

Atmospheric Blocking in Community Earth System Model Large Ensemble 2 (CESM-LENS2)

Blocking in climate models?

- Atmospheric blocking is characterized by persistent and stationary high-pressure systems in the atmosphere. These systems act as obstacles to the normal eastward progression of weather systems, causing them to become nearly stationary or meander very slowly.
- Although successive improvements in the representation of blocking are evident in climate models, they still underestimate the blocking frequency in the Northern Hemisphere (NH).^[1]

Objectives

- Assessment of blocking representation in Community Earth System Model Large Ensemble 2 (LENS2)
 - Evaluating future changes in NH blocking

Datasets

	LENS2	ERA5	NCEP DOE 2
Resolution	(0.9° X 1.25°)	(0.25° X 0.25°)	(2.5° X 2.5°)
Duration	Historical: 1980-2014 Future: 2066-2100	Historical: 1980-2014	Historical: 1980-2014
Variable	Daily Geopotential Height At 500 hpa	Daily Geopotential At 500 hpa	Daily Geopotential Height At 500 hpa

All datasets were interpolated to common 1 x 1.25 grid

Methodology ^[2]

$$GHGN(\phi, \lambda) = \frac{Z_{500}(\phi + \Delta, \lambda) - Z_{500}(\phi, \lambda)}{\Delta}$$

$$GHGS(\phi, \lambda) = \frac{Z_{500}(\phi, \lambda) - Z_{500}(\phi - \Delta, \lambda)}{\Delta}$$

Z_{500} = Geopotential height at 500 hpa

ϕ = Latitude, λ = Longitude, $\Delta = 15^\circ$

A day is considered as 'blocked' if,

- GHGS > 0, GHGN < $-\frac{10 \text{ m}}{0.1^\circ \text{ lat}}$ (gradient reversal)
 - Persist for 5 or more days

$$\text{Blocking Frequency (BF)} = \frac{\text{Number of Blocked Days}}{\text{Total Number of Days}}$$

$$\text{Climatological Blocking Frequency} = \sum_{y=1}^N \frac{1}{N} (\text{BF}_y)$$

