Decadal climate forecasting for the energy-sector

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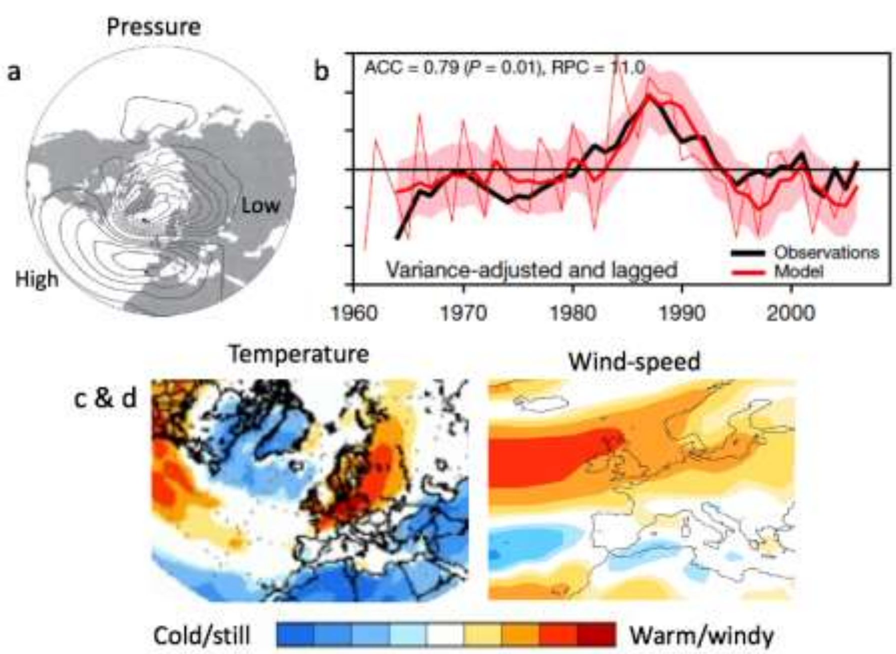
Throughout the world, power systems are undergoing massive change in response to the challenge of climate change. Renewable electricity sources – such as wind and solar PV – are playing an increasing role in power systems, fundamentally altering the way power systems operate. In Great Britain, for example, increasing levels of wind power installation now mean that shifts in wind speed are now as important as shifts in temperature in maintaining a secure (i.e., continuous and near-instantaneous) match between electricity-demand and electricity-supply and, as a result, anticipating low-wind-cold-snaps has become a key issue for supply security (Bloomfield et al 2018; Thornton et al 2017). Similar challenges around the integration of renewables into existing power systems are being faced by many countries across the world, raising an important question: how will climate variability and climate change affect the behaviour of power systems in the coming years and decades?



The winter "North Atlantic Oscillation" (NAO) and its impact on Europe. Figures show the positive-phase: reverse signs for the negative-phase. (a) Surface pressure anomalies associated with the NAO (lower-than-normal over Northern Europe/Atlantic, higher-than-normal to the south). (b) Decadal evolution of the NAO (observed NAO in black, central prediction in thick red line). (c and d) Impact of the winter-mean NAO on European surface temperatures and near-surface wind speed. In winter, negative NAOs are usually associated with cold temperatures and low wind over Northern Europe, leading to both ***increased demand*** *for heating energy and* ***lower-than-normal generation*** *from wind power. See, e.g., Ely et al (2013), Thornton et al (2019), Bloomfield et al (2020) and Smith et al (2020) for relevant discussion. These figures from Hurrell et al (2003), Smith et al (2020), NOAA CPC and created using ESRL PSD.*

Recent years have seen increased interest from both academia and industry into the risks posed by climate variability and change for power system operations and planning. Much of this research, however, has been based either on an assumption of an unchanging climate (i.e., using historical observations) or else very-long-term climate model projections (relating to 2050 or beyond). There is therefore a significant "decadal-scale information gap" (1-10 years) between these extremes which is significant for power system planning. High quality decadal-scale climate information could, for example, support the provision of early warning systems for stress periods such as low-wind years, or support the identification of optimal "pathways" for integrating new infrastructure over the course of several years.

Decadal-scale climate forecasting is, however, scientifically challenging in that it seeks to make a concrete *prediction* of near-term future climate (i.e., statements about what *will* happen based on some initial starting state) as opposed to the long term projections more commonly with climate models (i.e., *possible* outcomes contingent on the occurrence of a particular greenhouse gas scenario). Until recently, it has been widely believed that the skill of decadal forecasting was rather limited, but recent developments have indicated surprising skill several years ahead (Smith et al, 2020). This PhD will build on these recent developments to explore the extent to which skilful decadal climate predictions can be used to inform the operation and management of the energy system from a season to several years ahead.

Drawing upon a range of disciplines (climate science, mathematics, physics and engineering) – and with the support of a world-leading CASE partner - this project will therefore seek to pioneer the use of decadal forecasting for energy system applications. A central focus of the work will be to characterize and understand decadal forecast skill and to identify and develop applications through which it can be utilized. The student can therefore expect to be involved in:

1) assessing and understanding the skill of decadal predictions;
2) developing and applying models to "convert" predictions into energy-system relevant quantities; and
3) engaging energy-sector stakeholders to develop sector-relevant applications of decadal forecasts.

It is intended that a prototype forecast application (e.g., a year- or decade- ahead energy demand forecast) will be produced by the end of the project.

Training opportunities:

The student will join the Energy Meteorology research group (research.reading.ac.uk/met-energy) in the Meteorology Department at Reading University and work with an experienced supervisory team. World leading MSc-level training in meteorological science will be provided, and students encouraged to participate in relevant summer schools, seminars and workshops. Through a CASE studentship with the UK Met Office (co-supervisors Thornton and Smith) and it is expected there will be opportunities to engage with and undertake a substantial placement (3-months). On completion, it is expected that the student will have a good grounding in climate science and its applications with excellent career prospects, particularly within the growing Climate Services sector.

Student profile:

This project will suit an individual with a strong quantitative background in mathematical/physical science, engineering, statistics or similar. The student will undertake high-quality meteorological research with a focus on process-understanding. They must be enthusiastic about going beyond traditional subject boundaries and to engage with industry stakeholders.

Funding particulars:

CASE studentship with UK Met Office

References:

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https://research.reading.ac.uk/scenario/