The response of severe aircraft turbulence to climate change

Paul D. Williams[1]

[1]Department of Meteorology, University of Reading, Earley Gate, Reading, RG6 6BB, UK.
E-mail: p.d.williams@reading.ac.uk

Severe aircraft turbulence is a rare and extreme event, representing only 0.1% of the atmosphere at flight cruising altitudes at any time. Nevertheless, it is a natural hazard that is encountered by thousands of planes annually, injuring hundreds of passengers and flight attendants, and costing airlines up to $500 million. Anthropogenic climate change is expected to strengthen the vertical wind shears at aircraft cruising altitudes within the atmospheric jet streams. Such a strengthening would increase the prevalence of the shear instabilities that generate clear-air turbulence. However, the responses of light, moderate, and severe clear-air turbulence to climate change have not previously been studied, despite their importance for aircraft operations.

This paper uses climate model simulations to analyse the transatlantic wintertime clear-air turbulence response to climate change in five aviation-relevant turbulence strength categories. We find that the probability distributions for an ensemble of 21 clear-air turbulence diagnostics generally gain probability in their right-hand tails when the atmospheric carbon dioxide concentration is doubled. By converting the diagnostics into eddy dissipation rates, we find that the ensemble-average airspace volume containing light clear-air turbulence increases by 59% (with an intra-ensemble range of 43%–68%), light-to-moderate by 75% (39%–96%), moderate by 94% (37%–118%), moderate-to-severe by 127% (30%–170%), and severe by 149% (36%–188%). We conclude that the prevalence of transatlantic wintertime clear-air turbulence will increase significantly in all aviation-relevant strength categories as the climate changes.