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Beyond IEC Turbulence Intensity: What the $TI_{10}min/TI_{30}s$ Ratio Reveals About the Spectral Nature of a Wind Measurement Site

Speaker:
Alejandro Blanco

June 18, 2026

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01. **The Origin**

02. Von Karman Wind Spectrum

03. Project phases:
    - Ratio $TI_{10}min/TI_{30}s$
    - Data Collection Every Second
    - Transform TI30 into IEC-scale TI
    - Real Sites

04. Conclusions

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The Origin

- In 1999, Tirso Vazquez while programming the first Kintech Engineering data logger (EOL 2020) recognized that the 10-minute standard deviation was influenced by phenomena unrelated to actual turbulence, mainly changes in average speed;
- Kintech Engineering programmed the EOL2020 logger to measure the average of the 20 standard deviations of 30-second periods existing in 10-minute periods;
- In 2009, Kintech Engineering requested a study on the new variable based on 30-second periods that was proposed in the past;

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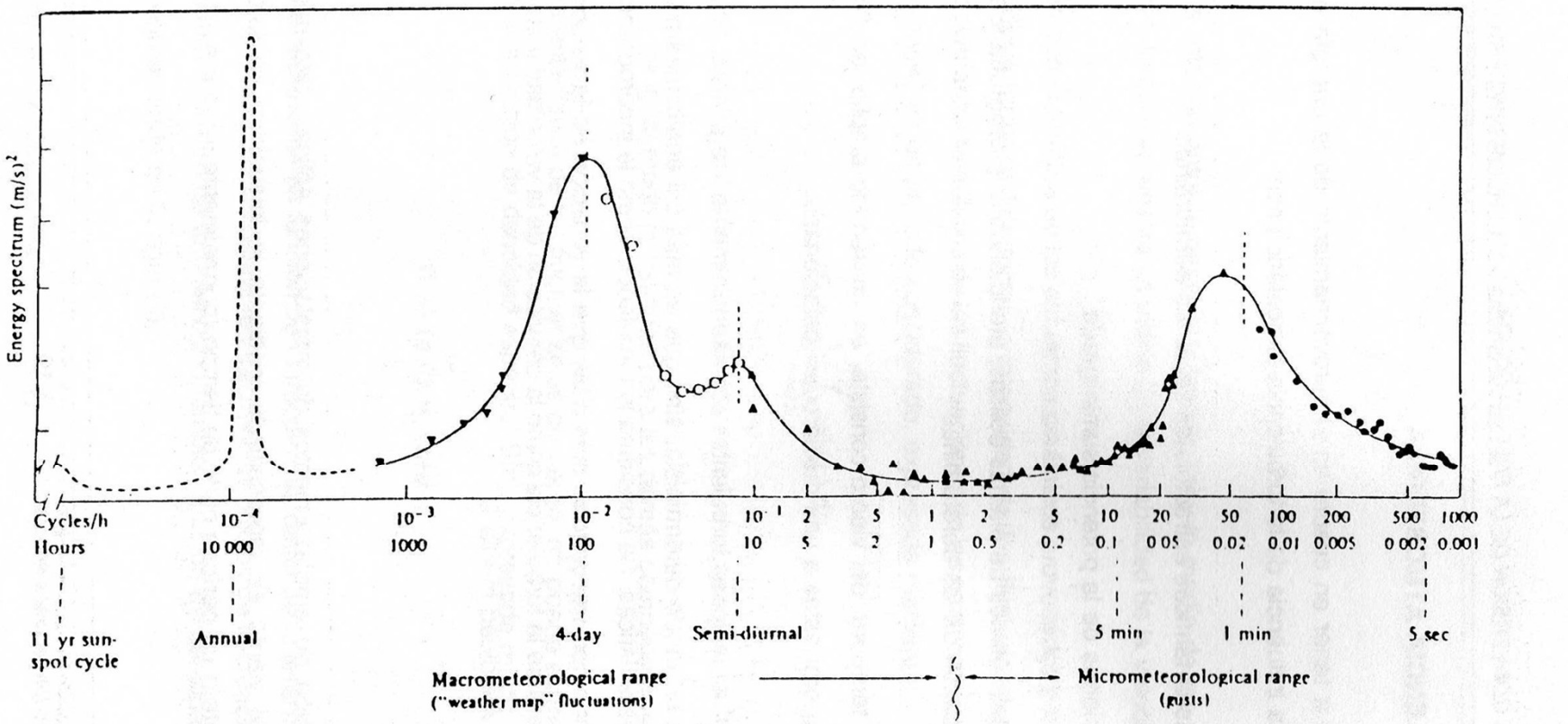
Von Karman Wind Spectrum



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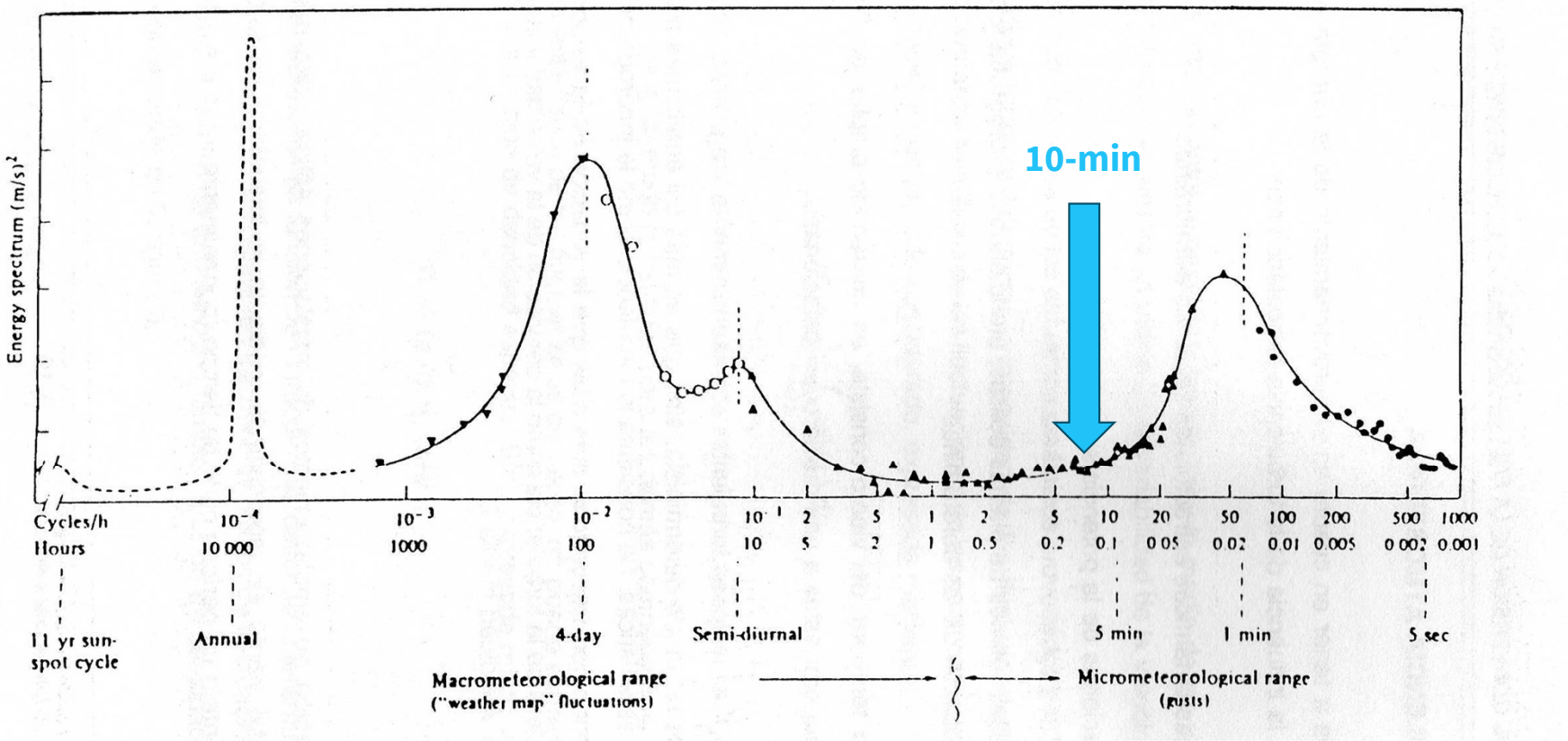
Von Karman Wind Spectrum



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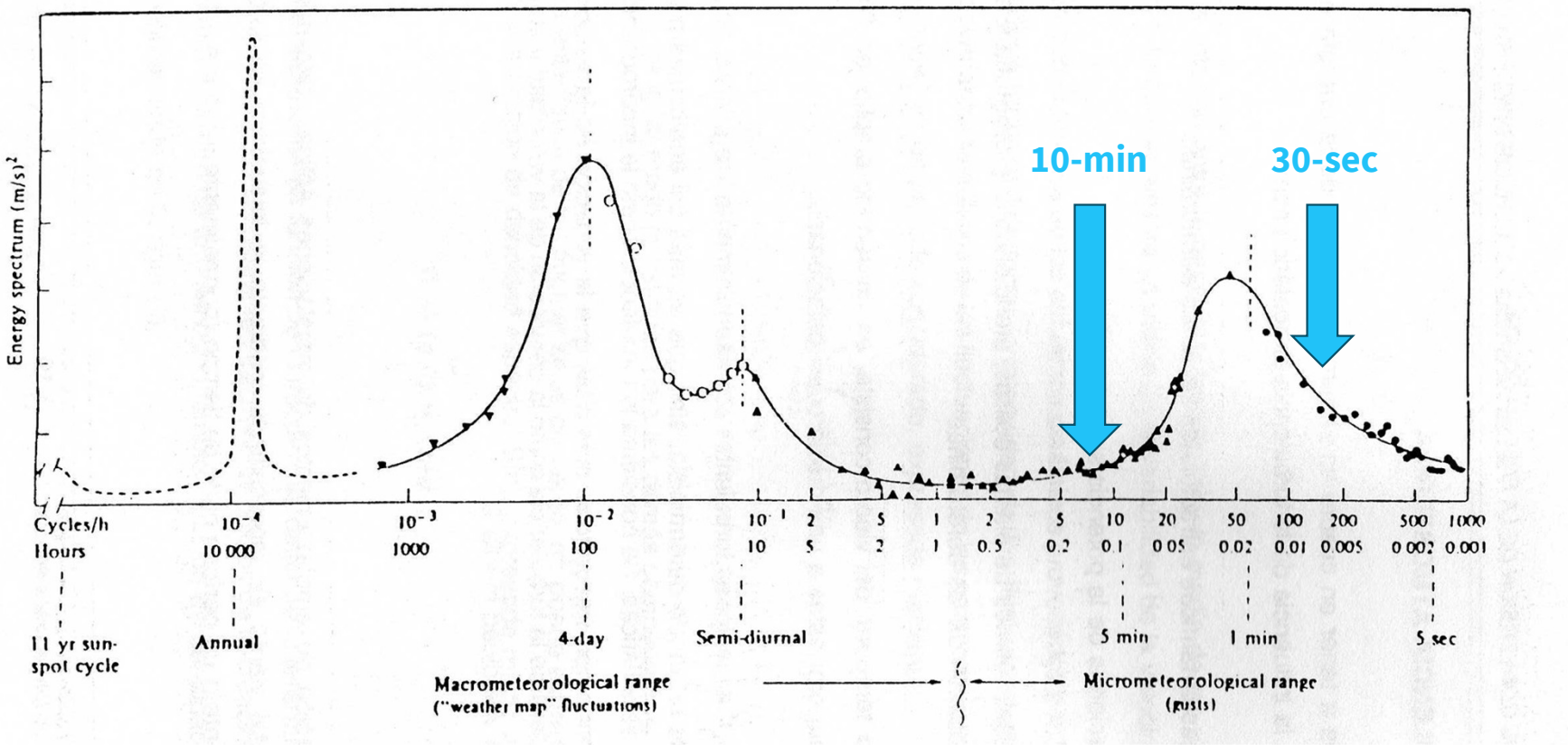
Von Karman Wind Spectrum



