A climatology of North Atlantic upper-tropospheric weather patterns under present and future climates

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We present a weather pattern classification for the north Atlantic, designed for application to aviation. The aim of the classification is to obtain, for a particular season, a set of typically-occurring weather patterns, defined such that every day can be classified as one of the set of patterns. The classification is based on the projections of daily 250 hPa geopotential height anomaly on to the north Atlantic oscillation and east Atlantic patterns, calculated using 21 years of ERA-Interim data. Separate classifications are performed for winter and summer seasons, resulting in 5 frequently occurring weather types for winter and 3 for summer. The resulting weather types are characterised by the pattern of upper-level winds, in particular the strength and location of the jet stream. As an application, we show that the optimal routing of trans-Atlantic flights varies by weather pattern; both the location and duration of the flights is different for each weather type. As flight duration is related to fuel use and thus carbon dioxide emissions, eastbound flights through a weather pattern with a strong jet stream will have the smallest carbon dioxide emissions. Data from a subset of CMIP5 models is then used to understand how these weather patterns might change within the next hundred years.