Vortex Webinar: High-Resolution Wind Data and how we capture extreme events

Date: 2 December 2025

Agenda Overview

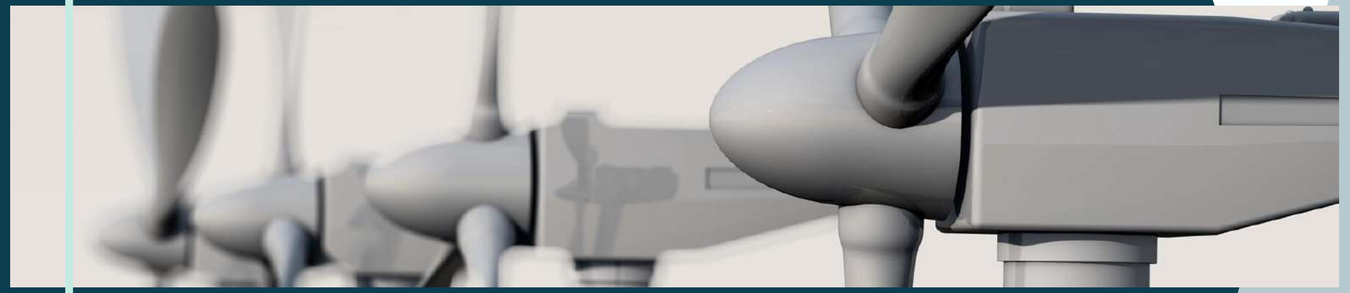
- Introduction to Vortex
- Introduction to Vortex **TIMES,** a high-resolution wind modelled data
- Validation and Remodeling for Vortex **TIMES**
- Case Study: how Vortex **TIMES** performed against real typhoon events in the Philippines
- Q&A Session

EXPERIENCED

More than 20 years modelling the wind.

FOCUSED

We are not a consultancy firm.



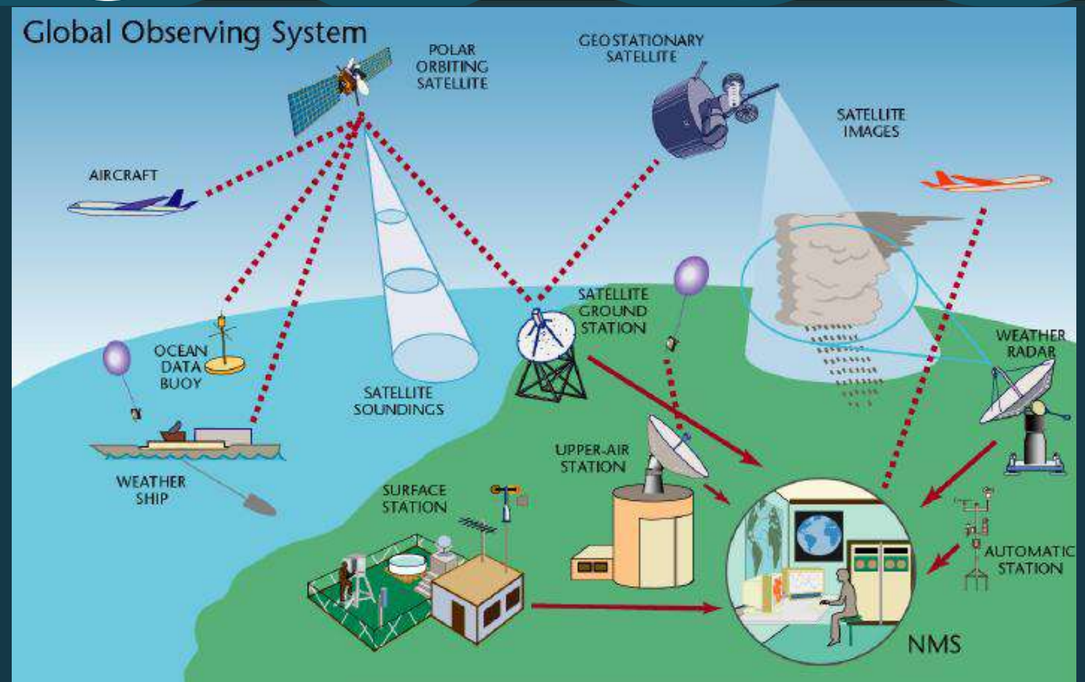
ON-DEMAND

Wind data is calculated on-demand.

VORTEX

Wind Modelling: WRF & Reanalysis

Reanalysis	Temporal Resolution	Spatial Resolution	Vertical Levels
ECMWF	1H	27km	37
MERRA-2	6H	50km	42
CFSR	6H	37km	37



DOWNSCALING

MACROSCALE:

Raw reanalysis data
ERA5, MERRA2, CFSR

Terrain

Roughness

WRF ← Weather Research and Forecasting Model developed by National Center for Atmospheric Research (NCAR)

MESOSCALE:

MAPS SERIES

3 & 1 km resolution

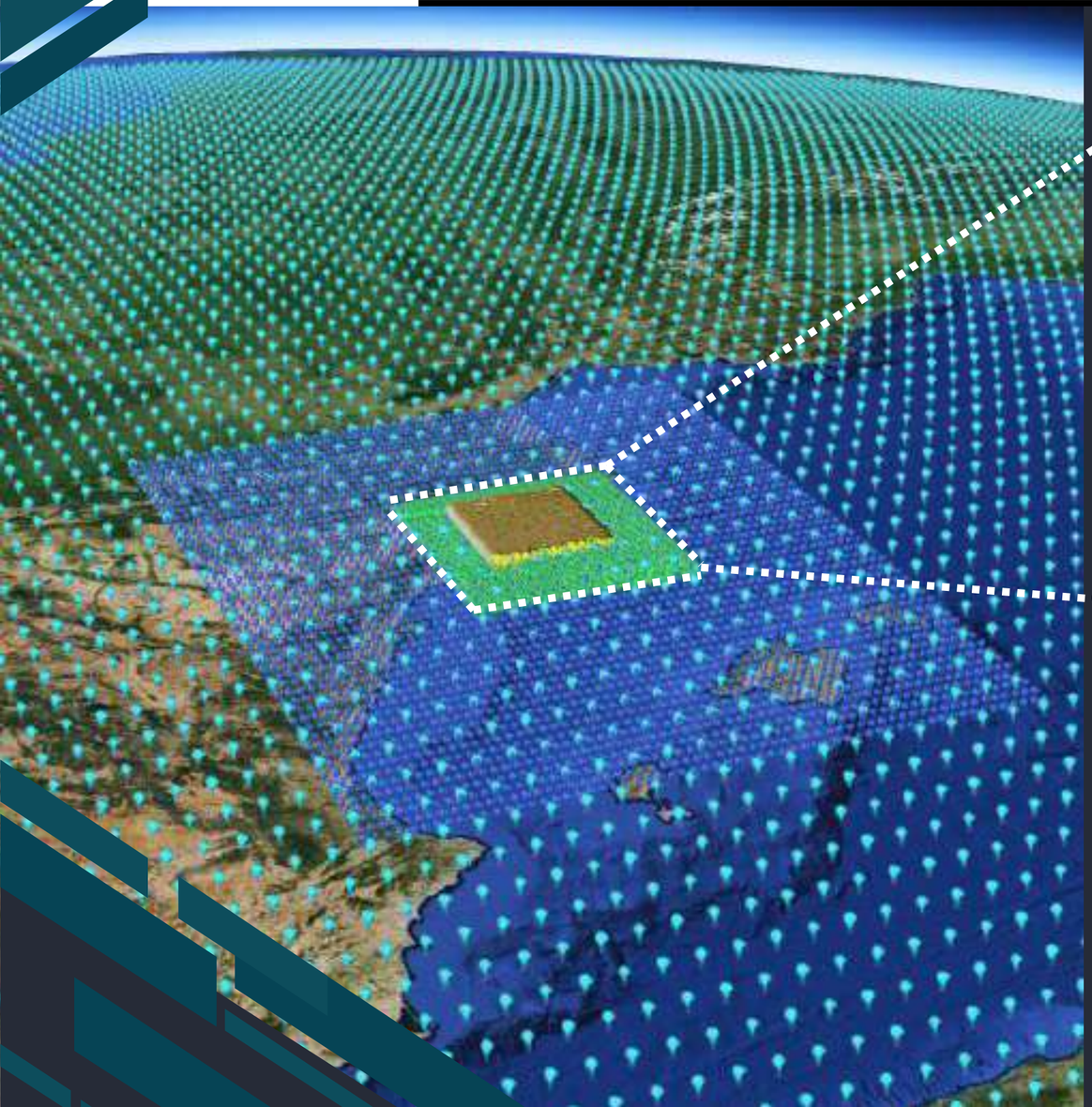
WRF

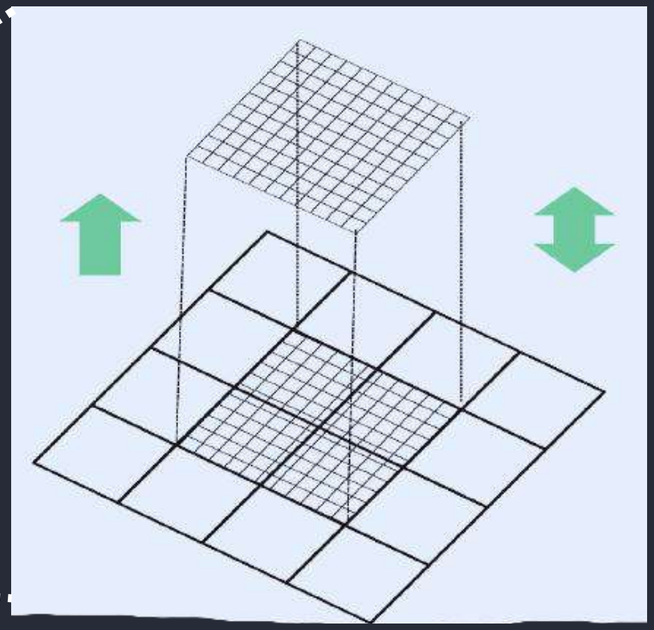
MICROSCALE:

300 & 100 m resolution

MAST FARM LES BLOCKS TIMES

Wind Modelling: Nesting Approach

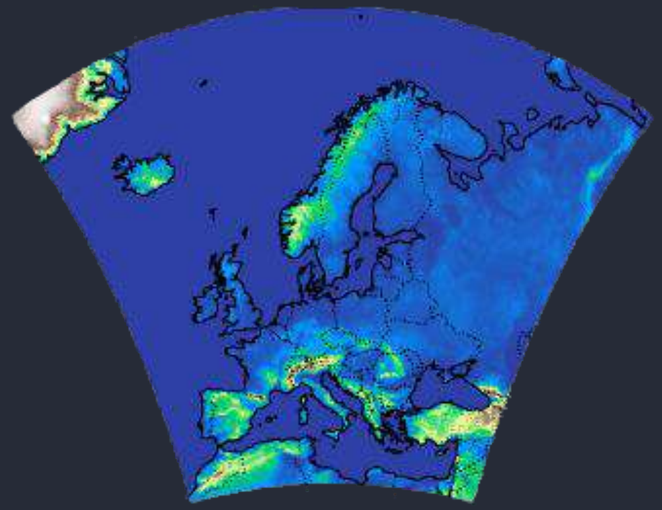




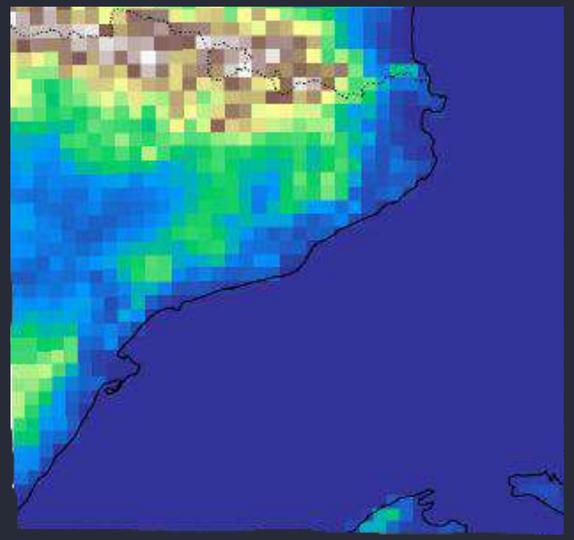
- WRF Modelling apply 3:1 nesting ratio
- One-way Information Flows from the parent down to nested domain
- Two-way Data is exchanged between the two domains

