



meridian

Recent Storm Events in NZ

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- Recent storms in Wellington
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- Recent storms
- Return periods
- West Wind during a storm
- Conclusions



What were the recent storms?

- 20th June 2013
 - Southerly winds
 - Gusts up to 200 kph (56m/s) on Mt Kaukau – highest since records began in 1969
 - Worst since 10th April 1968 - Wahine Storm
- September and October 2013
 - Northerly winds
 - Two significant storms, wind gusts of 170 kph (47m/s) on Mt Kaukau
- 16th March 2014 – *Cyclone Lusi*
 - *Northerly winds*
 - *Wind gust of 135 kph (37m/s)*



The Beaufort Scale

"Over thousands of years sailors have learnt to estimate the speed of the wind just by looking about. This technique matured into what we now call the Beaufort scale. The universe tells you everything you need to know about it as long as you are prepared to watch, to listen, to smell, in short to observe!"

.....Howtoons 2006

FORCE 0	SPEED 0 Knots 0 mph 0 km/h	SEA	Sea like a mirror
		LAND	Smoke rises vertically



FORCE 1	SPEED 1-3 Knots 1-3 mph 1-6 km/h	SEA	Ripples with the appearance of scales are formed, but without foam crests
		LAND	Direction of wind shown by smoke but not by wind varies



FORCE 2	SPEED 4-6 Knots 4-7 mph 7-11 km/h	SEA	Small wavelets. Crests have a glassy appearance and do not break
		LAND	Wind felt on face; leaves rustle; ordinary vane moved by wind



FORCE 3	SPEED 7-10 Knots 8-12 mph 12-19 km/h	SEA	Large wavelets. Crests begin to break. Foam of glassy appearance.
		LAND	Leaves and small twigs in constant motion; wind extends light flag



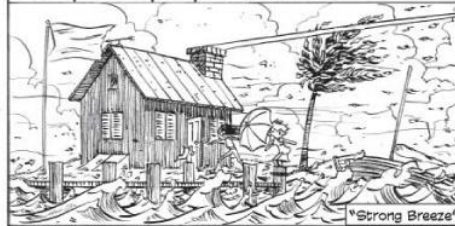
FORCE 4	SPEED 11-16 Knots 13-18 mph 20-29 km/h	SEA	Small waves, becoming longer, fairly frequent white horses
		LAND	Raises dust and loose paper; small branches are moved



FORCE 5	SPEED 17-21 Knots 19-24 mph 30-39 km/h	SEA	Moderate waves, taking a more pronounced long form; many white horses are formed.
		LAND	Small trees in leaf begin to sway; wavelets form on inland waters



FORCE 6	SPEED 22-27 Knots 25-31 mph 40-50 km/h	SEA	Large waves begin to form; the white foam crests are more extensive everywhere.
		LAND	Large branches in motion; whistling heard in telegraph wires; umbrellas use difficult.



FORCE 7	SPEED 28-33 Knots 32-38 mph 51-62 km/h	SEA	Sea heaps up and white foam from breaking waves starts to blow in streaks with wind.
		LAND	Whole trees in motion; umbrellas discarded; inconvenience felt when walking



FORCE 8	SPEED 34-40 Knots 39-46 mph 63-75 km/h	SEA	Moderate high waves of greater length; edges of crests begin to break into spindrift.
		LAND	Breaks twigs off trees; generally impedes progress



FORCE 9	SPEED 41-47 Knots 47-54 mph 76-87 km/h	SEA	High waves. Crests of waves begin to tumble and roll over. Spray may affect visibility
		LAND	Slight structural damage occurs; chimney pots and slates removed



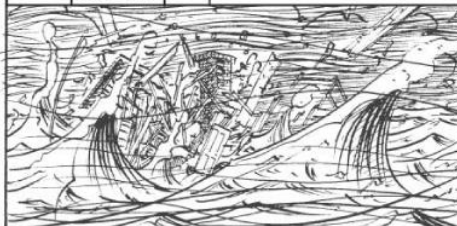
FORCE 10	SPEED 48-55 Knots 55-63 mph 88-102 km/h	SEA	Very high waves. Surface of the sea takes on a white appearance. Visibility affected
		LAND	Seldom experienced inland; trees uprooted; considerable structural damage occurs



FORCE 11	SPEED 56-63 Knots 64-72 mph 103-117 km/h	SEA	Exceptionally high waves. The sea is covered with long white patches of foam.
		LAND	Very rarely experienced on land; accompanied by widespread damage.



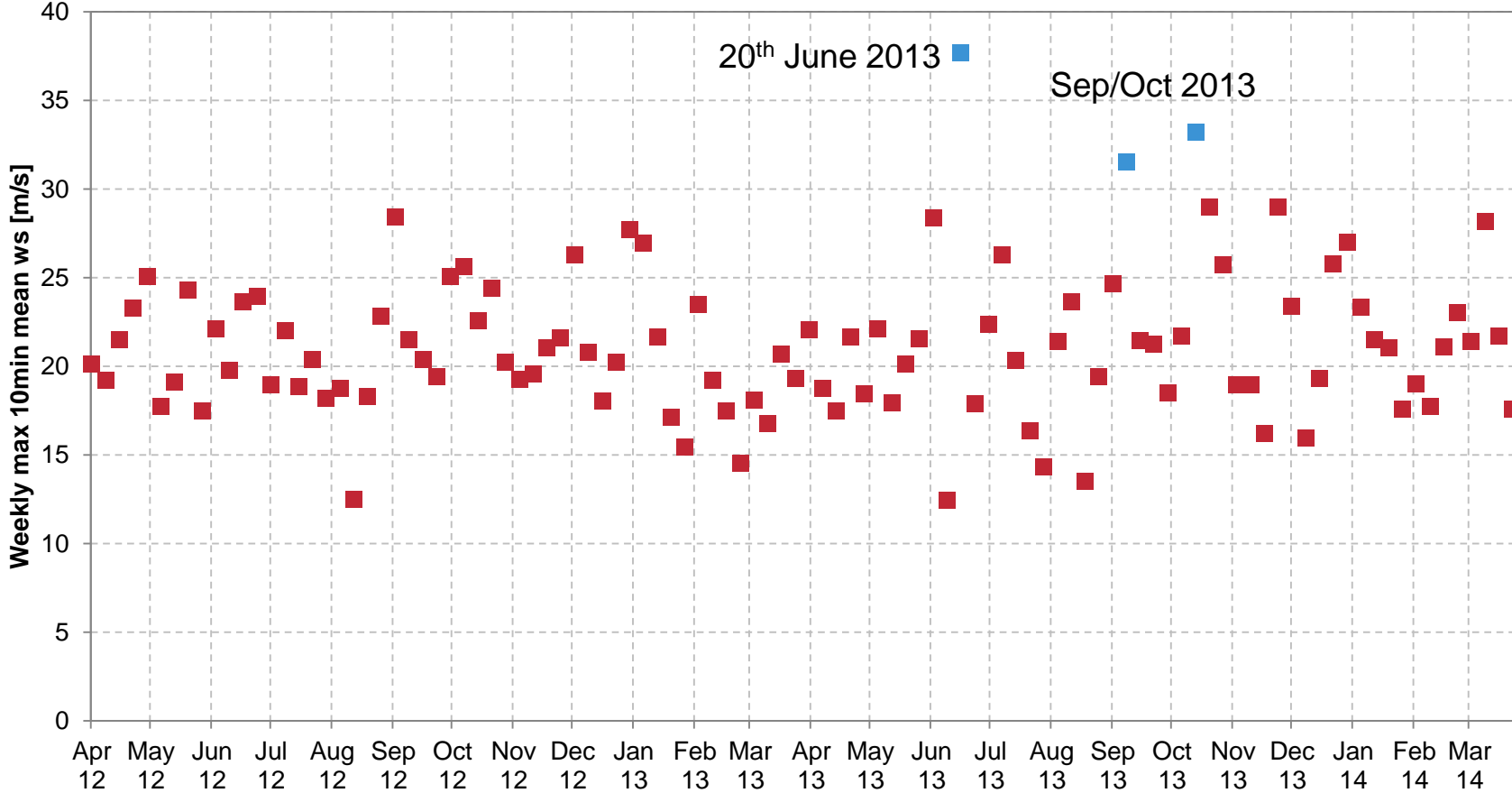
FORCE 12	SPEED over 63 Knots over 72 mph over 117 km/h	SEA	Huge waves; air is filled with foam and spray. Sea white with driving spray; visibility very seriously affected
		LAND	Countryside is devastated



