Can Extreme Arctic Climate Change Be Avoided With Cost Effective Mitigation?

THE ISSUE. Because the Arctic is warming much faster than the global average, Arctic nations have a special interest to understand climate responses to hypothetical reductions of greenhouse gas (GHG) emissions and to know whether aggressive mitigation efforts now make good economic sense.

WHY IT MATTERS. Climate warming threatens a wide variety of essential ecosystem services on a global scale, with notable high rates of change in the Arctic. But how would the climate respond to reduced GHG emissions, and how well do scientists know that reduced emissions can eventually stabilize the climate or forestall worsening impacts? Government decision-makers and the public at large need to understand the degree to which mitigation efforts (actions to limit the magnitude or rate of long-term change) might still reduce the threat of global warming so they can make rational choices and best evaluate the relative cost-benefit of policy and regulatory options.

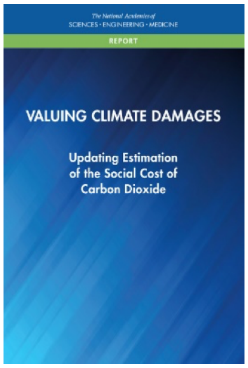
STATE OF KNOWLEDGE. May of 2017 marked the first time in recorded history that the monthly global concentration of carbon dioxide in the atmosphere reached 400 parts per million (ppm), dramatically up from a pre-industrial level of about 284 ppm. If unchecked, carbon emissions are now on track to reach 750 ppm or higher by 2100. Scientists concluded years ago that the planet can no longer avoid significant warming during this century, primarily because of GHG retention and heat already mixed into ocean depths. But if global GHG emissions were quickly and dramatically reduced, then many dangerous outcomes—such as massive loss of sea ice/glaciers/permafrost, significant sea level rise, and severe weather events—could still be partially avoided. Using supercomputer earth-system simulations, one prominent model result showed that if 450 ppm could be maintained (through ~70% less emissions by 2100), then global mean temperatures would increase by ~1°F through the end of the century. By contrast, global mean temperatures would rise by ~4°F if emissions continued on the present trajectory (Washington et al. 2009).

A popular international modeling scenario that stabilizes the global GHG budget by 2100 (with ~60% emission reduction from peak in 2040) is known as "representative concentration pathway (RCP) 4.5". It aims to limit the increase of GHG down-welling radiation to 4.5 watts per square meter (relative to preindustrial levels, consistent with ~630 ppm). This "moderate" policy scenario would be relatively inexpensive but requires that all nations undertake mitigation simultaneously, implementing an effective, phased and standardized emissions pricing structure that increases over time (see Stocker et al. 2013).

Recent climate model projections focusing especially on the Arctic region also indicate that GHG emission mitigation could slow temperature changes by the second half of this century. Relative to the 1981-2005 baseline, results from a collection of general circulation models (with RCP4.5 assumptions) show an Arctic end of century mean temperature increase of 12.6°F in late autumn. By contrast, with no mitigation, Arctic mean temperature projections increase by 23.4°F (Overland et al. 2013). Either way leads to unprecedented disruption of Arctic ecosystems and economies, with new projections of an Arctic mean increase range of 7.2 - 9.0°F in late autumn by mid-century (AMAP 2017).

While integrated modeling efforts continually improve, they all consistently build a strong case that opportunities for mitigation are highly time sensitive. Prompt implementation could still make a significant difference in future climate outcomes. Given the many unavoidable uncertainties, mitigation policies based on science will seek to avoid credible worst-case scenarios projected beyond mid-century.

Where the Science is Headed. Now that science has identified a potential path of climate stabilization, the information can be increasingly coupled with socio-economic factors to address specific cost-benefit tradeoffs that may guide ongoing decisions about how much society should invest in a broad menu of carbon reduction efforts. Robust modeling offers the best hope to achieve predictive skill in estimating not only the degree to which destructive climate change impacts might yet be mitigated under future scenarios but also the means for better estimating the true social costs of GHG emissions.



While many aspects of emerging social cost estimates remain controversial, they all recognize common direction: GHG emissions cause substantial economic harm but also allow for economic growth, so we must develop a sophisticated process that most accurately represents future cost-benefit into present monetary values (e.g. see Revesz 2014; NAS 2017). This approach yields a dollar estimate of net damages society incurs from each metric ton increase in GHG emissions. Such tools may help identify specific policies that deserve priority, such as stringent but feasible reductions in short-lived climate forcers (like black carbon, methane, nitrous oxides), which can offer more promising focus because the benefits of mitigation occur more quickly for those compounds (Sand 2016). Such tools may also stimulate new approaches to GHG sequestration or geoengineering efforts or further incentivize growth of innovative technologies. Increasingly sophisticated tools may also reduce persistent public skepticism about how climate and economic benefits of abated GHG emissions get calculated (see NAS 2017). As modeling revisions continually reduce error, oversimplification, and entrenched biases, the updated social cost approach shows merit and properly frames a constructive path forward.

Key References

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