Wind Modelling: Resolution

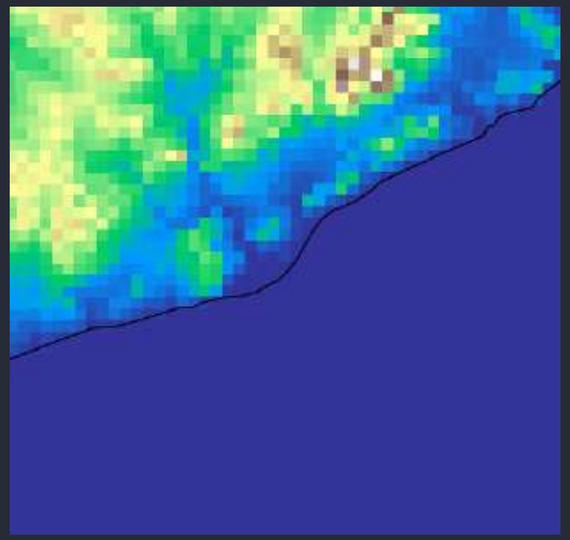
27 km

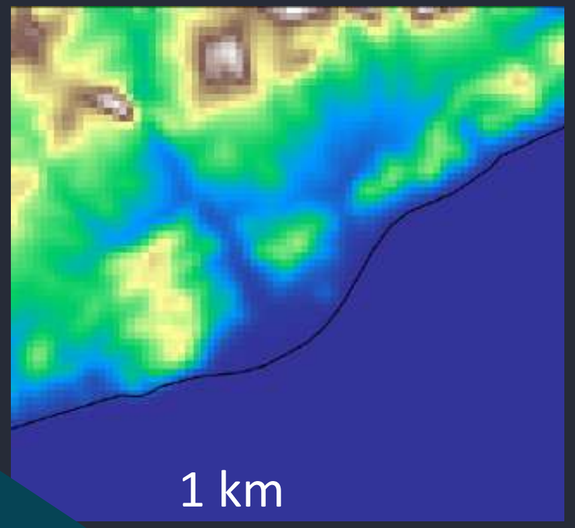


9 km

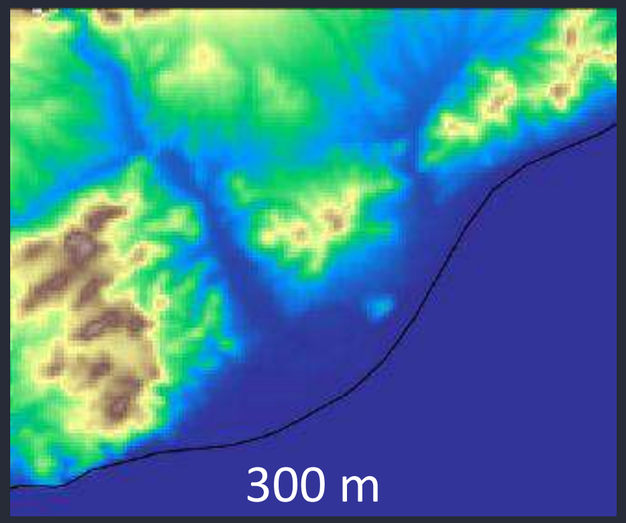


3 km

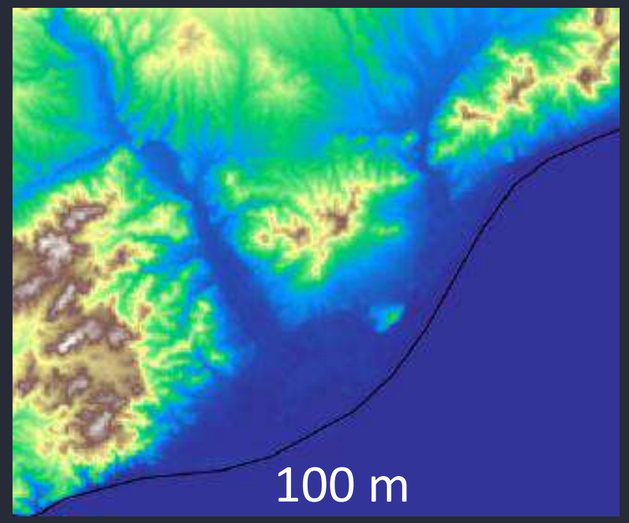




1 km



300 m

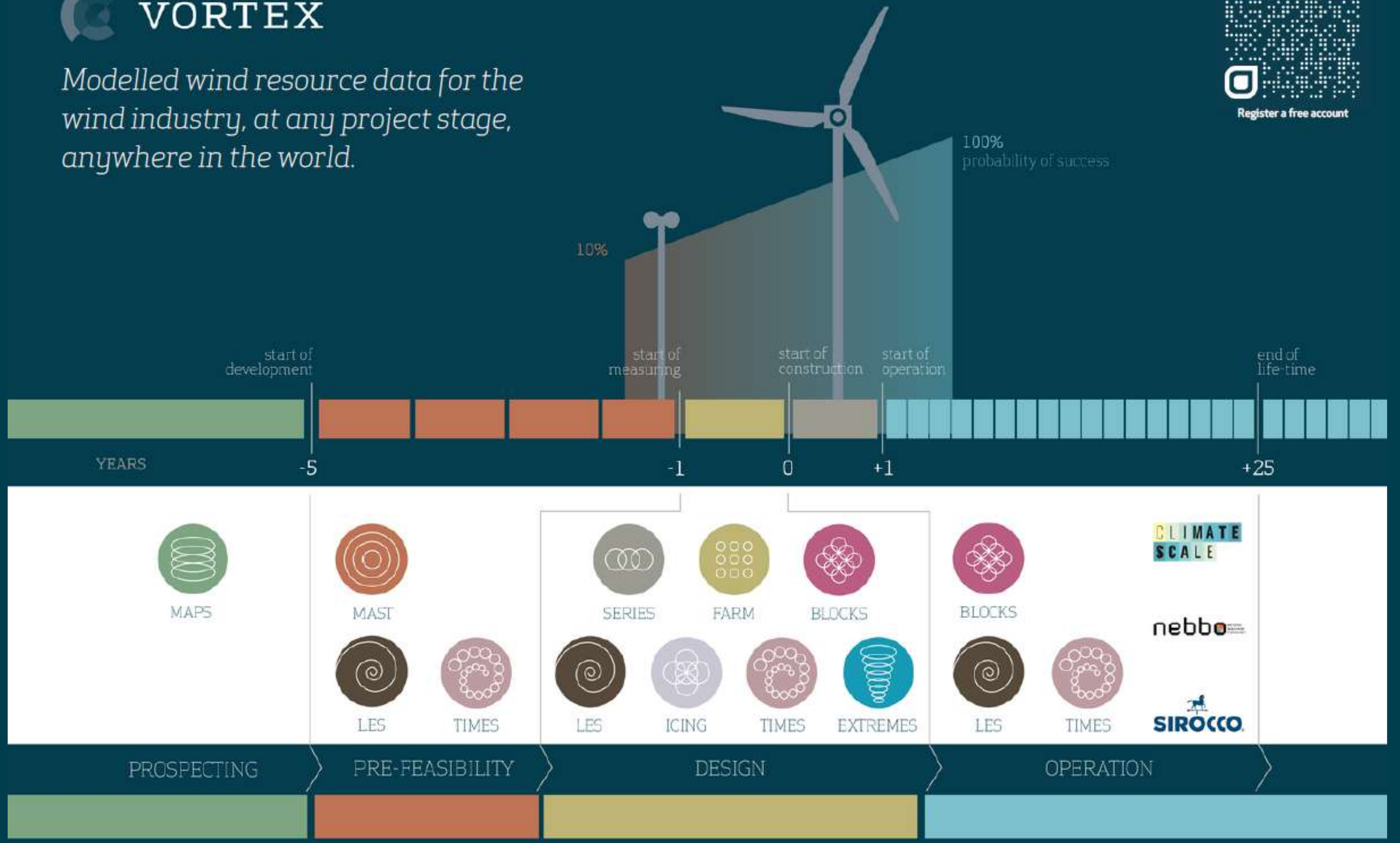


100 m

VORTEX

Modelled wind resource data for the wind industry, at any project stage, anywhere in the world.

Register a free account



VORTEX

Past

–40 YEARS

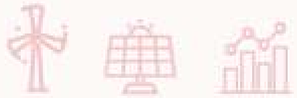
Trusted partner in historical wind data for wind resource assessment, providing insights spanning the past 40 years up to the present.

SIROCCO

Short-term

+14 DAYS

Delivering the most accurate short-term power production forecasts for wind and solar farms, globally.



nebbo BEYOND WEATHER FORECAST

Seasonal

+6 MONTHS

Seasonal monthly weather forecasts to strategise in advance for O&M, wind asset performance and energy trading.

CLIMATE SCALE

Projections

100 YEARS

Historical data and climate projections for risk assessment, resilience, and sustainability compliance.

Modelling an Area and Single Point Data

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FOR AN AREA?

REGION
Prospecting phase
MAPS

WIND FARM WIND DISTRIBUTION
Design phase
FARM

WIND FARM GRIDDED TIME SERIES
Design phase
BLOCKS

WIND FARM ICING PROBABILITY
Design phase
ICING

FOR A POINT?

WIND DISTRIBUTION
Pre-feasibility phase
MAST

MULTIYEAR TIME SERIES HOURLY
Design phase
SERIES

EXTREME EVENTS
Design phase
EXTREMES

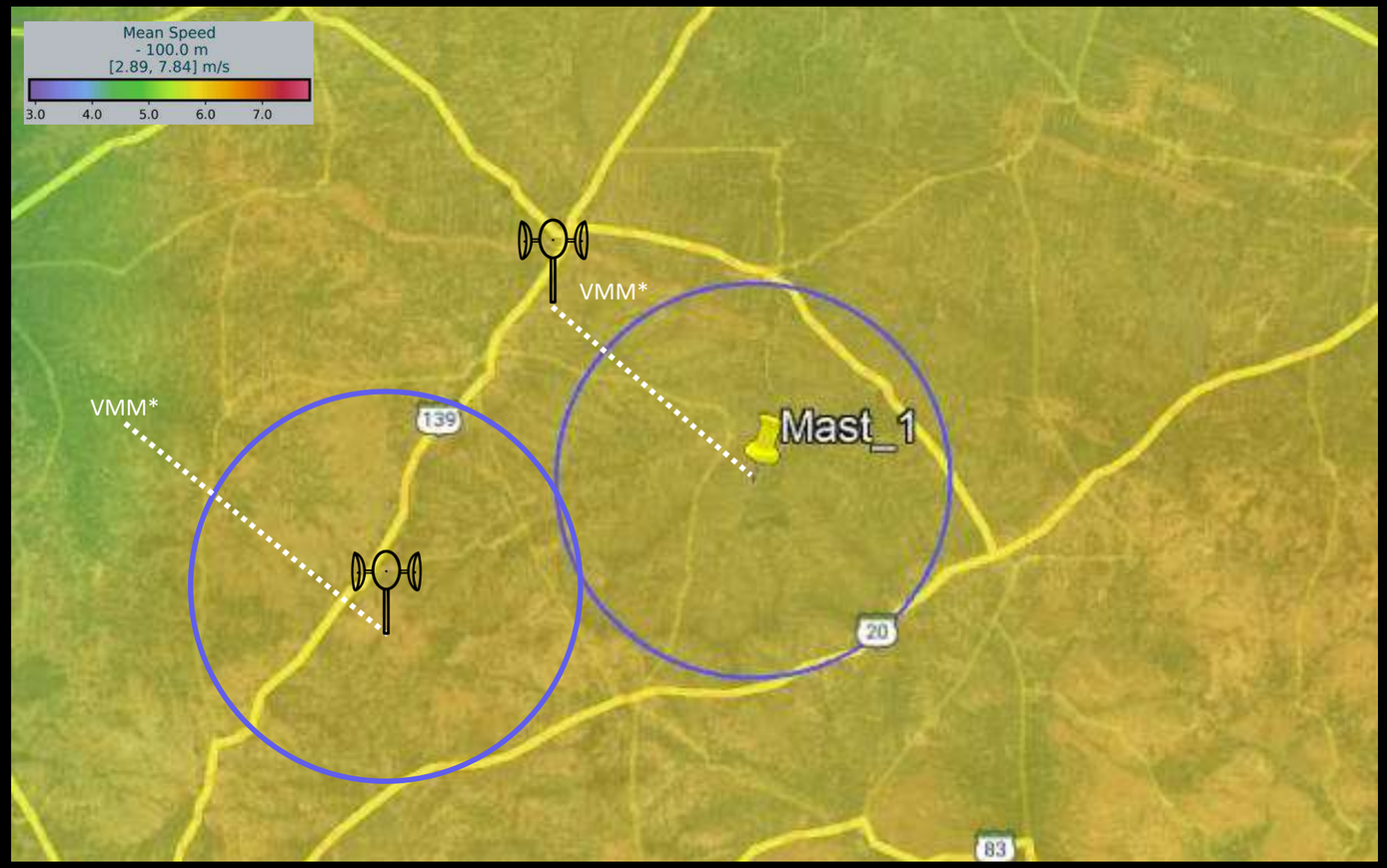
ONE YEAR TIME SERIES with TURBULENCE
Any phase
LES

MULTIYEAR TIME SERIES with TURBULENCE
Any phase
TIMES

Calibration Available with data from Met Mast & LiDAR

Pre-feasibility study with Single Point Data

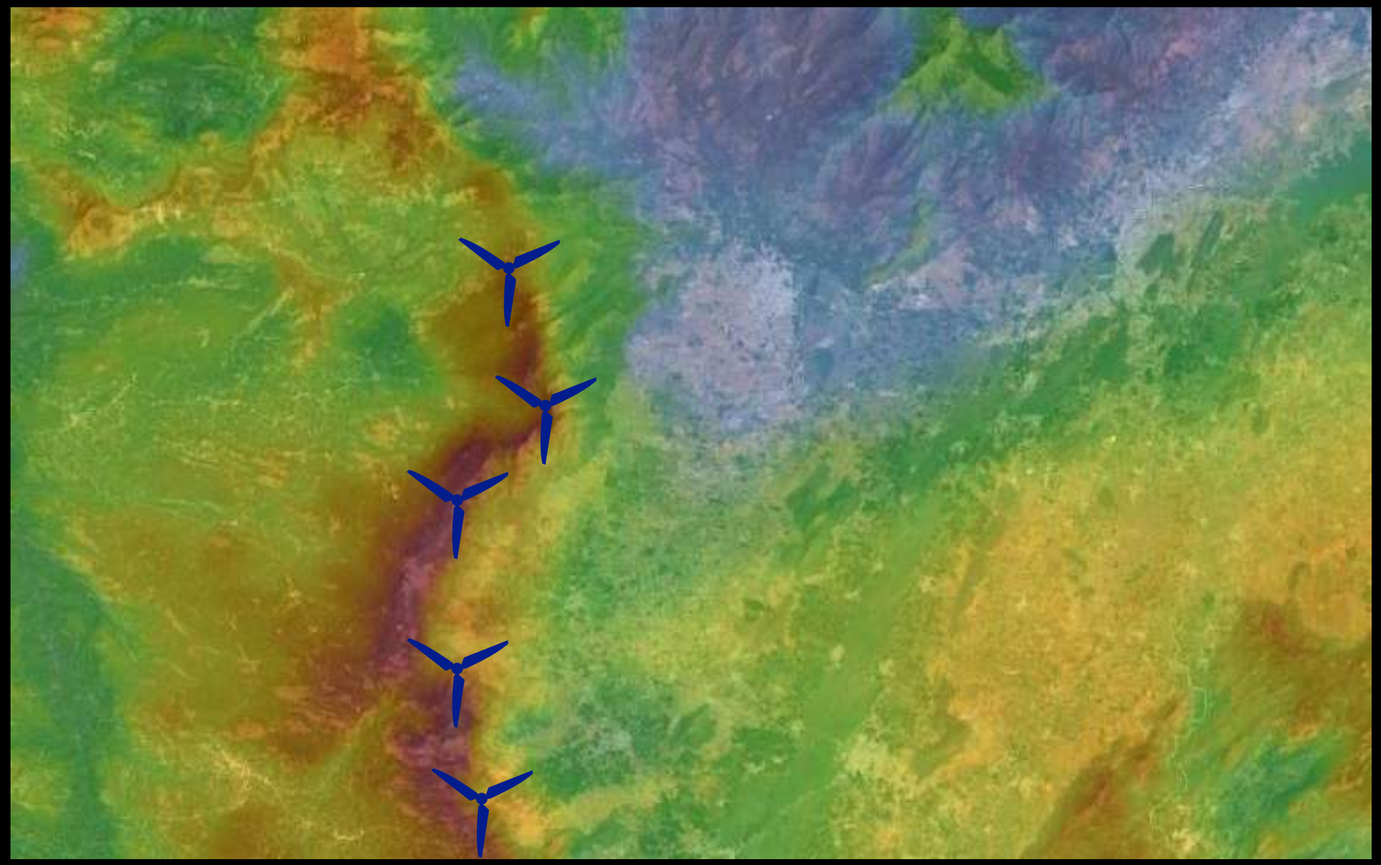
	SERIES	MAST	LES	TIMES
Spatial resolution	3 KM	100 M	100 M	300 M
Temporal resolution	1 Hour	–	10-Minutes	10-Minutes
Long-Term	10, 20, 30 years	Long-Term	One-year Rolling	10, 20, 30 years
Calibration	✓	–	✓	✓
Heights	50-300 M	50-300 M	50-300 M	10-440 m
Data output	Txt	Tab	Txt	Txt
Turbulence Intensity	–	–	✓	✓
Richardson Number	✓	–	✓	✓
Vertical Wind Speed	–	–	✓	✓



