Wind station representativeness and forecast verification

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The worst performing wind forecasts in the country.

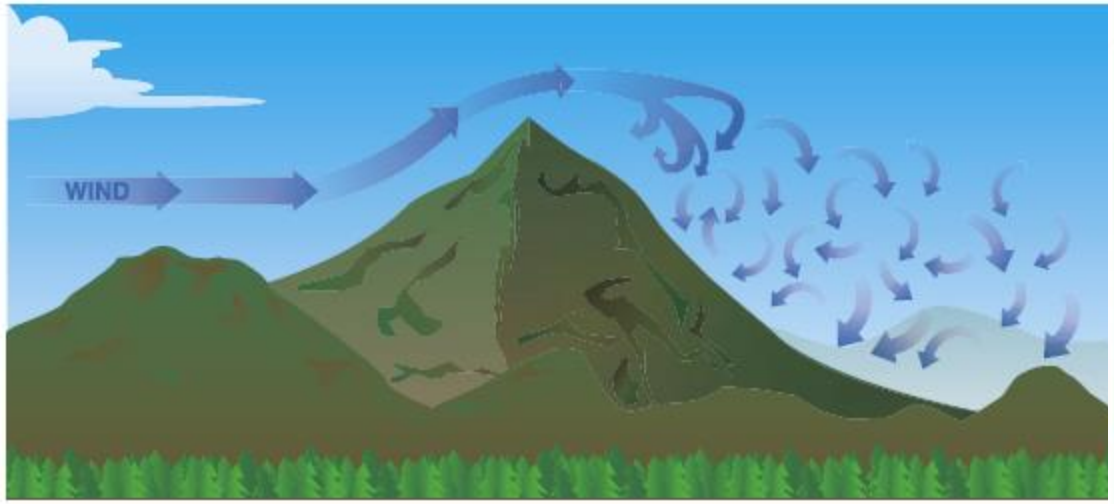
For 2022 lead-day 1 Official forecasts:

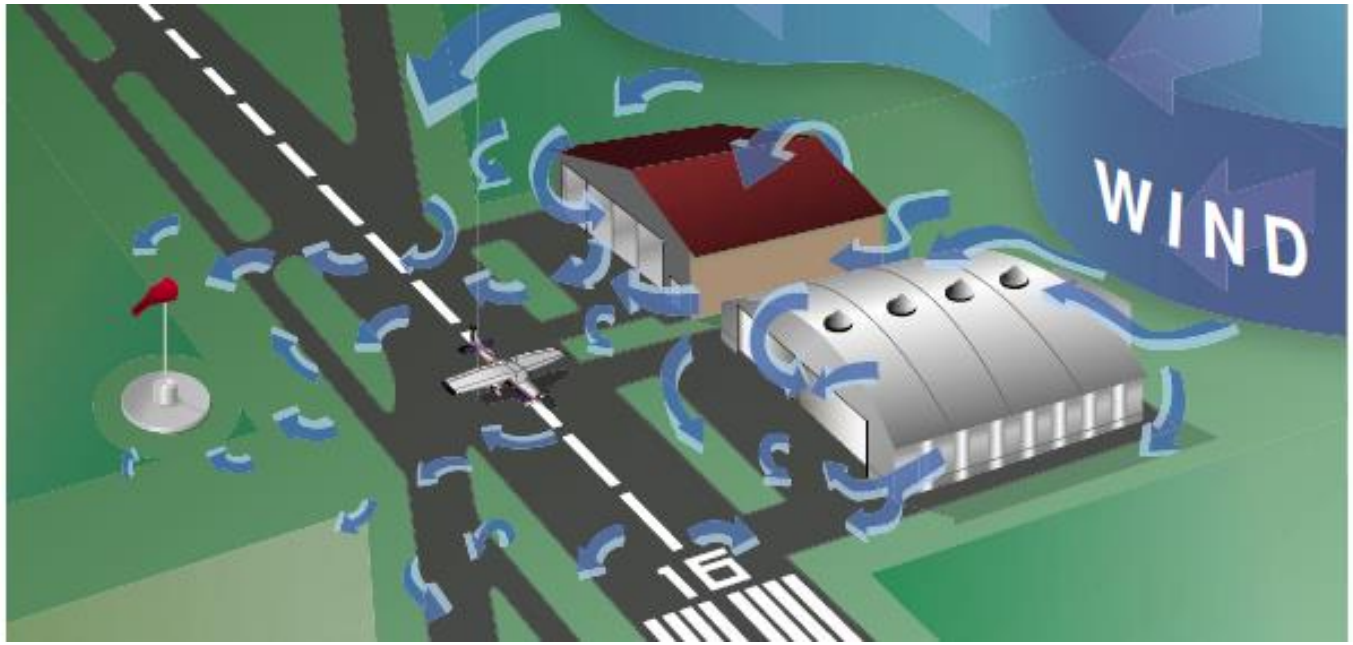
52% were within 5 knots (typical station: 87-95%)

From southerly direction median forecast was 365% of median observation.

From east, much less biased.

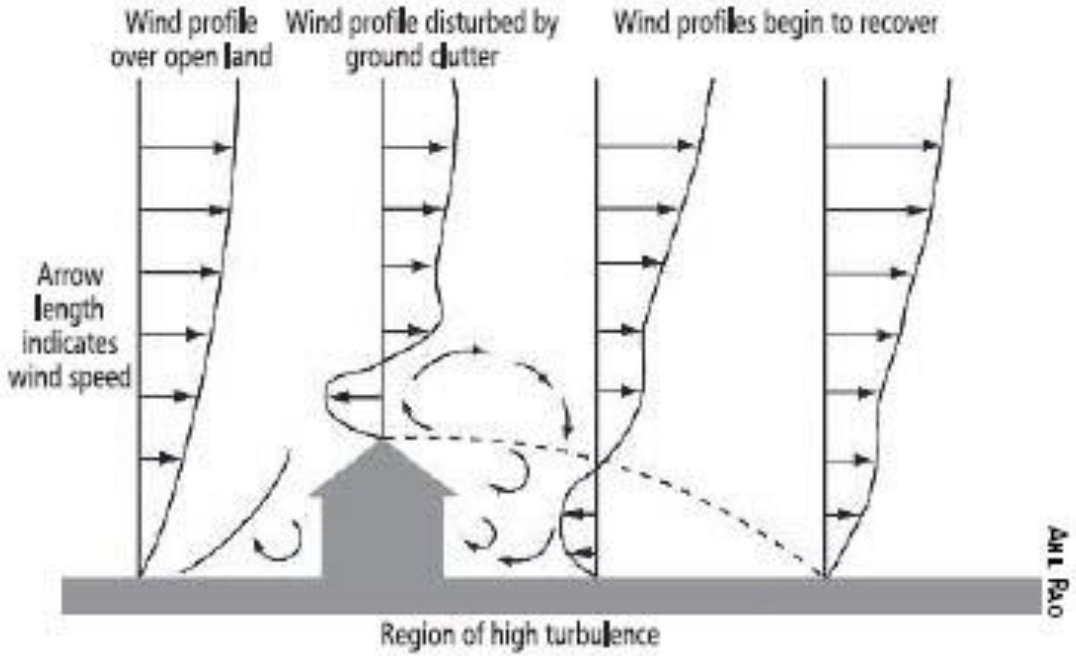
Rosslyn Bay, Queensland (033208)





Highly localised winds in rough terrain and behind obstacles such as buildings and vegetation

Wind speed also increases with height

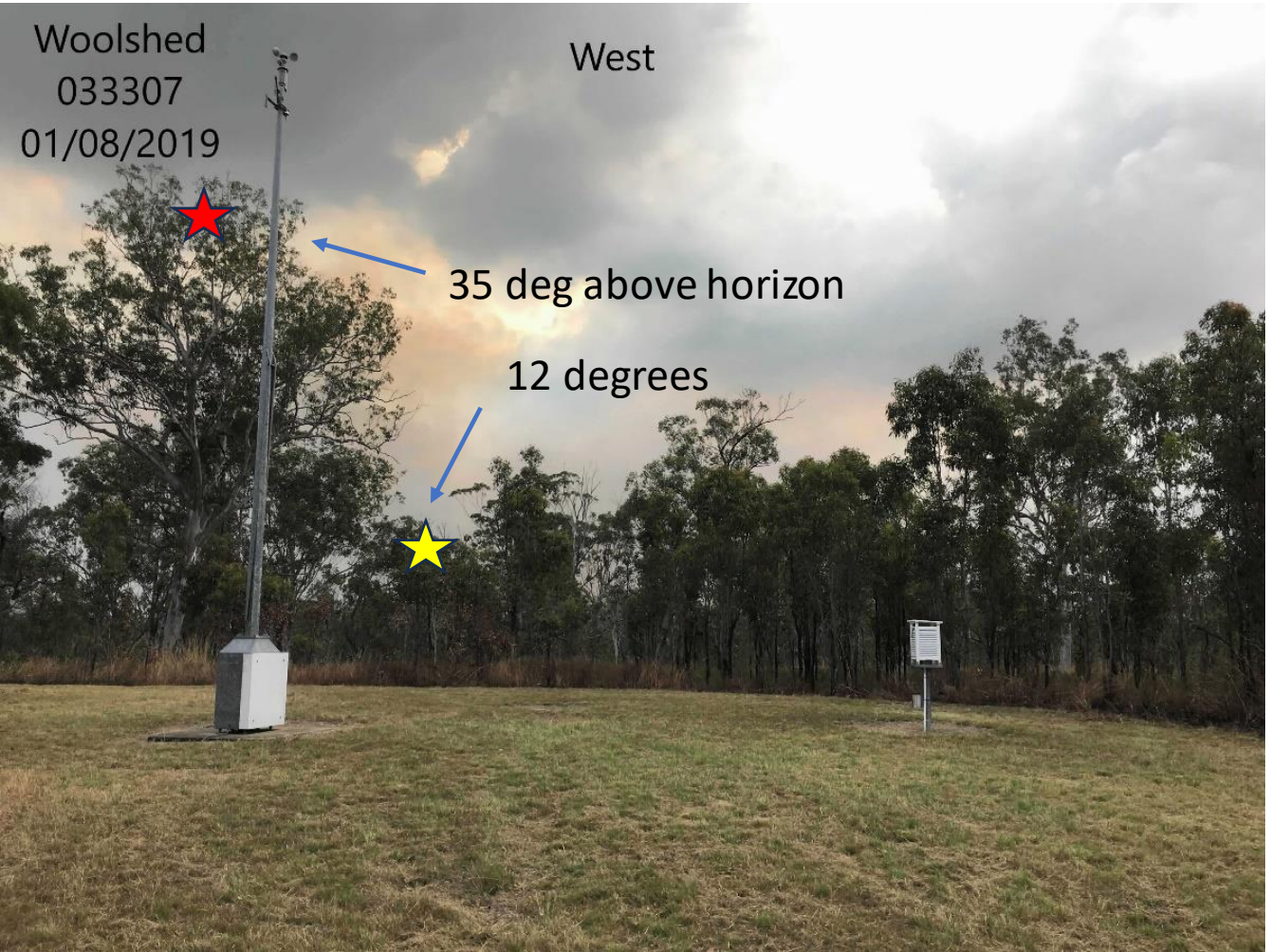


https://www.weather.gov/source/zhu/ZHU_Training_Page/winds/Wx_Terms/Flight_Environment.htm

https://physics.stackexchange.com/questions/628716/does-wind-turbulence-increase-or-decrease-with-height-from-ground

