

# Supporting Information for “Increasing Frequency and Persistence of the Summertime Greenland High Regime Not Captured by a Seasonal Prediction Model Very Large Ensemble”

Simon H. Lee<sup>1</sup>, Lorenzo M. Polvani<sup>2,3,4</sup>

<sup>1</sup>School of Earth and Environmental Sciences, University of St Andrews, St Andrews, UK

<sup>2</sup>Department of Applied Physics and Applied Mathematics, Columbia University, New York, NY, USA

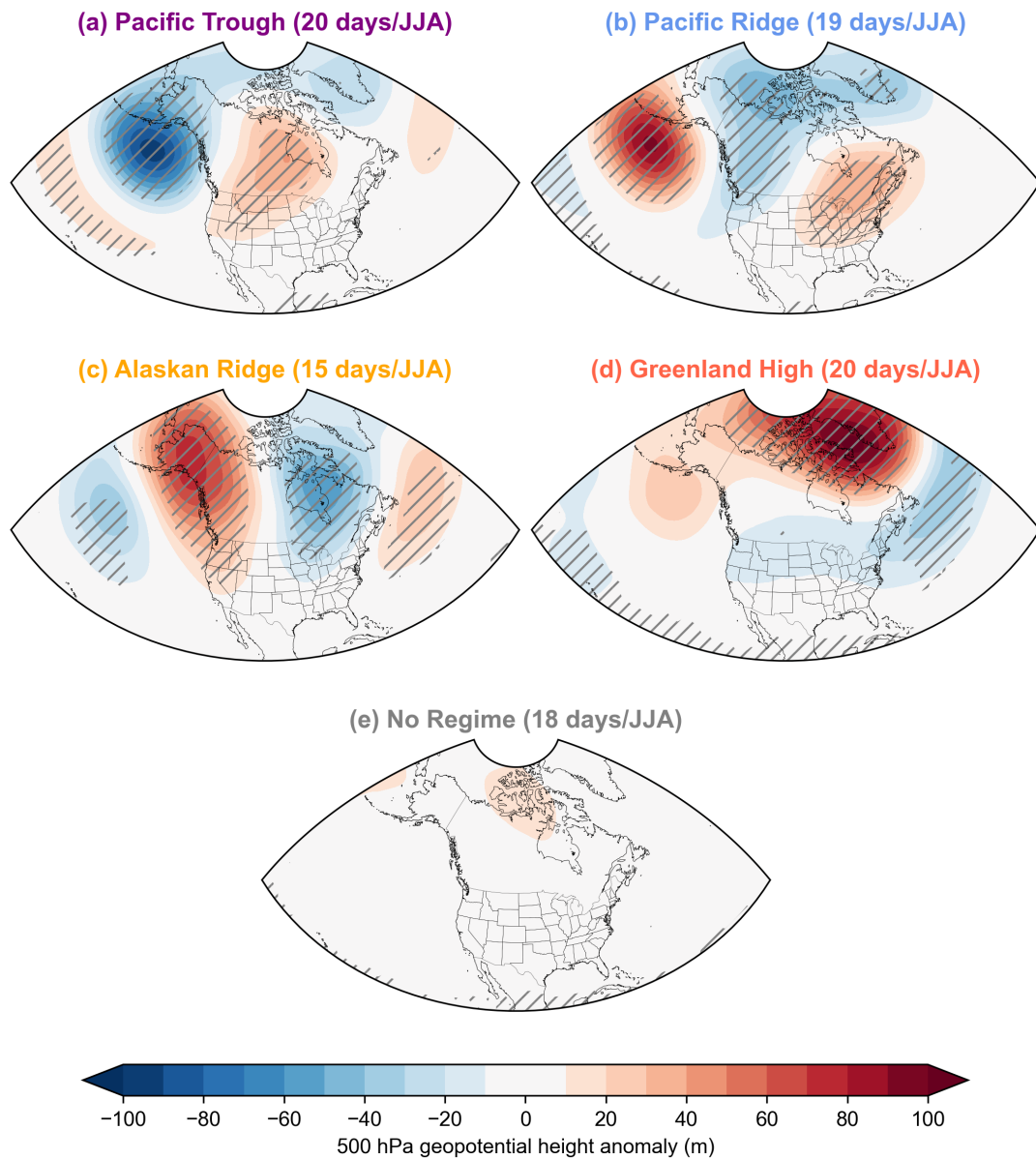
<sup>3</sup>Department of Earth and Environmental Sciences, Columbia University, New York, NY, USA

<sup>4</sup>Lamont-Doherty Earth Observatory, Columbia University, Palisades, NY, USA

