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Increased shear in the North Atlantic upper-level jet stream over the past four decades

Paul Williams, Simon Lee, and Thomas Frame
University of Reading, Department of Meteorology, Reading, United Kingdom (p.d.williams@reading.ac.uk)

Earth's equator-to-pole temperature gradient drives westerly mid-latitude jet streams through thermal wind balance. In the upper atmosphere, anthropogenic climate change is strengthening this gradient by cooling the polar lower stratosphere and warming the tropical upper troposphere, acting to strengthen the upper-level jet stream. In contrast, in the lower atmosphere, Arctic amplification of global warming is weakening the meridional temperature gradient, acting to weaken the upper-level jet stream. Therefore, upper-level trends in the speed of the jet stream represent a closely balanced tug-of-war between two competing effects.

Here we isolate one of the competing effects, by studying the upper-level shear instead of the upper-level speed. We use three different reanalysis datasets to show that, while the zonal wind speed in the North Atlantic polar jet stream at 250 hPa has not significantly changed since the start of the observational satellite era in 1979, the vertical shear has increased by 16%. We further show that this trend is attributable to the thermal wind response to the enhanced upper-level meridional temperature gradient. The increased shear is consistent with the intensification of clear-air turbulence expected from climate change, which will affect aviation in the busy transatlantic flight corridor. We conclude that the impacts of climate change on the upper-level jet stream are being partly obscured by the traditional focus on speed rather than shear.