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Estimating global warming from anthropogenic heat emissions

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Historical observations show a constant exponential growth of the worldwide energy production. A continuation of this trend might be fueled or even amplified by the exploration of new carbon-free energy sources like fusion power. However, the consumption of this primary energy by human civilisations and consequent dissipation to heat induces a direct climate warming, the so called anthropogenic heat flux (AHF) forcing.

While the current globally averaged AHF is negligibly small compared to the indirect forcing from greenhouse gas emissions, it can have significant impacts on local to regional scale. In a scenario with strongly increased primary energy consumption, for example from nuclear power, the impacts of the AHF can, however, become a relevant factor for anthropogenic post-greenhouse gas climate change even on the global scale.

We estimated the future warming from different scenarios of a growing AHF forcing in climate models ranging from simple, conceptual Energy Balance Models to a climate model of intermediate complexity. The feedbacks associated with the additional forcing, in particular the ice-albedo feedback and the ocean heat uptake, allow for a detailed analysis of the impacts of the AHF. Moreover, the influence of the heterogeneity of the forcing was examined.

The global mean temperature response from the AHF today is of the order of $0.010 - 0.016\,\mathrm{K}$ in all model configurations tested. A transient tenfold increase of this forcing heats up the Earth system additionally by roughly $0.1 - 0.2\,\mathrm{K}$ in the models used in this work.

Further growth can also affect the tipping probability of certain climate elements. E.g. we find that the AHF can affect the sea ice patterns through changes in the ocean circulation in the North Atlantic and, therefore, further amplify the temperature response in certain parts of the Arctic region.

In contrast to nuclear power, most renewable energy sources do not or only partially contribute to the AHF forcing as the energy from these sources dissipates anyway. Hence, the transition to a (carbon-free) renewable energy mix, which explicitly does not rely on nuclear power, eliminates the global climate impacts from the increasing AHF forcing, independent of the growth of energy production.