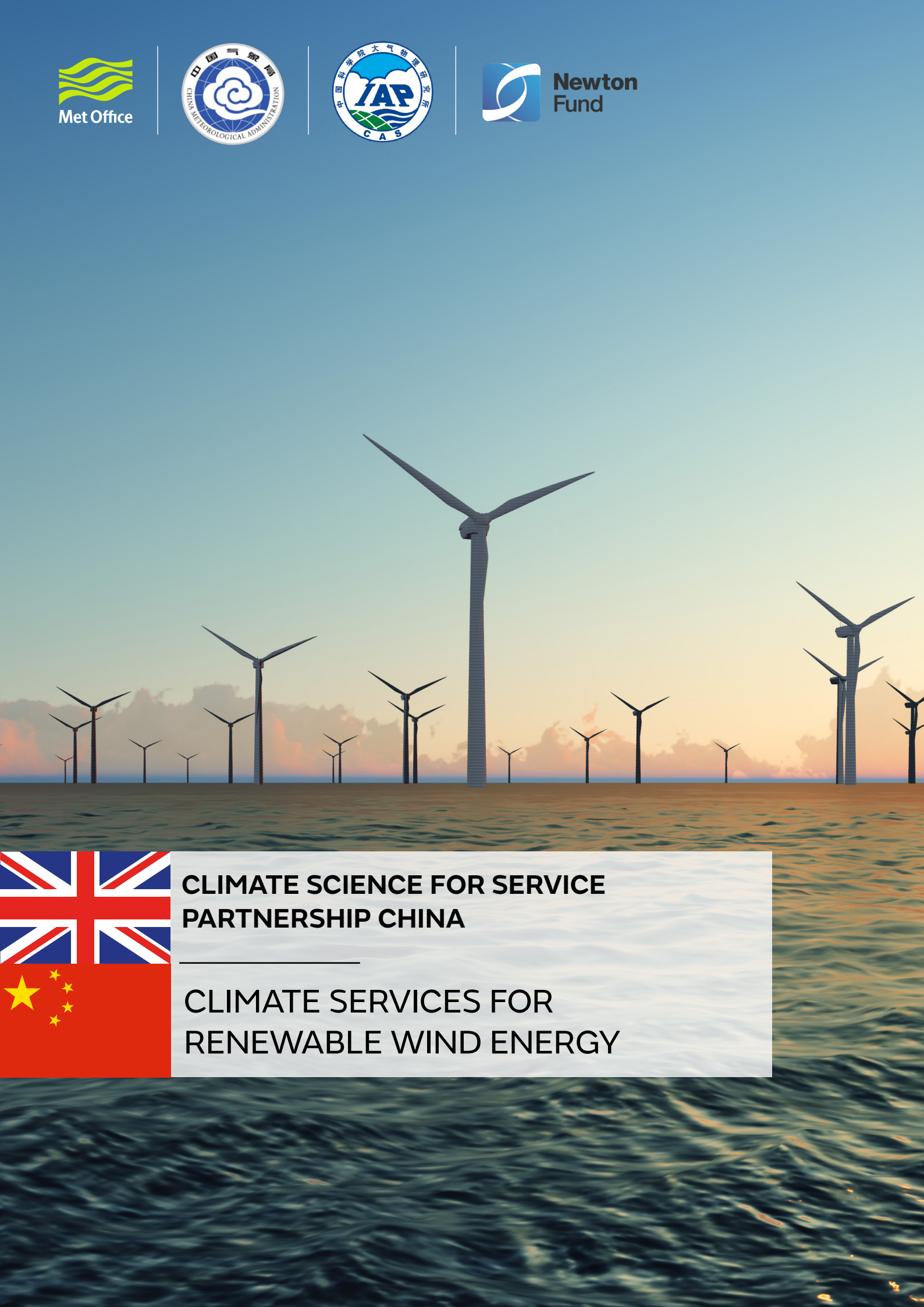
Met Office

Newton Fund



CLIMATE SCIENCE FOR SERVICE PARTNERSHIP CHINA

CLIMATE SERVICES FOR RENEWABLE WIND ENERGY

WIND ENERGY IN THE UK AND CHINA

China has the greatest installed wind power capacity in the world. By August 2020, this capacity exceeded 220 million kilowatts, with a utilization rate of 97%[1]. Moving forward, China aims to promote large scale development and consumption of wind power. This will be important for China to reach carbon neutrality targets by 2060.