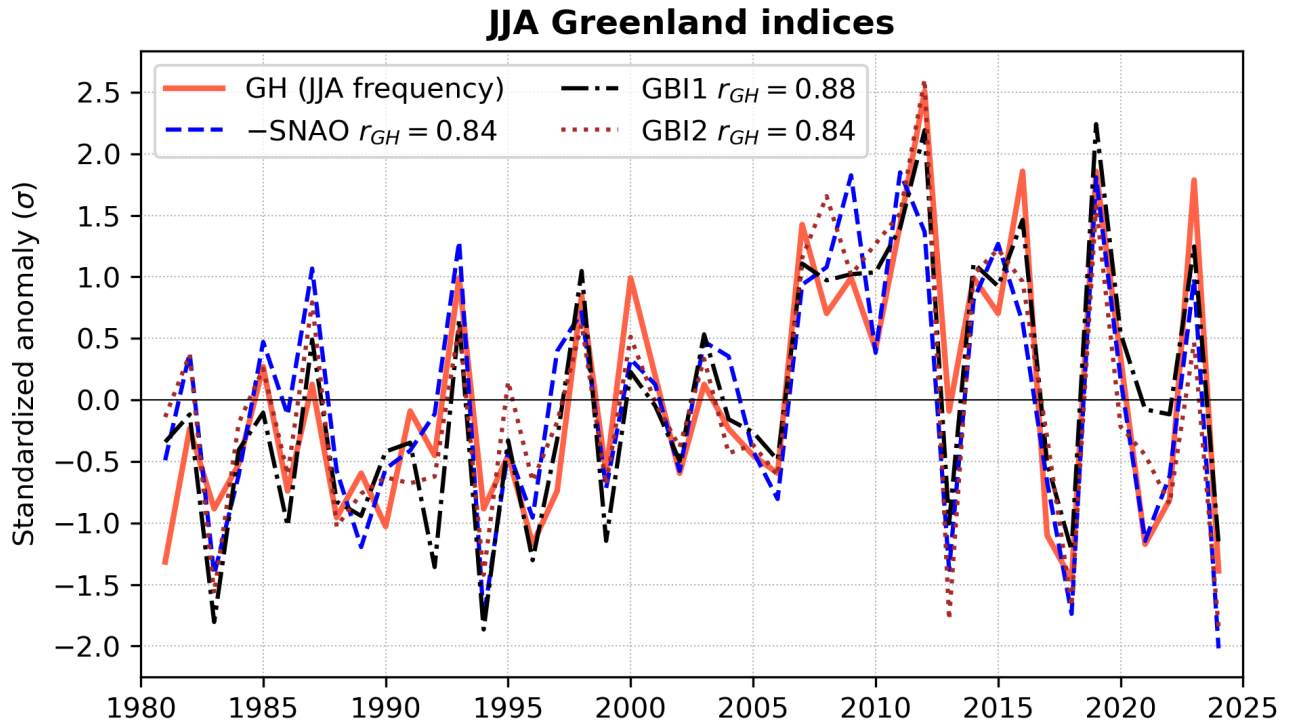
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1. Figures S1 to S6