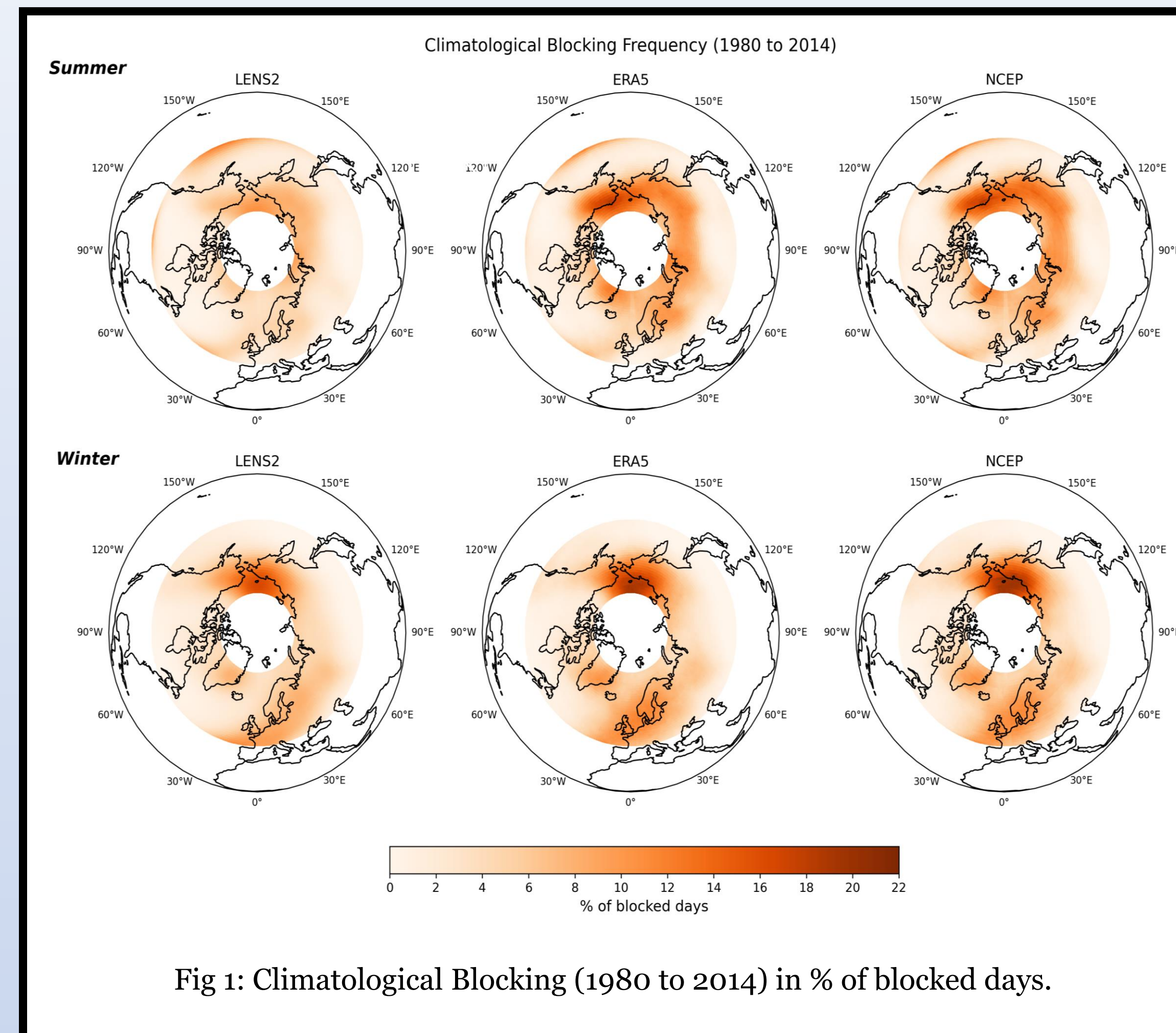


Fig 1: Climatological Blocking (1980 to 2014) in % of blocked days.

