AN OVERVIEW OF NEW TOOLS TO HELP FORECAST UNUSUAL TO EXTREME WEATHER EVENTS IN SOUTHERN CALIFORNIA

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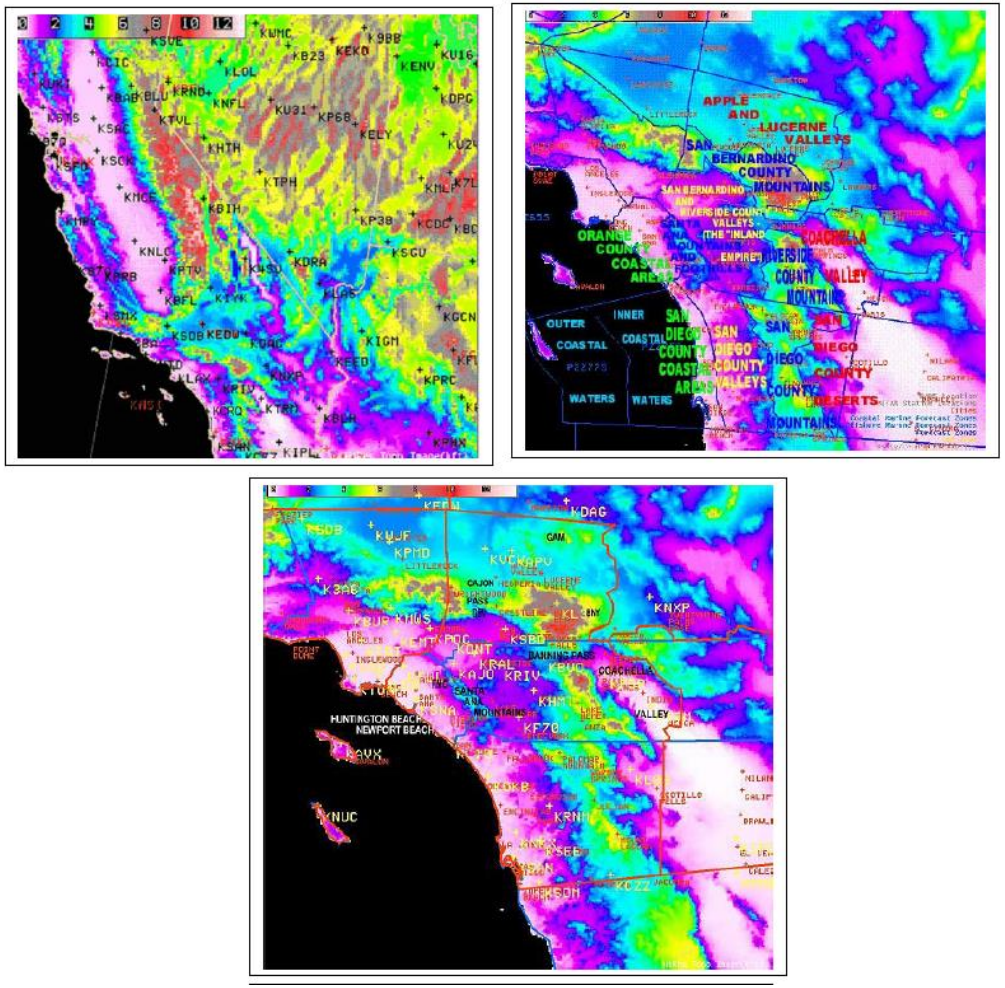
INTRODUCTION

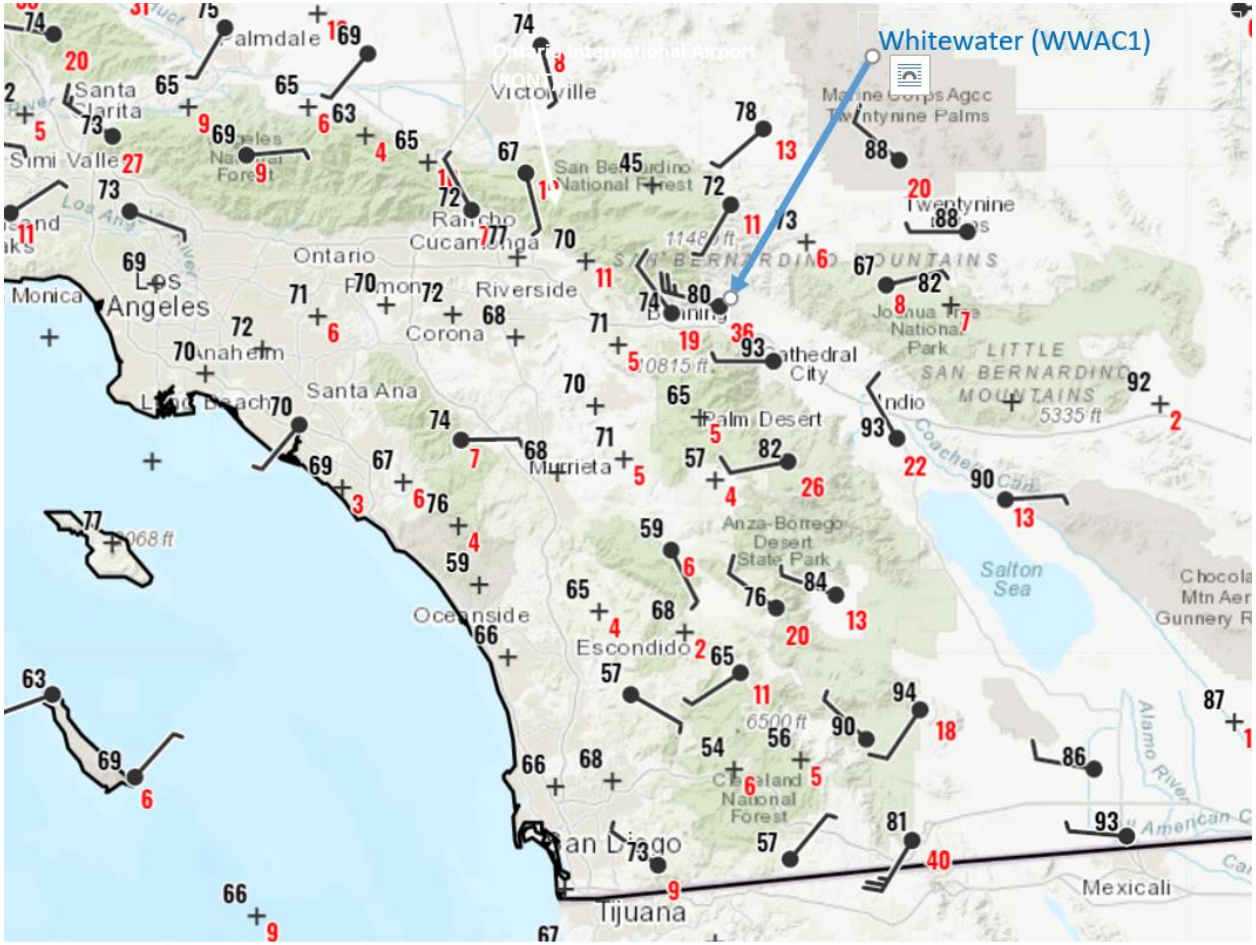
- On 26 February, 2020, winds at Sill Hill, in the San Diego County Mountains, gusted to 106 mph, (possibly the highest wind gust ever measured in San Diego County). It occurred under especially strong Santa Ana Wind conditions. Excessive winds also occur from the west as well in Southern California. Extreme temperatures, sometimes in excess of 120 degrees occur with some regularity.
- The models are improving steadily, but still struggle with extreme events. An “Adjusted Multiple Regression” approach helps with such extreme events.
- Accurate forecasts become optimally important to the delivery of precise IDSS messaging for such events.
- Some thoughts and examples on how the National Blend of Models (NBM) and probabilistic data plays a valuable role in this are also discussed from a point approach as well as an “area “approach.

INTRODUCTION



- Terrain map of WFO SGX CWA. Color coding in the legend is in thousands of feet MSL.

NBM FORECASTS AS SEEN VIA THE 1-D VIEWER FOR WIND GUSTS AT WHITEWATER



- Whitewater (WWAC1) is a sensor in the mountain pass just northwest of Palm Springs near Banning. It is typically one of the windiest locations with onshore (i. e. westerly) flow.

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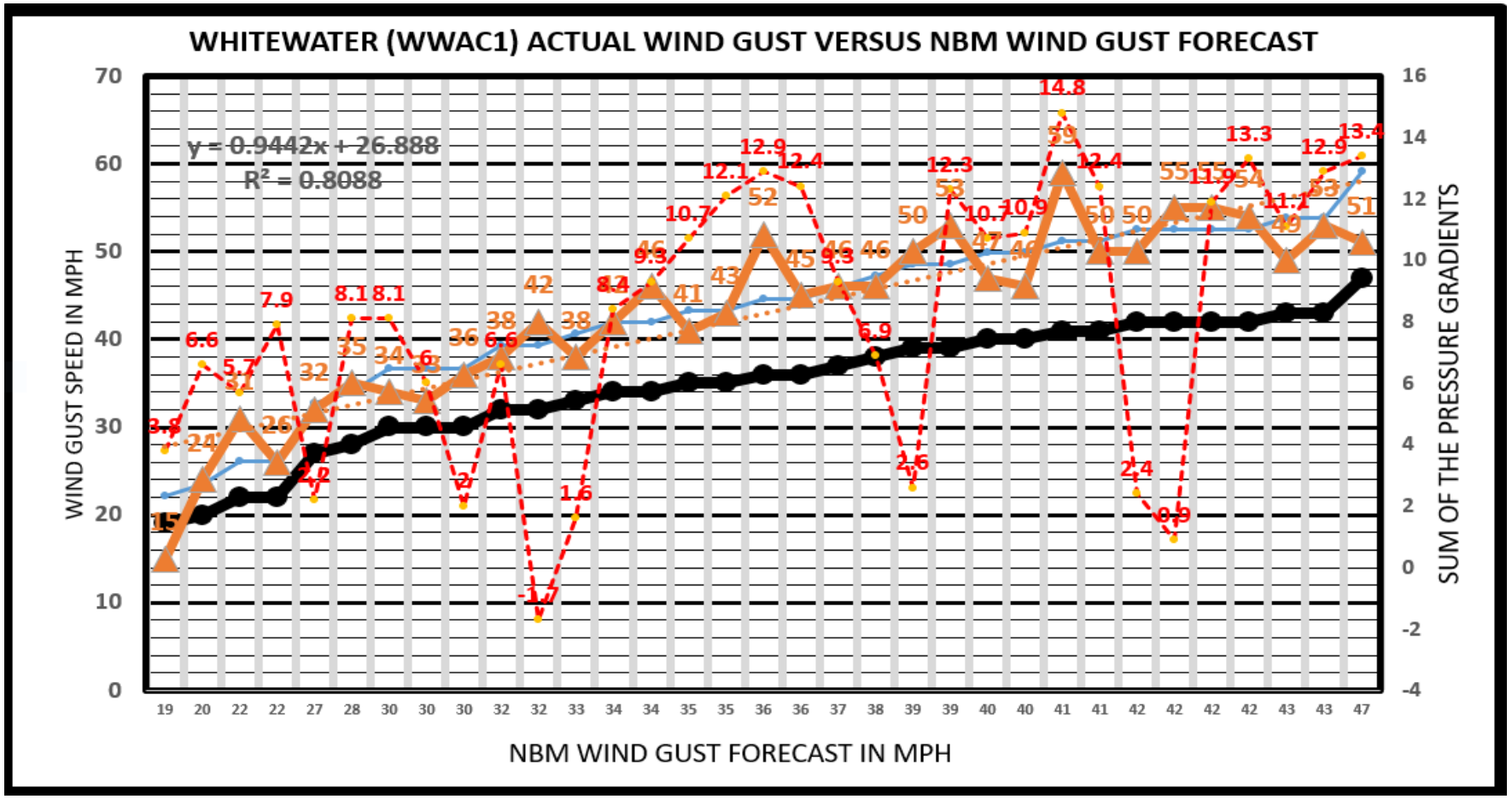

- The above is a graph utilizing the NBM along with other parameters to estimate the expected wind gust speed at Whitewater (WWAC1).

