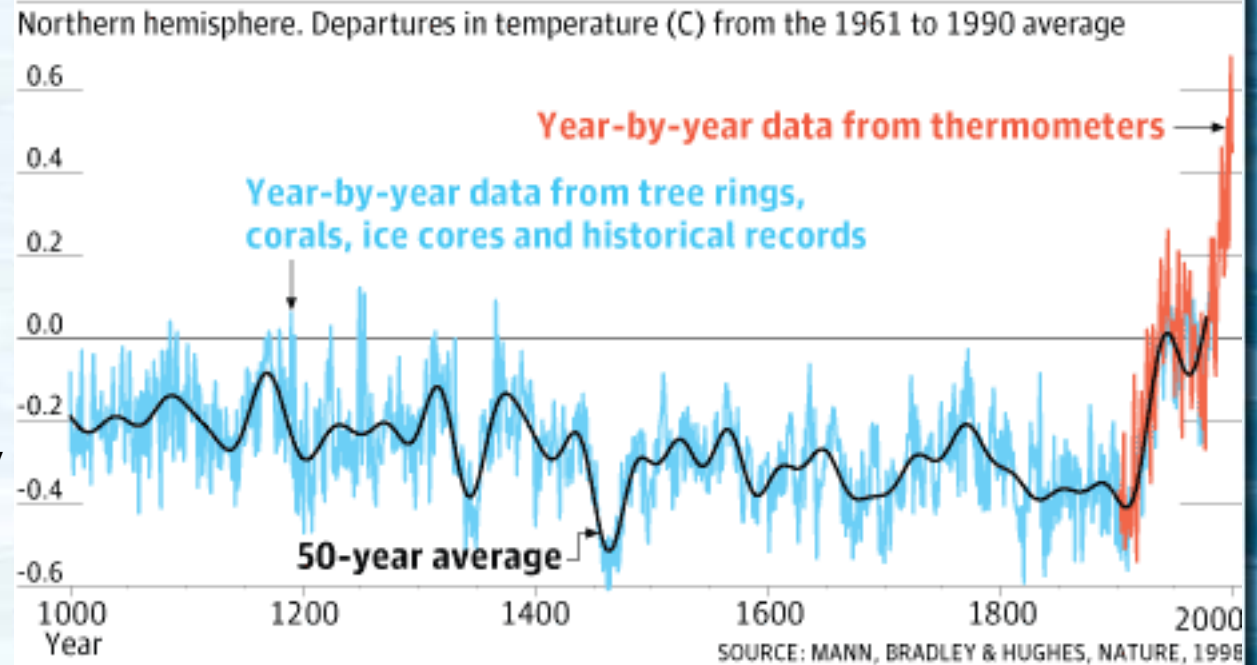
Evidence – how we know what we know

Proxy Data

- *Tree Rings
- *Corals
- *Ice Cores
- *Sediment Cores
- *Pollen Records
- *Fossils
- *Radiocarbon and other isotope decay dating

→ Combined
Reconstruction

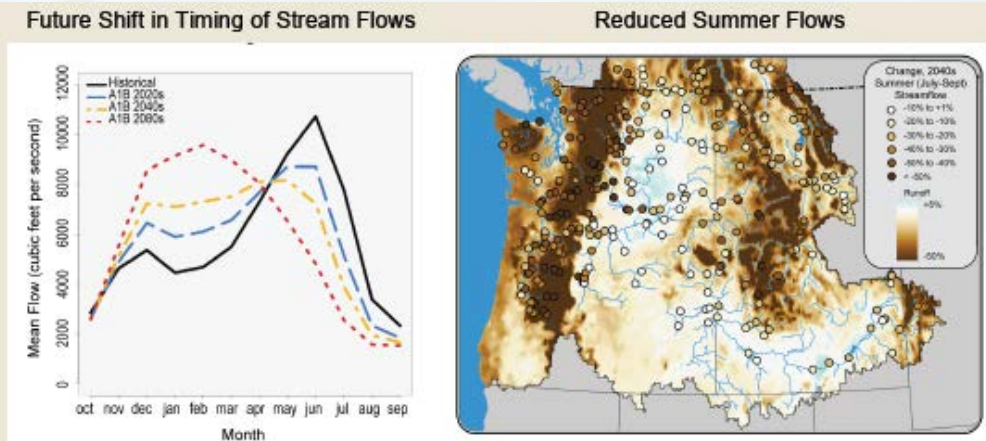
Variations of the Earth's surface temperature