Mesoscale Map at 1 KM Terrain Complexity: Simple-Flat

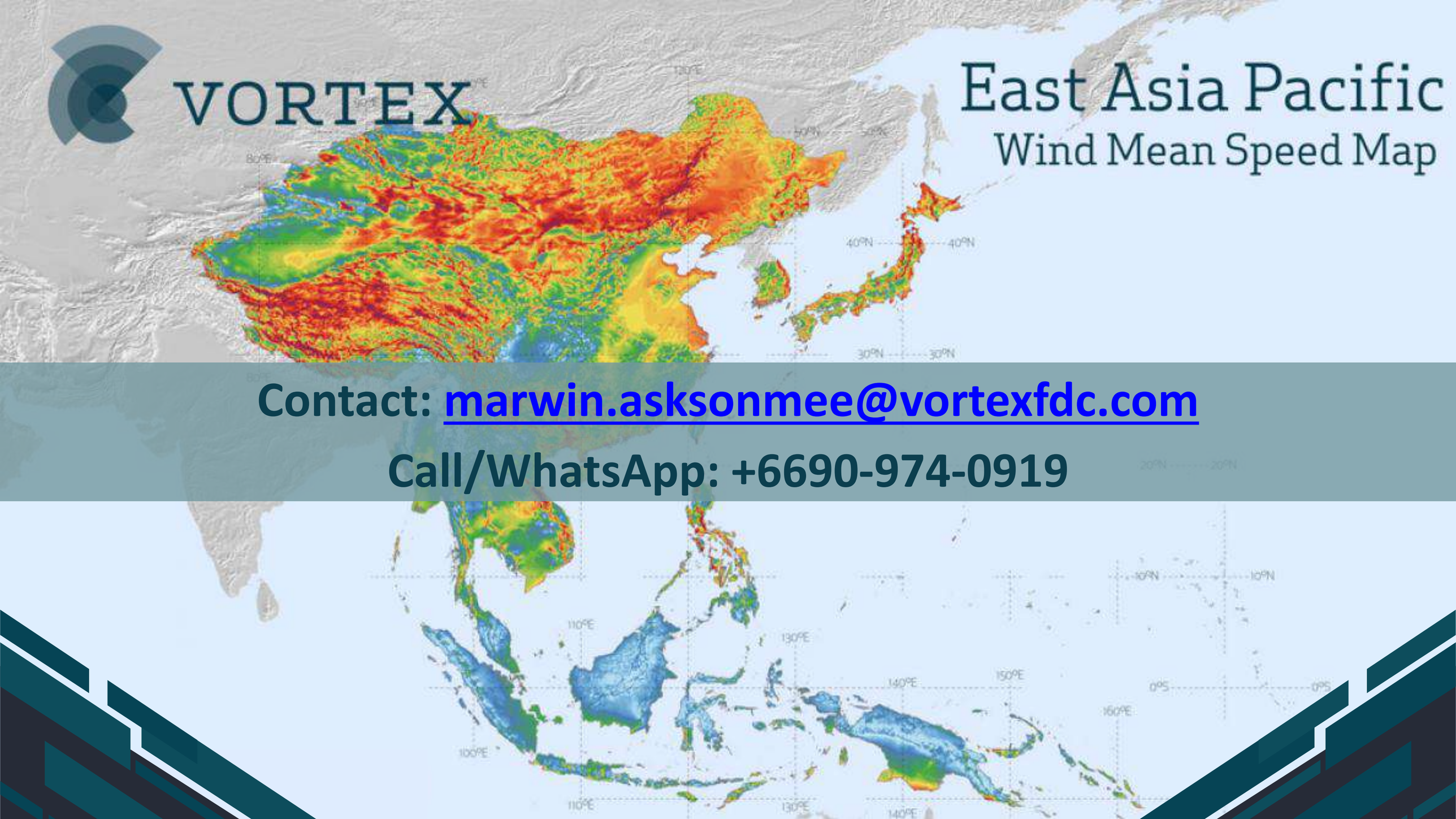
- VMM stands for Virtual Met Mast

Vortex Wind Map



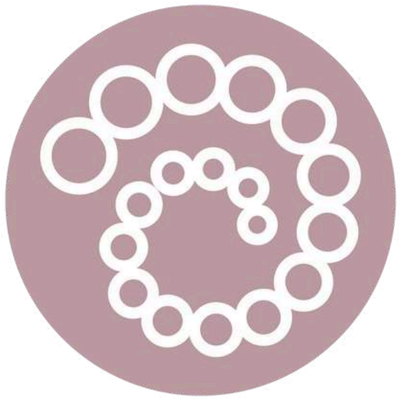
Microscale Map at 100 Meters Terrain Complexity: Complex

	MAPS	FARM	BLOCKS
Spatial resolution	Up to 1 KM	100 M	100 M
Temporal resolution	–	–	30-Minutes
Long-Term	Typical Meteorological year	Typical Meteorological year	One-year Rolling
Calibration	–	✓	✓
Heights	50-300 M	50-300 M	50-300 M
Data output	ESRI's / KMZ	ESRT's / WRG	ESRI's/ WRG/ Txt
Vref	–	✓	–
Turbulence Intensity	–	✓	✓
Richardson Number	–	–	✓



Contact: marwin.asksonmee@vortexfdc.com

Call/WhatsApp: +6690-974-0919



TIMES

The Ultimate Wind Time Series & Its Long-Term Calibration Method

VORTEX

Gerard Cavero Siscart
Data Scientist

Outline

- TIMES
  - Overview
  - Methodology
  - Included variables
  - Deliverables
  - Validation

- TIMES Remodeling
  - Overview
  - Calibration example
  - Validation

- Take aways

TIMES

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TIMES

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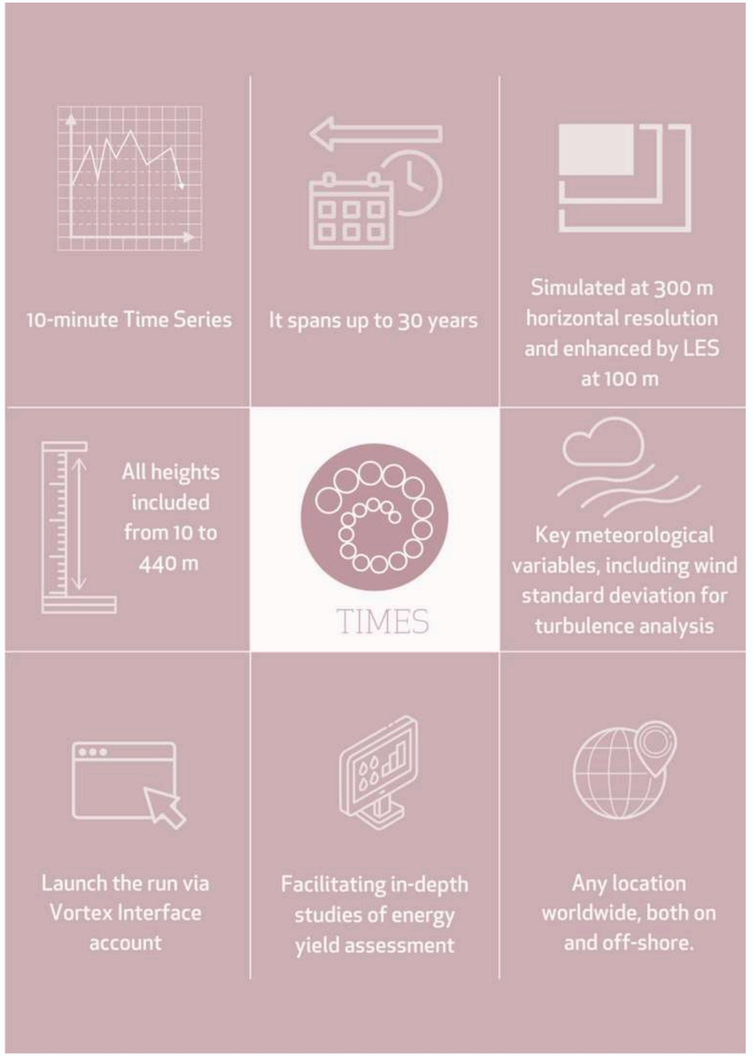
TIMES

Overview

- Long-term, high-resolution 10-minute time series (up to 30 years, covering all heights from 10–440 m).
- Enhanced with Vortex-LES, improving microscale description.
- Possibility to calibrate it with on-site measurements: TIMES Remodeling.



