Research finds that Earth's climate is approaching 'dangerous' point

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NASA and Columbia University Earth Institute research finds that human-made greenhouse gases have brought the Earth's climate close to critical tipping points, with potentially dangerous consequences for the planet.

From a combination of climate models, satellite data, and paleoclimate records the scientists conclude that the West Antarctic ice sheet, Arctic ice cover, and regions providing fresh water sources and species habitat are under threat from continued global warming. The research appears in the current issue of Atmospheric Chemistry and Physics.

Tipping points can occur during climate change when the climate reaches a state such that strong amplifying feedbacks are activated by only moderate additional warming. This study finds that global warming of 0.6ºC in the past 30 years has been driven mainly by increasing greenhouse gases, and only moderate additional climate forcing is likely to set in motion disintegration of the West Antarctic ice sheet and Arctic sea ice. Amplifying feedbacks include increased absorption of sunlight as melting exposes darker surfaces and speedup of iceberg discharge as the warming ocean melts ice shelves that otherwise inhibit ice flow.

The researchers used data on earlier warm periods in Earth's history to estimate climate impacts as a function of global temperature, climate models to simulate global warming, and satellite data to verify ongoing changes. Lead author James Hansen, NASA Goddard Institute for Space Studies, New York, concludes: "If global emissions of carbon dioxide

continue to rise at the rate of the past decade, this research shows that there will be disastrous effects, including increasingly rapid sea level rise, increased frequency of droughts and floods, and increased stress on wildlife and plants due to rapidly shifting climate zones."

The researchers also investigate what would be needed to avert large climate change, thus helping define practical implications of the United Nations Framework Convention on Climate Change. That treaty, signed in 1992 by the United States and almost all nations of the world, has the goal to stabilize atmospheric greenhouse gases "at a level that prevents dangerous human-made interference with the climate system."

Based on climate model studies and the history of the Earth the authors conclude that additional global warming of about 1ºC (1.8ºF) or more, above global temperature in 2000, is likely to be dangerous. In turn, the temperature limit has implications for atmospheric carbon dioxide (CO2), which has already increased from the pre-industrial level of 280 parts per million (ppm) to 383 ppm today and is rising by about 2 ppm per year. According to study co-author Makiko Sato of Columbia's Earth Institute, "the temperature limit implies that CO2 exceeding 450 ppm is almost surely dangerous, and the ceiling may be even lower."

The study also shows that the reduction of non-carbon dioxide forcings such as methane and black soot can offset some CO2 increase, but only to a limited extent. Hansen notes that "we probably need a full court press on both CO2 emission rates and non-CO2 forcings, to avoid tipping points and save Arctic sea ice and the West Antarctic ice sheet."

A computer model developed by the Goddard Institute was used to simulate climate from 1880 through today. The model included a more comprehensive set of natural and human-made climate forcings than previous studies, including changes in solar radiation, volcanic particles, human-made greenhouse gases, fine particles such as soot, the effect of

the particles on clouds and land use. Extensive evaluation of the model's ability to simulate climate change is contained in a companion paper to be published in Climate Dynamics.

The authors use the model for climate simulations of the 21st century using both 'business-as-usual' growth of greenhouse gas emissions and an 'alternative scenario' in which emissions decrease slowly in the next few decades and then rapidly to achieve stabilization of atmospheric CO2 amount by the end of the century. Climate changes are so large with 'business-as-usual', with additional global warming of 2-3ºC (3.6-5.4ºF) that Hansen concludes "'business-as-usual' would be a guarantee of global and regional disasters."

However, the study finds much less severe climate change – one-quarter to one-third that of the "business-as-usual" scenario – when greenhouse gas emissions follow the alternative scenario. "Climate effects may still be substantial in the 'alternative scenario', but there is a better chance to adapt to the changes and find other ways to further reduce the climate change," said Sato.

While the researchers say it is still possible to achieve the "alternative scenario," they note that significant actions will be required to do so. Emissions must begin to slow soon. "With another decade of 'business-as-usual' it becomes impractical to achieve the 'alternative scenario' because of the energy infrastructure that would be in place" says Hansen.

Source: NASA/Goddard Space Flight Center