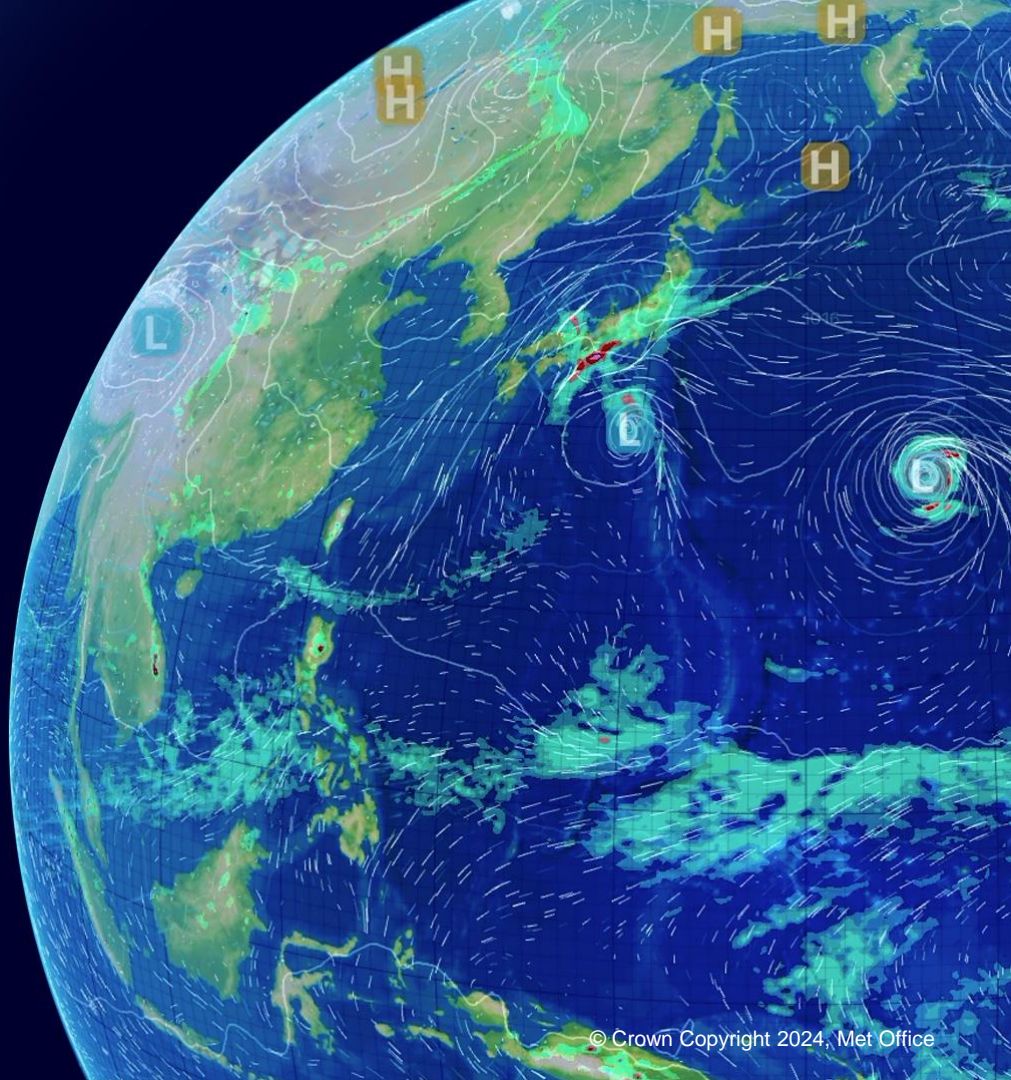


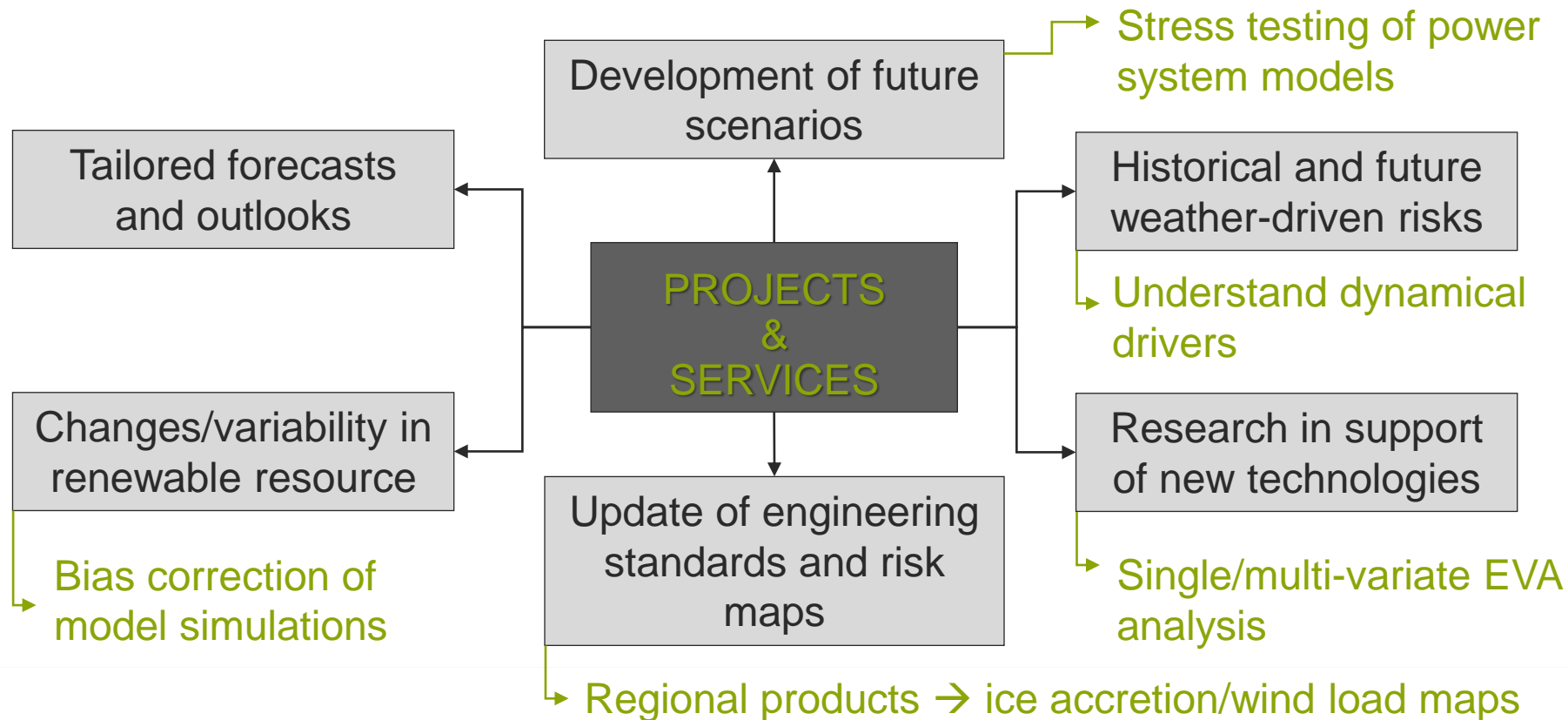
Using reanalysis for energy applications: A climate scientist perspective

Paula LM Gonzalez

25 April 2024



Energy research @ Met Office: how do we use reanalyses?



Desirable features: a climate scientist perspective

Completeness

- ↳ Consistency in time and space

Multi-variate

- ↳ Explore (thermo-)dynamical drivers
- ↳ Bias correction / complementarity

High-freq outputs

- ↳ Power conversion / forcing models

Relevant levels

- ↳ Reduce uncertainty of scaling
- ↳ Shear & veer, turbulence, stability

Global

- ↳ Extend research to emerging markets

Multi-decadal records

- ↳ Capture modes of climate variability

High-res outputs

- ↳ Capture more local effects

Ensemble/coupled

- ↳ Uncertainty estimates
- ↳ Metocean applications

Acknowledging limitations: a climate scientist perspective

Need for bias correction

- ↳ Onshore/offshore differences
- ↳ Observation-poor areas
- ↳ Complexity for multi-variate analysis

Resolution vs. frequency?

- ↳ Information lost if high-res data is not provided at high-freq

Is there a “right”/“best” one?

- ↳ Diversity, need for intercomparison
- ↳ Variable- and region- dependent
- ↳ Beyond small scale effects → impacts on resources adequacy assessments

Next Generation Challenges in Energy Climate Modelling

- The **NextGen/NextGenEC research community** got started in 2020, tasked with delivering a workshop funded by H2020 PRIMAVERA → covid!
- We've hosted **3 online workshops** (2020/2021/2022), with 200+ registrations, ~80-90 people per session(all continents, strong student/ECR representation)
- We've published **2 community papers** (and are still working on more...)