TIMES

Methodology

ERA5 Reanalysis → WRF model

TIMES

Methodology

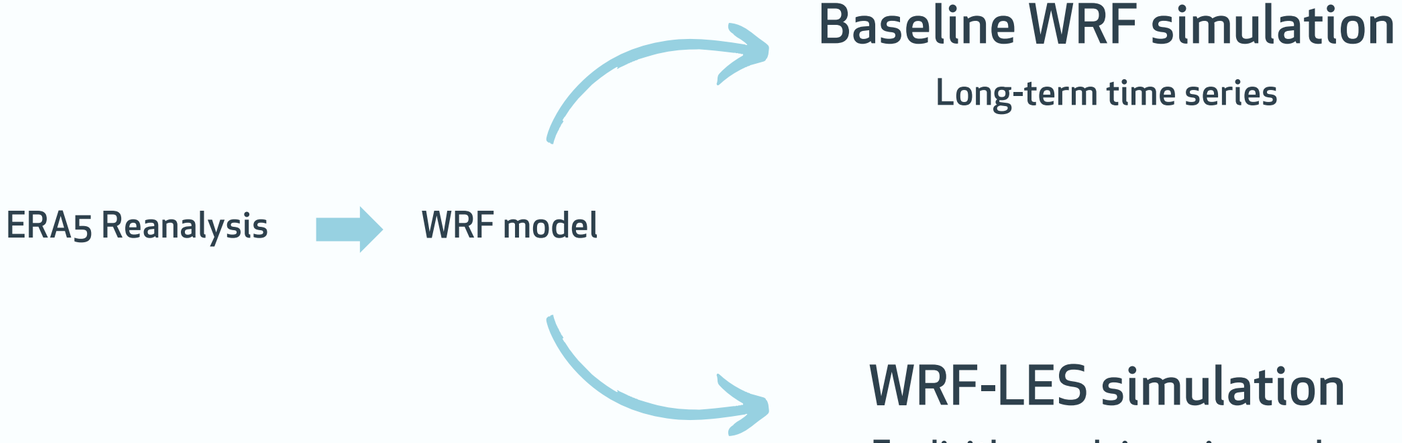
Baseline WRF simulation

Long-term time series

ERA5 Reanalysis → WRF model

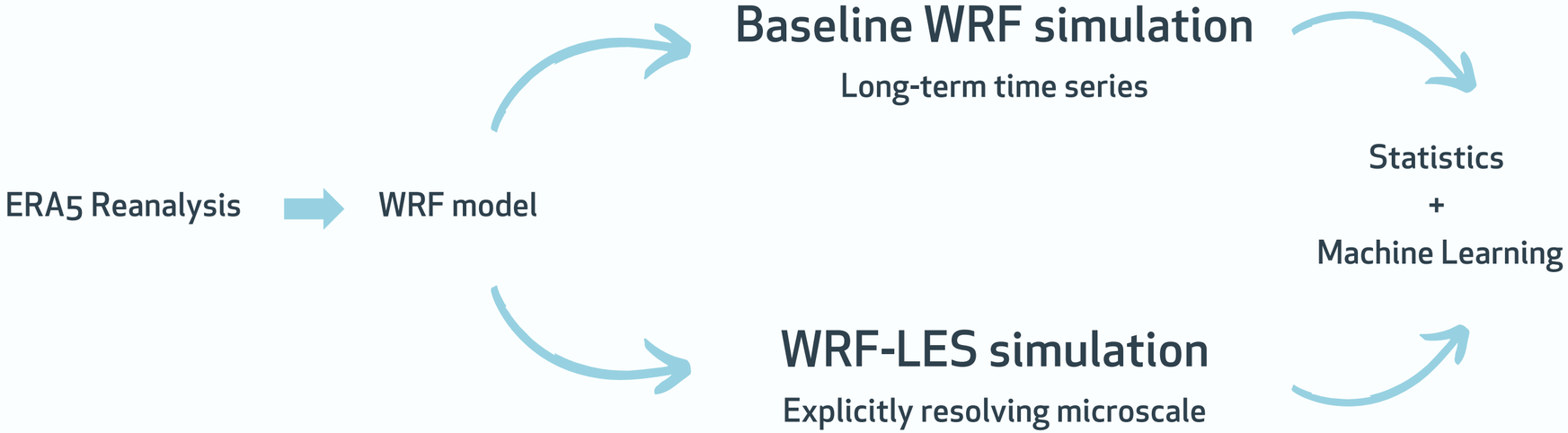
TIMES

Methodology



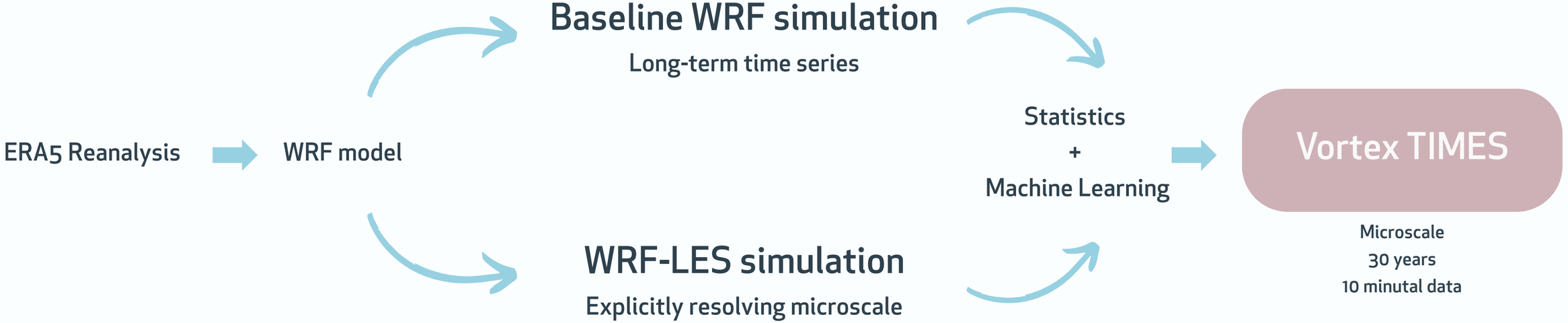
TIMES

Methodology



TIMES

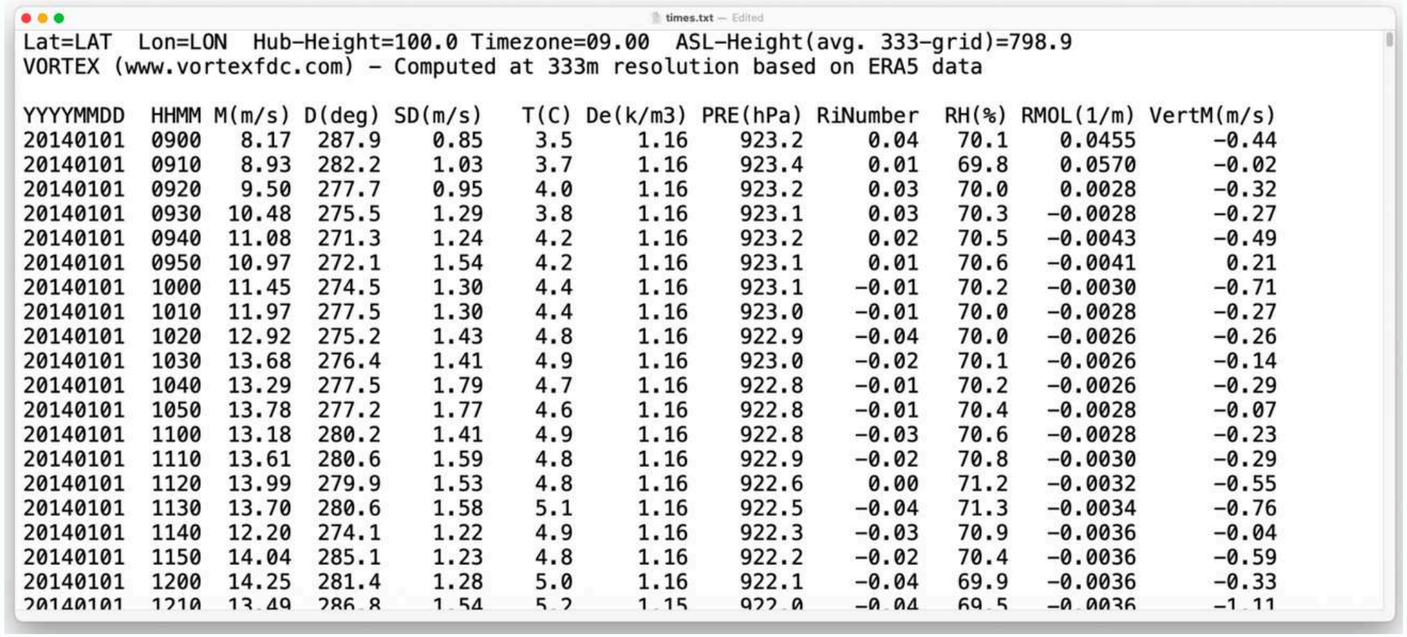
Methodology



TIMES

Variables

- Wind Speed
- Wind Direction
- Wind Standard Deviation
- Temperature
- Air Density
- Pressure
- Richardson Number
- Relative Humidity
- RMOL
- Vertical Wind Speed
- 3-second Gust (available soon)



times.txt — Edited

```
Lat=LAT  Lon=LON  Hub-Height=100.0 Timezone=09.00  ASL-Height(avg. 333-grid)=798.9
VORTEX (www.vortexfdc.com) - Computed at 333m resolution based on ERA5 data

YYYYMMDD  HHMM M(m/s) D(deg) SD(m/s)   T(C) De(k/m3) PRE(hPa) RiNumber  RH(%) RMOL(1/m) VertM(m/s)
20140101  0900   8.17  287.9    0.85    3.5     1.16    923.2     0.04   70.1    0.0455      -0.44
20140101  0910   8.93  282.2    1.03    3.7     1.16    923.4     0.01   69.8    0.0570      -0.02
20140101  0920   9.50  277.7    0.95    4.0     1.16    923.2     0.03   70.0    0.0028      -0.32
20140101  0930  10.48  275.5    1.29    3.8     1.16    923.1     0.03   70.3   -0.0028      -0.27
20140101  0940  11.08  271.3    1.24    4.2     1.16    923.2     0.02   70.5   -0.0043      -0.49
20140101  0950  10.97  272.1    1.54    4.2     1.16    923.1     0.01   70.6   -0.0041       0.21
20140101  1000  11.45  274.5    1.30    4.4     1.16    923.1    -0.01   70.2   -0.0030      -0.71
20140101  1010  11.97  277.5    1.30    4.4     1.16    923.0    -0.01   70.0   -0.0028      -0.27
20140101  1020  12.92  275.2    1.43    4.8     1.16    922.9    -0.04   70.0   -0.0026      -0.26
20140101  1030  13.68  276.4    1.41    4.9     1.16    923.0    -0.02   70.1   -0.0026      -0.14
20140101  1040  13.29  277.5    1.79    4.7     1.16    922.8    -0.01   70.2   -0.0026      -0.29
20140101  1050  13.78  277.2    1.77    4.6     1.16    922.8    -0.01   70.4   -0.0028      -0.07
20140101  1100  13.18  280.2    1.41    4.9     1.16    922.8    -0.03   70.6   -0.0028      -0.23
20140101  1110  13.61  280.6    1.59    4.8     1.16    922.9    -0.02   70.8   -0.0030      -0.29
20140101  1120  13.99  279.9    1.53    4.8     1.16    922.6     0.00   71.2   -0.0032      -0.55
20140101  1130  13.70  280.6    1.58    5.1     1.16    922.5    -0.04   71.3   -0.0034      -0.76
20140101  1140  12.20  274.1    1.22    4.9     1.16    922.3    -0.03   70.9   -0.0036      -0.04
20140101  1150  14.04  285.1    1.23    4.8     1.16    922.2    -0.02   70.4   -0.0036      -0.59
20140101  1200  14.25  281.4    1.28    5.0     1.16    922.1    -0.04   69.9   -0.0036      -0.33
20140101  1210  13.49  286.8    1.54    5.2     1.15    922.0    -0.04   69.5   -0.0036      -1.11
```

TIMES

One purchase, all deliverables

- Monthly Updates: 
  - Updated 10-minute time series every month.
  - Always up to date.
- Multiple Data Formats: 
  - Text file (.txt)
  - windPRO (.mesores)
  - OpenWind (.csv)
  - NetCDF (.nc)

TIMES

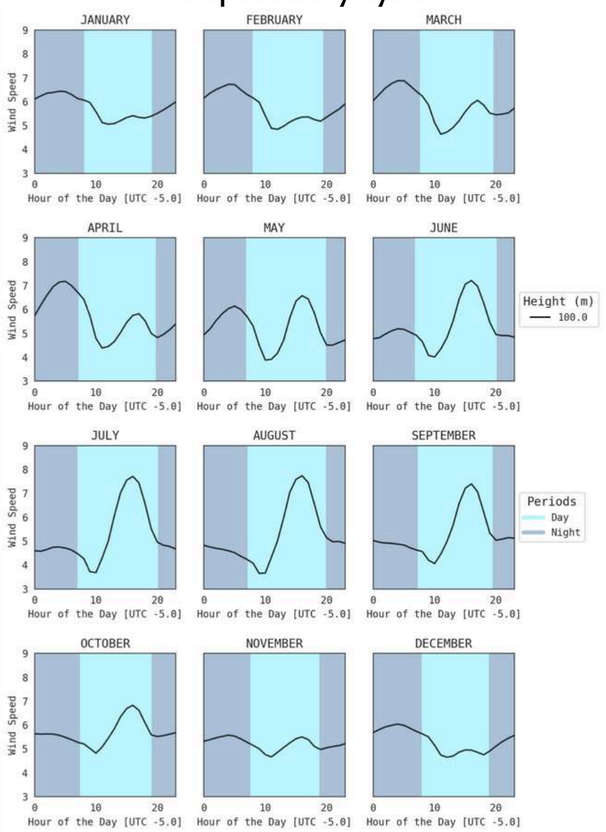
One purchase, all deliverables

NEW FEATURE!

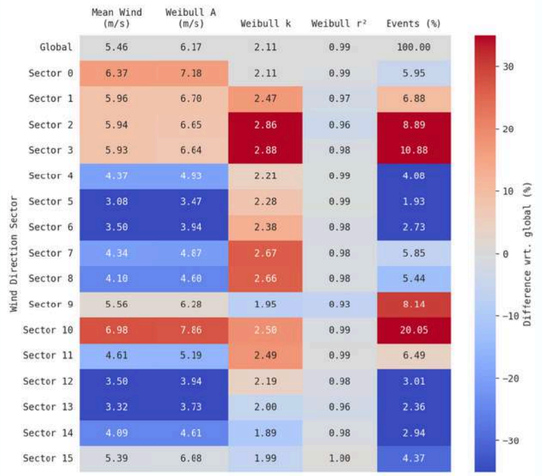
- Automated wind analytics:
  - General Overview
  - Wind Speed
  - Turbulence Intensity
  - Wind Direction
  - Weibull fit
  - Vertical Structure

PDF

Wind Speed Daily Cycle

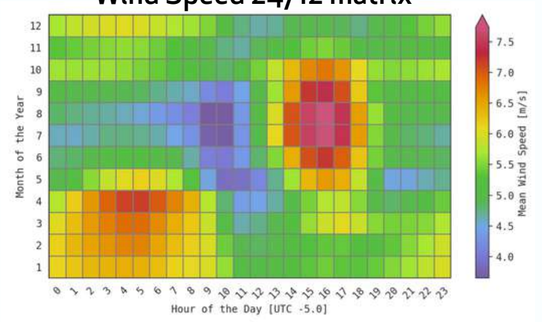


Directional Wind Behavior

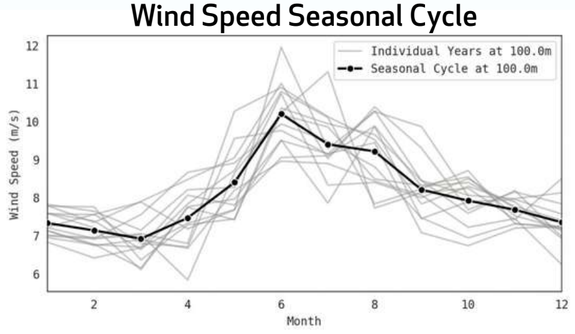


	Mean Wind (m/s)	Weibull A (m/s)	Weibull k	Weibull r²	Events (%)
Global	5.46	6.17	2.11	0.99	100.00
Sector 0	6.37	7.18	2.11	0.99	5.95
Sector 1	5.96	6.70	2.47	0.97	6.88
Sector 2	5.94	6.65	2.86	0.96	8.89
Sector 3	5.93	6.64	2.88	0.98	10.88
Sector 4	4.37	4.93	2.21	0.99	4.08
Sector 5	3.08	3.47	2.28	0.99	1.93
Sector 6	3.50	3.94	2.38	0.98	2.73
Sector 7	4.34	4.87	2.67	0.98	5.85
Sector 8	4.10	4.60	2.66	0.98	5.44
Sector 9	5.56	6.28	1.95	0.93	8.14
Sector 10	6.98	7.86	2.50	0.99	20.05
Sector 11	4.61	5.19	2.49	0.99	6.49
Sector 12	3.50	3.94	2.19	0.98	3.01
Sector 13	3.32	3.73	2.00	0.96	2.36
Sector 14	4.09	4.61	1.89	0.98	2.94
Sector 15	5.39	6.08	1.99	1.00	4.37