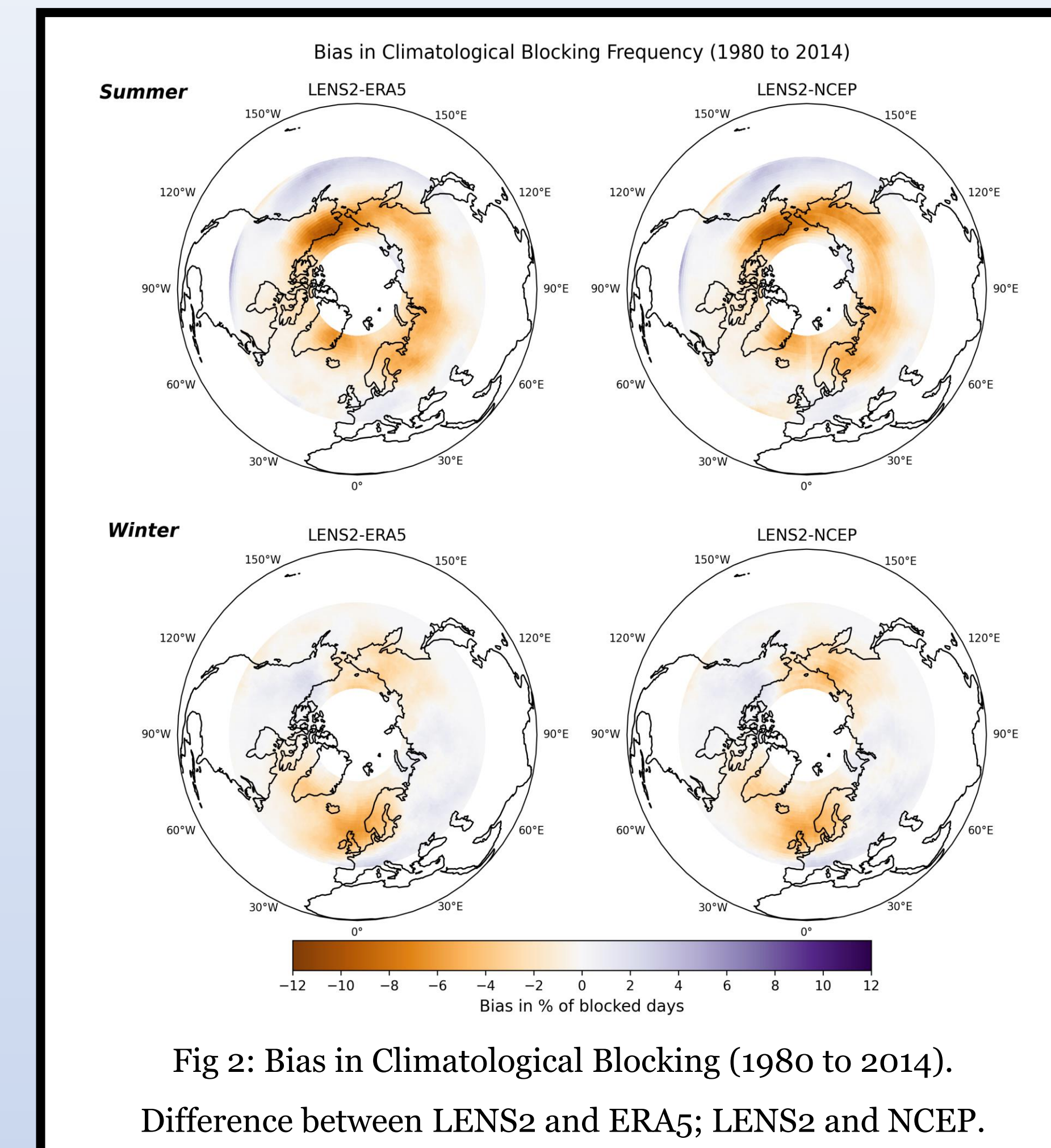


Fig 2: Bias in Climatological Blocking (1980 to 2014). Difference between LENS2 and ERA5; LENS2 and NCEP.