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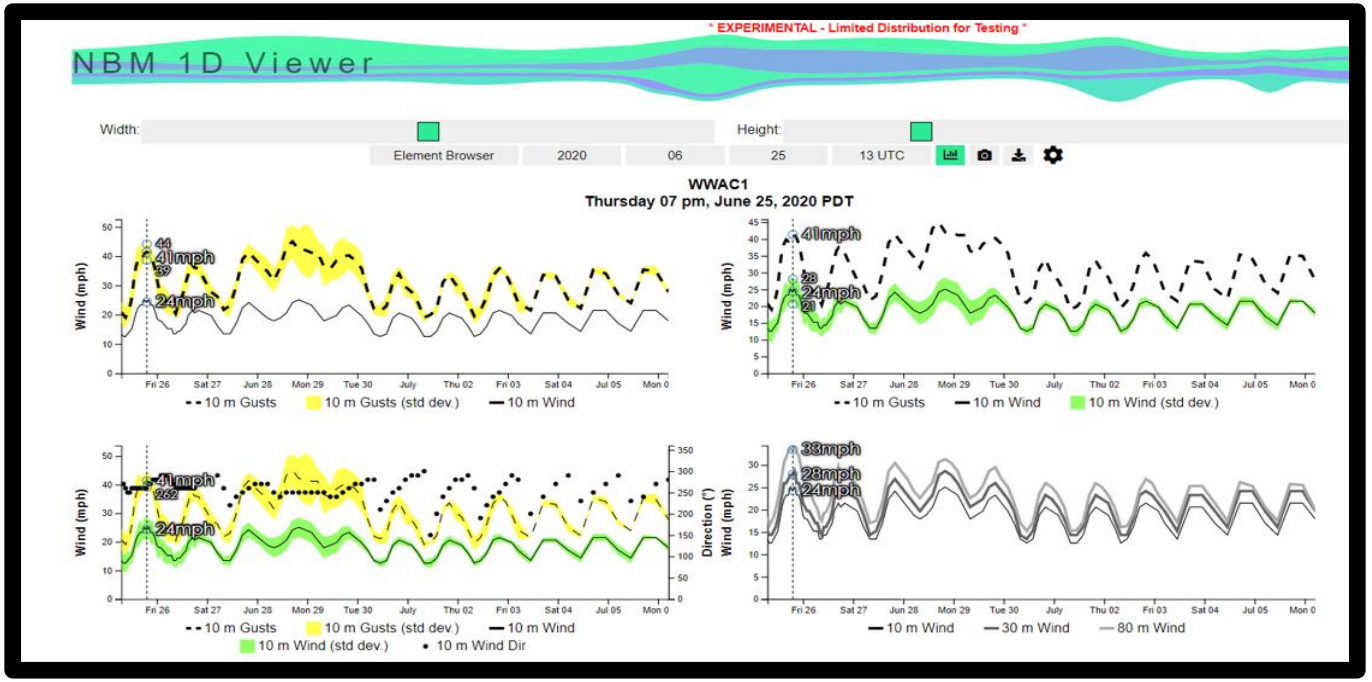

- The methodology is to go into the experimental 1-D Viewer and using the 1300 UTC run, find the highest NBM westerly wind gust forecast in the first 24 hours of the forecast period (a black vertical dotted line with circles indicates the time the wind is being evaluated in the graphic).

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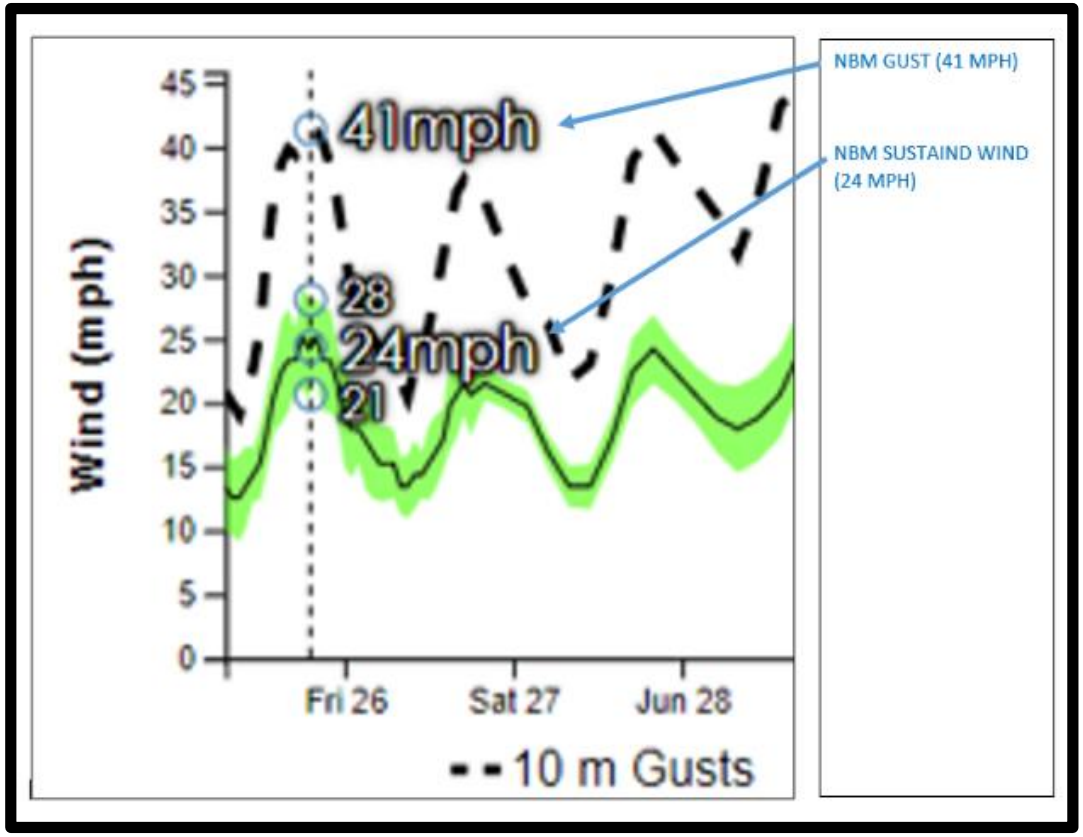

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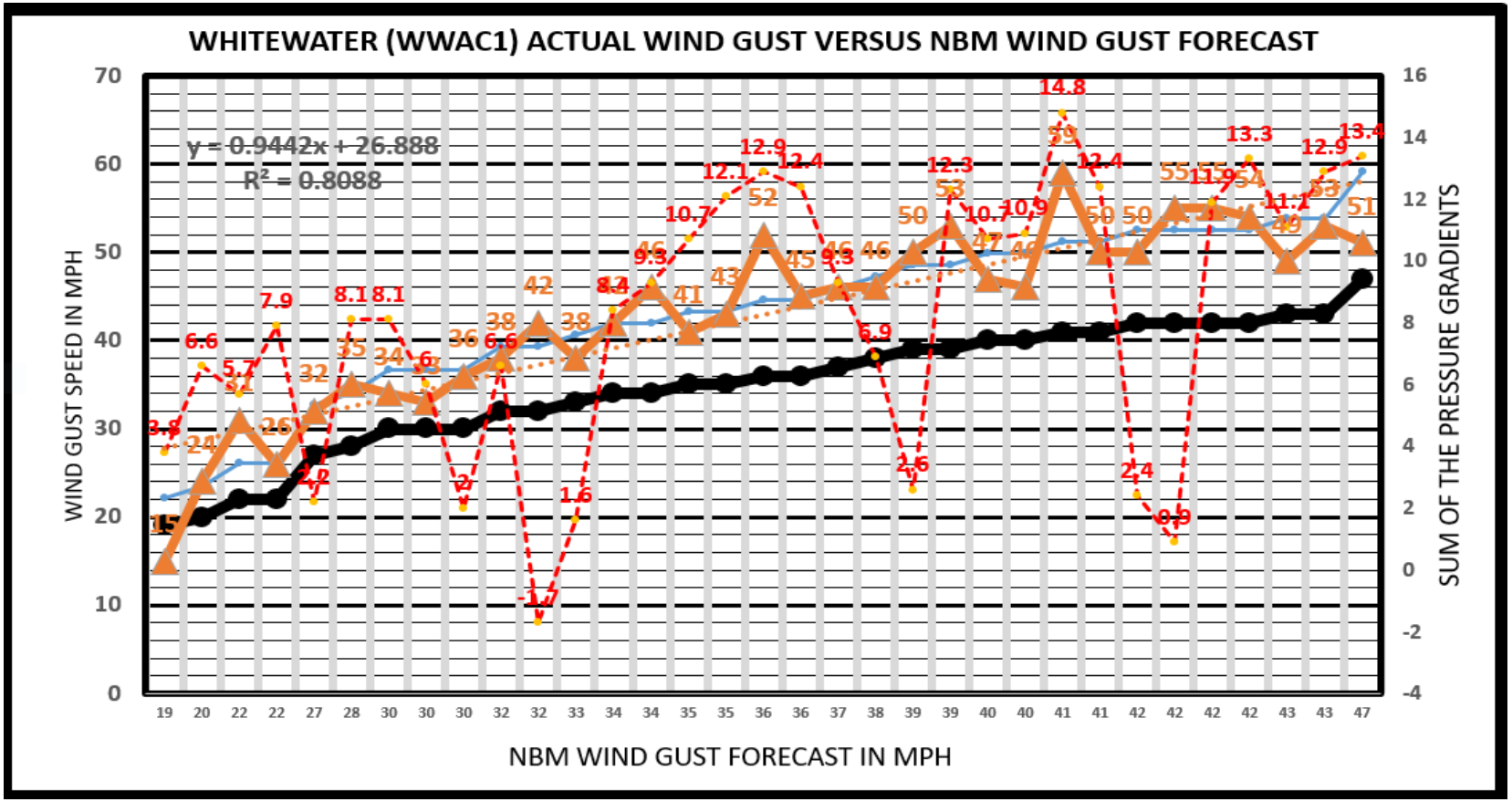

- Next it is compared to the actual wind gust from the observations (thick orange line with triangles).

