1. Department of Meteorology, University of Reading
2. National Centre for Atmospheric Science, Reading

S2S4E Climate Services for Clean Energy | University of Reading

Understanding the impact of meteorological variability on the European power system

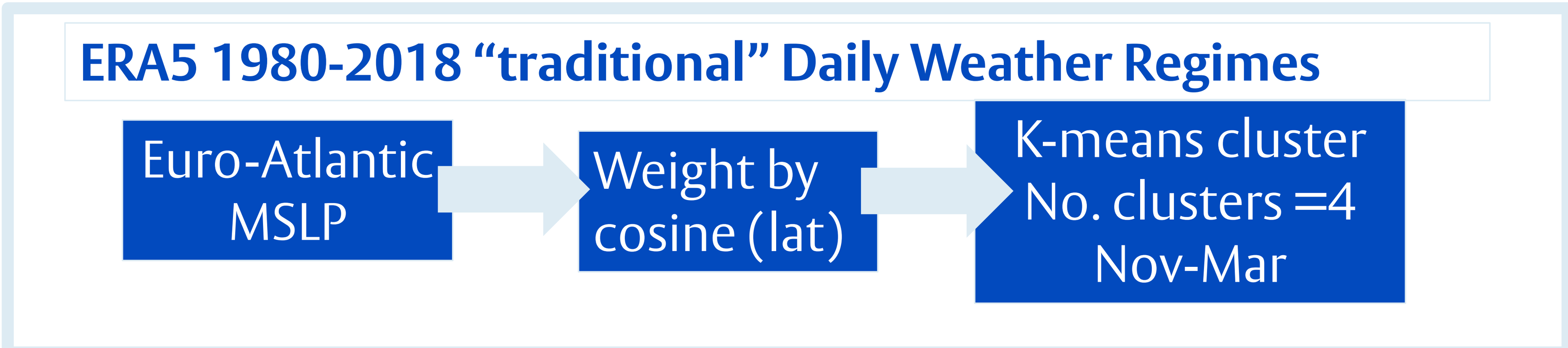
Bloomfield H.C. [1] | Brayshaw, D.J. [1,2] | Charlton-Perez, A.[1]

