EGU25-3272, updated on 19 Mar 2025
https://doi.org/10.5194/egusphere-egu25-3272
EGU General Assembly 2025

Climate change will increase aircraft take-off distances and reduce payloads, but by how much?

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Climate model output at 30 European airports (including 25 of the busiest) is used to investigate summer take-off distance required – TODR – and maximum take-off mass – MTOM – and how they may change in the future. We compare data from 2035–2064 to a historical baseline of 1985–2014 using three future forcing scenarios which represent low (SSP1-2.7), medium (SSP3-7.0), and high (SSP5-8.5) future emissions trajectories defined by the widely used Shared Socioeconomic Pathways, SSPs.

This work presents data for the A320 aircraft manufactured by Airbus but the calculation framework is widely applicable to any similar fixed-wing aircraft and uses entirely open-access input data.

We use 10 models from the 6th Coupled Model Intercomparison Project (CMIP6) which have a range of equilibrium climate sensitivity values; a measure of the amount of global warming they give for a doubling of carbon dioxide concentrations.

We use a numerical scheme which considers the resultant forces on an aircraft in the runway acceleration phase of its take-off and show that 30-year average values of TODR could increase by up to 100 m by mid-century. There is, however, significant variability since daily data is used throughout.

We quantify the changing probability distribution of TODR using kernel density estimation and illustrate this using an example showing how increases in extreme daily maximum temperature could alter distributions of TODR.

Additionally, we project that the 99th percentile (a one in a hundred day event) of the TODR from 1985-2014 may by exceeded on as many as half the summer days for some sites in the future.

Four of the airports studied (Chios, Pantelleria, San Sebastian and Rome Ciampino) have runway lengths which are shorter than the TODR when the aircraft is carrying its maximum payload. This means that the weight they carry must be reduced to fulfil safety constraints, which will only become more stringent as temperatures increase further. Relative to the mean weight-restriction amount for the historical period, we find that the number of passengers may have to be reduced by up to 10-12 passengers per flight, again accompanied by a significantly increased chance of

exceeding extreme historical values.