SEASONAL

VORTEX

Seasonal Wind Speed Anomaly Forecasts

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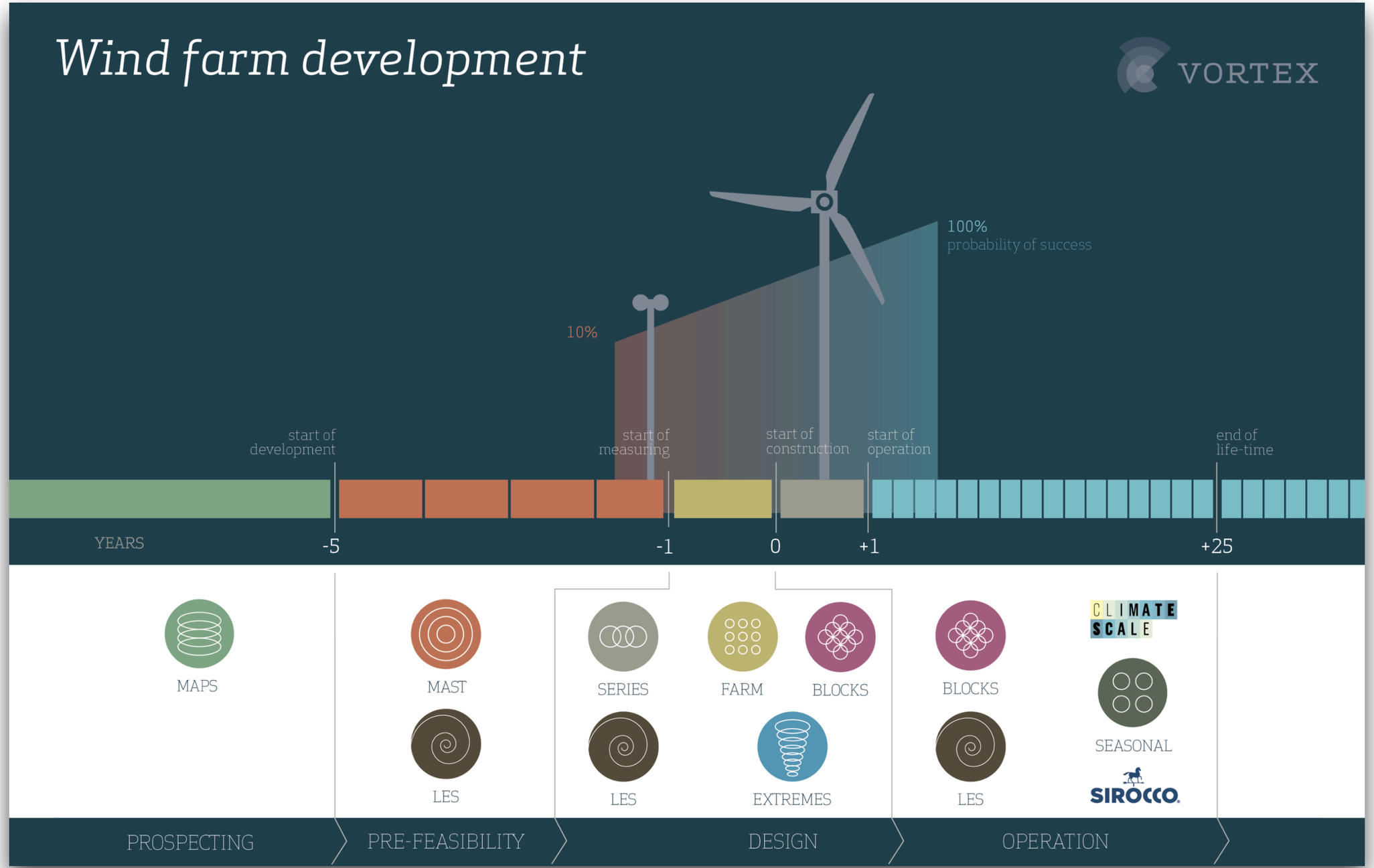

Wind farm development
VORTEX
100%
probability of success
10%
start of development
start of measuring
start of construction
start of operation
end of life-time
YEARS
-5
-1
0
+1
+25
MAPS
MAST
LES
SERIES
FARM
BLOCKS
LES
EXTREMES
BLOCKS
LES
CLIMATE SCALE
SEASONAL
SIROCCO
PROSPECTING
PRE-FEASIBILITY
DESIGN
OPERATION