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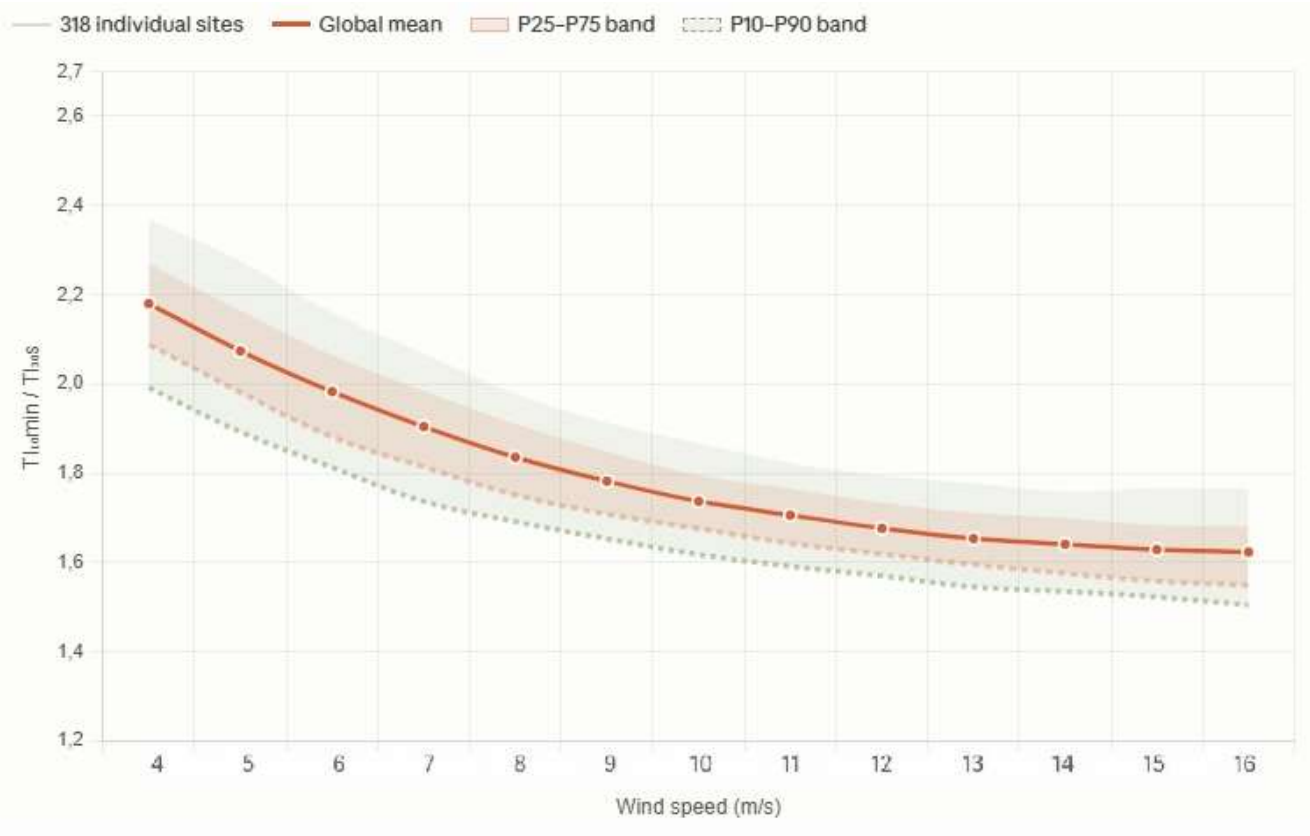

$$FC(v) = 0.0049 \cdot v^2 - 0.1398 \cdot v + 2.6414 \text{ - } R^2 = 0{,}9982$$

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Data Collection Every Second

With more than 6 million seconds of wind speed data, we have studied the phenomena that affect the calculation of Turbulence Intensity, including:

- Changes in average speed.
- High-frequency winds.
- Low-frequency winds.

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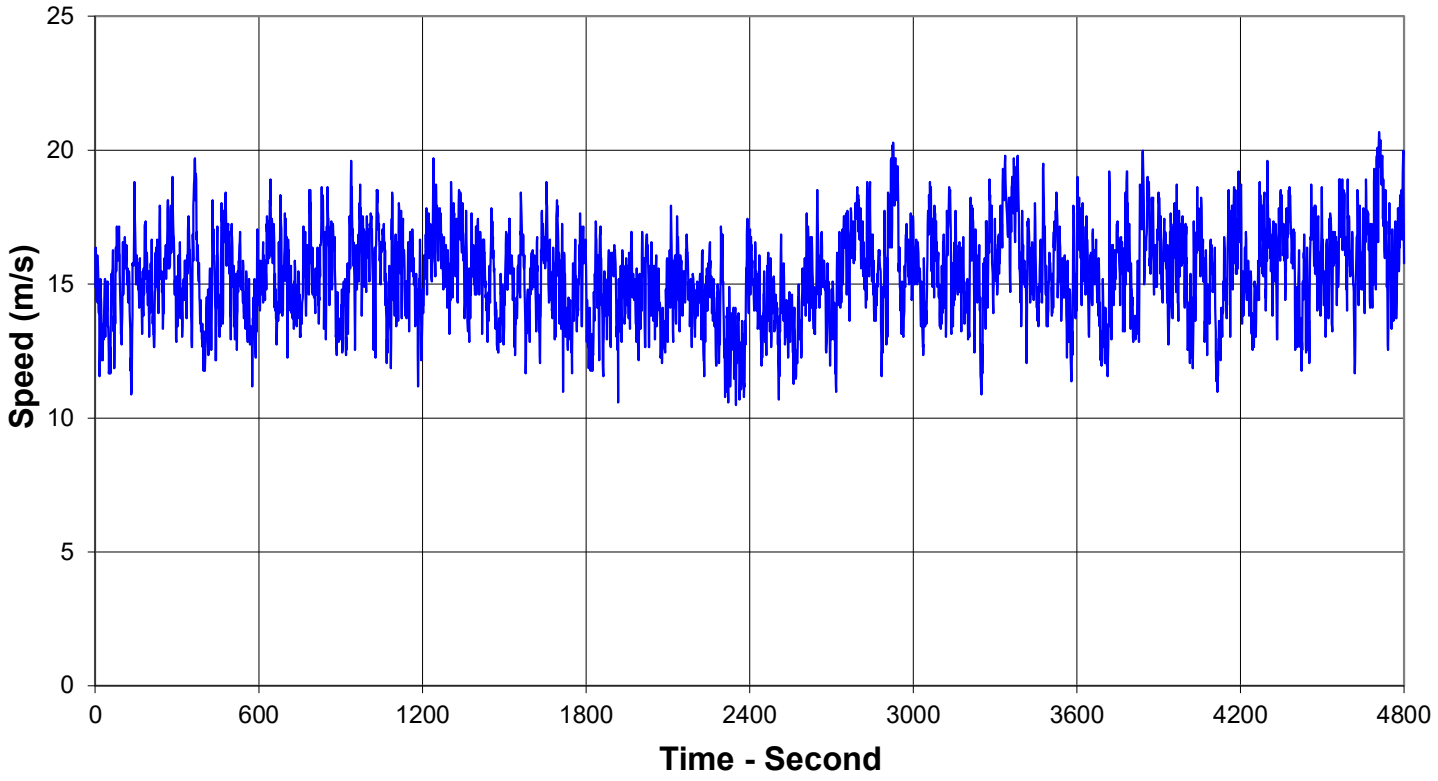
Data Collection Every Second: High-frequency winds



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Data Collection Every Second: High-frequency winds

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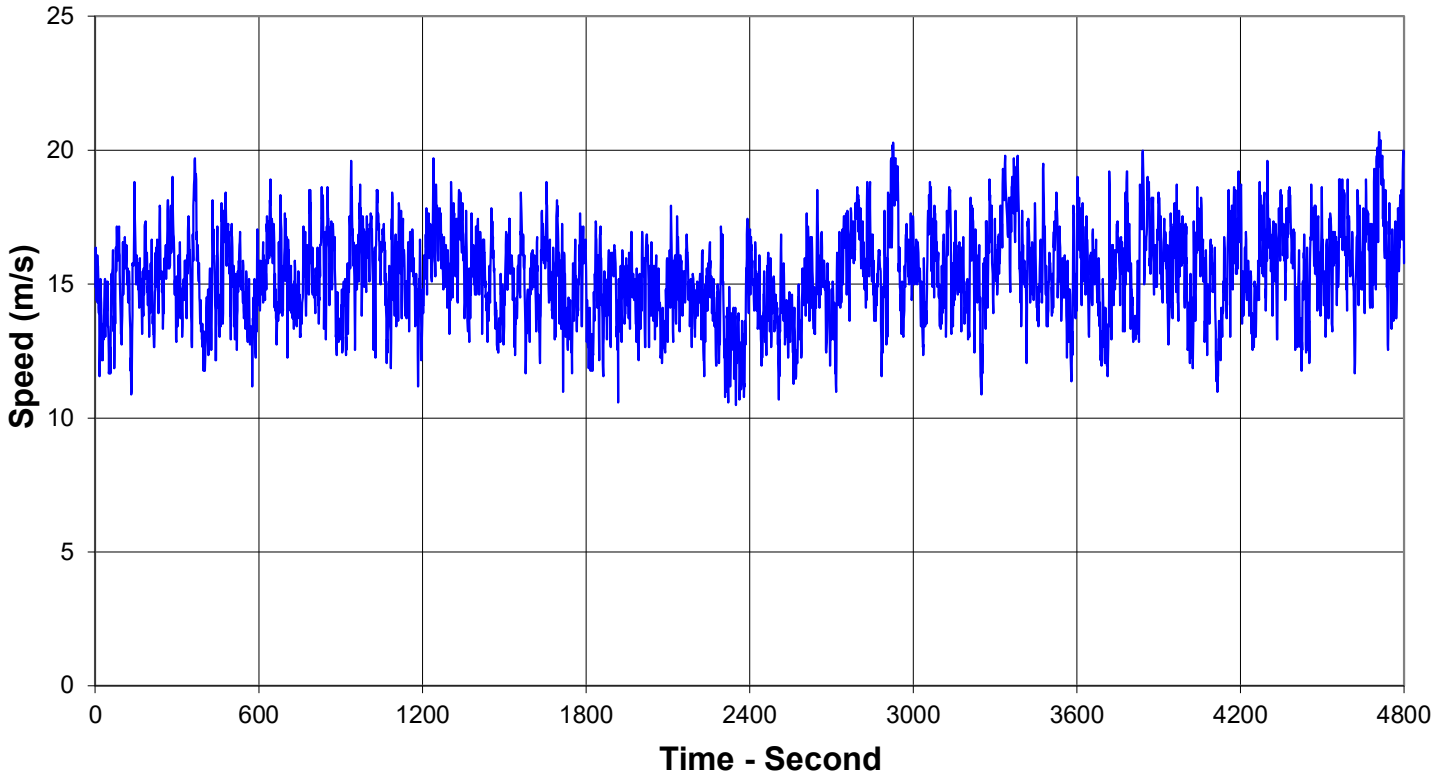

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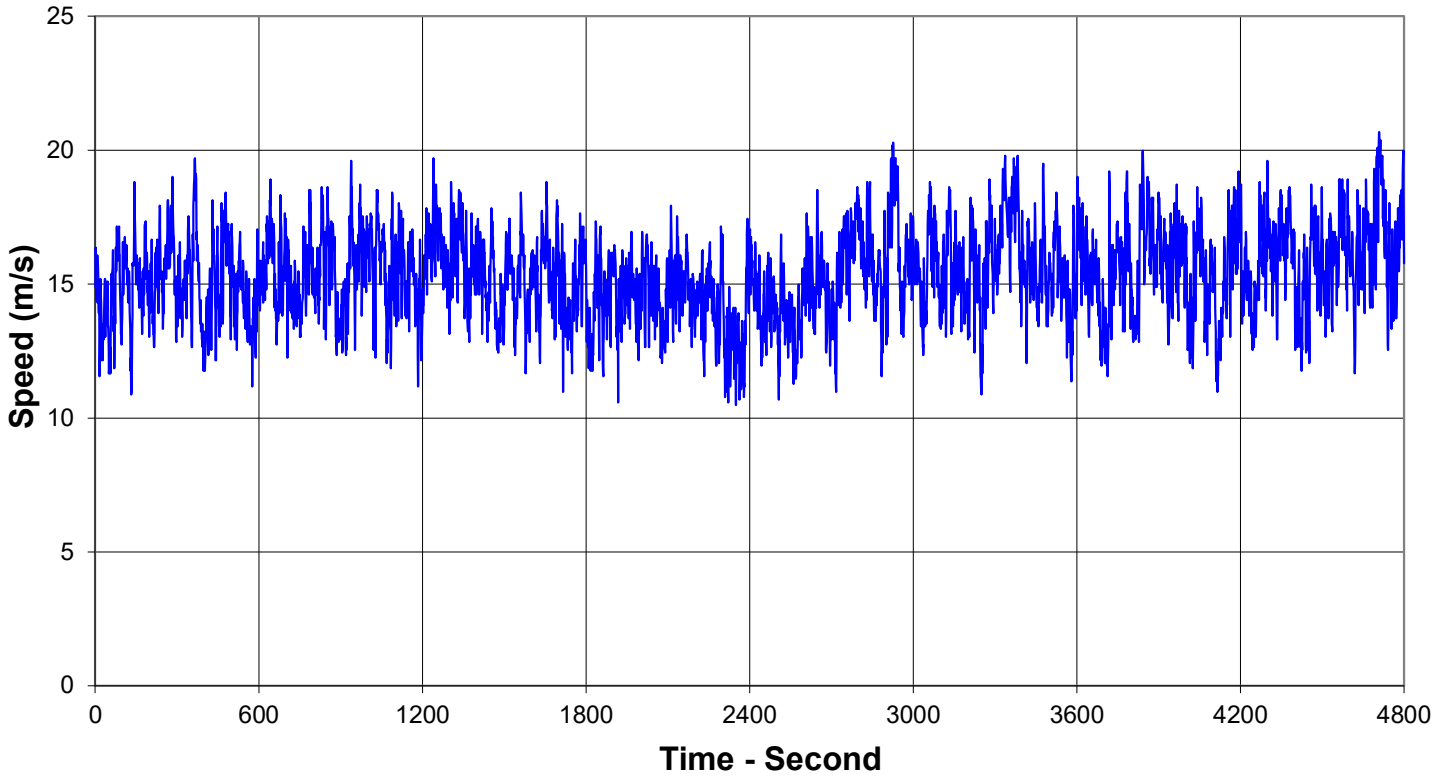
Data Collection Every Second: High-frequency winds

$$\text{RATIO} = \left(\frac{TI_{10\,\text{min}}}{TI_{30\,\text{sec}}} \right) \Downarrow$$