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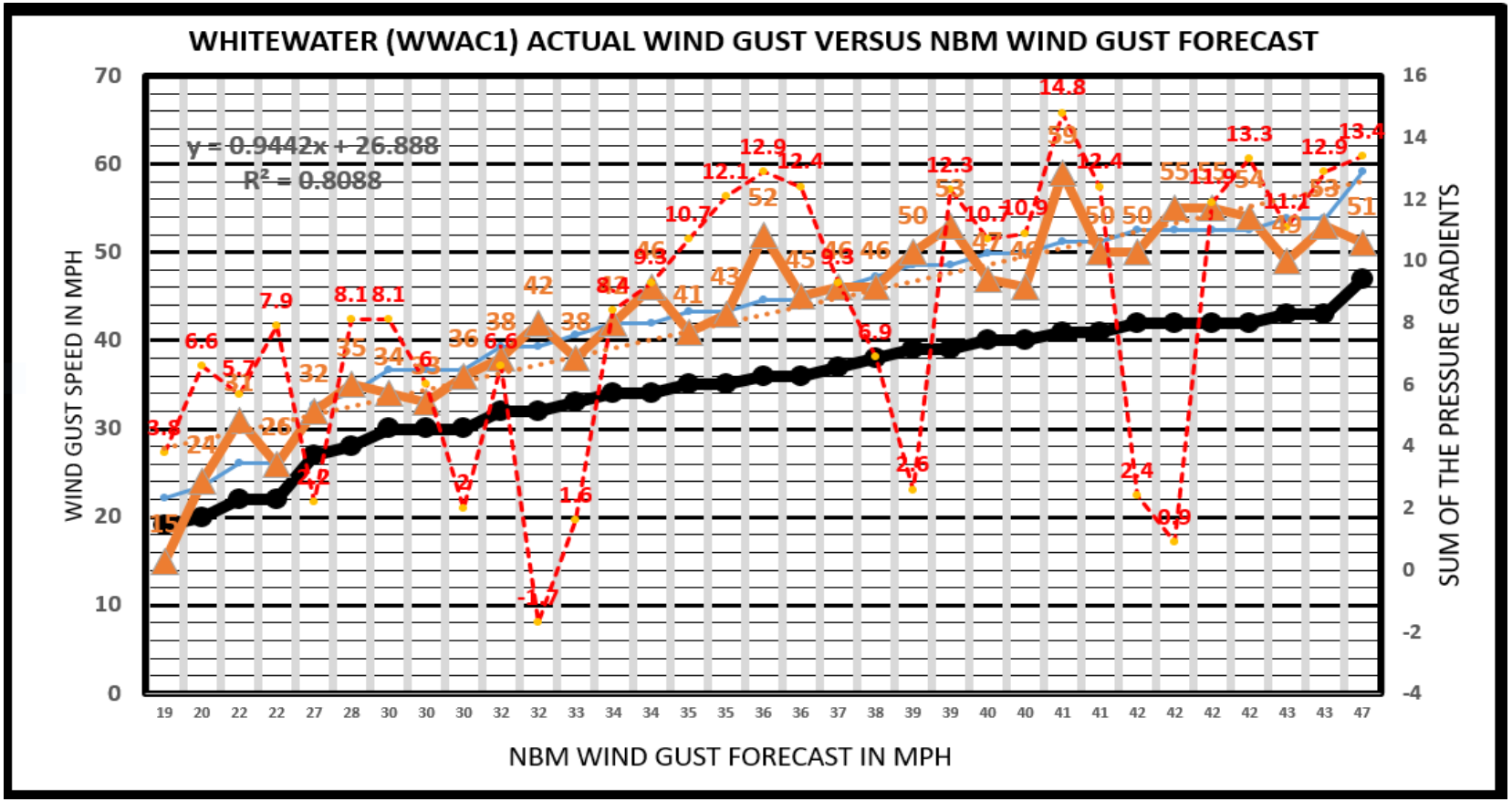

- A linear regression technique is used to create a curve to forecast the wind gust (blue line is the regression forecast) based on the NBM wind gust forecast (the thick black line with circles).
- The thin orange dotted line is the trend line for the actual observations.

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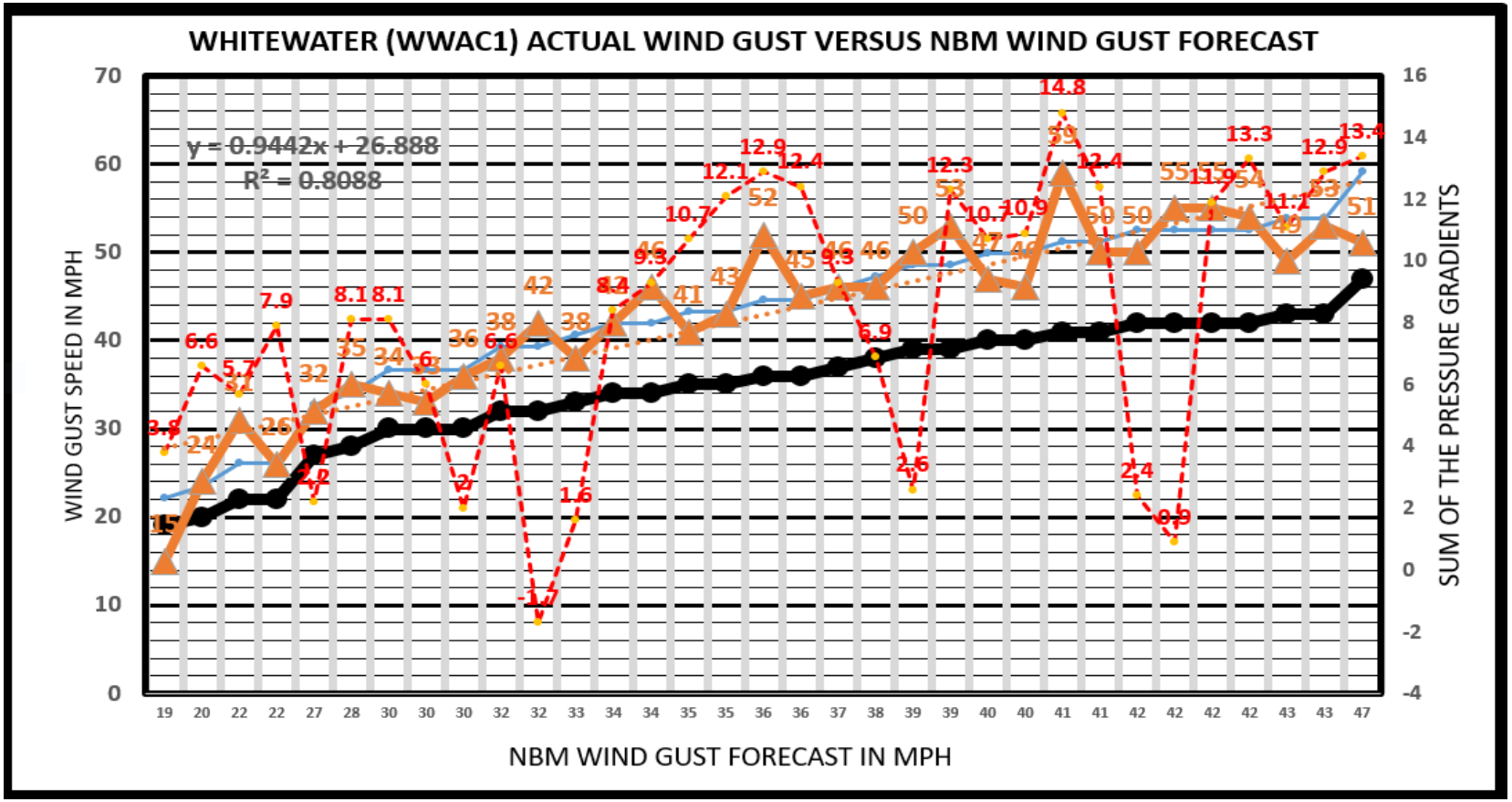

- The red dashed line is the 1200 UTC KSAN to KLAS pressure gradient <u>added to</u> the KSAN to KYUM surface pressure gradient to obtain a surface pressure "gradient sum" (the gradient sum is an attempt to account for the location of the trough of low pressure, which may be near KLAS or near KYUM).

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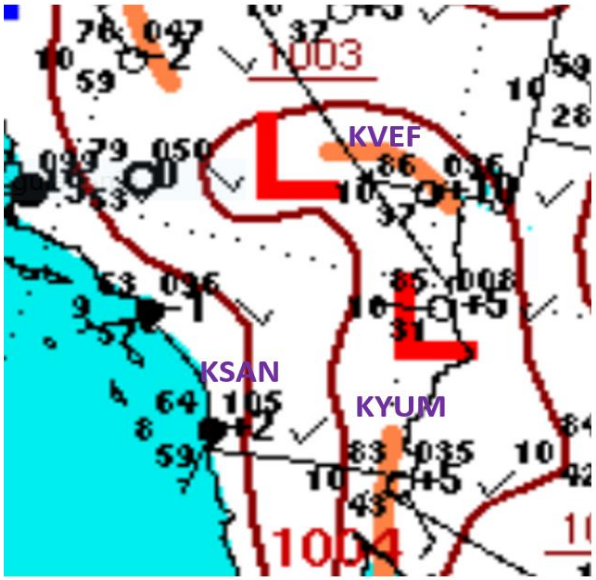

- The red dashed line on the previous slide is the 1200 UTC KSAN to KLAS pressure gradient added to the KSAN to KYUM surface pressure gradient to obtain a surface pressure "gradient sum" (recall, the gradient sum is an attempt to account for the location of the trough of low pressure, which may be near KLAS or near KYUM).
- The decoded MSLP values above for San Diego (KSAN), Las Vegas (KLAS), and Yuma (KYUM) are 1010.5, 1003.6, AND 1004.5 respectively
  - The gradient value is +6.9 for KSAN to KLAS
  - The gradient value is +7.0 mb for KSAN to KYUM
- The sum of the two gradients is 13.9 mb. Per the chart on the previous slide, the 41 mph NBM gust results in, based on the regression, about 51 mph gust on the chart.
- There is an enhancement needed on top of the multiple regression forecast of 51 mph when surface pressure gradients are very strong. Since there is a large (double digit) gradient sum, it results in approximately an additional 4 mph, raising the wind forecast up to the mid 50s, not far from the 49 mph wind gust value that occurred.

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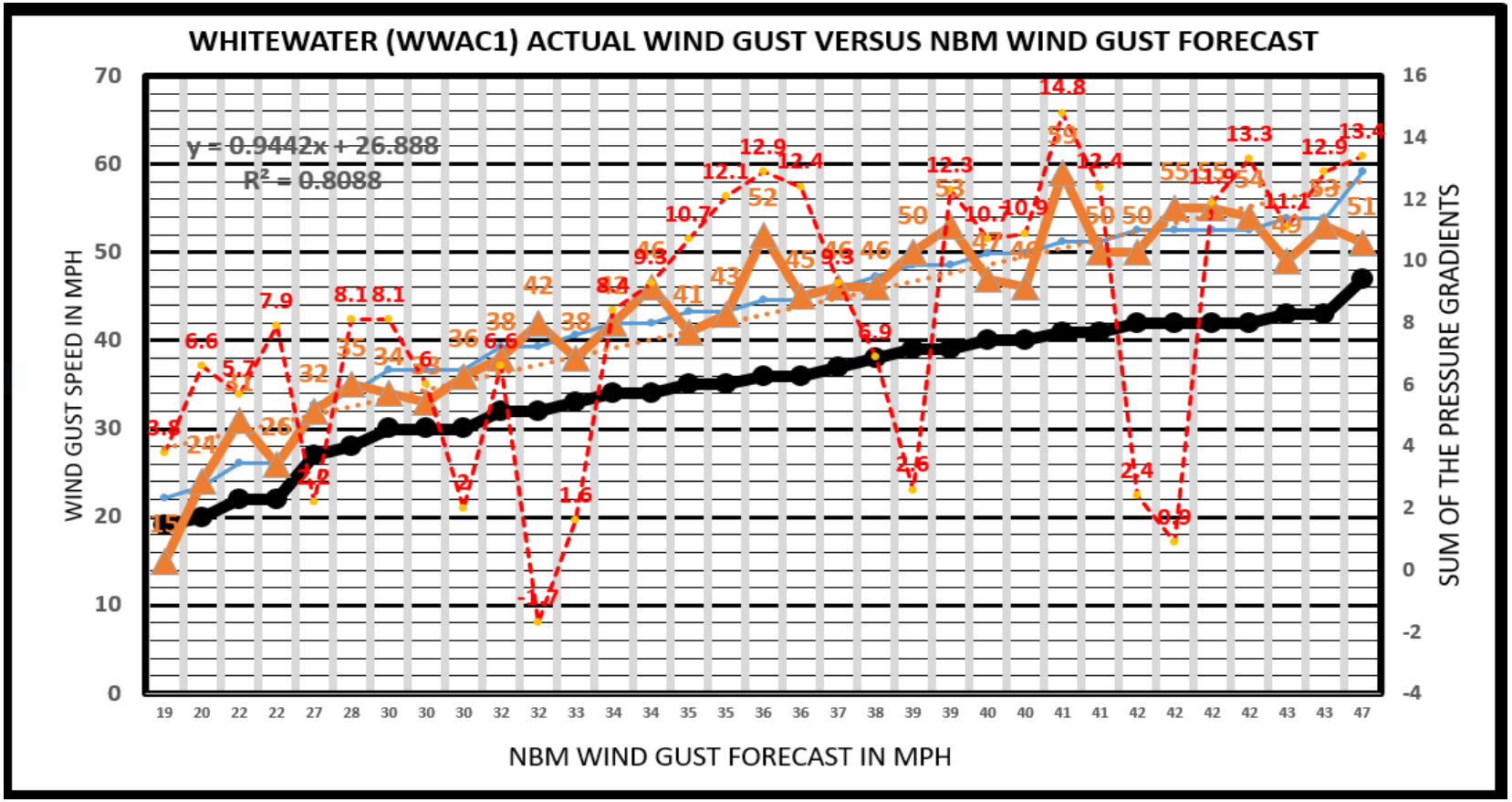

- This slide shows the original NBM gust forecast (black curve) and the curve created by the regression equation created on this slide (blue curve), along with the actual wind gusts (thick orange curve), its trend line (light dotted orange curve), and the surface pressure gradient sum (red dashed curve).

