[MUSIC PLAYING]

LAUR HESSE FISHER: We know that you know that the Earth is warming, but you might have questions like, how did scientists figure out that this warming is happening and that it's caused by humans? How strong is the evidence, really? What risks can we expect? And what can we do about them?

Climate science is not a new field. By the time of the American Civil War, scientists understood that the Earth is kept warm by a handful of gases that make up less than 1% of our atmosphere, but that these gases keep the sun's radiation from being immediately lost to outer space. And they understood that if humans were to change the amount of these gases in our atmosphere, our climate would be transformed.

Today, these predictions are coming to life. And as global temperatures rise and extreme weather intensifies, you probably have more questions. The online primer Climate Science, Risk, & Solutions from the Massachusetts Institute of Technology is our effort to bring the story of climate science to everyone who wants to learn. Used in universities and high schools around the world, this primer answers how scientists know what they know about climate change. It takes learners through the history of climate science, the risks we face now, and will face in the future, and the options we have to overcome climate change, and secure a safe and prosperous planet for ourselves and for future generations.

To do this, we worked with MIT's professor Kerry Emanuel, an acclaimed climate communicator who has been studying the Earth's weather system for over 40 years. So let's let him share a peek at what you'll learn in Climate Science, Risk, & Solutions from MIT.

KERRY EMANUEL: Human-caused climate change began with the Industrial Revolution, when people began burning large quantities of coal and oil, releasing carbon dioxide into the atmosphere. And although scientists have long predicted that this influx of CO_2 would raise the Earth's temperature, now that we can see it happening, a very reasonable question people ask is, how can we trace these trends all the way back to the dawn of the fossil fuel age? Surely, that's too long ago for us to have accurate records of world temperatures, let alone how much carbon dioxide was in the air.

In fact, by the 19th century, people were using thermometers and keeping careful records of temperature in enough places around the globe for us to reconstruct average world temperatures. Naturally, most of these measurements were taken at land-based stations, but some came from the ocean surface, too. This is crucial data when trying to learn the Earth's average surface temperature, since, of course, the oceans take up most of the world's surface.

It's not enough to simply average all the temperature records we have together. One must carefully account for the uneven distribution of temperature measurements around the world, the way growing cities have become warmer than the surrounding countryside, and many other variables. But one way to know if our calculations are good is to see if different groups working independently of each other have reached the same conclusions.

And indeed, the five major groups tracking global temperatures have produced very similar records, discovering the same ups and downs from year to year. Since the 1960s, we have been able to add satellite measurements of infrared radiation at the Earth's surface to our arsenal of instruments. And it is reassuring to see that these two track closely with the thermometer record from around the world.

But what about carbon dioxide? How can we really know the temperature rise traced by all these different sources is caused by rising CO2 levels? Indeed, it was not until the 1950s that scientists began measuring the CO2 content of the atmosphere directly. For climate scientists, it's not enough to know that CO2 levels have been rising since the 1950s. We want to return to the beginning of the Industrial Revolution.

And our greatest asset here is ice taken from Greenland and Antarctica. As snow falls in these frigid parts of the world, it traps small samples of air along with it. Because the snow never melts, over time, it becomes compressed in layers of ice with tiny bubbles inside that preserve ancient air. This record of air samples goes back hundreds of thousands of years.

By drilling into the ice and collecting cores, scientists can create a year-by-year record of our past atmosphere. And it is these ice core samples that show us the history of CO2 in the atmosphere, which we now know held steady at around 280 parts per million for almost all of recorded human history until it began to creep up in the 19th century, and truly take off in the mid 20th, to the point that the CO2 content of the atmosphere is fully 50% higher than it was 150 years ago.

From these combined records, we can now see plainly what climate scientists have predicted all along. CO2 levels have been rising as we burn fossil fuels, and temperatures have been rising with them.

LAUR HESSE FISHER: The pace of climate science has never been faster, which is why MIT's Climate Science, Risk, & Solutions has been newly updated for 2024 with the latest data and scientific consensus. And with help from MIT Open Learning, all this information has been paired with fun online learning techniques, where you can watch, listen to, and play with the data.

All of this is connected to other learning resources from MIT that will help you drill deeper into the topics that interest you the most, whether that's the basic science of the greenhouse effect, the climate models that help scientists peer into our future climate, or the solutions at hand, from renewable energy to carbon capture. Are you ready to have your questions answered about climate change and climate science? Then visit climateprimer.mit.edu to begin.