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LETTER TO THE EDITOR

Update to aircraft observations and reanalysis depictions of trends in the North Atlantic winter jet stream wind speeds and turbulence

Three more Northern Hemisphere winters (2021–2023) of European Centre for Medium-range Weather Forecasts Reanalysis v5 (ERA5) data and the North Atlantic Oscillation series have become available. These winters can be used to extend the 2002–2020 wind-speed time series in our article (Tenenbaum et al., 2022; figs 2 and 4). When we add these new years to the previous results, the statistical significance assigned to the now 22-year North Atlantic winter jet stream increase within the Global Aircraft Data Set (GADS) boxes disappears. We take the boundary for significance as a value above the 95% confidence level.

Figure 1 (our original fig. 2) and Figure 2 (our original fig. 4) are included in this Letter to the Editor. The *F*

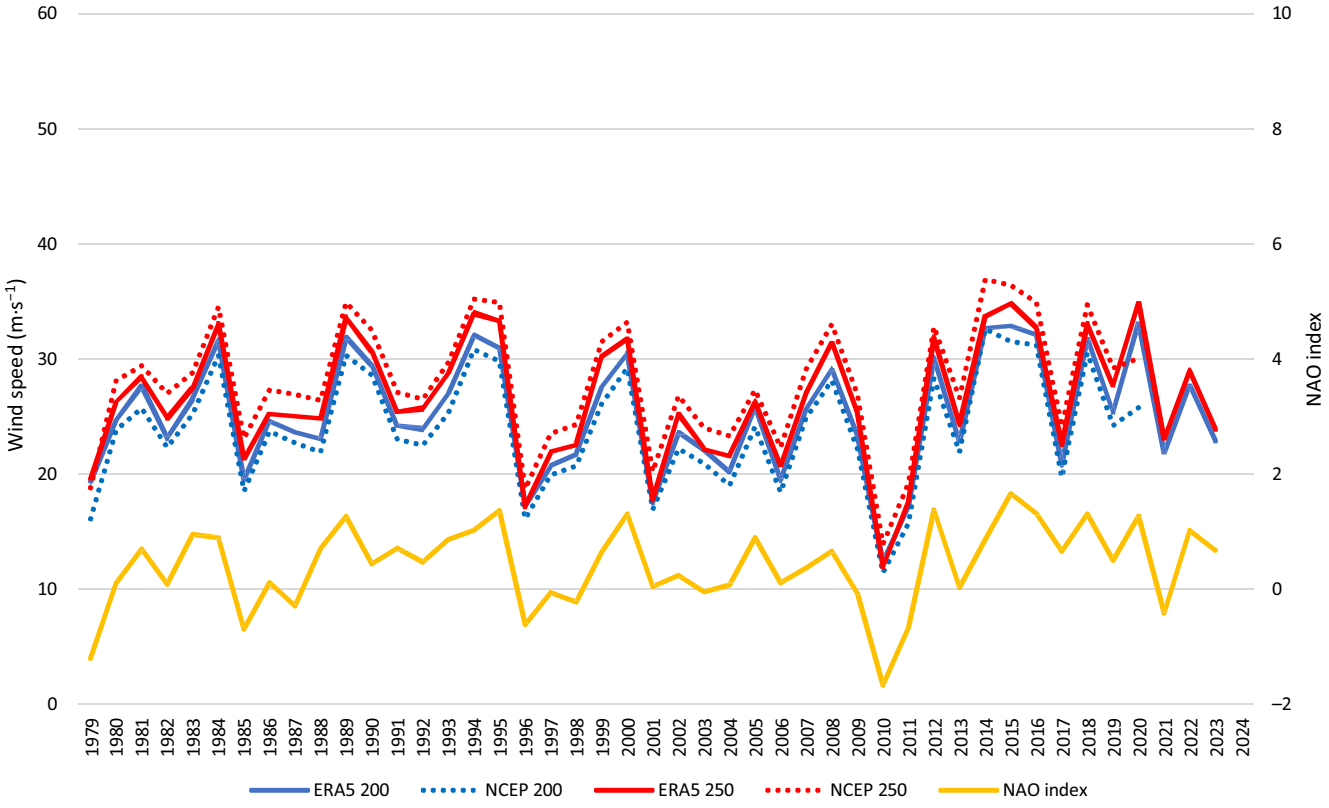

FIGURE 1 Tenenbaum et al. (2022, fig. 2) with 2021–2023 added, wind speeds and North Atlantic Oscillation (NAO) index, 1979–2023. Original caption: ERA5 and NCEP reanalysis wind speeds for 200 and 250 hPa and NAO index averaged over the three eastern North Atlantic boxes (40°W–10°W) for DJF labelled by January year. For clarity, the NCEP values are offset by $-1.5\ m{\cdot}s^{-1}$ (200 hPa) and $+1.5\ m{\cdot}s^{-1}$ (250 hPa). On average the 250 hPa wind speeds are slightly greater than 200 hPa values, an effect which will be clearer in subsequent figures. Note the striking correlation of the wind speeds with the NAO index (Pearson correlation coefficient of NAO index with ERA5 200 hPa, 0.88; 250 hPa, 0.89). See Hurrell et al. (2003) for link to the current NAO data source.

