# New study quantifies impact of climate change adaptation on future warming through energy use feedback



A recent scientific study published in Nature has introduced a novel methodology to quantify how future energy usage changes, driven by adaptation to anthropogenic climate change (ACC), influence greenhouse gas (GHG) emissions and subsequently affect global warming. This approach centres on a measurement termed the “Climate Adaptation Feedback” (CAF), representing the difference in global mean surface temperature (GMST) projected with and without adaptation-induced energy consumption over a specified future horizon.

The research sets its baseline scenario on a combination of Representative Concentration Pathway (RCP) 8.5, representing a high-emission trajectory, and Shared Socioeconomic Pathway (SSP) 2, which reflects moderate socioeconomic conditions. By comparing projections of future warming that include adaptive energy use against those that do not, the CAF quantifies the extent to which adaptation either exacerbates or mitigates warming, depending on whether its value is positive or negative.

To construct these projections, the authors calculated the change in global carbon dioxide (CO₂) emissions arising from adaptive energy use on a country-by-country basis. They considered how ACC changes local temperature distributions and how these changes affect energy demand. The study utilises approximately 25,000 subnational regions with internally consistent historic temperature profiles to capture this spatial diversity. The emissions were attributed to two key energy consumption types: electricity and other fuels, such as natural gas, oil, and biofuels.

Central to the methodology are ‘dose-response’ functions derived from historical energy consumption data, which relate daily temperature exposure to energy demand within various fuel categories. These functions also incorporate socioeconomic covariates, including projected GDP per capita and population changes, which influence local energy demand responses to temperature variation. This allows the model to reflect adaptations not only from immediate temperature fluctuations but also from longer-term changes such as increased adoption of heating and cooling technologies, especially in developing economies.

The team incorporated uncertainties into their calculations by employing 33 Global Climate Models (GCMs) from the Coupled Model Intercomparison Project Phase 5 (CMIP5) to represent climate variability under the SMME framework. Statistical uncertainties in the energy-temperature response functions were captured using a Gaussian distribution approach, combined with the climate model ensemble to create a comprehensive uncertainty characterization.

The cumulative additional CO₂ emissions from adaptive energy use over periods extending to the end of the century were translated into changes in GMST through a linear coefficient β, which links cumulative emissions to temperature increase. This coefficient was empirically estimated using varying RCP and GCM projections, and found to be larger than the classic transient climate response to cumulative carbon emissions (TCRE), likely due to correlated increases in other greenhouse gases alongside CO₂.

Importantly, the analysis also considered the economic valuation of the CAF by utilizing the Climate Impact Lab’s Data-driven Spatial Climate Impact Model (DSCIM). This model quantifies damages from climate change across sectors such as mortality, labour, energy, agriculture, coastal storms, and sea level rise, translating temperature changes into monetary terms. Avoided damages due to negative CAF values (where adaptation leads to less warming) were calculated considering discount rates grounded in economic theory.

The research differentiates itself from previous work by adopting a data-driven empirical approach rather than relying on Integrated Assessment Models (IAMs). Unlike IAMs, which impose structural assumptions about economic behaviour and policy responses, this methodology draws directly on observed historical responses of energy demand to temperature, allowing for detailed regional analysis and flexible uncertainty assessment. However, the absence of IAM structure means that certain future influences such as government policies or voluntary behavioural changes beyond historical patterns are not accounted for.

Supporting data encompassed detailed country-level projections of energy use, emissions intensities, population, and economic growth from recognised international sources including the International Energy Agency (IEA), International Institute for Applied Systems Analysis (IIASA), and Organisation for Economic Co-operation and Development (OECD). These sources provided comprehensive inputs to enable the construction of country-specific emissions factors reflecting differences in energy fuel mixes.

Additionally, the study examined a dynamic version of the CAF that iteratively updates temperature projections based on emissions changes induced by adaptation, with subsequent effects on future adaptive energy use. This recursive approach revealed that while there are concurrent emissions-temperature feedbacks, their quantitative impact on the overall CAF estimate is minimal, reaffirming the robustness of the baseline calculations.

This comprehensive analysis enhances understanding of the complex interplay between human adaptation to climate change and the resultant feedback effects on global temperature trajectories. By providing spatially detailed and empirically grounded estimates, the work offers a refined basis for assessing how adaptive behaviours in energy consumption contribute to climate dynamics over the coming decades.

Source: [Noah Wire Services](https://www.noahwire.com)