UK Weather Patterns and Scottish Storms

Dr James Pope

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1. Executive Summary

- Climatologically the period 1981-2010 saw predominantly higher occurrence of specific weather patterns associated with stormy conditions than the period 1951-1980.
- The period 2011-2020 saw 10% more occurrence of these patterns than the 1981-2010 climatology.
- It is not possible (based on this analysis) to ascertain if these observations are due to natural variability, a climate signal, or some combination of the two.

2. Introduction

A question has been asked about whether the climate of Scotland has been getting stormier with impacts on the ferry services to Scottish island communities. There is a perception that recent years have been stormier than those seen before, which is causing increased delays and cancellations.

3. Methodology

An analysis of recent weather patterns was conducted building on work undertaken in the Outer Hebrides (Pope et al., Submitted). Six of the Met Office 30 Static Weather Patterns (Neal et al., 2016) had been identified (Figure 1) for as being predominantly associated with stormy conditions for the Outer Hebrides during meteorological winter (December-January-February). This was based on an analysis of the occurrence of Named Storms and National Severe Weather Warning Service (NSWWS) warnings with at least an amber warning over the islands.

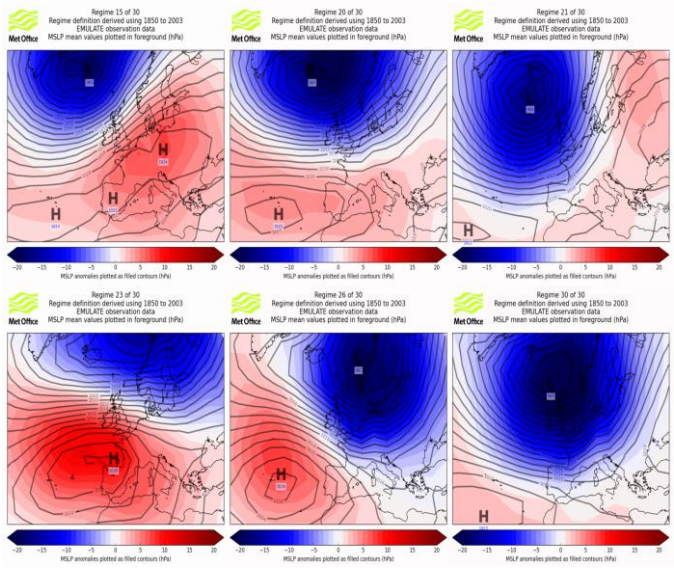

Figure 1 – The six weather patterns sub-selected from the 30 weather patterns described in Neal et al. (2016).

In all cases, these weather patterns feature a low-pressure system to the north and/or west of the British Isles resulting in strong westerly flow (Figure 1), and climatological analysis of the weather patterns, indicates that patterns 23 and 26 as especially windy.

Based on the ERA5 reanalysis (Hersbach et al., 2020), Harrison et al. (2022) utilised a historical set of weather pattern occurrences from 1950 to 2020 (Neal, 2022) and the same occurrence data was used here. For an extended winter period (November to March, inclusive) a climatology was calculated for each weather pattern for the period 1981-2010. A series of rolling 20-year periods were then created for this extended winter, from 1951-1970 through to 2001-2020; and a final 10-year slice (2011-2020). Percentage change anomalies for each of our six pre-selected weather patterns were then calculated between each 20-year (and the 10-year) period to the climatology.

4. Results

The period 2011-2020 saw the highest occurrence of these six weather patterns, with a 10% change in the occurrence relative to the 1981-2010 climatology (Figure 2). The only other period with a noticeable increase is the 1981-2000 period (5%). By contrast time periods from the earlier section of the record display noticeable decreases in the occurrence of these patterns relative to the climatology, with 25% less occurrence in the 1951-1970 period and an 18% decrease in the period 1961-1980. The time periods through the climatological period (1991-2010 and 2001-2020) show negligible difference to the climatology. Based on an assessment of the individual patterns, it is weather patterns 20, 23, 26 and 30 which are predominantly driving this increase frequency in the 2011-2020 period.

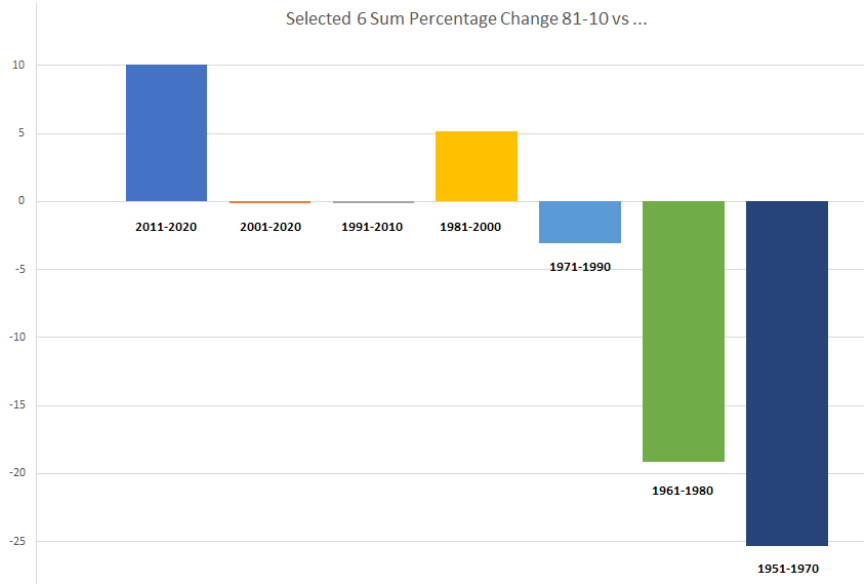

Figure 2 – Percentage change in the extended winter occurrence of the six selected weather patterns for each rolling 20-year period to the 1981-2010 climatology for these patterns.