Methodology

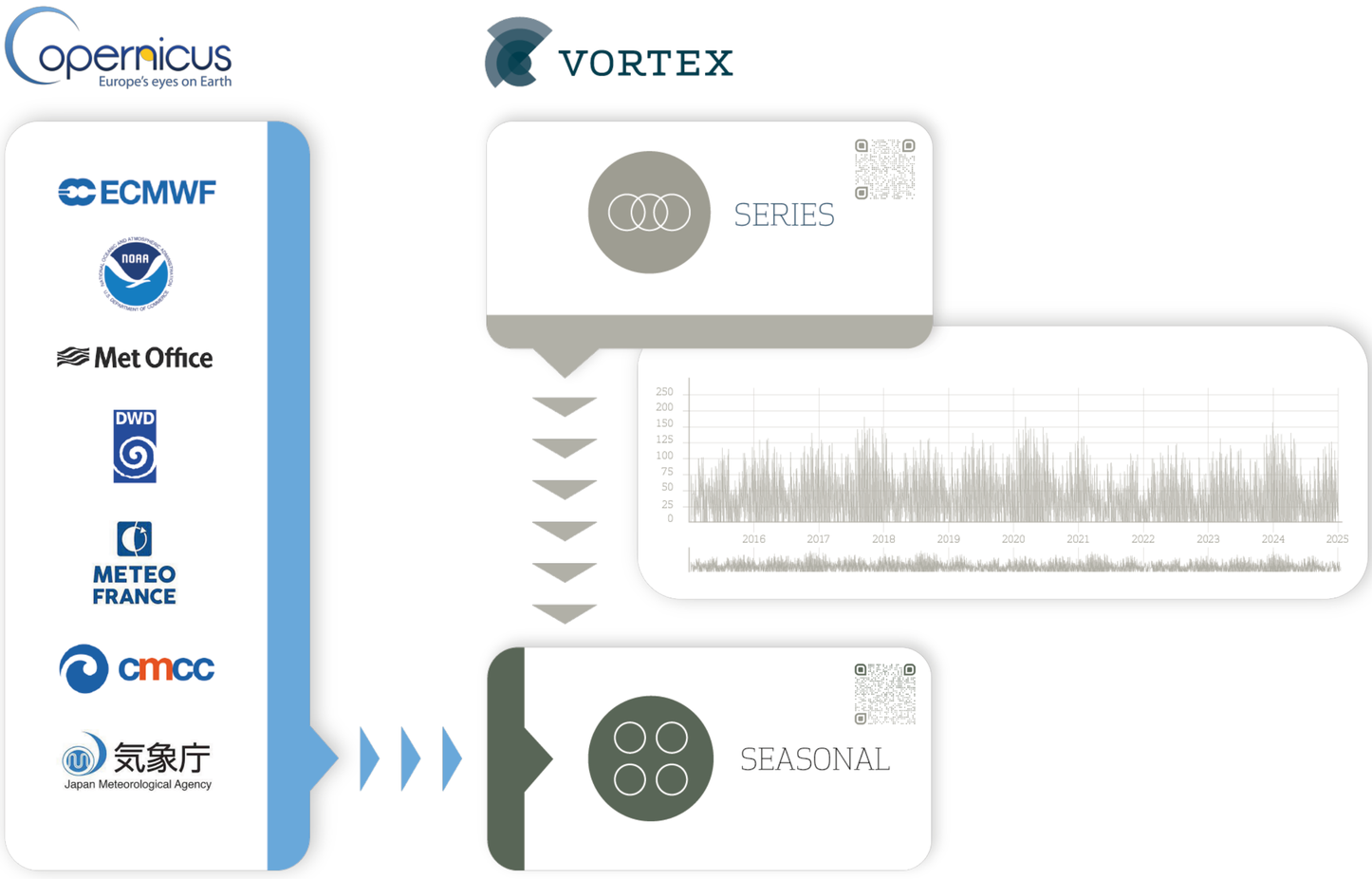


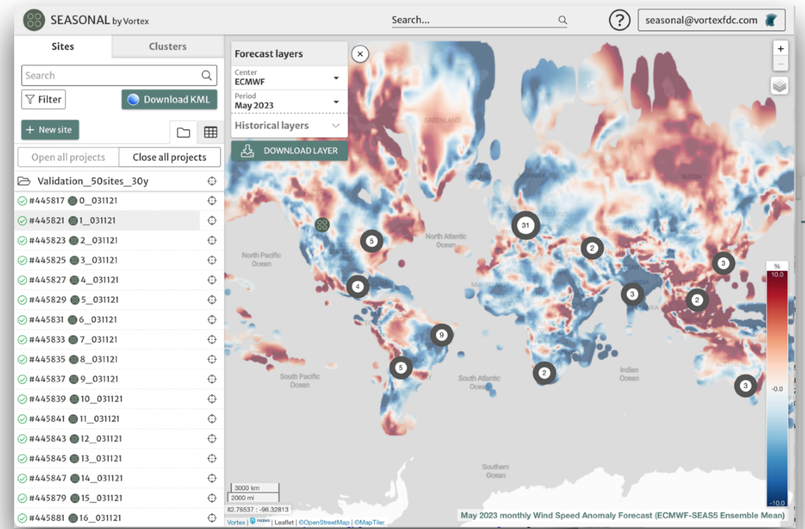
Figure 1. Illustration of Vortex SEASONAL [1] prediction methodology

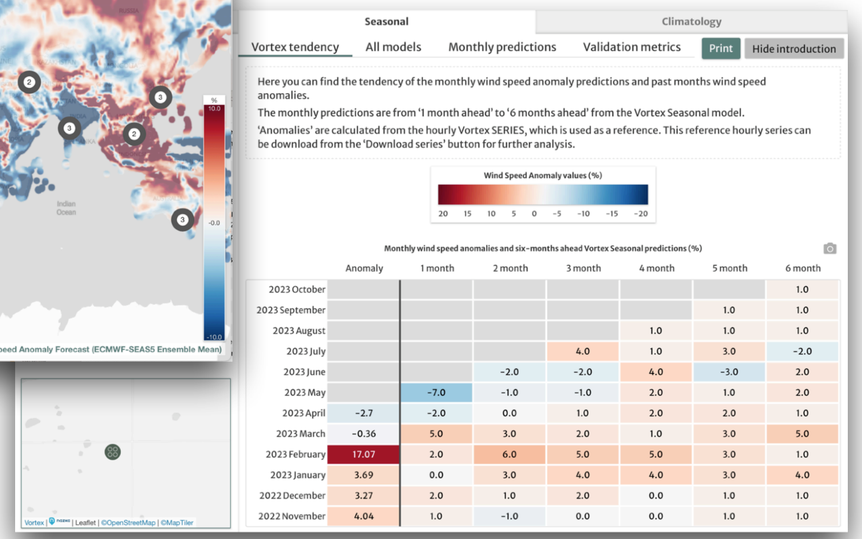
1. A **Vortex SERIES** is launched to obtain the monthly wind speed averages as climatic reference.
2. **Anomalies** are calculated for each month over a reference period for different **seasonal models** from **Copernicus**.
3. The models are **compared** for each site and lead month, and then **ranked** based on the reference anomalies.
4. To further enhance the forecast skill, **machine learning** techniques are employed, and the improvement over climatology and trending are maximised to **select the best performing seasonal model**.