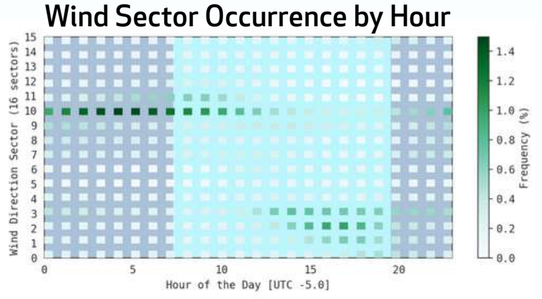
Wind Speed 24/12 matrix



Wind Speed Seasonal Cycle



Wind Sector Occurrence by Hour



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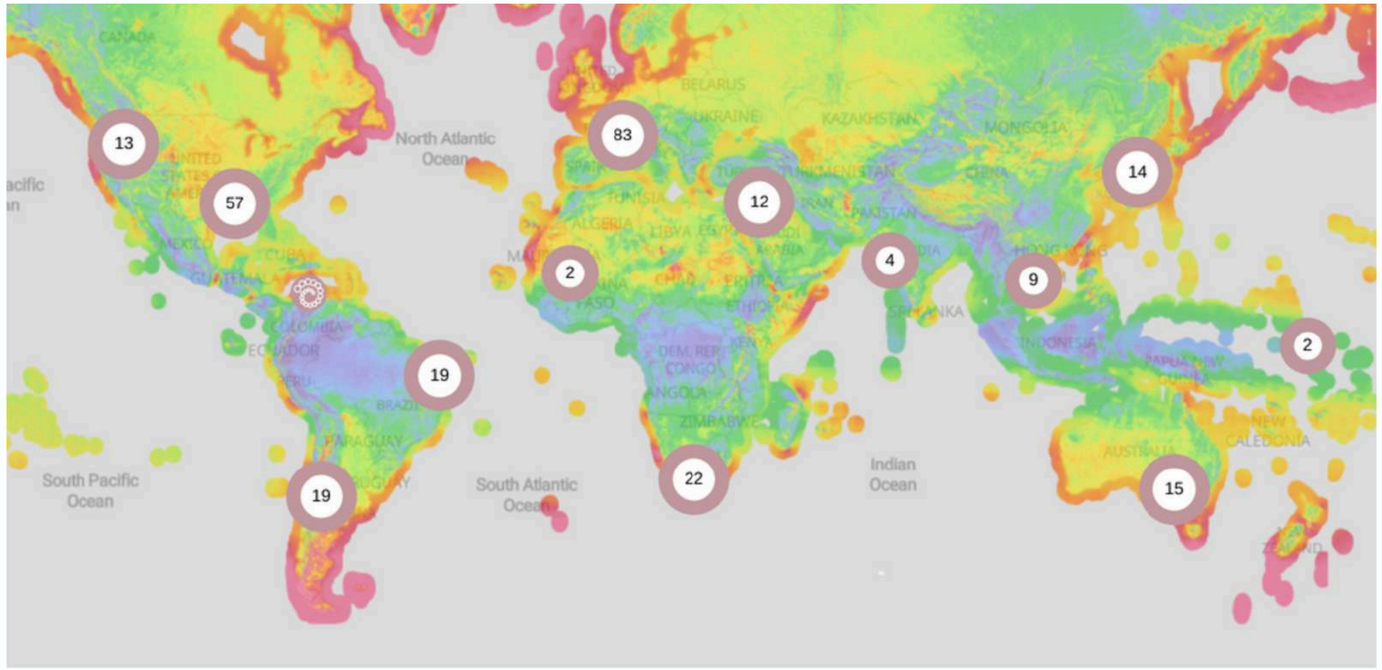
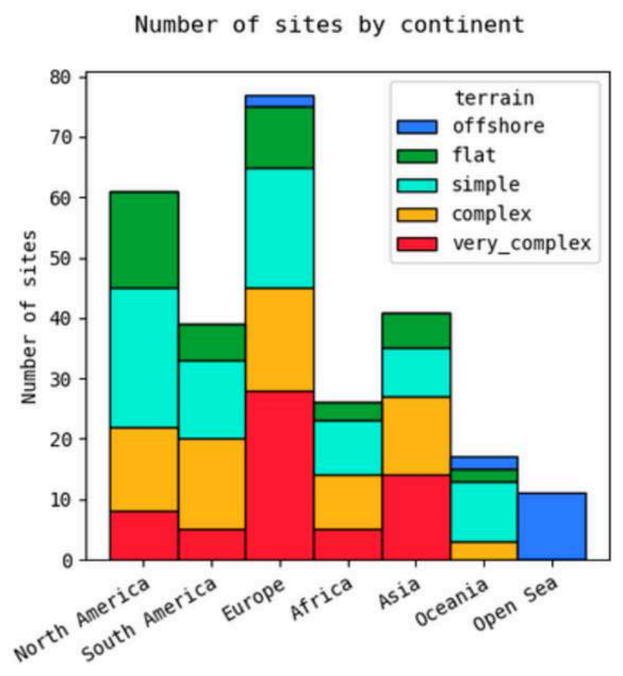
TIMES

Validation

- Validated at 272 sites (322 measurement points), covering all terrain complexity types.





TIMES
Validation

Overall Wind Speed metrics

Mean Absolute Bias (%)	5.71 ± 4.72
10-min Correlation	0.70 ± 0.09

Overall TI curve metrics

Mean Absolute Bias (%)	13.96 ± 8.17
RMSE (% of TI)	1.70 ± 0.80

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TIMES

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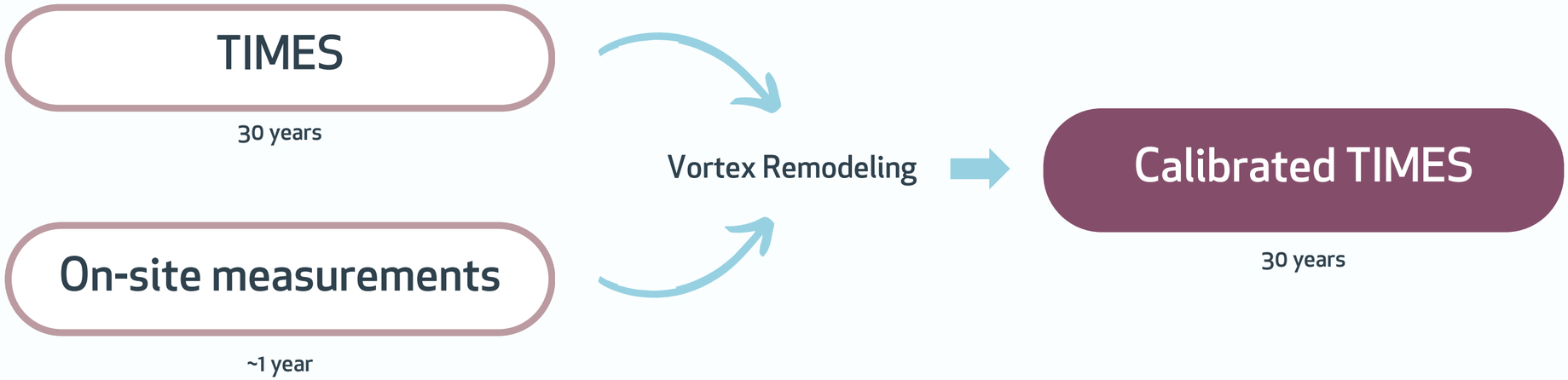
TIMES Remodeling

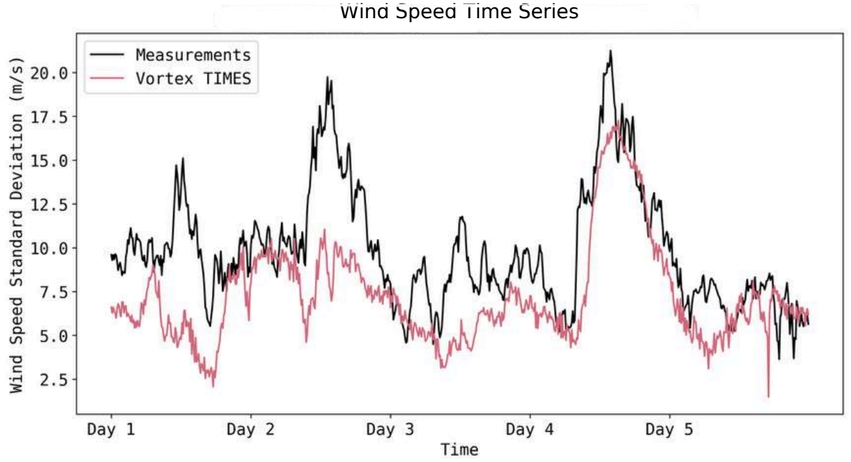
Overview

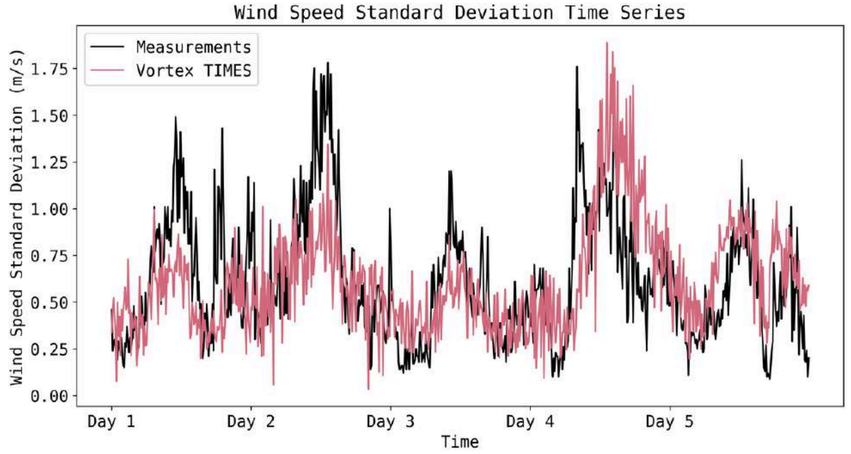
- Time-domain MCP calibration of Wind Speed, Direction and Turbulence Intensity.
- Included in each TIMES run. Unlimited calibrations.
- Delivery time: ~1h



TIMES Remodeling

Calibration example



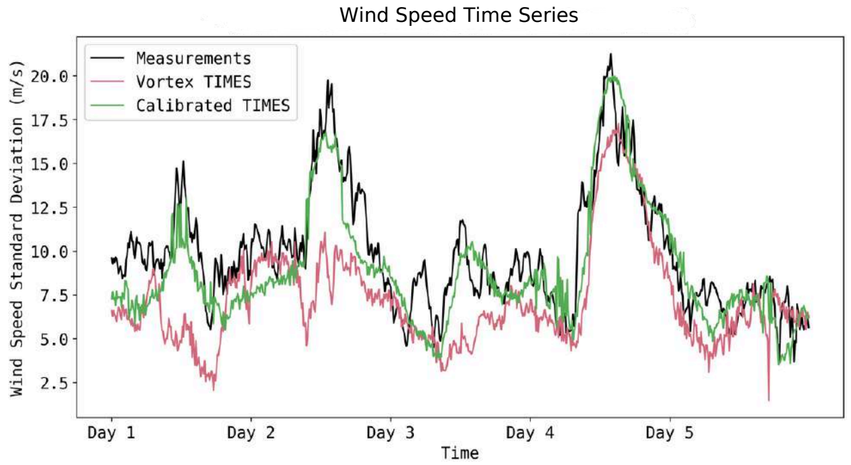


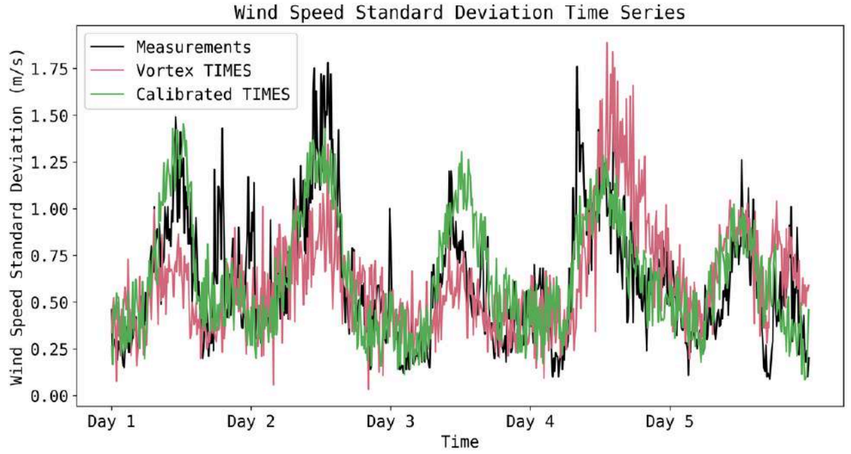
OUT OF TRAINING PERIOD!

(this period was not used for training)

TIMES Remodeling

Calibration example





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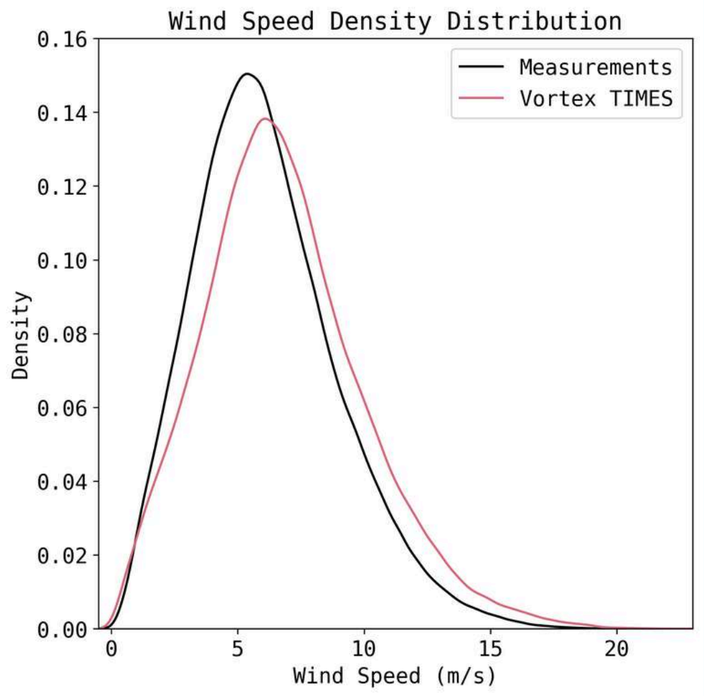
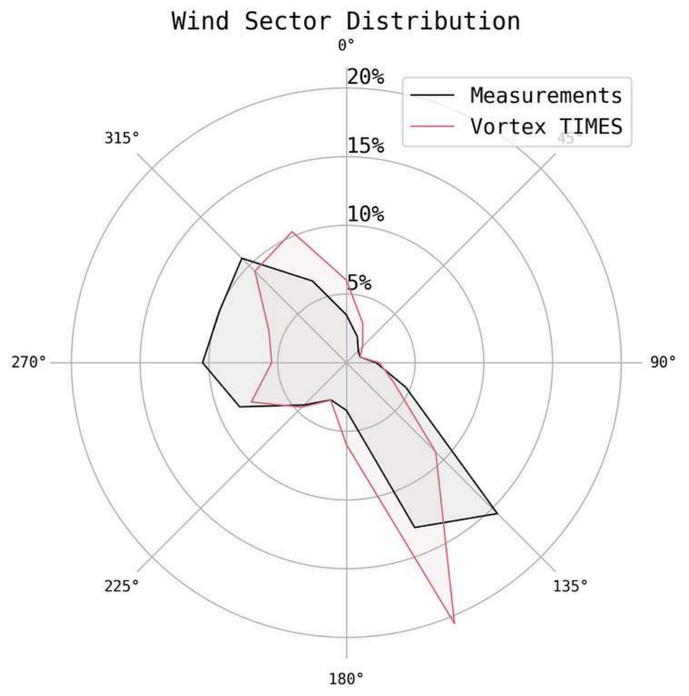
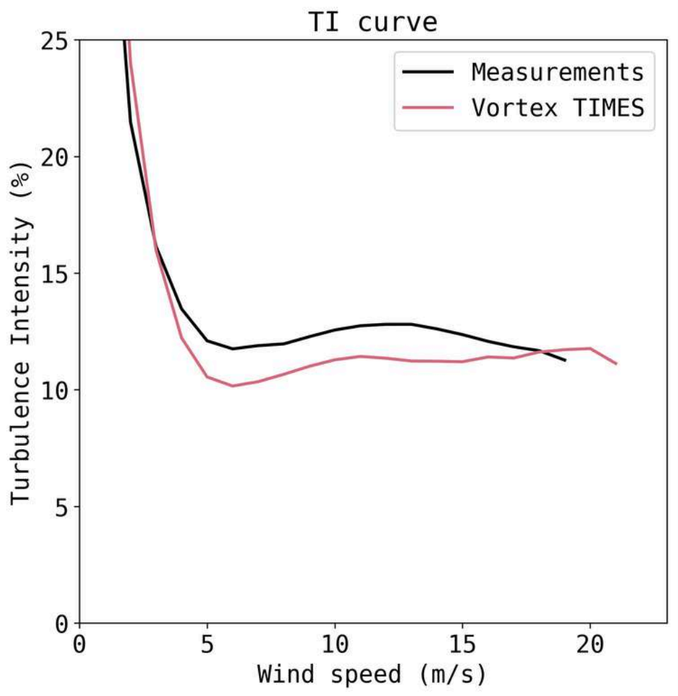
TIMES Remodeling

