IPCC AR6 Commitment

IPCC AR6 WG1 4.7 Climate Change Beyond 2100

On multi-century time scales it is common to explore changes that are due to long-term commitment. Here we differentiate between:

- **Committed emissions due to infrastructure.** Infrastructure that causes greenhouse gas emissions cannot be changed straight away leading to a commitment from existing infrastructure that some emissions will continue for a number of years into the future
- **Climate response to constant emissions. Some** of the scenario extensions beyond 2100 make assumptions about constant emissions.
- **Committed climate change to constant atmospheric composition**. There is widespread literature on how the climate continues to change after stabilisation of radiative forcing
- **Committed response to zero emissions**. How climate would continue to evolve if all emissions ceased. The SR1.5 assessed changes in climate if emissions of all greenhouse gases and aerosols ceased. Section 4.7.2 assesses new results considering cessation of CO2-only emissions which forms a significant term in calculating remaining carbon budgets.

Committed change, long-term commitment: Changes in the climate system, resulting from past, present and future human activities, which will continue long into the future (centuries to millennia) even with strong reductions in greenhouse gas emissions. Some aspects of the climate system, including the terrestrial biosphere, the deep ocean and the cryosphere, respond much more slowly than surface temperatures to changes in greenhouse gas concentrations. **As a result, there are already substantial committed changes associated with past greenhouse gas emissions.** For example, global mean sea level will continue to rise for thousands of years, even if future CO2 emissions are reduced to net zero and global warming halted, as excess energy due to past emissions continues to propagate into the deep ocean and as glaciers and ice sheets continue to melt. (Section TS.2.1, Box TS.4, Box TS.9) {1.2.1, 1.3, Box 1.2, Cross-Chapter Box 5.3}

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Based on idealized model simulations that explore the climate response once CO2 emissions have been brought to zero, the magnitude of **the zero CO2 emissions commitment is assessed to be likely smaller than 0.3°C for time scales of about half a century and cumulative CO2 emissions broadly consistent with global warming of 2°C.**

Despite the large uncertainties surrounding the quantification of the effect of additional Earth system feedback processes, such as emissions from wetlands and permafrost thaw, these feedbacks represent identified additional risk factors that scale with additional warming and mostly increase the challenge of limiting warming to specific temperature levels.
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The present rates of response of many aspects of the climate system are proportionate to the rate of recent temperature change, but some aspects may respond disproportionately. Some climate system components are slow to respond, such as the deep ocean overturning circulation and the ice sheets. It is virtually certain that irreversible, committed change is already underway for the slow-to-respond processes as they come into adjustment for past and present emissions.

The paleoclimate record indicates that tipping elements exist in the climate system where processes undergo sudden shifts toward a different sensitivity to forcing, such as during a major deglaciation, where 1°C degree of temperature change might correspond to a large or small ice-sheet mass loss during different stages (Box TS.2). For global climate indicators, evidence for abrupt change is limited, but deep ocean warming, acidification and sea level rise are committed to ongoing change for millennia after global surface temperatures initially stabilize and are irreversible on human time scales (very high confidence). At the regional scale, abrupt responses, tipping points and even reversals in the direction of change cannot be excluded (high confidence). Some regional abrupt changes and tipping points could have severe local impacts, such as unprecedented weather, extreme temperatures and increased frequency of droughts and forest fires.

Models that exhibit such tipping points are characterized by abrupt changes once the threshold is crossed, and even a return to pre-threshold surface temperatures or to atmospheric carbon dioxide concentrations does not guarantee that the tipping elements return to their pre-threshold state.