> 33.6 m/s
> 118 km/h

Last two years at Mill Creek

Weekly maximum 10min mean wind speed at Mill Creek 30m mast



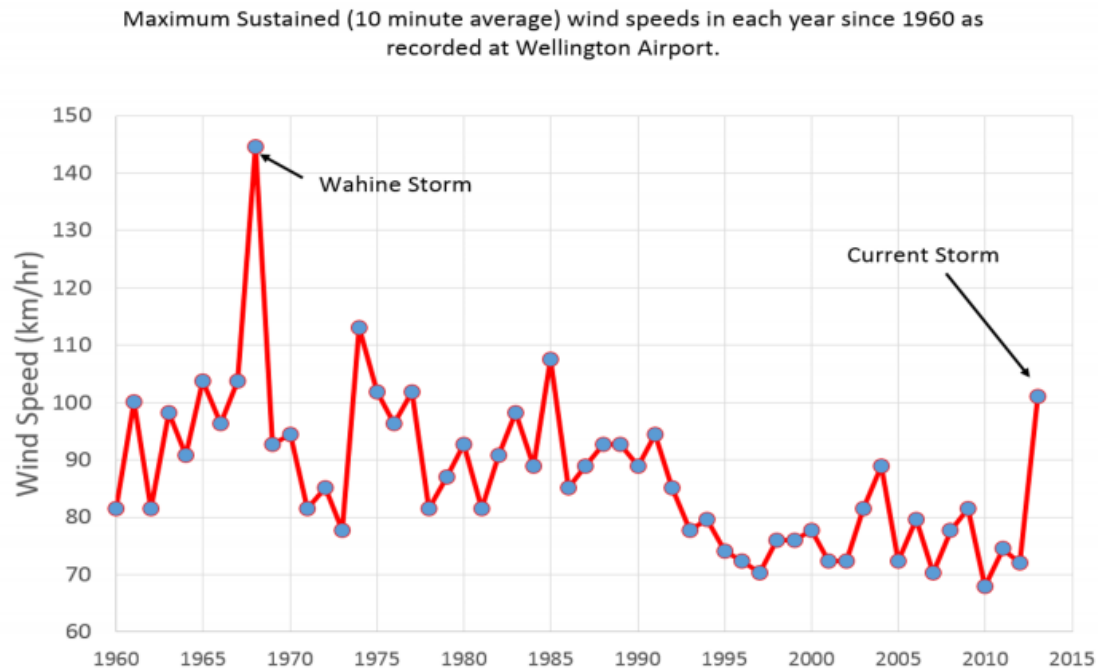
International Storm Classifications

Beaufort Scale	10-minute sustained winds	NE Pacific & N Atlantic	NW Pacific	NW Pacific	N Indian Ocean	SW Indian Ocean	Australia & S Pacific
0-7	<28 knots	Tropical Depression	Tropical Depression	Tropical Depression	Depression	Zone of Disturbed Weather	Tropical Disturbance Tropical Depression Tropical Low
7	28-29 knots				Deep Depression	Tropical Disturbance	
8	30-33 knots	Tropical Storm	Tropical Storm		Tropical Storm	Cyclonic Storm	
9-10	34-47 knots			Severe Tropical Storm	Severe Cyclonic Storm	Severe Tropical Storm	Category 2 tropical cyclone
11	48-55 knots			Typhoon	Typhoon	Very Severe Cyclonic Storm	
12+	56-63 knots	Category 1 hurricane					
	64-72 knots	Category 2 hurricane					
	73-83 knots						
	84-85 knots	Category 3 Hurricane					
	86-98 knots						
	99-107 knots	Category 4 hurricane					
	108-113 knots						
114-119 knots	Category 5 hurricane	Super Typhoon	Super Cyclonic Storm	Very Intense Tropical Cyclone	Category 4 severe tropical cyclone		
>120 knots					Category 5 severe tropical cyclone		

For 46 weeks of the past year at Mill Creek, we experienced at least one “Category 1 Tropical Cyclone” a week.

What is an Extreme wind speed for Wellington?

- 20th June 1013
 - Our highest recorded wind speed in 18yrs of monitoring in the Wellington region
 - Highest mean wind speed at Wellington Airport in 28 years
 - Measured at Wellington Airport – Category 2 tropical cyclone
 - Measured at West Wind – Category 3 tropical cyclone



20th June 2013 storm

- Intense southerly winter storm
- 15m high waves in Cook Strait
- 30,000 homes lost power
- 900 call outs by Fire Service
- Interislander broke its mooring
- \$40m clean up