WMO recommends "open-terrain" measurement:
measured at 10 m height with
10-30:1 distance to height ratio of upwind obstacles
(2-6 deg above horizon)

Bureau forecasts: 10 m, but no mention of "open terrain"



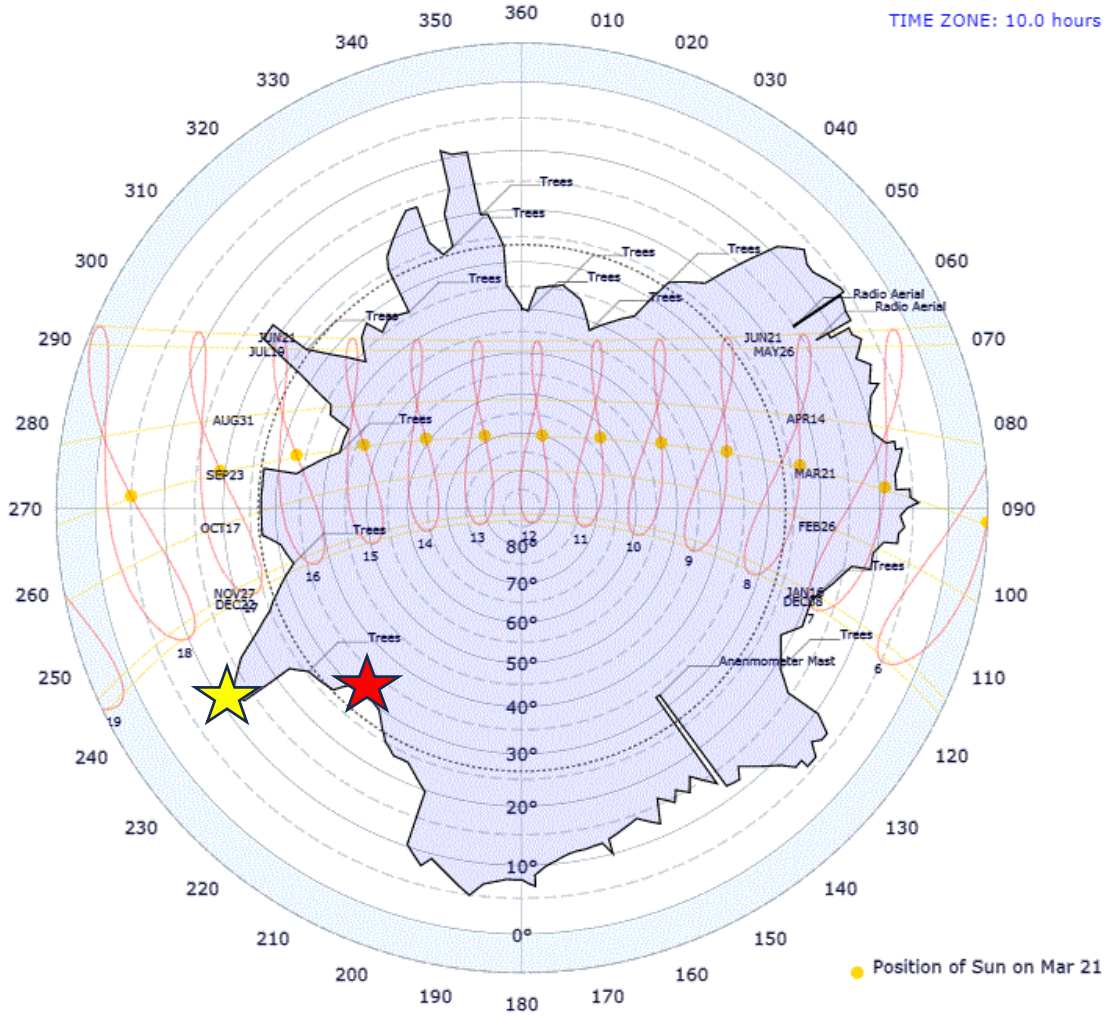
SKYLINE SURVEY

SUN POSITIONS FOR WOOLSHED

SITE NUMBER: 033307
DATE OF SURVEY: 24/05/2018

Upward view of sky

LATITUDE: -19.41676
LONGITUDE: 146.53620
ALTITUDE: 556 m
TIME ZONE: 10.0 hours



Expert ratings of station photos, skylines, google maps for exposure

"+2"

"+1"

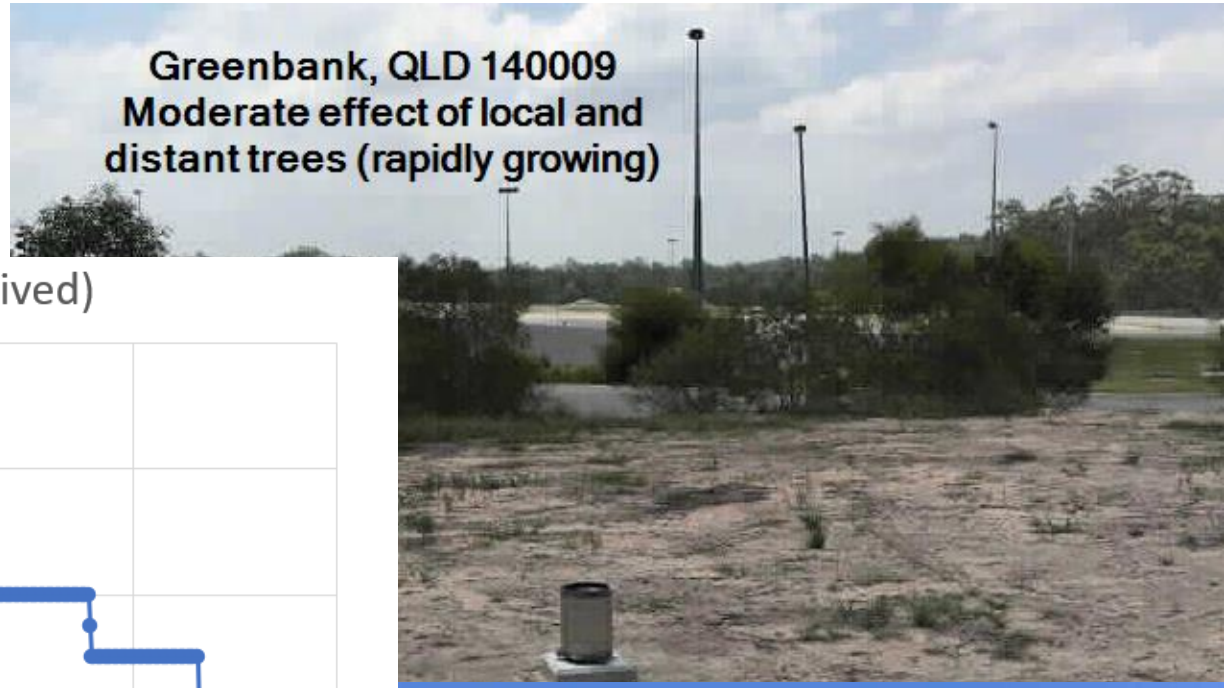
"0"

"-1"

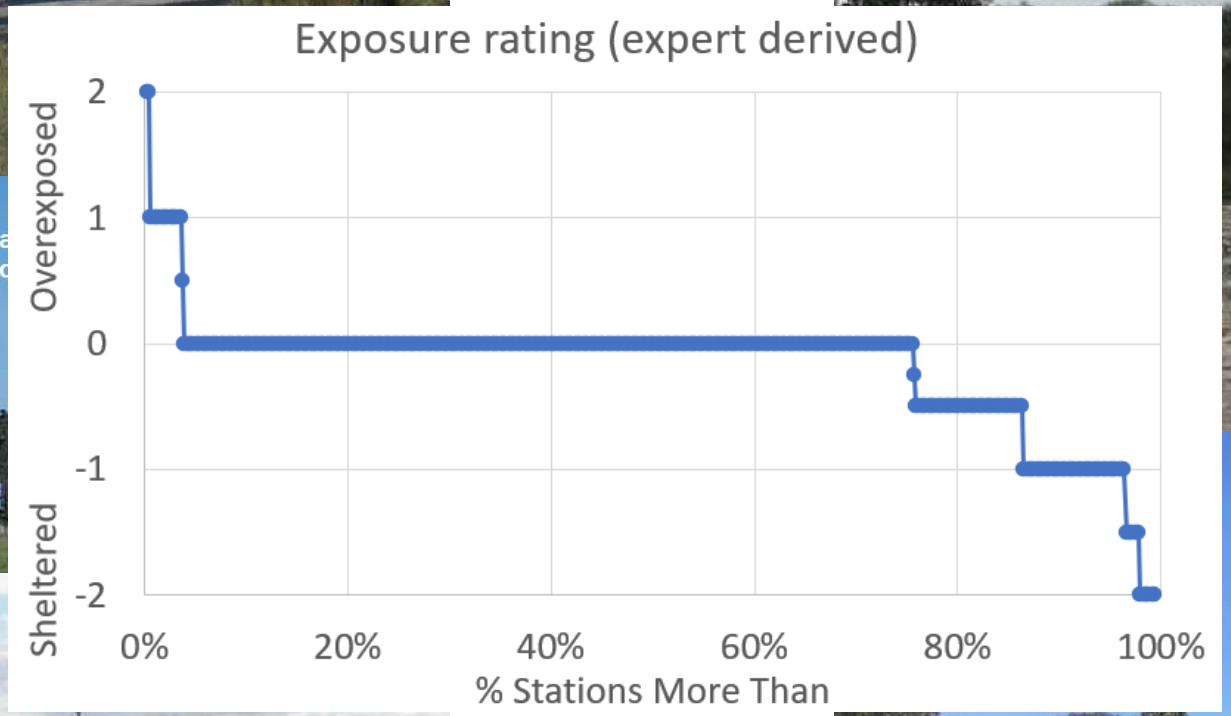
"-2"

