Next generation NOAA reanalyses:

Wind Energy and Power System Modelling user requirements

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Outline

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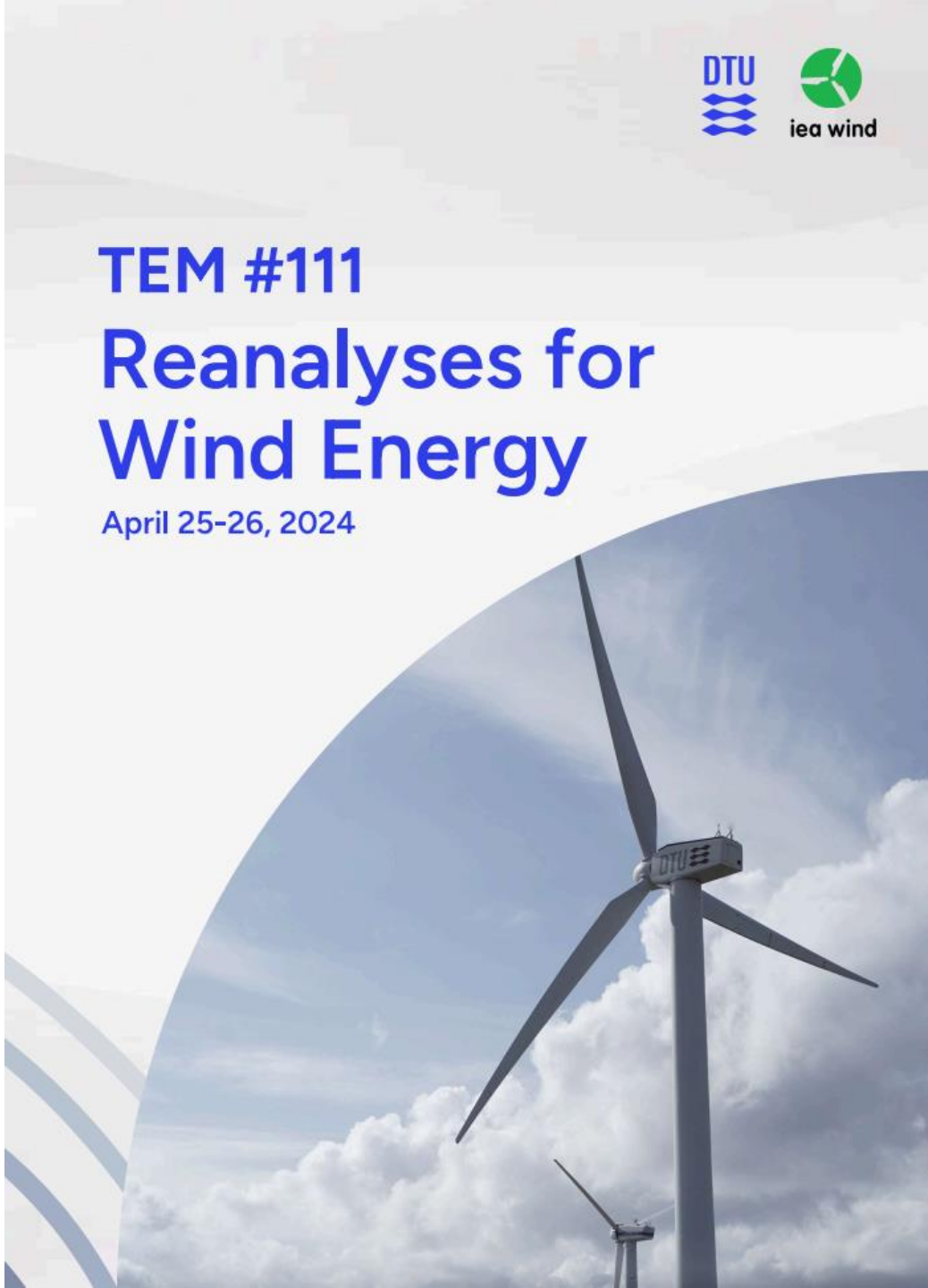
2. The IEA Topical Expert Meeting #111
3. CFSR and CFSv2: Reliable Workhorses of the Offshore Wind Industry
4. Next generation NOAA reanalyses: user requirements
5. Next steps and contact details