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Data Collection Every Second: High-frequency winds

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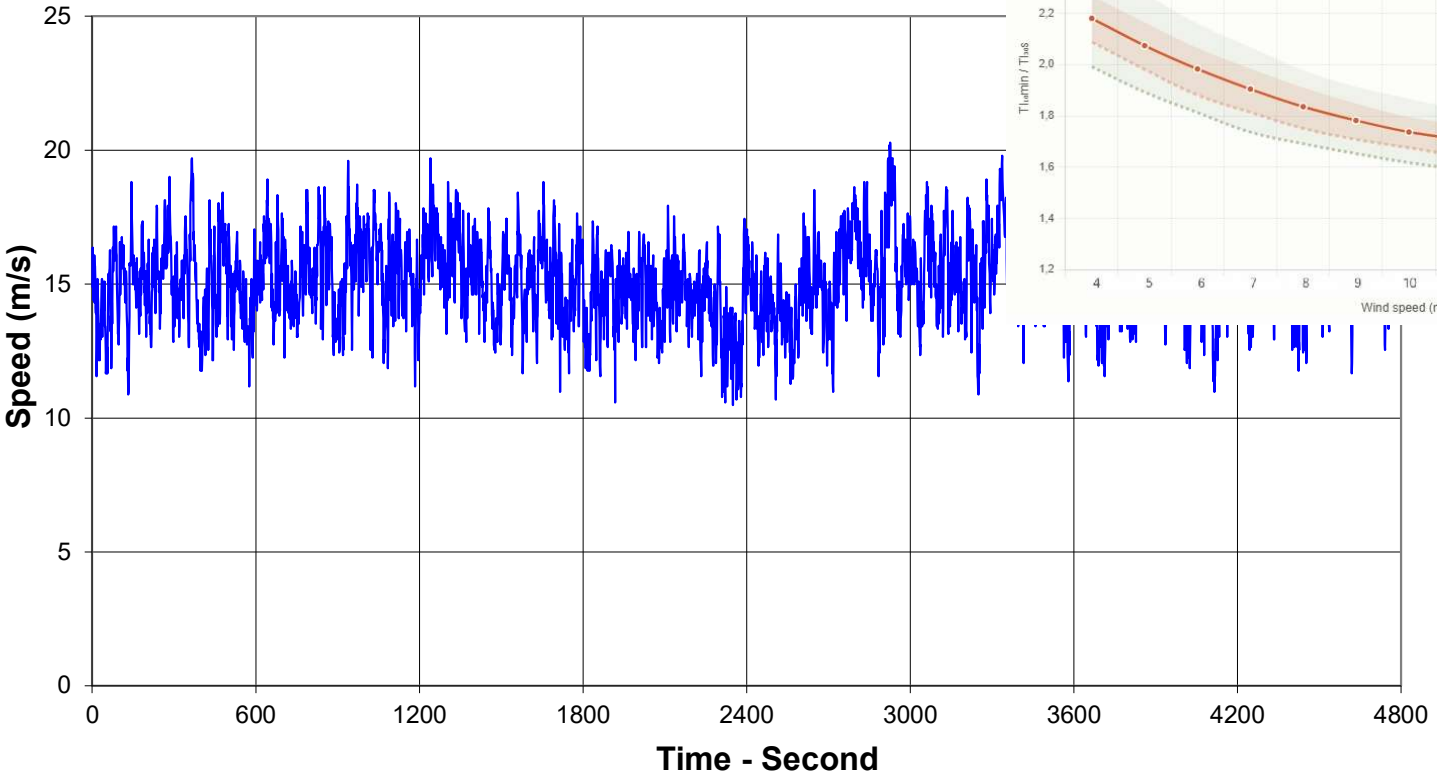

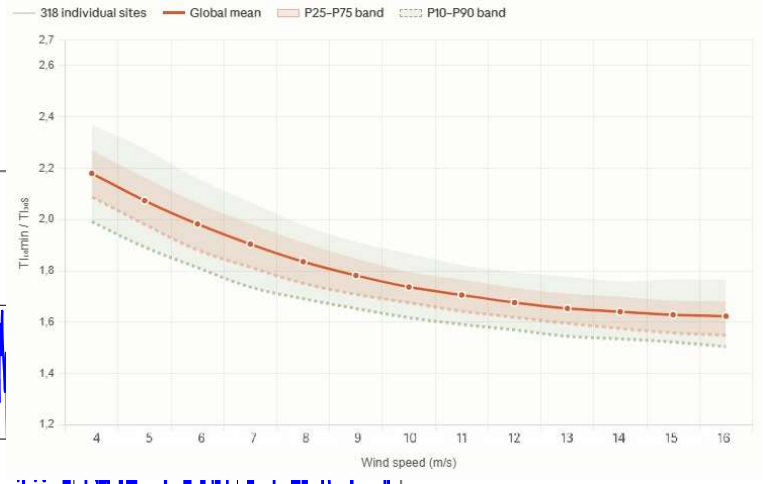

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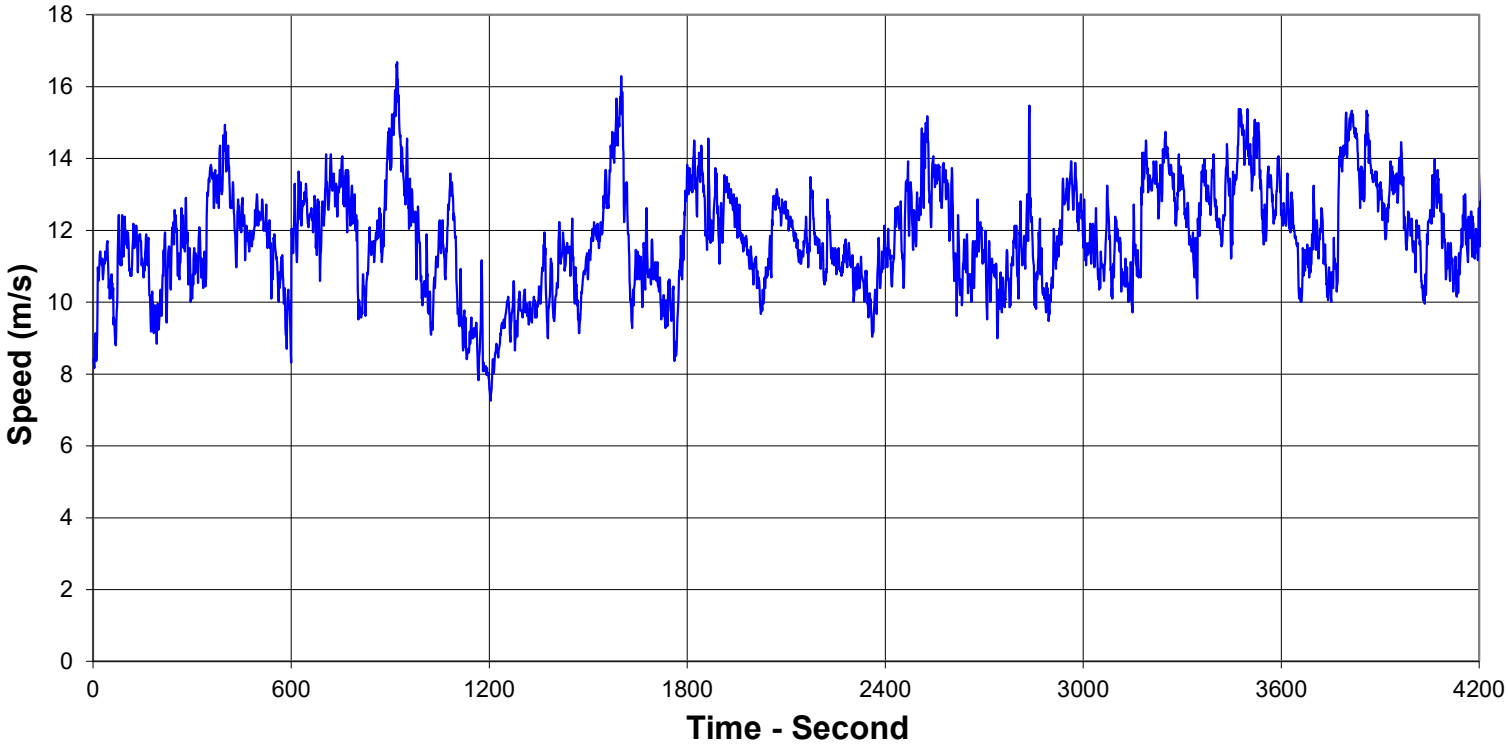
Data Collection Every Second: Low-frequency winds



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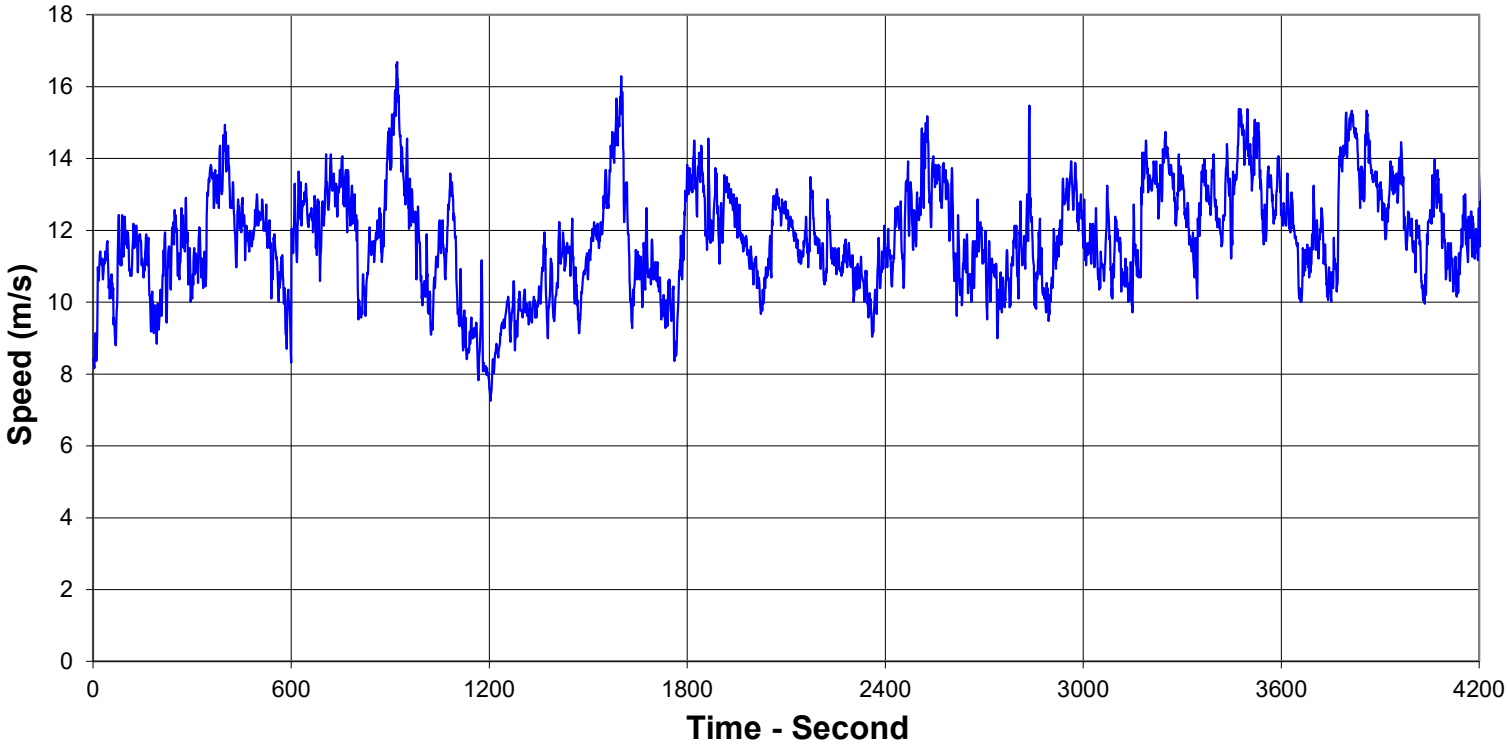