The United Kingdom is also a global leader in offshore wind energy, with more installed capacity in offshore wind than any other country[2]. By working together, the UK and China can share vital knowledge gained in the wind energy sector. This has the potential to maximise the efficiency of wind power generation, in our current and future climate.

Climate Science for Service Partnership China (CSSP China) research is investigating past, present and future climate variability and extremes, and how these might impact key sectors, including energy. The project brings together scientists from the Met Office, China Meteorological Administration (CMA), the Institute of Atmospheric Physics (IAP) at the Chinese Academy of Sciences and other China and UK partners.

By working with the energy community to understand how climate information can be used in decision-making, CSSP China research can help to manage the risks and opportunities for wind energy from future climate variability and change.

How can climate science help decision makers?

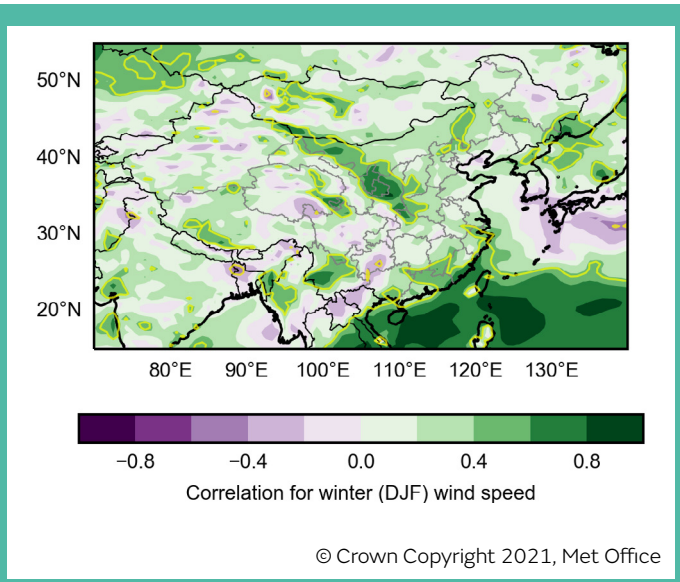
CSSP China research has found that in some regions in China **winter average near-surface wind speed** can be predicted months ahead using the Met Office seasonal forecasting system[3]. Further research confirmed the skill of this predictability is robust, as well as identifying the sources of this predictability in the model, such as the El Nino Southern Oscillation[4].

Where can winter wind speed be predicted?

The winter average near-surface wind speed can be predicted in three distinct regions:

- **Southern and southeastern China off the coast of the South China Sea** (SE China)
- **Northern-central China, south of Mongolia** (NC region)
- **Southwestern China, centred on Yunnan Province** (SW region)

The yellow contour lines in Figure 1 represent areas with strong forecast skill.



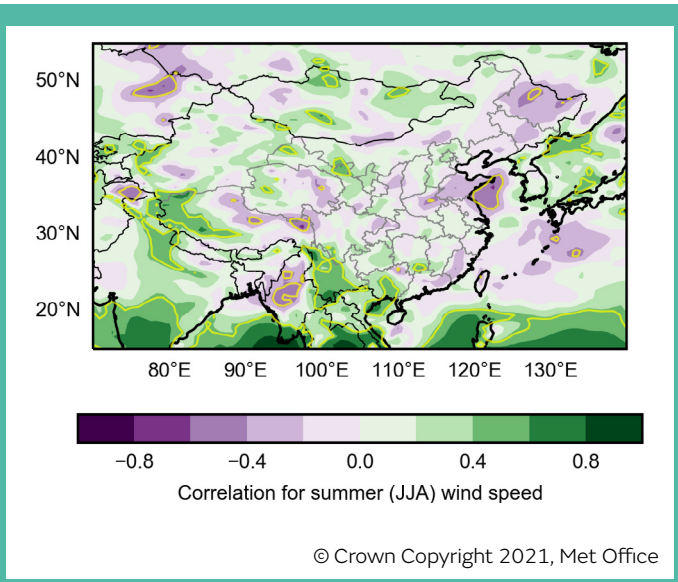


Figure 1 - **Correlation of modelled seasonal mean near-surface wind speed with observations.** These maps show the relationship between seasonal mean near-surface (10m) wind speed in the Met Office seasonal forecasting system (GloSea5) and observations (ERAI) for the winter (left, December-January-February) and summer (right, June-July-August). Darker red colours indicate areas of significant predictability, which can be seen in the winter months but not in the summer.[3]

Is this useful for China's energy sector?

