PURDUE UNIVERSITY
Ka Ying Ho, Lei Wang, Purdue University, Yi Ming, Boston College
Email: ho234@purdue.edu

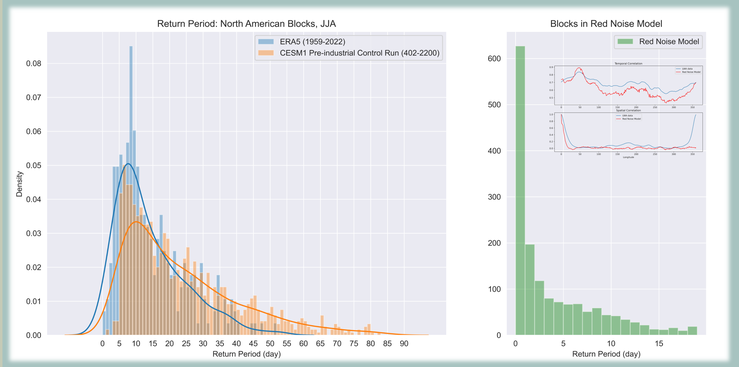
The Recurrence of Blocking: A Random Process? Or a Coherent and Regular Evolution?

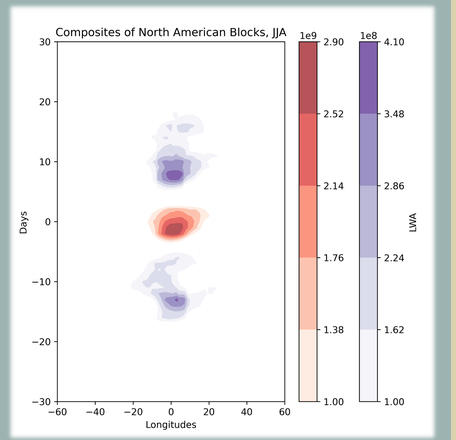
Motivations: Does blocking recur regularly? Or does it appear randomly like transient synoptic-scale eddies? Can we predict blockings beyond that of a red noise process? Are there any internal modes of variability driving this persistent phenomenon? In the study, we will evaluate if there is any recurrence pattern of the North American and European blocks, using the ERA5 reanalysis data, CESM1 output and a red noise model.

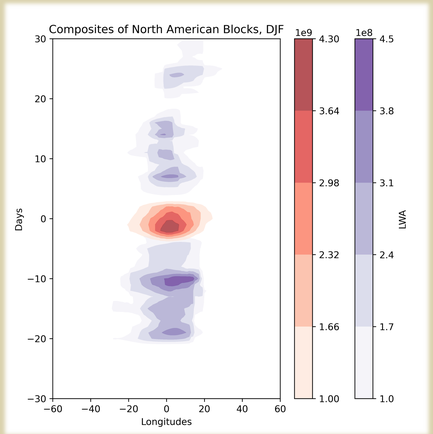
Histograms: Recurrence of blockings in ERA5 (blue), CESM1 (orange) & red noise model (green)

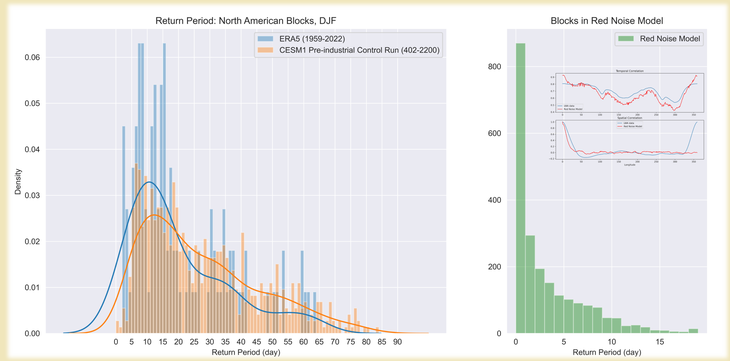
Hovmöller diagrams: Composites of LWA values of blocking events (red), as well as their previous and next events (purple), Composites of LWA flux during the blocking events