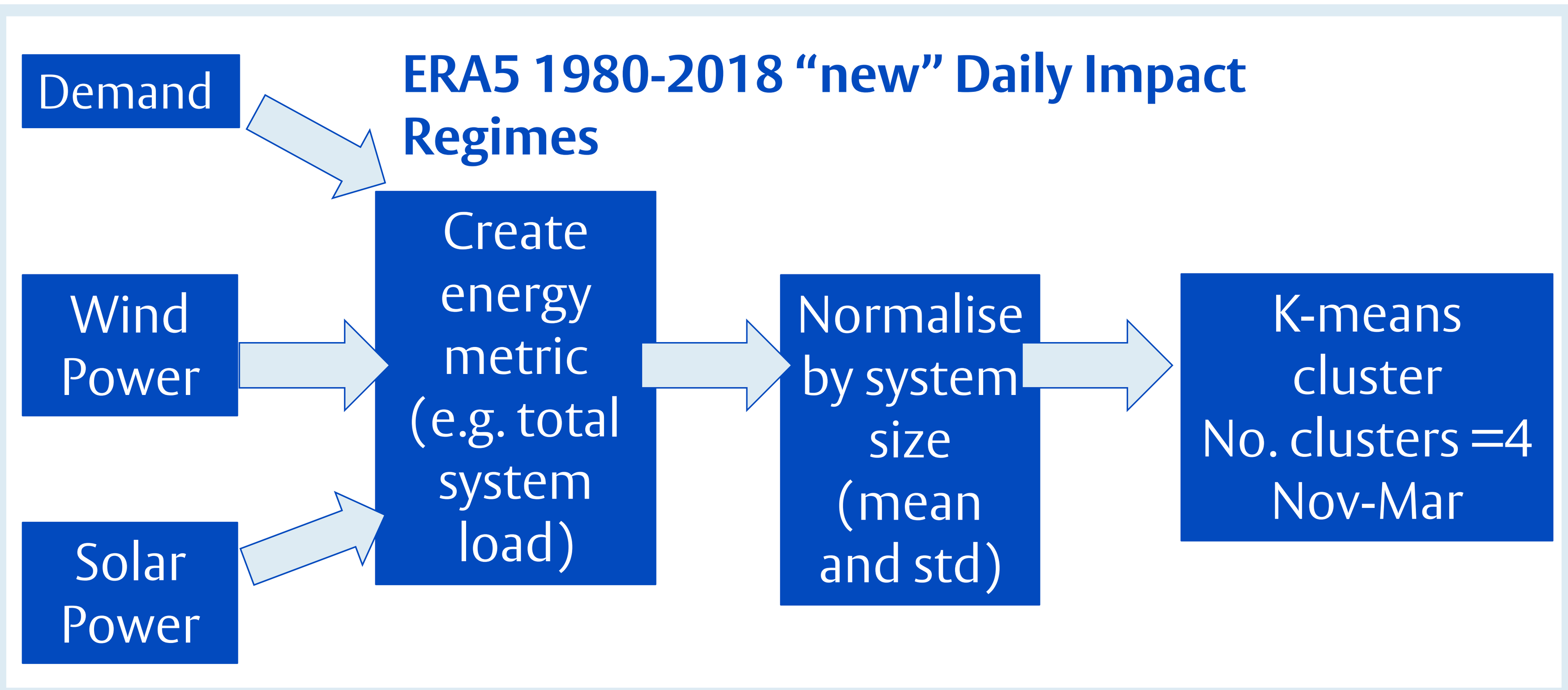
Contact: h.c.bloomfield@reading.ac.uk

Introduction

- Increasing use of renewable power has led to a growing demand for weather information weeks-to-months ahead from power system planning and energy trading.
- European climate variability is often viewed in terms of meteorological patterns (e.g. Michelangeli et al., 1995) derived using clustering techniques on large scale meteorological fields. Such approaches represent meteorological variability well, but do not necessarily capture the circulation patterns that drive the strongest impact onto a power system.
- In this study, the process of determining the circulation patters of interest is reversed: **impact patterns** are derived directly from power system and used to identify the meteorological characteristics which drive the greatest power system response.
- The ability of impact patterns in representing weather-dependent power system behavior is shown to outperform an equivalent **'traditional' weather pattern** method.

Method





Results

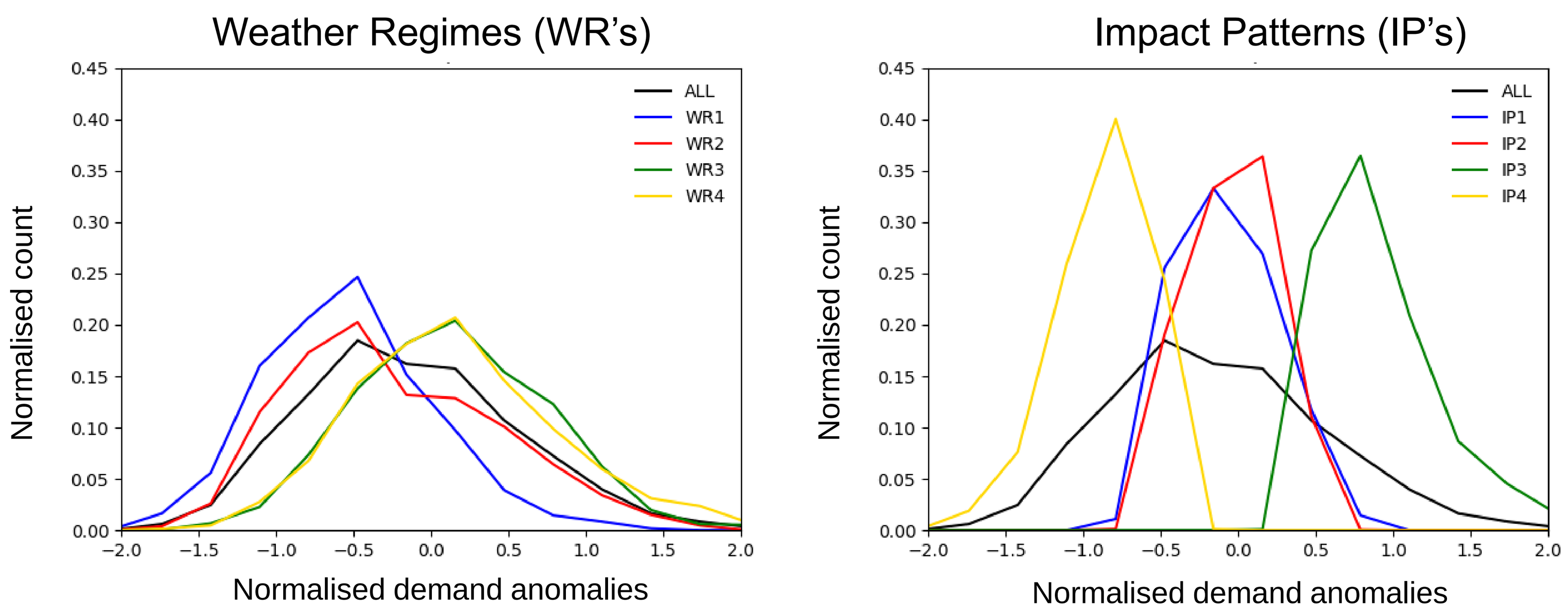


Figure 1: A comparison of November-March European aggregate normalised demand anomalies during weather regimes (WR's; left) and Impact Patterns (IP's; right). Differences between the demand anomalies in IP's and WR's, show the potential value of the pattern definitions.

