

Climate Science Update



Photo: M. Fitzpatrick

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How Certain is Climate Science?

Uncertainty is ubiquitous in our daily lives. To most of us, uncertainty means not knowing. To scientists, however, uncertainty is how well something *is* known. And, therein lies an important difference, especially when trying to understand what is known about climate change.

In science, there's often not absolute certainty. But, research reduces uncertainty. In many cases, theories have been tested and analyzed and examined so thoroughly that their chance of being wrong is infinitesimal. Other times, uncertainties linger despite lengthy research. In those cases, scientists make it their job to explain how well something is known. When gaps in knowledge exist, scientists qualify the evidence to ensure others don't form conclusions that go beyond what is known.

Even though it may seem counterintuitive, scientists like to point out the level of uncertainty. Why? Because scientists want to be as transparent as possible and it shows how well certain phenomena are understood.

Decision makers in our society use scientific input all the time. But they could make a critically wrong choice if the unknowns aren't taken into account. For instance, city planners could build a levee too low or not evacuate enough coastal communities along an expected landfall zone of a hurricane if uncertainty is understated. For these reasons, uncertainty plays a key role in informing public policy.

Uncertainty in science describes *how well* something is known.

Likelihood Terminology	Likelihood of the occurrence/ outcome
Virtually certain	> 99% probability
Extremely likely	> 95% probability
Very likely	> 90% probability
Likely	> 66% probability
More likely than not	> 50% probability
About as likely as not	33 to 66% probability
Unlikely	< 33% probability
Very unlikely	< 10% probability
Extremely unlikely	< 5% probability
Exceptionally unlikely	< 1% probability

Likely or not?

Likelihood is the probability of a well-defined outcome actually happening.¹ For example, it is very likely (greater than 90% probability) that cold days and nights are becoming less frequent and hot days and nights more frequent over most land areas on Earth. If global heat-trapping emissions continue to rise, these trends are virtually certain to continue.²

Likelihood and Confidence Limits

Taking into account the many sources of scientific understanding, climate scientists have sought to provide decision-makers with careful language regarding uncertainty. A “very likely” outcome, for example, is one that has a greater than 90 percent chance of occurring. Climate data or model projections in which we have “very high confidence” have at least a 9 out of 10 chance of being correct.

Uncertainty plays a key role in informing public policy

However, in this culture of transparency where climate scientists describe degrees of certainty and confidence in their findings, climate contrarians have linked less than complete certainty with not knowing anything. The truth is, scientists know a great deal about climate change. We have learned, for example, that the burning of fossil fuels and the clearing of forests release carbon dioxide (CO₂) into the atmosphere. There is no uncertainty about this. We have learned that carbon dioxide and other gases in the atmosphere trap heat. Again, there is no uncertainty about this. Earth is warming because these gases are now being released faster than they can be absorbed by natural processes. It is very likely (greater than 90 percent probability) that human activities are the main reason for the world's temperature increase in the past 50 years.

Climate Science Certainty

Scientists know with very high confidence that:

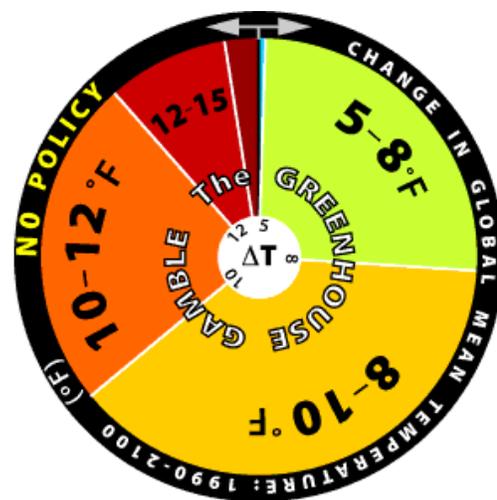
- human-induced warming influences physical and biological systems throughout the world;
- sea levels are rising;
- glaciers and permafrost are shrinking;
- oceans are becoming more acidic; and
- ranges of plants and animals are shifting.

Scientists are uncertain, however, about how much global warming will occur in the future (between 2.1 degrees and 11 degrees Fahrenheit by 2100). They are also uncertain how soon the summer sea ice habitat where the ringed seal lives will disappear. Curiously, much of this uncertainty has to do with—are you ready?—humans. The choices we make in the next decade, or so, to reduce emissions of heat-trapping gases could prevent catastrophic climate change.

So, what's the bottom line? Science has learned much about climate change. Science tells us what is more or less likely to be true. We know that acting now to deeply reduce heat-trapping emissions will limit the scope and severity of further impacts – and that is virtually certain.

References

1. IPCC. (2006) Guidance notes for lead authors of the IPCC fourth assessment report on addressing uncertainties. In Manning 2006. *Adv Clim Change Res* 2:13–21. Online at www.ipcc.ch/pdf/supporting-material/uncertainty-guidance-note.pdf
2. IPCC. (2007) *Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (AR4)*. S. Solomon et al. eds., Cambridge University Press, Cambridge, UK and NY, USA.
3. Sokolov, A.P. et al. (2009). Probabilistic forecast for twenty-first century climate based on uncertainties in emissions (without policy) and climate parameters. *J. Climate*, **22**, 5175-5204. Online at globalchange.mit.edu/resources/gamble/



The Climate Roulette Wheel

The "roulette" wheel above depicts the probability of global warming over the next hundred years, assuming a scenario in which "no policy" action is taken to try to curb the global emissions of heat-trapping gases.

The face of the wheel is divided into six slices, with the size of each slice representing the estimated probability of the temperature change in the year 2100 falling within that range.³

This fact sheet is available online at www.ucsusa.org/climatescienceupdate

The Union of Concerned Scientists is the leading science-based nonprofit working for a healthy environment and a safer world.