Future climate change commitment IPCC 2001

Climate system INERTIA

An Assessment of the Intergovernmental Panel on Climate Change Climate Change 2001

Synthesis Report
Summary for Policymakers

Question 5

What is known about the inertia and time scales associated with the changes in the climate system, ecological systems, and socio-economic sectors and their interactions?

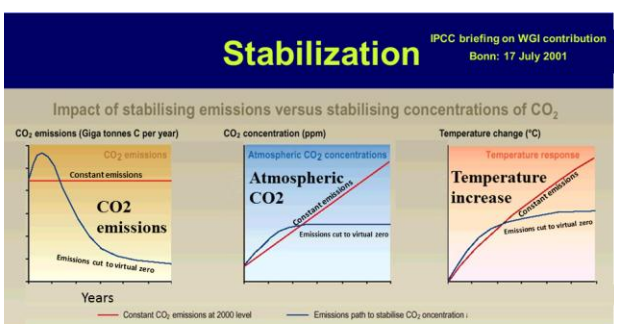
Inertia is a widespread inherent characteristic of the interacting climate, ecological, and socio-economic systems. Thus some impacts of anthropogenic climate change may be slow to become apparent, and <u>some could be irreversible if climate change is not limited in both rate and magnitude before associated thresholds, whose positions may be poorly known, are crossed.</u>

Inertia in Climate Systems

Stabilization of CO_2 emissions at near-current levels will not lead to stabilization of CO_2 atmospheric concentration, whereas stabilization of emissions of shorter lived greenhouse gases such as CH_4 leads, within decades, to stabilization of their atmospheric concentrations.

Stabilization of CO_2 concentrations at any level requires eventual reduction of global CO_2 net emissions to a small fraction of the current emission level. The lower the chosen level for stabilization, the sooner the decline in global net CO_2 emissions needs to begin - (see Figure SPM-**5** ***a 95% reduction to virtual zero carbon emissions***).

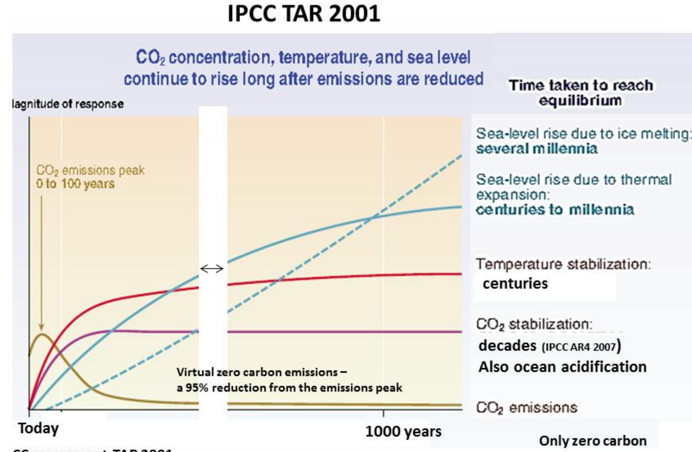
After stabilization of the atmospheric concentration of CO_2 and other greenhouse gases, surface air temperature is projected to continue to rise by a few tenths of a degree per century for a century or more, while sea level is projected to continue to rise for many centuries (see Figure SPM-5).



In fact only in the case of essentially complete elimination of emissions - can the atmospheric concentration of CO2 ultimately be stabilized at a constant level.

IPCC AR4 2007 assessment Working Group 1 Question 10.3

IPCC TAR 2001



CC assessment TAR 2001

Figure SPM-5: After CO_2 emissions are reduced and atmospheric concentrations stabilize, surface air temperature continues to rise slowly for a century or more. Thermal expansion of the ocean continues long after CO_2 emissions have been reduced, and melting of ice sheets continues to contribute to sea-level rise for many centuries. This figure is a generic illustration for stabilization at any level between 450 and 1,000 ppm, and therefore has no units on the response axis. Responses to stabilization trajectories in this range show broadly similar time courses, but the impacts become progressively larger at higher concentrations of CO_2.

Only zero carbon emissions allows global temperature and ocean acidification to stabilize

The slow transport of heat into the oceans and slow response of ice sheets means that long periods (*hundreds of years*) are required to reach new climate system equilibrium.

Some changes in the climate system, plausible beyond the 21st century, would be effectively irreversible. For example, major melting of the ice sheets and fundamental changes in the ocean circulation pattern could not be reversed over a period of many human generations. The threshold for fundamental changes in the ocean circulation may be reached at a lower degree of warming if the warming is rapid rather than gradual.

Inertia in Socio-Economic Systems

Unlike the climate and ecological systems, inertia in human systems is not fixed; it can be changed by policies and the choices made by individuals.

The capacity for implementing climate change policies depends on the interaction between social and economic structures and values, institutions, technologies, and established infrastructure. The combined system generally evolves relatively slowly. It can respond quickly under pressure, although sometimes at high cost (e.g., if capital equipment is prematurely retired). If change is slower, there may be lower costs due to technological advancement or because capital equipment value is fully depreciated. There is typically a delay of years to decades between perceiving a need to respond to a major challenge, planning, researching and developing a solution, and implementing it.

Anticipatory action, based on informed judgment, can improve the chance that appropriate technology is available when needed. **The development and adoption of new technologies can be accelerated by technology transfer and supportive fiscal and research policies.** Technology replacement can be delayed by "locked-in" systems that have market advantages arising from existing institutions, services, infrastructure, and available resources. Early deployment of rapidly improving technologies allows learning-curve cost reductions.

Policy Implications of Inertia

Inertia and uncertainty in the climate, ecological, and socio-economic systems imply that safety margins should be considered in setting strategies, targets, and time tables for avoiding dangerous levels of interference in the climate system.

Stabilization target levels of, for instance, atmospheric CO_2 concentration, temperature, or sea level may be affected by:

- The inertia of the climate system, which will cause climate change to continue for a period after mitigation actions are implemented
- Uncertainty regarding the location of possible thresholds of irreversible change and the behavior of the system in their vicinity
- The time lags between adoption of mitigation goals and their achievement. Similarly, adaptation is affected by the time lags involved in identifying climate change impacts, developing effective adaptation strategies, and implementing adaptive measures.

Inertia in the climate, ecological, and socio-economic systems makes adaptation inevitable and already necessary in some cases, and inertia affects the optimal mix of adaptation and mitigation strategies. Inertia has different consequences for adaptation than for mitigation—with adaptation being primarily oriented to address localized impacts of climate change, while mitigation aims to address the impacts on the climate system. These consequences have bearing on the most cost-effective and equitable mix of policy options. Hedging strategies and sequential decision making (iterative action, assessment, and revised action) may be appropriate responses to the combination of inertia and uncertainty. In the presence of inertia, well-founded actions to adapt to or mitigate climate change are more effective, and in some circumstances may be cheaper, if taken earlier rather than later.

The pervasiveness of inertia and the possibility of irreversibility in the interacting climate, ecological, and socio-economic systems are major reasons why anticipatory adaptation and mitigation actions are beneficial. A number of opportunities to exercise adaptation and mitigation options may be lost if action is delayed.