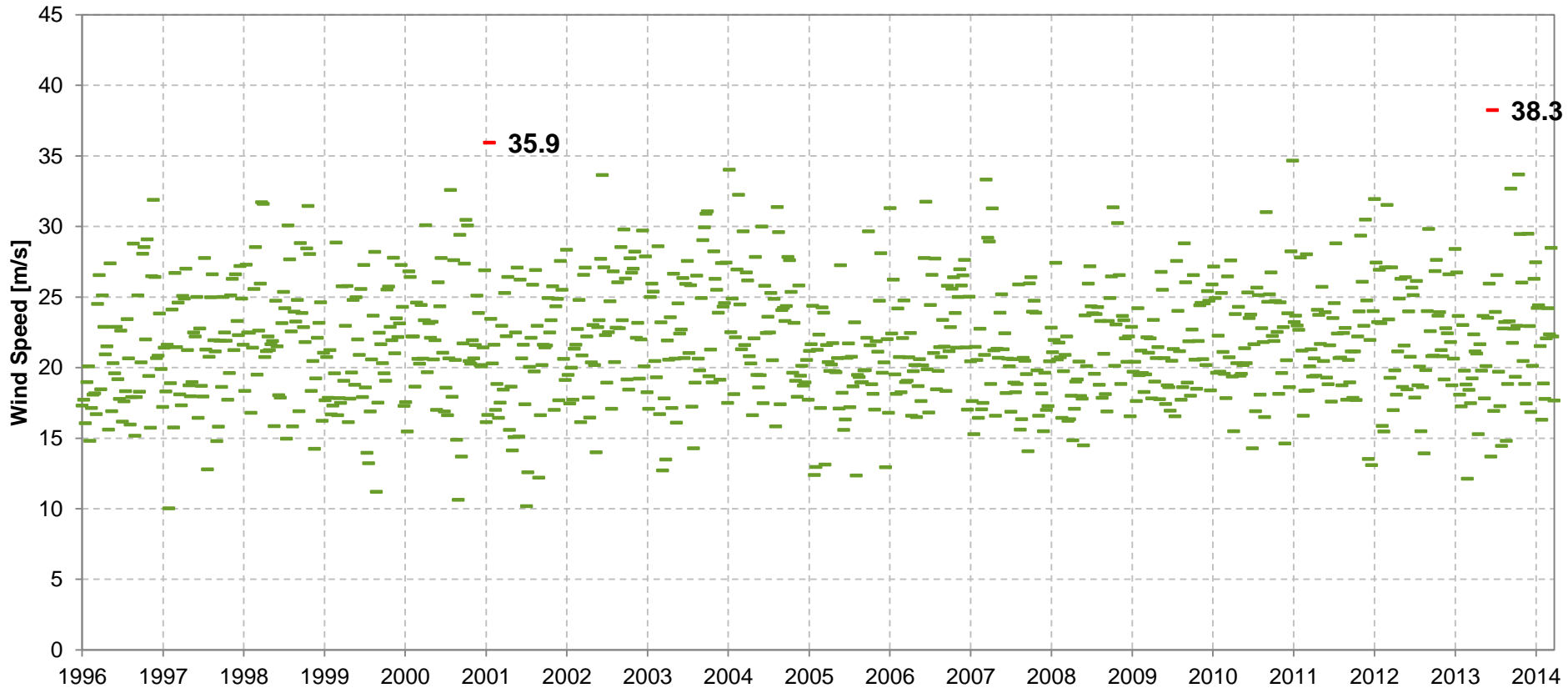
How often does this occur?

- 20th June 2013
- “*Strongest in more than 50 years*” – Ministry of Transport
- “*Worst in 45 years*” – 3 News
- “*Strongest sustained 10-minute winds that Wellington airport has seen since 1985*” – NIWA

Mill Creek

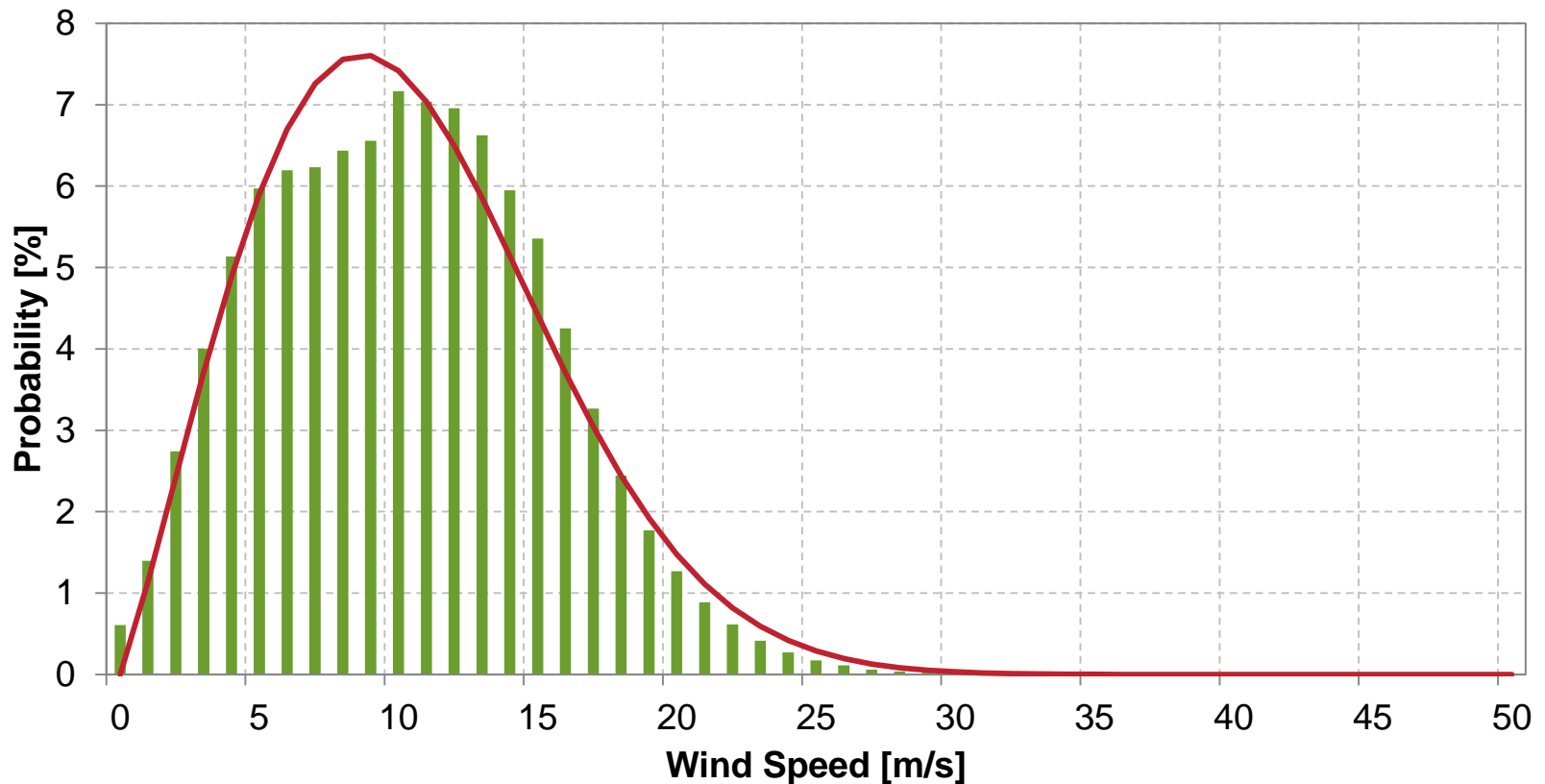
- 4.5 yrs actual data, 18yrs total with correlations to near by masts
- 20th June 2013 – 38.3 m/s