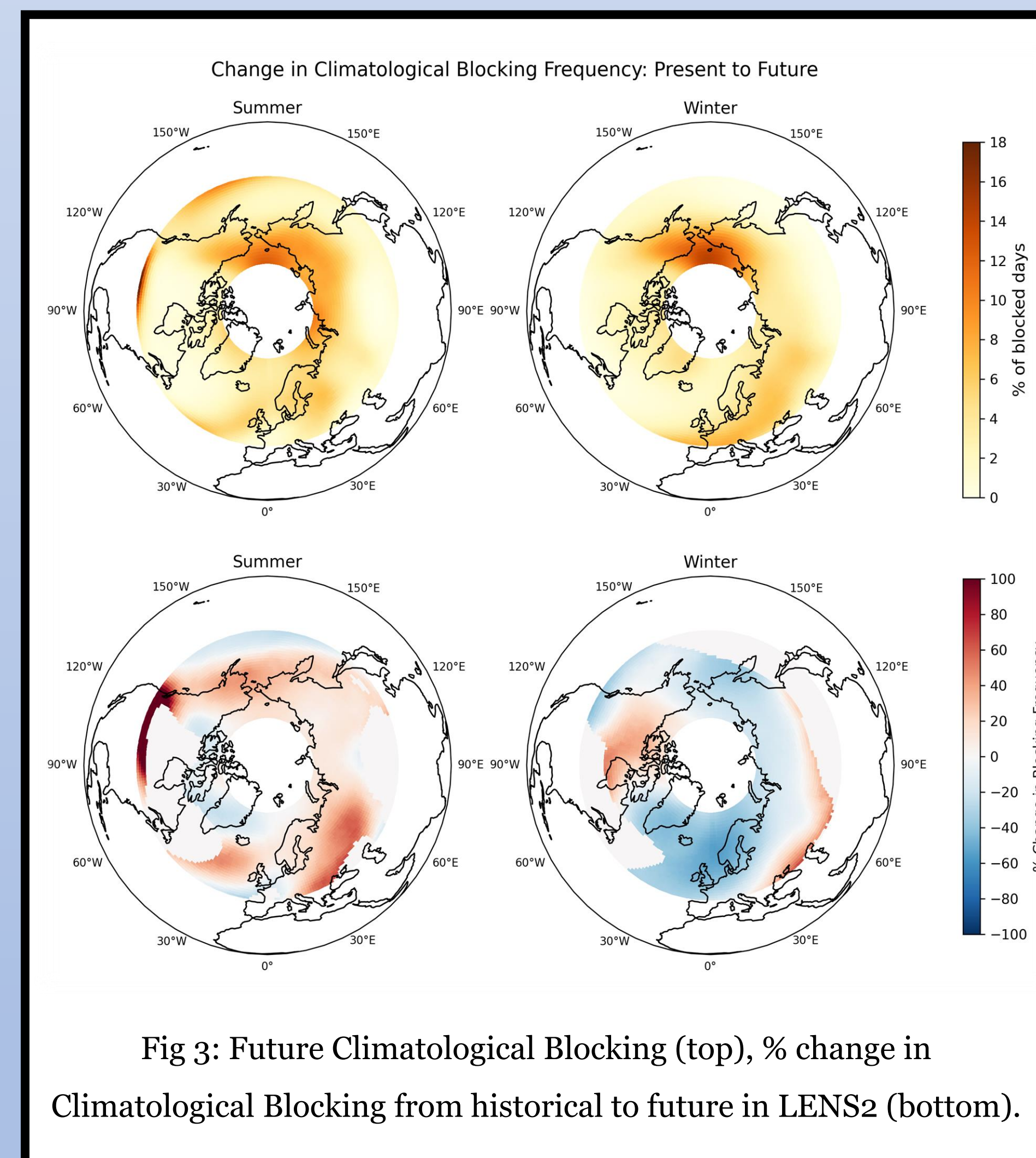


Fig 3: Future Climatological Blocking (top), % change in Climatological Blocking from historical to future in LENS2 (bottom).