Expert ratings of station photos, skylines, google maps for exposure

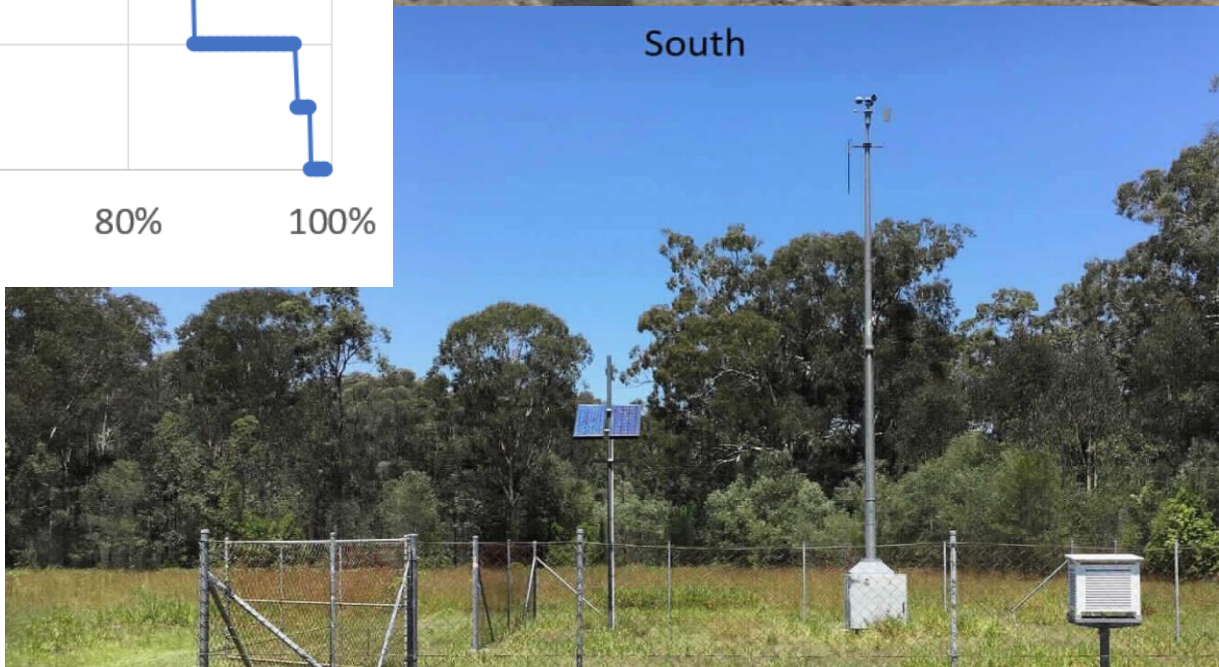
"+2"



"-1"



"0"



Expert assessment costly, subjective. Can you use the data itself?

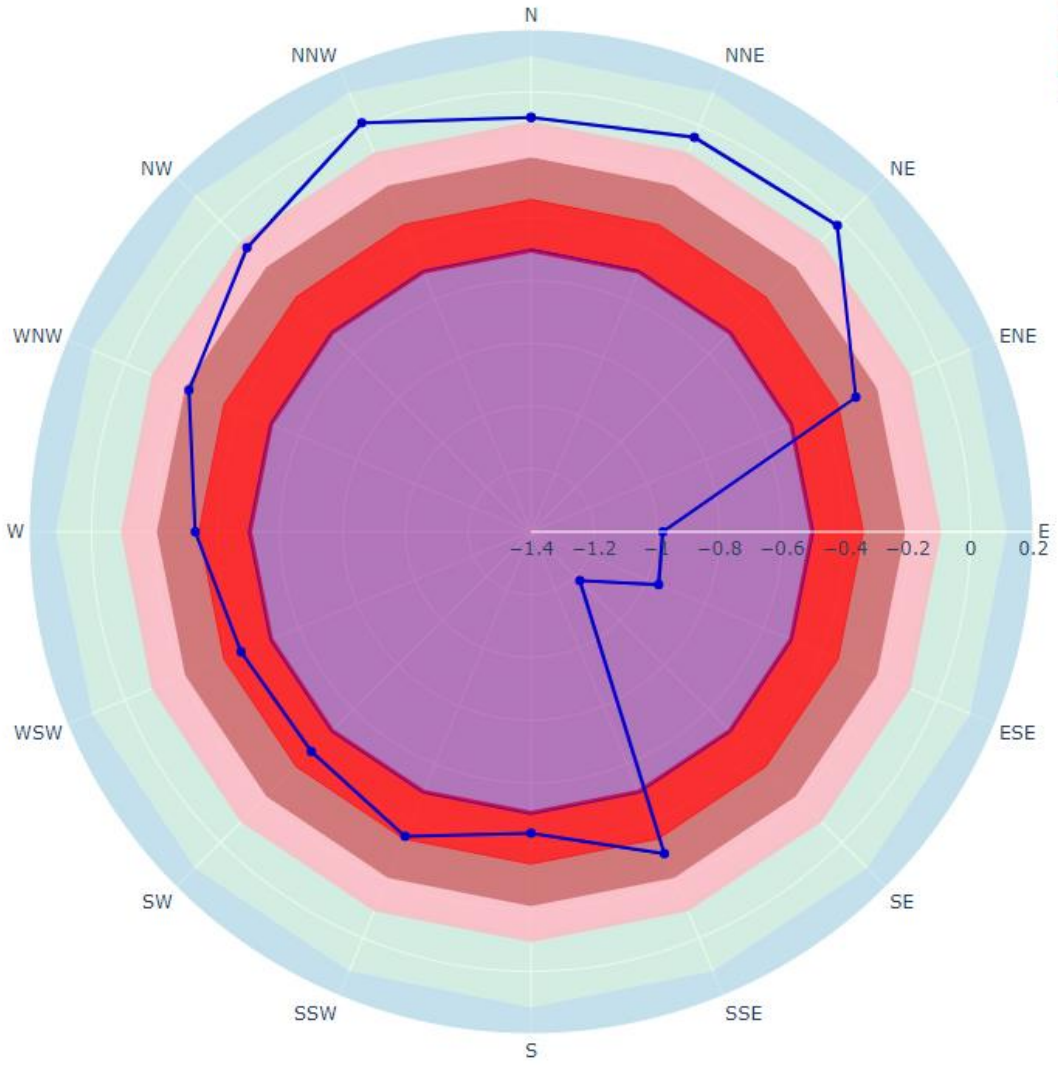
Gust factor = 3 second peak gust / 10 minute average wind

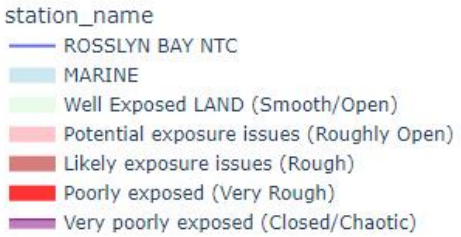
Exposure Correction Factor = open terrain wind / actual average wind

Terrain Class Name	Roughness Length (m) - (Z_o)	Typical 10min Gust Factor (GF)	Exposure correction factor (Powell)	Exposure correction factor (WMO80)
Sea	0.0002	< 1.3	0.75 - 0.83	0.85 - 0.92
Smooth	0.005	1.3 - 1.4	0.83 - 0.91	0.92 - 0.96
Open	0.03	1.4 - 1.5	0.91 - 1.10	0.96 - 1.05
Roughly Open	0.1	1.5 - 1.6	1.10 – 1.23	1.05 - 1.1
Rough	0.25	1.6 - 1.75	1.23 - 1.46	1.1 - 1.19
Very Rough	0.5	1.75 - 1.9	1.46 - 1.79	1.19 - 1.33
Closed/Chaotic	> 1.0	> 1.9	> 1.79	> 1.33

ROSSLYN BAY NTC - Average 10 minute gust factor

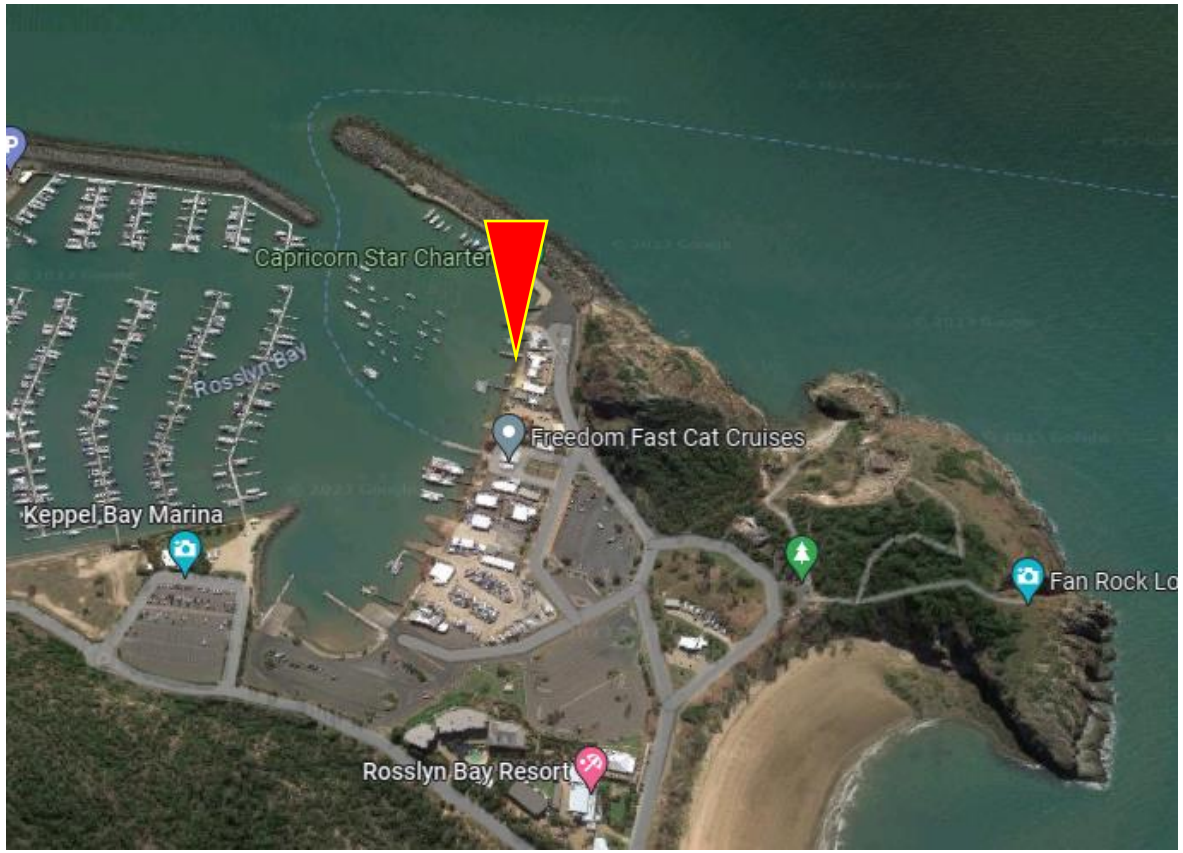
* Compared to an average, well exposed land site (GF~1.4).
* Categorised by wind direction * Radial = 1.4 - GustFactor





