



Climate Change

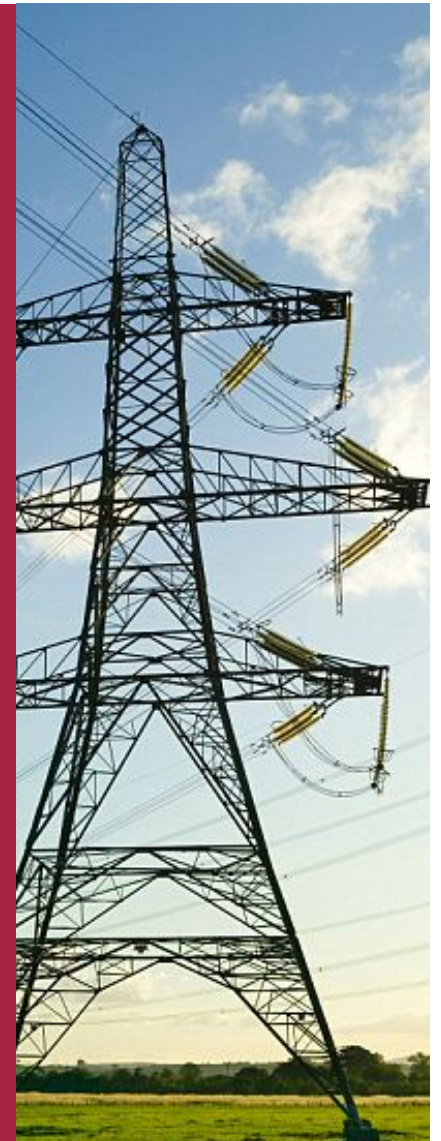
A case study approach to understanding variability and risk in the energy sector: Winter 2010

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MOTIVATION

- Using a case study approach to:
 - Demonstrate the value of climate information for understanding variability and informing risk

Understanding Variability

Return times of particular classes of events and their impacts

Pattern based analysis of large-scale drivers using historical reanalysis

Seasonal Forecasting

How can seasonal forecasts be used for the energy sector?

Future Change

Changes in return times of events under future climate

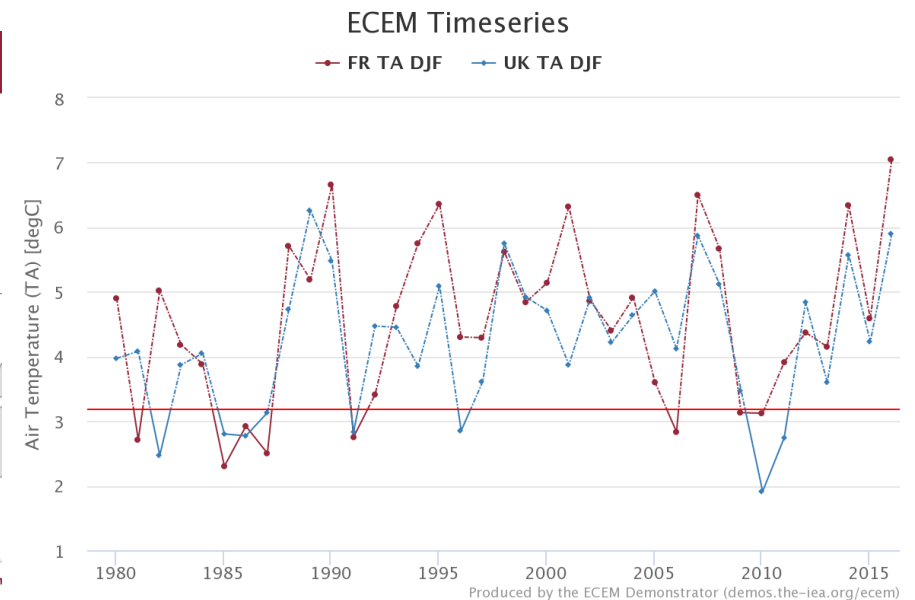
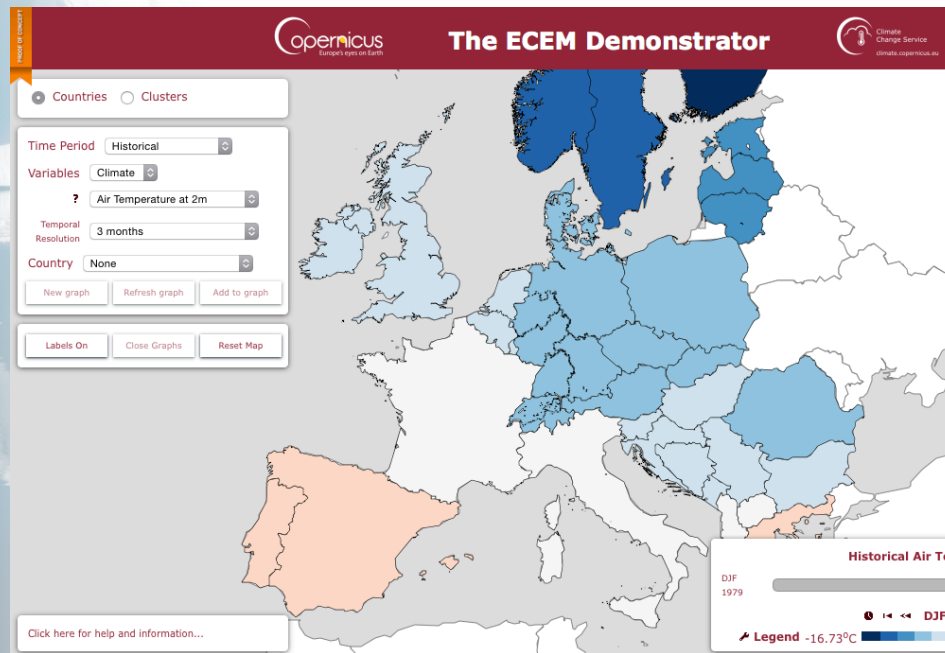
Identifying vulnerabilities under future power systems



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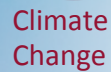
MOTIVATION

- Using a case study approach to:
 - Get the best out of the ECEM demonstrator tool and datasets
 - How might demonstrator tool be used to understand risks of particular events?



