

Lessons about a future warmer world using data from the past¹

Selected intervals in the past that were as warm or warmer than today can help us understand what the Earth may be like under future global warming. A latest assessment of past warm periods, by an international team of 59 scientists from 17 nations including Cambridge Earth Sciences' Professor Eric Wolff, shows that in response to the warming ecosystems and climate zones will spatially shift and on millennial time scales ice sheets will substantially shrink.

The study was an outcome of a workshop that took place in Bern and was coordinated by the University of Bern in Switzerland, the University of New South Wales in Australia, and Oregon State University in the United States. The compiled evidence from the past suggests that even with a global warming limited to within 2°C above preindustrial levels, as aimed at in the Paris Agreement, climate zones and ecosystems will shift, rapid polar warming may release additional greenhouse gases, and sea-level will rise by several meters over several thousand years. These observations show that many current climate models designed to project changes within this century may underestimate longer-term changes.

Over the past 3.5 million years, several time intervals are known for being 0.5-2°C warmer than the so-called preindustrial temperatures of the 19th century. These intervals reveal much stronger regional warming at high latitudes than in the tropics, similar to what models predict for a 2°C global warming by the year 2100. Although not all these past warmings were caused by higher CO₂ concentrations, they are helpful to assess the regional effect of a warming of a scale comparable to that aimed at in the Paris Agreement.

Cambridge Earth Sciences' Professor Eric Wolff commented that *“the strength of this work is that it looks at what actually happened in the past when parts of the Earth were warmer. This adds a layer of physical evidence to our understanding of what will happen in future”*

Ecosystems and climate zones will generally shift poleward or to higher altitudes. In response, permafrost thaw may release additional carbon dioxide and methane to the atmosphere, driving additional warming. Past observations suggest that if warming can be limited to no more than 2°C as proposed by the Paris accords, the risk of catastrophic runaway greenhouse gas feedbacks is relatively low. Nevertheless, the significant amount of additional CO₂ released from permafrost and soils must be considered in future emission budgets.

“Accounting for the additional release of CO₂ leaves even less room for error or delay as humanity seeks to lower its CO₂ emissions and stabilize

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global climate within reasonable limits”, Hubertus Fischer, of the University of Bern, emphasizes.

Even a warming of 1.5-2°C above preindustrial levels will be sufficient to trigger substantial long-term melting of ice in Greenland and Antarctica and sea-level rise of more than 6 meters that will last for thousands of years. Rates of sea-level rise higher than those of the last decades are likely.

Alan Mix of Oregon State University noted the importance of this sea-level rise, stating, “*we are already beginning to see the effects of rising sea level. This rise may become unstoppable for millennia, impacting much of the world’s population, infrastructure, and economic activity that is located near the shoreline*”.

Comparison of observations of the past with computer simulations suggests that models may underestimate long-term warming and its amplification in polar regions.

Katrin Meissner of University of New South Wales, Australia, commented that, “*while climate model projections seem to be trustworthy when considering relatively small changes over the next decades, it is worrisome that these models likely underestimate climate change under higher emission scenarios, such as a ‘business as usual’ scenario, and especially over longer time scales.*”

According to the researchers, this information from the past underscores the urgency of reducing CO₂ emissions soon to meet the Paris Agreements in this century and beyond.

Palaeoclimate constraints on the impact of 2 °C anthropogenic warming and beyond, Hubertus Fischer, Katrin J. Meissner, Alan C. Mix et al is published in *Nature Geoscience*.

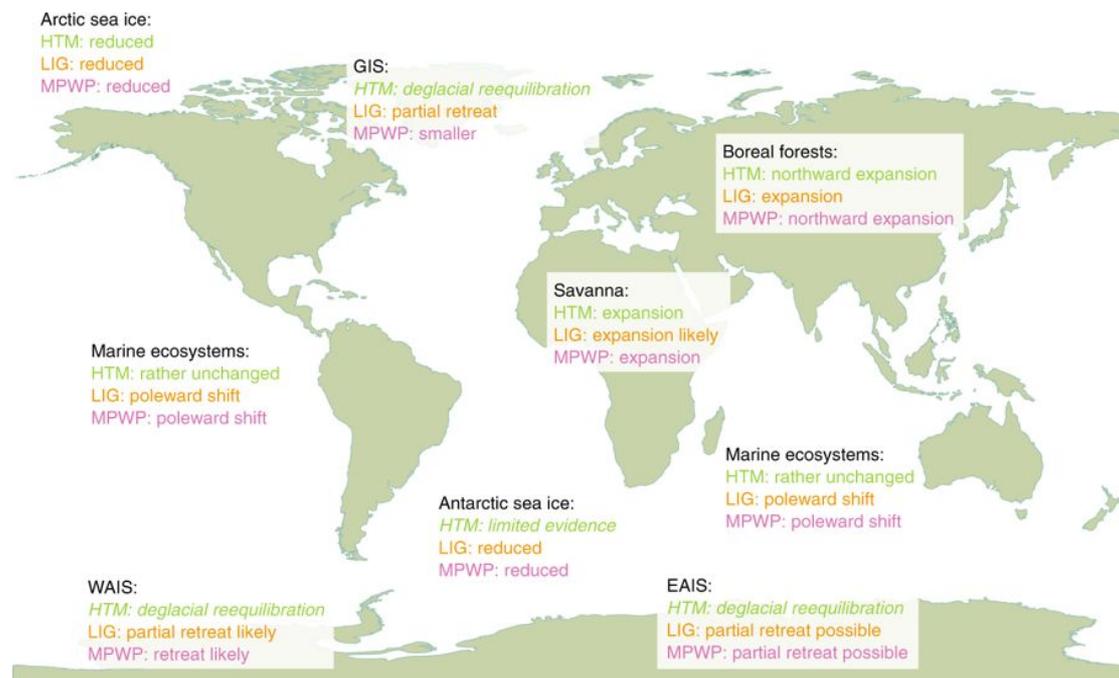


Fig. 3 Impacts and responses of components of the Earth system. The figure summarizes the changes in parts of the Earth system deduced for the Holocene Thermal Maximum (HTM), last interglacial (LIG) and mid-Pliocene Warm Period (mPWP). GIS, WAIS and EAIS are the Greenland, West Antarctic and East Antarctic Ice Sheets.