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A WARMER, WETTER WORLD: GLOBAL WARMING EFFECTS WILL CONTINUE FOR A CENTURY EVEN IF EMISSIONS CURBED NOW

Though significant uncertainty remains regarding the amount of global warming that will occur over the next century or two, scientists agree that the trend will continue for the next hundred years even if fossil fuel consumption is dramatically reduced.

Scientists predict significant increases in global temperature and sea level this century. And related changes in weather patterns are expected to affect agricultural production. Global warming is likely to have the greatest human impact in poor countries unable to adequately respond to the changes.

Professor Robert Dickinson of the Georgia Institute of Technology's School of Earth and Atmospheric Sciences presented the evidence behind this assessment at the annual meeting of the American Association for the Advancement of Science (AAAS) on Feb. 17 in Boston. Dickinson's presentation, titled "Predicting Climate Change," was part of the symposium "Climate Change: Integrating Science, Economics and Policy."

"Current climate models can indicate the general nature of climate change for the next 100 to 200 years," Dickinson says. "But the effects of carbon dioxide (CO₂) that have been released into the atmosphere from the burning of fossil



A rising global temperature is melting polar ice, causing an increase in sea level. In this photo, from the National Oceanic and Atmospheric Administration (NOAA), melting ice drifts in the Ross Sea.

fuels last for at least 100 years. That means that any reductions in CO₂ that are expected to be possible over this period will not result in a cleaner atmosphere and less global warming than we see today for at least a century."

Climate models indicate temperature increases of 3 to more than 10 degrees Fahrenheit this century and a sea level rise of 6 inches to nearly 3 feet. The burning of fossil fuels emits greenhouse gases, such as CO₂, into the atmosphere. These gases contribute to global warming, and the temperature increase expands

the oceans and causes ice sheets to melt, in turn increasing sea level.

Despite differences in climate model projections and the limitations of the models themselves, scientists agree that significant consequences from global warming will occur in this century, Dickinson says.

"Given enough time, there may be as many winners as losers. However, many of the losers will be very unhappy, such as people who live on islands that will be put under water," Dickinson says. "It will take a lot of time for humans to adjust their systems to these changes. The biggest problem is the speed at which global warming is occurring.

"If it were happening over 1,000 years, rather than 100 years, it would hardly be noticed. But we're talking about fairly large changes within the next generation. We're talking about people with houses on the beach having to move. The U.S. is fairly resilient, and people can move. But in Bangladesh and other low-elevation areas with few resources, there will be severe difficulties."

The world can also expect large shifts in agricultural productivity, Dickinson says. Some regions will become more productive, and others will become less so because of changing patterns in temperature and rainfall. Overall, there will be more rainfall, but also more evaporation leading to more floods and more droughts.

Climate modelers are fairly certain of these consequences because their models have improved as their understanding has increased of the underlying physical processes of climate change. Dickinson adds, however, that the models still have some limitations. For example, current climate models do not adequately address the issue of natural temperature variability.

The global temperature has increased more rapidly in the past 10 years, but the changes are more dramatic in high latitudes perhaps because of natural variability, Dickinson explains.

"There's a question of how much the natural variability is related to the human-caused global warming," Dickinson says. "The latter could be amplifying some of the patterns of natural variability. It's not necessarily a question of either/or. Both are occurring. In Alaska, for example, warming of several degrees -- rather than just 1 degree -- has occurred over the past 100 years."

Also, some evidence suggests that the coupling of natural temperature variability and human-caused global warming is causing an increase in El Nino weather patterns in the tropics, with

consequences elsewhere. For example, Australia and Indonesia may see more droughts, while the West Coast of the United States may see more rainfall.

Climate models are also limited in giving reliable regional details on global warming, Dickinson adds. For example, models cannot distinguish changes between Atlanta and New York City. The models can predict differences between high latitudes and the tropics.

Much research is yet to be done regarding climate change, but Dickinson believes policymakers can already glean some guidance from the evidence he will cite in his presentation at AAAS. That evidence comes from research at the National Center for Atmospheric Research, where Dickinson worked for 21 years, as well as his current research and the 2001 report of the Intergovernmental Panel on Climate Change.

For example, enough data exists to develop mitigation and adaptation plans regarding greenhouse gases, Dickinson says. Mitigation involves strategies for reducing greenhouse gases or changing other factors to compensate for them (a fairly new concept). Reductions can involve both consuming lesser amounts of fossil fuels and also finding ways to capture the gases and put them in places other than the atmosphere. The latter approach is called sequestration and is part of a U.S. Department of Energy research initiative.

"The only way to stop the increase of carbon dioxide in the atmosphere is to reduce CO2 emissions to 20 to 30 percent of today's levels," Dickinson says. "This may require a similar reduction in the consumption of fossil fuels. I believe we will eventually achieve that goal, but it will probably take 100 years. That means reductions in automobile emissions and carbon dioxide released from coal-powered electric power generation and other industrial activities.

"We have to move our energy systems to forms other than fossil fuels. And when I say we, I don't just mean the United States. The U.S. is the biggest user of fossil fuels, but China and India are likely to surpass the U.S. in the next 50 years, and China may surpass the U.S. in the next decade."

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