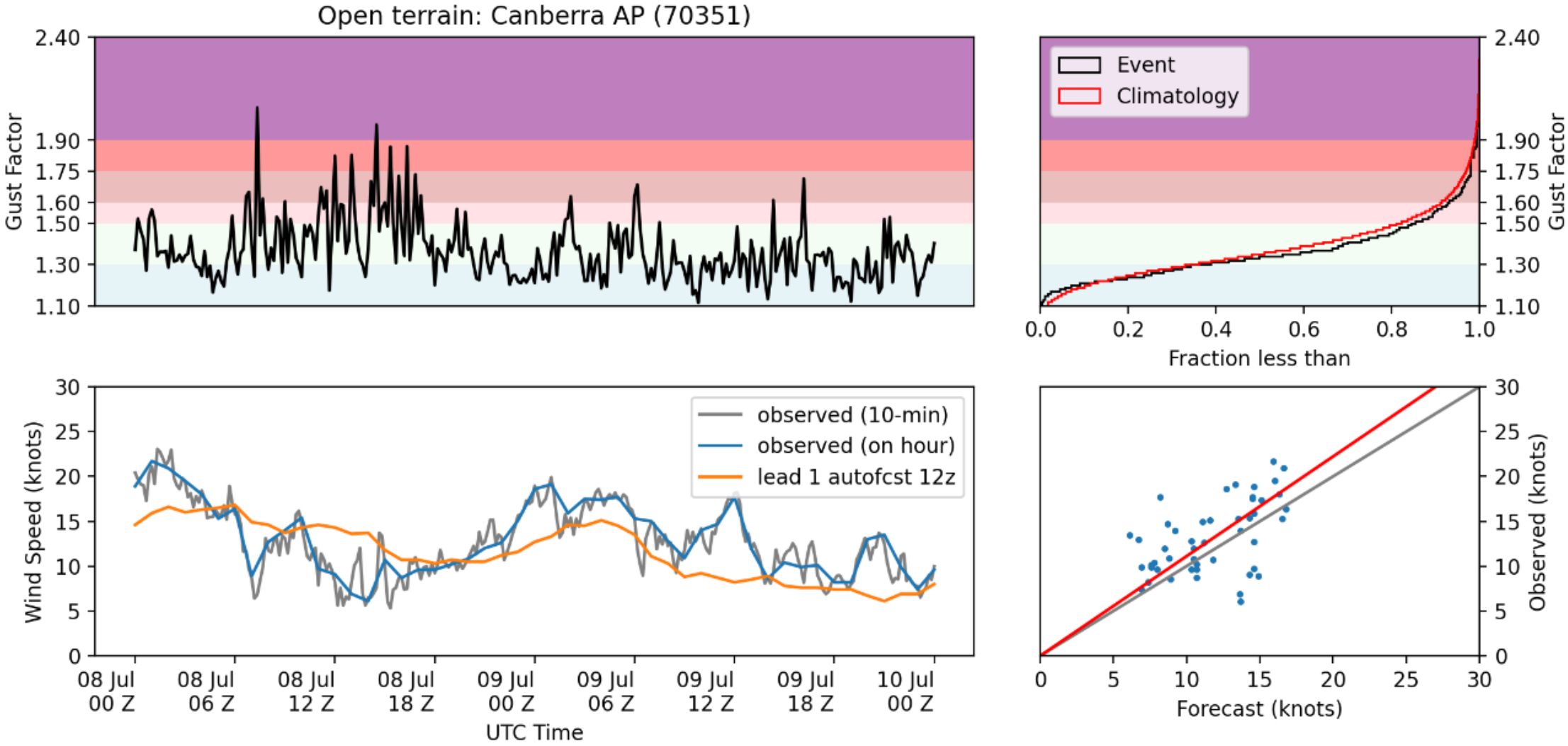
Rosslyn Bay
4-year average
Gust Factor by direction

North



South

Gust factor during an individual event



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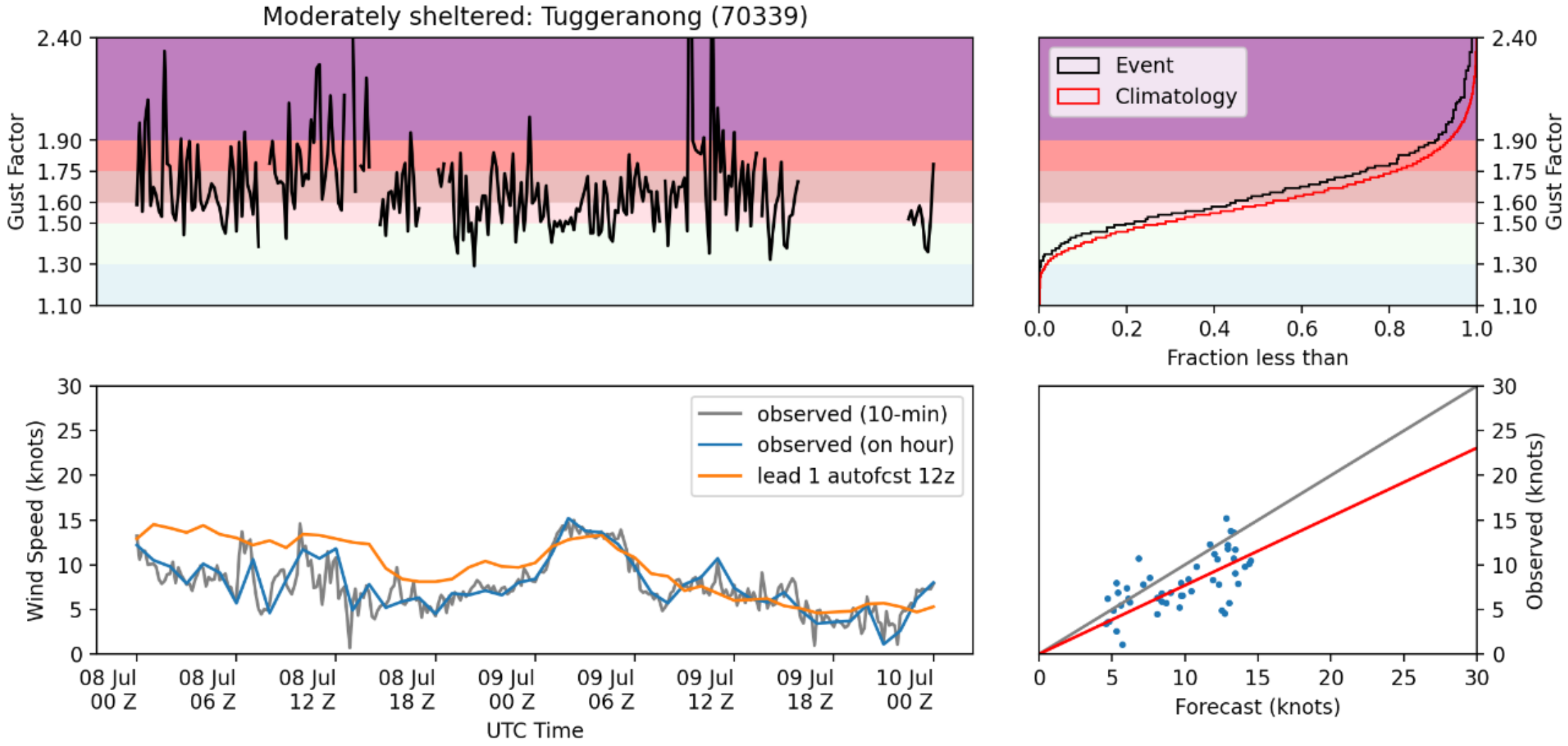
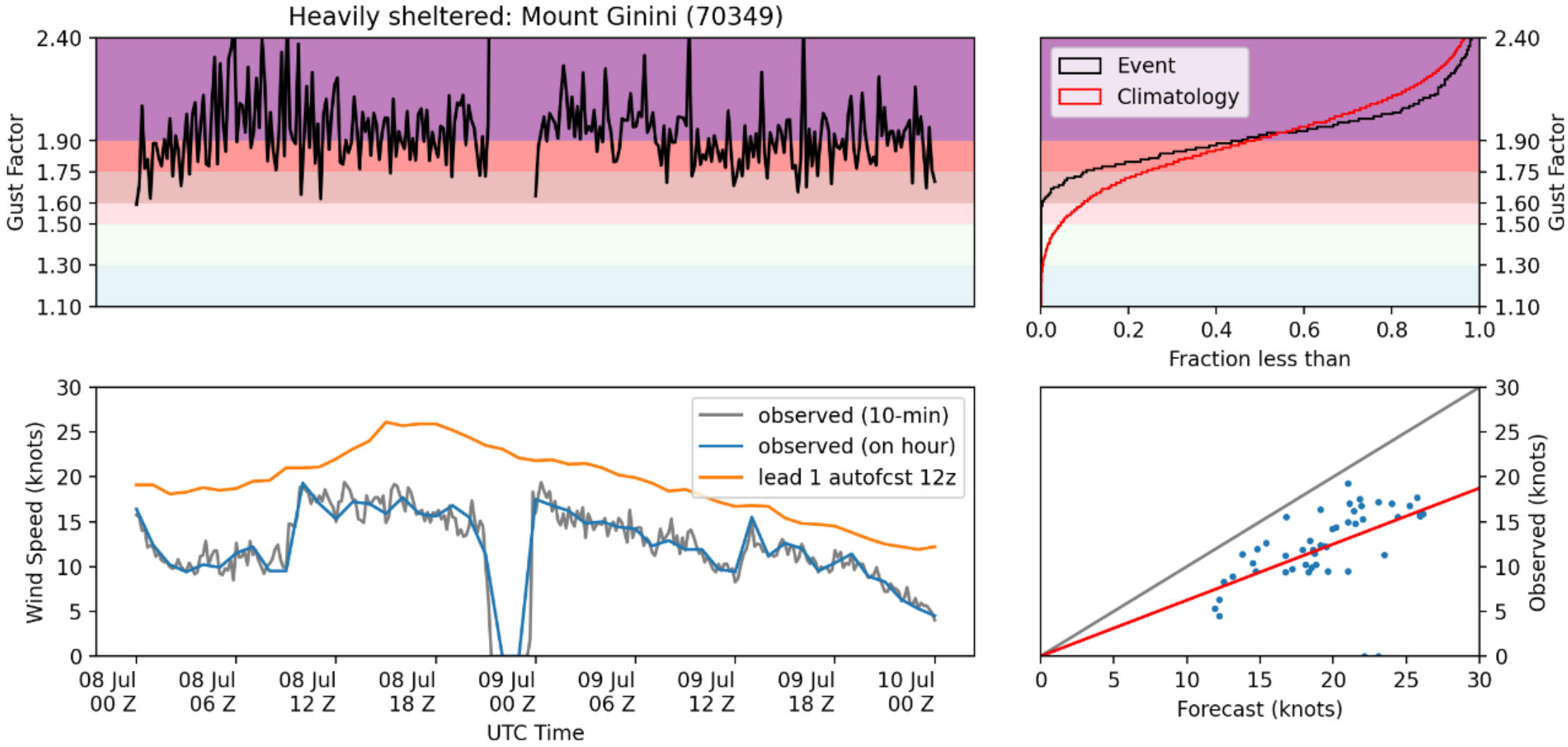