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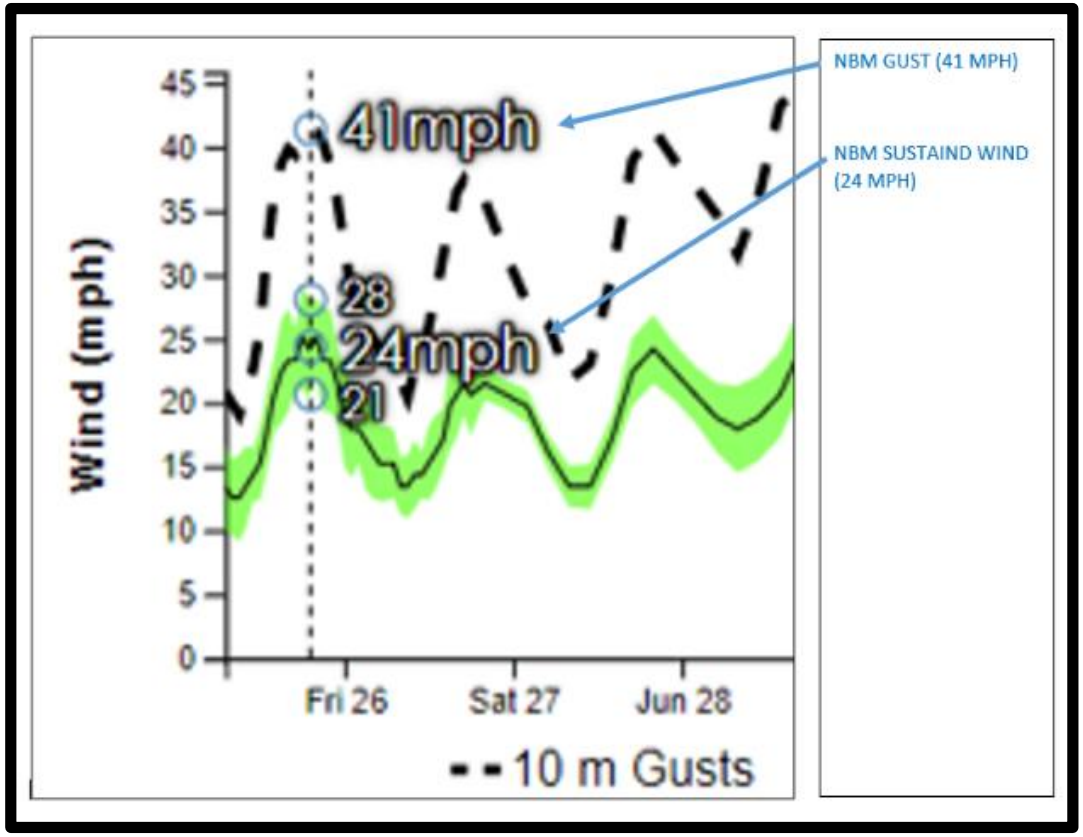

- Recall the 41 mph value for the test day (6/25/2020).

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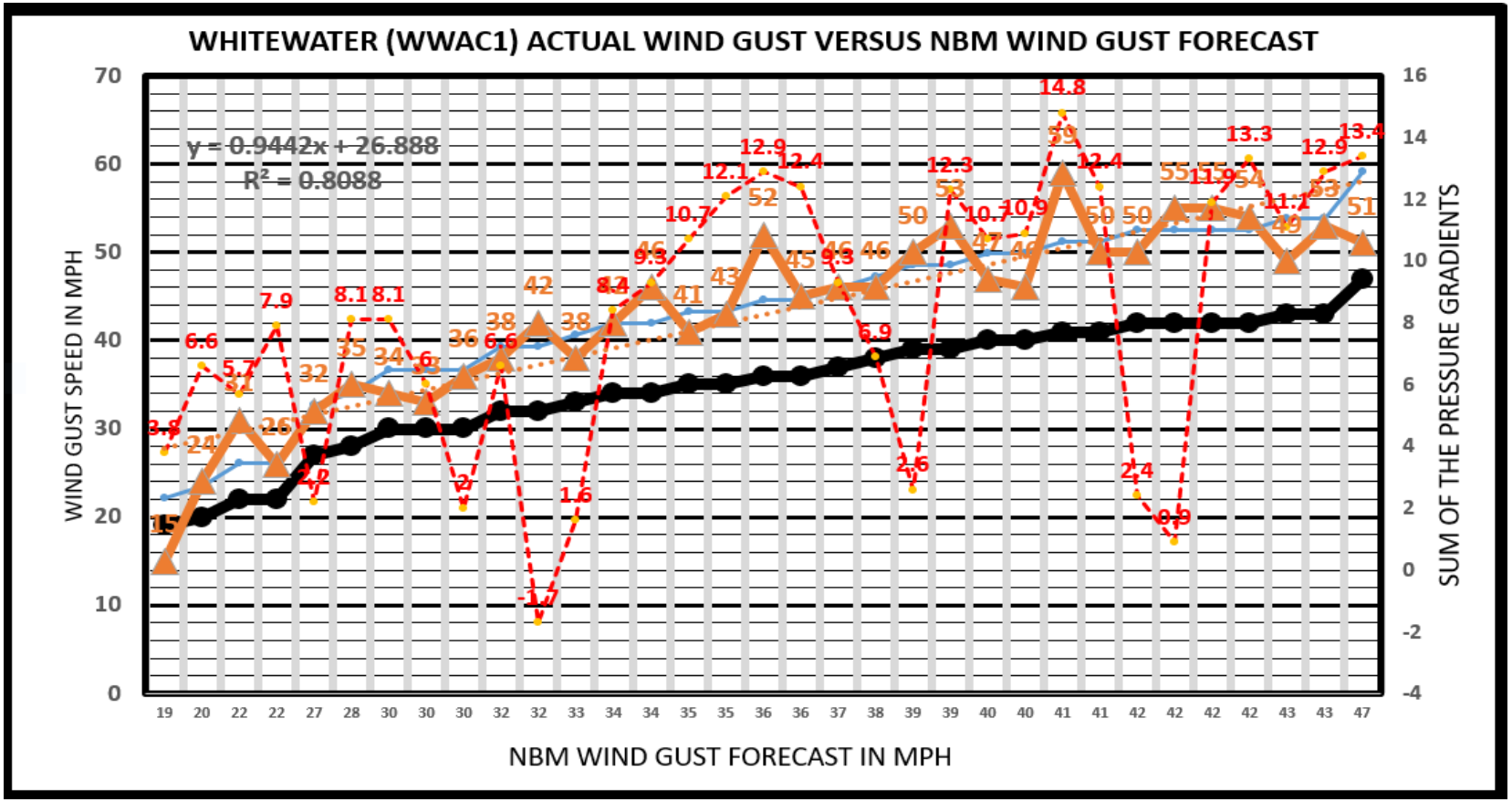
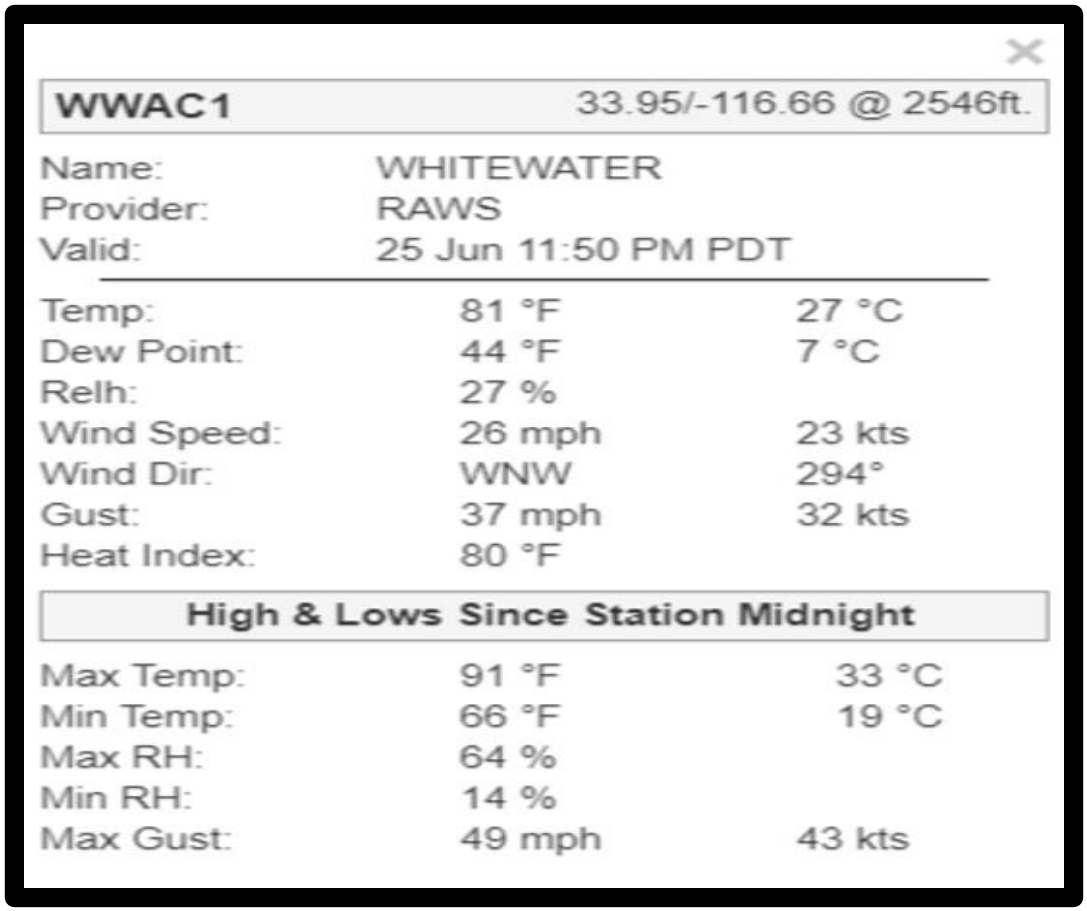


- Plugging in the 41 mph NBM value into the black dotted curve would result in wind gusts of about 51 mph as seen via the orange curve with triangles, but with a double digit “gradient sum” of 13.9, one would think typically it would boost the expected peak gust up a bit to a value of around 55 or so.