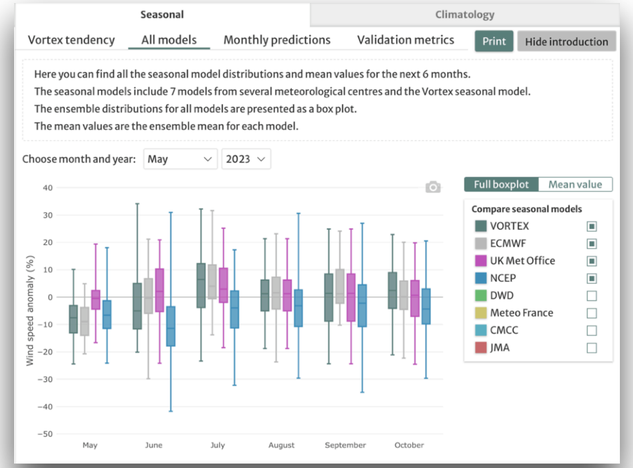
SEASONAL

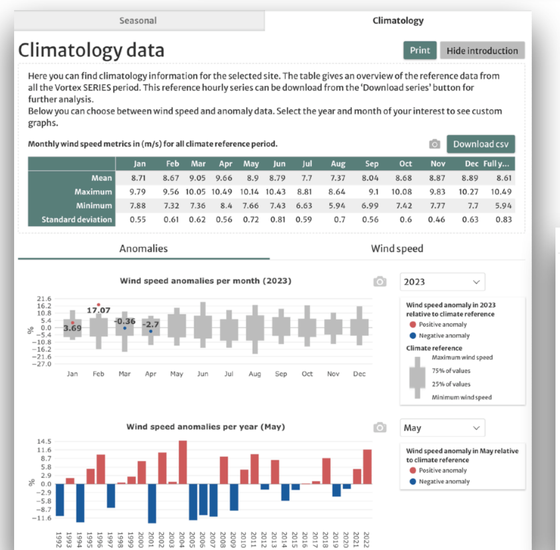
VORTEX

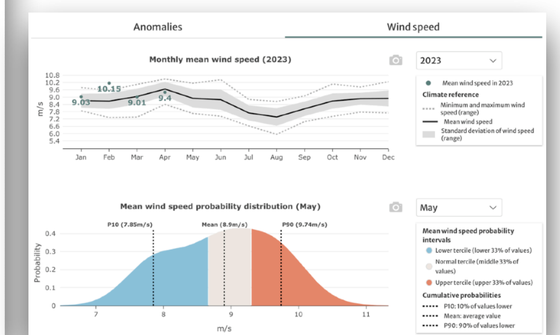
Interface

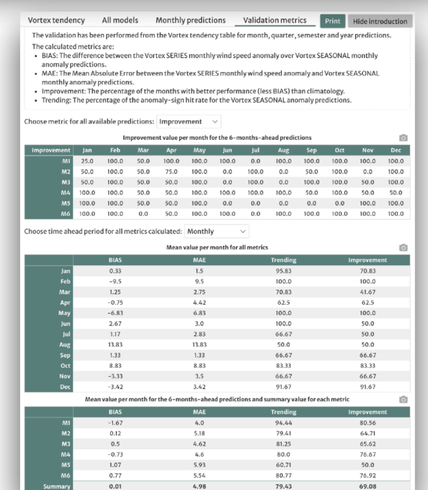


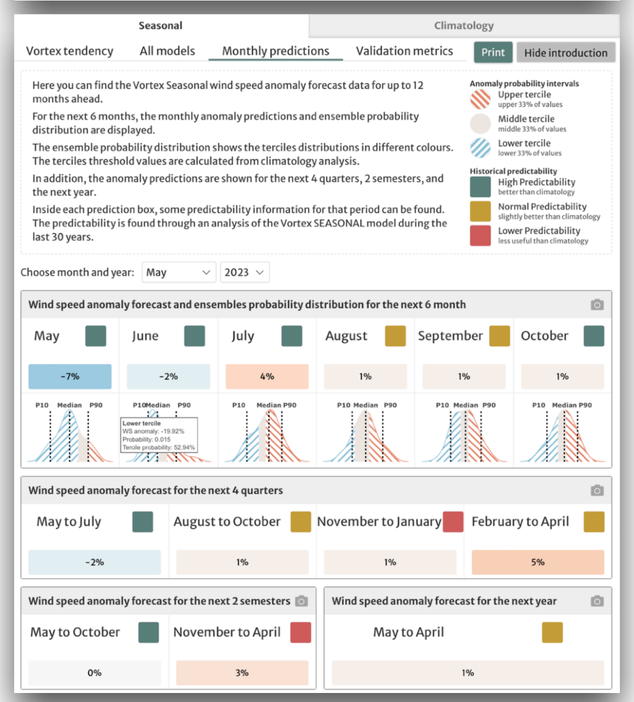












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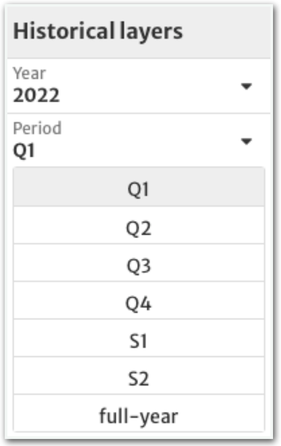
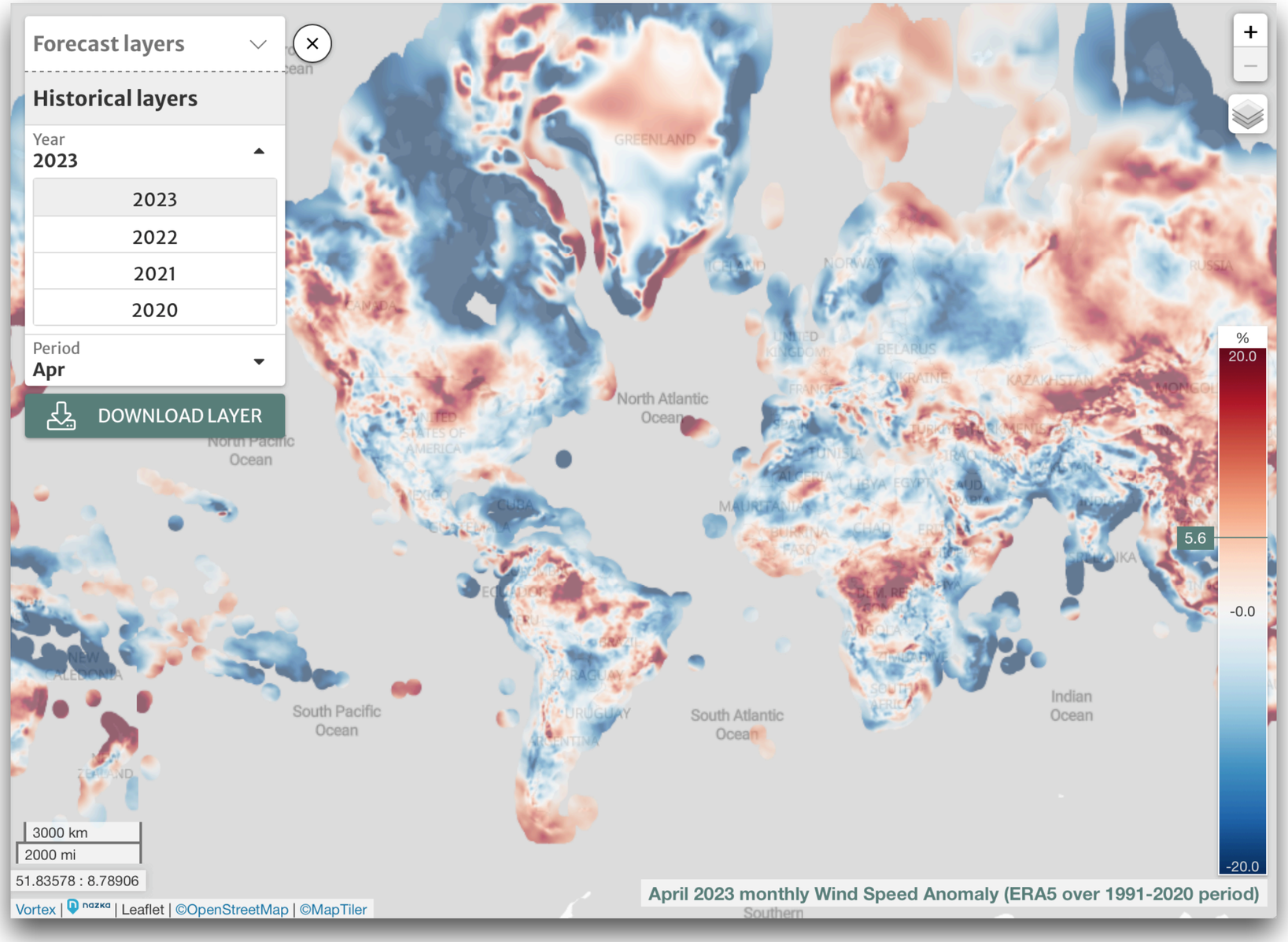
Global Wind Speed Anomaly **Historical** Layers