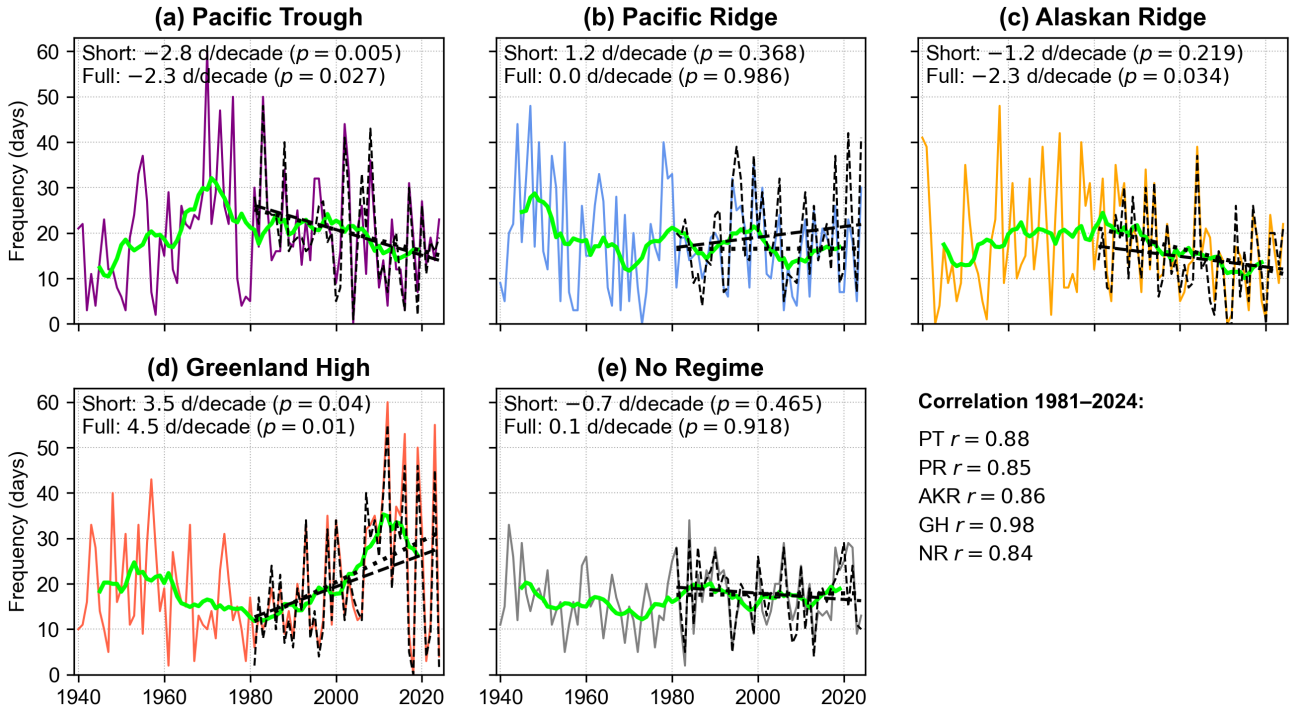
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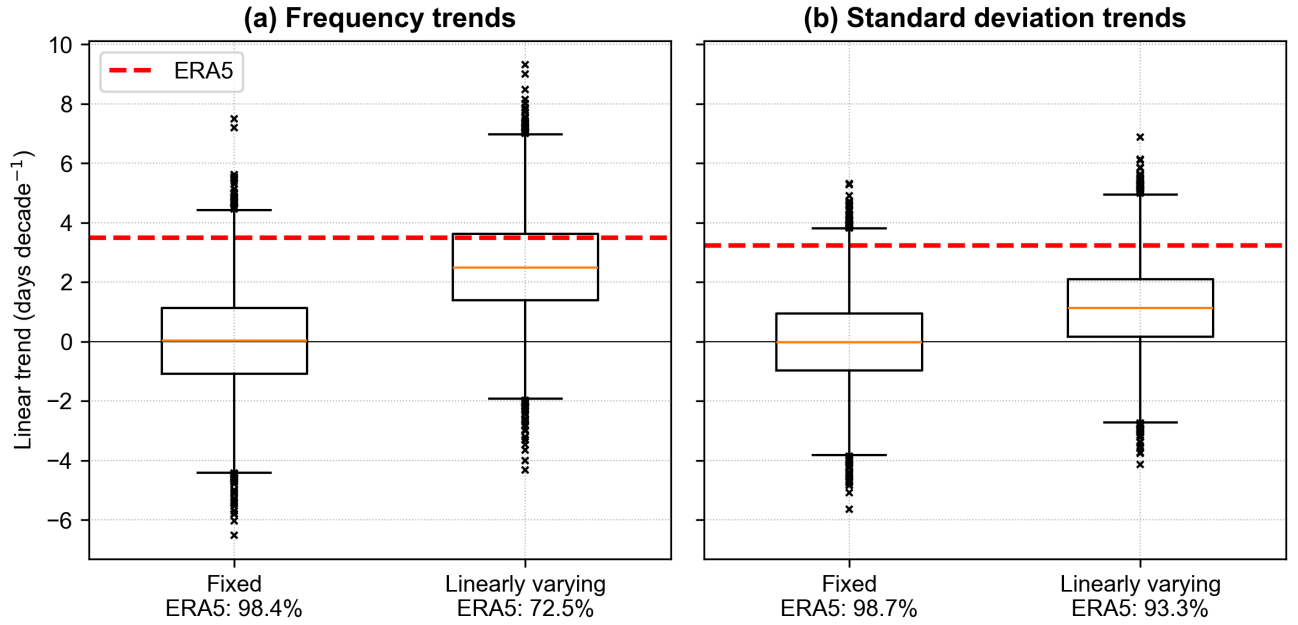
**Figure S1.** Composite mean de-trended and low-pass filtered ERA5 500 hPa geopotential height anomalies for all days in JJA 1981–2024 assigned to (a) Pacific Trough, (b) Pacific Ridge, (c) Alaskan Ridge, (d) Greenland High, and (e) No Regime. The mean seasonal frequency (days) are also given. Hatching denotes regions where two-thirds of days have the same-signed anomaly as the mean.