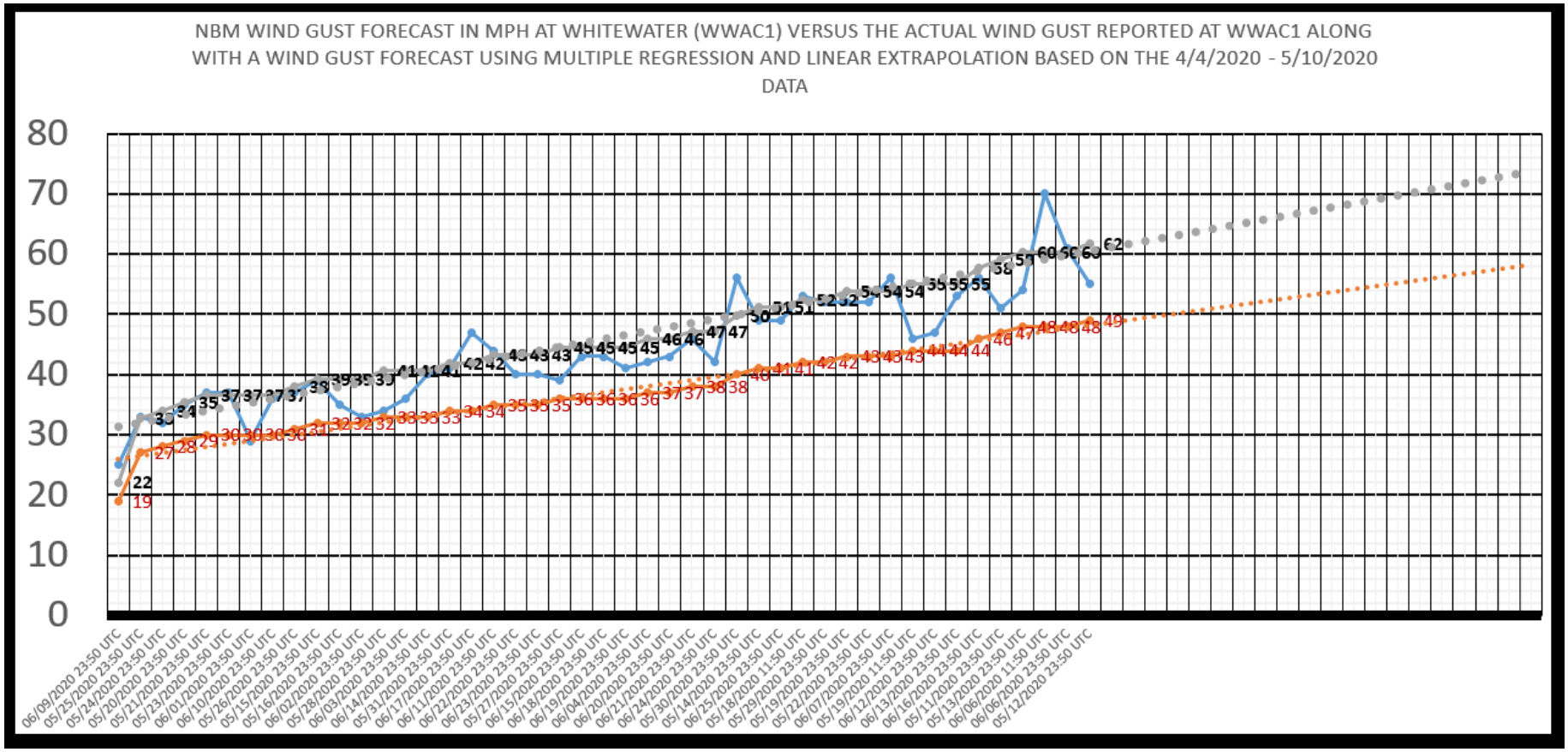
NBM FORECASTS AS SEEN VIA THE 1-D VIEWER FOR WIND GUSTS AT WHITEWATER



WWAC1	33.95/-116.66 @ 2546ft.	
Name:	WHITEWATER	
Provider:	RAWS	
Valid:	25 Jun 11:50 PM PDT	
Temp:	81 °F	27 °C
Dew Point:	44 °F	7 °C
Relh:	27 %	
Wind Speed:	26 mph	23 kts
Wind Dir:	WNW	294°
Gust:	37 mph	32 kts
Heat Index:	80 °F	
High & Lows Since Station Midnight		
Max Temp:	91 °F	33 °C
Min Temp:	66 °F	19 °C
Max RH:	64 %	
Min RH:	14 %	
Max Gust:	49 mph	43 kts

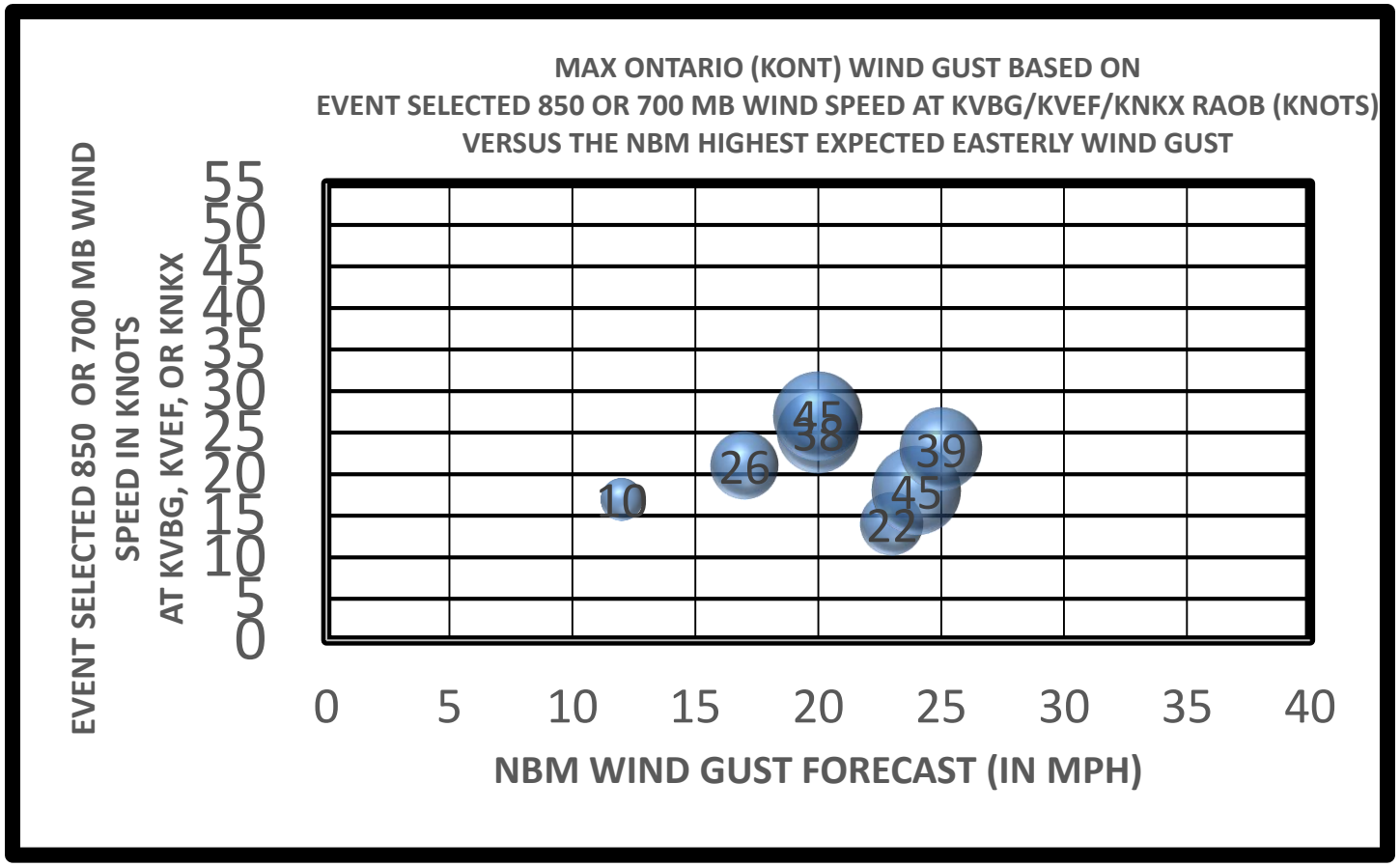
- The peak wind gust verification on the Weather and Hazards Weather Viewer for the afternoon of 6/25/2020 was 49 mph as shown in the bottom of the above image.

NBM FORECASTS AS SEEN VIA THE 1-D VIEWER FOR WIND GUSTS AT WHITEWATER



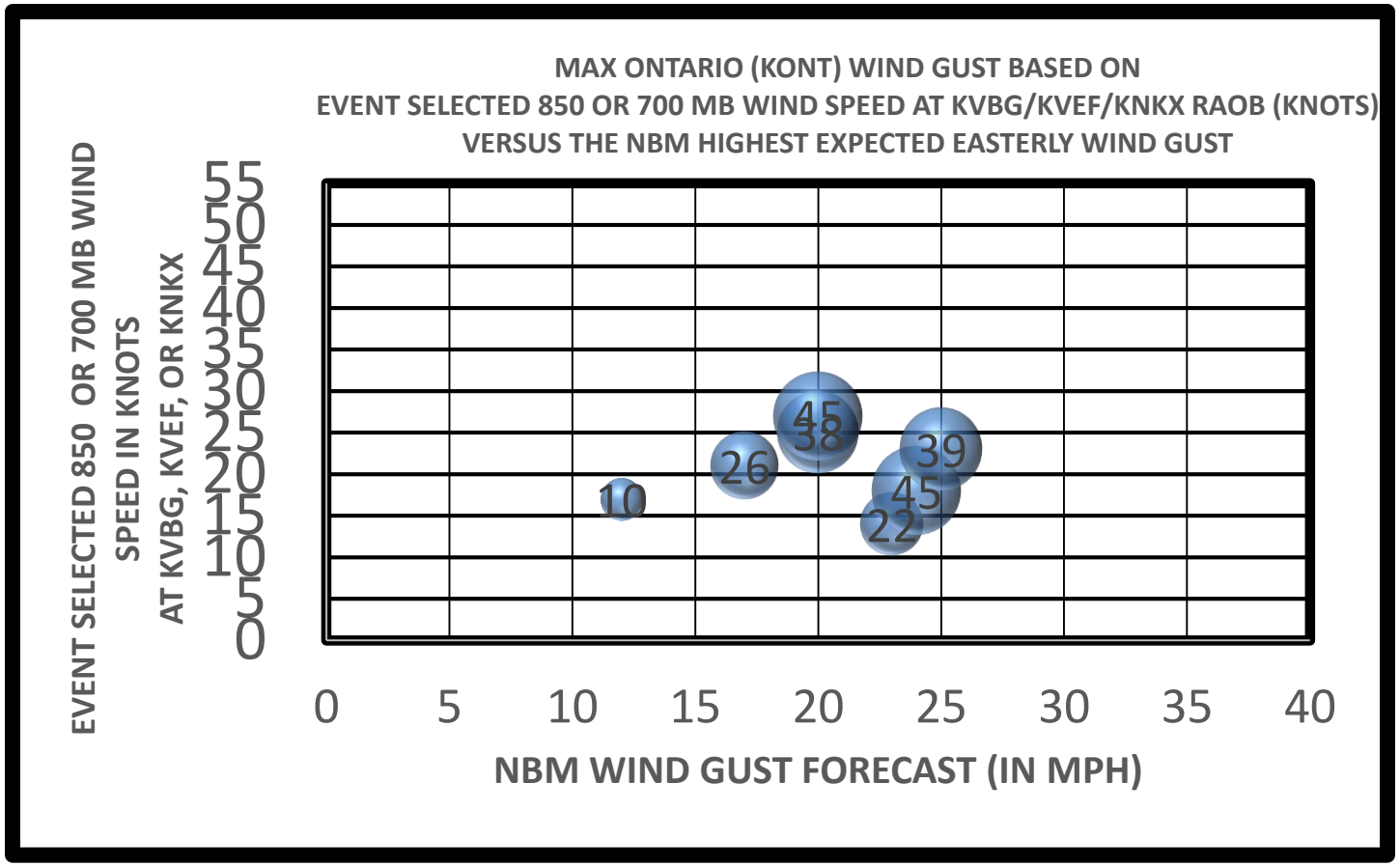
- Here is another example for Whitewater. (Note the color scheme change for this data set).
- The orange line is the NBM wind gust forecast, and the blue line is the actual wind gusts reported.
- The gray dotted line is the extrapolation of the wind gust forecast.
- The orange dotted line is the extrapolation of the NBM forecast.
- The regression formula created by the earlier Whitewater graphics is used in this slide, with NBM data from the approximately mid- May through mid-June period used to see how well it forecasts what actually happens.
- The actual wind gust reports seem to frequently differ from the regression forecast, but almost always above the original NBM forecast.
- “Huge gradient sum” days may be responsible for the days where the actual wind gust is well above the regression forecast.