1) Who we are

Rémi Gandoin C2Wind, Denmark	Jacob Tornfeldt Sørensen DHI, Denmark	Justin Sharp EPRI, USA	Jim Wilczak NOAA, USA
			
Offshore wind engineer	Innovation and Product Portfolio Manager, Energy and Ports	Renewable Energy and Meteorology Subject Matter Expert	Meteorologist
Yield Assessment, Site Conditions, Integrated Load Analysis	Metocean (waves hydrodynamics) hindcast modelling	Energy Meteorology	Boundary Layer Meteorology, Renewable Energy, Air Quality, Remote Sensing

2) The IEA Topical Expert Meeting #111

International Energy Agency Wind Technology Collaboration Program: #1 R&D platform since 1979

Wind Energy engineering and science applications **heavily depend on reanalysis** datasets

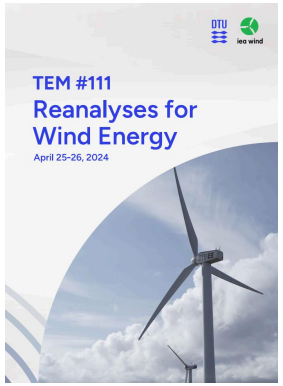
Until TEM#111, little to no direct contact/dialog between reanalysis and wind energy communities.

TEM#111 aimed at:

- Connecting Wind Energy / Global & Regional Reanalysis communities
- Summarizing state of the art (use cases, reanalysis advancement)
- Agreeing on follow-up actions:
  - Keep both communities **up to date**
  - Collecting **user requirements** for future datasets
  - **Validation** using high quality in-situ datasets

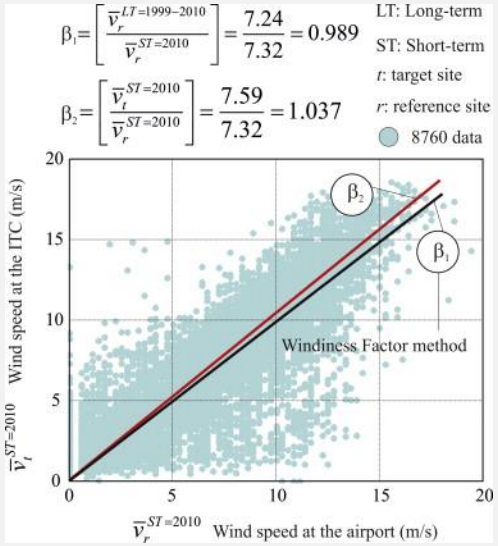
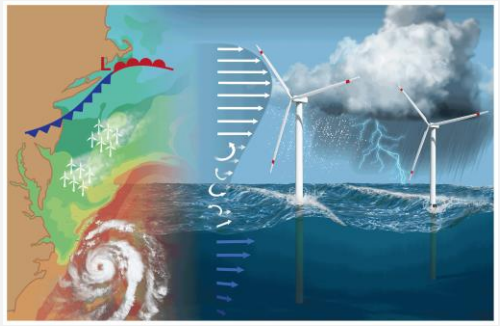
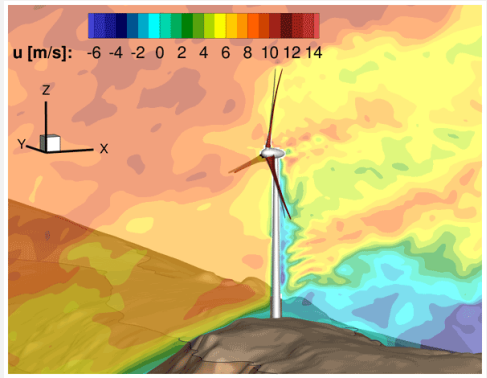
And many others..