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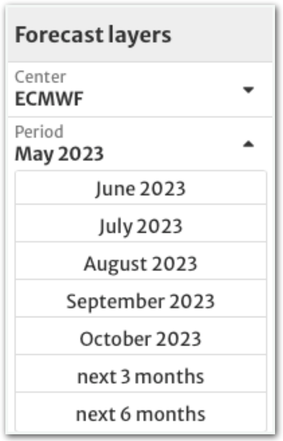
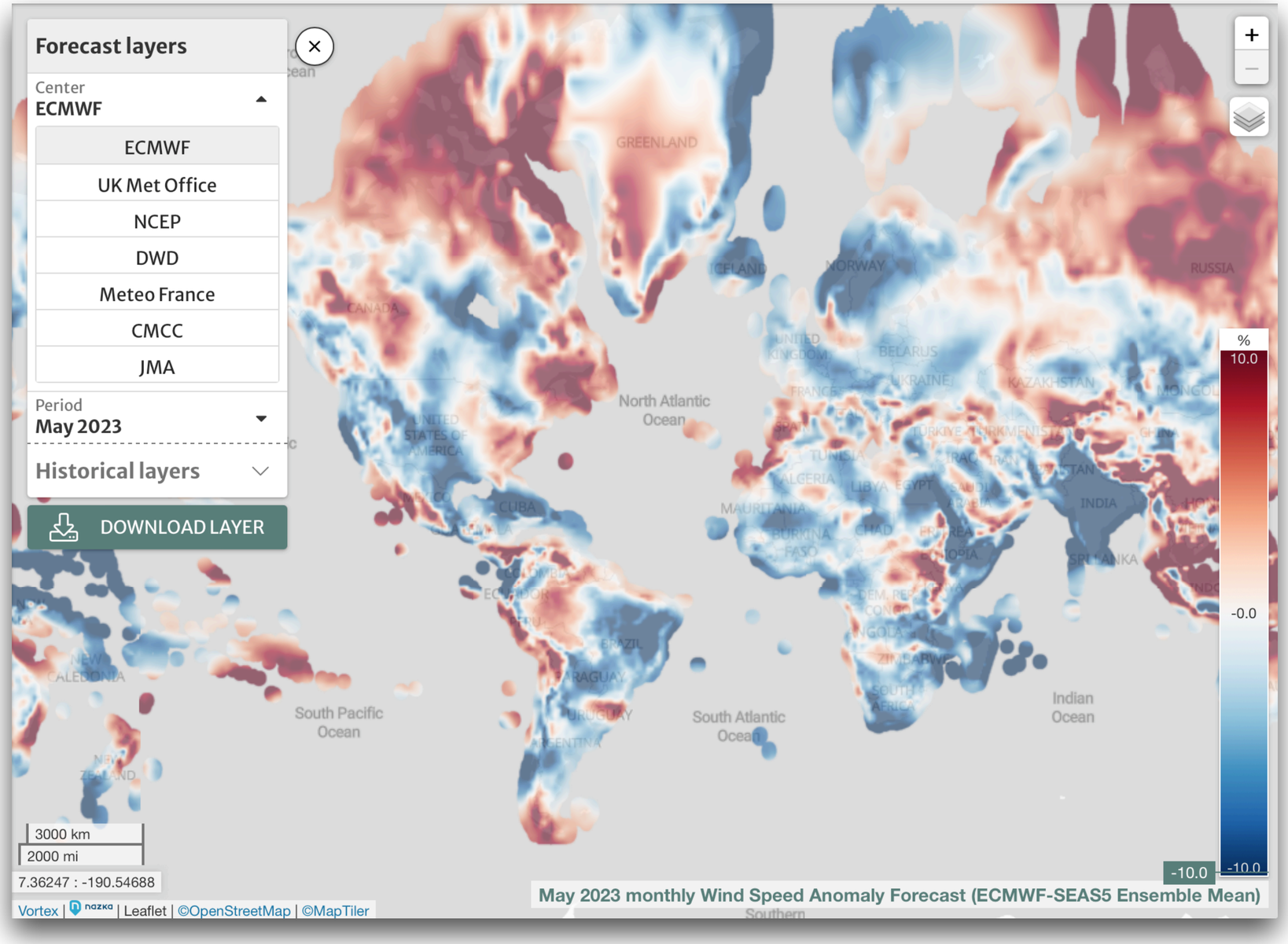
Global Wind Speed Anomaly **Forecast** Layers





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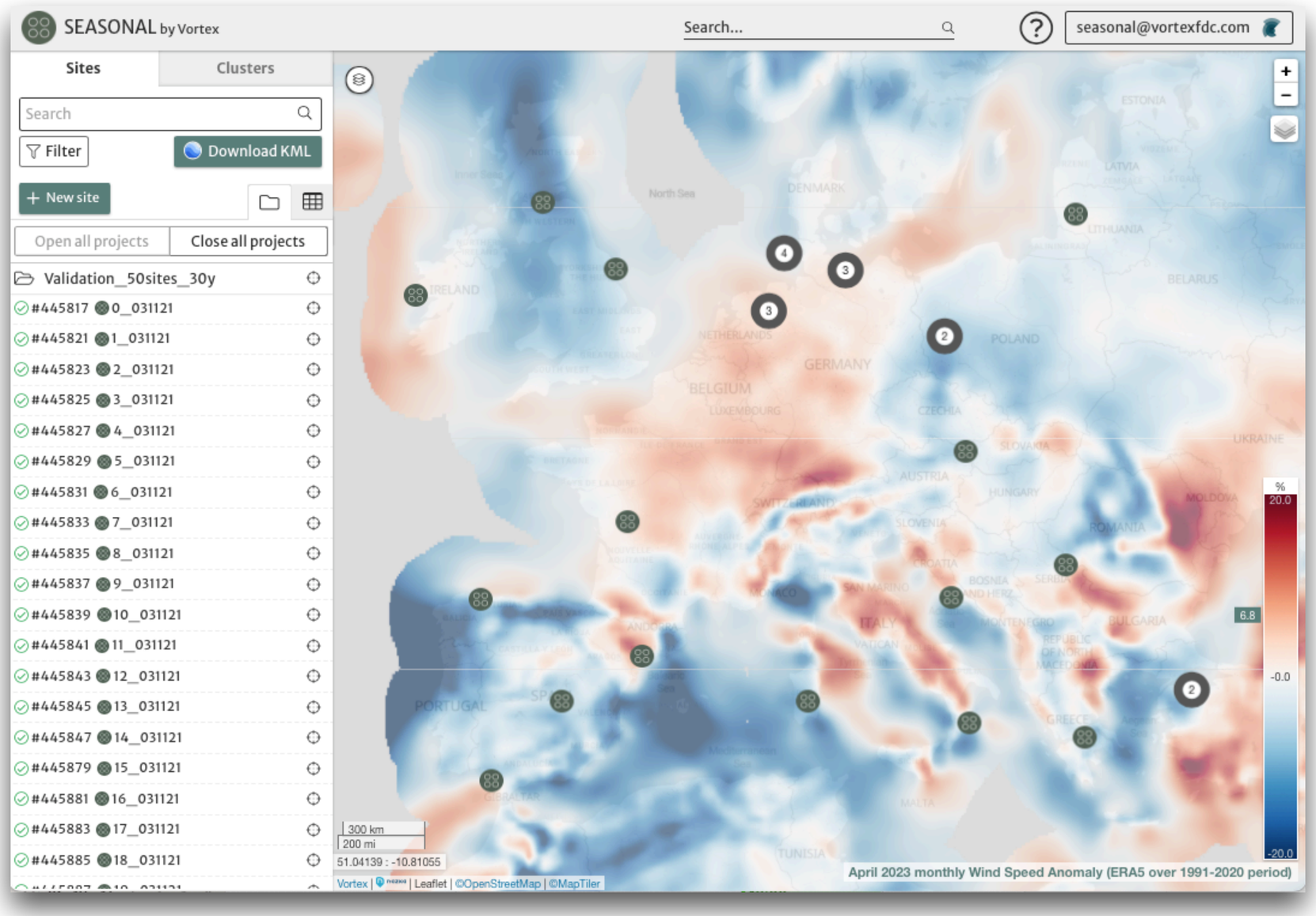
Site-specific Forecasts



