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Why scientists are (almost) certain that climate change is man-made

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ON NOVEMBER 2ND the Intergovernmental Panel on Climate Change (IPCC), which represents mainstream scientific opinion, said that it was extremely likely that climate change is the product of human activity. Extremely likely in IPCC speak means having a probability of over 95%. The claim forms part of its fifth assessment on the state of the global climate. In its first assessment, in 1990, the IPCC had said that "the observed increase [in air temperatures] could be largely due to natural variability." Why have climate scientists become so much more certain that climate change is man-made, not natural?



Many factors influence the climate but perhaps the single most important is carbon dioxide (CO₂). CO₂ absorbs infra-red heat at a constant rate and at a higher rate than nitrogen and oxygen—the main constituent parts of the atmosphere—so the more CO₂ in the air, the more the atmosphere will tend to warm up. Scientists attribute climate change to human activity mainly because people have been responsible for large increases in CO₂. At the start of the industrial revolution, in about 1800, there were 280 parts per million (ppm) of CO₂ in the atmosphere. That had been the level for most of human history. This year, however, concentrations exceeded 400 ppm, the first time it had reached that level for a million years.

Most of the increase has been caused by people burning fossil fuels. In the United States, for example, 38% of the CO₂ produced in 2012 came from generating electricity and 32% came from vehicle emissions (the rest came from industrial processes, buildings and other smaller CO₂ production). People also produce CO₂ when they cut down forests for farmland and pasture. But the rate at which CO₂ absorbs heat—which has been established accurately in

laboratories—does not explain all the increase in global temperatures. If CO₂ concentrations were to double from 1800 levels, global temperatures would rise by roughly 1°C. But there are many other influences upon the climate.

Rising CO₂ levels directly influence other phenomena, such as clouds, which amplify or sometimes diminish the increase in temperatures. Adding soot and other aerosols (fine particles suspended in the air) further adds to, or subtracts from, the effect of CO₂. As a result, the Earth's temperature will in practice warm up by more than 1°C for each doubling of CO₂ concentrations. All climate scientists agree on that. How much more, though, is a matter of scientific dispute. In practice, too, the increase in global surface air temperatures has been smaller than climate computer models had predicted. But what is no longer seriously disputed is that humans are the main agents of climate change.

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