

## The Basic Stuff

*If something is based on “theory,” we can still say we know it!*

Anyone watching television or reading the daily paper over the past decade or so could hardly be blamed for thinking climate science a murky affair, rife with disagreement and doubtful claims. One “expert” is pitted against another, the first muttering something about solar flares and the other trying to explain what “peer review” means. But there hasn’t been *real* disagreement on climate change for some time—at least in reputable scientific circles. The remaining arguments are about fine details. But it’s easy—and comforting—to find a marginal crackpot on television telling us not to worry. That’s irresponsible journalism, and it gives an impression of doubt where none exists.

We know the Earth is warming, we know it’s *our* carbon dioxide emissions causing it, and we know that—without big reductions in those emissions—the climate will change in ways that are harmful to our way of life.

Those who publicly doubt climate change will say that because it is based on “theory,” it can be

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dismissed as mere conjecture. But that is to mistake what is meant by “theory.” It is scientific theory that the Earth is round, and it is theory that the sun will rise in the east tomorrow. For scientists, *all* knowledge is refutable, given the right evidence.

There’s a degree of doubt associated with every theory. If one day the sun rose in the west, theories about planetary movement would change. The real issue is—what is the *degree* of doubt?

Climate science is complex. But one of the largest international assemblies of scientists

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ever formed, the Intergovernmental Panel on Climate Change (IPCC), agrees on the basics. Even the *slightest* chance they are right would warrant serious action, a kind of insurance policy against calamity. But the chances of the IPCC being correct are not slim—you can bet your house on it. Here are some basics.

*Carbon dioxide*<sup>1</sup> (*carbon*) in the atmosphere warms the Earth, acting as an insulating blanket. It lets in more energy as sunlight than it lets out as heat, trapping that heat. We’ve known this since the early 1800s.<sup>2</sup> Without greenhouse gases, the Earth would be inhospitable—but there can be too much of a good thing. More than 100 years ago, scientists began to worry, calculating how much carbon was emitted by burning coal and to what degree it might warm the atmosphere. Emissions then were tiny, and it remained a theoretical curiosity.

*Carbon concentrations are linked with temperature over long periods of time.*<sup>3</sup> Carbon concentrations—

calculated in parts per million—were measured directly starting in the 1950s, and it’s possible to track levels going back hundreds of thousands of years by looking at tiny bubbles trapped in Antarctic ice. The deeper into the ice you go, the further back in time the air was trapped. Temperature is calculated by measuring the ratio of two kinds of molecules—a heavy isotope of oxygen and deuterium—set by the temperature at the time the bubbles were formed. We know that when carbon levels increase, so does temperature.<sup>4</sup> There are other ways to confirm this link, like looking at ancient tree rings or the sediment at the bottom of deep lakes. They all say the same thing.

We know the Earth is warming, we know it’s our carbon dioxide causing it, and we know the changes will be harmful to our way of life.

*Carbon levels are rising fast, and human activity is responsible.* Deforestation and fossil fuel use are what is changing the game. The carbon concentration has risen from pre-industrial levels of 280 parts per million to more than 390, higher than it’s been for hundreds of thousands of years. It’s still rising by three parts per million each year. We know we’re responsible because we know how much carbon we release, and we know how much is absorbed.<sup>5</sup> Roughly, the difference is us. Really dangerous levels of carbon occur around 450 parts per million, so

without big changes, we’ll be there when today’s preschoolers are attending university.

*We are causing the latest warming, which is happening alarmingly fast.*<sup>6</sup> Average worldwide temperatures have risen by 1.8 F (0.6 C) in the last century—the fastest rise in the past 1,000 years. The rise is directly correlated to the rise in carbon. Temperature cycles in the past that saw ice ages come and go were caused by subtle changes in the Earth’s orbit (called Milankovitch cycles), but that’s not the case now. Those cycles are regular, we know when they occur—and this isn’t one of them.

*The future looks bleak if we don’t change our behavior.*<sup>7</sup> Warming is not a gradual, gentle process that lets Torontonians wear shorts in December and lengthens the golf season in New York State. It disrupts ecosystems, causes violent storms and changes weather patterns. It will render life very difficult. That story continues in “Climate Science III—The Bad Stuff.”

*Finally, this stuff is coming at us faster than is generally acknowledged in the popular media.* The IPCC is authoritative, but conservative.<sup>8</sup> The latest science shows that we’ve already passed their worst-case scenarios. Stuff that wasn’t supposed to happen for decades is happening before our eyes, like the summer melting of Arctic ice and permafrost, and the recent droughts in Australia.

# Endnotes

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## Climate Science I – The Basics

- <sup>1</sup> There are other greenhouse gases—methane, nitrous oxide and water vapor, among others—but for simplicity I’ll stick to carbon dioxide, as it contributes more than 60% of the greenhouse effect.
- <sup>2</sup> For a historical account of this discovery, see <http://www.aip.org/history/climate/co2.htm>
- <sup>3</sup> See Siegenthaler et al., “Stable Carbon Cycle—Climate Relationship During the Late Pleistocene,” in *Science*, Vol. 310, Nov. 25, 2005. Also: [http://cdiac.ornl.gov/trends/temp/vostok/jouz\\_tem.htm](http://cdiac.ornl.gov/trends/temp/vostok/jouz_tem.htm)
- <sup>4</sup> Sometimes the temperature goes up first, before the carbon rises, which caused some people to doubt the link. What this shows though, is the existence of “feedback mechanisms” where an increase in temperature causes something to happen (like the melting of permafrost that holds stored carbon) that releases more carbon. See “Climate Science III—The Complex Stuff” pg \_\_ for details on feedback.
- <sup>5</sup> By oceans, forests, etc.
- <sup>6</sup> World Meteorological Organization, “Extreme Weather Events Might Increase,” press release, July 2, 2003. See also [http://www.greenfacts.org/studies/climate\\_change/l\\_3/climate\\_change\\_2.htm#3](http://www.greenfacts.org/studies/climate_change/l_3/climate_change_2.htm#3)
- <sup>7</sup> For a full account of what might happen in the climate see *Heat* by G. Monbiot, and for the geopolitical sphere, see *Climate Wars* by G. Dyer.
- <sup>8</sup> The IPCC was saddled at the outset by a need to generate an unusually high degree of consensus—near unanimity—before it publishes any results. It takes time to build that consensus, and the outcome is rendered very conservative. It also takes a great deal of time to go through the rigorous peer-review process. The end result is they use data that is, literally, years out-of-date. For the 2007 report, field data from the turn of the century was used.