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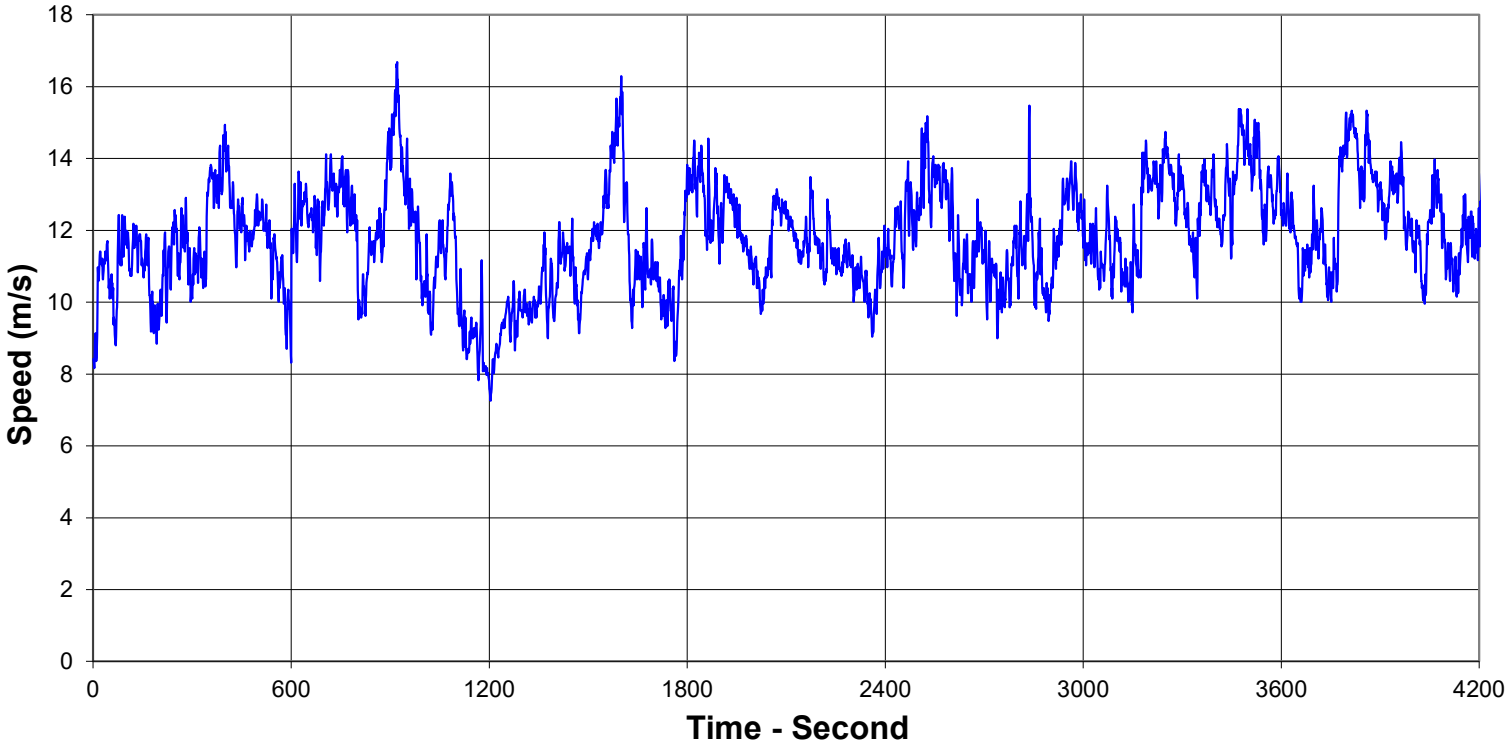

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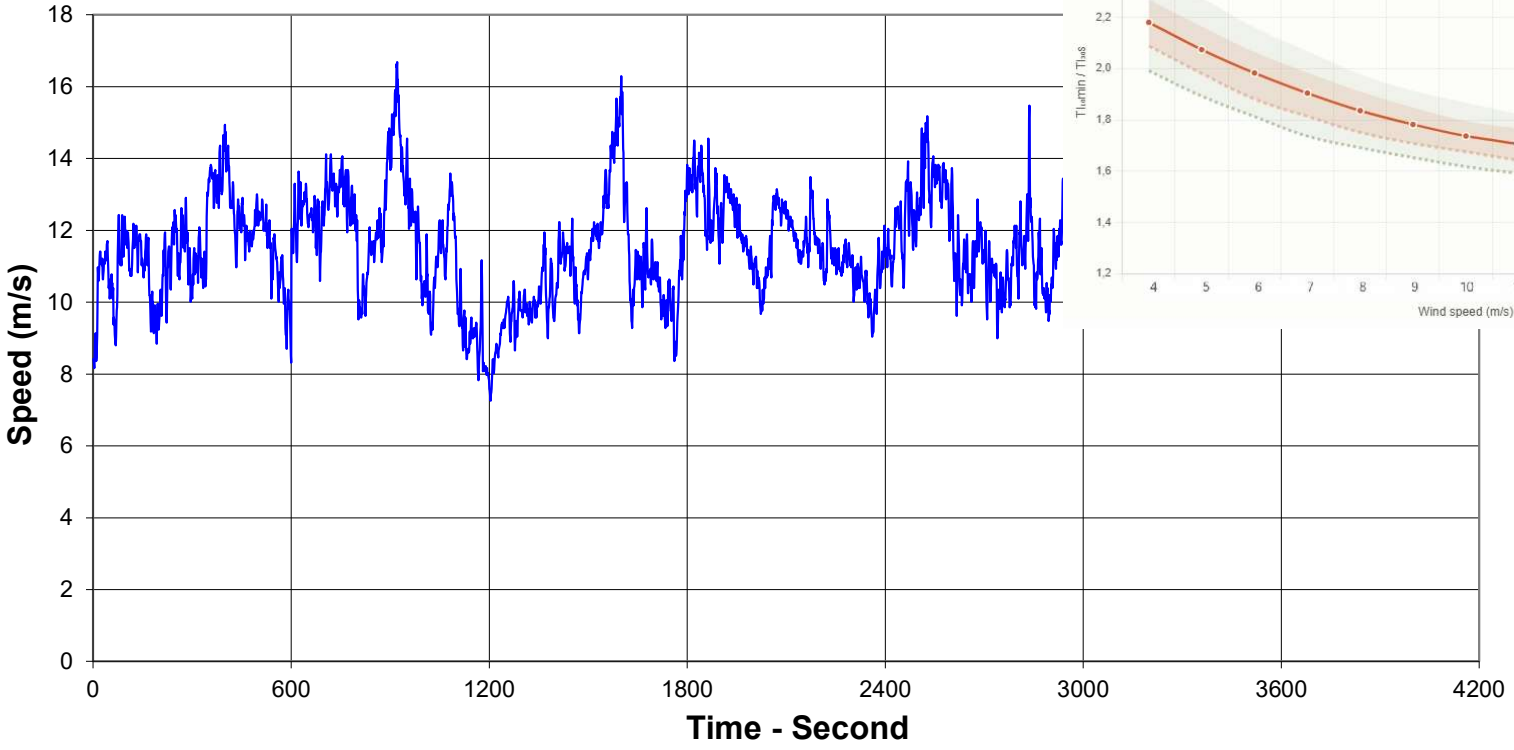

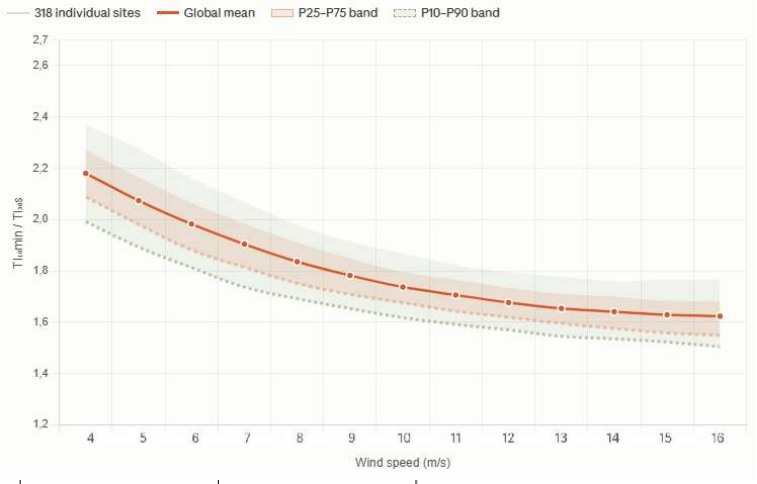

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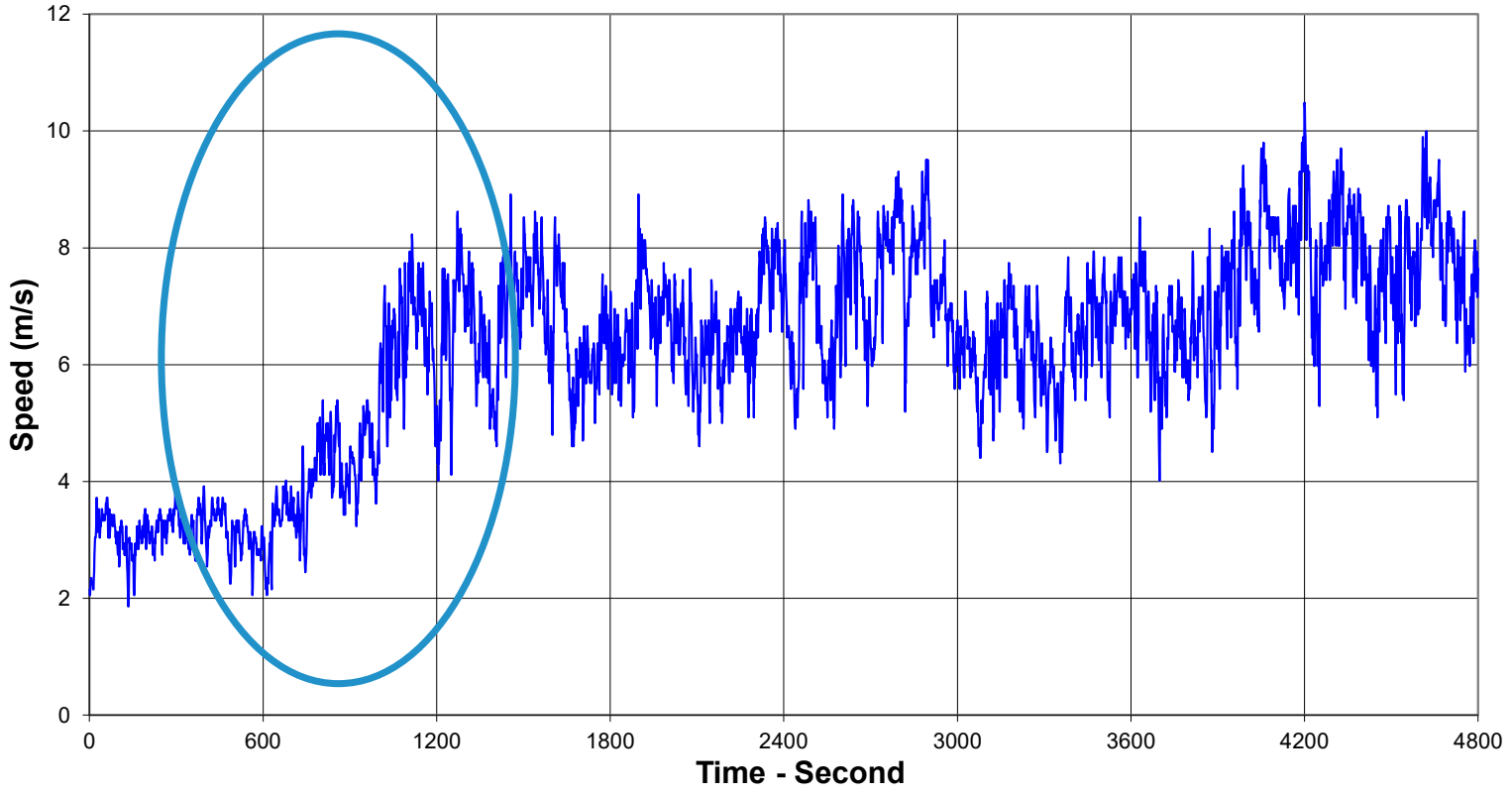
Data Collection Every Second: Changes in average speed



