The effect of high climate sensitivity on the global energy system in stringent mitigation scenarios

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This study analyses the effect of climate sensitivity on the global energy system in mitigation scenarios considering stringent targets. The current status of global negotiations for climate change mitigation called for greenhouse gas (GHG) emissions reductions to limit global temperature rise to 2 °C and 1.5 °C by the end of the century compared to pre-industrial values. Achieving these targets will require significant changes in the mix of fuels and energy technologies at global scale. Moreover, these changes will be more drastic in the case that the climate system is highly sensitive to changes in GHG emissions. We analyze the changes in the energy system at global scale considering targets for stabilization of global temperature change at 2 and 1.5 °C by the end of the 21st century. We include scenarios assuming a stronger response of the climate system to increasing concentrations of GHG emissions. We applied an integrated assessment model with detailed representation of the energy, agriculture and land use sectors, disaggregated into 32 global regions. We found that increased stringency of the mitigation target led to paths with earlier and deeper cuts in GHG emissions, stabilizing at around 15 $GtCO_2eq$ in 2100. Carbon emissions leveled off at near-zero values for both targets, but shifted from the late century to 2050 in the 1.5 degree target. In contrast, considering a world with high climate sensitivity resulted in more drastic emission reductions than the 1.5 degree scenarios with central climate sensitivity. For example, net zero carbon emissions were reached by 2040 and kept negative values afterwards. In terms of energy supply, all scenarios resulted in considerable changes in the energy mix that reached similar levels by 2100. However, the pathways until mid century were clearly different. The speed of decarbonization and carbon capture and storage (CCS) penetration were the highest when aiming at the 2 degree target with high climate sensitivity, followed by the 1.5 degree target with central climate sensitivity. For example, the share of fossil fuels in energy supply fell to less than 50% by 2100, with around half of supply coming from CCS (both fossil fuel and biomass energy supply). While these transformations occurred around 2080 in the 2 degree scenario with central climate sensitivity, considering a higher climate sensitivity for the same target realized even deeper changes before 2050. Accordingly, the average mitigation costs in this scenario were about 250% and 50% higher than the 2 °C and 1.5 °C targets considering central climate sensitivity, respectively.

Keywords: climate mitigation targets, energy system, integrated assessment model, climate sensitivity