Gust factor during an individual event



Jerramungup, WA
(DPIRD - unofficial)
3 metre

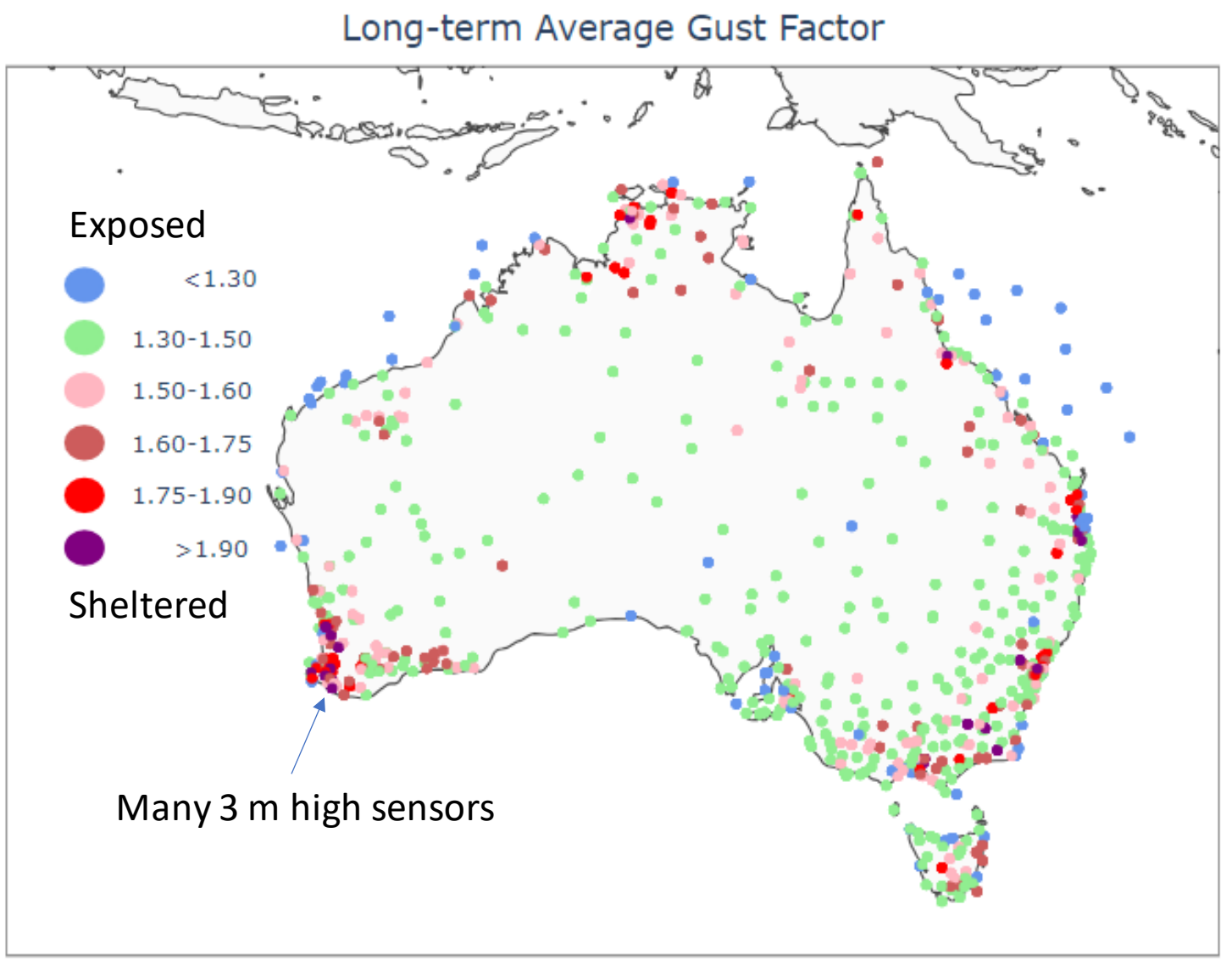
Cape Leeuwin, WA
(official)
10 metre

Hobart, TAS
(official)
20 metre

Ocean stations highly exposed

Many inland stations adequately exposed

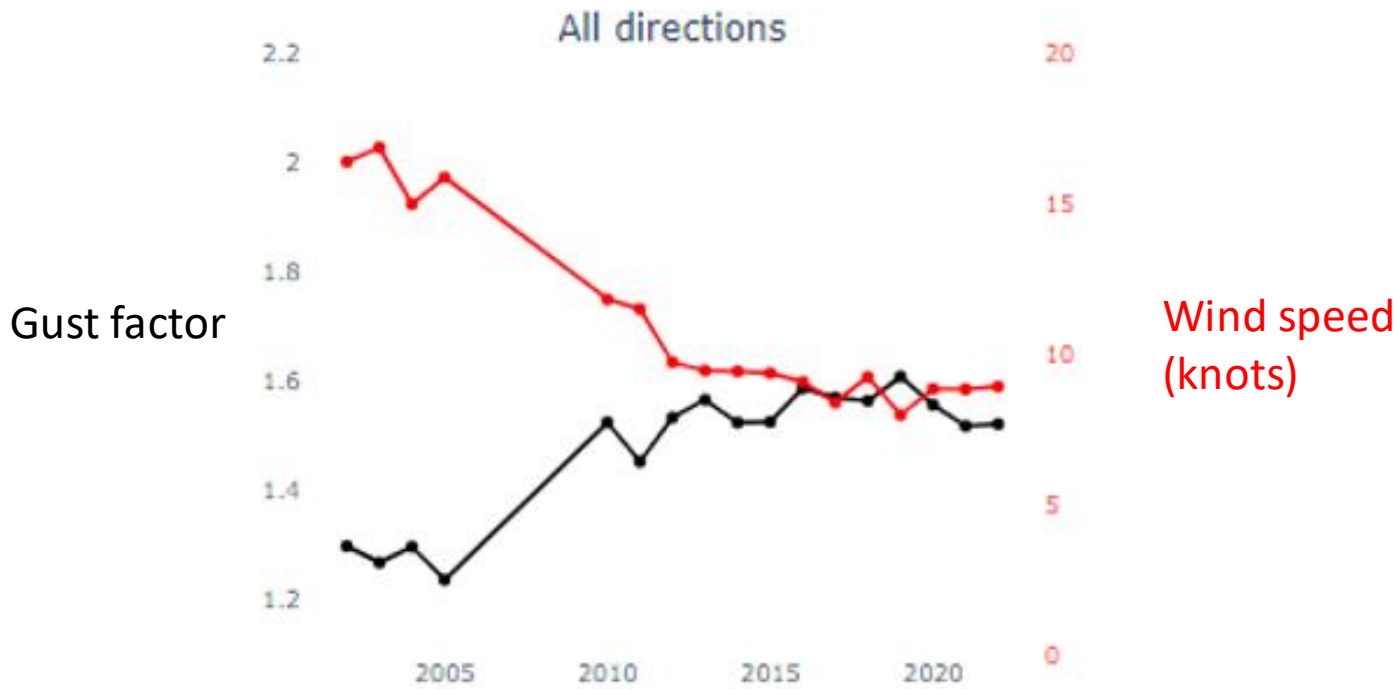
Unofficial stations at non-standard height are biased



Average 10min Gust Factor and Wind Speed Vs Year for Mt Terrible Radar AWS (Categorised by direction)

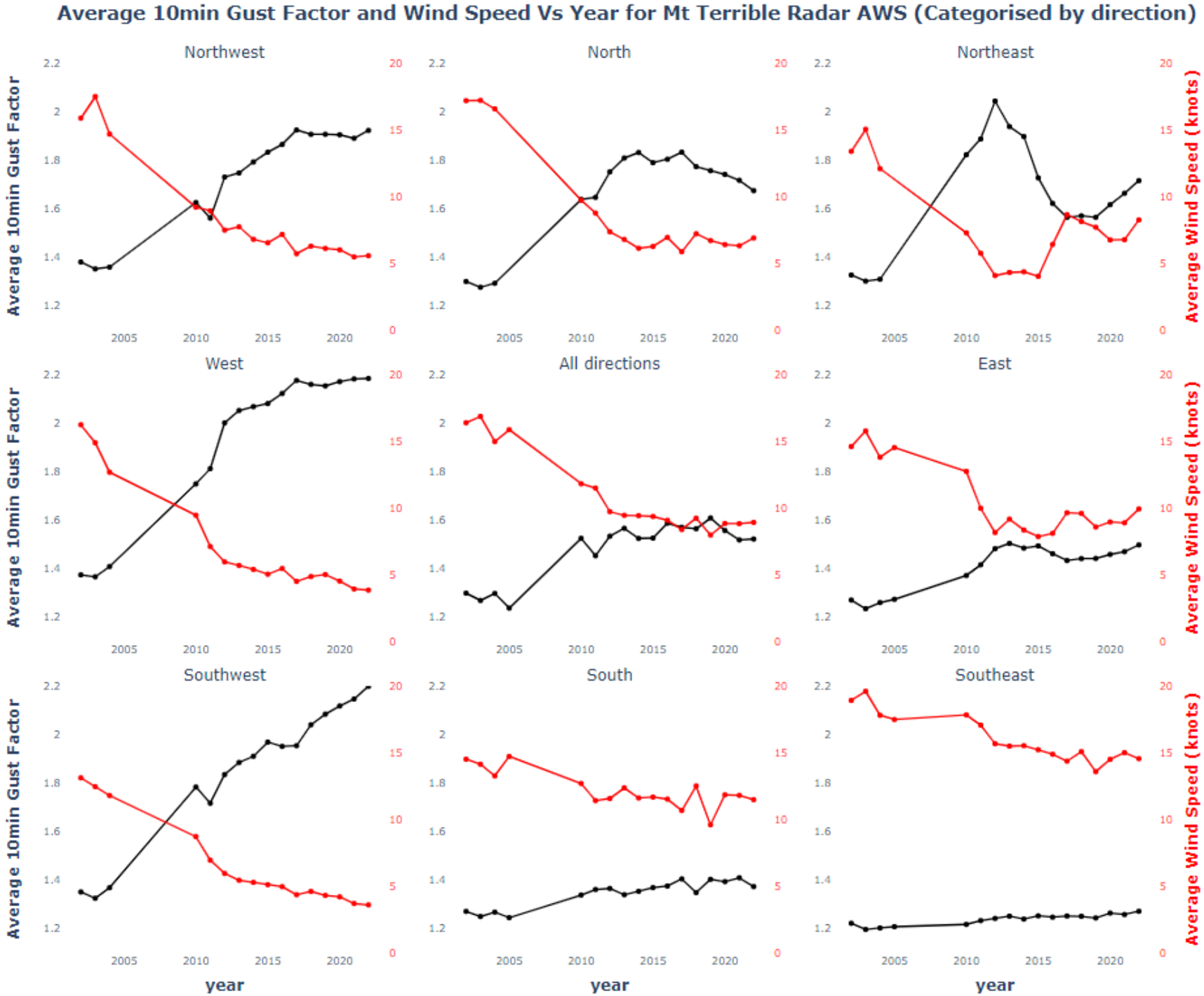
2003-2023

Mt Terrible Radar



2003-2023

Mt Terrible Radar
Gust factor (left)
Wind speed (right)

