Caution needed when linking weather extremes to amplified planetary waves

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The Northern Hemisphere mid-latitudes have experienced frequent summer weather extremes in the last decade (1-2). In a recent PNAS paper, Petoukhov et al. (3) propose a single physical mechanism that could help explain the occurrence of these weather extremes. They suggest that such extremes are associated with well-developed synoptic-scale planetary waves, in particular large amplitude quasi-stationary waves with zonal wave numbers of m=6-8.

If this proposed mechanism is indeed the cause of increased summer extremes, one might expect the amplitudes of wave numbers m=6-8 to show an increase over time. However, Screen and Simmonds (4) show that this is not the case. Summer-mean daily amplitude trends of 500 hPa geopotential height (Z_{500}) at 45°N are negative for wave numbers m=6 and 8 and only weakly positive for m=7 (see Fig 2b in Ref 4).

To enable a more direct comparison with Petoukhov et al. (3), for this Letter we repeated our analysis using monthly-mean 300 hPa meridional wind (V_{300}) averaged over latitudes 37.5-57.5°N. The linear changes over 1979-2012, with associated two-tailed probabilities (p) in parentheses, are: -0.07 (0.92), 0.04 (0.95) and -0.27 ms^{-1} (0.43), for m=6, 7 and 8 respectively in July, and 0.27 (0.73), 0.58 (0.31) and 0.24 ms^{-1} (0.51) in August. None of these trends are statistically significant, and neither are equivalent trends for Z_{500} (consistent with geostrophy). We also computed equivalent trends based on the longer period 1948-2012 using data from the same source as Petoukhov et al. (3). None of the 65-year trends are significant (at the $p \leq 0.1$ level) either, for V_{300} or Z_{500}.

It is plausible that amplitude changes are nonlinear in time, or have emerged only recently in response to accelerated Arctic warming (5). Petoukhov et al. (3) report more months with high-amplitude wave numbers m=6-8 and fewer months with low-amplitude wave numbers m=6-8 in the last 11-year period (2002-2012) than in the previous two periods (i.e., 1980-1990 and 1991-2001), but do not provide estimates of the statistical significance of these differences.

We computed the mean amplitudes of wave numbers m=6, 7 and 8 in the last 11-year period versus the previous twenty-three years (1979-2001). The differences in epoch-mean amplitudes are: 0.32 (p = 0.45), 0.07 (0.87) and -0.13 ms^{-1} (0.53), for m=6, 7 and 8 respectively in July, and 0.11 (0.83), 0.06 (0.86) and 0.13 ms^{-1} (0.56) in August. None of the differences are statistically significant, nor are equivalent differences based on Z_{500}. Thus, there is neither

a significant linear trend nor a recent significant shift in the amplitudes of quasi-stationary planetary waves with wave numbers *m*=6-8.

Further work is required to more fully test the hypotheses and interpretations of Petoukhov et al. (3), which the authors of that study acknowledge. However, Ref 4, this Letter and Fig 3 in Ref 3 provide early indications that long-term change in planetary wave amplitudes, if present, are not statistically significant, and emphasizes the need for caution when linking the increased occurrence of weather extremes to amplified planetary waves.

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Footnotes

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