Copernicus
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- A series of case study documents available from the ECEM demonstrator

Can we anticipate cold spells and their impacts?

In the northern extra-tropics winter climate shows large fluctuations compared to other regions and seasons. Large-scale weekly to monthly fluctuations, such as the NAO, are a source of long-range climate predictability across northern Europe. Seasonal forecast systems have recently demonstrated a moderate level of success at predicting winter NAO [5], which consequently leads to some skill in reproducing near surface wind speeds and temperatures during winter [6].

While the winter 2010 event was unusually cold compared to recent history, it was warmer than winter 1963, despite exhibiting similar atmospheric conditions. It has been suggested that winter 2010 might have been cooler without the background of global warming observed in the 20th Century [7]. The ECM climate projections allow investigation of changes in risk to the energy sector from events such as cold winters under future climate change scenarios.

Can we trust the data?

The skill in seasonal prediction systems is still relatively low (depending on the variable, season and region) when assessed over multiple years, so caution is advised for cases analysed here. Extreme events, however, in which stronger driving factors are present, may offer higher levels of predictability. The Met Office Globalcast Seasonal Forecast system, for example, found signals of a negative NAO and consequent cool temperatures for reforestation forecasts during winter 2010 up to a season in advance [8]. This suggests seasonal forecasts could be useful when planning for extremes and worse case events.

The current historical reanalysis, while reliable for many variables and countries, shows some weaknesses in wind capacity factor. The next generation reanalysis dataset (ERA5) is, however, likely to provide improved estimates of wind speed and therefore the related energy variables.

References and links

- [1] National Grid, Winter Consultation Report 2010/2011, 26 June 2010.
- [2] The UK's Energy Supply: security or independence? 26 May 2011.
<http://www.energy-supply.com/assets/documents/2011-05-26%20Security%20and%20Independence.pdf>
- [3] G. Oudiz, et al., Geophysical Research Letters, 38, 11 (2011).
- [4] Wind Power in the United Kingdom
http://www.adapted.co.uk/WindPower_in_the_United_Kingdom.pdf
- [5] A. A. Guezou, et al., Geophysical Research Letters, 41, 2514-2519 (2014).
- [6] R. T. Clark, et al., Environmental Research Letters, 12, 024002 (2017).
- [7] J. C. McCreary, et al., Geophysical Research Letters, 37, L20704 (2010).

If you have something you'd like to add to this case study story (e.g., data, image, narrative) or would like to suggest another event for analysis, please submit your feedback via the feedback form on the Demonstrator.

Record power demand in winter 2010

Security of electricity supplies was threatened across much of northern Europe during winter 2010 (December 2009 to February 2010), with high levels of demand seen across many countries. In France peak electricity demand hit a record high, and with variability of nuclear power below normal, imports from neighbouring countries reached near upper limits for several consecutive days [1]. In the UK, electrical supply constraints from Norway coincided with record levels of gas demand [2]. The shortfall was met by increased imports from the rest of Europe. A peak in weather-sensitive electricity demand is seen in the ECM historical reanalysis for France and UK during winter 2010. Larger day-to-day fluctuations are seen in France due to greater electrification of heating in France compared to UK.

Figure 1: Left: Winter mean weather-sensitive electricity demand in France and UK. Right: Daily fluctuations in electricity demand (anomalous relative to 1979-2010).

A very cold winter

Winter 2010 made headlines for being unusually cold across much of northern Europe. A series of cold snaps with hard frosts and snowfalls were observed, particularly during the second half of December 2009 and first half of January 2010. Eastern and Northern westerly brought cold air from Scandinavia and Siberia towards northern Europe, while southern Europe was warm and wet. The contrast between conditions in northern and southern Europe is consistent with a southward-displaced jet stream and a prolonged strong atmospheric pressure differential across the North Atlantic (shown as the negative phase of the North Atlantic Oscillation, or NAO-) [3].

Figure 2: Left: Mean temperature anomaly (differences compared to 1981-2010 mean) across Europe for winter 2010. Right: Historical winter mean temperatures in France and UK.

Peak in demand sensitive to cold spells

Temperature is a dominant driver of demand across Europe (elasticity and residential gas heating), with a negative relationship between the two. Relative humidity, solar radiation and wind speed also play a role in influencing demand. The ECM reanalysis shows a high correlation between temperature and weather-sensitive electricity demand in the UK.

Figure 3: Modelled electricity demand against temperature during the winter months over the historical reanalysis in the UK.

What if winter 2010 happened today?

The ECM historical reanalysis provides estimates of renewable energy supplies based on today's energy mix and the historical climate drivers. This allows assessment of potential impacts of past climate events if they happened today. A winter like 2010, which saw persistent cold and still conditions, would have a larger impact on the energy sector today due to increased renewables capacity. In 2010 wind power contributed around 2% to electricity generation in the UK, rising to 11% in 2015 [4]. The winter conditions in 2010 would have led to a substantial reduction in wind power capacity factor compared to average winter conditions.

Figure 4: Estimated winter mean wind power capacity factor based on today's energy mix and the historical climate drivers for the UK.