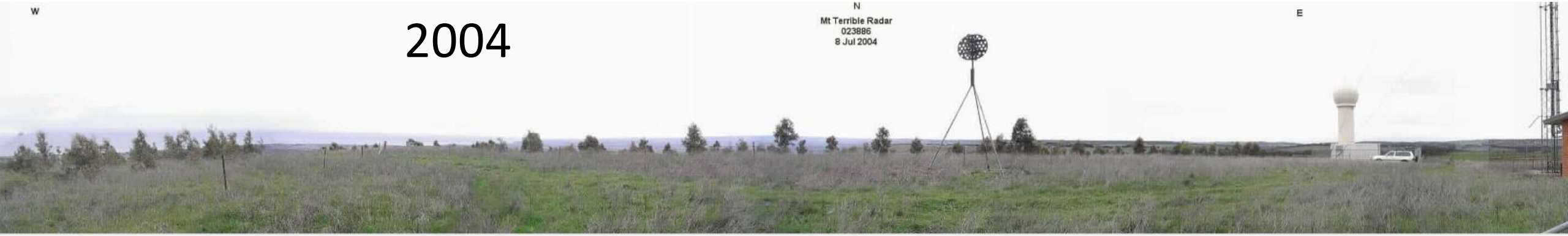


West

North East

South East

2004

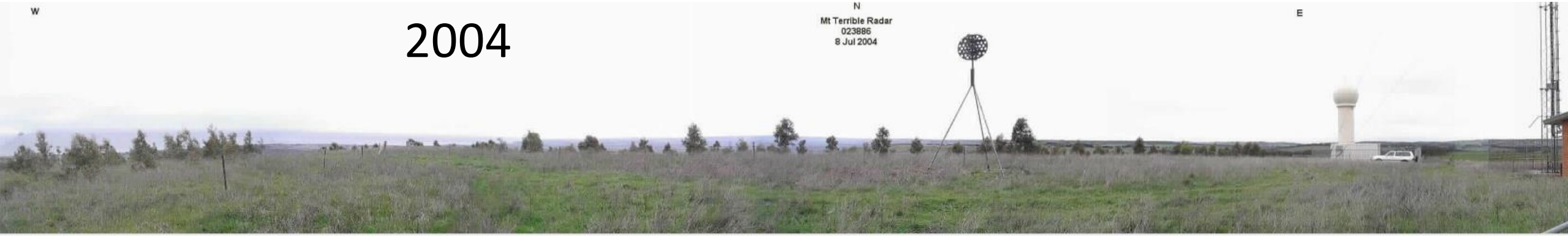


West

North East

South East

2004



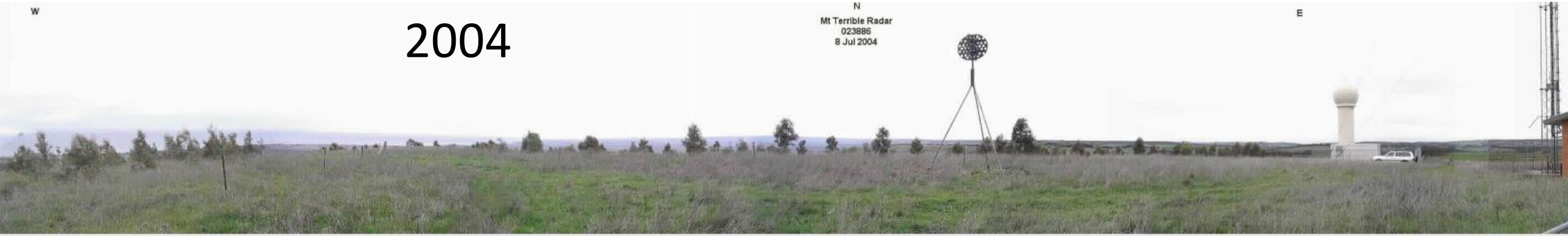
2011

West

North
East

South
East

2004



2011

2017

Combienbar, VIC
Gust factor ~2.1

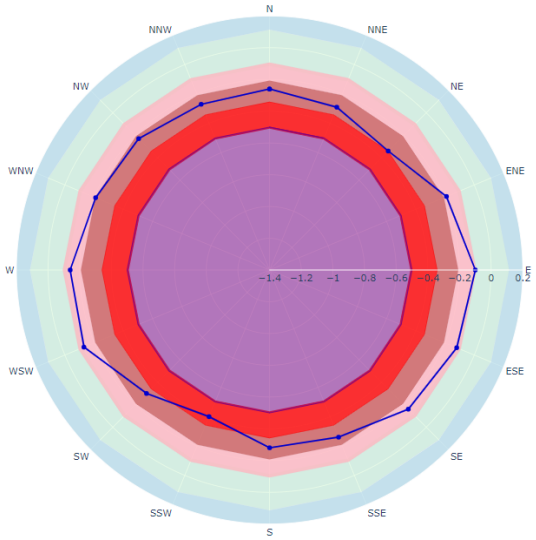
Combienbar, VIC
Gust factor ~2.1

After bushfire
Gust factor ~1.8, avg wind up 40%

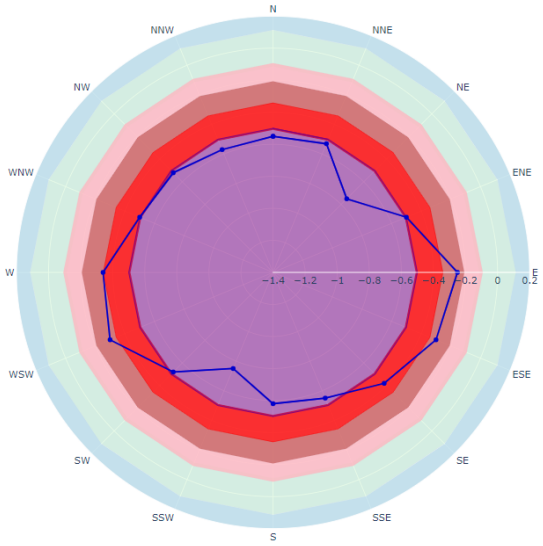
Coldstream, VIC
Comparison site installed 2009

2018-2022 Gust Factors

COLDSTREAM - Average 10 minute gust factor
* Compared to an average, well exposed land site (GF~1.4).
* Categorised by wind direction * Radial = 1.4 - GustFactor



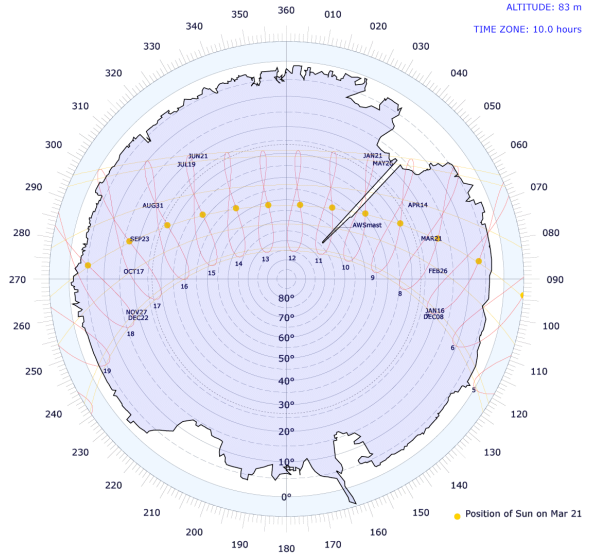
COLDSTREAM COMPARISON - Average 10 minute gust factor
* Compared to an average, well exposed land site (GF~1.4).
* Categorised by wind direction * Radial = 1.4 - GustFactor



SKYLINE SURVEY

SUN POSITIONS FOR COLDSTREAM COMPARISON

SITE NUMBER: 086320
DATE OF SURVEY: 22/03/2012
LATITUDE: -37.7239
LONGITUDE: 145.4095
ALTITUDE: 83 m
TIME ZONE: 10.0 hours



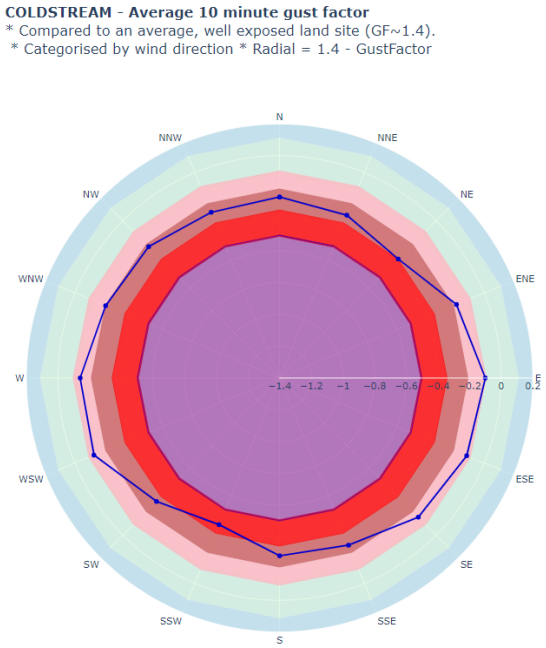
Gust Factor is not always vegetation/building/terrain related.
Hardware/software can also affect readings.