Calibration example





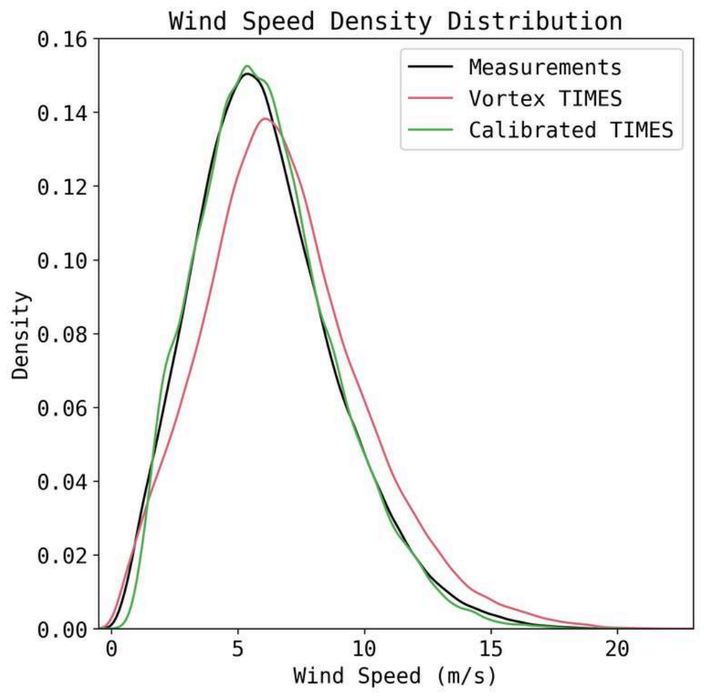


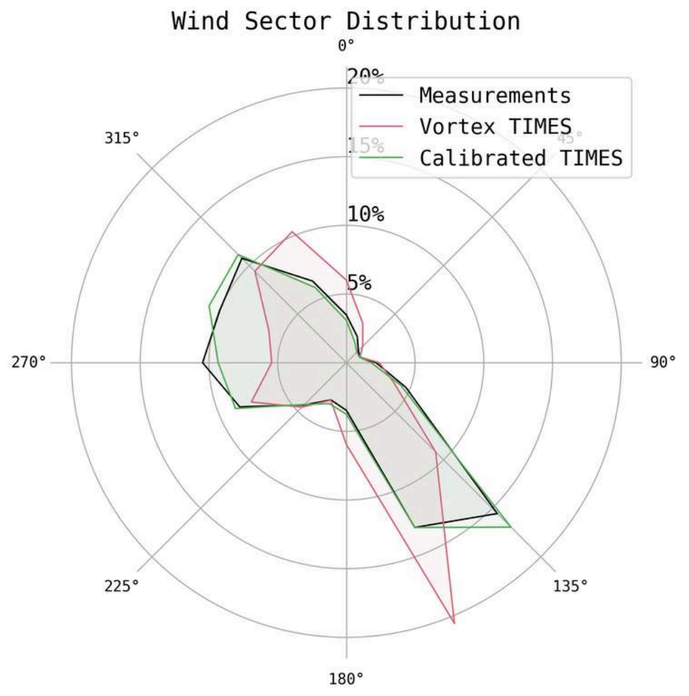
OUT OF TRAINING PERIOD!

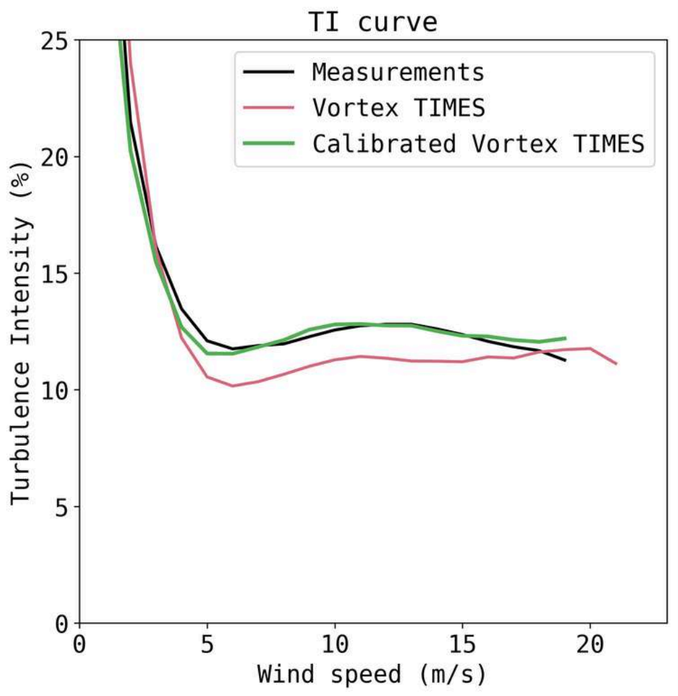
(this period was not used for training)

TIMES Remodeling

Calibration example







OUT OF TRAINING PERIOD!

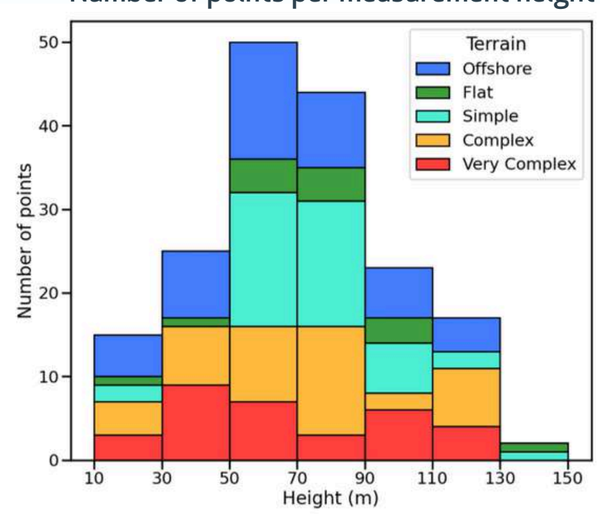
(this period was not used for training)

TIMES Remodeling

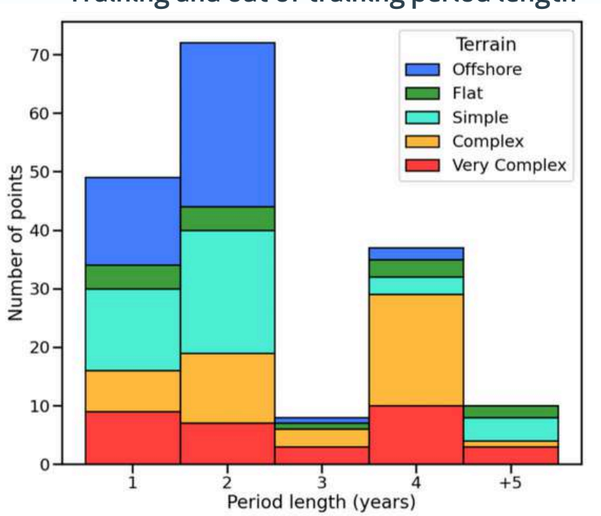
Validation

- Validated at 143 sites (176 measurement points), covering all terrain complexity types.
- 1 year of data has been used for training (training period).
- The performance is assessed on unseen data (out of training period).

Number of points per measurement height



Training and out of training period length



TIMES Remodeling

Validation

Overall Wind Speed metrics

	TIMES
Mean Absolute Bias (%)	5.07 ± 4.63
10-min Correlation	0.74 ± 0.09

OUT OF TRAINING PERIOD!

(this period was not used for training)

TIMES Remodeling

Validation

Overall Wind Speed metrics

	TIMES
Mean Absolute Bias (%)	5.07 ± 4.63
10-min Correlation	0.74 ± 0.09

Remodeling →

Calibrated TIMES	
1.59 ± 2.08	Decreased by 65%
0.78 ± 0.06	Improved by 5%

OUT OF TRAINING PERIOD!

(this period was not used for training)

TIMES Remodeling

Validation

Overall TI curve metrics

	TIMES
Mean Absolute Bias (%)	10.71 ± 8.30
RMSE (% of TI)	1.46 ± 0.96

OUT OF TRAINING PERIOD!

(this period was not used for training)

TIMES Remodeling

Validation

Overall TI curve metrics

	TIMES
Mean Absolute Bias (%)	10.71 ± 8.30
RMSE (% of TI)	1.46 ± 0.96

Remodeling →

Calibrated TIMES	
6.50 ± 5.30	Decreased by 39%
0.65 ± 0.37	Decreased by 56%

OUT OF TRAINING PERIOD!

(this period was not used for training)

Outline

- TIMES
  - Overview
  - Methodology
  - Included variables
  - Deliverables
  - Validation
- TIMES Remodeling
  - Overview
  - Calibration example
  - Validation
- Take aways

TIMES

VORTEX

TIMES

Take aways

TIMES

Take aways

- TIMES is a long-term, high-resolution time series with well-grounded microscale physics.

TIMES

Take aways

- TIMES is a long-term, high-resolution time series with well-grounded microscale physics.
- The validation shows great accuracy (Wind Speed Absolute Bias of 5.7% across 272 sites).

TIMES

Take aways

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- The validation shows great accuracy (Wind Speed Absolute Bias of 5.7% across 272 sites).
- Multiple deliverables: detailed PDF reports with in-depth data analysis.

TIMES

Take aways

- TIMES is a long-term, high-resolution time series with well-grounded microscale physics.
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- Multiple deliverables: detailed PDF reports with in-depth data analysis.
- Unlimited Wind and Turbulence Intensity calibrations with Vortex Remodeling technology.

TIMES

Take aways

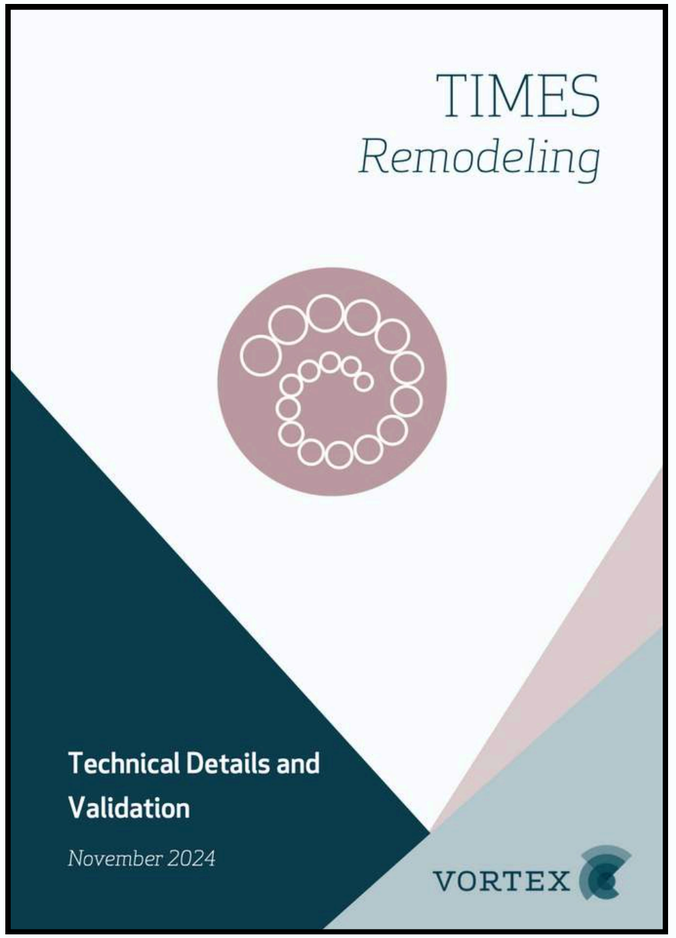
- TIMES is a long-term, high-resolution time series with well-grounded microscale physics.
- The validation shows great accuracy (Wind Speed Absolute Bias of 5.7% across 272 sites).
- Multiple deliverables: detailed PDF reports with in-depth data analysis.
- Unlimited Wind and Turbulence Intensity calibrations with Vortex Remodeling technology.
- TIMES Remodeling validation shows an excellent agreement with measurements, providing more accurate long-term wind estimates for the location.

TIMES Remodeling

Validation

Explore the full Technical Documents at our Knowledge Center: vortexfdc.com/resources/

TIMES



TIMES Remodeling

TIMES

Thank you!