EUROPEAN CLIMATIC ENERGY MIXES (ECEM)

ECEM CS 001

Winter 2009-2010

A series of case studies based on extreme events which illustrate how the ECEM Demonstrator can be used by the energy sector to enhance understanding and support decision making.

Key Lessons

- The ECM historical reanalysis dataset provides the ability to:
 - Investigate an event or type of event in the context of recent history.
 - Ask "what if" questions based on today's energy mix and the climate drivers.
- The Demonstrator can be useful for anticipating future risks through:
 - Seasonal forecasts
 - Climate projections

For more information visit www.ecm-climate.opernicus.eu or contact the ECEM team at support@ecm-climate.opernicus.eu

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European Centre for Medium-Range Weather Forecasts

UEA University of East Anglia

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CASE STUDIES – WINTER 2009/2010

- Use ECEM demonstrator and data to boost decision-making
 - Unusually cold winter of 2009/2010 can be seen in the ECEM data
 - Impact of a winter like 2009/2010 would have bigger impact on energy sector today
- The ECEM datasets:
 - Bring together credible climate and energy data
 - Processed in a consistent way over Europe
 - Covering a range of time scales and resolutions
- Reanalysis, seasonal forecasts and climate projection data can:
 - Reveal dependencies and risks across Europe
 - Put an event into context of recent history
 - Ask 'what if' questions
 - Help to anticipate future risks

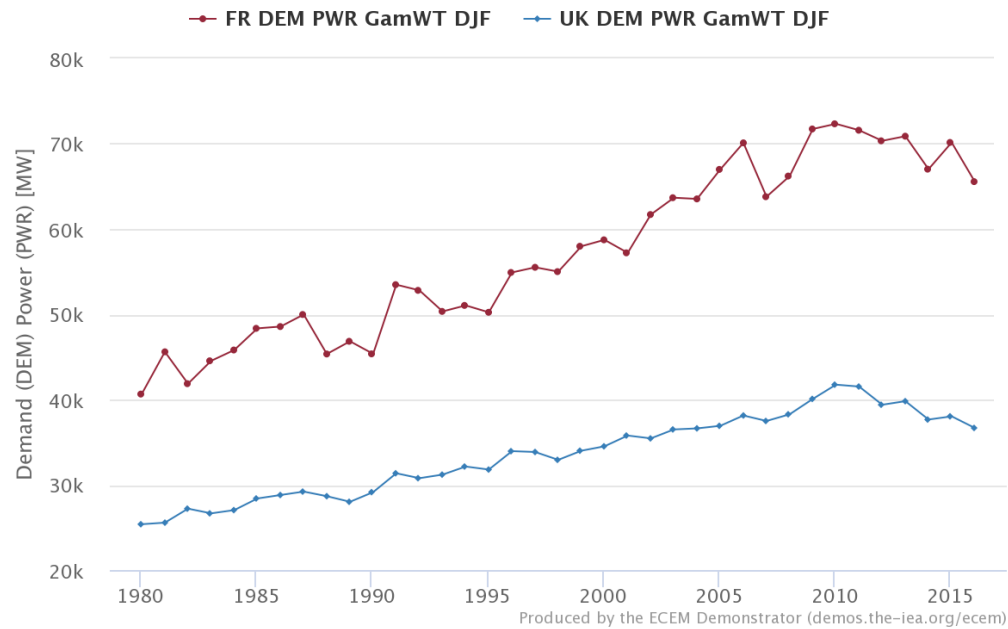


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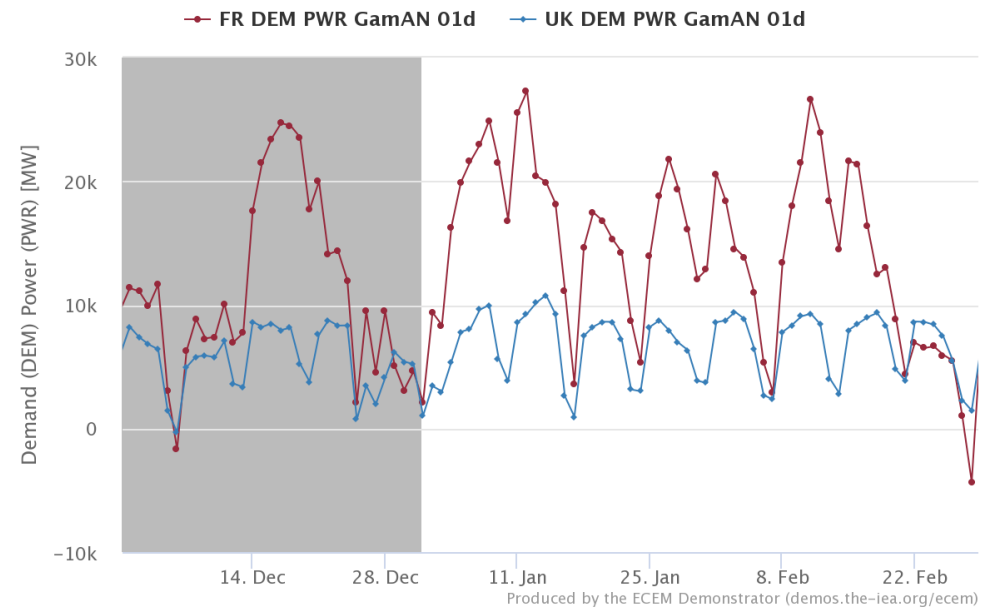
CASE STUDIES – WINTER 2009/2010

