Importance of wind speed and wind gust errors for power outage prediction during rain/wind events in the NE US

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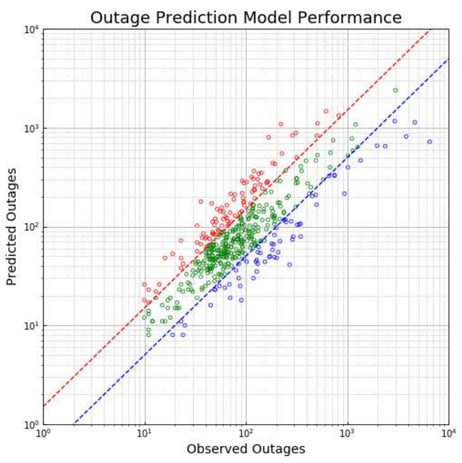
1. STUDY OBJECTIVES

Rain and wind events are quite common across the Northeast United States. Occasionally, such events can cause infrastructural damages due to a combination of significant rain and powerful winds. This study will seek to determine the importance of wind speed and wind gust related error as it pertains to the Outage Prediction Model's [OMP] performance.

Objectives of this study:

- ✓ Evaluate prediction of wind speed and wind gusts during rain/wind events
  - Are these variables accurate and reliable?
- ✓ Determine the influence of wind speed/gust error to the OPM accuracy

2. STORM EVENTS



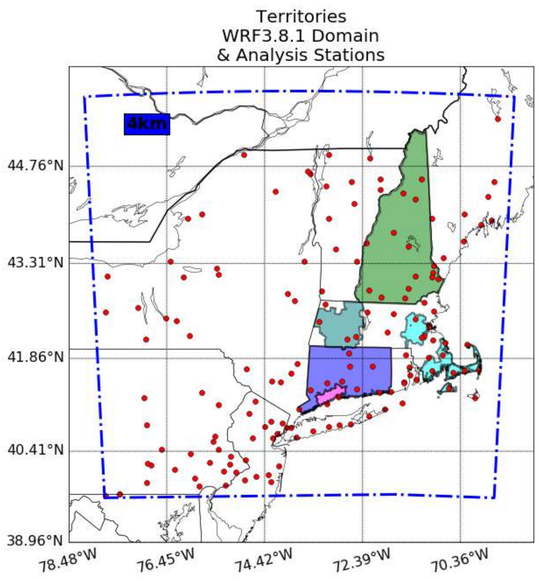
Over-predicted OPM events are selected for this analysis

Figure 1:
Log-Log plot of observed outages (x) vs. predicted outages (y) for ~400 rain/wind events.

Over-predicted events are denoted as red circles and under-predicted events are denoted as blue circles.

Each point represents one territory (of 5 total territories) for one event.

3. MODEL DOMAIN, OPM TERRITORIES, WEATHER STATIONS



Territory	n Stations
NH	14
WMA	3
EMA	12
UI	2
CT	8

Figure 2:
Blue segmented line - WRF3.8.1 inner domain [4km].

Shaded territories - green = New Hampshire, cyan = Eastern Massachusetts, Blue = Connecticut, Magenta = UI, Teal = Western Massachusetts territory.

The red points represent stations that fall within the model domain.

For the following images, the utilized observations were extracted for all stations within each specific territory (varies by territory as shown below).

5. WEATHER VARIABLE EVALUATION w respect to OPM error

Table 1 Statistical metrics categorized by OPM performance

	T2	TD	TW	RH	WS	WG
Overestimation						
R2	0.96	0.96	0.97	0.74	0.41	0.13
BIAS	-0.42	0.64	-0.02	4.46	0.52	3.33
RMSE	2.16	2.15	1.66	9.92	2.03	4.56
CRMSE	2.12	2.05	1.66	8.85	1.96	3.11
In-Between						
R2	0.94	0.95	0.96	0.64	0.39	0.16
BIAS	-0.36	0.53	-0.03	4.01	0.52	2.56
RMSE	2.25	2.07	1.67	10.56	1.85	4.02
CRMSE	2.22	2.00	1.67	9.76	1.77	3.09
Underestimation						
R2	0.93	0.95	0.95	0.69	0.46	0.26
BIAS	-0.35	0.44	-0.08	3.67	0.40	2.61
RMSE	2.17	2.03	1.75	9.50	1.99	3.87
CRMSE	2.15	1.98	1.74	8.76	1.95	2.85

One statistic represents all available hourly observations at all available stations for all events.

A subtle relationship b/n wind gust and OPM performance exists herein this table: Wind gust performs best for underestimated events and performs worst for overestimated events (positive bias exists for both, however).

