Emission pathways avoiding dangerous anthropogenic interference with the climate system

Kirsten Zickfeld

School of Earth and Ocean Sciences, University of Victoria

The ultimate objective of climate change mitigation is to reduce the amount of anthropogenic greenhouse gas (GHG) emissions in order to achieve “stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system” (UNFCCC, Article 2). Before being able to specify a stabilization target, scientists and policymakers are thus confronted with the challenging task of defining “what is dangerous”. One interpretation has been offered by the Intergovernmental Panel on Climate Change (IPCC). In its Third Assessment Report it developed a synthesis framework addressing five “reasons for concern”, which relate different categories of impacts to the respective level of climate change at which they are likely to occur.

In this paper we use different interpretations of ‘dangerous’ climate change (e.g. the 2 °C global mean temperature threshold suggested by the European Union or the collapse of the so-called thermohaline circulation in the Atlantic Ocean) to derive greenhouse gas emissions corridors which reduce the risk of such a change, while considering expectations about the socio-economically acceptable pace of emissions reductions. Emissions corridors embrace the range of carbon dioxide emissions that are compatible with normatively defined policy goals or ‘guardrails’. They are calculated along the conceptual and methodological lines of the Tolerable Windows Approach. We also derive emissions trajectories that are optimal from a cost-effectiveness perspective. The analytical framework consists of an integrated assessment model (IAM) comprising a globally aggregated multi gas climate model and a model of the world economy for assessing the monetary costs of climate protection.

Our results indicate a large sensitivity of the emissions corridors and the cost-effective paths on (i) the assumption of what constitutes ‘dangerous’ climate change, (ii) the level of acceptable risk and (ii) uncertain physical quantities such as climate sensitivity (i.e. the warming resulting from a doubling of the pre-industrial atmospheric carbon dioxide concentration in equilibrium). For example, reducing the probability of thermohaline circulation collapse to 0.1 requires effective emissions reductions relative to business-as-usual within this century for medium estimates of the climate sensitivity. If the acceptable risk of circulation collapse is restricted or climate sensitivity is assumed to be higher, the timing of required emissions reductions is shifted towards the early decades of this century.