Many wind farms are located and being constructed in the north of China and in southern coastal areas. Skilful forecasts in these regions could help facilities predict their output power months ahead of time.

The predictability of near-surface (10m) wind speed are directly related to the wind speed at the hub heights of wind turbines (80 - 120m). By predicting the winter average wind speed ahead of time in the autumn, the renewable energy supply for the winter in the SE and the NC region in China can be estimated. This will help the energy sector in these regions make important decisions for meeting energy demand.

In Europe, high wind speed predictability corresponds to an ability to forecast **seasonal wind power**[5]. In China, wind speed predictability could also be applied to the potential seasonal mean wind power generated. Climate scientists could work directly with energy experts in China to develop tailored, location-specific forecasts.

How are climate services for energy developed in Europe?

Seasonal forecasts for offshore maintenance planning

A climate service co-designed by the Royal Netherlands Meteorological Institute (KNMI), and TenneT (an industrial partner) focusses on offshore maintenance and supply operations in the North Sea[6]. The maintenance of wind parks and platforms in the North Sea is conducted by boats. Therefore, planners agree safe thresholds for wind speed, significant wave height and mean wave period. Evaluating the future likelihood of conditions being within these thresholds helps planners to optimise scheduling of vessel hire and management.

KNMI engaged with TenneT at the start of the project to develop decision trees for different threshold values for the maintenance process[7] (Figure 2a). This enabled scientists to better understand and evaluate how seasonal forecasts can influence the decision-making process. The agreed thresholds can be mapped onto a probability grid set by the forecast (Figure 2b). By choosing a probability confidence value, such as 75%, the user can identify opportunities where it is likely the wave height will be low enough to run the vessel.

The service is currently being trialled on a real-time basis. The partners meet frequently to discuss the forecast, and how it can be refined. This means the forecast is constantly being evaluated improved to meet user requirements. The SECLI-FIRM project (http://www.secli-firm.eu/) is a series of ongoing studies which are demonstrating how industrial and research partners can work together to co-design and improve the provision of climate information for the energy sector.

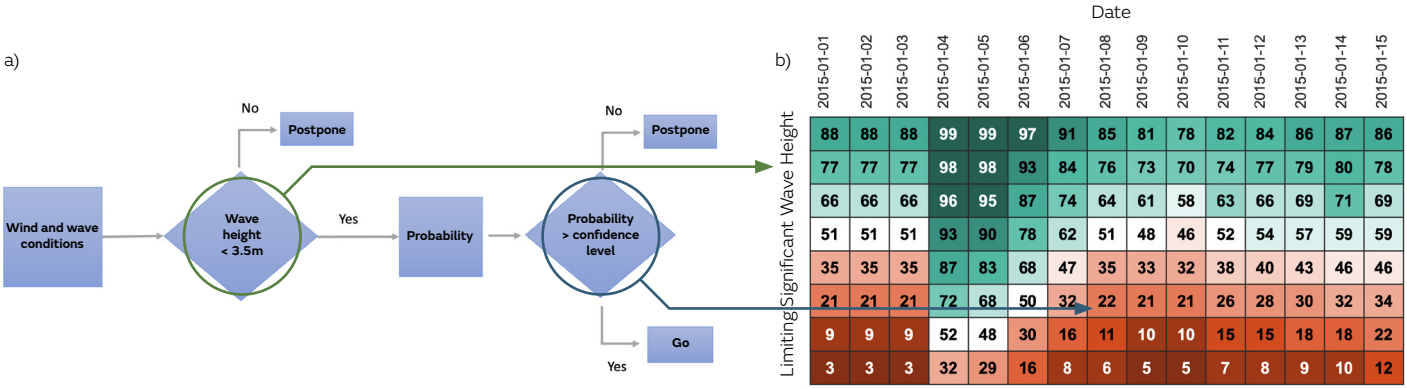


Figure 2 - **The decision tree is mapped to threshold values for wind and wave conditions, allowing the company to plan in advance** a) Example decision tree for maintenance planning. b) Example forecast of the probability of the Significant Wave Height being less than a series of maximum limits (rows) as a function of lead time (columns)[7].