For questions, contact
gerard.cavero@vortexfdc.com

VORTEX

VORTEX

TIMES Performance During Extreme Events

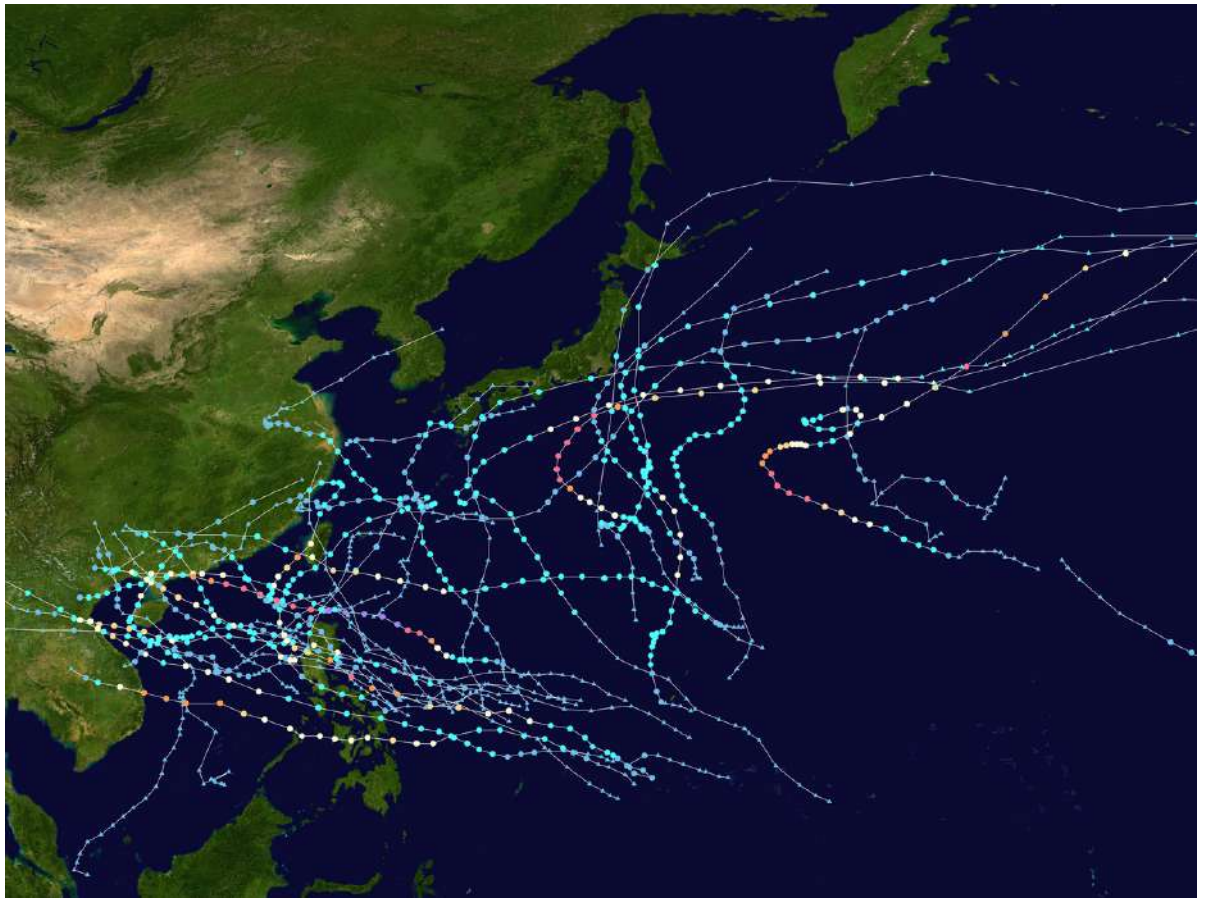
Real Case Study of Recent Philippines Typhoons

Dec 2025

Typhoon Season

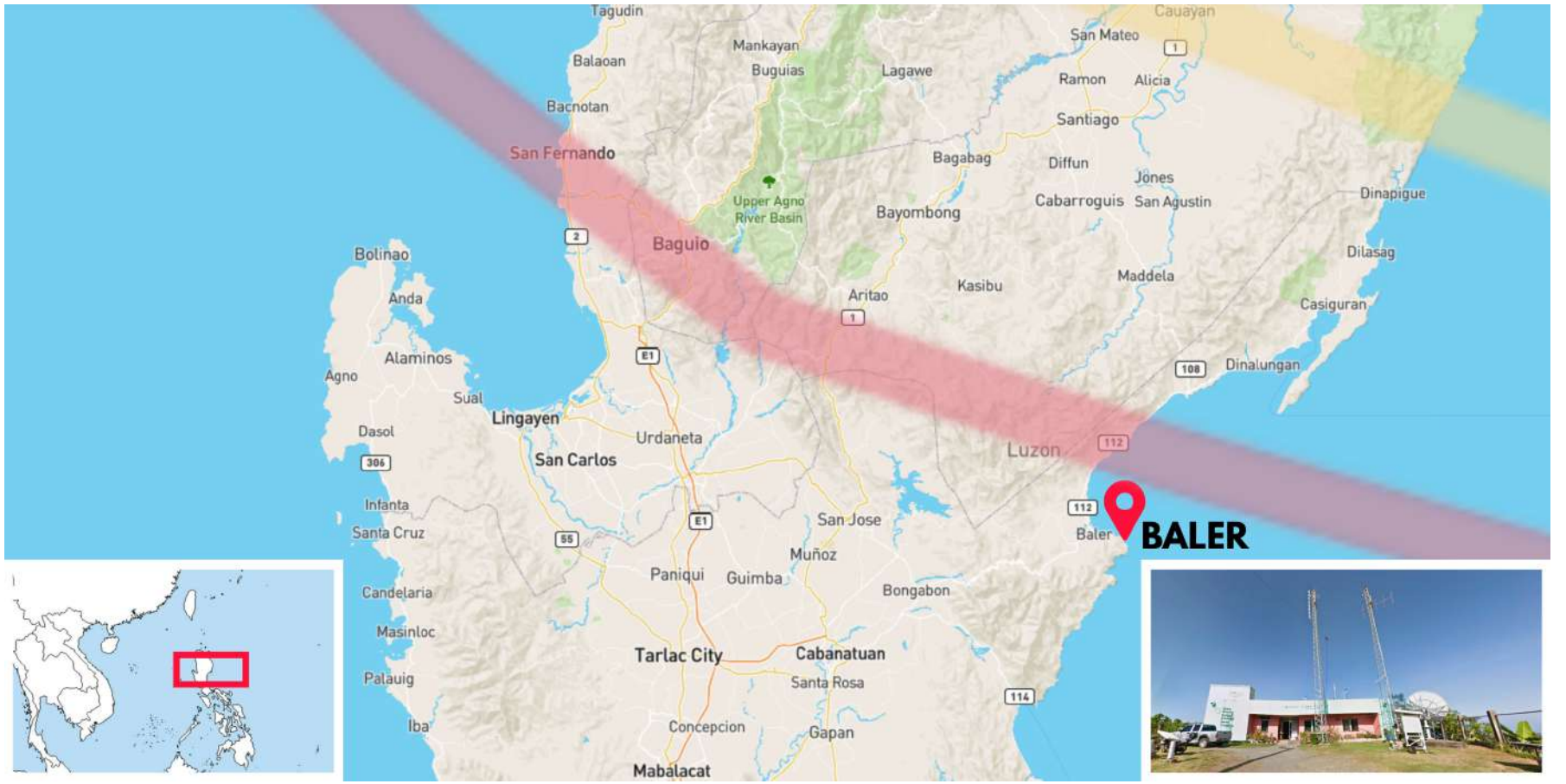
2025 Pacific Typhoon Season	
Storms	27
Typhoons	14
Strongest event	Ragasa
Max speed	57m/s

Source: International Best Track Archive for Climate Stewardship (IBTrACS)

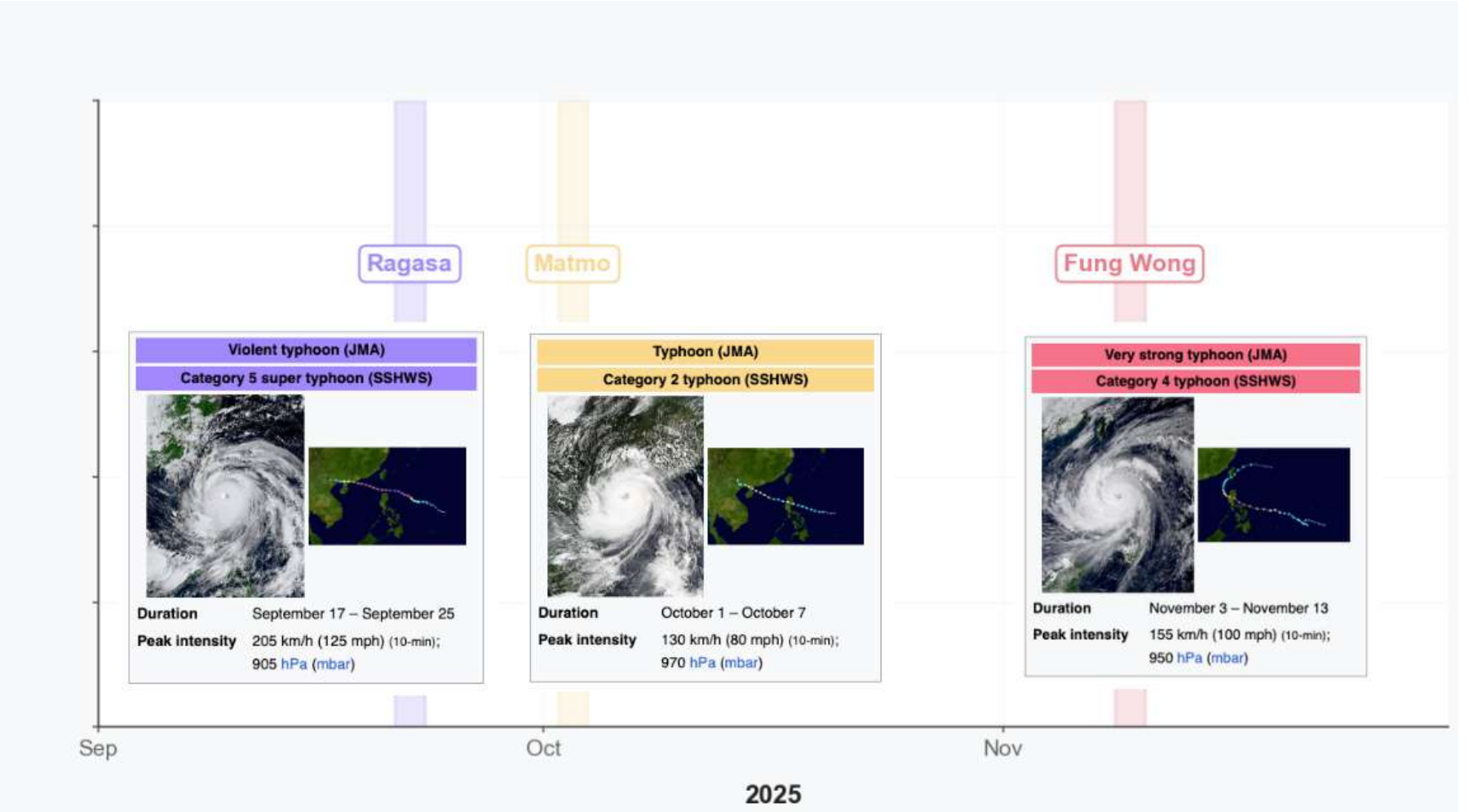


Typhoons Philippines

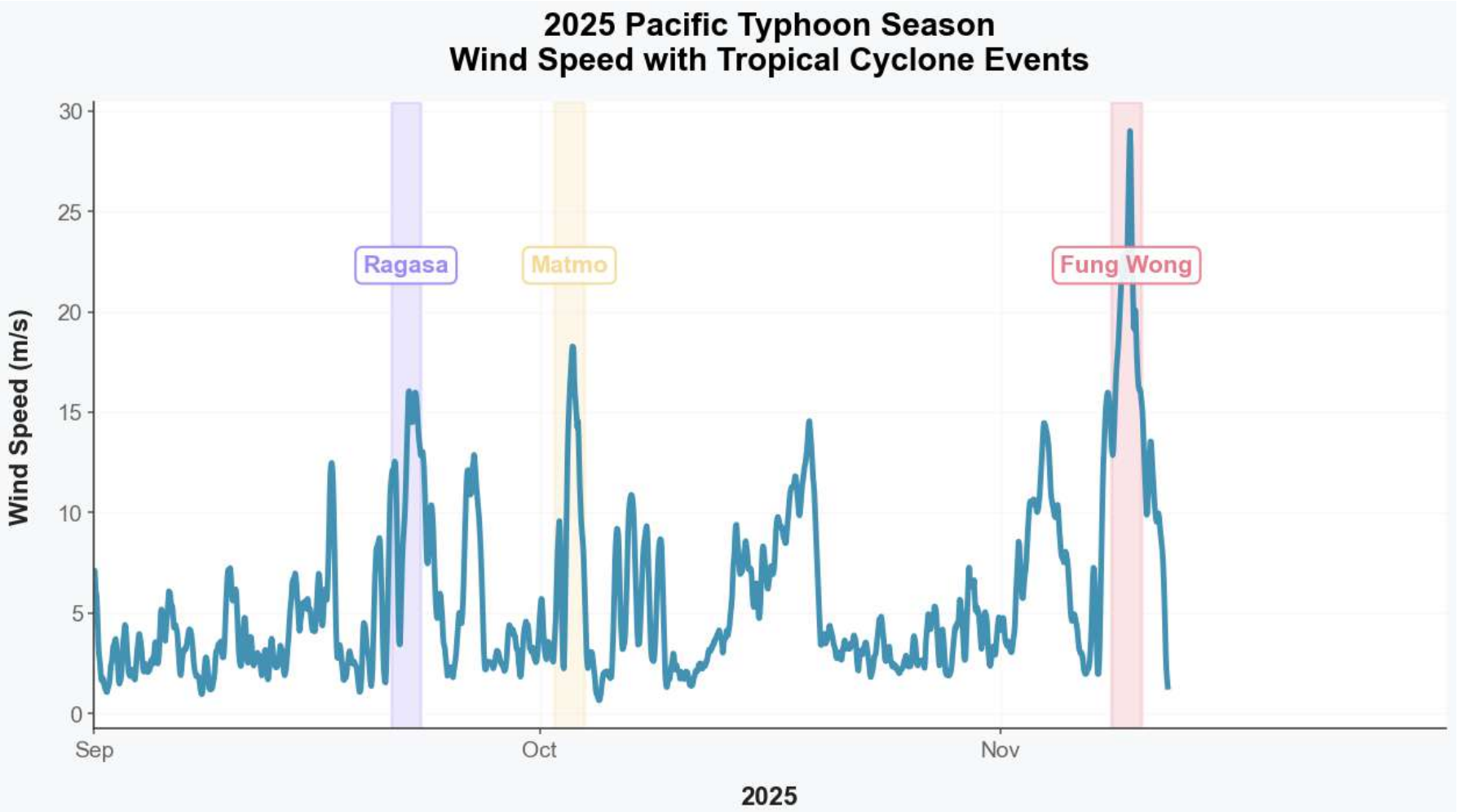
Case Study


Tagudin
Balaoan
Bacnotan
San Fernando
Mankayan
Buguias
Lagawe
Upper Agno River Basin
Baguio
Bayombong
Bagabag
Santiago
San Mateo
Ramon
Alicia
Diffun
Jones
Cabarroguis
San Agustin
Dinapigue
Dilasag
Casiguran
Maddela
Kasibu
Aritao
Dinalungan
Luzon
Bolinao
Anda
Alaminos
Agno
Sual
Lingayen
Dasol
Urdaneta
San Carlos
Infanta
Santa Cruz
Candelaria
Masinloc
Palauig
Iba
Paniqui
Guimba
San Jose
Muñoz
Bongabon
Tarlac City
Cabanatuan
Santa Rosa
Concepcion
Gapan
Mabalacat
Baler
BALER