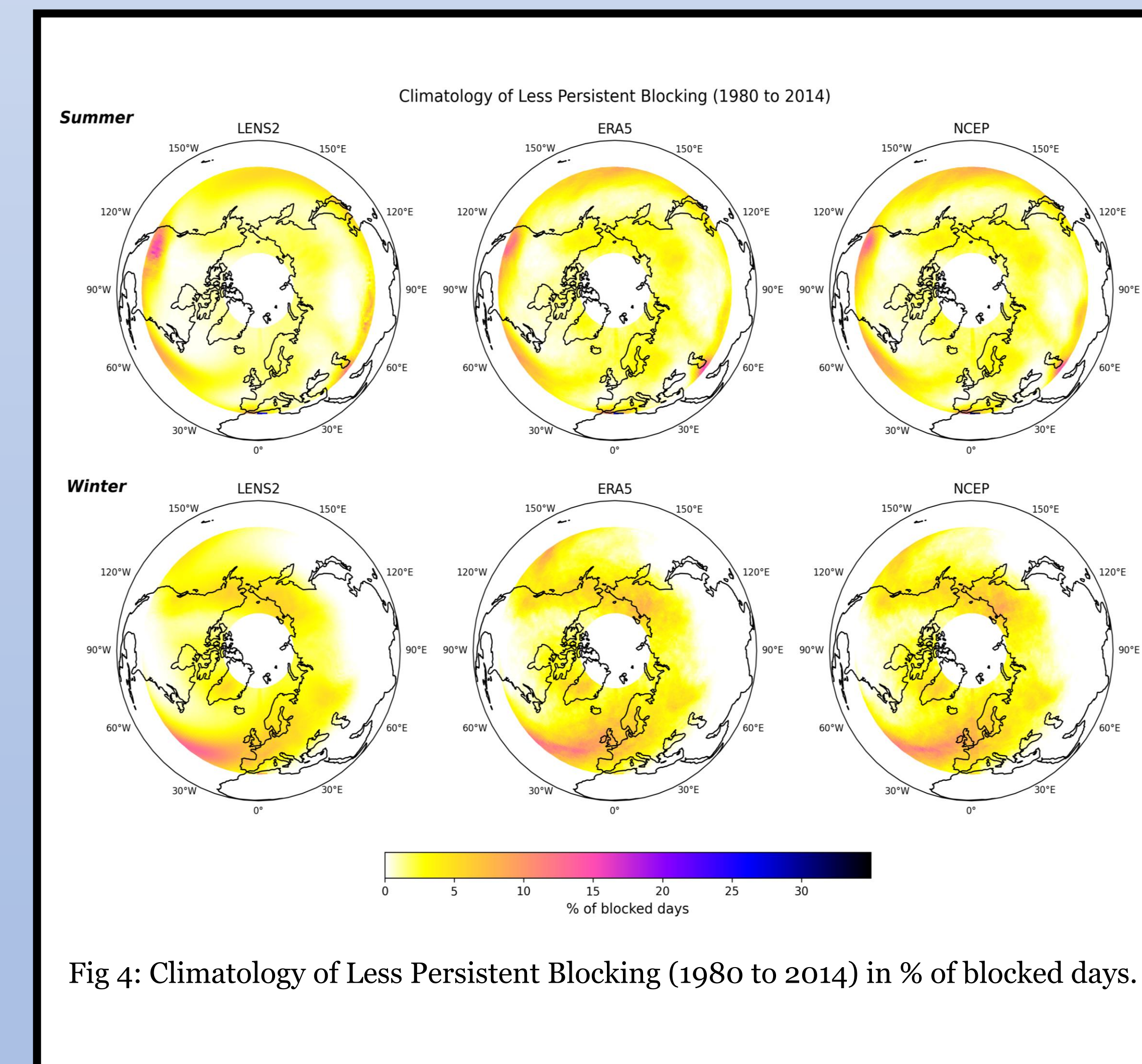


Fig 4: Climatology of Less Persistent Blocking (1980 to 2014) in % of blocked days.

Outcomes and challenges

- Blocking representation
 - Improvement in winter blocking representation in LENS2, specifically over Greenland, Pacific, and European regions (-4 to +2%)
 - Significant deficiencies in summer blocking (-12 to +12%)
- Future projection
 - LENS2 suggests overall decline in future winter blocking frequency by ~11% in the NH, under the SSP370 scenario
 - Unconventionally, LENS2 produced an increase in future summer blocking frequency by ~12%

What about less persistent blocking?

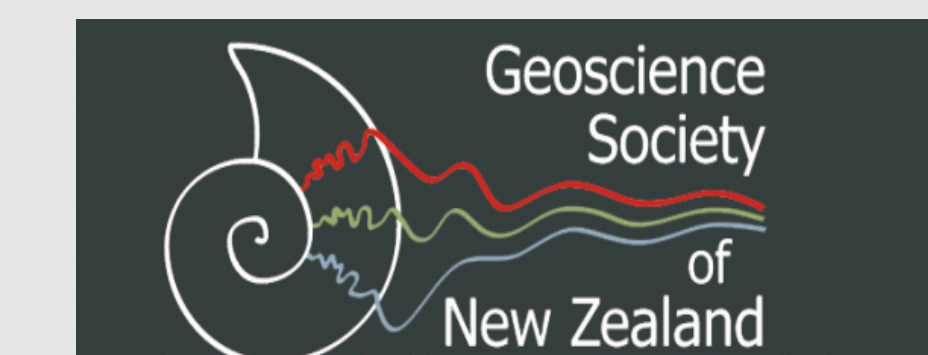
- We define Less Persistent Blocking (LPB) conditions as a blocking regime that satisfies gradient reversal criteria and persists for less than 5 days.
- We found a significant presence of LPB in the lower latitudes of the NH.
- Precursors of LPB dissipation need to be investigated to better understand onset mechanism of blocking.

References

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- Scherrer, S. C., (2006). Two-dimensional indices of atmospheric blocking and their statistical relationship with winter climate patterns in the Euro-Atlantic region. *International Journal of Climatology: A Journal of the Royal Meteorological Society*, 26(2), 233-249.

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