**Weekly maximum mean wind speed
Mill Creek 60m Mast**



Simple Weibull – Mill Creek

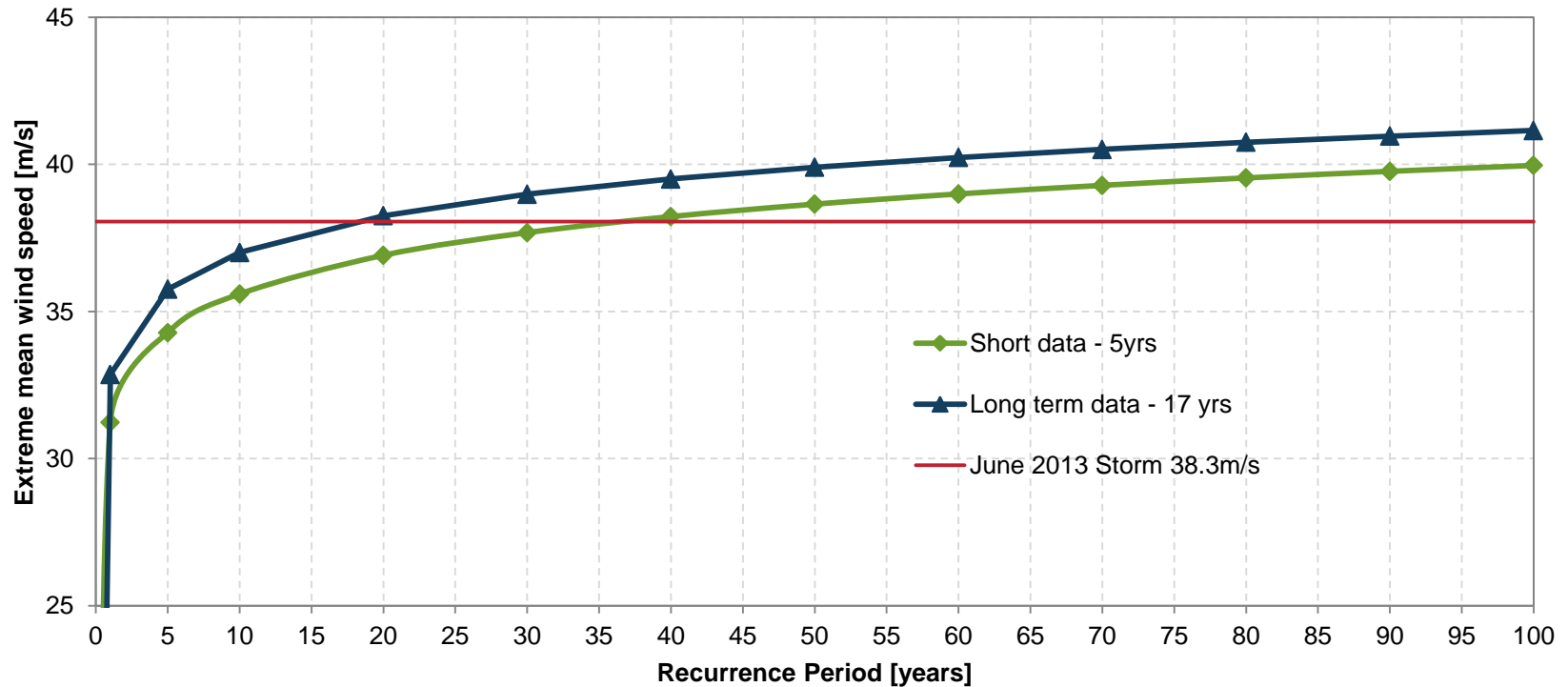
- Weibull analysis on the Mill Creek 60m Mast
- Probability of 38.3m/s, return rate of 4.5yrs
- Seasonal variability? Over smoothing?



Actual Distribution Weibull Distribution

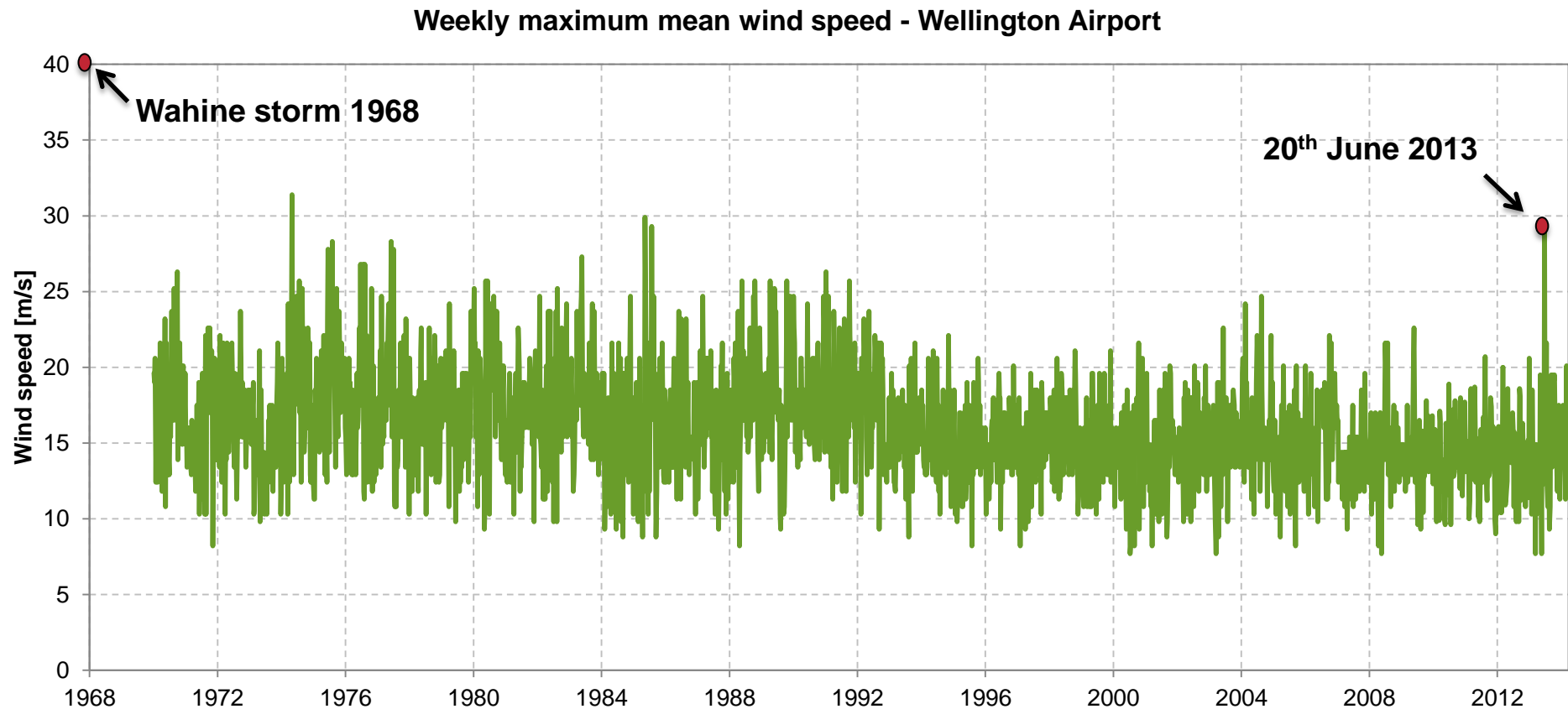
Gumbel Analysis – Mill Creek

- Gumbel analysis
- Method of Independent Storms
- Short term vs Long term data
- 20 – 30 yrs return



