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Global warming and cooling, and the development dilemma

Professor Robert Wade and Professor David Seckler suggest that Antarctica's ice loss highlights the interplay of natural climate cycles, Earth's thermostatic mechanisms, and human-induced greenhouse gas emissions, and emphasise the urgent need to reduce emissions while balancing global development challenges.

This post is a revision of 'Prospects for containing global warming, based on a short account of the Earth's climate mechanisms'.

In the past few years, Antarctica has displaced the northern hemisphere at the centre of the debate about the future of climate change and our biophysical system, due to (1) collapse of glaciers into the sea and (2) dramatic shrinkage in sea ice. These events have raised the scientifically-based alarm level about future climate and weather prospects.

What follows is a schematic account of the basic mechanisms that drive Earth's climate, including the alarming trends in Antarctica. That sets the context for an assessment of prospects for slowing global warming, and the fundamental dilemma faced by the governments and peoples of developing countries.

We begin with the trend of global average temperature from 1850 to 1900. This is commonly called "the pre-industrial period" in the climate community, and its average temperature is taken as the baseline for measuring increases in temperature since then. This is misleading, because 1850-1900 is in the Little Ice Age, when temperatures were abnormally low. Taking this period as the baseline tends to exaggerate the "abnormality" of current high temperatures. A thousand years ago during the "Medieval Warm Period" global temperatures were close to today's.

Global temperature increased slowly from 1900 to 1980and increased fairly fast after 1980. Each decade since the 1980s has been the hottest on record. The short-term trend flattened between 2013 and 2022. Most climate scientists describe this as a "pause" or "hiatus", and are confident that the longer-term upward trend has resumed.

The determinants of climate

The Earth's climate system is controlled by two basic mechanisms. The first mechanism is the several Milankovitch (M) cycles, which refer to the solar system of the Earth as it rotates and wobbles and tilts around the Sun, changing the amount of radiation hitting Earth and its regions (Ruddiman 2014).

The Milankovitch mechanism is external. The second climate mechanism is internal, and concerns the influence of temperature on Earth's two turbulent fluids, water and air. The influence is thermostatic, such that when it gets too hot, climate cools, and vice versa. The history of temperature over the past million years shows remarkably robust thermostatic pattern, such that when temperature reaches around one to two degrees centigrade above the present average global cooling sets in, and when it reaches around four centigrade below the present average, global warming sets in (Lindzen 2018).

In short, temperature is affected both by the external cycles and by the Earth's internal thermostatic climate system.

A third temperature mechanism has recently come into play, which is the "green house" effect of excessively rising greenhouse gas (GHG)density in the atmosphere due to human activities. Much of the literature on climate change presumes that this is the only relevant mechanism for explaining the fast increasing global temperature since 1980.

We agree that the green house effect is currently the major cause of rising temperature. But we question whether one can be confident that global temperature will continue to rise without limit until the stock of GHG stabilizes or falls. That forecast ignores the complicated thermostatic mechanism of the climate system that reacts to the higher temperature, and could cause temperature to fall sometime in the future. The thermostatic effect will interact with the M cycles, which are in a mildly cooling phase at present, acting to reinforce the thermostatic effect battling against the GHG warming effect.

To understand the thermostatic mechanism and how it could lead to lower temperatures, we have to start with the image of Earth's climate system made up of two turbulent fluids interacting with each other: water and air, which are differentially heated and cooled by the Sun.

Water

Water comes in three phases: liquid, solid and vapour.

One of the most important water currents is the Great Conveyor Belt (GCB). It flows in irregular circles around the oceans; in the Atlantic Ocean nearly from one pole to the other and between North America and Europe in the northern portions. The current speeds up and slows down over centuries. On average it takes about a thousand years for a water molecule to travel around the whole circuit.

The oceans have absorbed over 90 percent of the excess heat produced by human activity over the past 50 years (Antarcticand Southern Ocean Coalition, n.d.). In its Gulf Stream and North Atlantic portions the GCB transports a vast amount of heat, equivalent to one million nuclear reactors, to northern Europe. Increasing temperature in polar regions might release a massive flood of freshwater from increased rain and melting glaciers to cause the GCB to slow and cool, causing the atmosphere of the higher latitudes north and south to cool substantially.

Ice

Partly because warm flows to cool, not the reverse, the polar regions are warming faster than any other large region on the globe. Antarctic sea ice has decreased 40% over the past few years. This creates loss of regional albedo or whiteness: the loss of reflection of radiation back into space, which increase swarming. Glacier melting is accelerating in both polar regions, including giant glaciers in East Antarctica previously thought to be stable. This could cause dramatic sea level rise by tens of meters. This mechanism then feeds into the possible slowing and cooling of the GCB, just discussed (Antarctic and Southern Ocean Coalition, n.d.).

Water vapour and rain

As global temperature rises the oceans evaporate more water vapour into the atmosphere, where it acts as the single most powerful greenhouse gas. Most of the tropics have already reached the saturation point of water vapour, intensifying rain and flooding. The water vapour spreads into cooler temperature regions, raising temperature, rain, flooding and snow.

Future

Steven Koonin calls his book on climate science *Unsettled*(2021). Allowing for all the "unsettled" we still think that some broad conclusions about the likely future can be drawn. If the history of climate cycles over the past million years is a guide, global temperature will continue to rise as long as the stock of GHG in the atmosphere keeps rising, up to the point where the combination of thermostatic mechanisms and M cycles acts in force to slow down the rise and send it into reverse. This may well start to happen when the temperature is only one or two degrees centigrade above the present level. The transition will be accompanied by more violent weather, rapidly rising oceans, large changes in regional climates (Lindzen 2018).

We are confident about the direction of the trends in these climatic factors, but not confident of the timing. Thinking about climate change has to locate decades in centuries and millennia of years.

But when discussing the future, we tend to focus on the next few decades, and it is hard to focus at this microscopic level. All we can say now is that the warming trends will continue over the near future, but by how much we cannot say. The conclusion is that human society needs to reduce GHGemissions as quickly and by as much as we reasonably can.

This then feeds into the fundamental development dilemma. In the timeframe of the next several decades the Earth could not support South Asia and Sub-Saharan Africa reaching the resource-intensity of present-day China, let alone the western average. Many developing country governments already struggle to find resources even for basic public services, let alone to phase out their existing resource-intensive fossil fuel facilities and replace with renewable energy.

The pressure on the already rich countries to hugely increase their financing for renewable energy and climate adaptation in developing countries is only going to intensify. But most rich countries are already growing at close to zero, and resist pledging more than a small fraction of the finance for the energy transition in developing countries.

But before we succumb to apocalyptarian thinking we should note that the International Energy Agency forecasts that — based only on today's policy settings by governments worldwide, even without new climate policies – demand for the three fossil fuels will probably peak before the end of this decade (International Energy Agency 2023). Which is to say that the *humansystem* for slowing climate change will probably be fairly effective in slowing the rise and then accelerating the fall in GHG emissions. The accelerating fall in GHG emissions will induce a slowing rise of temperature. The slowing rise of temperature will be helped by the *natural system* of thermostatic climate control coupled with the present cooling phase of the M cycles. The combination could substantially slow global warming – and ease a violent transition to global cooling.

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