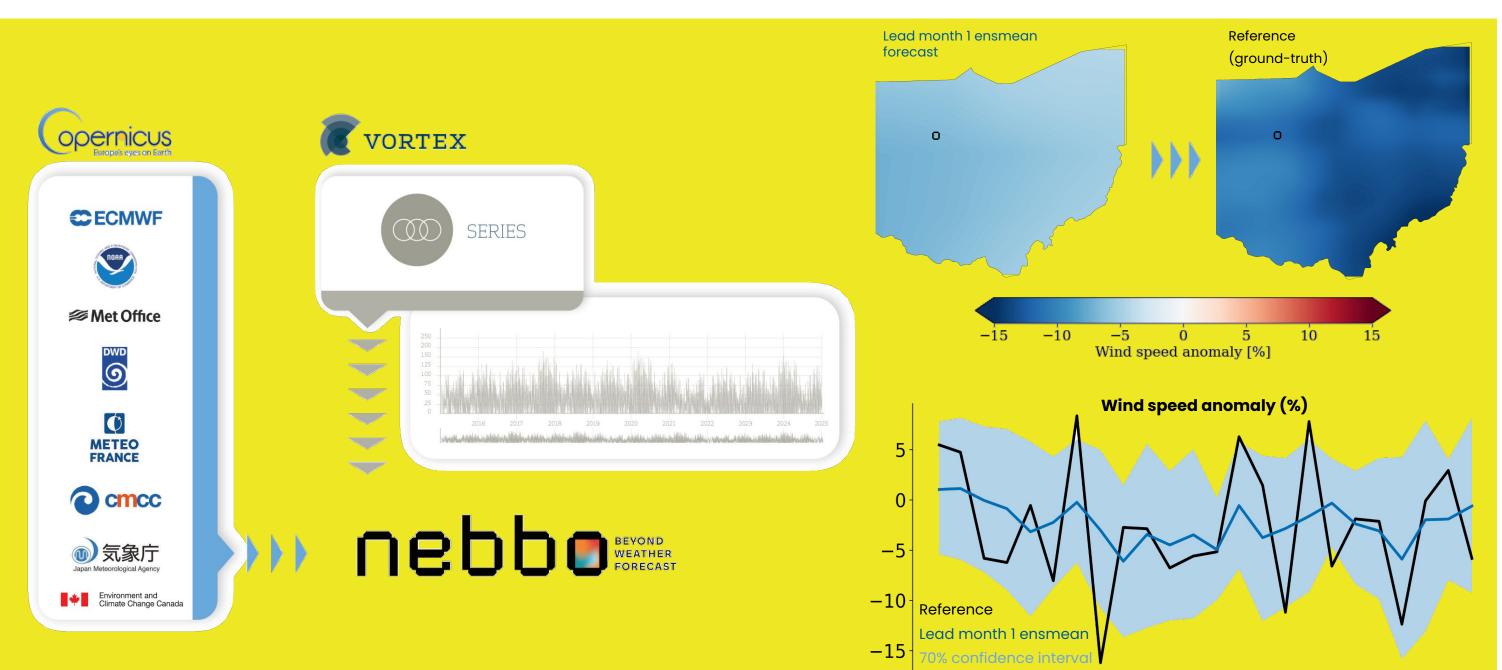
Using Al downscaling and physical models to anticipate & mitigate wind drought months

Seasonal wind forecasts: how to anticipate and mitigate wind drought impacts

D. Ponsà, T. Anderson, G. Castro & Y. Zurita



Extra tables & figures

Forecast metrics

for 1, 2 and 3 months ahead

		L1	L2	L3
	MAE (m/s)	0.33	0.35	0.37
\leftrightarrow	Interval width (m/s)	1.08	1.27	1.24
\odot	Coverage (%)	75	79	75
+	Anomaly sign hit rate (%)	79	79	71

Fig. 2: Re-forecast metrics for Nebbo multi-model & Feb 2023 - Jan 2025 period. The ensemble mean of lead months 1 (L1), 2 (L2) & 3 (L3) is compared with Vortex SERIES ground-truth.