- Record power demand in 2010

ECEM Timeseries



ECED Timeseries

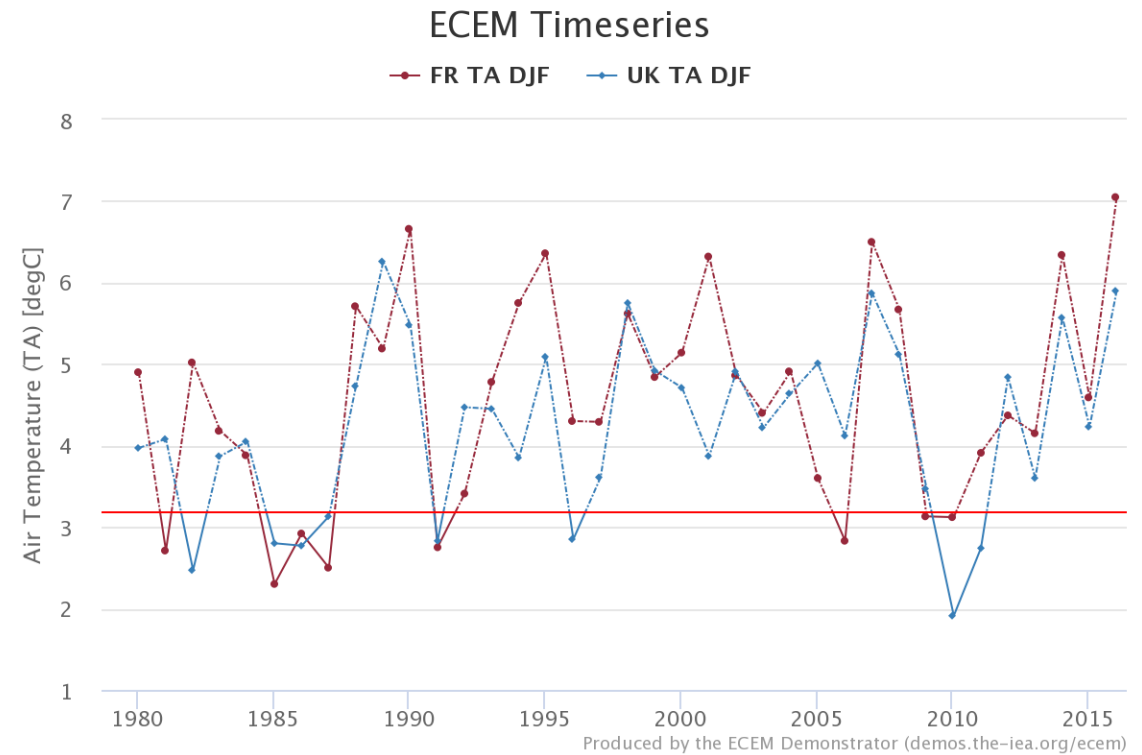
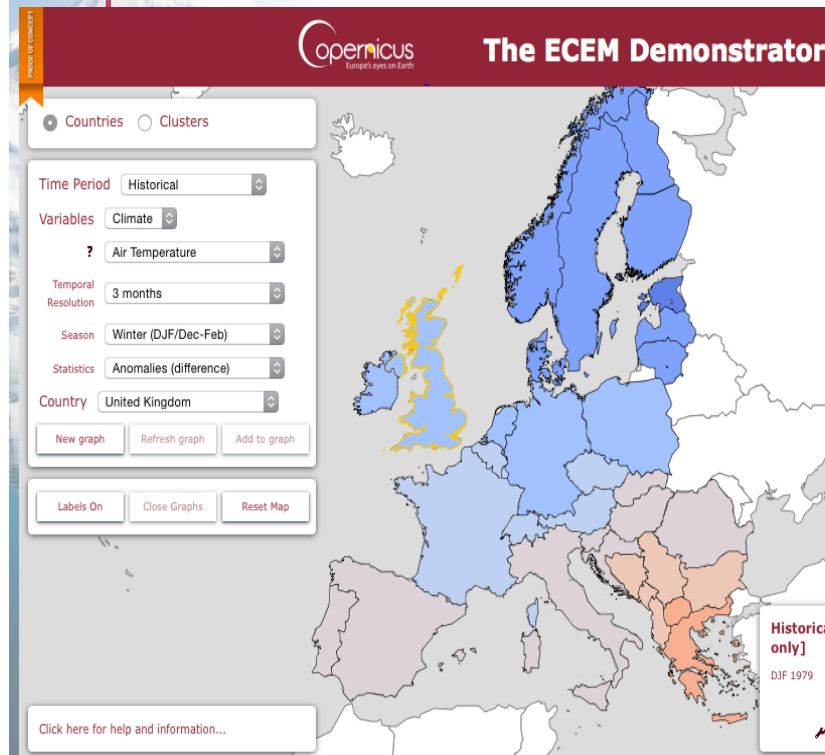




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CASE STUDIES – WINTER 2009/2010

