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Contrail avoidance in a changing climate – an analysis of CMIP5 HadGEM2-ES projections

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Current civil transport aircraft fleet, formed largely of high-bypass ratio, turbofan-powered, swept wing aircraft, tend to operate at peak efficiency and hence cruise between altitudes of 9km and 12km. Unfortunately, this altitude band coincides with the atmospheric position at which contrails are most likely to be formed. There is growing evidence that contrails cause a significant proportion (possibly a majority) of the radiative forcing, that in turn is responsible for the anthropological global warming effect that can be attributed to the civil air transport system. To change this altitude range would require either a drop in efficiency for existing propulsive units or a change in aeroplane design. If a new legislative background were postulated in which the contrail altitude band must be avoided, the question of what the optimum design for a civil aircraft to operate under this new regime may be can be asked. The objectives of this work are to conduct an initial constraints analysis to bound the problem, to determine the penalty of operating current aircraft outside of the contrail band and to what extent this can be mitigated; to conduct a survey of existing aircraft configurations that are naturally optimised outside of the contrail band, as well as new technologies and the extent to which they can contribute; finally, to output conceptual aircraft designs that meet the criterion for contrail avoidance. The focus of the work presented here is on the background climate and how changes in temperature and humidity at different levels from the CMIP5 HadGEM2-ES projections will change contrail formation and persistence.