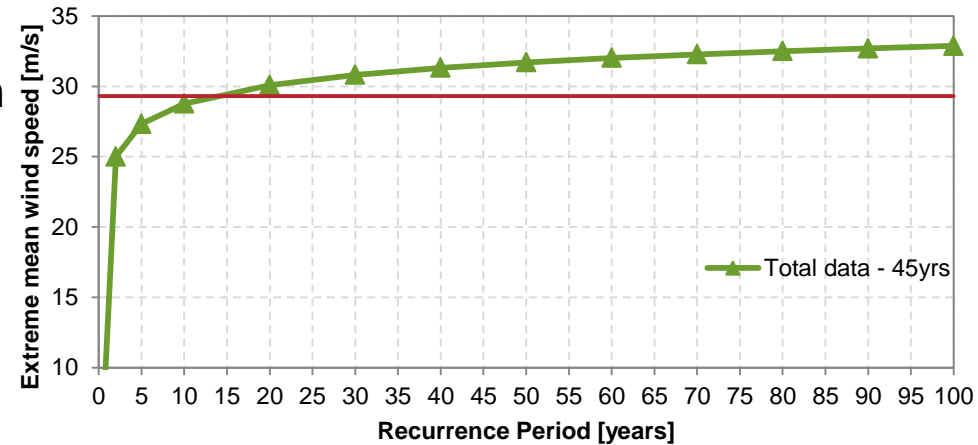
Wellington Airport Data

- 45 yrs of actual data
- 20th June 2013 – 29.3 m/s

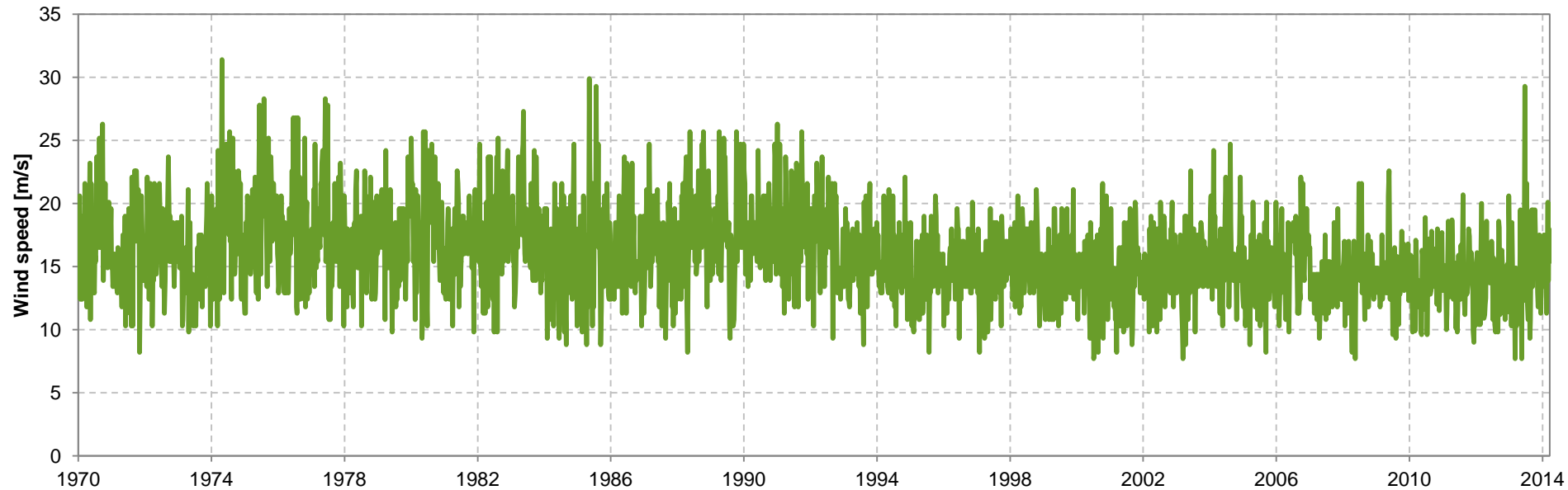


Gumbel Analysis – Wellington Airport

- Analysis on all 45yrs shows return period of 15 years
- Can we use all the data?