Climatology

Seasonal | **Climatology**

Climatology data

Print | Hide introduction

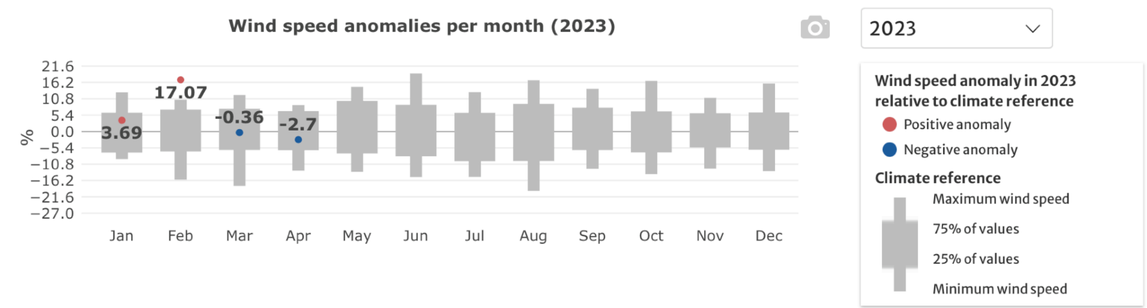
Here you can find climatology information for the selected site. The table gives an overview of the reference data from all the Vortex SERIES period. This reference hourly series can be download from the 'Download series' button for further analysis.
Below you can choose between wind speed and anomaly data. Select the year and month of your interest to see custom graphs.

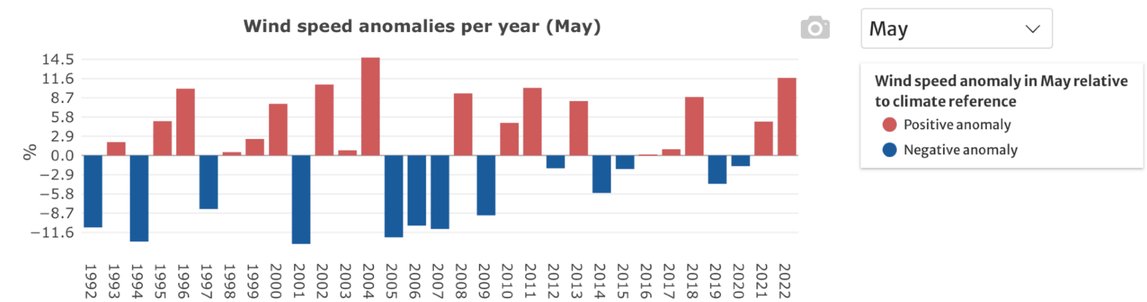
Monthly wind speed metrics in (m/s) for all climate reference period.

Download csv

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Full y...
Mean	8.71	8.67	9.05	9.66	8.9	8.79	7.7	7.37	8.04	8.68	8.87	8.89	8.61
Maximum	9.79	9.56	10.05	10.49	10.14	10.43	8.81	8.64	9.1	10.08	9.83	10.27	10.49
Minimum	7.88	7.32	7.36	8.4	7.66	7.43	6.63	5.94	6.99	7.42	7.77	7.7	5.94
Standard deviation	0.55	0.61	0.62	0.56	0.72	0.81	0.59	0.7	0.56	0.6	0.46	0.63	0.83

Anomalies | Wind speed





Climatology

Seasonal | **Climatology**

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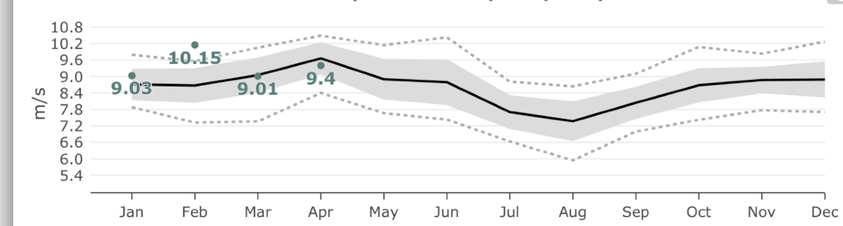
Minimum	7.88	7.32	7.36	8.4	7.66	7.43	6.63	5.94	6.99	7.42	7.77	7.7	5.94
Standard deviation	0.55	0.61	0.62	0.56	0.72	0.81	0.59	0.7	0.56	0.6	0.46	0.63	0.83

Anomalies | **Wind speed**

Monthly mean wind speed (2023)

2023



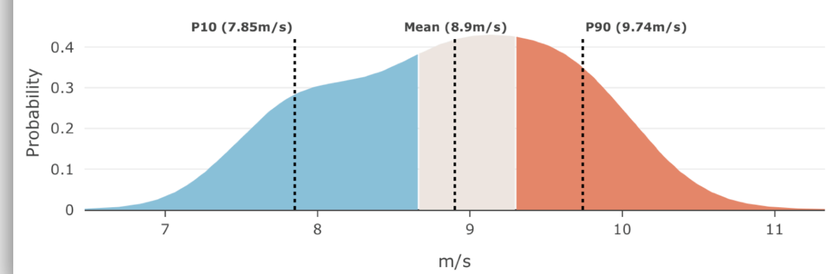
- Mean wind speed in 2023

Climate reference

- Minimum and maximum wind speed (range)
- Mean wind speed
- Standard deviation of wind speed (range)

Mean wind speed probability distribution (May)

May



Mean wind speed probability intervals

- Lower tercile (lower 33% of values)
- Normal tercile (middle 33% of values)
- Upper tercile (upper 33% of values)

Cumulative probabilities

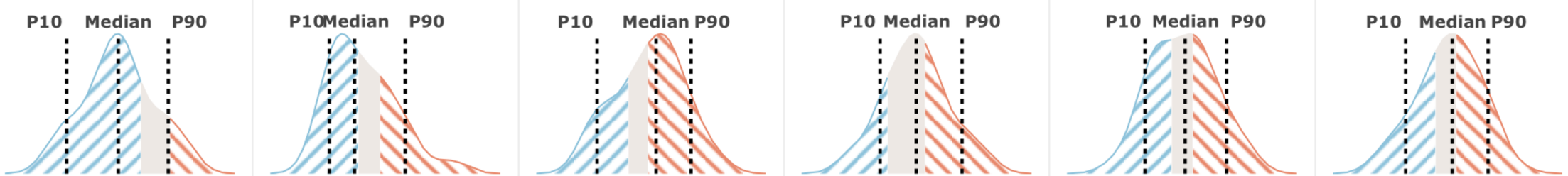
- P10: 10% of values lower
- Mean: average value
- P90: 90% of values lower

Next 6 months: Monthly Predictions

Seasonal	Climatology

Wind speed anomaly forecast and ensembles probability distribution for the next 6 month