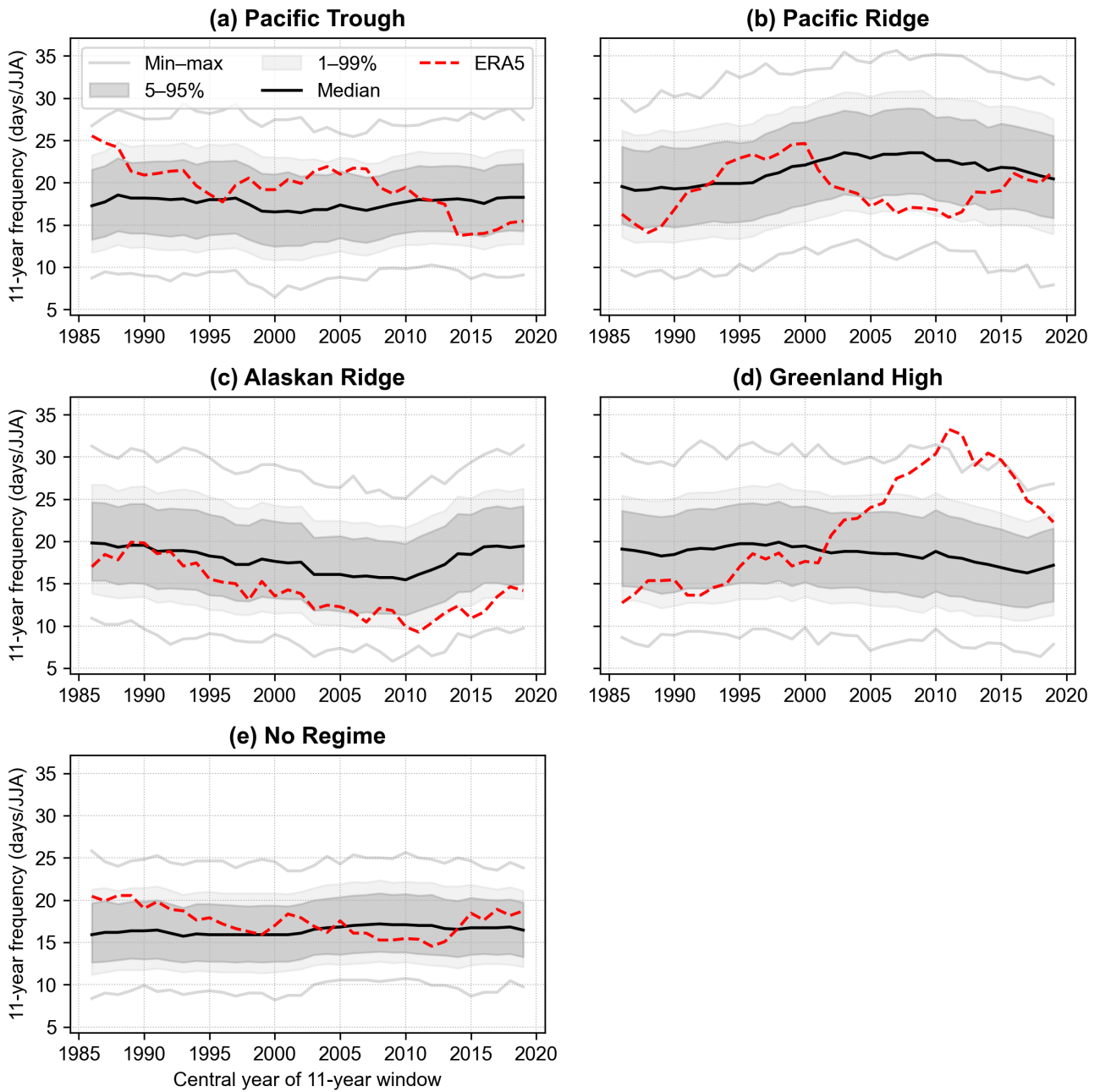
**Figure S2.** Standardized time series across 1981–2024 for the JJA Greenland High regime frequency (solid red line), the negative of the SNAO index (blue dashed line), GBI1 (black dot-dashed line) and GBI2 (brown dotted line). Correlations of the SNAO and GBI time series with the GH time series are given in the legend; these do not change by more than 0.01 if the time series are detrended. The SNAO is computed as the leading empirical orthogonal function of daily 0000 UTC ERA5 mean sea-level pressure anomalies in the region 20–80°N, 90°W–40°E during JJA (e.g., Dunstone et al., 2023). GBI1 and GBI2 are computed following Hanna et al. (2018).