NORTHEASTERLY WIND PATTERNS AT ONTARIO (KONT)



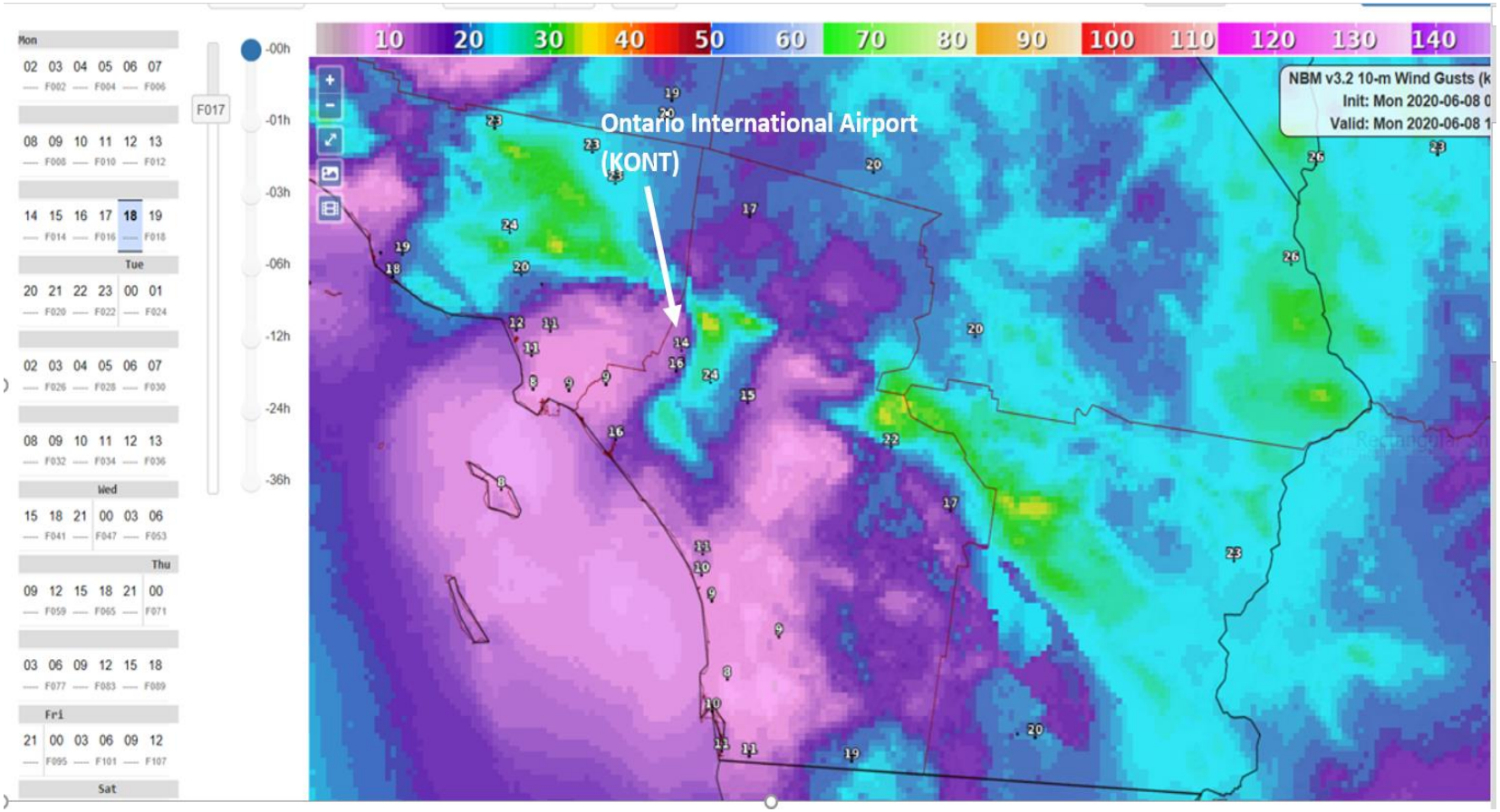
- Since the NBM is available for only back to about April 2020 there are only a few cases available, but there was enough to see the NBM's "under-forecasting" issue at some locations.
- If the KVEF 700 mb wind is larger than the largest 340-179 degree 850 mb wind, then that wind is the max wind used, otherwise, the highest 340-179 degree 850 mb wind seen at KVBG/KVEF/KNKX is used.

NORTHEASTERLY WIND PATTERNS AT ONTARIO (KONT)



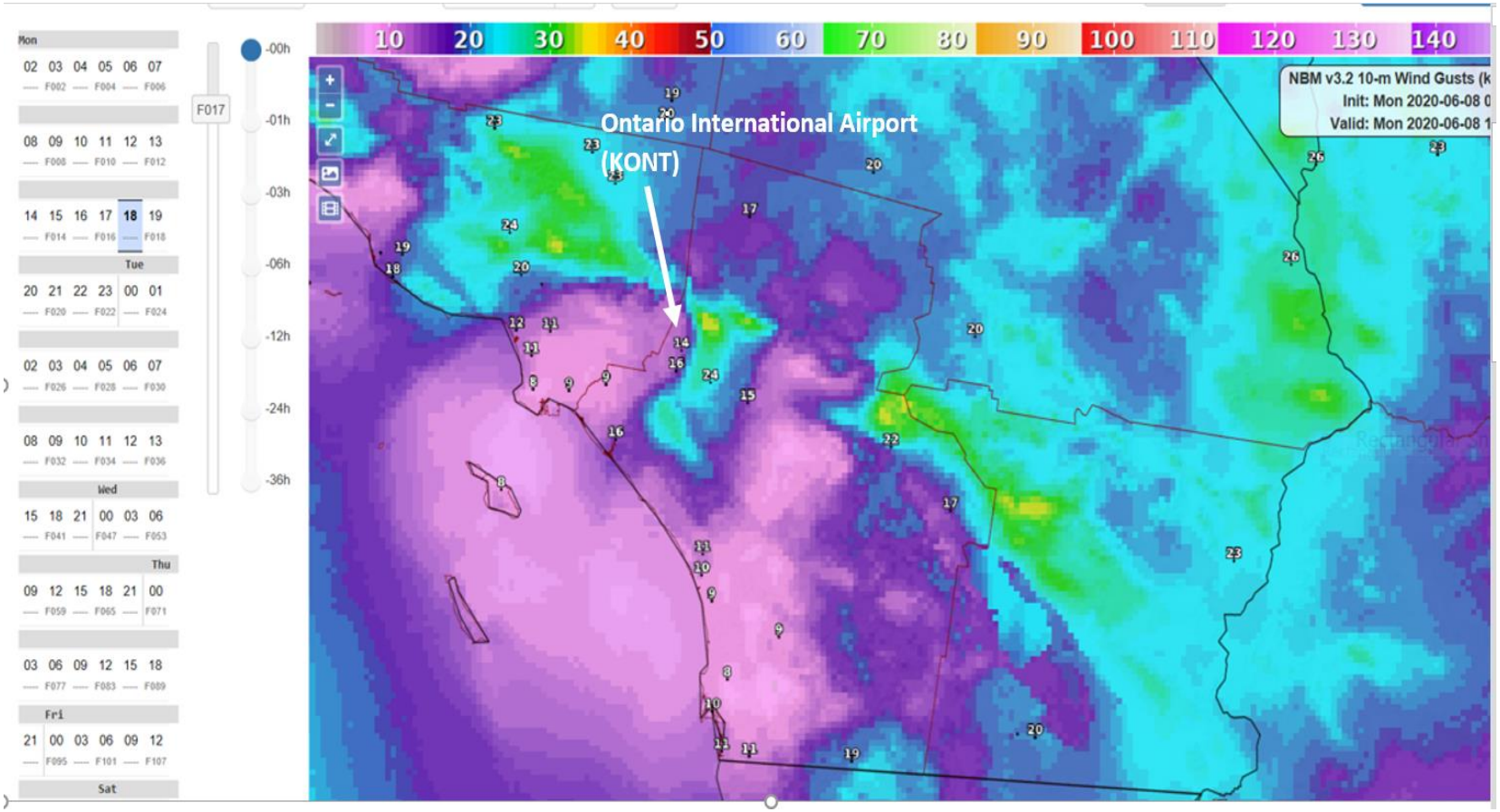
- Here, the KONT NBM forecast is well under the observed values (observed values are inside the bubbles).

NORTHEASTERLY WIND PATTERNS AT ONTARIO (KONT) EXAMPLE



- Here, the KONT NBM wind gust forecast is about 14 knots.

NORTHEASTERLY WIND PATTERNS AT ONTARIO (KONT) EXAMPLE



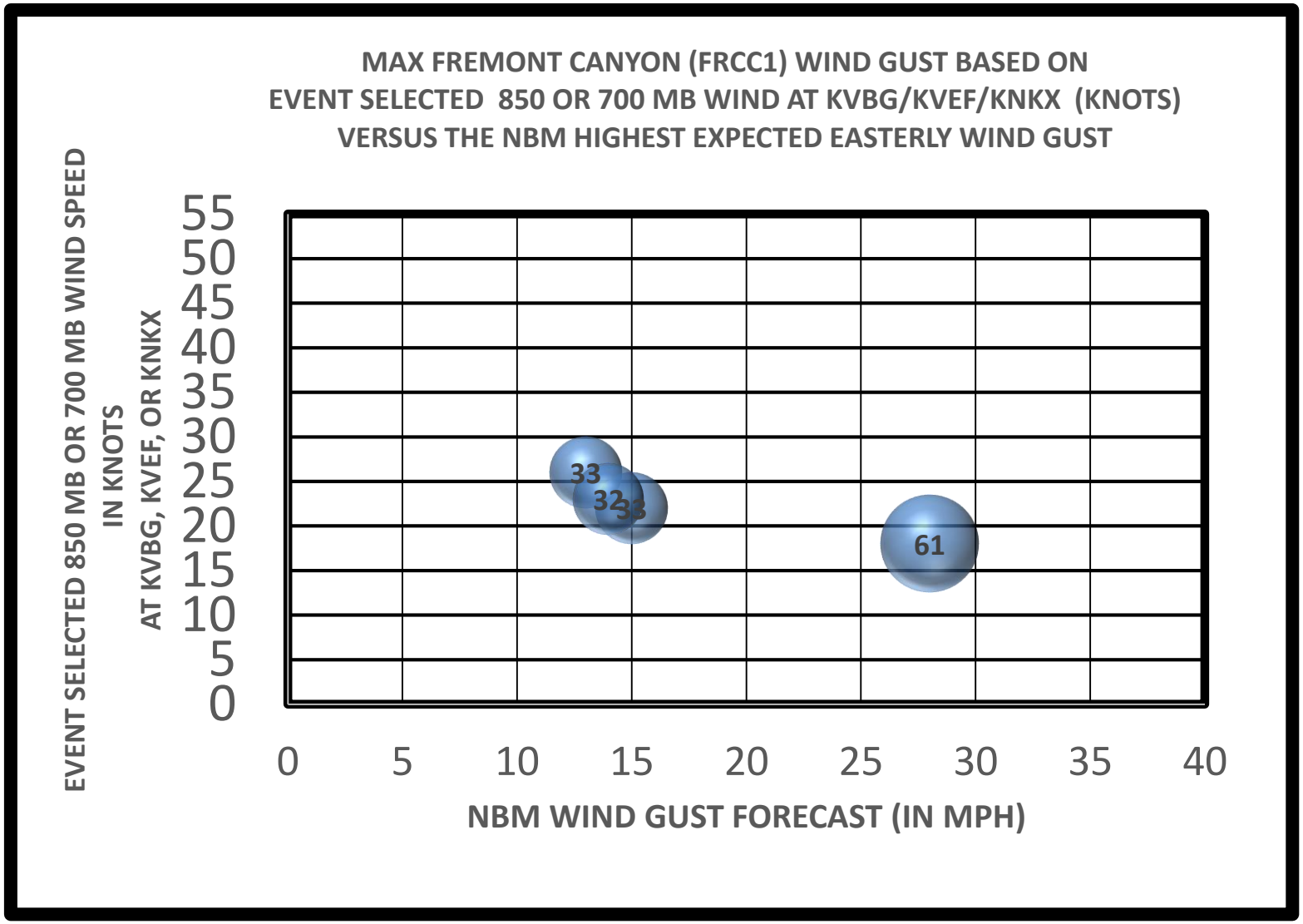
- For the 6/8/2020 Santa Ana Wind Event, a patch of wind gusts between 30 and 40 knots shows up northeast of KONT, but the highest NBM forecasted wind gust for KONT was only 22 mph for this event per the 1-D Viewer. Winds at KONT gusted to 45 mph (it is also included in the graphic with the bubbles shown earlier).