May	June	July	August	September	October
-7%	-2%	4%	1%	1%	1%



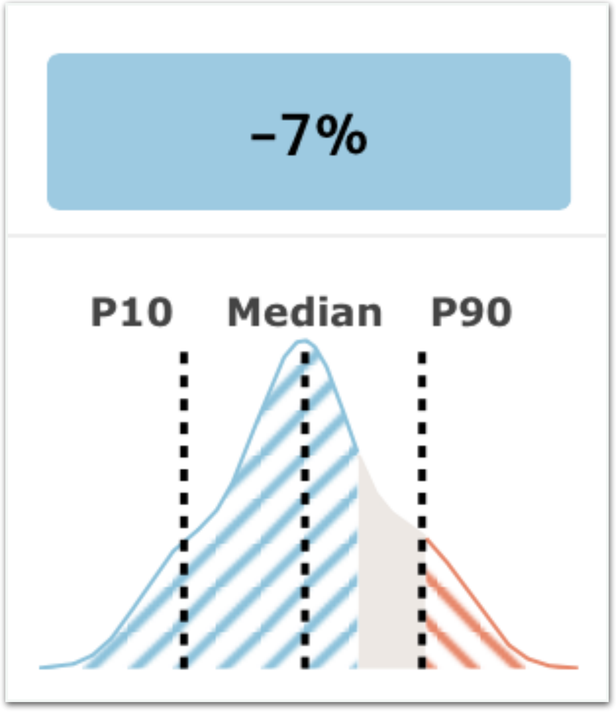
Historical predictability

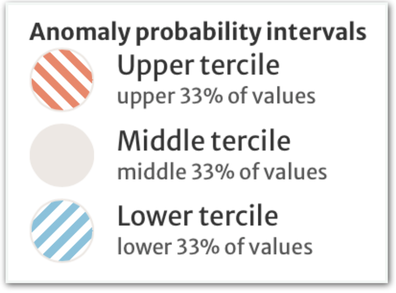
- High Predictability — better than climatology
- Normal Predictability — slightly better than climatology
- Lower Predictability — less useful than climatology

Wind Speed Anomaly values (%)

20 15 10 5 0 -5 -10 -15 -20

Ensemble distribution and Tercile Probability

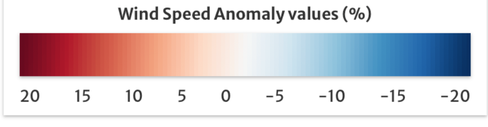




Lower tercile
WS anomaly: -22.83%
Probability: 0.014
Tercile probability: 76.47%

Middle tercile
WS anomaly: 2.93%
Probability: 0.021
Tercile probability: 15.69%

Upper tercile
WS anomaly: 9.09%
Probability: 0.012
Tercile probability: 7.84%



Next 12 months: Quarter, bi-annual and annual predictions

Seasonal	Climatology

Wind speed anomaly forecast for the next 4 quarters

May to July	August to October	November to January	February to April
-2%	1%	1%	5%

Wind speed anomaly forecast for the next 2 semesters

May to October	November to April
0%	3%

Wind speed anomaly forecast for the next year

May to April
1%

Historical predictability

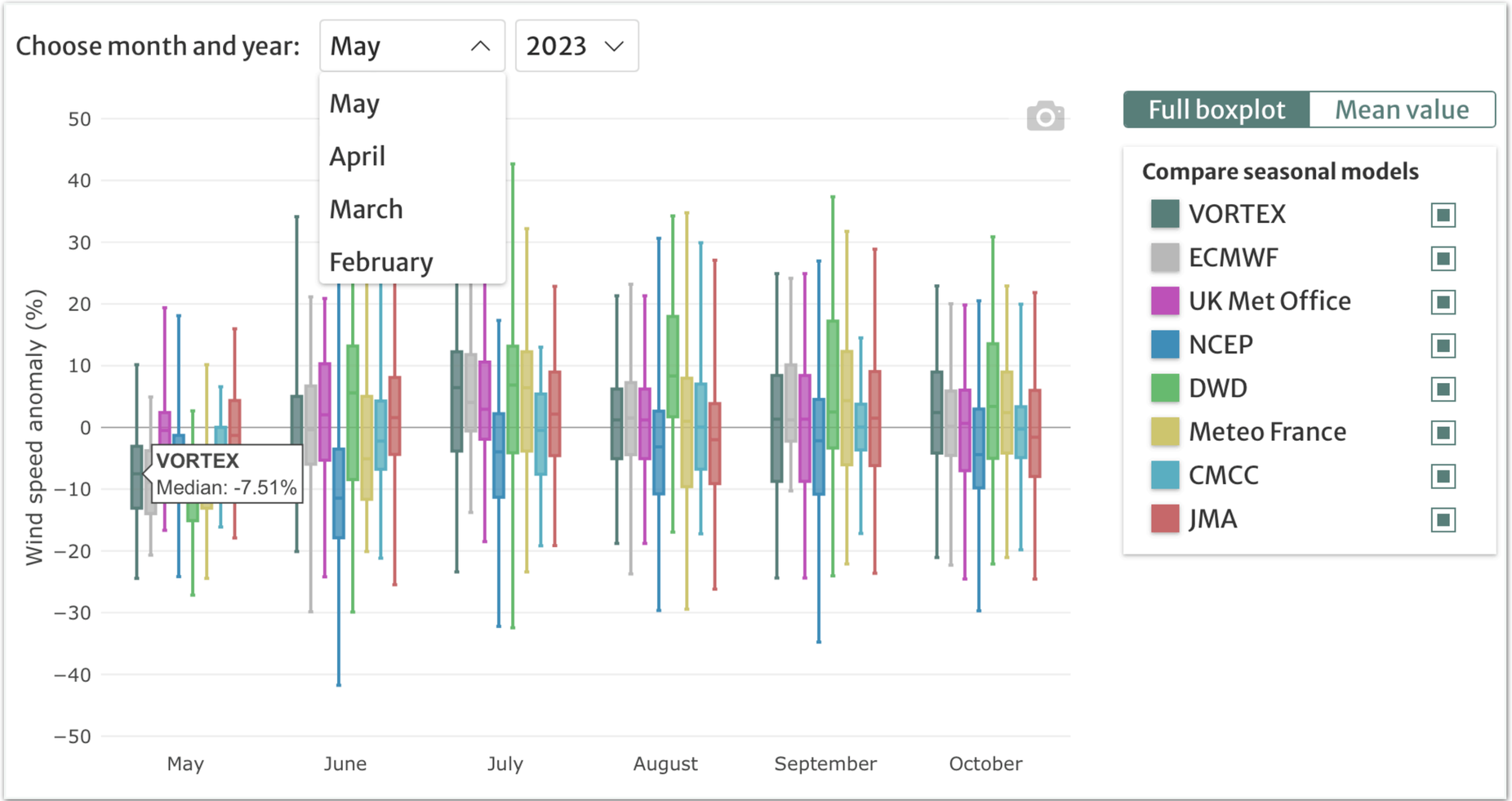
- High Predictability — better than climatology
- Normal Predictability — slightly better than climatology
- Lower Predictability — less useful than climatology

Wind Speed Anomaly values (%)

20 15 10 5 0 -5 -10 -15 -20

All Models

Seasonal | Climatology



Vortex Tendency

Seasonal | Climatology

Monthly wind speed anomalies and six-months ahead Vortex Seasonal predictions (%)