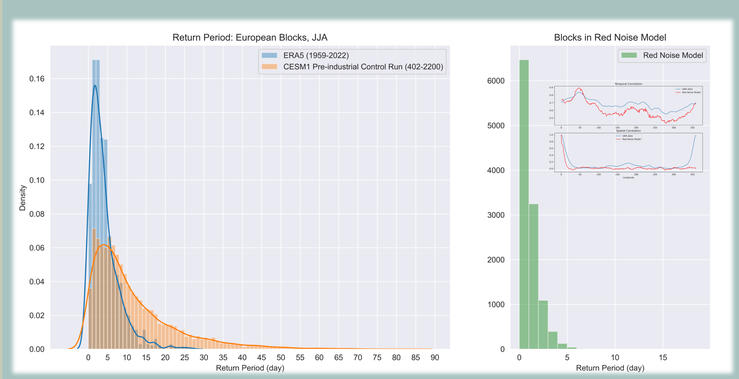
Top – North American Blocks, Bottom – European Blocks, Left – JJA, Right - DJF

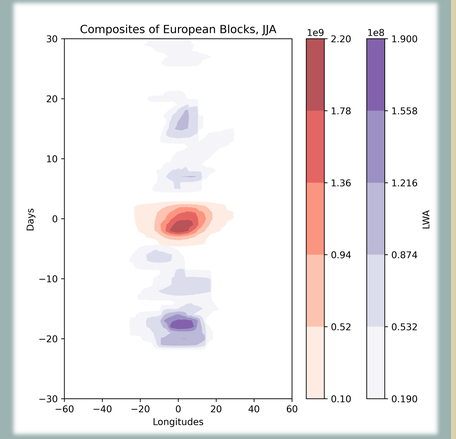


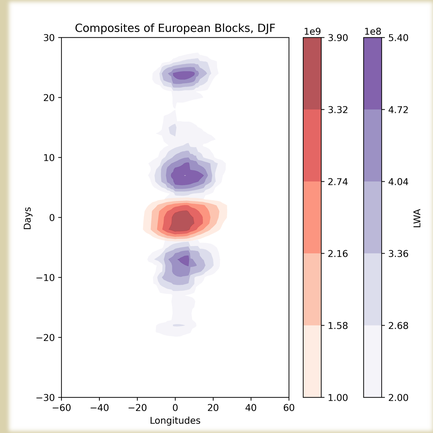


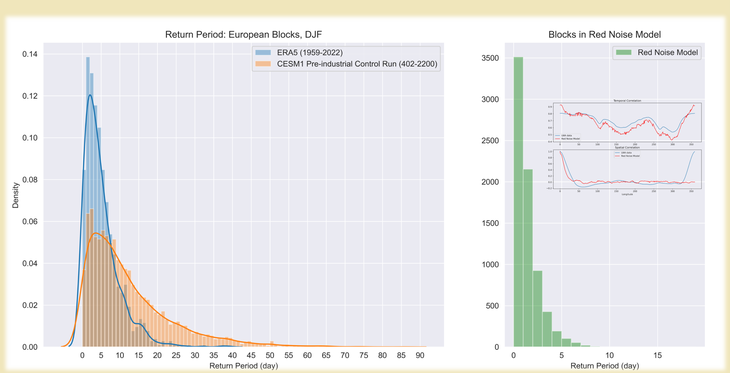












Blocking Events & Recurrence:

Events above a Local Wave Activity (LWA) threshold, moving within 18º in lon, 13.5 in lat each day, for at least 5 days (Martineau et al., 2017)

Return Period: Period between first day of two consecutive blocks

Red Noise Model: Built from the variance, temporal and spatial correlations of observed LWA data

$$\Delta W_n = [\Phi(\Delta W_{n-1}) + \epsilon_n] \times spatial\ correlation\ matrix$$

ΔW = deviation of LWA from mean, Φ = lag-1 autocorrelation in time, ϵ_n = white noise, (Masato et al., 2009)

Key Takeaways

1. Blockings from observation (ERA5) and climate model (CESM1) has a recurrence pattern that is distinct from blockings in a red noise model
2. The recurrence of blocks in North America and Europe are 10 days and 5 days respectively
3. The recurrence pattern has seasonal difference, which appears clearer in JJA than in DJF

Masato, G., B. J. Hoskins, and T. J. Woollings, 2009: Can the Frequency of Blocking Be Described by a Red Noise Process?. J. Atmos. Sci., 66, 2143–2149, https://doi.org/10.1175/2008JAS2907.1.

Martineau, P., G. Chen, and D. A. Burrows, 2017: Wave Events: Climatology, Trends, and Relationship to Northern Hemisphere Winter Blocking and Weather Extremes. J. Climate, 30, 5675–5697, https://doi.org/10.1175/JCLI-D-16-0692.1.