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Response of different Earth System Models to ramp-up/ramp-down greenhouse gases concentration trajectory

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It has been relatively well established that, in the past, large abrupt and irreversible changes in the climate have consistently occurred when the climate system crossed certain thresholds. Given the massive amount of greenhouse gases released by human activities, which will further increase in the coming decades, it is crucial to evaluate the reversibility and inertia of the climate system in response to such an anthropogenic perturbation. Indeed, a few model projections have shown that the human contribution to greenhouse gases emission is likely to force the climate system towards potentially risky thresholds, which could dramatically alter the Earth's climate.
In order to evaluate the robustness of such a scenario, we compare model results from 4 different state-of-the-art European EMSs (EC-EARTH, HadGEM2, IPSL-CM5-LR, MPI-ESM) in response to the same increase and decrease of anthropogenic forcing. More specifically, 95 years of ramp-up simulations based on the CMIP5 RCP8.5 scenario (where the radiative forcing value is gradually increased up to 8.5 W/m2) are followed by 95 years of ramp-down simulations (where the radiative value is reduced at the same rate down to its initial value). The response and the inertia of the climate system are investigated and the possibility of abrupt and/or (ir)reversible climatic changes are analysed in the different models.
In particular, the behaviour of the Atlantic Meridional Overturning Circulation (AMOC) under the ramp-up/ramp-down is addressed and its relation to the evolution of other physical parameters is pointed out. Indeed, the stability of the AMOC, which is believed to lay in a monostable or bistable regime depending on the mean climate state, is controlled by different feedback mechanisms. A classical diagnostic for determining the transition between the single and multiple equilibria regime of the AMOC is the sign of the meridional freshwater transport at 30°S in the Atlantic. We therefore outline the response of advective salt feedback under radiative forcing and we evaluate the potential existence of multiple equilibria of the AMOC for the different models considered, a key issue in evaluating the possible proximity of a critical climatic threshold.