NORTHEASTERLY WIND PATTERNS AT ONTARIO (KONT) EXAMPLE

KONT	06/08/2020 17:53 UTC	30	77	14	9.05	32.22	40	44.88
KONT	06/08/2020 17:55 UTC	30	77		9.05	28.77	40	
KONT	06/08/2020 18:00 UTC	30	78.8		8.53	25.32	40	31.07
KONT	06/08/2020 18:05 UTC	30	78.8		8.53	28.77	40	44.88
KONT	06/08/2020 18:10 UTC	30.01	78.8		8.53	27.62	40	37.98
KONT	06/08/2020 18:15 UTC	30	78.8		8.53	28.77	50	36.82
KONT	06/08/2020 18:20 UTC	30.01	78.8		7.88	28.77	40	39.13

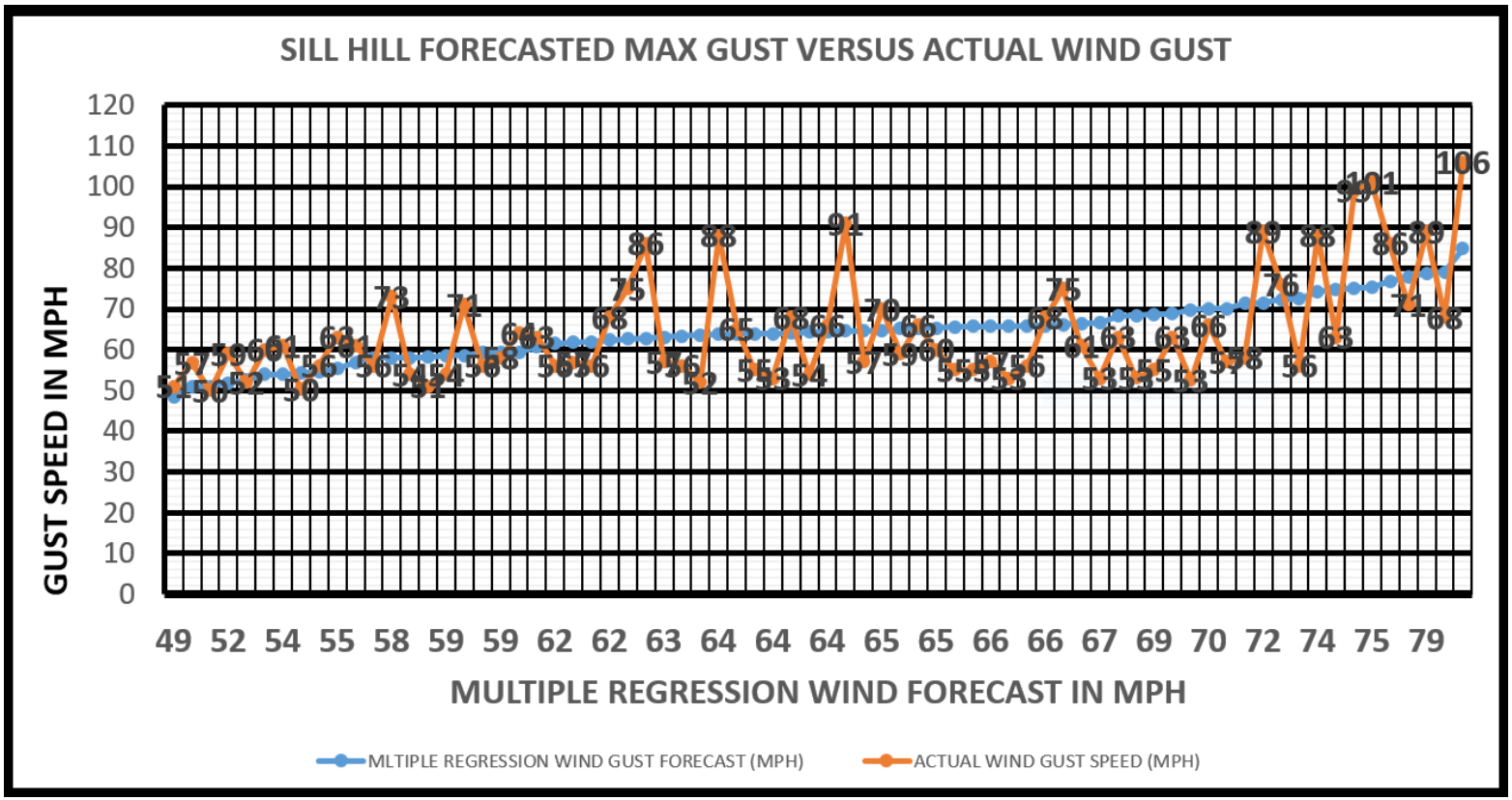
- For the 6/8/2020 the KONT gusts are shown above in mph in the last column.

NORTHEASTERLY WIND PATTERNS AT FREMONT CANYON (FRCC1)



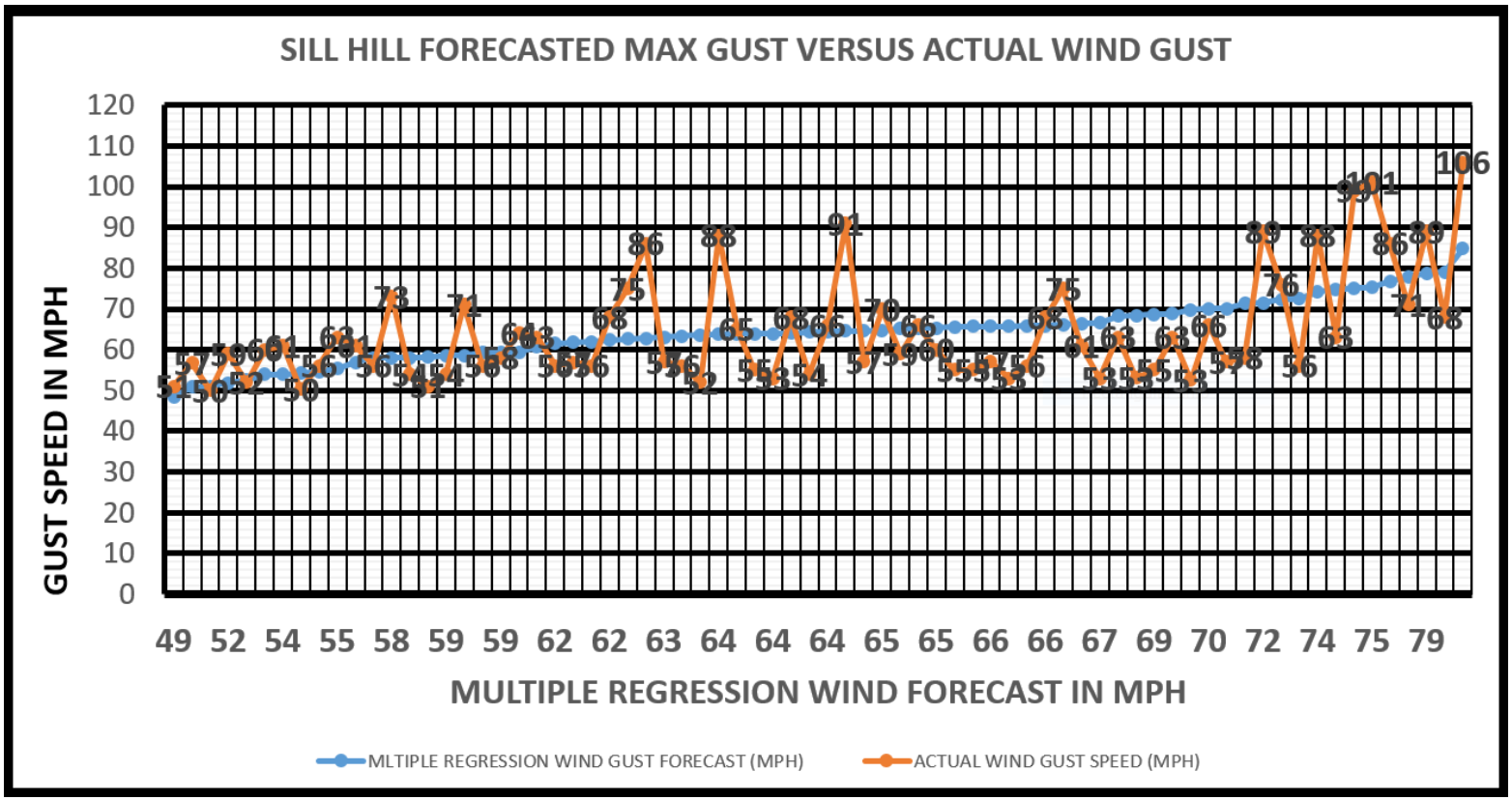
- Note that the NBM based wind gust for FMC (in the mountains southwest of KONT) is showing up to be about ½ of what actually happened for the 4 events shown above.

NON-NBM FORECASTS FOR WIND GUSTS AT SILL HILL



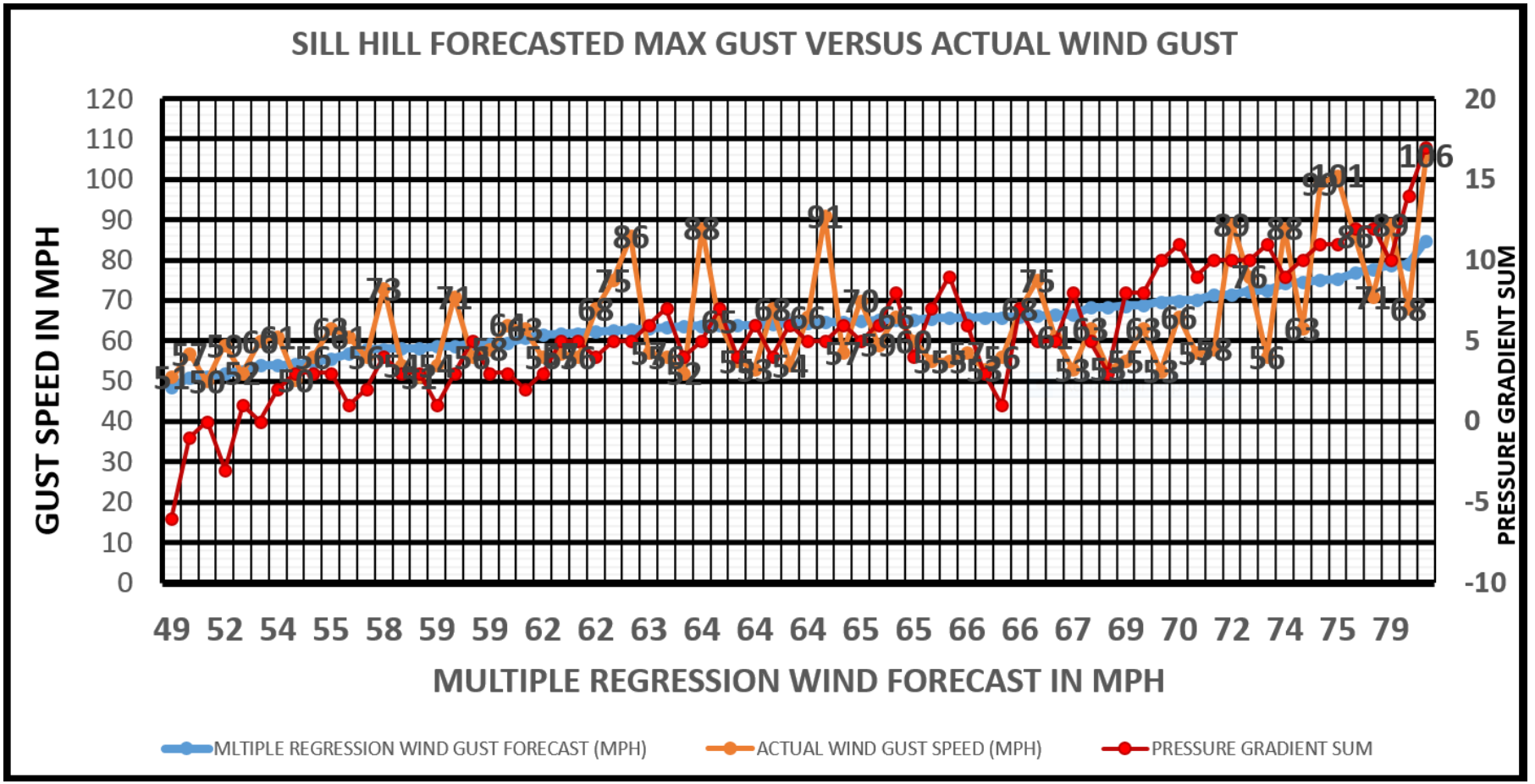
- For Sill hill, the regression includes no NBM data (no NBM data was available, unlike the others).
- The regression uses:
  - The time with the largest 850 mb offshore flow height gradient from KVEF to KNKX for the event.
  - The highest of the 850 mb winds between 340 to 179 degrees obtained via comparing the KVBG/KVEF/KNKX raobs at that time.
  - The 850 mb temperature gradient from KVEF to KNKX at that time
  - The 1200 UTC KSAN to KLAS pressure gradient added to the KSAN to KYUM surface pressure gradient to obtain a surface pressure gradient sum.