Proceedings:
https://iea-wind.org/task11/tems/



2) The IEA Topical Expert Meeting #111

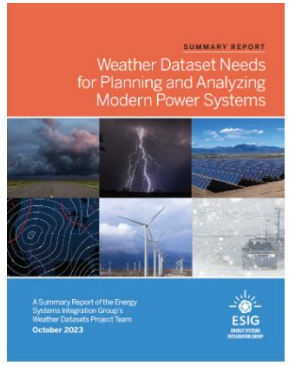
What Reanalysis data are used for, in Wind Energy:

Siting	Long-term correction of in-situ measurements	Design of offshore wind farms	R&D and Innovation
 			

2) The IEA Topical Expert Meeting #111

What Reanalysis data are used for, in Power System planning:

The increasing weather-dependence of supply and demand is making power system planning dramatically more complex and in need of much more comprehensive weather data for robust system planning. The electricity system is rapidly shifting to a system in which wind, solar, hydro, and nuclear generators provide most of the generation; energy-limited resources such as battery storage are rapidly becoming more prevalent; behind-the-meter generation is blurring the lines between generation and load; and load is fundamentally changing as transportation and heating electrify. To robustly quantify the range and probability of possible supply/demand combinations in future planning scenarios requires long time series of temporally coincident weather variables that accurately describe the frequency distribution and evolution of all the weather impacts concurrently affecting the electricity system.



To assess the gaps in existing weather data used in power system planning and outline a process for producing ideal weather datasets for planning studies, ESIG convened a Weather Datasets Project Team. This group of experts in meteorology and power system planning developed a report that provides details on what is needed and why, outlines the status of and gaps in existing data and methods, and describes an approach to building a solid, long-term solution.

This project produced the following set of publications:

Executive Summary

Weather Dataset Needs for Planning and Analyzing Modern Power Systems (Full Report). This is the complete text of the report, including detail on all aspects of the gaps, needs, and solutions, as well as a section covering meteorology fundamentals for power systems planners, engineers, and others. This full version is intended for technical experts engaged deeply in this work. (108 pages, plus glossary, references, and appendices) A high-resolution version of the full report can be found here (40MB).

Weather Dataset Needs for Planning and Analyzing Modern Power Systems (Summary Report). The summary report distills the gaps, needs, and solutions, and does not include the full background section on meteorology fundamentals. This version is intended for a broader audience in power system planning, and it can be paired with "Meteorology 101" if further detail on meteorology for power system modeling and planning is desired. (34 pages, plus selected bibliography and appendix)

"Meteorology 101: Meteorological Data Fundamentals for Power System Planning." This overview of meteorology for power system planners, engineers, modelers, and others is a stand-alone version of Section 2 in the full report. We have published it as a stand-alone document to accompany the summary version of the report, for readers of the summary who wish to delve more deeply into datasets and models used in power system planning studies.

Fact sheets to come.