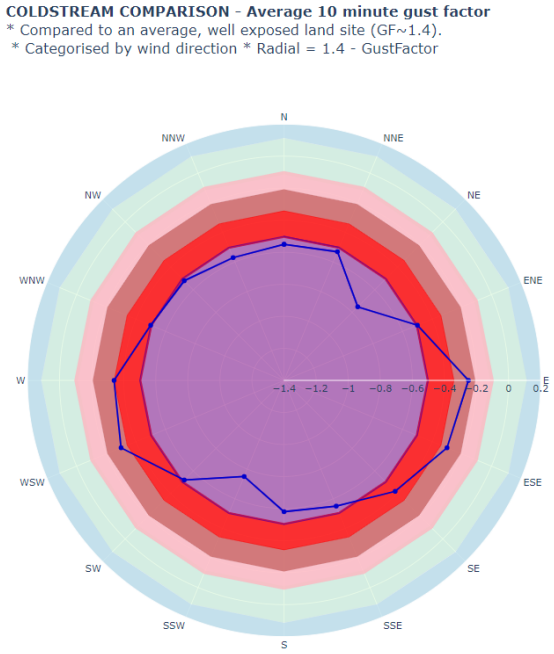
comparison Telmet

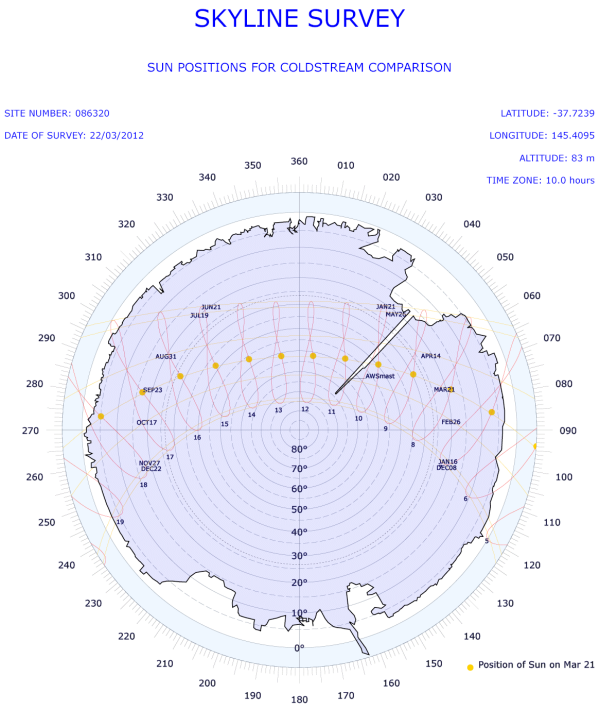
original Almos

Coldstream, VIC
Comparison site installed 2009

2018-2022 Gust Factors







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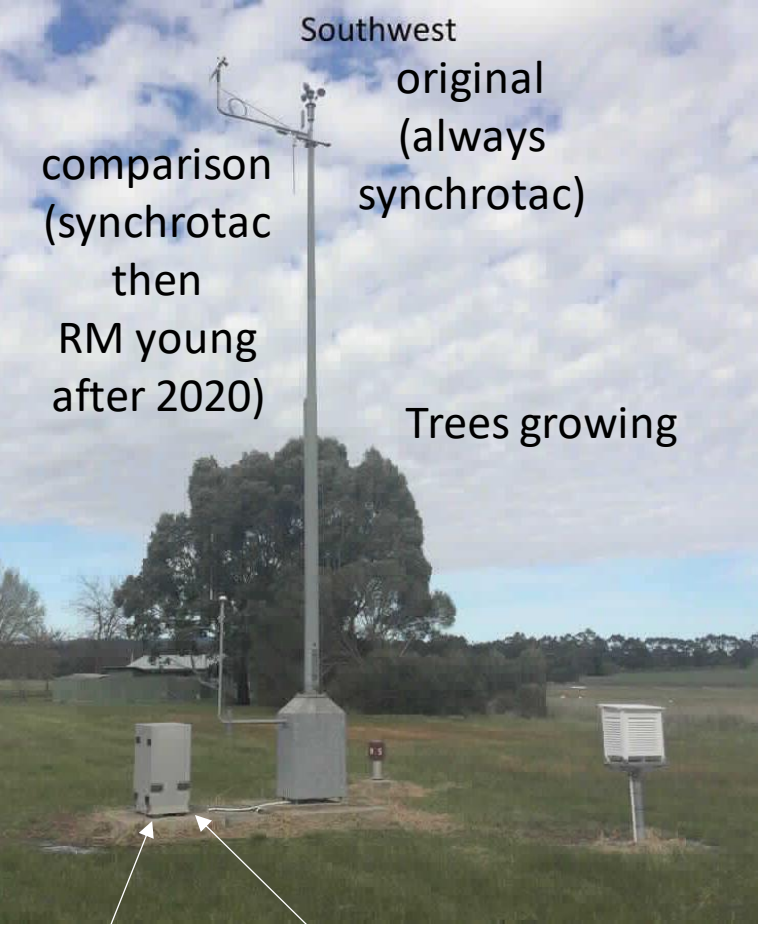
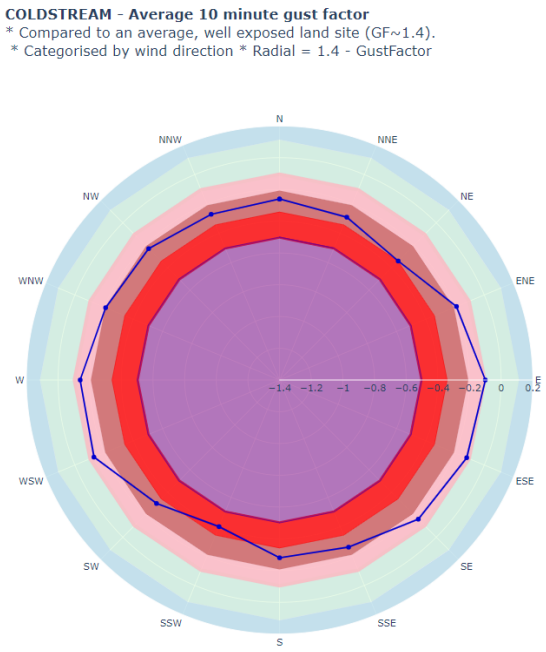
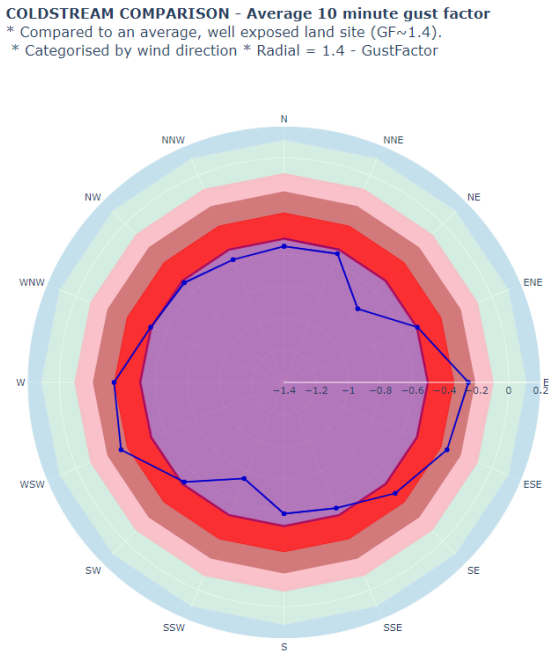
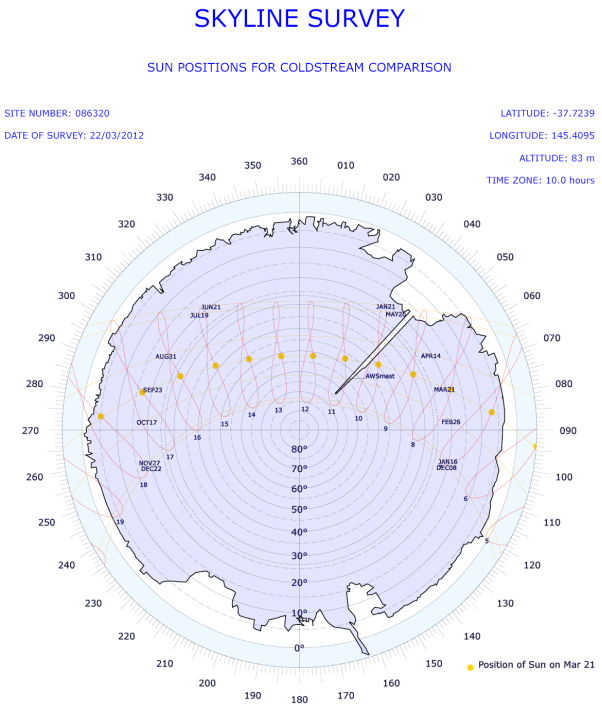


Coldstream, VIC
Comparison site installed 2009

2018-2022 Gust Factors







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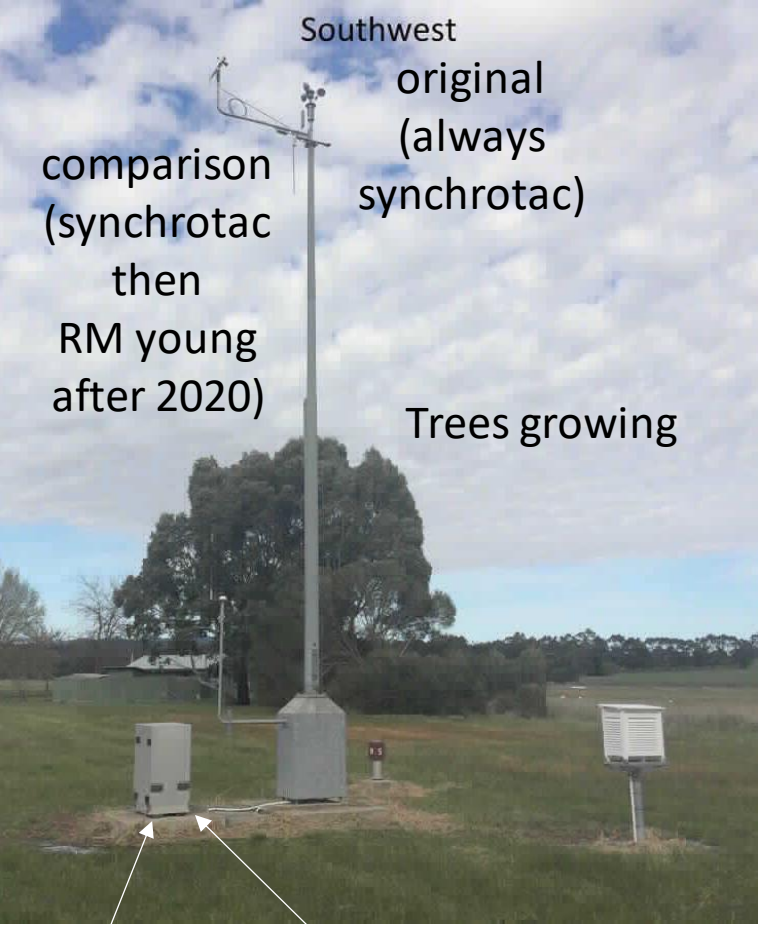
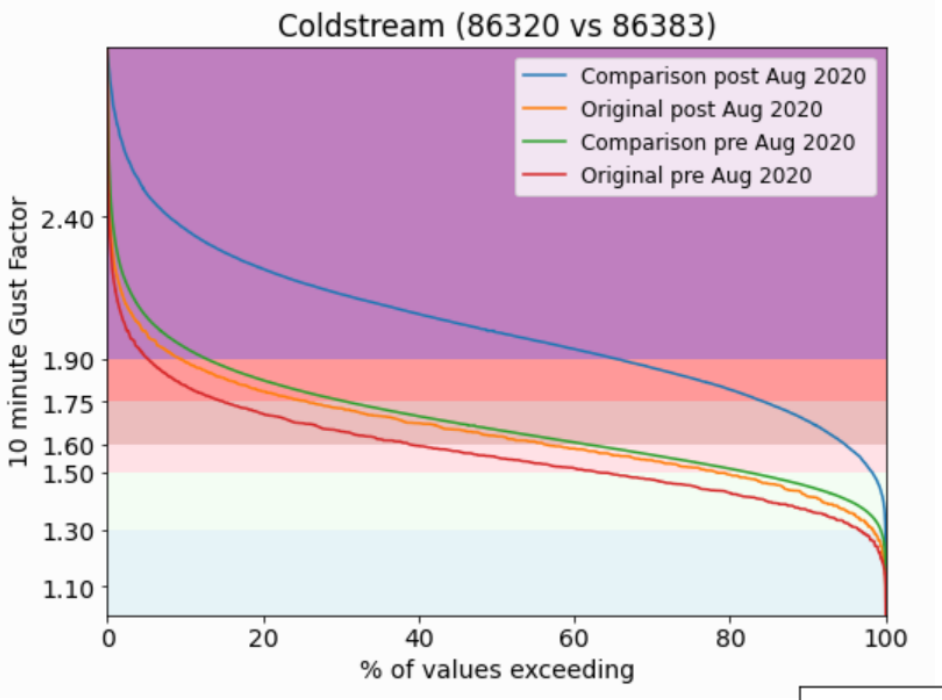