- A very cold winter

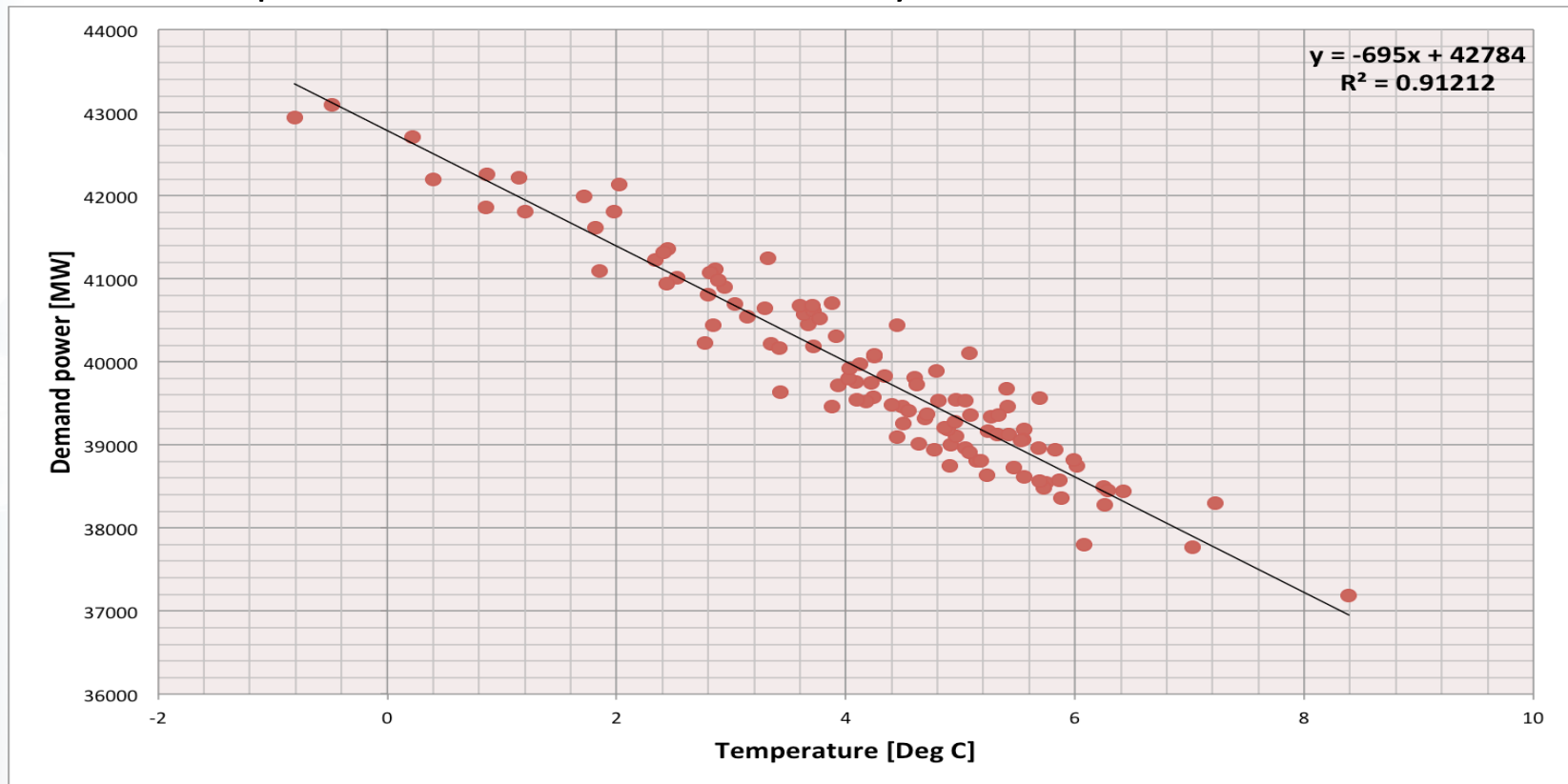




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CASE STUDIES – WINTER 2009/2010

- Linking temperature and demand
 - Temperature and modelled electricity demand over UK

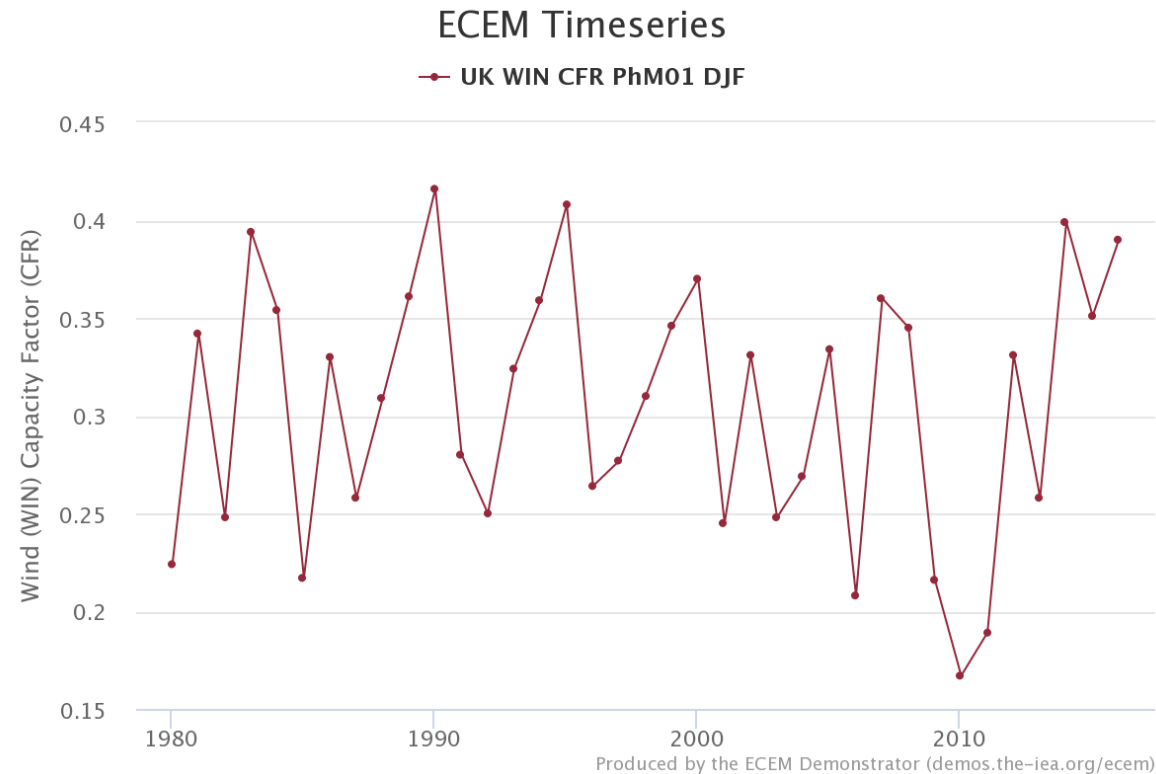




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CASE STUDIES – WINTER 2009/2010

- What if winter 2009/2010 happened today?