EXECUTIVE SUMMARY | SUMMARY REPORT | METEOROLOGY 101 | FULL REPORT | WEBINAR RECORDING

NEWS RELEASE

TABLE 2
Summary of Current Power System Modeling Weather Input Data Sources

	Spatial Resolution	Temporal Resolution	Length	Continuously Extended	Correct Variables / Levels	Coincident and Coherent	Validated/Uncertainty Quantified for Power System Use	Detailed Documentation	Future-Proofed	Availability/ Ease of Access	Curation and Advice	Region Covered
MERRA-2[a]	~60 km	60 min	1980–present	Yes	Yes/No	Yes	No		Probably		Basic	Global
ERA5[b]	~30 km	60 min	1940–present	Yes	Yes/No	Yes	Some		Yes		Good	Global
HRRR[c]	3 km	15 min	2014–present	Yes	Yes/No	Yes/No	No		Unideal		Basic	U.S.
WIND Toolkit[d]	2 km	5 min	2007–2014	No	Yes/Yes	Yes	Yes		No		Basic	Various
WTK-LED[e]	2 km/4 km	5 min	3 year/ 20 year	No	Yes/Yes	Yes	Not yet	Not yet	No	Unknown, dataset not yet available		Various
NSRDB[f]	4 km/ 60 km	30 min	1998–present	Yes	Yes/No	Solar only	Yes		Yes		Basic	Most of globe
CERRA[g]	11 km/5.5 km	60 min	1980–present		No/Yes	No solar	Yes		Possibly		Basic	Europe
CONUS404[h]	4 km	60 min/ 15 min (precip)	1980–2020	No	Unknown/ Probably	Yes	Not the intended use					Continental U.S.
BARRA[i]	12 km/ 1.5 km	60 min	1990–2019	No	Yes/ Probably	Yes				Fee-based		Australia/ New Zealand
Public Observing Networks[j]	Non-uniform, variable density	1 hr or less	Variable	Yes	Yes/No	Mostly	Varies. Not for power systems	Varies	Usually	Usually easy	Varies	Global
Renewable Energy Project Data[k]	Non-uniform, variable density	Usually minutes	Variable but rarely more than 10 years	Varies	Yes/ Usually	Yes	Usually	Varies, but usually poor	Varies	Usually poor	Usually none	Very limited
Proprietary Statistically Derived VRE Shapes[l]	Non-uniform, variable density	Usually hourly	Variable. Rarely reliable long records.	Varies	Usually incomplete	No	Partial	See note	No		None	Very limited

Fully Met | Close to Being Met | Partially Met | Met in a Very Limited Way | Not Met at All | Not Enough Info. for Determination

Summary of the most applicable datasets globally that are (or can be) used to provide weather inputs for power system analysis tasks, especially for providing estimate of site-level generation, and concurrent weather-driven load and generation outage risks. The degree to which the needs of each column heading are met is estimated with color coding. See documentation for each dataset for all details.

3) CFSR and CFSv2: Reliable Workhorses of the Offshore Wind Industry

No, **ERA5 is not the preferred dataset**:

- ERA5 (IFS in general) underestimates strong wind speeds due a too large drag coefficient*