NON-NBM FORECASTS FOR WIND GUSTS AT SILL HILL



- Note that for forecasts in blue (the multiple regression forecast) in excess of 70 mph, the wind gusts verified above 70 mph at least 50% of the time, which is basically a high wind scenario for the area.
- Below about 60 mph, values match up quite closely.
- Cases evaluated were for events with wind gusts to 50 mph or higher after 1/1/2013.

NON-NBM FORECASTS FOR WIND GUSTS AT SILL HILL



- Note that there is a bump up on some days in the orange verification curve, especially above 70 mph, that seams to be partly due to the pressure gradient sum in the double digits (see the added red curve for the pressure gradient sum). Note that negative gradient sums are shown as positive, and positive gradient sums as negative for ease in comparison to other data.
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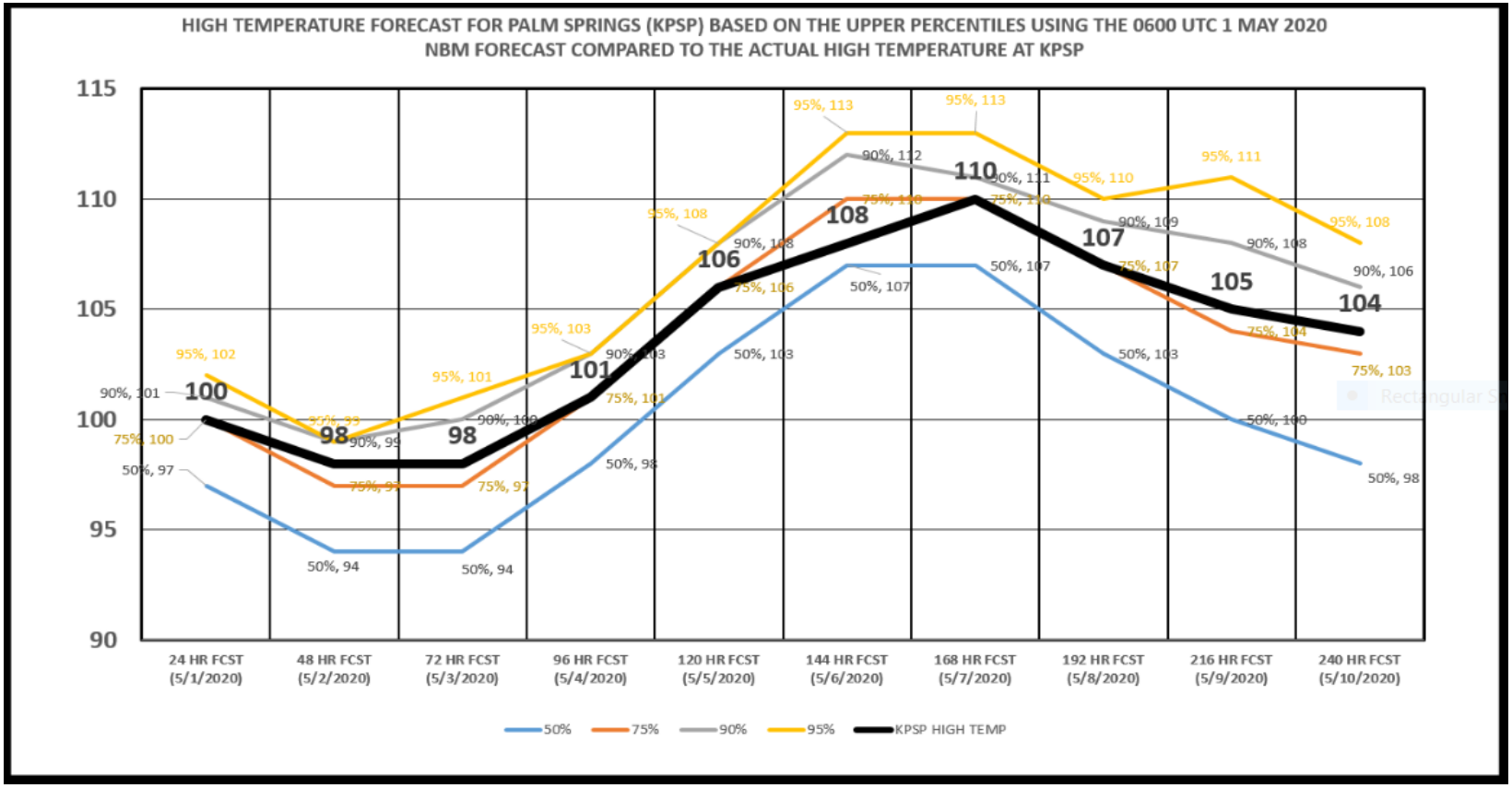
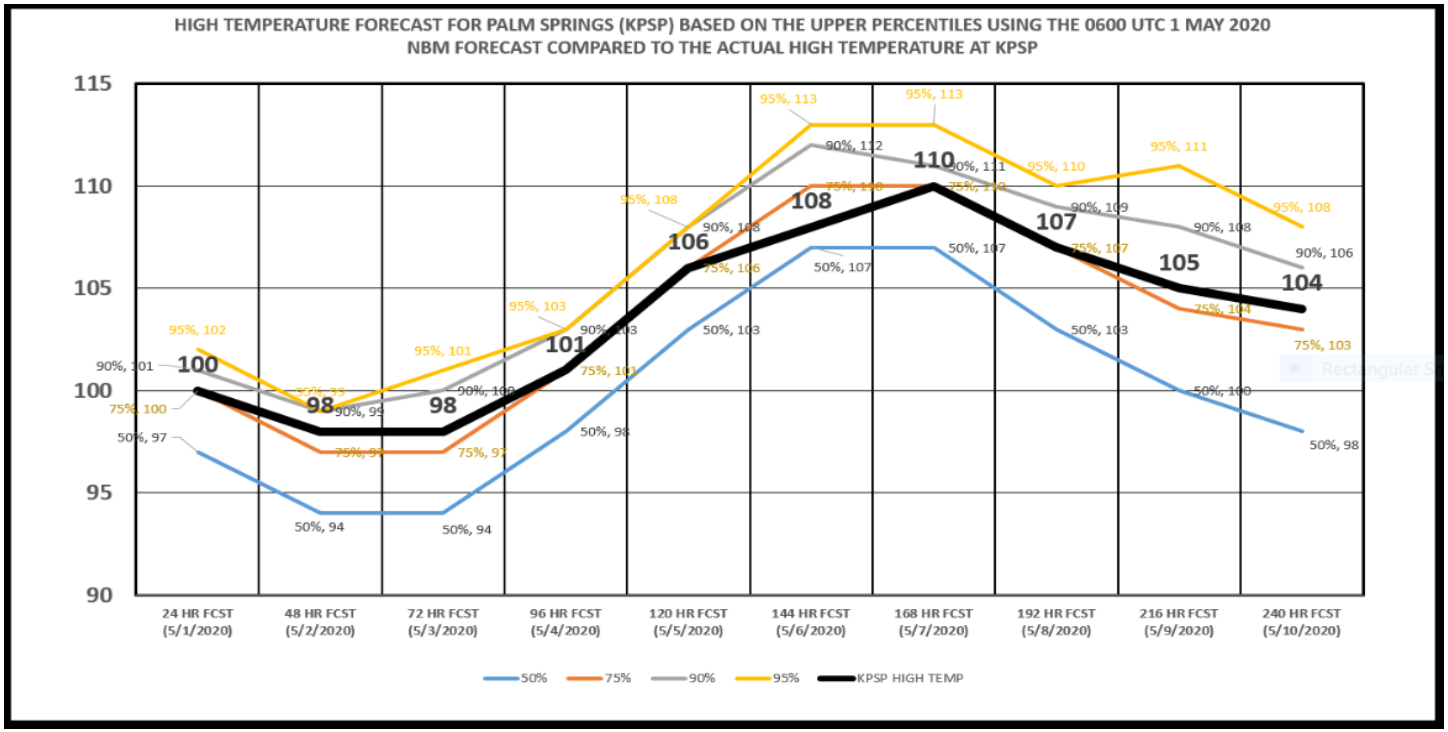
EXTREME HEAT AND THE NBM



- The 1-D viewer also proved handy for looking at heat wave events in the extended forecast period.
- This is the Palm Springs area in the Coachella Valley.

EXTREME HEAT AND THE NBM



- Pattern recognition is important. As a first stab at heat waves, typically the upper percentiles (with higher temperatures) are critical in the extended, so the 50th percentile to 95th percentile was graphed using the 1-D Viewer data in this example.
- The actual event seemed to most closely follow (only about a degree or so off) the 75th percentile contour for KPSP, and always above the 50th percentile value (by about a few degrees most of the time).
- Looking at the upper percentiles is probably a sound method for anomalously warm conditions, especially those that approach record values, for example, 500 mb heights about 50 meters or so above average (which puts heights at around 595 decameters during the summer), northerly flow below canyons and passes, (similar to what happens with N-NE flow below the canyons and passes of the Inland Empire, also serving to keep the low level air mass dry and mixed)
- Even using the T850 + 30 degrees F max T estimation method for these types of days, especially not too far from sea level, can be informative. In the above case, by simply using the 850 mb temperature at around 26 degrees C (79 degrees F), it gives 79 + 30 = 109 degrees F, very close to the KPSP values seen near the peak of this event.
- Values also get to around the T850 + 30 degrees F max T estimate, outside of the deserts, and within the past several years 120 degrees occurred near the inland coastal plain on the western side of the valley areas.

CONCLUSION

- The combination of the new NBM tools along with multiple linear regression can help adjust NBM forecasts to produce more accurate forecasts in extreme situations.
- IDSS directly benefits from the potentially improved wind forecasts at key locations such as Ontario Airport, Whitewater, Fremont Canyon, and the Sill Hill area in the San Diego County mountains. Palm Springs is another important site for extreme weather forecasting.
  - Firefighters especially can reap the benefits in this regard as well as Airport Operations Crews.
  - Forecasts of extreme high temperatures, from a public health standpoint, can also be made more accurate as well.
- Forecasts can only get better as the NBM improves.