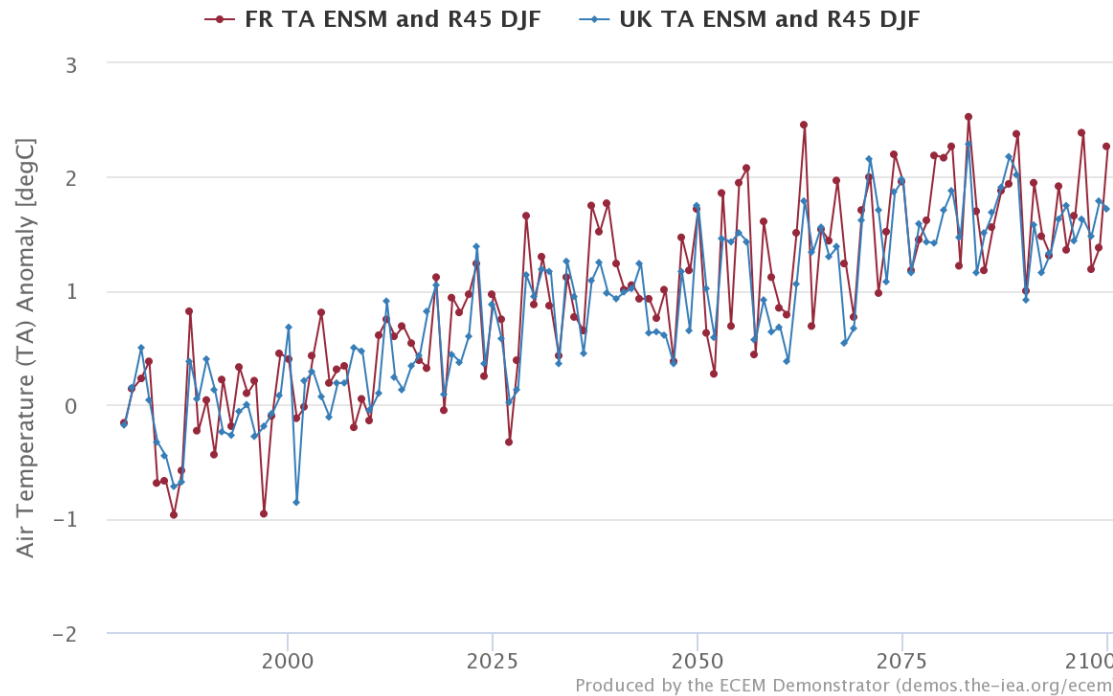


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CASE STUDIES – WINTER 2009/2010

- Can we anticipate cold spells and their impacts?
 - Climate projections useful to anticipate changes in risk
 - Fewer cold winters likely in future

ECM Timeseries: Air Temperature (TA) Anomaly – DJF only

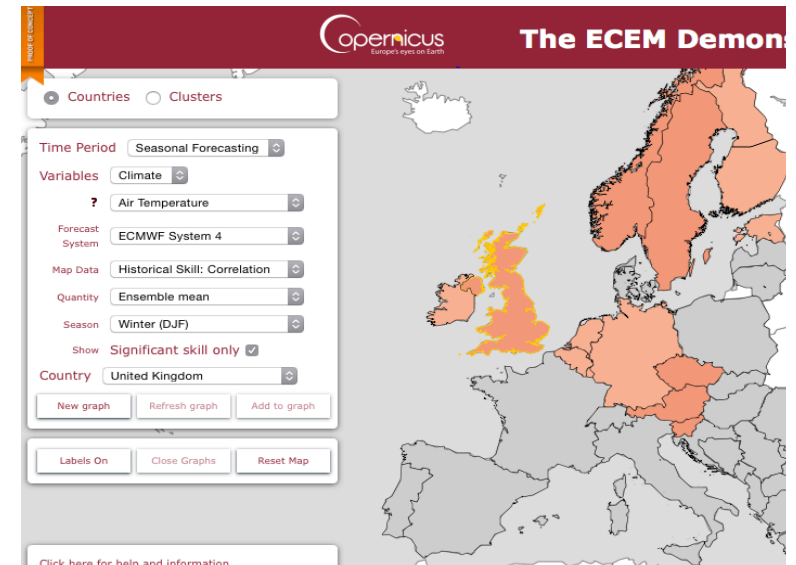




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CASE STUDIES – WINTER 2009/2010

- Can we anticipate cold spells and their impacts?
 - Seasonal forecasting shows some skill
- Words of caution!
 - Seasonal forecasts not skillful everywhere
 - Some variables from reanalysis still have some weaknesses
- The demonstrator does provide valuable insight for a wide range of energy-relevant applications/questions

