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Climate impact of supersonic air traffic: an approach to optimize a potential future supersonic fleet – results from the EU-project SCENIC

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Abstract. The demand for intercontinental transportation is increasing and people are requesting short travel times, which supersonic air transportation would enable. However, besides noise and sonic boom issues, which we are not referring to in this investigation, emissions from supersonic aircraft are known to alter the atmospheric composition, in particular the ozone layer, and hence affect climate significantly more than subsonic aircraft. Here, we suggest a metric to quantitatively assess different options for supersonic transport with regard to the potential destruction of the ozone layer and climate impacts. Options for fleet size, engine technology (nitrogen oxide emission level), cruising speed, range, and cruising altitude, are analyzed, based on SCENIC emission scenarios for 2050, which underlay the requirements to be as realistic as possible in terms of e.g., economic markets and profitable market penetration. This methodology is based on a number of atmosphere-chemistry and climate models to reduce model dependencies. The model results differ significantly in terms of the response to a replacement of subsonic aircraft by supersonic aircraft, e.g., concerning the ozone impact. However, model differences are smaller when comparing the different options for a supersonic fleet. Those uncertainties were taken into account to make sure that our findings are robust. The base case scenario, where supersonic aircraft get in service in 2015, a first fleet fully operational in 2025 and a second in 2050, leads in our simulations to a near surface temperature increase in 2050 of around 7 mK and with constant emissions afterwards to around 21 mK in 2100. The related total radiative forcing amounts to 22 $\frac{mW}{m^2}$ in 2050, with an uncertainty between 9 and 29 $\frac{mW}{m^2}$. A reduced supersonic cruise altitude or speed (from Mach 2 to Mach 1.6) reduces both, climate impact and ozone destruction, by around 40%. An increase in the range of the supersonic aircraft leads to more emissions at lower latitudes since more routes to SE Asia are taken into account, which increases ozone depletion, but reduces climate impact compared to the base case.

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