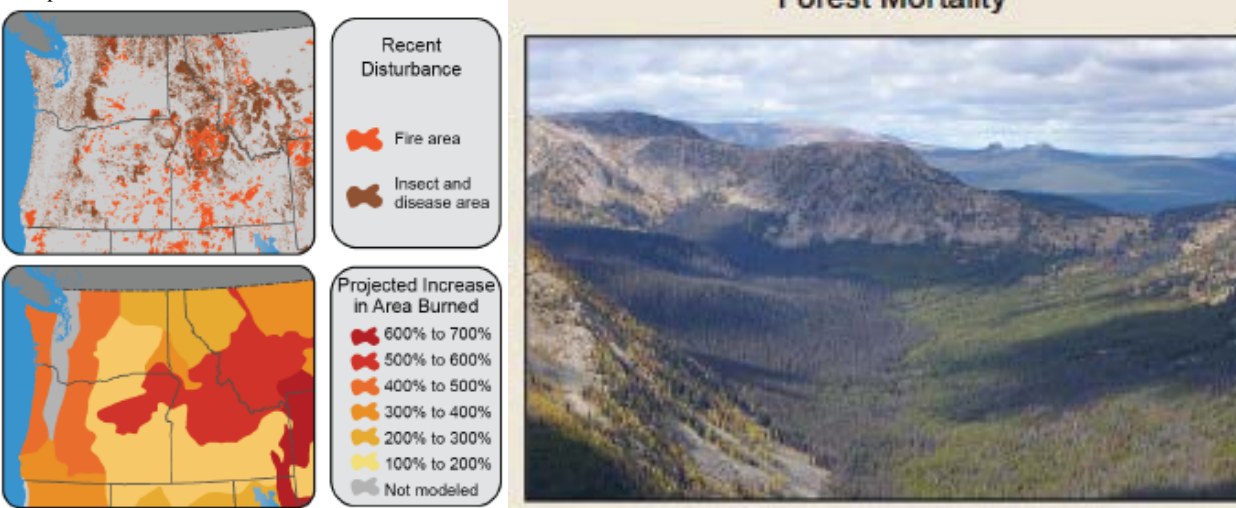
Hockey stick photo courtesy clker.com

Pacific Northwest Impacts

From NCA released 5/6/14



↓ **Figure 21.7.** NW forest disturbances from fire and insect. (Top) – observations. (Bottom) – Projected change for 21st century with 1 C° temperature increase.



↑ **Figure 21.4.** Projected inundation for Seattle area assuming no adaptation, for mean high water (high tide) for projections to 2100. 88" high compounds sea level rise and storm surge event.

← **Figure 21.6.** Forest mortality due to fire and insect activity is already evident in the Northwest. Continued changes in climate in coming decades are expected to increase these effects. Trees killed by a fire (left side of watershed) and trees killed by mountain pine beetle and spruce beetle infestations (orange and gray patches, right side of watershed) in subalpine forest in the Pasayten Wilderness, Okanogan-Wenatchee National Forest, Washington, illustrates how cumulative disturbances can affect forests. (Photo credit: Jeremy Littell, USGS).

← **Figure 21.2.** (Left) projected changes in NW streamflow timing (increased winter, decreased summer). (Right) Projected summer flow reduction pattern. Both use the A1B scenario – warming due to emissions that are gradually slowed later in 21st century, accompanied by current global economic growth

What can we do?

Among the science-based solutions...

- Become and stay informed
- Support relevant educational initiatives at your schools
- Ask that your public servants respond rationally to scientific information
 - Support governmental observation systems
 - Support governmental research and encourage private support for peer-reviewed research
- Think globally, and act locally
 - Involve yourself in citizen science programs!
 - citizenscience.org
- Remain skeptical ... but real
 - *We are entitled to our own opinions, but not our own facts.*

Some reliable sources based upon peer-reviewed science

- ⌘ Intergovernmental Panel on Climate Change *5th Assessment Reports* (2013-14, IPCC AR5, <http://ipcc.ch/>)
- ⌘ *National Climate Assessment* (2014), US Global Change Research Program, <http://globalchange.gov/>
- ⌘ *Northwest Climate Assessment Report* (2013), OCCRI, <http://occri.net/reports>
- ⌘ *Skeptical Science* (John Cook, updated and cited 2014), <http://skepticalscience.com/>
- ⌘ *State of the Climate* (monthly) – NOAA National Climatic Data Center, <http://www.ncdc.noaa.gov/sotc/>
- ⌘ Global Systems Science (updated 2014), Lawrence Hall of Science, University of California, <http://www.globalsystemscience.org>
- ⌘ National Center for Science Education Climate Education Portal, <http://ncse.com/climate/>