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Using high-resolution climate models to predict increases in atmospheric turbulence

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Atmospheric turbulence has a serious, dangerous, and costly impact on aviation. Turbulence makes up most weather-related in-flight accidents and costs the global aviation sector up to US$1 billion every year. Upper level turbulence can be broken down into four main types: Clear-Air Turbulence (CAT), Convectively Induced Turbulence (CIT), Near-Cloud Turbulence (NCT), and Mountain Wave Turbulence (MWT). Aviation is often impacted by CAT, which is not visible on radar and is therefore extremely hard to detect in advance of an encounter. Previous literature has shown that climate change is strengthening CAT globally, with increased severity particularly over the North Atlantic, a busy flight route, within the winter months. These findings have been based on CMIP3 and CMIP5 climate models, which have now been superseded by CMIP6 (Coupled Model Intercomparison Project Phase 6) models with higher resolution.

In this presentation we build and develop these previous findings further by using the CMIP6 HighResMIP PRIMAVERA simulations, which have grid spacings from 135km to 25km. CAT has not previously been investigated with models that come this close to resolving individual patches of turbulence. Comparisons between several resolutions have given us a better understanding of how different climate models, and their grid spacings, represent turbulence. Despite some multidecadal and yearly variability, CAT is found to increase in frequency, in all turbulent severities, in time and with increased near-surface temperatures. Interestingly, atmosphere-only global climate models predict a smaller increase in CAT, in comparison to coupled atmosphere-ocean models. Our findings suggest that an increasing mean near-surface temperature over the North Atlantic will lead to further light to severe turbulence events, which results in extremely bumpy air travel, longer travel times, and increased CO2 emissions into the atmosphere.