Results

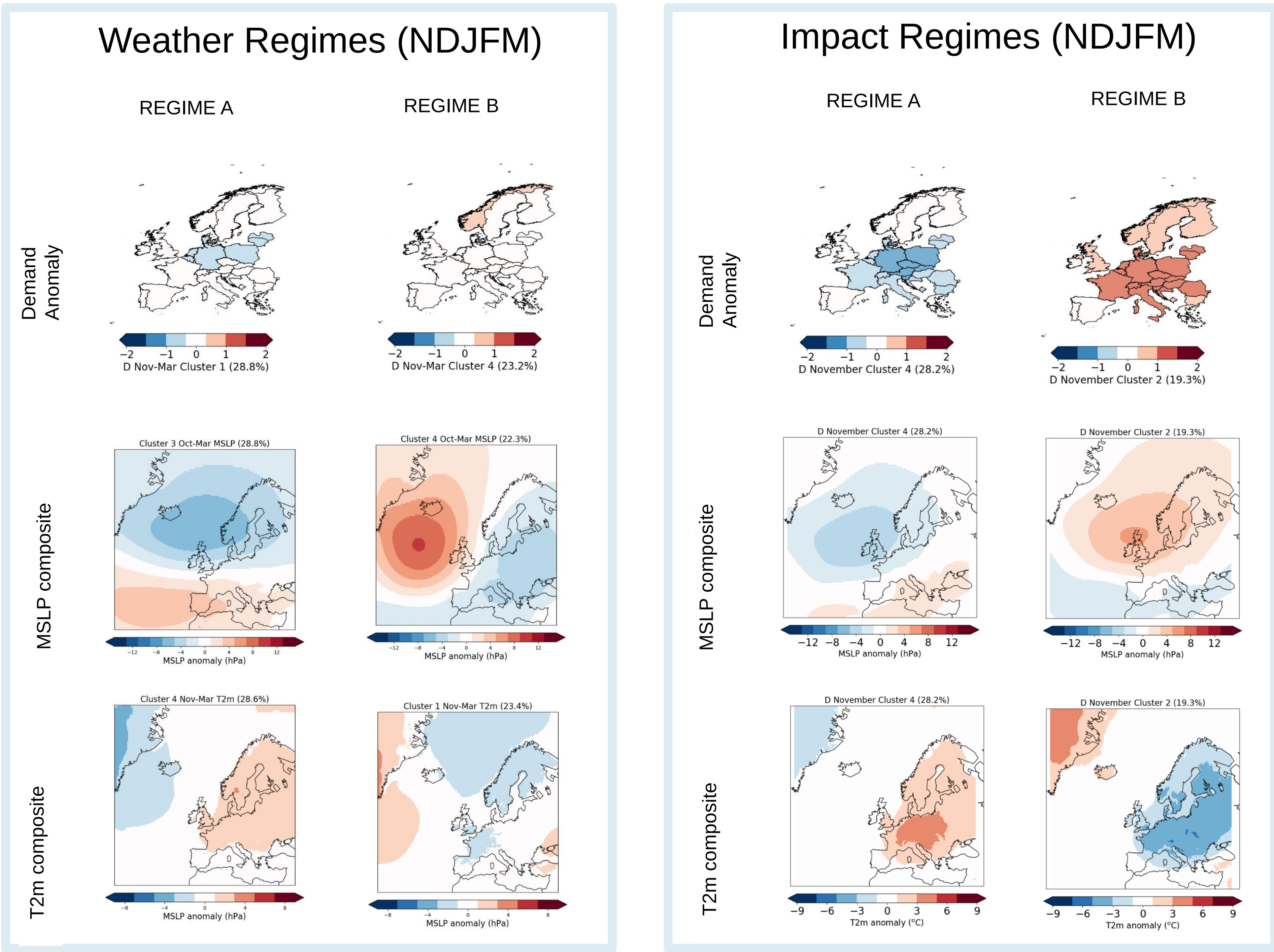


Figure 2: A comparison of normalised demand anomalies from the first two weather and impact regimes. MSLP and temperature composites for each regime are also shown

- Figure 2 shows the MSLP composites of the first two weather regimes and impact patterns. While the sets of patterns share some similarities (e.g., the first pattern roughly corresponds to NAO+), the associated surface temperature signatures through which the weather strongly influences European demand are very different. Hit rates comparing allocations to WR's and IP's never exceed 50%, confirming that WR and IPs show rather distinct patterns
- A key focus for future work is prediction and the potential trade off between S2S NWP prediction skill of a circulation pattern vs the quality of the link between the circulation pattern and the desired surface impact (c.f., seasonal gas demand forecasting; Thornton et al, 2019).

Conclusions

- Impact patterns reproduce coherent meteorological features consistent with traditional meteorological analyses. However, they have much stronger connections to the surface variables of interest.
- Impact patterns enable coherent forecast maps of European-power-system-scale anomalies to be produced. They highlight that not all meteorological patterns are equally useful in power system applications.

References: Bloomfield et al., (in prep) Impact patterns to understand variability in European energy balance indicators
Michelangeli et al., (1995) Weather Regimes: Recurrence and Quasi Stationarity. *Journal of the Atmospheric Sciences*
Thornton et al., (2019) Skilful seasonal prediction of winter gas demand *Environmental Research Letters*

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