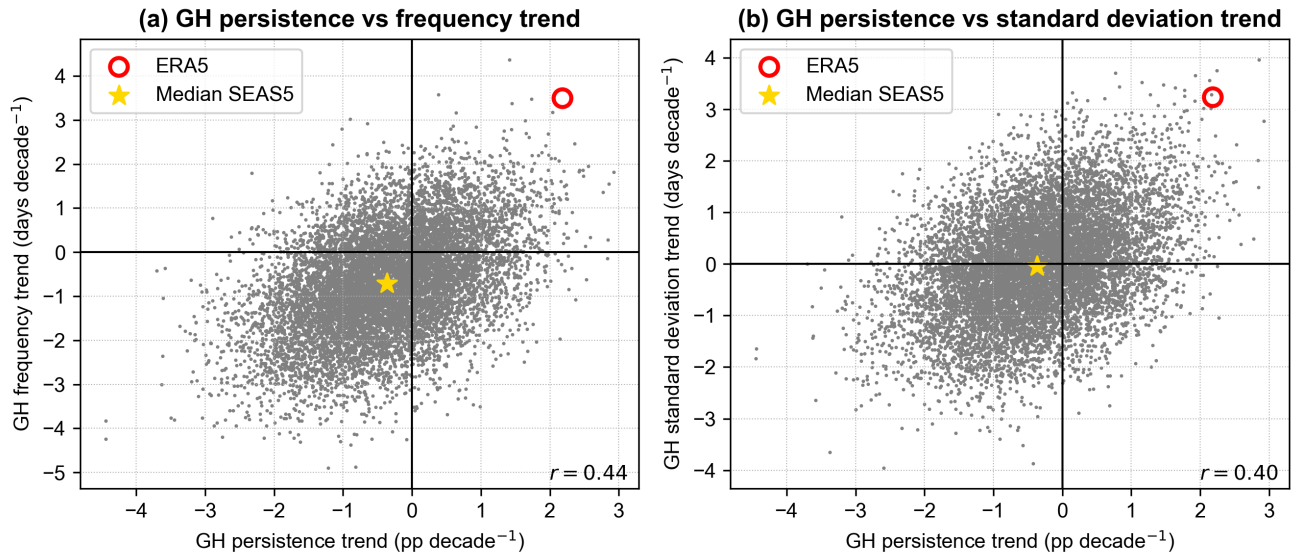
**Figure S3.** Comparison of JJA frequencies of (a–d) the four regimes and (e) No Regime computed over 1940–2024 (colored time series) and 1981–2024 (black dashed time series). Linear trends over 1981–2024 are shown for the frequencies based on 1981–2024 data (‘short’, black dashed line) and 1940–2024 (‘full’, black dotted line). The correlations of the two time series over 1981–2024 are also shown. The green line denotes an 11-year centered moving average of the 1940–2024 time series.



**Figure S4.** Boxplots of Markov model trends in (a) frequency and (b) standard deviation (computed over 11-year centered overlapping windows), with (left) fixed persistence probabilities and (right) linearly-varying persistence probabilities (see main text for details). The ERA5 trend is shown as a red dashed line. The percentile of the ERA5 trend within the Markov model trends are also shown on the  $x$ -axis labels.



**Figure S5.** 11-year centered running mean JJA frequency of the (a) Pacific Trough, (b) Pacific Ridge, (c) Alaskan Ridge, (d) Greenland High and (e) No Regime in the 10,000-member SEAS5 ensemble. Red dashed line denotes ERA5.



**Figure S6.** Scatter plot of SEAS5 GH persistence trends with (a) frequency trends and (b) standard deviation trends. Red open circle denotes ERA5 and the yellow star denotes the median across all the SEAS5 ensemble members.

**References**

- Dunstone, N., Smith, D. M., Hardiman, S. C., Hermanson, L., Ineson, S., Kay, G., ... others (2023). Skilful predictions of the summer North Atlantic Oscillation. *Communications Earth & Environment*, 4(1), 409. doi: 10.1038/s43247-023-01063-2
- Hanna, E., Fettweis, X., & Hall, R. J. (2018). Brief communication: Recent changes in summer Greenland blocking captured by none of the CMIP5 models. *The Cryosphere*, 12(10), 3287–3292. doi: 10.5194/tc-12-3287-2018