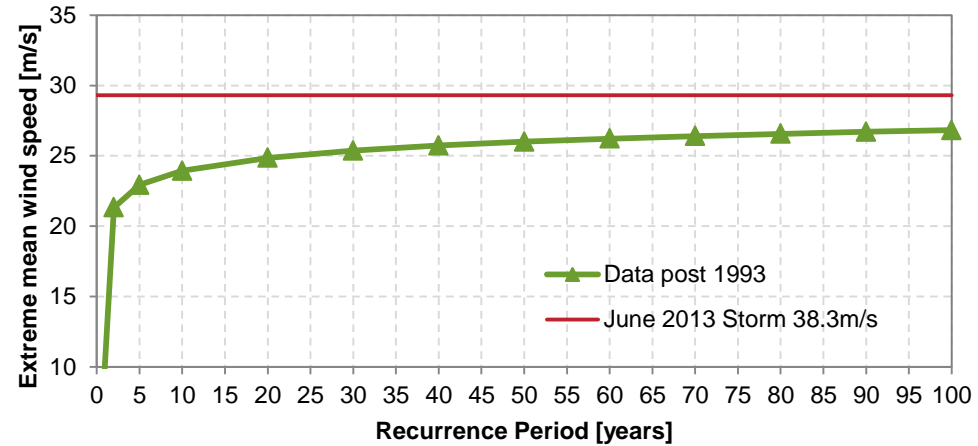


Weekly maximum mean wind speed - Wellington Airport

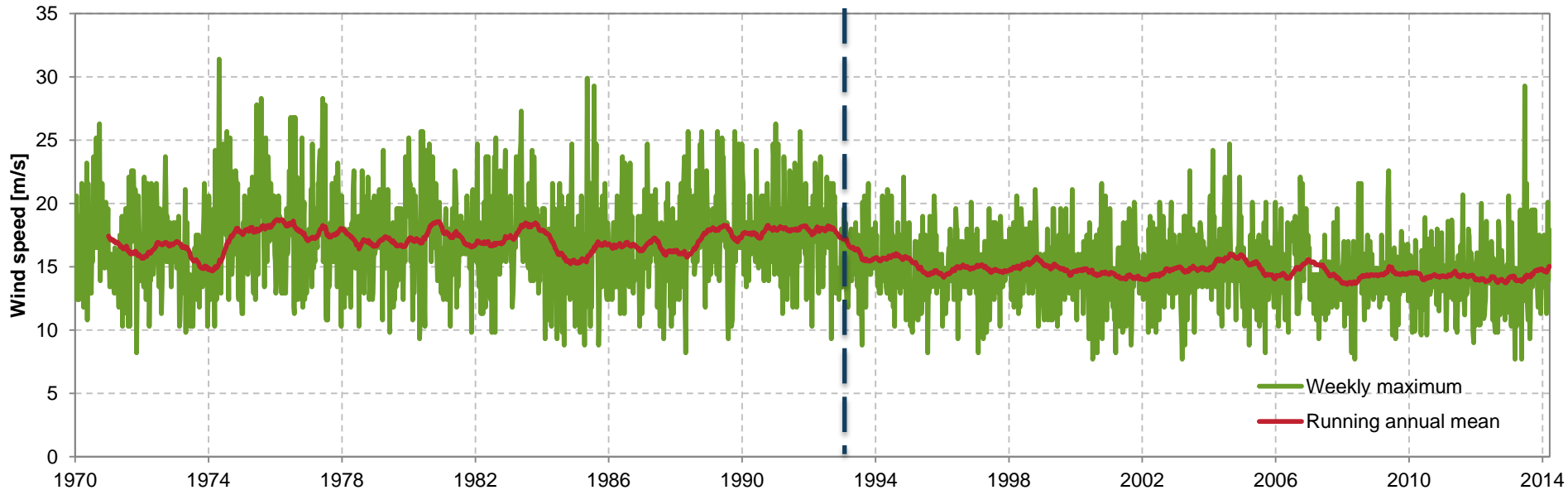


Gumbel Analysis – Wellington Airport post 1993

- Apparent change in wind speeds post 1993
- Performing analysis only on data post 1993 gives an extremely long return period