BAMS Meeting Summary

The Importance of Weather and Climate to Energy Systems

A Workshop on Next Generation Challenges in Energy–Climate Modeling

H. C. Bloomfield, P. L. M. Gonzalez, J. K. Lundquist, L. P. Stoop, J. Browell, R. Dargaville, M. De Felice, K. Gruber, A. Hilbers, A. Kies, M. Pantelli, H. E. Thornton, J. Wohland, M. Zeyringer, and D. J. Brayshaw

Joule

CellPress

Perspective

Overcoming the disconnect between energy system and climate modeling

Michael T. Craig,^{1,29} Jan Wohland,^{3,329,*} Laurens P. Stoop,^{4,5A,29} Alexander Kies,^{1,27} Bryn Pickering,⁶ Hannah C. Bloomfield,^{9,10} Jethro Browell,¹¹ Matteo De Felice,¹² Chris J. Dent,^{13,14} Adrien Deroubaix,^{15,28} Felix Frischmuth,¹⁶ Paula L.M. Gonzalez,¹⁰ Aleksander Grochowski,¹⁷ Katharina Gruber,¹⁸ Philipp Härtel,¹⁶ Martin Kittel,¹⁹ Leander Kotzur,²⁰ Inga Labuhn,²¹ Julie K. Lundquist,^{22,23,24} Noah Pflugrad,²⁵ Karin van der Wiel,⁶ Marianne Zeyringer,²⁶ and David J. Brayshaw¹⁰

Extreme weather events for energy systems: Exploring their impacts, predictability and future research directions

What is good enough practise in estimating future climate risk in the energy sector? — using wind energy as an example

- **2024 online workshop planned!** (likely for September) → if interested:

<https://research.reading.ac.uk/met-energy/next-generation-challenges-workshop/>

Other timely synergies

- **CMIP7 Impacts and Adaptation data request task force** (March 2024)
- To liaise with **impacts, adaptation and climate services** communities to identify list of **high priority variables** that serve the majority of user needs
- To highlight needed **vertical levels** and their **temporal coverage** and **frequency**

Geosci. Model Dev., 9, 3493–3515, 2016
www.geosci-model-dev.net/9/3493/2016/
doi:10.5194/gmd-9-3493-2016
© Author(s) 2016. CC Attribution 3.0 License.



The Vulnerability, Impacts, Adaptation and Climate Services Advisory Board (VIACS AB v1.0) contribution to CMIP6

Alex C. Ruane¹, Claas Teichmann², Nigel W. Arnell³, Timothy R. Carter⁴, Kristie L. Ebi⁵, Katja Frieler⁶, Clare M. Goodess⁷, Bruce Hewitson⁸, Radley Horton⁹, R. Sari Kovats¹⁰, Heike K. Lotze¹¹, Linda O. Mearns¹², Antonio Navarra¹³, Dennis S. Ojima¹⁴, Keywan Riahi¹⁵, Cynthia Rosenzweig¹, Matthias Themessl¹⁶, and Katharine Vincent¹⁷

New variables requested by the energy sector (for historical, DECK, and ScenarioMIP experiments, as well as requests for experiments within HighResMIP).

Daily mean	100 m wind speed	m s^{-1}	Focus on wind speeds at 100 m above surface
Daily mean	Eastward 100 m wind	m s^{-1}	
Daily mean	Northward 100 m wind	m s^{-1}	
Not specified	Wind speed	m s^{-1}	Stored at model level, not pressure level
Not specified	Wind direction	Degrees	Renewable energy (wind)
Not specified	100 m wind speed and gusts	m s^{-1}	Also, 80 and 120 m for energy resources and infrastructure

Do reach out if you want to contribute requests/ experiences/ case studies

Relevant references

- Staffel & Pfenninger (2016) **Using bias-corrected reanalysis to simulate current and future wind power output.** <https://doi.org/10.1016/j.energy.2016.08.068>
- Davidson & Millstein (2022) **Limitations of reanalysis data for wind power applications.** <https://doi.org/10.1002/we.2759>
- Jurasz et al. (2020) **A review on the complementarity of renewable energy sources: Concept, metrics, application and future research directions.** <https://doi.org/10.1016/j.solener.2019.11.087>
- Wohland et al (2020) **European multidecadal solar variability badly captured in all centennial reanalyses except CERA20C.** <https://dx.doi.org/10.1088/1748-9326/aba7e6>
- Laurila et al. (2020) **Climatology, variability, and trends in near-surface wind speeds over the North Atlantic and Europe during 1979–2018 based on ERA5.** <https://doi.org/10.1002/joc.6957>
- Gutierrez et al. (2024) **Low-wind climatology (1979–2018) over Europe from ERA5 reanalysis.** <https://doi.org/10.1007/s00382-024-07123-3>
- Wohland et al (2023) **Extrapolation is not enough: Impacts of extreme land-use change on wind profiles and wind energy according to regional climate models.** <https://doi.org/10.5194/egusphere-2023-2533>
- Sundar et al. (2023) **Meteorological drivers of resource adequacy failures in current and high renewable Western U.S. power systems.** <https://doi.org/10.1038/s41467-023-41875-6>
- Cannon et al. (2015) **Using reanalysis data to quantify extreme wind power generation statistics: A 33 year case study in Great Britain.** <https://doi.org/10.1016/j.renene.2014.10.024>

Any questions or comments?

Paula LM Gonzalez

Paula.Gonzalez@metoffice.gov.uk