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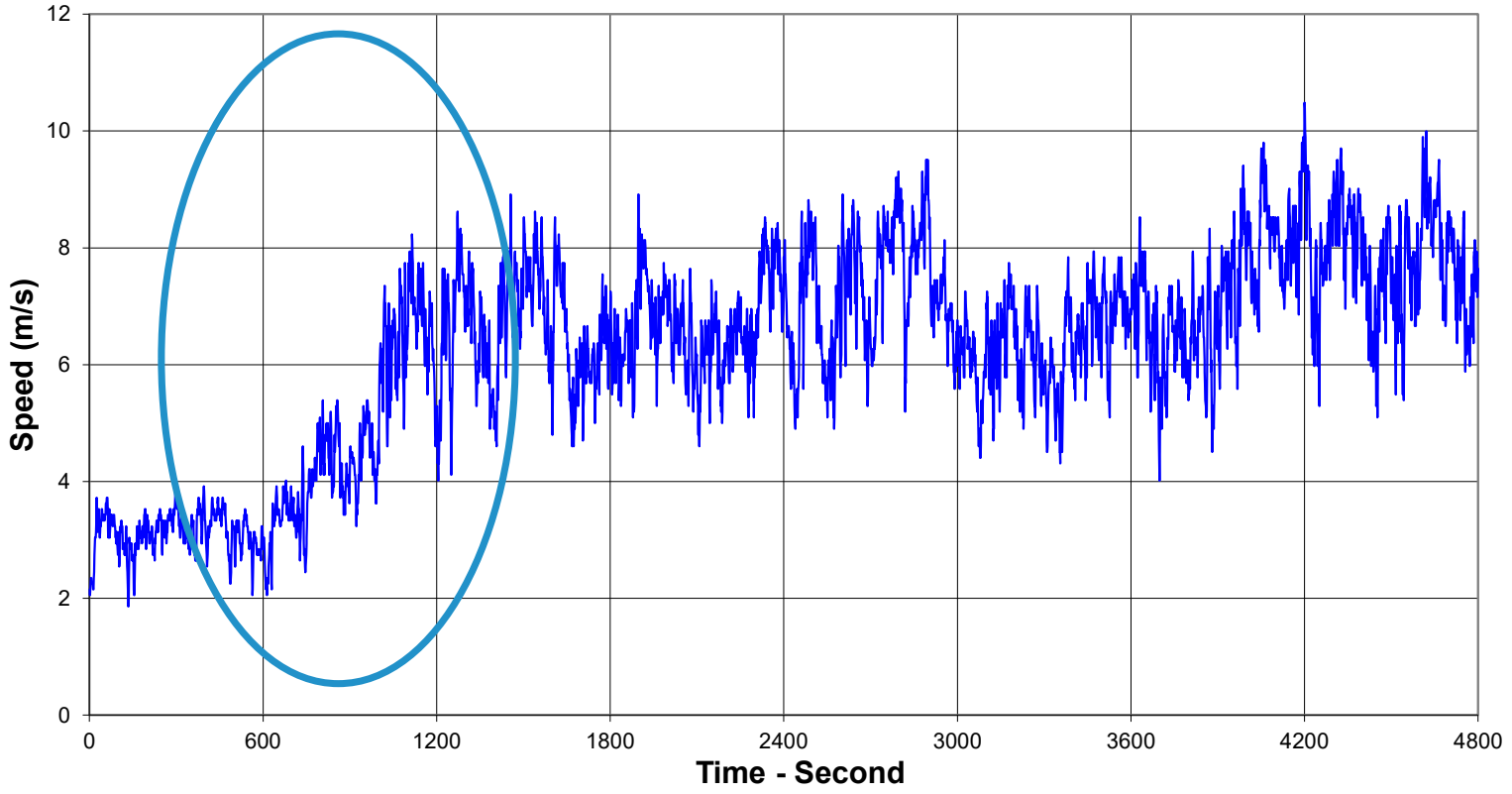

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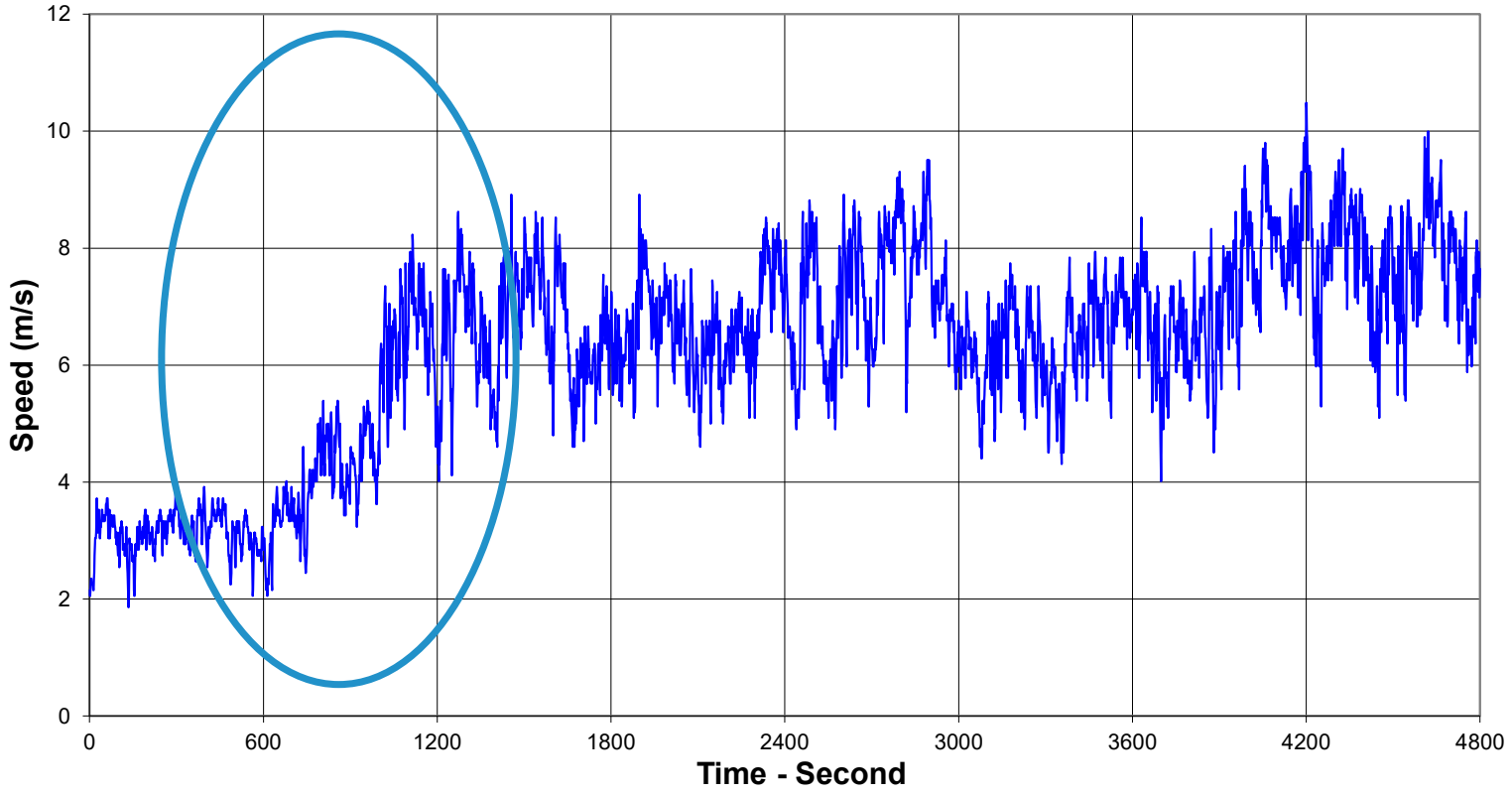

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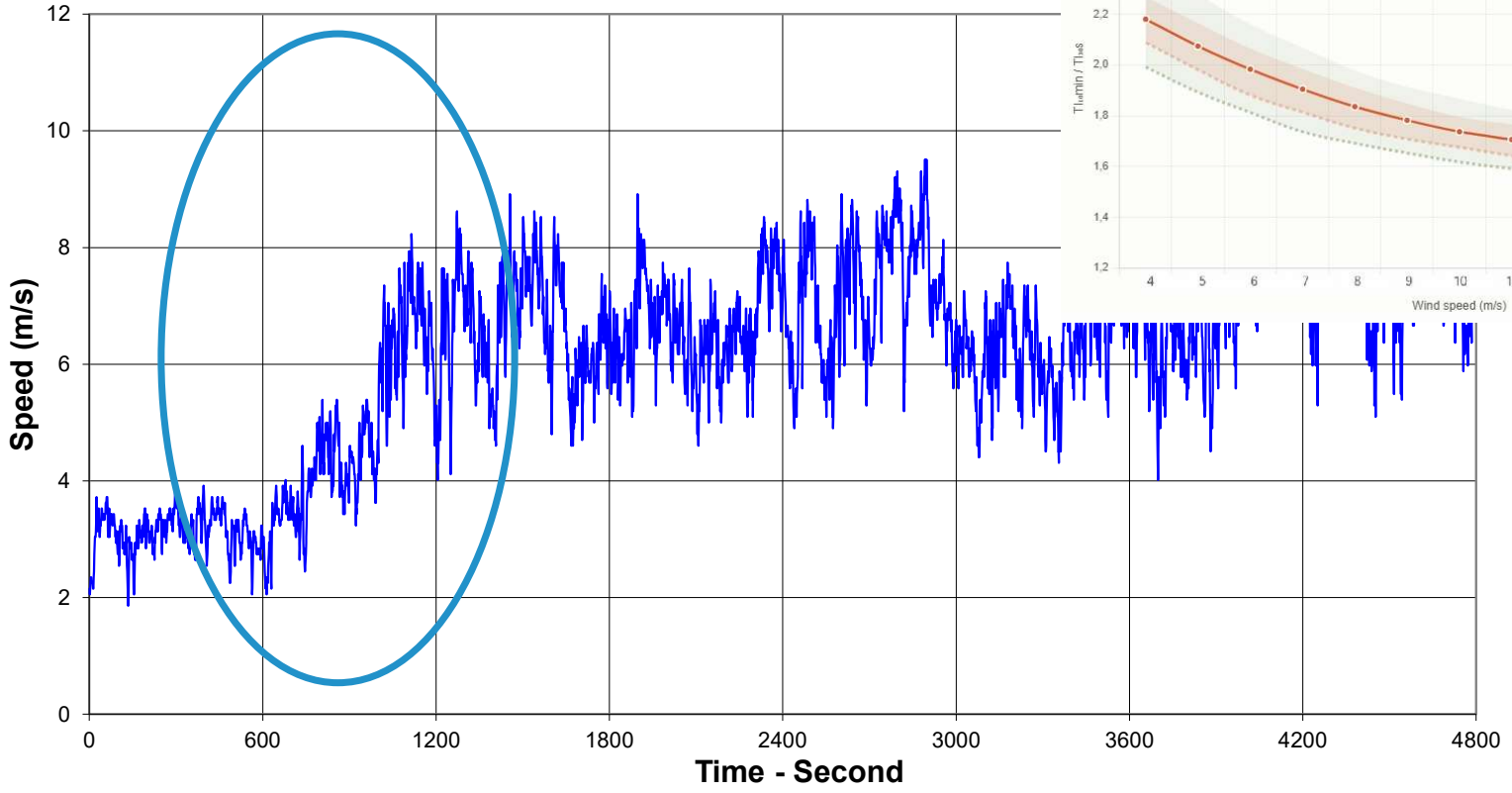