What can we learn?

- Using climate forecasts can help with planning for meteorological events months in advance
- Users should be involved in co-development of the service from the start of the project
- It is important for scientists to fully understand the decision-making process

Are you interested in using seasonal climate information?

We'd love to hear from you if you are interested in knowing more about this work, or in developing similar climate information for China.

Email: WCSSPProgrammeOffice@metoffice.gov.uk

WeChat: Met Office - ICS

Predicting potential energy supply

The European Climatic Energy Mixes (ECEM) Demonstrator (http://ecem.wemcouncil.org/) is an online interactive tool which can be used to visualise, explore and download climate and energy data sets (Figure 3), supported by the Copernicus Climate Change Service (C3S)[8].

The data can be viewed and analysed on historical, seasonal forecasting and climate projection timescales. Users can select different variables, emissions and energy scenarios, such as the percentage renewable energy source. By using this tool, energy companies and policy makers can assess how different energy supply mixes in Europe meet demand. This can help with long term planning, helping decision makers to build a climate resilient energy system.

The Demonstrator was developed with frequent input from stakeholders and prospective users[9]. The project responded flexibly and dynamically to the users' feedback, who found the final tool design and supporting documentation user friendly. The tool is no longer maintained, however feedback will be incorporated into an operational service run by C3S.

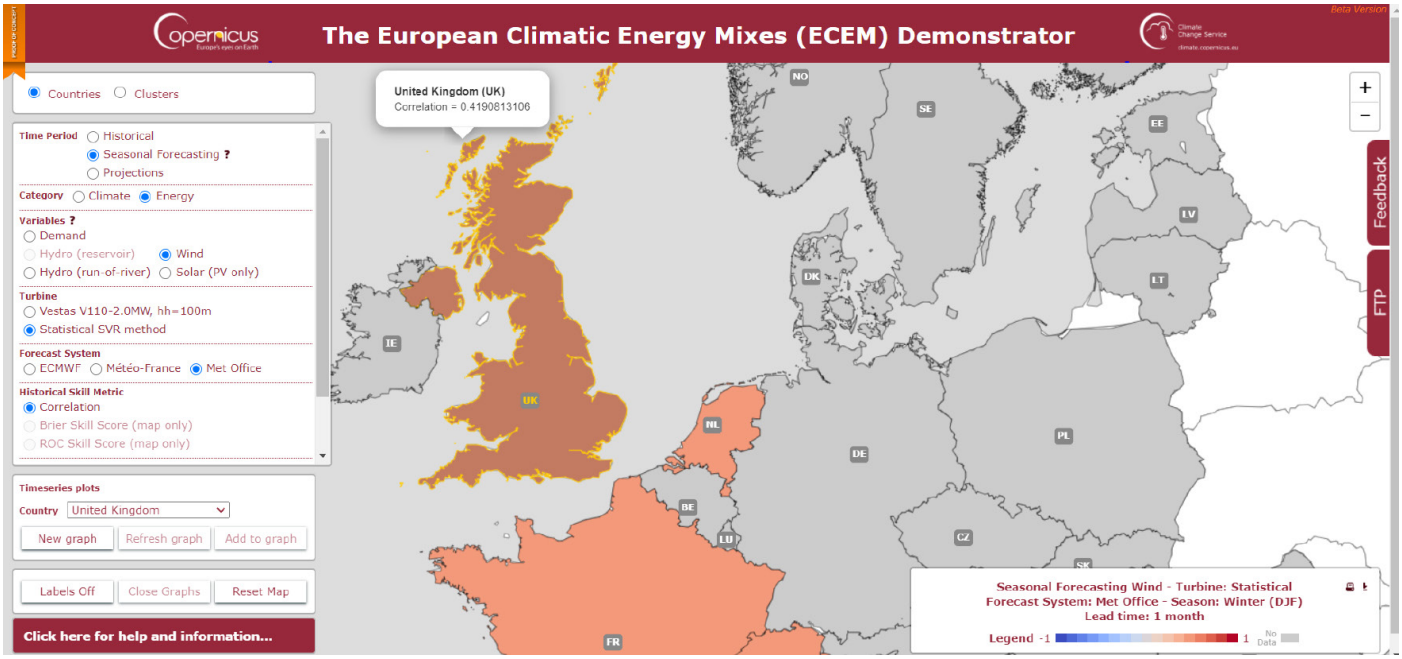


Figure 3 – Screenshot showing the interactive online map from the Copernicus Climate Change Service (C3S) European Climatic Energy Mixes (ECEM) Demonstrator[10].

