

How important are climate models for revealing the causes of environmental change?

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The human impact on the environment, especially through the release of greenhouse gases, is an area of controversy in public understanding of climate change, and is important for predicting future changes. Many studies into our collective impact use climate models to understand the causes of observed climate changes, both globally and in specific regions. Writing in *WIREs Climate Change*, Professors Gabriele Hegerl from the University of Edinburgh and Francis Zwiers from the University of Victoria assess the role of climate models in studies of observed changes and the robustness of their results.

"Since the mid-1990s, a wide range of studies have shown that [greenhouse gas](#) increases have influenced the climate, globally and regionally, affecting many variables," said Hegerl. "However, even to scientists, the roles of observations, physical insight, and climate models in estimates of the human contribution to recent [climate change](#) are not always clear."

In this review paper the authors assess research methods for understanding the causes of observed [climate change](#), ranging from approaches that refrain from using climate models, to different approaches using models including 'fingerprint' analysis and large-scale detection and attribution studies.

"Detection and attribution methods attempt to separate observed climate

changes into components that can be explained either by the variability of the climate system or external changes, such as human activity," said Hegerl. "Most detection and attribution studies use climate models to interpret the observations. Models are used both to determine the expected 'fingerprint' of climate change and to access the uncertainty in the estimated magnitude of observations given [climate variability](#)."

Hegerl and Zwiers also explore how some researchers have attempted to identify manmade and externally forced climate change from observations only. However, while methods that do not use climate models avoid assumptions about the expected response, they do use other strong assumptions, such as the response to forcing being instantaneous or that climate change and variability can be separated by timescale.

Another challenge facing observation based studies is the impact of natural events, such as volcanic activity which bellows dust and aerosols into the stratosphere, which could have an anomalous cooling effect for a few years.

Professor Hegerl argues that research which does not rely on climate models makes strong assumptions about how the effects of human influence on the climate can be distinguished from the effects of the natural variability of the [climate system](#). This research supports the conclusion that human influence has changed recent temperatures that is drawn from studies that use models. These strong assumptions do not have to be made when using physically based climate models, but because climate models are not perfect their use does introduce other uncertainties. These uncertainties are small for large-scale temperature change, but are larger and less well understood for changes related to impacts, such as regional temperatures, extremes, and precipitation.

"Our review discusses the role [climate models](#) play in determining the

causes of recent climate change, and shows that results about the causes of recent climate change are firmly based on observations," concluded Hegerl. "Climate change detection and attribution is first, and foremost, about understanding these observed changes. However, detection and attribution requires a model of why the climate may be changing to be able to draw conclusions from observations."

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