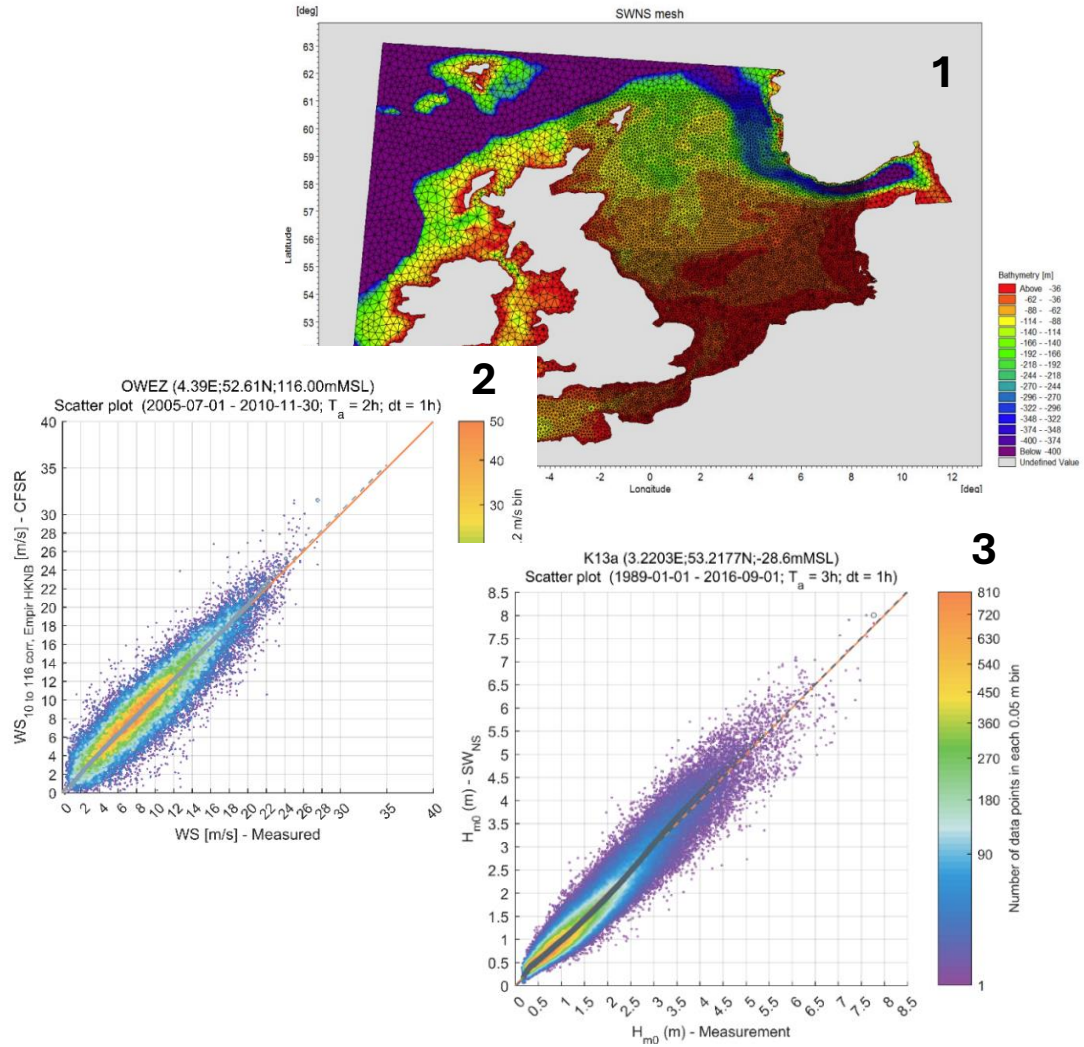
CFSR and CFSv2 heavily used in the offshore wind industry (and in marine engineering in general). Used as input to **wave, currents and water level modelling.**

✓ Pros

- "Known" dataset, with 10+ years of project, hands-on experience
- Slightly overestimates extreme wind speeds (good for design)

❖ Cons

- Same model, but two different grids and land-sea masks ☹
- Wind at 10 m only (pressure level wind is not useable for us)



*Gandoin, R. and Garza, J.: Underestimation of strong wind speeds offshore in ERA5: evidence, discussion and correction, Wind Energ. Sci., 9, 1727–1745, https://doi.org/10.5194/wes-9-1727-2024, 2024.

Source: https://offshorewind.rvo.nl/files/view/99763fec-74a7-4d28-89e1-f0ff3442715a/1558076843hkn_20190516_presentation%20webinar%20metocean%20study-f.pdf

4) Next generation NOAA reanalyses: user requirements

Need to have:

- Please do not retire CFSv2 without having a well-tested, robust replacement.
- Next reanalysis should be as good as ERA5, without the strong wind speed bias.
- 40 years is enough
- 10 and near hub height (100-150m) wind
- Hourly time series
- API access

Nice to have:

- Wind, temperature up to 500m
- Wave model (to be used as boundary conditions)
- Early testing of model data
- Easy data access, something like the CDS

5) Next steps and contact details

Stay in touch

- Write to us:
  - Rémi Gandoin <RGA@C2Wind.com>
  - Jacob Tornfeldt Sørensen <jts@dhigroup.com>

- Subscribe:
  - Newsletter: https://www.linkedin.com/newsletters/7231744153947144194/
  - Slack Channel: https://join.slack.com/t/tem111reanaly-tkx6800/shared_invite/zt-2oml27glj-DeI5VfjSqeA8utX2vdxwFA