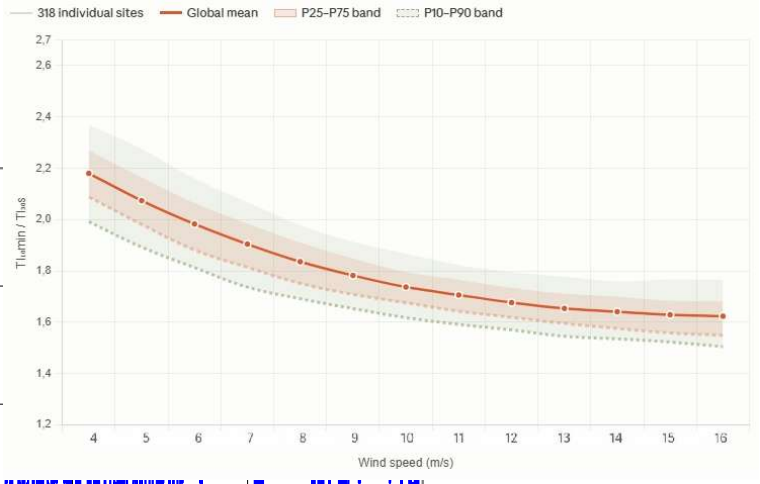

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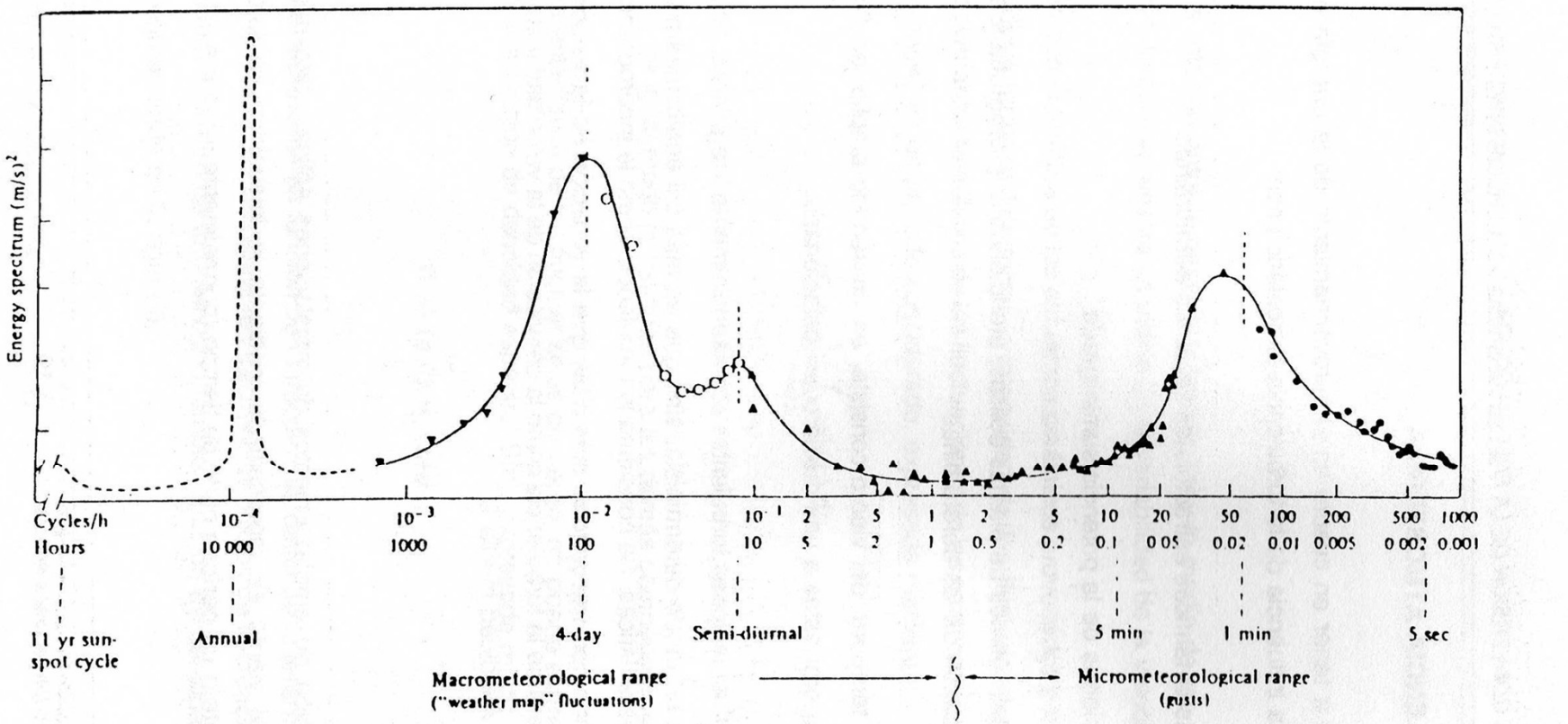
Von Karman Wind Spectrum



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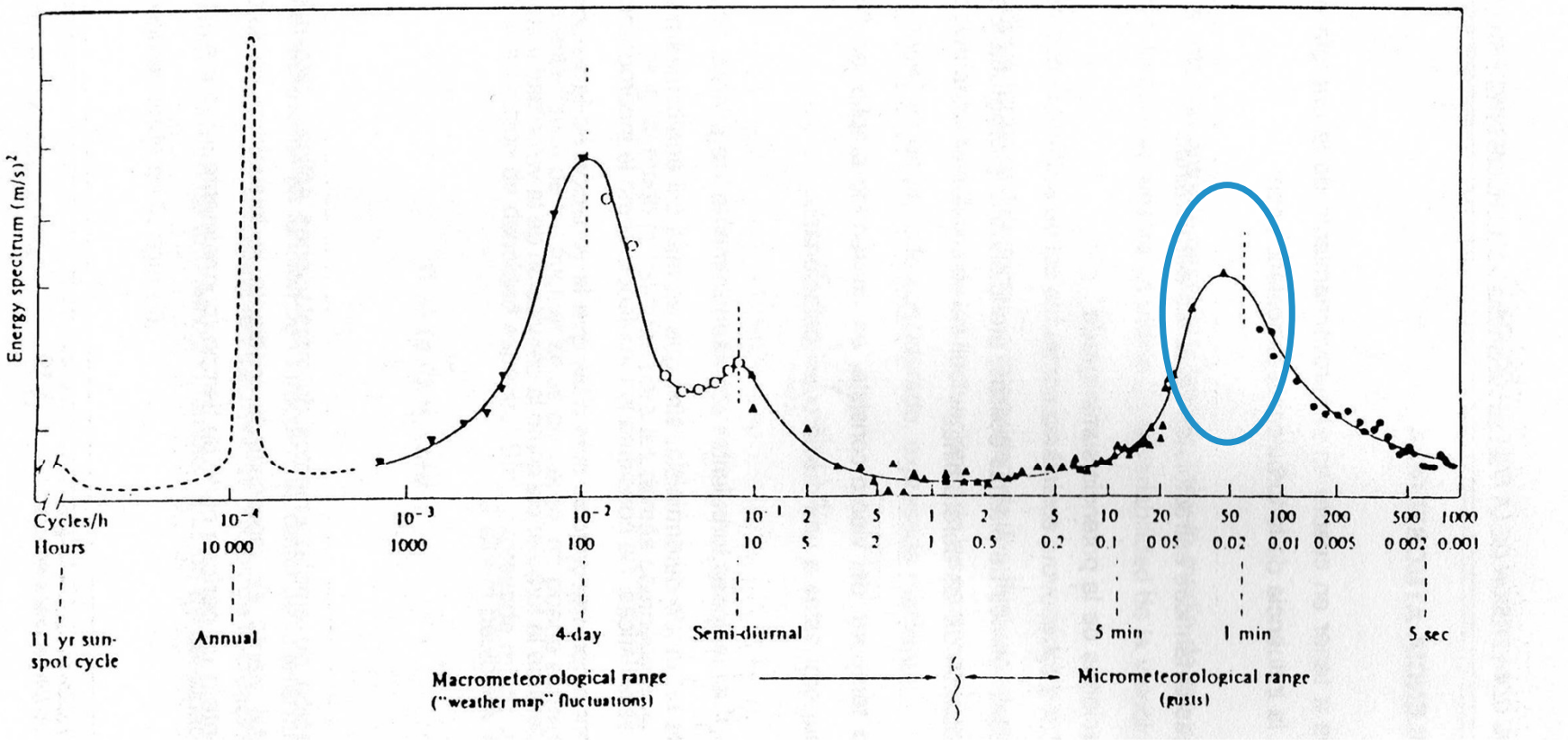

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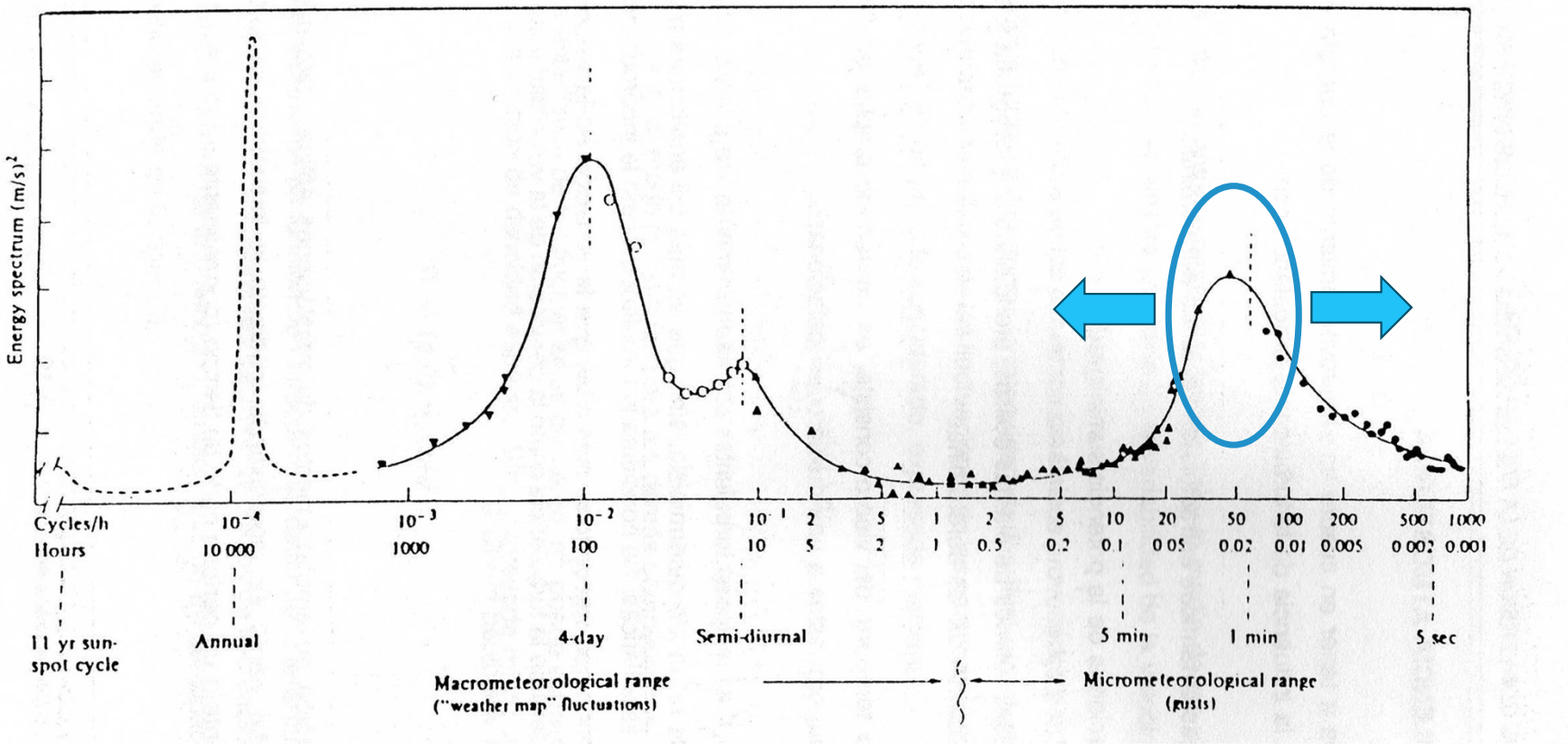

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Transform TI30 into IEC-scale TI

DateTime	FRQ(1)	FRQ(1)-TI	FRQ(1)-TI30
2026/01/05,22:30	8,958	0,162	0,088
2026/01/05,22:40	8,611	0,192	0,092
2026/01/05,22:50	8,316	0,188	0,13
2026/01/05,23:00	8,745	0,132	0,093
2026/01/05,23:10	9,138	0,148	0,099
2026/01/05,23:20	8,04	0,171	0,111
2026/01/05,23:30	8,174	0,130	0,076
2026/01/05,23:40	8,177	0,100	0,06
2026/01/05,23:50	8,684	0,066	0,039
2026/01/06,00:00	8,387	0,126	0,074
2026/01/06,00:10	7,698	0,115	0,076
2026/01/06,00:20	7,647	0,117	0,084
2026/01/06,00:30	6,478	0,176	0,119
2026/01/06,00:40	6,724	0,165	0,123
2026/01/06,00:50	7,74	0,195	0,127
2026/01/06,01:00	9,712	0,120	0,062
2026/01/06,01:10	9,234	0,116	0,072
2026/01/06,01:20	9,644	0,091	0,058
2026/01/06,01:30	9,163	0,132	0,072
2026/01/06,01:40	7,408	0,165	0,109
2026/01/06,01:50	7,283	0,174	0,101
2026/01/06,02:00	6,795	0,170	0,117
2026/01/06,02:10	6,68	0,221	0,142
2026/01/06,02:20	5,696	0,261	0,173
2026/01/06,02:30	6,133	0,199	0,123
2026/01/06,02:40	5,999	0,275	0,136
2026/01/06,02:50	7,732	0,200	0,132
2026/01/06,03:00	8,279	0,237	0,125

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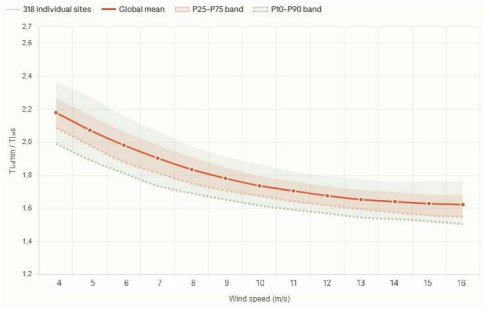