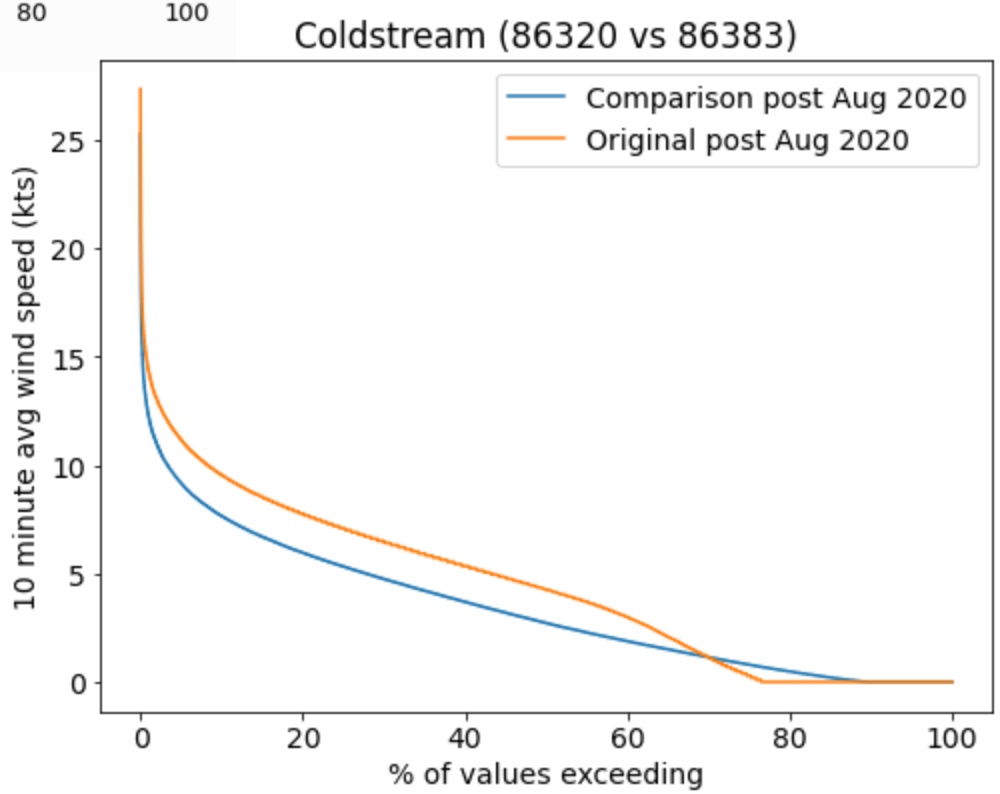
comparison
Telmet

original
Almos



New sensor has much higher GF.
Peak gusts the same, but
average winds substantially reduced.

Across country:
3.5% RM Young sensors
vs >90% Synchrotac,
22% Telmet (new), 66% Almos (old)



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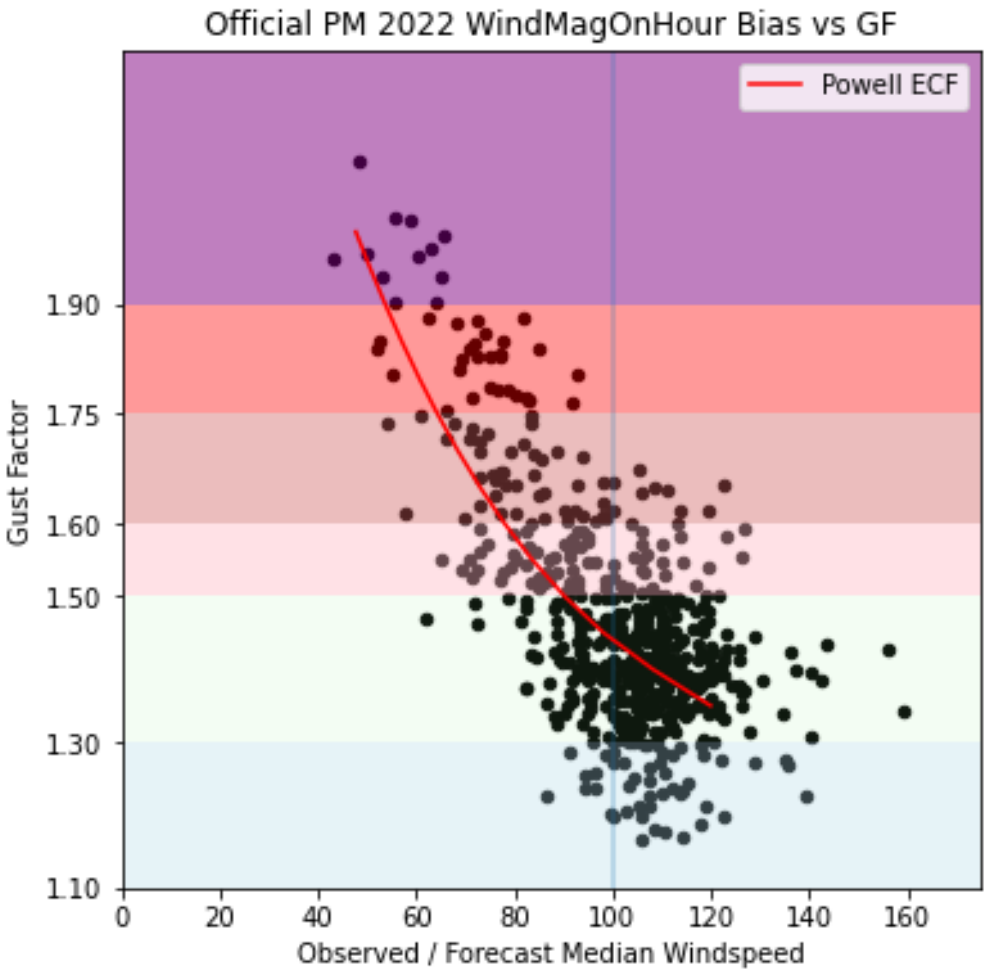
Hardware/software can also affect readings.

Each dot a station

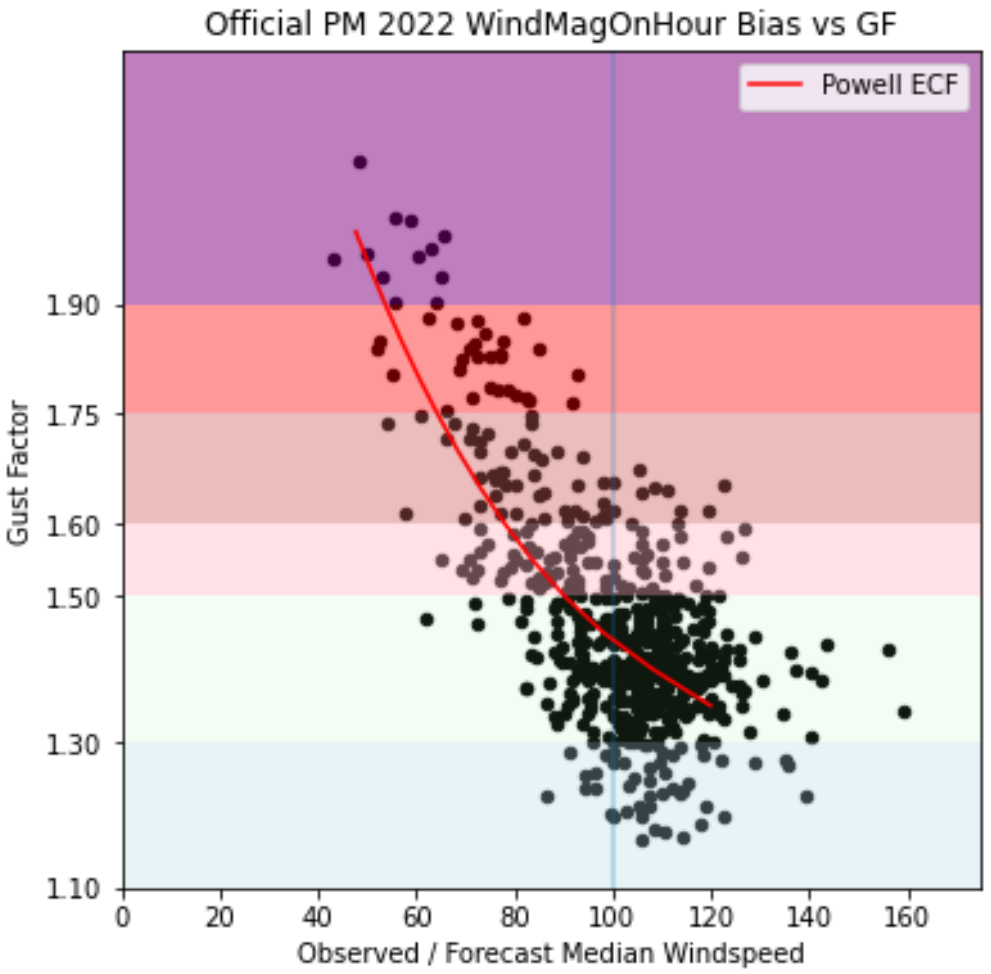


Over forecasting

Lead-day 1 Bias

Under forecasting

Each dot a station



Over forecasting

Lead-day 1 Bias

Under forecasting

Reflections:

Gust Factor/biases affected by equipment

Also, obvious connections between Gust Factor and obstructions

Will need annual revisiting as sensors change/veg grows

But our forecast definition is "10 metres above ground/sea", with no reference to "open terrain".

So then can we censor a station for being sheltered?

Contact: tom.pagano@bom.gov.au