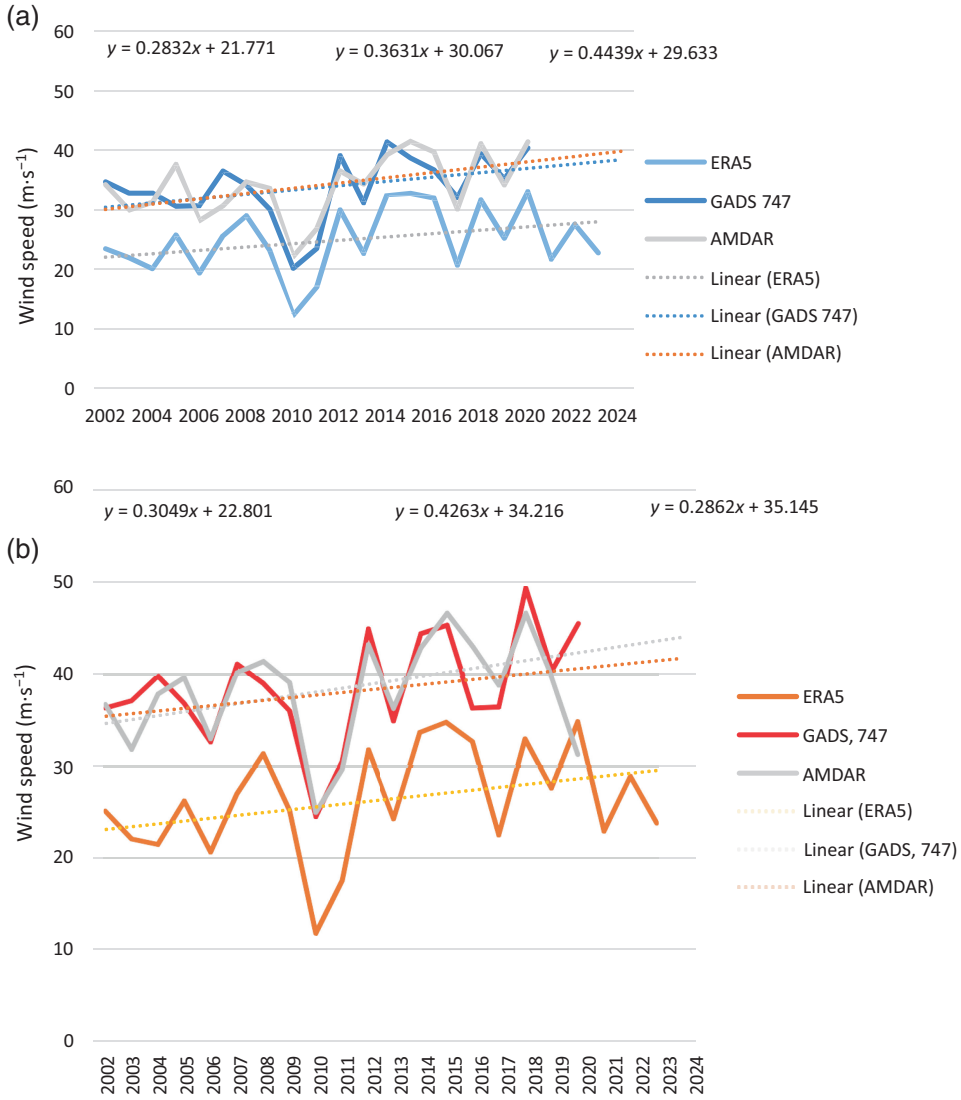

FIGURE 2 (a, b) Tenenbaum et al. (2022, fig. 4a,b) with 2021–2023 added. Original caption: Wind speed ($m \cdot s^{-1}$) averaged over the eastern North Atlantic boxes, $52 \pm 5°N$, 40°W to 10°W, for the ERA5 reanalysis and two observational archives, GADS 747 and AMDAR, at (a) 200 hPa and (b) 250 hPa. Fitted equations for ERA5 and GADS 747 are in same order as legends.

statistics values of the least-squares fits have dropped from 4.79 to 2.42 (200 hPa, confidence level 96% to 86%) and 5.03 to 2.49 (250 hPa, confidence level 96% to 87%).

The result is that the primary conclusion of Tenenbaum et al. (2022), that the wind speeds near the North Atlantic winter jet stream exit region increased by 2.5% per year, changes to 1.4% per year. But more crucially, it is no longer statistically significant. The other results concerning jet stream wind speeds remain: that one has to be careful in drawing conclusions about secular changes in the atmosphere due to changes, at least in the North Atlantic, in air traffic control procedures.

A related concern is whether the fall-off in aircraft observations due to Covid-19 affects the ERA5 results. There was a substantial drop off in aircraft observations during 2020–2022. Because of the financial pressures on air carriers associated with the pandemic, the last GADS observations in both the original fig. 4 and the revised Figure 2 were February 29, 2020. A lesser drop off in the aircraft observation count used in ERA5 has also occurred. This observation count drop off (which has not yet totally recovered) has led to some concern about a fall-off in forecast accuracy and implicitly in the reanalyses (Chen, 2020). Chen's conclusions have been convincingly challenged (Ingleby et al., 2021).

In summary, there are still hints of a wind speed increase of the North Atlantic winter jet stream over the last 20 plus years, but more years will be needed to reach a statistically significant conclusion.

FUNDING INFORMATION

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DATA AVAILABILITY STATEMENT

The contents of the GADS archive are proprietary to the air carriers and are covered in part by two licensing agreements between (1) the air carriers and State University of New York, Purchase (SUNY Purchase) and (2) the air carriers and the United Kingdom Meteorological Office (UKMO). The two agreements differ slightly but essentially require that the GADS observations not be passed on to other entities and not be placed onto a publicly available server. We are permitted to use the data in scientific publications provided individual flights cannot be directly identified. The GADS archive is currently maintained by the UKMO in Exeter, Devon, UK.

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