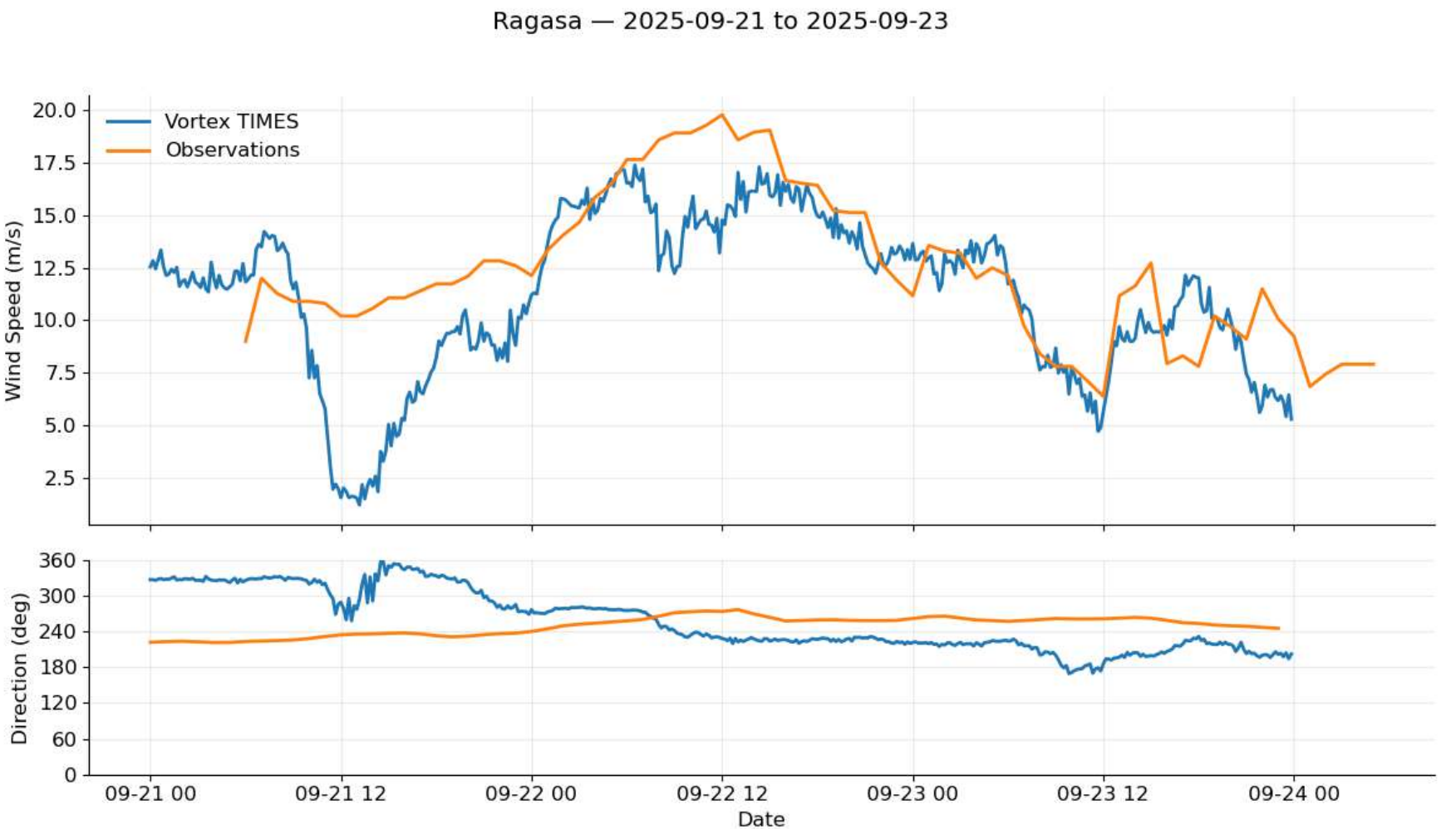
Case Study


Ragasa
Violent typhoon (JMA)
Category 5 super typhoon (SSHWS)
Duration September 17 – September 25
Peak intensity 205 km/h (125 mph) (10-min); 905 hPa (mbar)
Matmo
Typhoon (JMA)
Category 2 typhoon (SSHWS)
Duration October 1 – October 7
Peak intensity 130 km/h (80 mph) (10-min); 970 hPa (mbar)
Fung Wong
Very strong typhoon (JMA)
Category 4 typhoon (SSHWS)
Duration November 3 – November 13
Peak intensity 155 km/h (100 mph) (10-min); 950 hPa (mbar)
Sep
Oct
Nov
2025

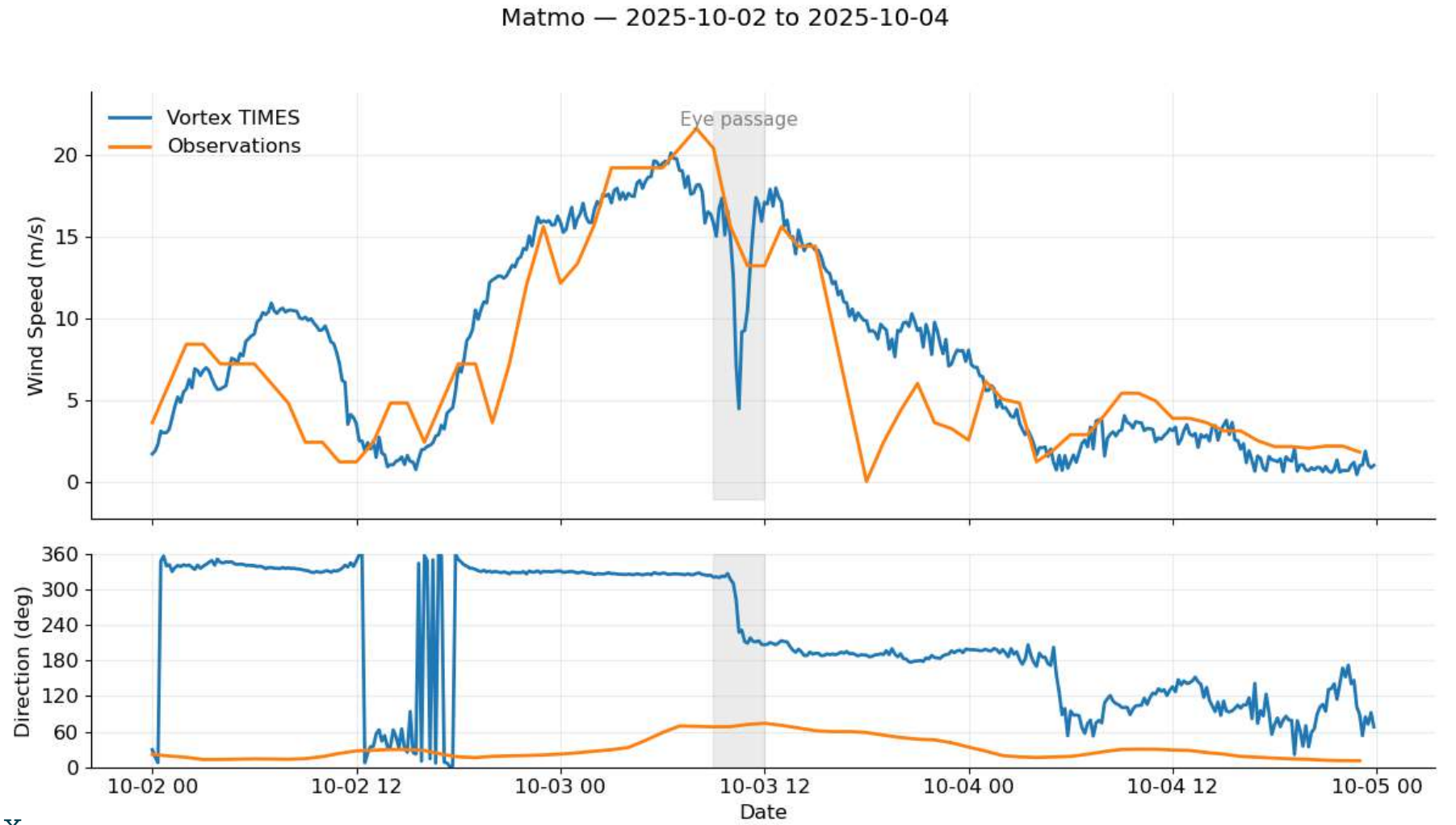
Case Study


2025 Pacific Typhoon Season
Wind Speed with Tropical Cyclone Events
Wind Speed (m/s)
30
25
20
15
10
5
0
Ragasa
Matmo
Fung Wong
Sep
Oct
Nov
2025

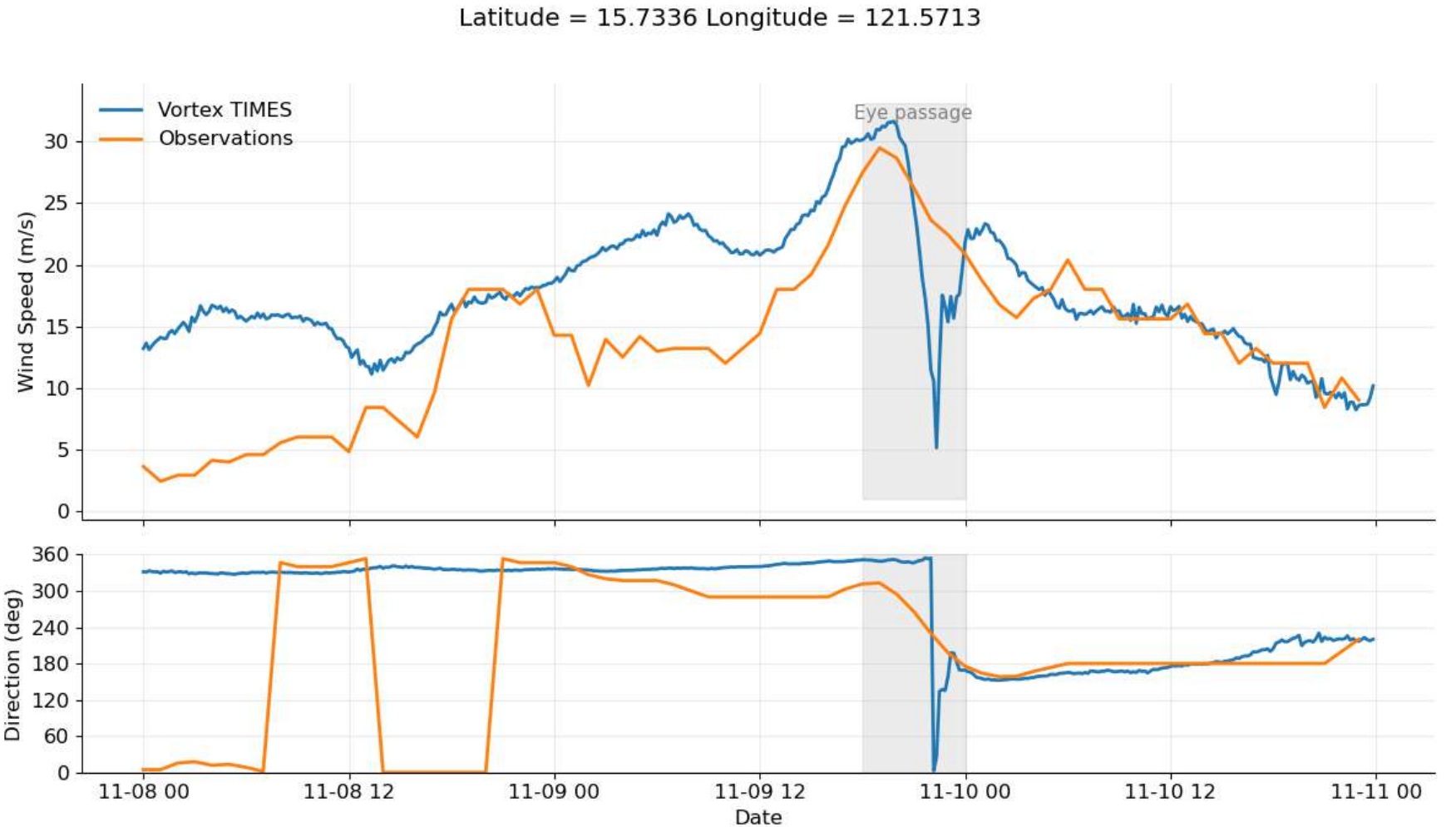
Ragasa


Ragasa — 2025-09-21 to 2025-09-23
Vortex TIMES
Observations
Wind Speed (m/s)
20.0
17.5
15.0
12.5
10.0
7.5
5.0
2.5
Direction (deg)
360
300
240
180
120
60
0
09-21 00
09-21 12
09-22 00
09-22 12
09-23 00
09-23 12
09-24 00
Date

Matmo


Matmo — 2025-10-02 to 2025-10-04
Vortex TIMES
Observations
Eye passage
Wind Speed (m/s)
0
5
10
15
20
Direction (deg)
0
60
120
180
240
300
360
10-02 00
10-02 12
10-03 00
10-03 12
10-04 00
10-04 12
10-05 00
Date

Fung Wong


Latitude = 15.7336 Longitude = 121.5713
Vortex TIMES
Observations
Eye passage
Wind Speed (m/s)
0
5
10
15
20
25
30
Direction (deg)
0
60
120
180
240
300
360
11-08 00
11-08 12
11-09 00
11-09 12
11-10 00
11-10 12
11-11 00
Date

Conclusions

- TIMES reproduces wind evolution and peak timing for all three typhoons.
- Ragasa was too distant for a strong signal, but the model follows the trend.
- Matmo and Fung-Wong show strong agreement in intensity and peak winds.
- 10-min data is essential for capturing fast wind fluctuations in extremes.

Questions

Questions?