	Anomaly	1 month	2 month	3 month	4 month	5 month	6 month
2023 October							1.0
2023 September						1.0	1.0
2023 August					1.0	1.0	1.0
2023 July				4.0	1.0	3.0	-2.0
2023 June			-2.0	-2.0	4.0	-3.0	2.0
2023 May		-7.0	-1.0	-1.0	2.0	1.0	2.0
2023 April	-2.7	-2.0	0.0	1.0	2.0	2.0	1.0
2023 March	-0.36	5.0	3.0	2.0	1.0	3.0	5.0
2023 February	17.07	2.0	6.0	5.0	5.0	3.0	1.0
2023 January	3.69	0.0	3.0	4.0	4.0	3.0	4.0
2022 December	3.27	2.0	1.0	2.0	0.0	1.0	1.0
2022 November	4.04	1.0	-1.0	0.0	0.0	1.0	1.0
2022 October	-11.4	-10.0	-1.0	-1.0	-1.0	1.0	-1.0
2022 September	-2.25	-2.0	0.0	-1.0	0.0	1.0	-2.0
2022 August	-14.58	-7.0	3.0	1.0	-5.0	2.0	-1.0
2022 July	-2.27	-6.0	-1.0	-1.0	-3.0	2.0	4.0
2022 June	2.89	2.0	8.0	7.0	4.0	8.0	5.0
2022 May	11.72	6.0	5.0	4.0	4.0	5.0	7.0
2022 April	8.74	6.0	5.0	4.0	1.0	3.0	4.0
2022 March	5.37	3.0	3.0	3.0	3.0	4.0	
2022 February	5.06	4.0	5.0	4.0	3.0		
2022 January	2.39	7.0	5.0	5.0			
2021 December	13.26	2.0	2.0				
2021 November	-3.6	-3.0					

Wind Speed Anomaly values (%)

20 15 10 5 0 -5 -10 -15 -20

Validation Metrics

The calculated metrics are:

- **BIAS**: The difference between the Vortex SERIES monthly wind speed anomaly over Vortex SEASONAL monthly anomaly predictions.
- **MAE**: The Mean Absolute Error between the Vortex SERIES monthly wind speed anomaly and Vortex SEASONAL monthly anomaly predictions.
- **Improvement**: The percentage of the months with better performance (less BIAS) than climatology.
- **Trending**: The percentage of the anomaly-sign hit rate for the Vortex SEASONAL anomaly predictions.

Mean value per month for the 6-months-ahead predictions and summary value for each metric

	BIAS	MAE	Trending	Improvement
M1	-1.67	4.0	94.44	80.56
M2	0.12	5.18	79.41	64.71
M3	0.5	4.62	81.25	65.62
M4	-0.73	4.6	80.0	76.67
M5	1.07	5.93	60.71	50.0
M6	0.77	5.54	80.77	76.92
Summary	**0.01**	**4.98**	**79.43**	**69.08**

Validation Metrics

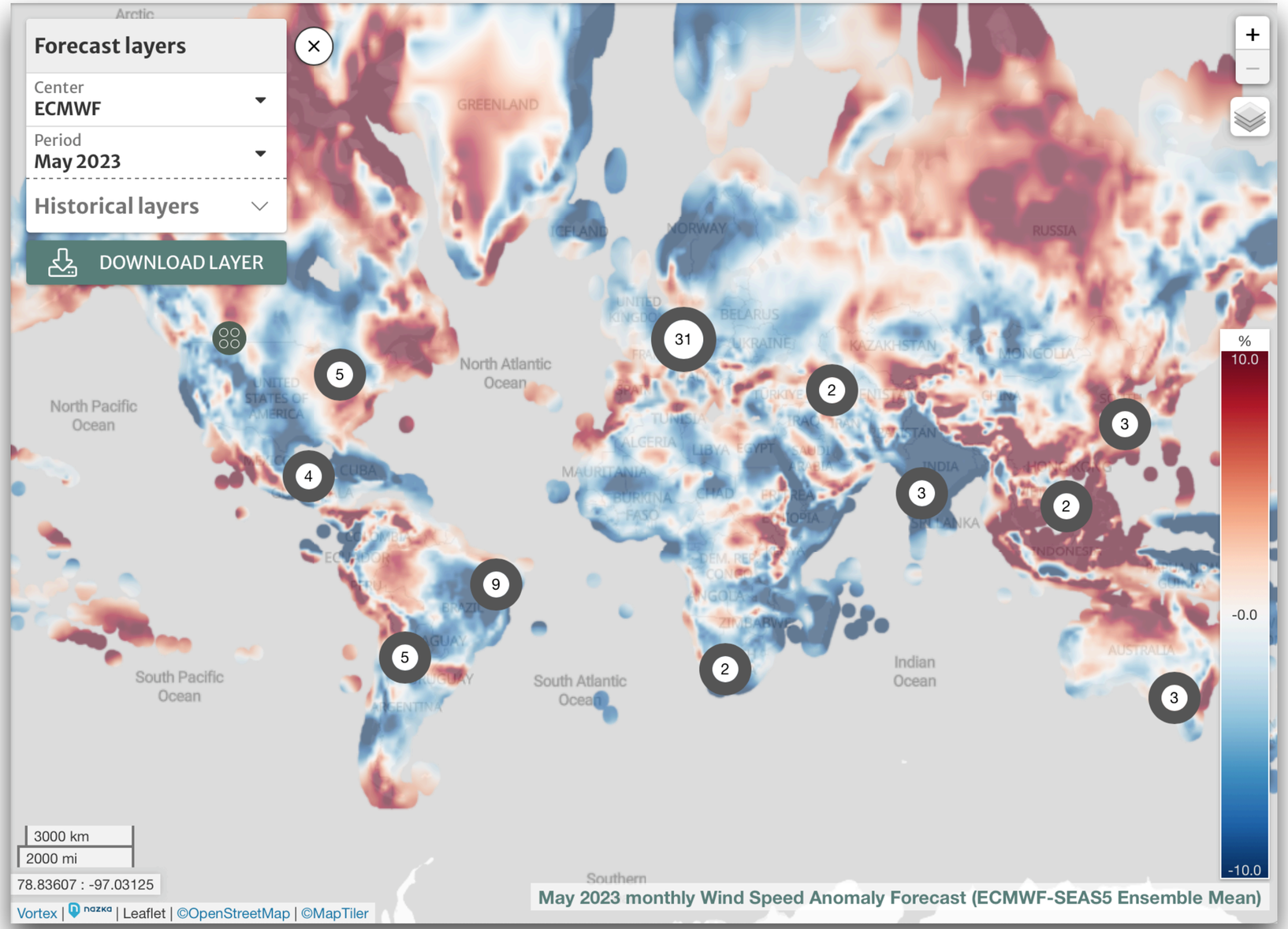
Mean value per quarters-ahead predictions and summary value for each metric

	BIAS	MAE	Trending	Improvement
Q1	-0.69	3.19	93.75	87.5
Q2	0.0	3.85	80.77	80.77
Q3	-0.5	4.5	60.0	60.0
Q4	-0.29	4.57	57.14	57.14
Summary	**-0.37**	**4.03**	**72.92**	**71.35**

Mean value per semester-ahead predictions and summary value for each metric

	BIAS	MAE	Trending	Improvement
S1	0.08	2.69	69.23	65.38
S2	0.43	2.14	92.86	92.86
Summary	**0.25**	**2.42**	**81.04**	**79.12**