nebbe								Search			Q (Download guide) (test@nebbo-weather.com											
Sites	Clusters	< Seasonal																	Cli	matol	ogy	
🔶 Hog Creek	(Hide metadata)				Overview						Validation					on me	metrics Print					
Project Description	#896 Unclassified Hog Creek Site	Choose prediction	n center: Ne	obo	~		_						Cho	oose co	overc	ıge ir	nterval	70	% \	~		
Date submitted	Jan 28, 2025	Monthly wind speed anomalies and six-months-ahead Nebbo seasonal predictions (%)									0	Chart Timeseries										
	40.79, -83.73	Forecast date	Ground truth		1 month			2 month	n		3 mont	h		4 mont	:h		5 mont	h		6 mon	ith	
,	United States	2025 January	-5.81	-9.23	-0.60	8.14	-9.74	-0.59	8.40	-9.62	0.30	10.02	-9.08	0.49	10.53	-9.75	0.11	10.25	-10.51	-0.27	9.82	• Wind Speed Anomaly values (%)
Baseline period	1993/01 - 2016/12 🗷	2024 December	2.94	-7.95	-1.90	4.04	-8.30	-0.59	7.42	-8.78	-0.65	6.88	-9.13	-0.55	7.74	-8.72	-0.41	7.68	-8.38	-0.69	7.69	10
Download series Download excel		2024 November	-0.09	-13.06	-1.97	7.88	-12.59	-1.72	8.52	-13.17	-1.70	10.58	-11.80	-0.87	11.26	-12.77	-0.50	12.42	-11.91	-1.26	10.44	10
		2024 October	-12.36	-15.83	-5.89	4.27	-12.62	-2.69	7.45	-12.97	-2.32	7.19	-11.52	-1.13	7.98	-10.76	-0.68	9.33	-10.52	-1.49	8.61	
Configure site do	ata	2024 September	-2.13	-9.87	-3.07	4.15	-9.88	-2.39	5.62	-9.13	-1.52	5.75	-9.50	-0.97	7.31	-10.47	-1.45	7.42	-9.15	-1.57	6.42	5
View mode	anomaly absolute	2024 August	-1.88	-8.37	-2.38	2.90	-9.81	-1.84	5.71	-9.36	-1.79	6.09	-9.33	-1.63	5.47	-10.16	-2.08	6.61	-10.24	-2.30	5.35	0
	Wind speed 🗸	2024 July	-6.58	-4.69	-0.32	4.10	-8.97	-2.57	3.48	-7.30	-1.47	4.57	-7.79	-1.73	4.53	-8.19	-1.67	5.28	-8.39	-1.55	4.86	
Variable		2024 June	7.81	-9.16	-1.61	6.06	-11.37	-1.90	7.59	-9.36	-1.73	5.97	-9.55	-1.50	6.23	-11.59	-1.94	7.78	-11.15	-2.30	6.91	-5
		2024 May	-11.18	-10.65	-2.84	4.15	-12.35	-1.85	8.22	-11.07	-1.62	7.62	-10.49	-1.16	8.33	-11.68	-1.32	10.00	-11.28	-1.67	8.24	-10
		2024 April	1.46	-12.05	-3.75	4.39	-10.10	-2.17	5.76	-8.55	-0.91	6.31	-8.30	-0.60	7.40	-9.94	-1.64	6.57	-10.26	-2.34	5.22	
6		2024 March	6.29	-6.87	-0.56		-9.77	-2.25		-9.74	-1.86		-9.70	-2.05		-11.16	-2.67		-10.35	-2.90	4.82	-15
11.2		2024 February	-5.16	-9.96	-4.95		-9.78	-2.20		-8.93	-1.64	5.82		-2.28		-9.02	-1.96		-10.22	-2.69	4.63	(Hide interval)
1A	Upper																					

	May	Aug	Nov		May	Aug	Nov	
2023				2024				

Fig. 1: Nebbo methodology represented at the left side. At the top right, the Hog Creek wind farm is displayed in an Ohio map (top) for both forecast & historical layers during the peak of its wind drought period (Oct 24). At the bottom right, the time series for the Nebbo multi-model forecast (ensemble mean) with lead month 1 and 70% coverage is shown for Feb 23 - Jan 25.

Introduction

Nebbo leverages **Al-enhanced seasonal forecasts** to **reliably** foresee **anomalous** episodes. In this poster, the **Hog Creek** park (40.79°, -83.730°; Dola, Ohio) is featured as a **use-case**. During **May – Nov 2024**, the site suffered from a **wind drought** which was **successfully foreseen months** in **advance**.

Methods

Our technology consists of 3 main steps:

- Forecast calibration through statistical downscaling using:
 - 3km mesoscale ERA5-simulated 30yrs time series as ground truth (Vortex SERIES)
 - 8 different state-of-the-art physical models from renowned weather centres (C3S hub)
- Multi-model definition
- Predictive interval construction
- Used to avoid reliability issues and obtain statistically valid results from the forecasted probability distribution

Results

Based on our methodology, we conclude that:

- Forecast bias is corrected but variance is still slightly large compared to reference (Fig. 4).
- The multi-model approach is generally more robust than individual models.
- Predictive intervals are effective:
 - They cover the ground truth approximately 70% of the time, as expected (Fig. 2).
 - They remain informative with reasonable width (Fig. 2).
 - They offer a better alternative to an imperfect forecast distribution.

Discussion

Our **methodology** successfully provides **reliable forecasts** across different **lead months**, particularly the first ones. The **multi-model** approach and **predictive intervals** enhance accuracy, ensuring **statistically valid** and **informative** results. Thus, **stakeholders** could **use** this **technology** to **anticipate** and **mitigate** the **impact** of **wind drought** periods, such as the observed in Hog Creek during May-Nov 2024.



Fig. 3: Overview tab of the Nebbo interface. It showcases the different predictions (with intervals) for different forecast months and lead months.

Forecast distributions

for 1, 2 and 3 months ahead

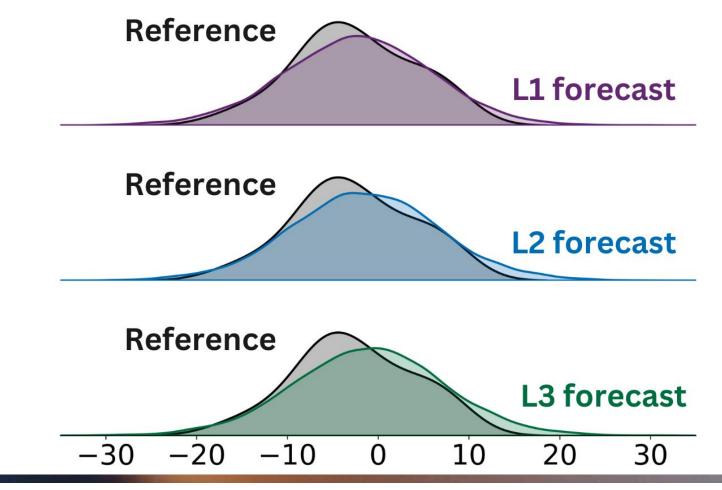


Fig. 4: Re-forecast distributions for Nebbo multi-model & Feb 2023 - Jan 2025 period. The ensemble forecast distributions of lead months 1 (L1), 2 (L2) & 3 (L3) is compared with Vortex SERIES ground-truth (Reference).

Contact Info: gerard.castro@nebbo-weather.com



