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Uncertainty in projected climate change caused by methodological discrepancy in estimating CO_2 emissions from fossil fuel combustion

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There are different methodologies to estimate CO_2 emissions from fossil fuel combustion. The term "methodology" refers to the way subtypes of fossil fuels are aggregated and their implied emissions factors. This study investigates how the choice of a methodology impacts historical and future CO_2 emissions, and ensuing climate change projections. First, we use fossil fuel extraction data from the Geologic Resources Supply-Demand model of Mohr et al. (2015). We compare four different methodologies to transform amounts of fossil fuel extracted into CO_2 emissions based on the methodologies used by Mohr et al. (2015), CDIAC, EDGARv4.3, and IPCC 1996. We thus obtain 4 emissions pathways, for the historical period 1750-2012, that we compare to the emissions timeseries from EDGARv4.3 (1970-2012) and CDIACv2015 (1751-2011). Using the 3 scenarios by Mohr et al. (2015) for projections till 2300 under the assumption of an Early (Low emission), Best Guess or Late (High emission) extraction peaking, we obtain 12 different pathways of CO_2 emissions over 1750-2300.
Second, we extend these CO_2-only pathways to all co-emitted and climatically active species. Co-emission ratios for CH4, CO, BC, OC, SO_2, VOC, N2O, NH3, NO_x are calculated on the basis of the EDGAR v4.3 dataset, and are then used to produce complementary pathways of non-CO_2 emissions from fossil fuel combustion only. Finally, the 12 emissions scenarios are integrated using the compact Earth system model OSCAR v2.2, in order to quantify the impact of the selected driver onto climate change projections.
We find historical cumulative fossil fuel CO_2 emissions from 1750 to 2012 ranging from 365 GtC to 392 GtC depending upon the methodology used to convert fossil fuel into CO_2 emissions. We notice a drastic increase of the impact of the methodology in the projections. For the High emission scenario with Late fuel extraction peaking, cumulated CO_2 emissions from 1700 to 2100 range from 1505 GtC to 1685 GtC; this corresponds to a relative uncertainty of about 11%. We attribute this uncertainty to the different aggregation in subtypes of fossil fuels used in the different methodologies, and more specifically to the aggregation of coal subtypes. This uncertainty in emissions translates into an uncertainty of about 0.5°C in the projected global mean surface temperature. An uncertainty of half a degree shows the importance of improving our understanding and estimates of fossil fuel combustion emissions, since a global warming of 2°C (and even 1.5°C) is now the international target as committed by all Parties during the last COP in Paris.