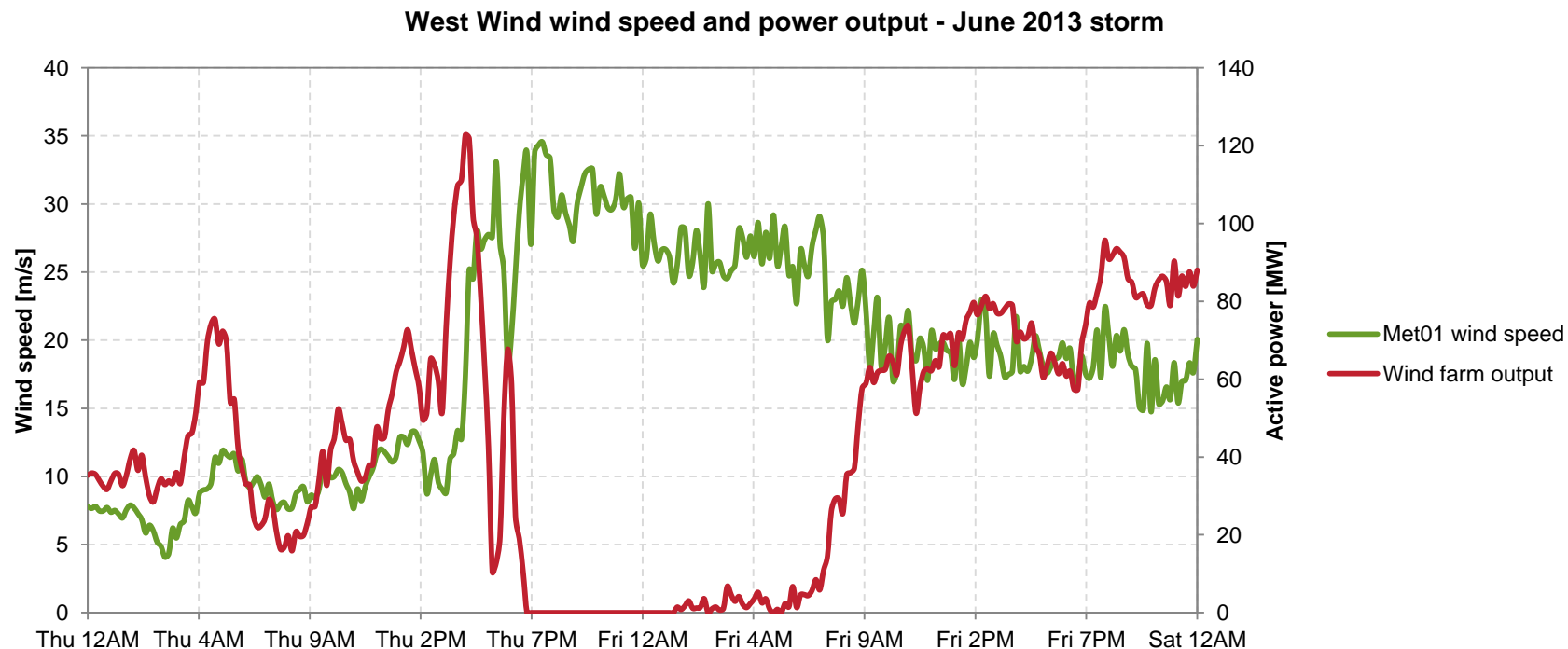


Weekly maximum hourly wind speed - Wellington Airport





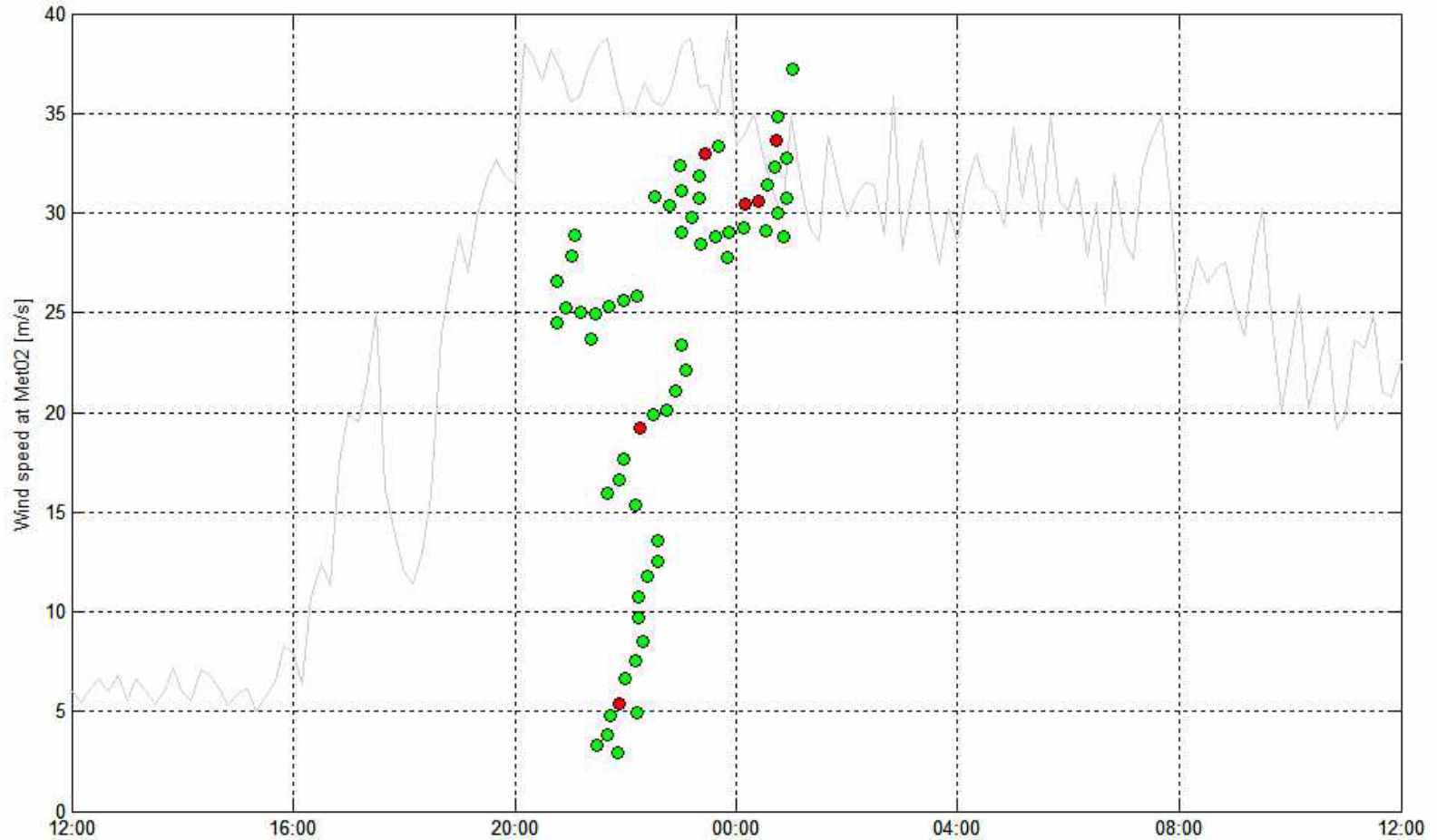
20th June 2013 – What happened at West Wind?

- Max 10min mean at a turbine was 41 m/s
- Max 3s gust at a turbine was 58 m/s
- All turbines eventually shut down due to either high wind, or for another reason, but then subsequently could not re-start in high winds.
- Wind farm was at full capacity just before the storm
- 24hrs after the initial front, farm at 70%





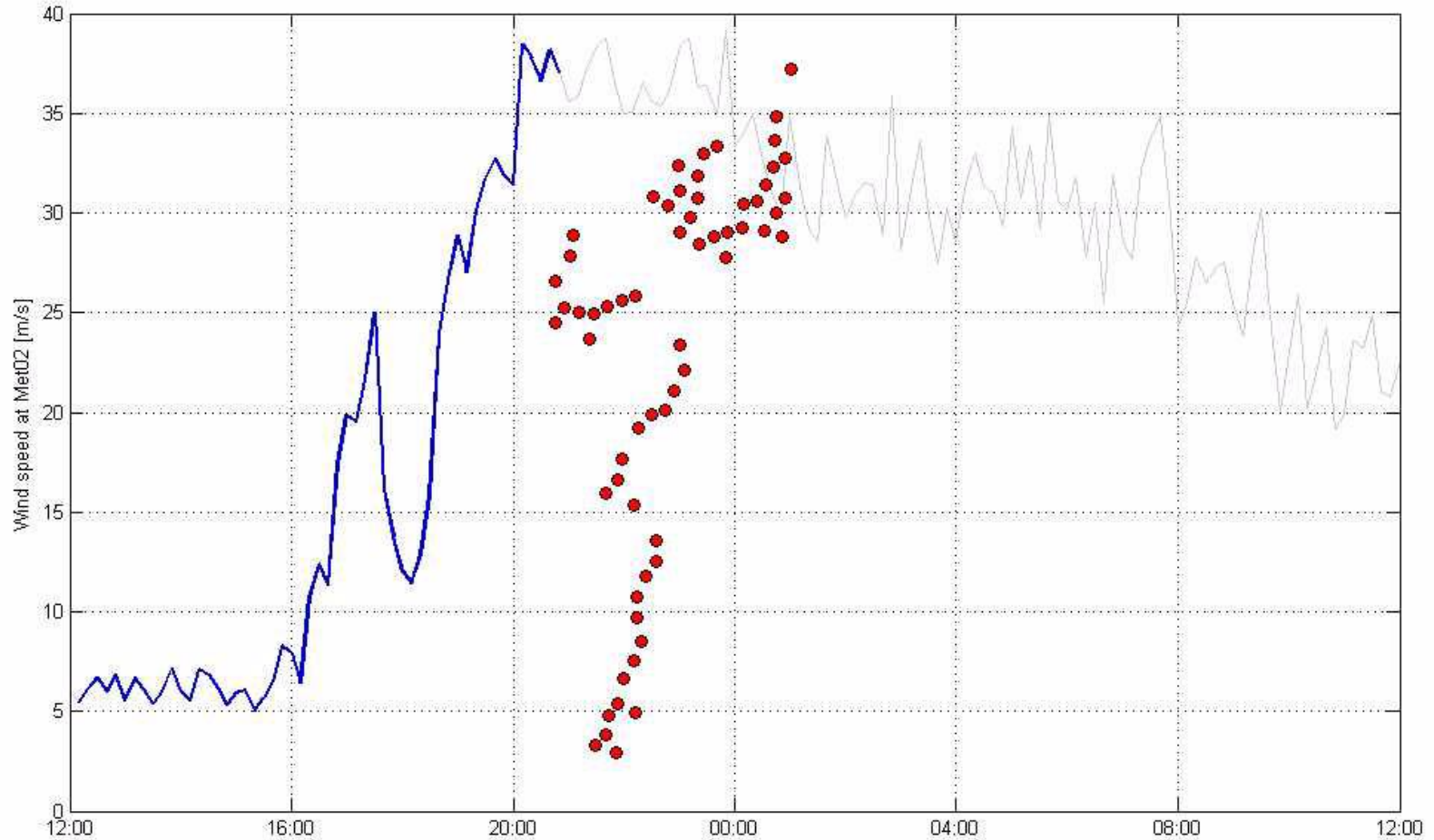
West Wind turbines during 20th June 2013 storm

