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Feature-oriented verification of wind speed forecasts

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Wind Forecasting and Verification

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- Unique aspects of wind forecast verification.
- Ramping events
- Comparisons with object oriented verification techniques.
- Comments

Some issues …

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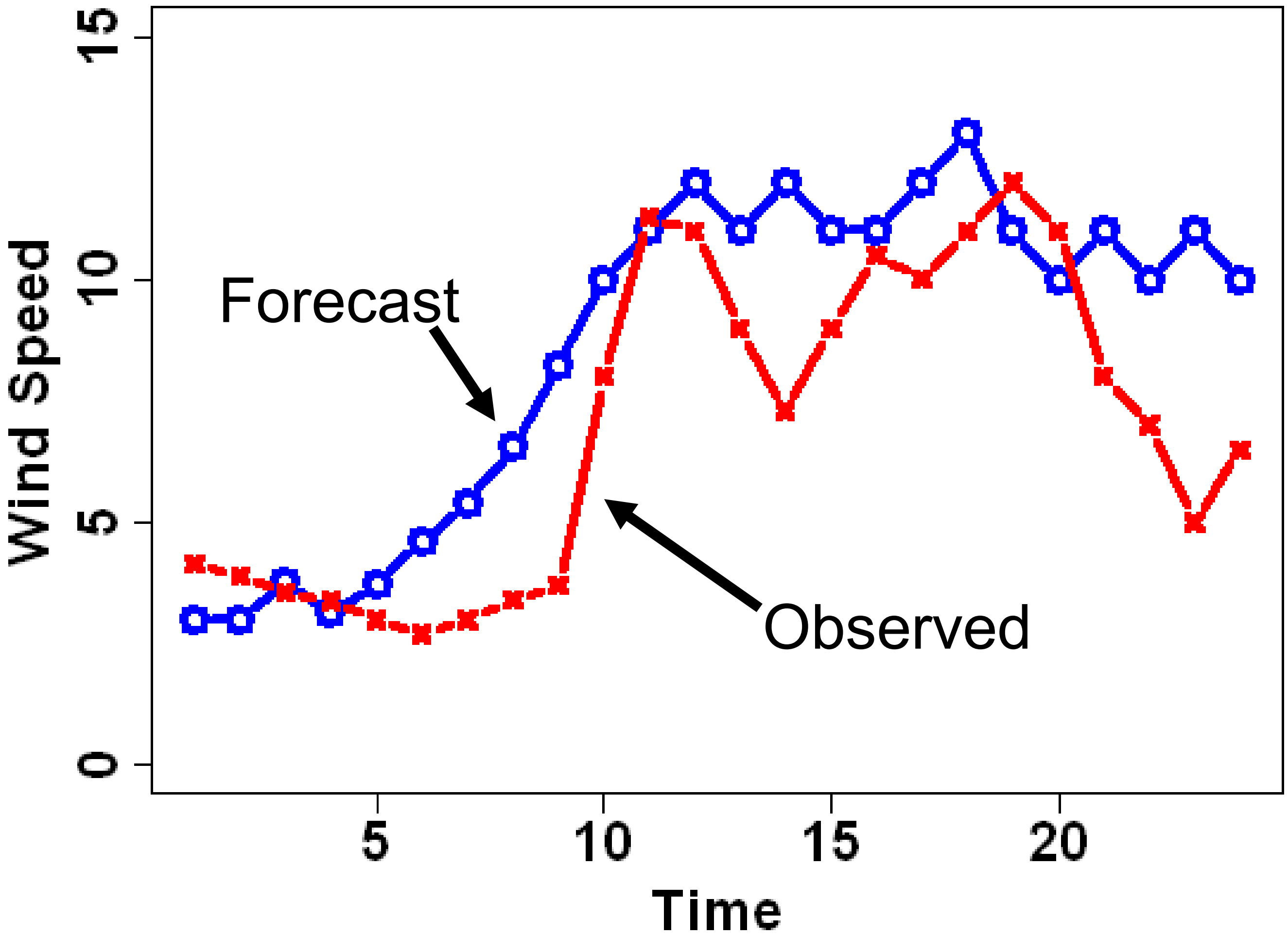
- Forecasts are used as time series – not as independent forecasts. Aggregation of errors can be misleading
- Lack of traditional wind speed measurements.
- Concerns differ between wind forecasts and power forecasts.
- Non-linear translation to power plus cut off points.
- Costs differ for over- and under-forecasted events and are affected by non weather events.