What can we learn?

- Good quality and accessible data is essential for climate services
- Major challenges include the relatively short duration of available time series and inconsistencies in datasets
- It is important to understand the different priorities of individuals or organisations
- Continuous feedback from users is key to developing an informative climate information tool that is user friendly

Are you interested in predicting energy supply?

We'd love to hear from you if you are interested in knowing more about this work, or in accessing similar information for China.

Email: WCSSPProgrammeOffice@metoffice.gov.uk

WeChat: Met Office - ICS

Be part of the project!

We'd love to hear from you if you are interested in knowing more about this work, or in accessing similar information for China.

As part of CSSP China, we are looking to work closely with those in the energy sector who have decisions affected by the weather and climate. We hope to use the new science research from CSSP China to develop new tools and products to meet your needs.

Please get in touch:

Email: WCSSPProgrammeOffice@metoffice.gov.uk

WeChat: Met Office - ICS

References

[1] National Energy Administration (2020). Wind power utilization level continues to improve in China. Available at: http://www.nea.gov.cn/2020-10/30/c_139478910.htm . Accessed 09 November 2020 (in Chinese).

[2] Statista (2020). Offshore wind power capacity by country. Available at: https://www.statista.com/statistics/264264/capacity-of-offshore-wind-power-plants-worldwide-2010/. Accessed 21 February 2021.

[3] Bett PE, Thornton HE, Lockwood JF, Scaife AA, Golding N, Hewitt C, Zhu R, Zhang P, Li C (2017). Skill and reliability of seasonal forecasts for the Chinese energy sector. J Appl Meteor Climatol 56:3099–3114. https://doi.org/10.1175/JAMC-D-17-0070.1

[4] Lockwood, J. F., Thornton, H. E., Dunstone, N., Scaife, A. A., Bett, P. E., Li, C., & Ren, H. L. (2019). Skilful seasonal prediction of winter wind speeds in China. Climate Dynamics, 53(7), 3937-3955.

[5] Bett PE, Thornton HE, de Felice M, Suckling E, Dubus L, Saint-Drenan Y-M, Troccoli A, Goodess C (2018) Assessment of seasonal forecasting skill for energy variables. ECEM deliverable D3.4.1, Met Office Technical Report. https://doi.org/10.5281/zenodo.1295517

[6] SECLI-FIRM (2020). Case study 6: North Sea wind and wave impact on maintenance planning and logistics. Available at: http://www.secli-firm.eu/wp-content/uploads/2020/04/h2020_776868_secli-firm_case_study_6_flyer_20200331.pdf. Accessed 03 March 2021.

[7] Steele, E., Neal, R., Dankers, R., Fournier, N., Mylne, K., Newell, P., ... & Upton, J. (2018). Using weather pattern typology to identify calm weather windows for local marine operations. In Offshore Technology Conference. Offshore Technology Conference.

[8] Troccoli, A., Goodess, C., Jones, P., Penny, L., Dorling, S., Harpham, C., ... & Blower, J. (2018). Creating a proof-of-concept climate service to assess future renewable energy mixes in Europe: An overview of the C3S ECEM project. Advances in Science and Research, 15, 191-205.

[9] Goodess, C. M., Troccoli, A., Acton, C., Añel, J. A., Bett, P. E., Brayshaw, D. J., ... & Wald, L. (2019). Advancing climate services for the European renewable energy sector through capacity building and user engagement. Climate services, 16, 100139.

[10] Copernicus Climate Change Service (C3S), Copernicus (2019). The European Climatic Energy Mixes (ECEM) Demonstrator. Available at: http://ecem.wemcouncil.org/. Accessed 13 May 2021.

Newton Fund

CSSP China is part of the Weather and Climate Science for Service Partnership Programme, supported by the UK-China Research and Innovation Partnership Fund as part of the Newton Fund. For more information, see https://www.metoffice.gov.uk/research/approach/collaboration/newton/cssp-china/index