5. Conclusions

Based on the analysis to date, the following conclusions have been drawn:

- Climatologically the period 1981-2010 saw predominantly higher occurrence of specific weather patterns associated with stormy conditions than the period 1951-1980.
- The period 2011-2020 saw 10% more occurrence of these patterns than the 1981-2010 climatology.
- Currently it is not possible to ascertain if this is either a) natural variability or b) a climate signal. It is entirely feasible it could be some combination of both. However, given we know that the natural variability can be quite large, identifying a climate signal as a trend is very difficult to do.

Based on this analysis, a perception that it has become stormier in recent years (2011-2020) is a valid belief, and the period 1981-2020 is stormier than the mid-20th century. A driving component of the occurrence of these westerly weather patterns is the phase of the North Atlantic Oscillation (NAO), which was relatively negative during the 1950 to 1980 period, compared to the 1981 present period (Figure 3), when it has been more positive. The positive phase is predominantly linked with the occurrence of westerly weather patterns.

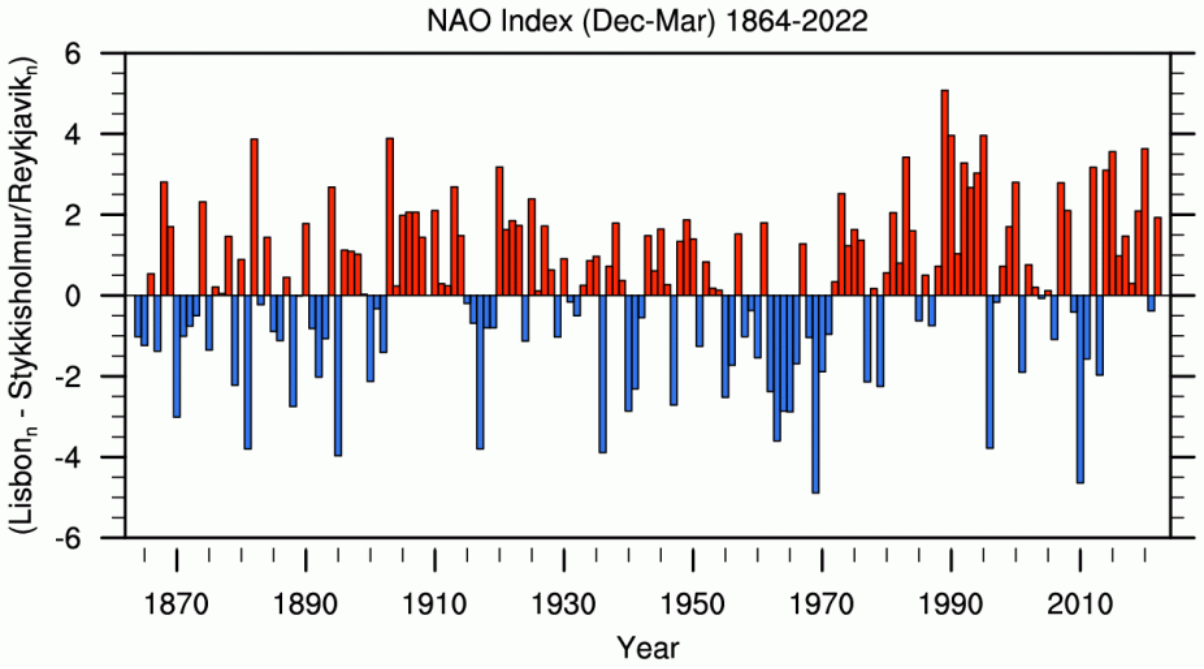

Figure 3 – Wintertime (December to March inclusive) phase in the North Atlantic Oscillation (NAO) where red colours indicate a positive phase (more westerly conditions) and blue colours a negative phase (more easterly conditions). Figure reproduced from: **Hurrell North Atlantic Oscillation (NAO) Index (station-based) | Climate Data Guide (ucar.edu)**

These results and conclusions must be caveated. Firstly, the six patterns chosen here were selected based on their impact on the Outer Hebrides, however different weather patterns would affect the diverse localities of Scottish Islands, while there will be some overlap, it is inevitable that patterns affecting Orkney and Shetland will be different to those affecting Skye or Arran. A formal analysis would need to assess the impacts on these different sets of islands before a robust conclusion could be drawn.

There would also be benefit from understanding the level of interannual variability within these groups of patterns, this would allow a stronger determination as to the driver of the change seen between 2011 and 2020. Similarly, the difference between 1951-1980 and 1981-2020 as a pair of periods is a strong signal, however the driving mechanism is unclear. A winter increase in these patterns is consistent with research into future changes in the weather patterns (Pope et al., 2022), however it is not possible to currently to differentiate between a projected climate change signal and natural variability within our climate. Further context could be added by looking at the locations and strength of the jet stream and/or NAO (Fig. 3), as briefly highlighted here. Finally, it should be noted no assessment of the climatology of these weather patterns has been undertaken, and we are unable to comment as to whether these individual weather patterns (or other weather patterns) have become windier (or calmer) during the 1950-2020 period.

6. References

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