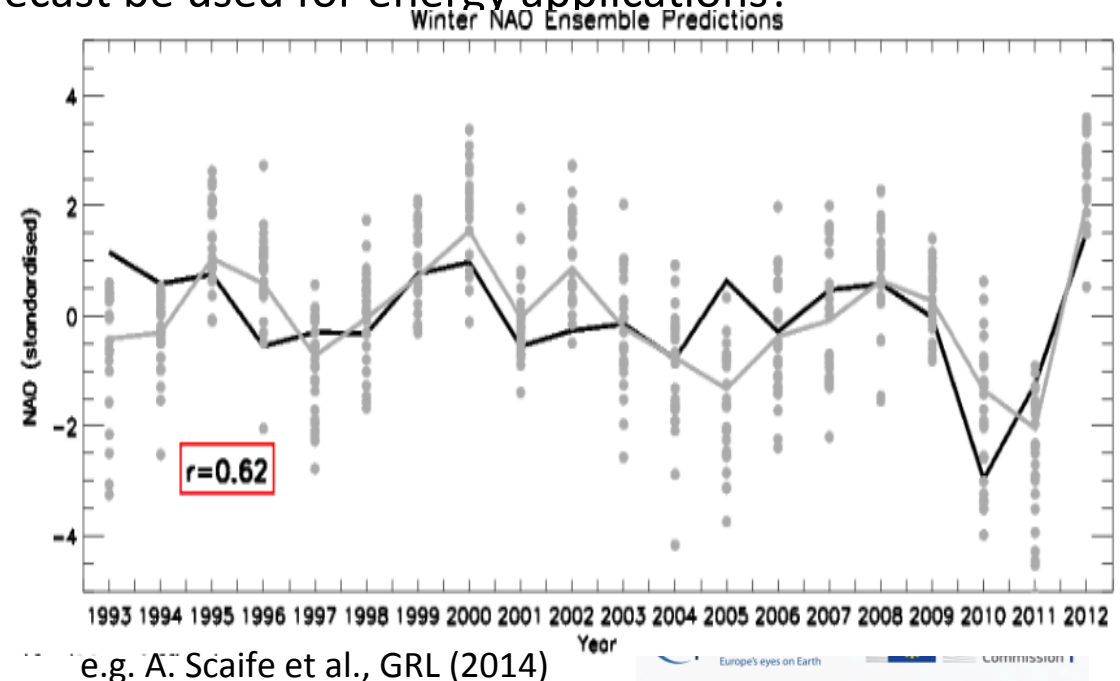
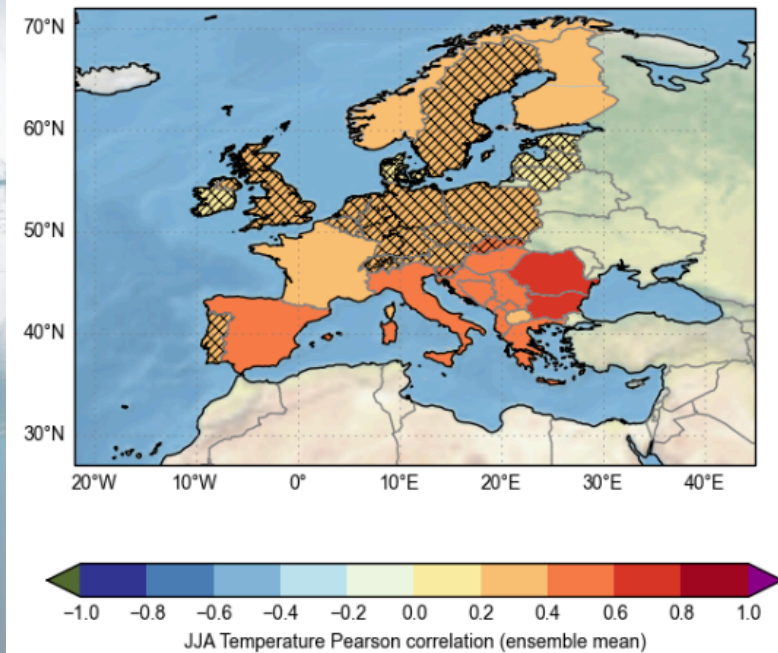




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CASE STUDIES – SEASONAL FORECASTS

- Highlight current state of seasonal forecasting
 - Skill in some variables, seasons and models (e.g. Balkans in JJA SAT)
 - Skill in seasonal forecasts of winter North Atlantic Oscillation
 - How could NAO forecast be used for energy applications?