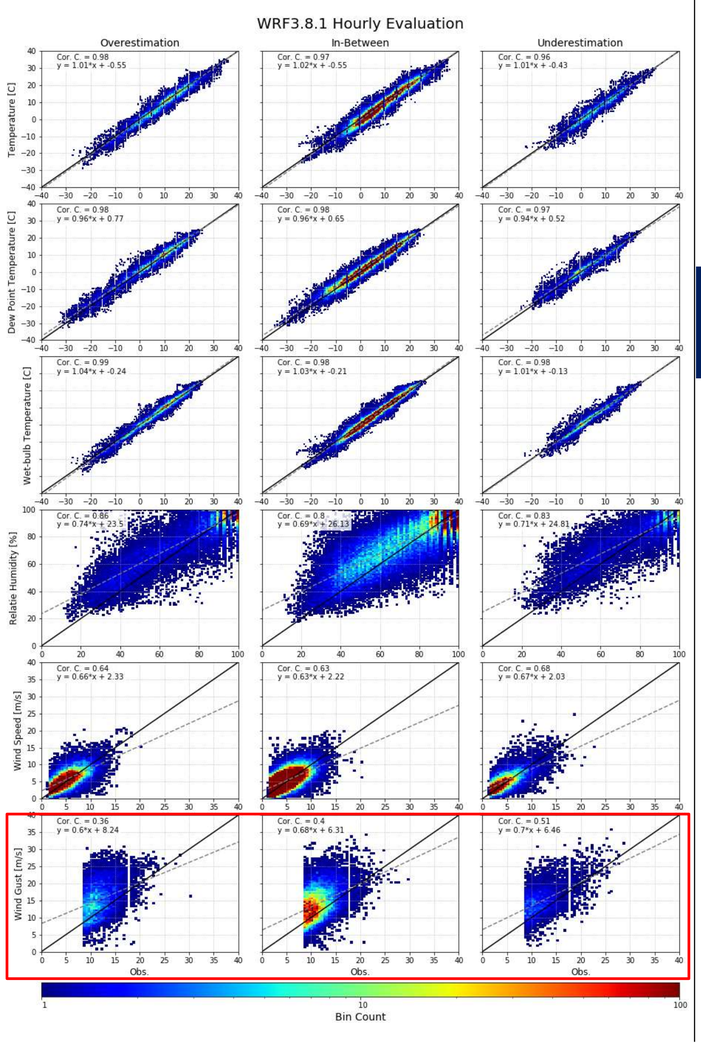


Fig. 3 WRF.3.8.1 hourly performance for all stations categorized by surface variable (row) and binned by OPM performance (column). All variables except for wind gust perform similarly with respect to OPM performance.

6. OPM VARIABLE EXAMPLE & EVALUATION

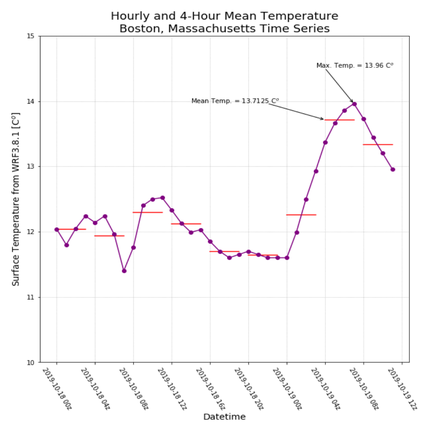


Fig. 4 Top: Time series example (temperature) of the "mean" and "max" variables that the OPM ingests. The process is the same for other surface variables as well.

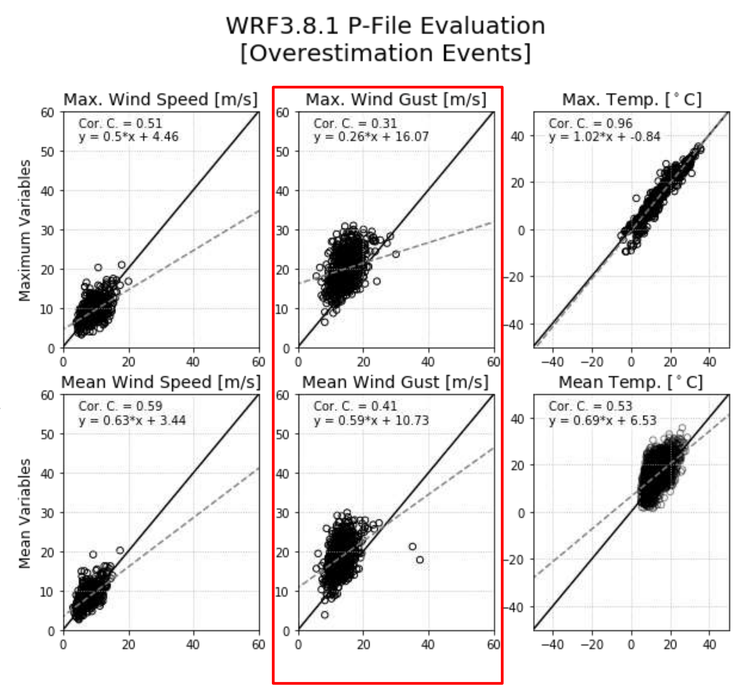


Fig. 5 Right: Parameter file evaluation for 82 events that were overestimated by the OPM. "Max" variables perform better than their 'mean' counterparts. Errors are quite large for wind gusts related variables.