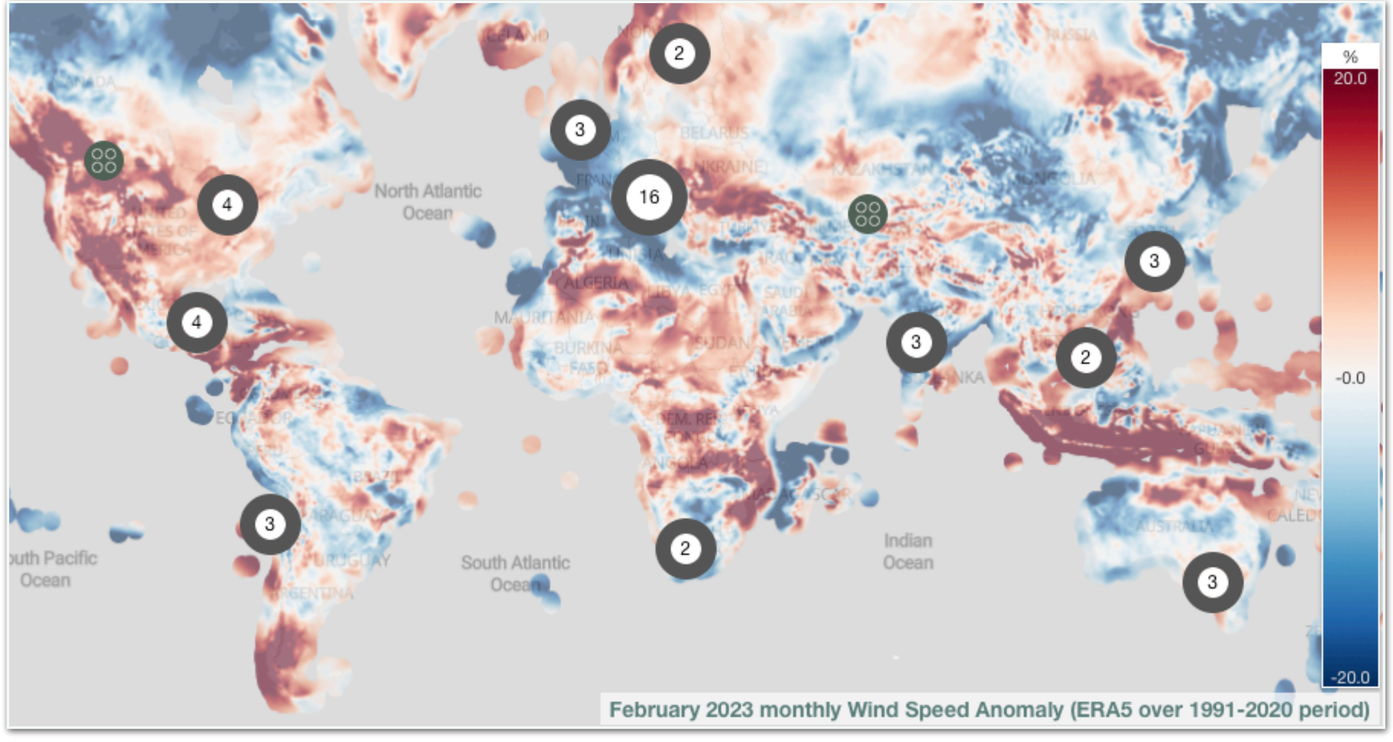
Global Validation



Global Validation

Table 1. **GLOBAL** Validation metrics for 6-month ahead prediction (**50** sites)

BIAS	MAE	Improvement over climatology (%)	Trending (%)
-0.02	8.56	57.88	60.53



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VORTEX

Thank You !

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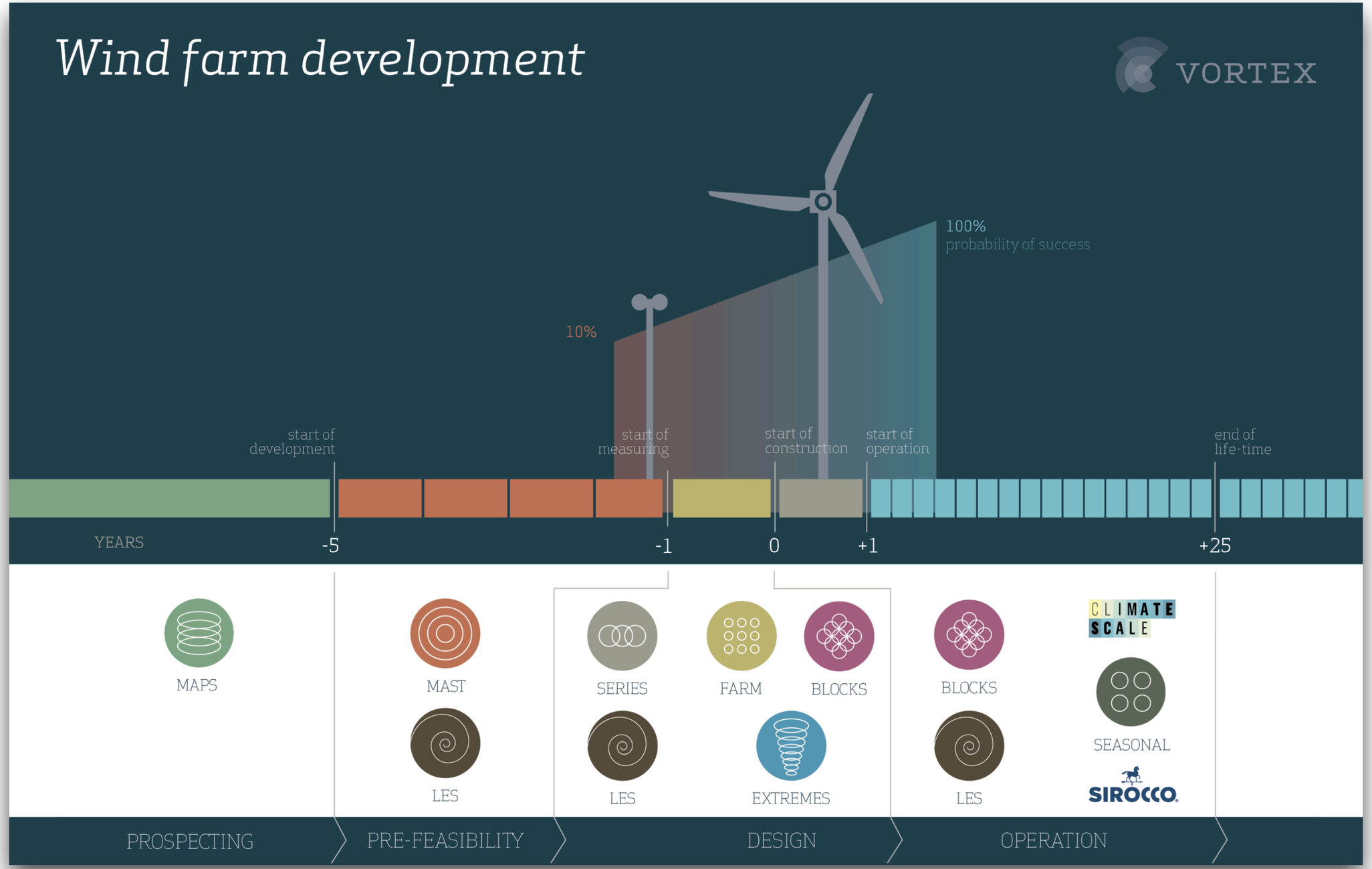
Wind farm development
VORTEX
100%
probability of success
10%
start of development
start of measuring
start of construction
start of operation
end of life-time
YEARS
-5
-1
0
+1
+25
MAPS
MAST
LES
SERIES
FARM
BLOCKS
LES
EXTREMES
BLOCKS
LES
CLIMATE SCALE
SEASONAL
SIROCCO
PROSPECTING
PRE-FEASIBILITY
DESIGN
OPERATION