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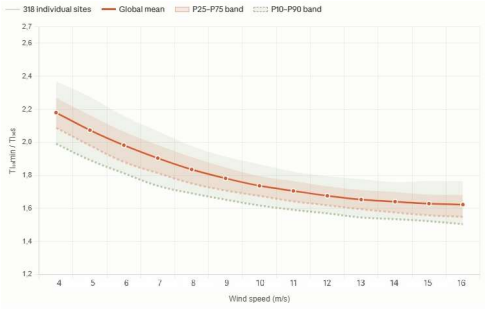

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IEC-scale TI = TI30 * FC(v)

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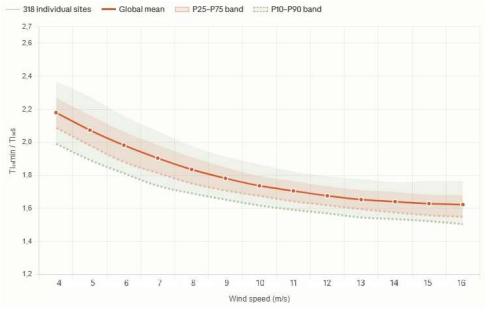
2026/01/06,02:50	7,732	0,200	0,132
2026/01/06,03:00	8,279	0,237	0,125



$$FC(v) = 0.0049 \cdot v^2 - 0.1398 \cdot v + 2.6414$$

IEC-scale TI = TI30 * FC(v)

FRQ(1)-IEC-scale TI
0,157
0,166
0,236
0,167
0,176
0,204
0,139
0,110
0,070
0,134
0,141
0,156
0,231
0,237
0,235
0,108
0,127
0,101
0,128
0,204
0,190
0,224
0,274
0,347
0,242
0,269
0,245
0,227

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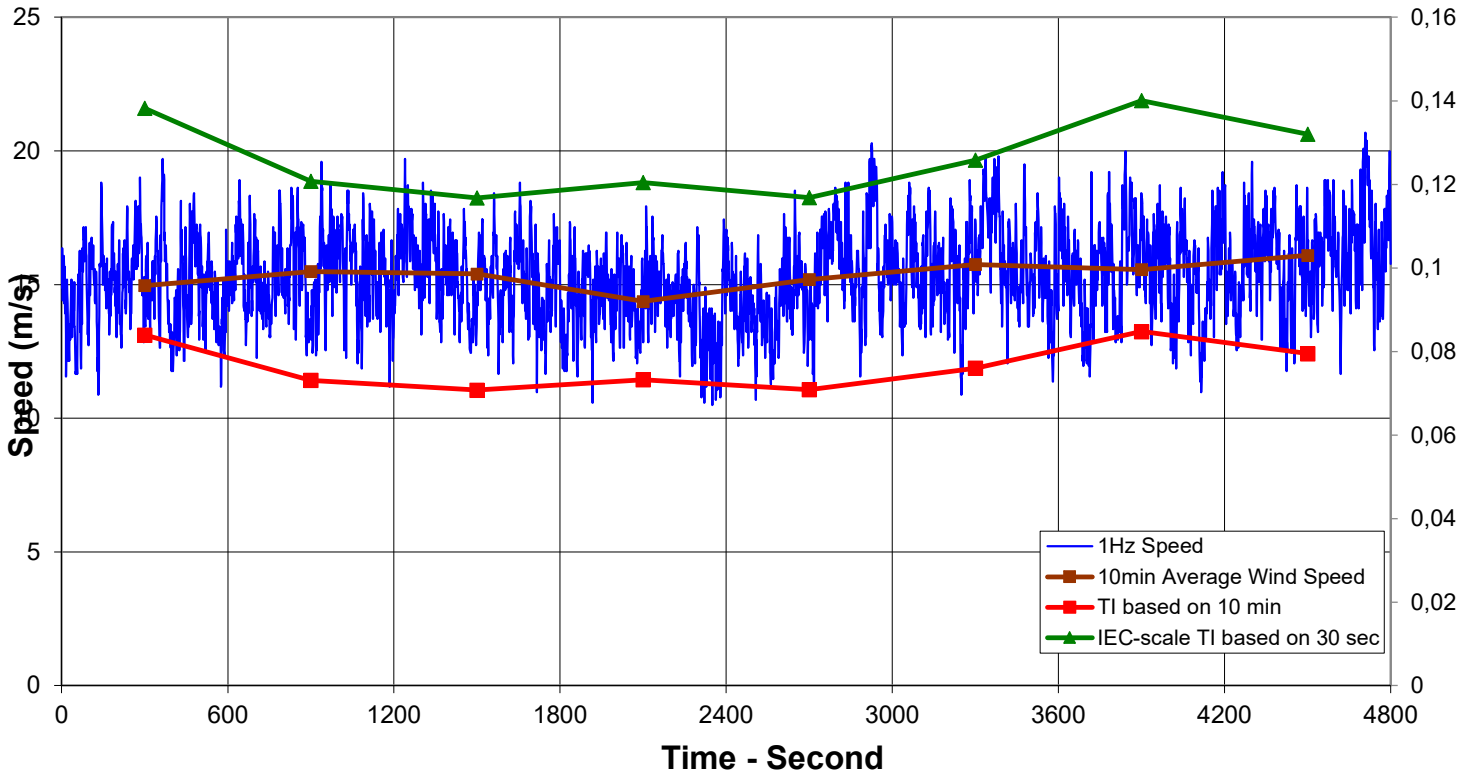
Data Collection Every Second: High-frequency winds

$$\text{RATIO} = \left(\frac{TI_{10\,\text{min}}}{TI_{30\,\text{sec}}} \right) \Downarrow$$



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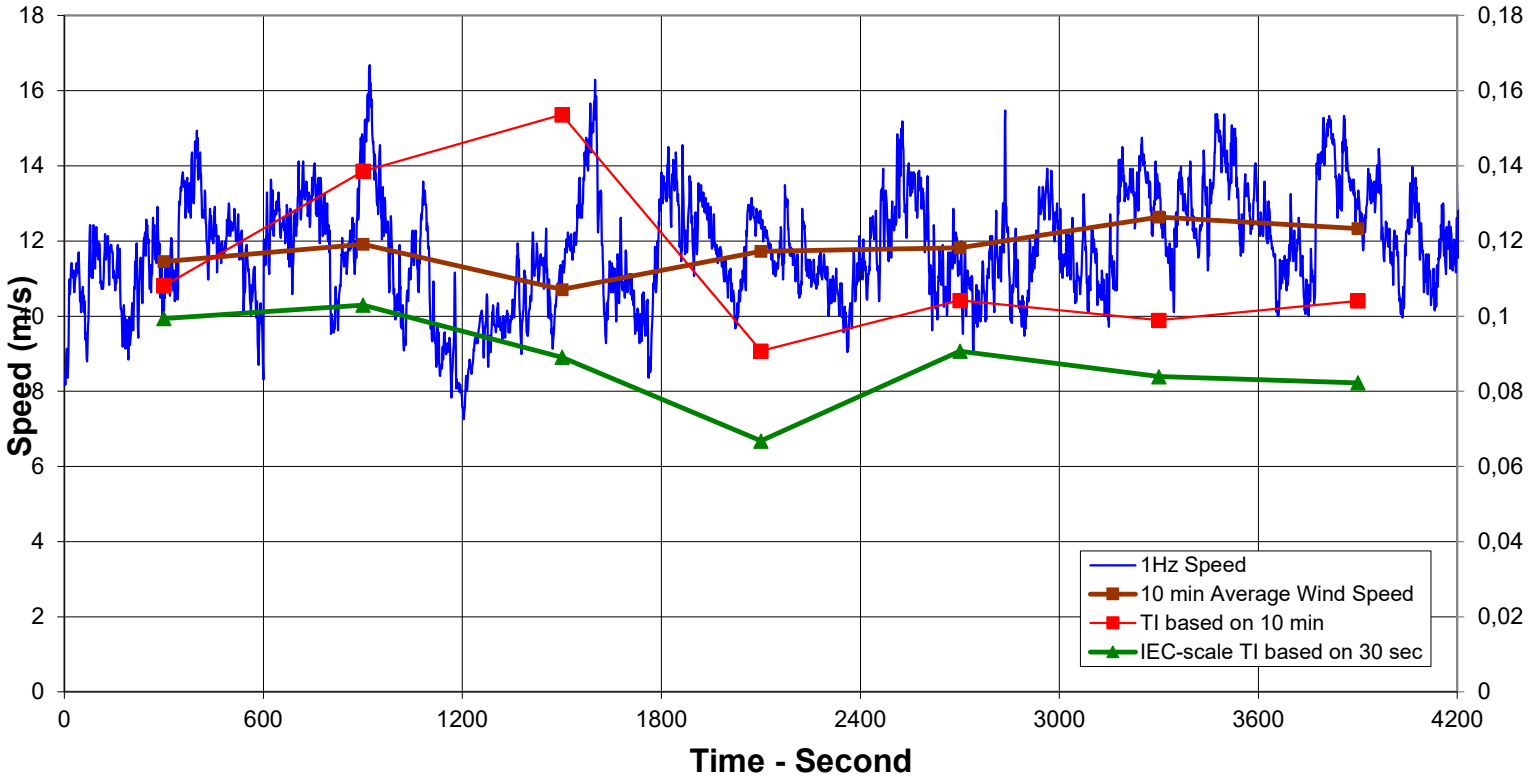
Data Collection Every Second: Low-frequency winds

$$\text{RATIO} = \left(\frac{TI_{10\,\text{min}}}{TI_{30\,\text{sec}}} \right) \Uparrow$$



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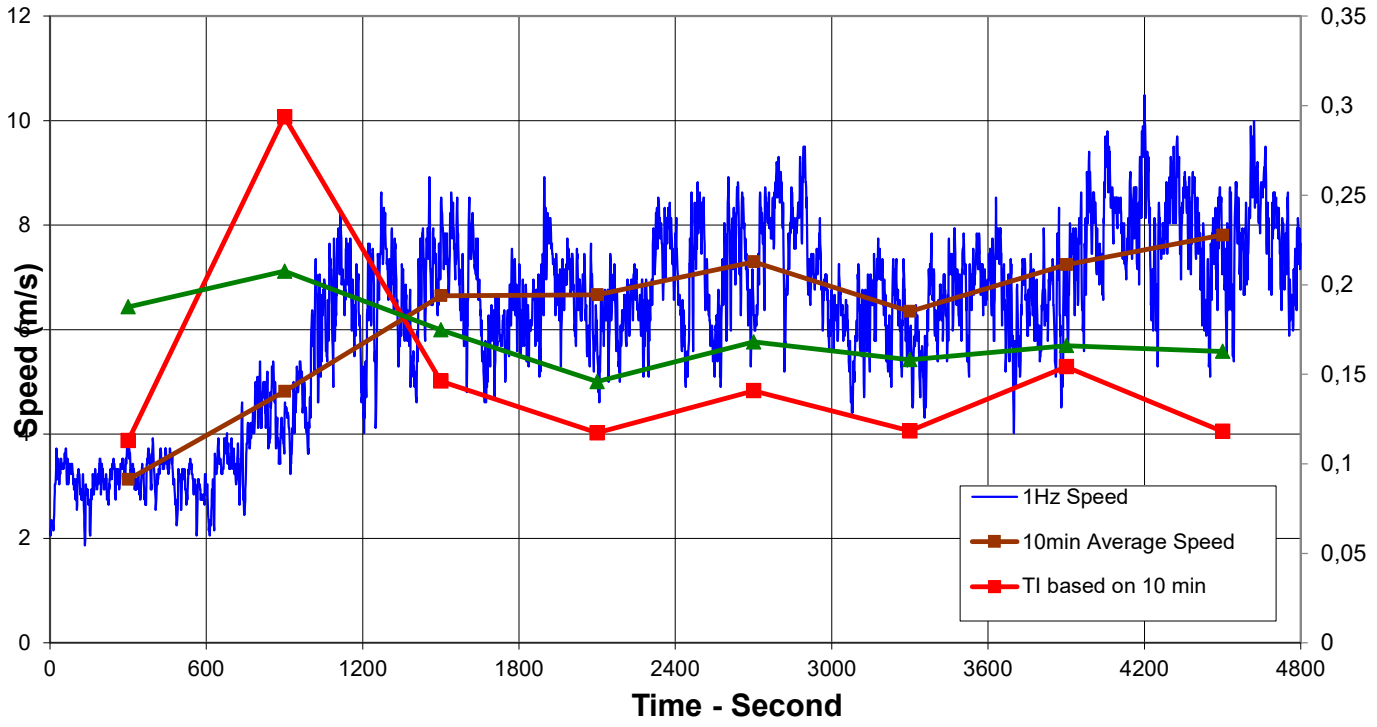
Data Collection Every Second: Changes in average speed

$$\text{RATIO} = \left(\frac{TI_{10\,\text{min}}}{TI_{30\,\text{sec}}}\right) \Uparrow \Uparrow$$