8. COMPARING STATISTICAL ERROR METRICS TO OPM ERROR

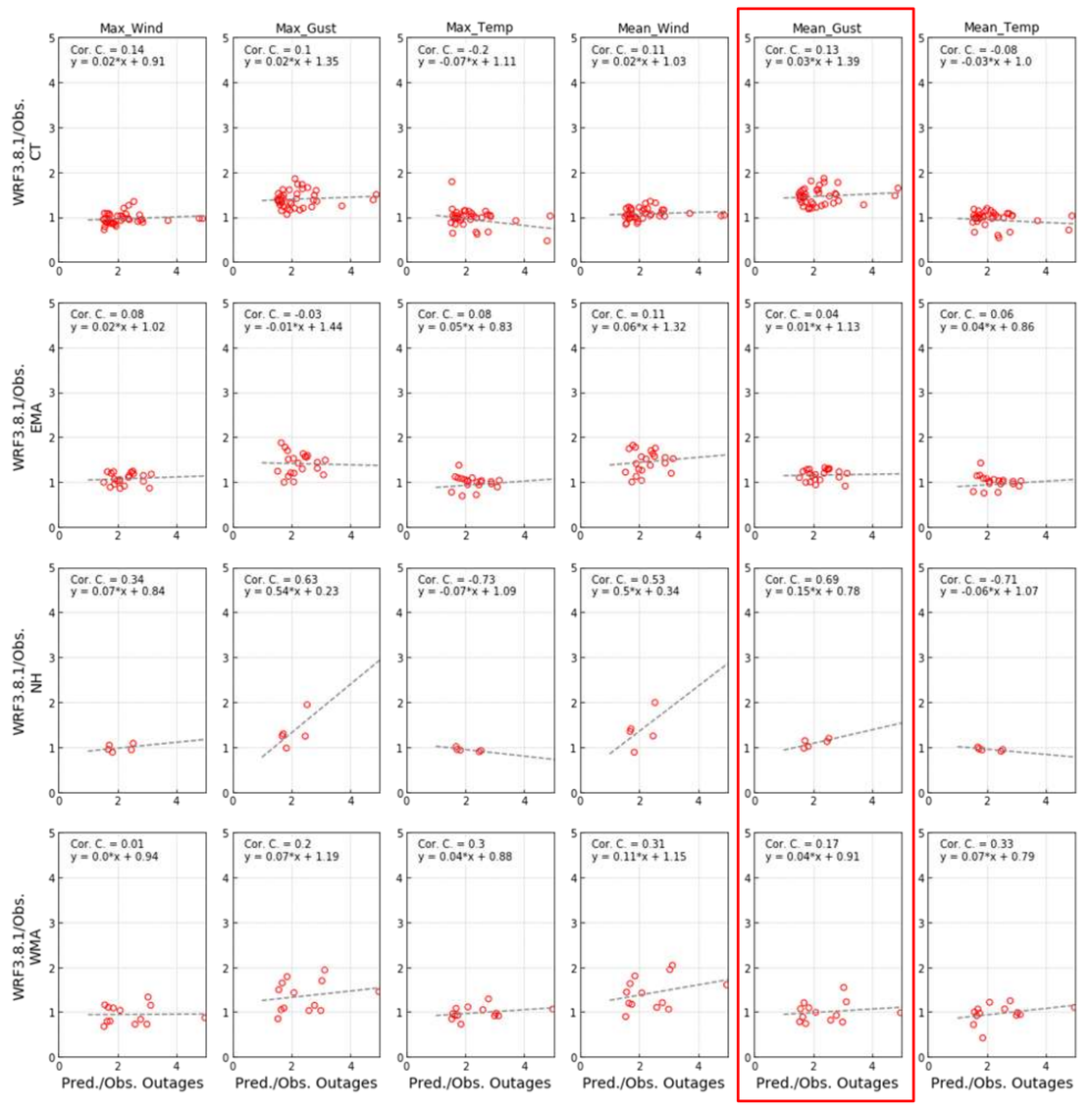


Fig. 6 Parameter file variables (column) binned by territory (rows) for 82 over-predicted rain/wind events. The 'x' axis is a ratio of predicted outages over observed outages and the 'y' axis is a ratio from WRF3.8.1 calculated parameter file values over calculated parameter file values from observations (at METAR stations). Only weak linear relationships exist between atmospheric variables (parameter file metrics) and OPM error (performance). A more dimensional algorithm must be utilized to determine stronger relationships b/n WRF3.8.1 performance and OPM performance.

10. SUMMARY AND FUTURE WORK

Summary

- ✓ Most surface variables perform well and as a result do not impact OPM performance significantly.
- ✓ Errors in wind gust prediction appears weakly (linearly) correlated to OPM error.

Future Work

- ✓ Build a more dimensional model to link WRF3.8.1 error to OPM error
- ✓ Bias correction to improve wind gust prediction
- ✓ Test new parameterizations to improve wind gust prediction
- ✓ Etc..

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