-  Turbine generating
-  Turbine shut down





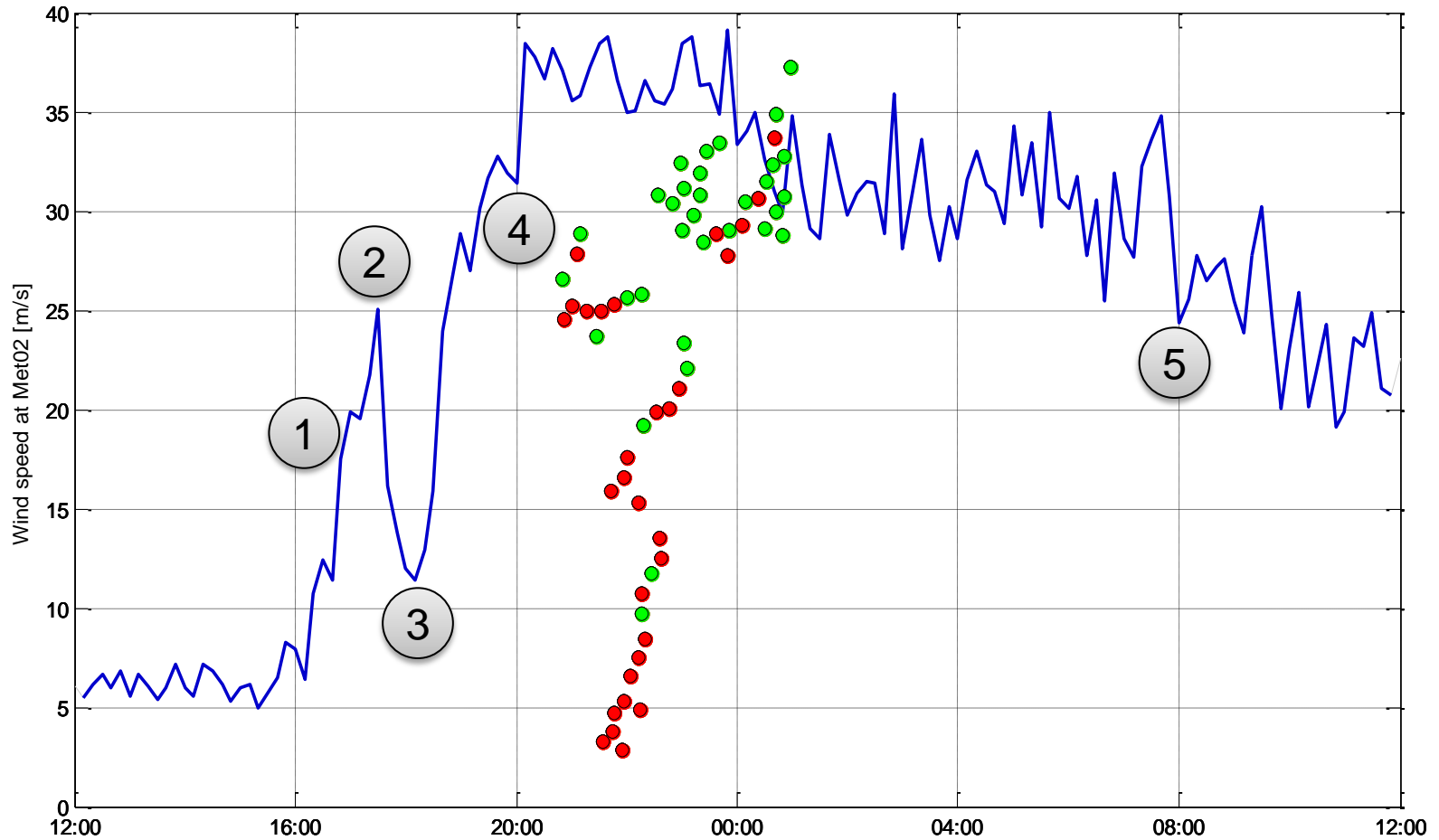
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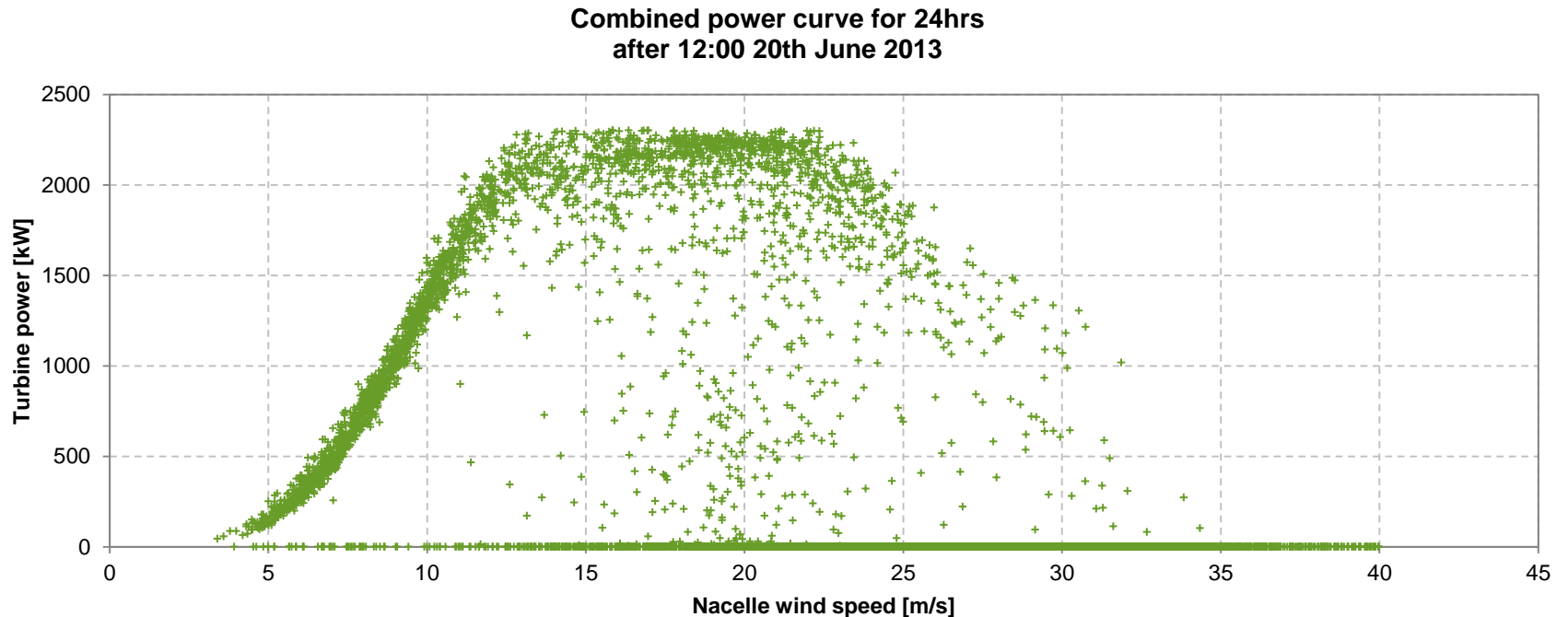
West Wind turbines during 20th June 2013 storm

-  Turbine generating
-  Turbine shut down



West wind summary

- No significant damage to turbines, minor damage to some yaw gears
- Access to site was a problem after the storm
- High wind ride through preformed well
- Turbines on the south coast saw the highest winds, gusting up to almost 60 m/s



Conclusions

- Last year certainly a year of strong winds for the region.
- Difficulty in determining the return period of these extreme events.
- Return period likely to be 20-30yrs, but possibly longer.
- Highlights the requirement for long term reliable wind data, which continues during the storms.
- Long term data series are hard to come as effected by technology enhancements and environment.