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01. The Origin

02. Von Karman Wind Spectrum

03. **Project phases:**
    - Ratio $TI_{10}min/TI_{30}s$
    - Data Collection Every Second
    - Transform TI30 into IEC-scale TI
    - **Real Sites**

04. Conclusions

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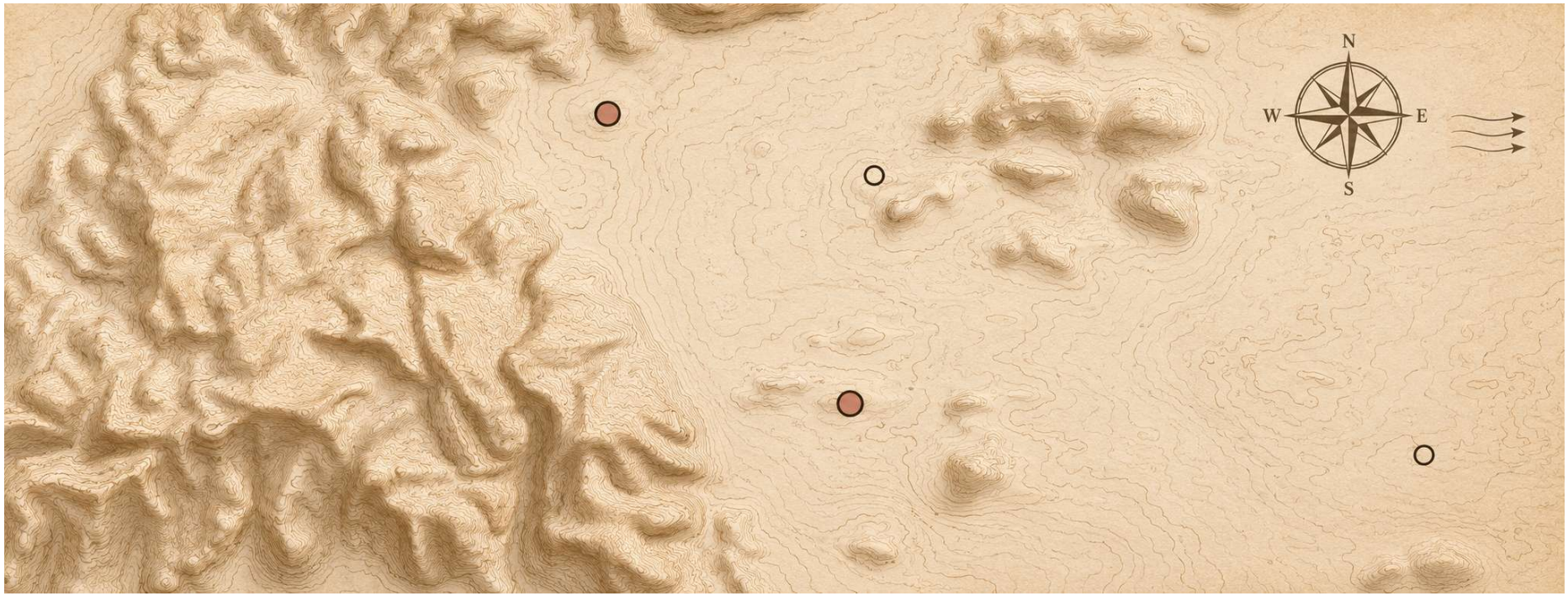
Real Sites



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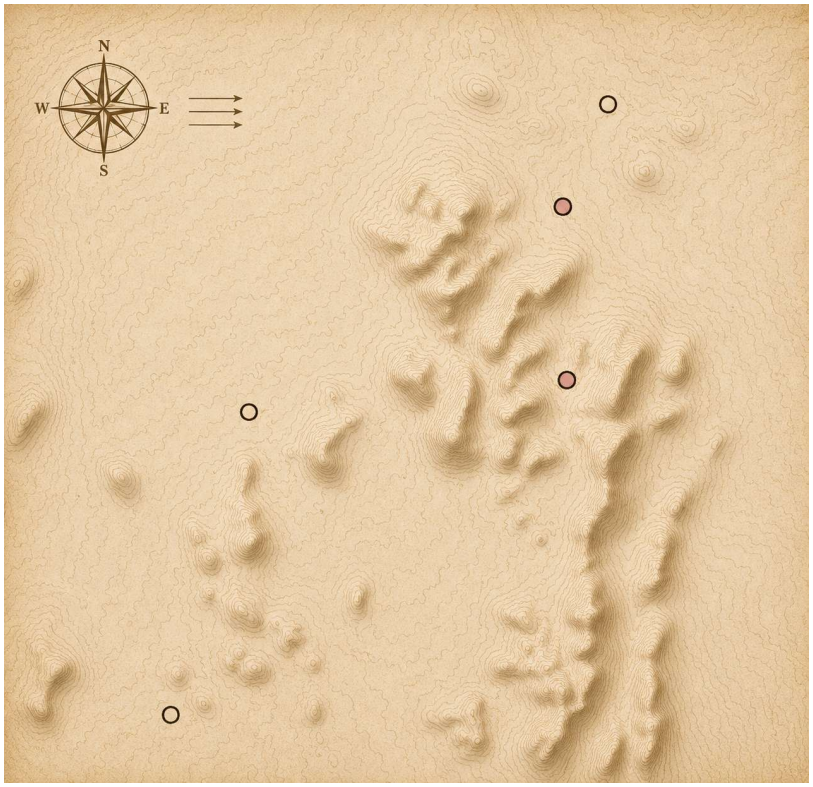
Real Sites



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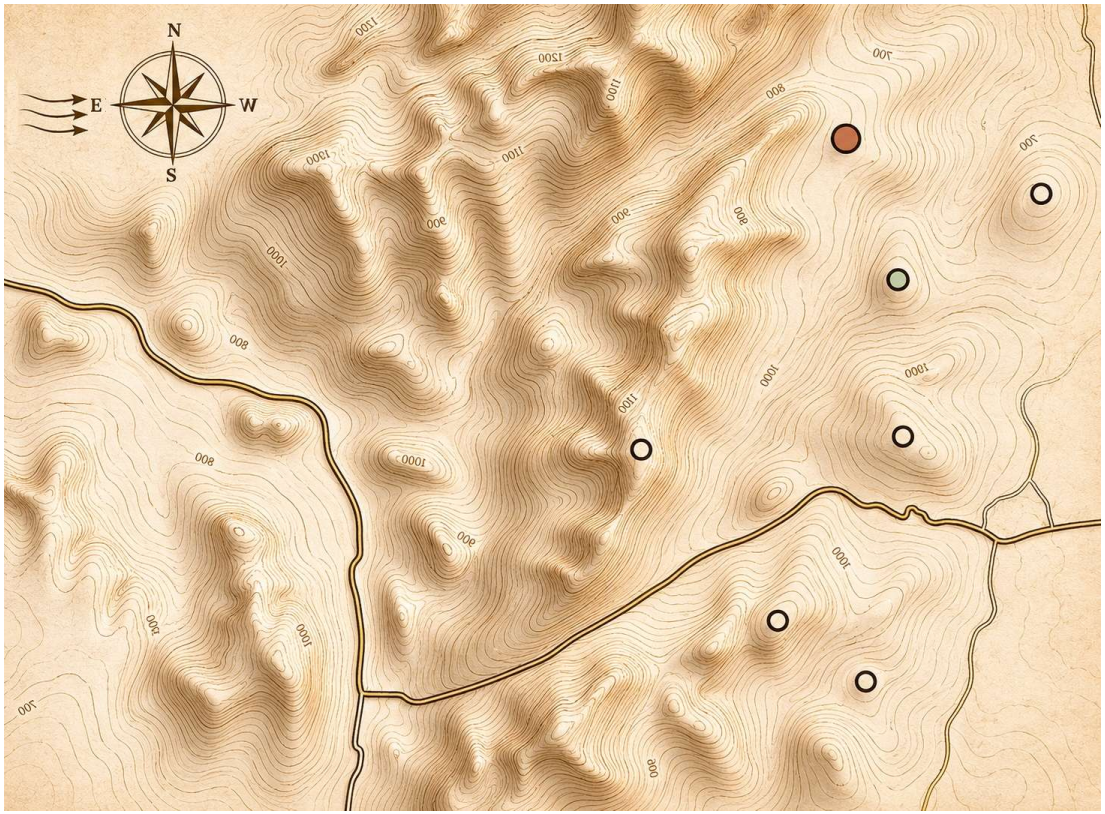
Real Sites



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04. **Conclusions**

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Conclusions

01 The 10-min standard deviation is INFLUENCED by phenomena unrelated to true turbulent loads on wind turbines.

02 The IEC-scale TI based on 30 sec reveals NEW INFORMATION about high-frequency wind phenomena not captured by the IEC standard.

03 The IEC-scale TI based on 30 sec can affect wind turbine subclass selection in up to 30% of measured sites.

04 The 30-second interval was validated: it captures critical high-frequency wind components while preceding the dominant spectral mass near 1-minute periods.

05 ~25% of global met towers already log IEC-scale TI based on 30 sec, enabling immediate comparison with IEC TI.

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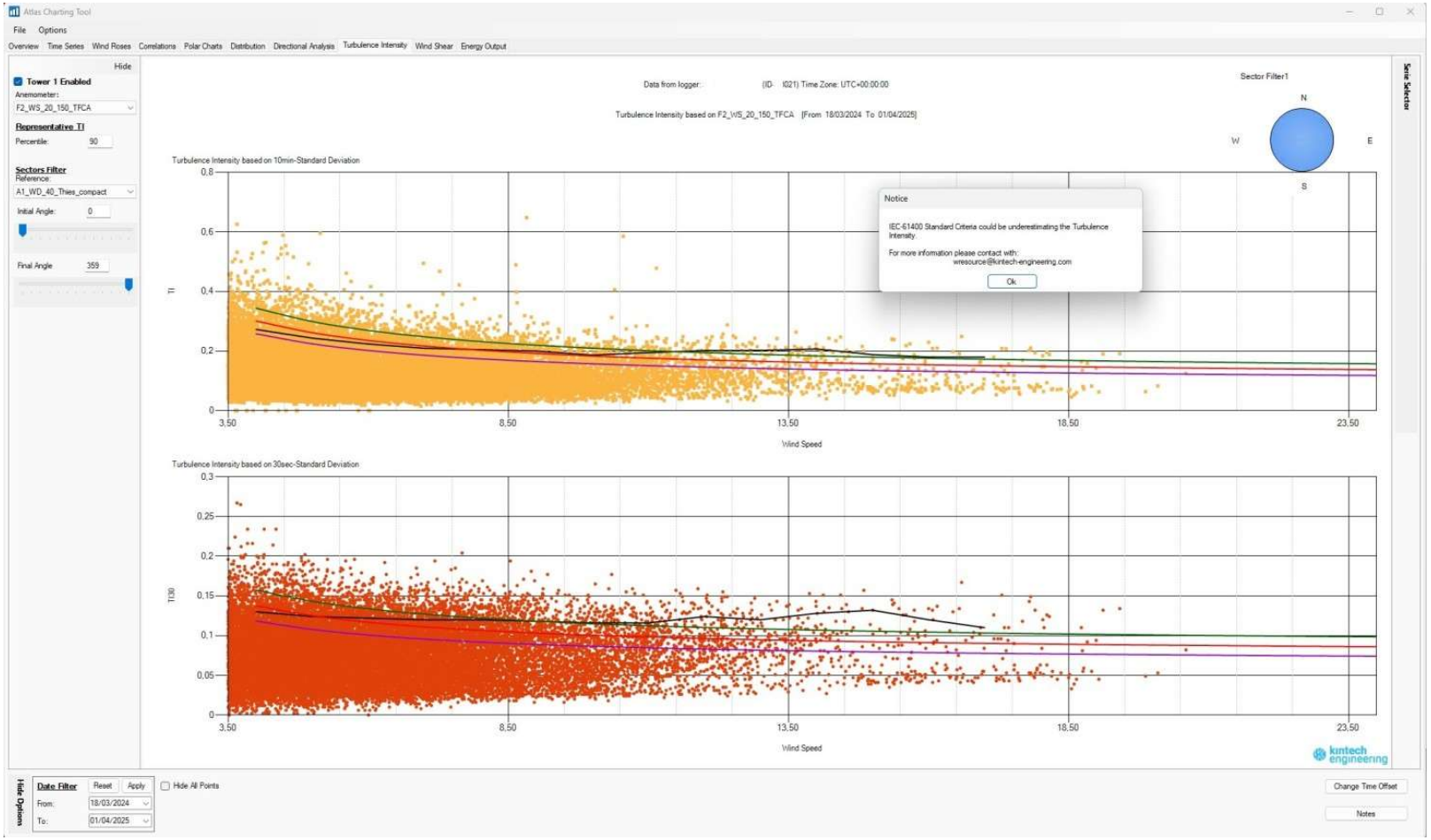
Conclusions



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THANK YOU

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