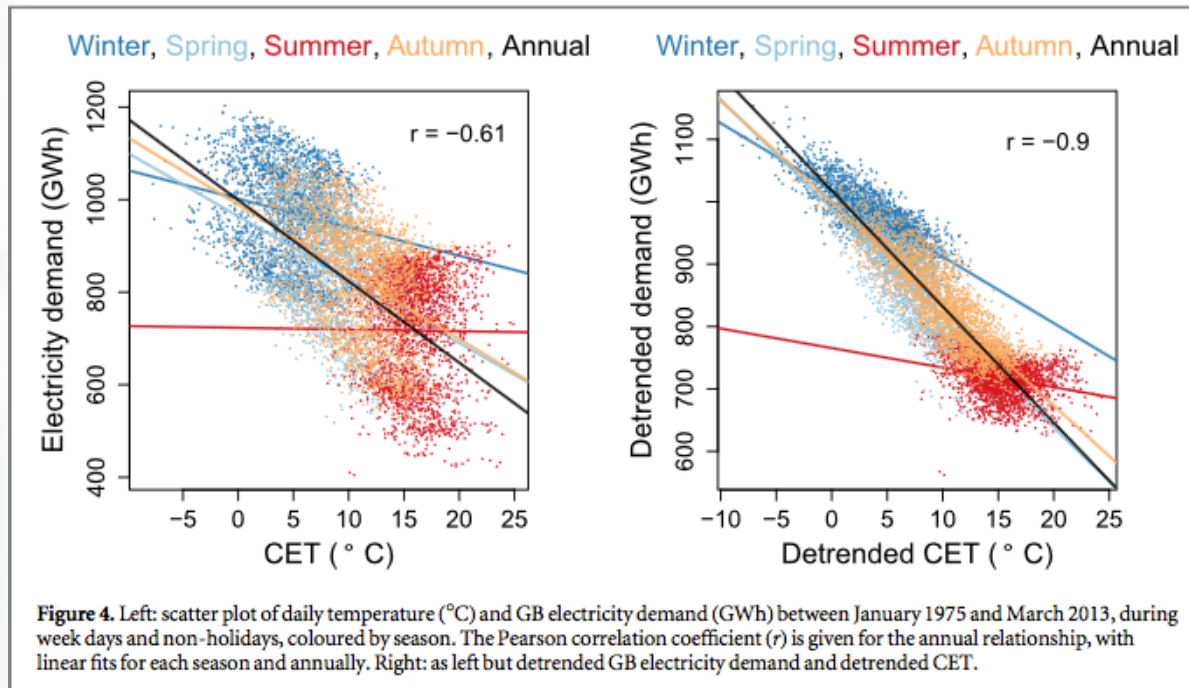




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CASE STUDIES – UNDERSTANDING VARIABILITY

- Use 30yr reanalysis based on current power system to study:
 - Co-variability between climate and energy indicators
 - Dependencies between European countries



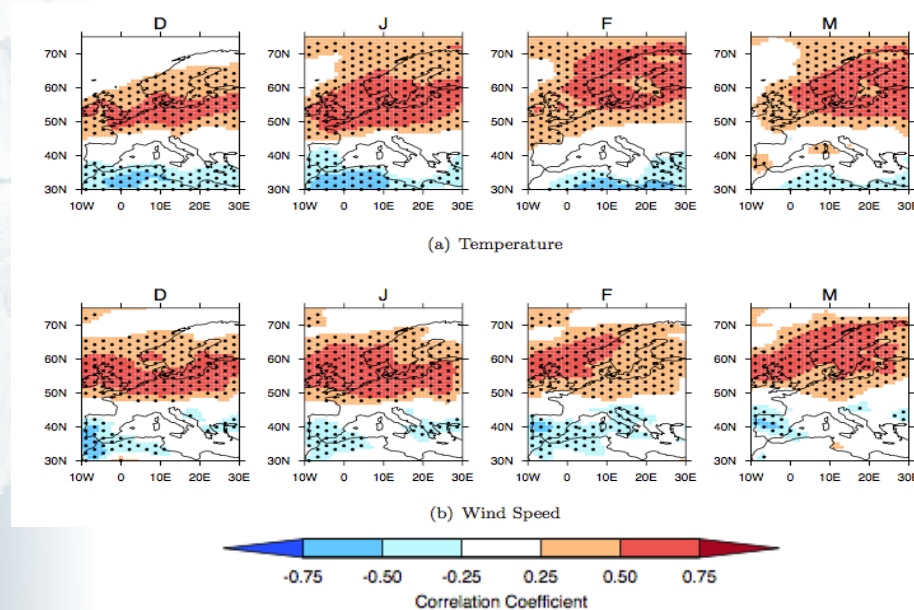
e.g. H. Thornton, B. Hoskins and A. Scaife, ERL, 11 (2016)



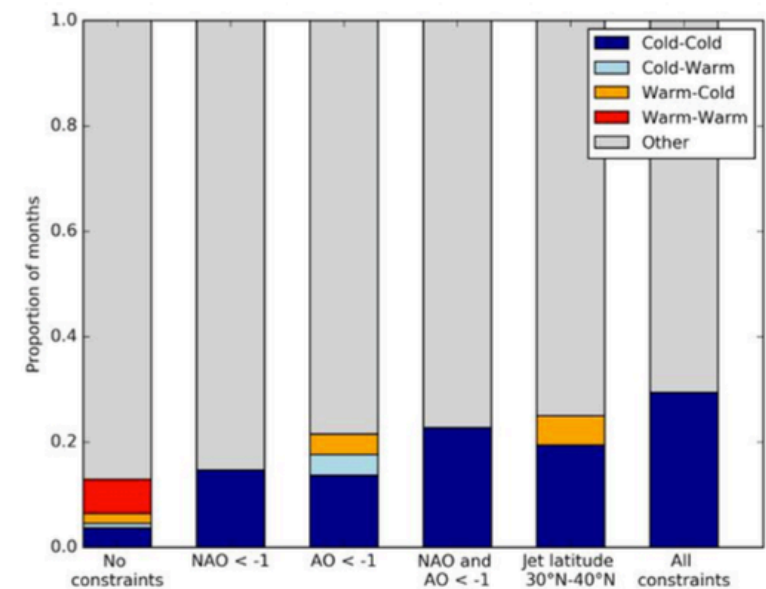
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CASE STUDIES – UNDERSTANDING VARIABILITY

- Use 30yr reanalysis based on current power system to study:
 - Large-scale modes of variability – e.g. North-South dipole, NAO
 - Pattern-based (EOF) analysis
 - Impacts of large-scale modes



C. Ely et al., (2013)



(a) Proportion of months

Sandra Hansen, David Brayshaw and John Methven



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CASE STUDIES – SUMMARY

- Current cases:
 - Winter 2010
 - Seasonal Forecasting (focus on the Balkans region)
 - Climate projections
 - Technical report on historical variability
- Other cases:
 - This is open for suggestion!



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CASE STUDIES – SUMMARY

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