Investigating the Influence of Atmospheric Blocking Morphology on Predictability

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Introduction

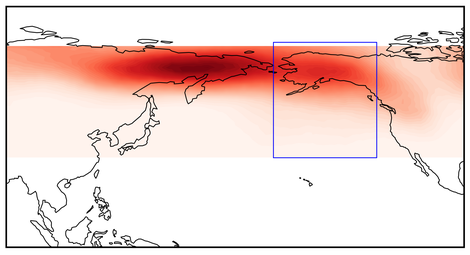
- Low-frequency variability (LFV) encompasses atmospheric and climate processes on time scales from a few weeks to decades like atmospheric blocking, cold spell and heat waves.
- Better understanding of LFV, could contribute to improved long term forecasts.
- From the results of Xavier et al. (2023) we found out that the predictability of the blocking events are different based on the morphology in an idealized land atmosphere coupled model.
- Western blocks which exists before the topography is unstable compared to the eastern blocks which exists after the topography.
- In the physical world, these positions correspond to Asian and American continents on either side of the Pacific.
- Hence we are investigating if this difference exist in more realistic scenario considering North Pacific blocks.

Data

- The daily data of geopotential height at 500 hPa is obtained from CMIP6 MIROC experiments. For the comparison study we used historical run, control run, abrupt carbon dioxide emission and SSP1 1.9 scenario.

Methodology

- Blockings are identified by calculating blocking index defined as in Davini et al., 2012 during the winter season DJFM.
- Inorder to study the stability of eastern and western north Pacific blocks, first step is to separate it geographically which explains as follows

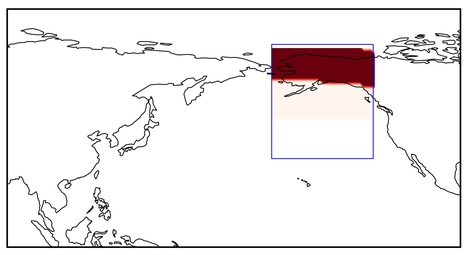


1. Calculate Average Instantaneous Blocking index (IB) occurrence in time in the selected area

$$AB(x,y) = \frac{\sum_t IB(t,x,y)}{dt}$$

2. Calculate average occurrence for each latitude and longitude

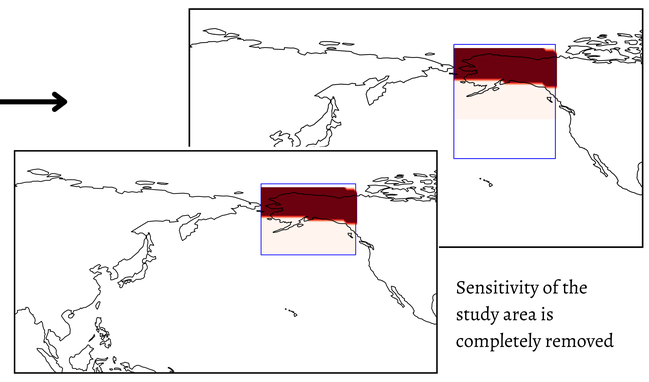
$$IB\% = \frac{\sum_{x,y} AB(x,y)}{dxdy}$$



3. Filter where occurrence is greater than calculated average

$$Filter(x,y) = \begin{cases} 1 & AB(x,y) > IB\% \cdot \alpha \\ 0 & \text{otherwise.} \end{cases}$$

'α' allows for comparison between different box sizes



Sensitivity of the study area is completely removed

- After classifying Eastern blocks and western blocks, we calculated IB index for each box
- In the defined area, if 20% of the latitude x longitude points has IB detected, and it is satisfied for at least 15° continuous longitude, that day is considered to be blocked
- Persistence of the blocking events are calculated if the above defined criteria is satisfied for continuous days

Results and Discussions

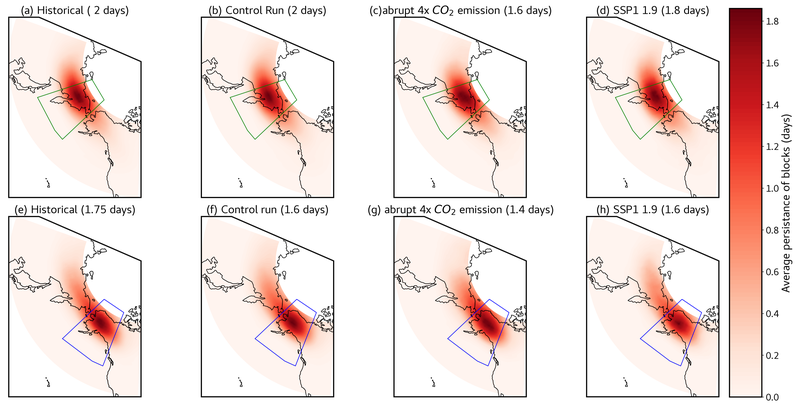
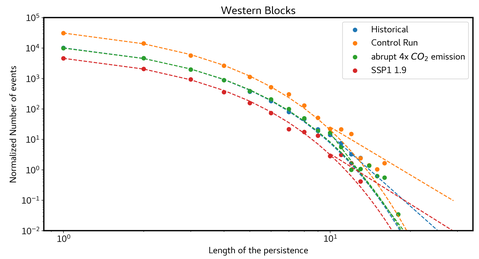


Fig.1 *Average Persistence of Blocking events in different Scenario. Top panel represents Western north Pacific blocks where as bottom panel describes eastern north Pacific blocks.*

- Average persistence of blocking events is lower in western blocks compared to eastern blocks
- It is noted that In both cases higher emission of carbon dioxide is decreases the stability of blocks
- Uncertainty of mean is 0.005 for all the scenarios which suggest that the mean values are relatively stable and consistent, indicating a high level of confidence in the estimated mean values.
- Analysis of different scenarios indicates that atmospheric blocking has constant stability irrespective of the conditions exist in the atmosphere

Conclusions

- Western north Pacific blocks are unstable compared to the eastern north Pacific blocks in all considered scenarios.
- The joint use of exponential and power-law fits implies that the majority of blocking events are brief, but sporadic extended events have a notable impact on the overall distribution.



The combination of the exponential and power-law fits suggests that while most blocking events have shorter duration, there are occasional prolonged events that contribute significantly to the overall distribution.

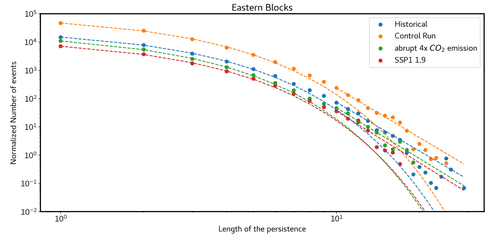


Fig.2 *The histogram peaks were fitted with an exponential function on a logarithmic scale, revealing a transition from an exponential decay pattern for shorter persistence lengths to a power-law correlation for longer duration.*

References

1. *Xavier et al. 2023. Variability and Predictability of a reduced-order land atmosphere coupled model, [preprint] EGUsphere*
2. *Davini, Paolo, et al. "Bidimensional diagnostics, variability, and trends of Northern Hemisphere blocking." Journal of Climate 25.19 (2012): 6496-6509.*

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