

ABRUPT CLIMATE CHANGE: FACTS AND FICTION

The US movie, *The Day After Tomorrow* has drawn attention worldwide to climate change and to the possibility that climate can undergo massive, extraordinarily rapid changes.

Released in Australia on 27 May 2004, *The Day After Tomorrow* is a fictionalised account of the havoc wreaked by out-of-control climate as North America is beset by the chilling beginnings of a new Ice Age. The movie features numerous catastrophic weather events including hurricanes, tornadoes, floods, and tidal waves striking New York. New York City swings from sweltering to freezing in just one day.

The featured weather extremes, claimed to be the result of a run-away greenhouse effect, create gripping special effects. However, *The Day After Tomorrow* is fantasy.

How likely are the climatic changes portrayed in the movie?

Extremely unlikely. Global warming may cause climate to change abruptly in the future, but the likelihood of this occurring in the next few decades is very low. Abrupt changes in climate have occurred in the geological past, but over decades not days as portrayed in the film.

The film also dramatically exaggerates the impacts of the changes. It is not possible for an Ice Age to occur in a few days.

What is abrupt climate change?

Abrupt climate change is a sudden, dramatic departure from the prevailing conditions.

The technical definition is “when the climate system is forced to cross some threshold, triggering a transition to a new state at a rate determined by the climate system itself and faster than the cause”. Thus even slow forcing can trigger an abrupt change.

You can think of this as like gently applying pressure to a light switch. Nothing happens until you push with enough force. Then the switch clicks and the light comes on.

What drives abrupt change in climate?

Abrupt climate change can be driven by changes in ocean currents. Europe’s climate is warmer than other countries at the same latitude because an ocean current pattern called the overturning circulation, or ocean conveyor, carries heat from low to high latitudes. (The Gulf Stream is part of this global oceanic conveyor belt.) Large floods of fresh water released from melting ice sheets could disrupt the ocean conveyor, decrease ocean heat transport, and cause cooling in Europe and Northern America.

For more information on ocean currents and their possible disruption, see www.pik-potsdam.de/~stefan/thc_fact_sheet.html

Another possible cause of abrupt climate change might be significant release of underground methane as the Siberian permafrost thaws. Methane is a more powerful and faster-acting greenhouse gas than carbon dioxide.

Have abrupt climatic changes happened in the past?

Yes. During the last Ice Age (20,000 to 100,000 years ago), temperatures in the northern Atlantic repeatedly changed by up to 10°C in 10 years.

Less extreme events occurred 8200 years ago, causing cold conditions and widespread drought, and during the so-called Little Ice Age (1300-1850 AD), which caused significant agricultural, economic and political impacts in Europe.

Is abrupt cooling the same as an Ice Age?

Abrupt cooling does not mean the start of another Ice Age. The present orbit of the Earth and high concentrations of carbon dioxide and other greenhouse gases in the atmosphere mean that a new Ice Age, with large ice sheets on northern hemisphere continents, is unlikely for thousands of years.

What is the difference between global warming and climate change?

Global warming refers to the gradual increase of the Earth's average surface temperature, due to greenhouse gases in the atmosphere. Climate change is a broader term that refers to long-term changes in climate, including average temperature and rainfall, as well as changes in the seasonal or geographic variability of temperature and rainfall.

Can global warming cause regional cooling?

As surprising as it sounds, yes, global warming can cause cooling in some parts of the world. Global warming can slow down ocean heat transport, causing cooling in some regions. Global warming is expected to cause an increase in rainfall at high latitudes. More rainfall, just like melting of northern hemisphere ice sheets, will make surface waters fresher and possibly reduce ocean heat transport. The northern Atlantic has already become less salty.

The Intergovernmental Panel on Climate Change (IPCC), has concluded that while a weakening (but not a complete shut down) of the thermohaline circulation is likely by the year 2100, Europe is still likely to be warmer than today due to increased greenhouse gas concentrations. Beyond 2100, according to the IPCC, the thermohaline circulation could completely, and possibly irreversibly, shut-down in either hemisphere if the increase in greenhouse gases is large enough and long lasting.

There is still much that is unknown about the world's climate and the way in which it is likely to respond to global warming, especially in the long-term. A key question is whether an increase in the concentration of atmospheric greenhouse gases could force the climate system closer to a threshold where there is an increased chance of an abrupt change in climate.

What would be the impact on Australia if there were an abrupt change in climate in the north Atlantic?

Changes in Australian climate are likely to be more subtle because we are not as strongly affected by heat carried by the North Atlantic ocean conveyor. Some changes in climate are possible due to changes in the global atmosphere.

A change in the Southern Ocean overturning may have larger impacts on us. However, there are few records of past climate variability in Australia, so we do not know if Australia experienced abrupt climate changes in the past.

Certainly, Australia would be affected by any trade and political implications of a rapid (or gradual) change in climate.

How is global warming likely to affect Australia?

Australia will be hotter and drier in coming decades according to CSIRO's climate change estimates. Over most of the continent, annual average temperatures will be 0.4 to 2°C greater than 1990 by 2030. By 2070, average temperatures are likely to increase by 1 to 6°C. The warming won't be the same everywhere. There will be slightly less warming in some coastal areas and Tasmania, and slightly more warming in the north-west.

The warmer conditions will produce more extremely hot days and fewer cold days.

South-western Australia can expect decreases in rainfall, as can parts of south-eastern Australia and Queensland. Wetter conditions are possible in northern and eastern Australia in summer and inland Australia in autumn.

For details, see www.dar.csiro.au/impacts/future.html

What relevant research is being undertaken in Australia?

Since the 1970s, Australian scientists have been performing internationally-recognised research into climate change and its likely impacts.

CSIRO, the Bureau of Meteorology, universities and Co-operative Research Centres are examining the role of oceans and their sensitivity to change. The thermohaline circulation (the "ocean conveyor" by which warm currents circulate) is being monitored closely.

For more information on global warming and climate change, see www.greenhouse.gov.au/science



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