A users perspective of a forecast

(A Dramatization!)



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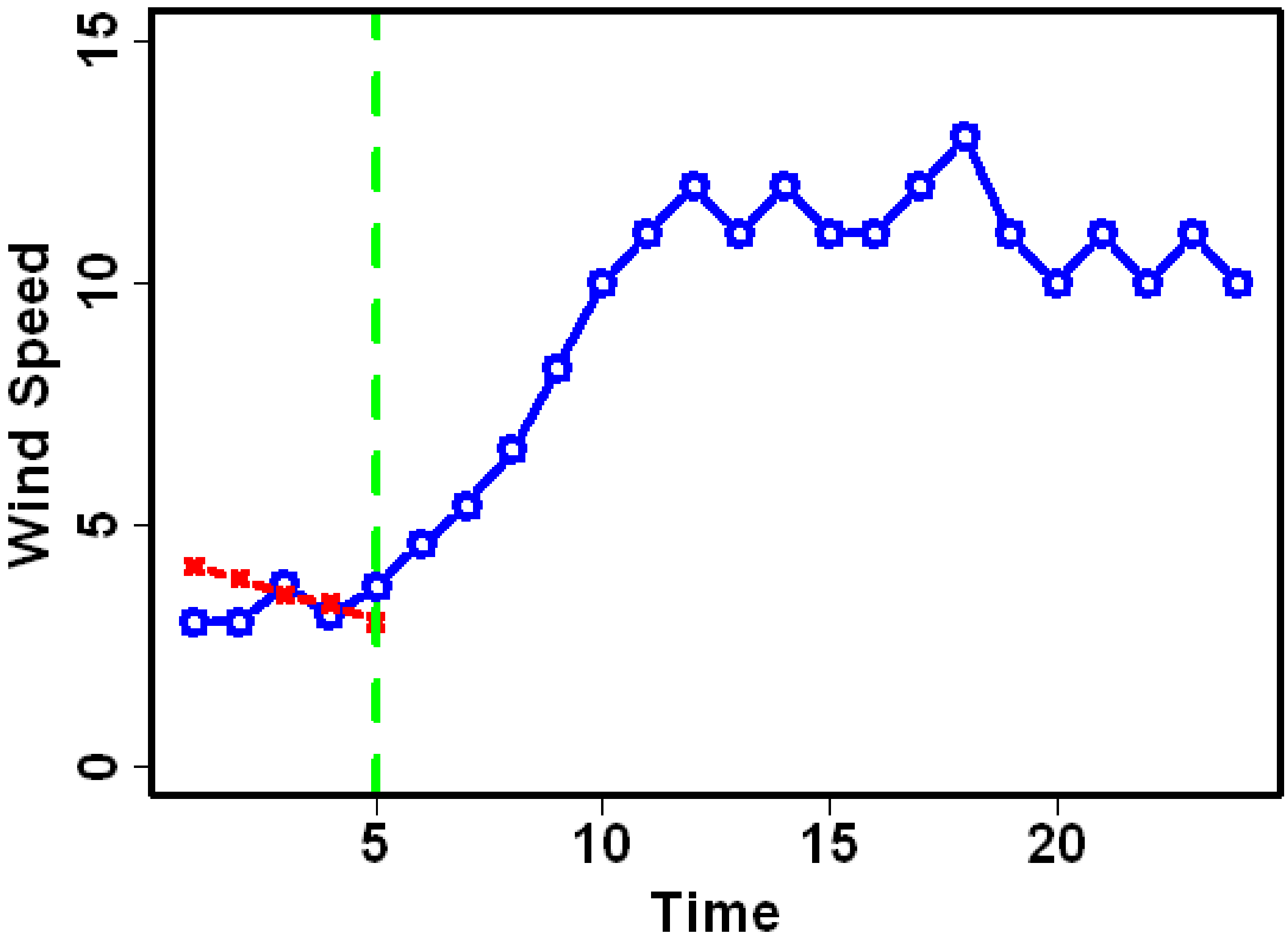

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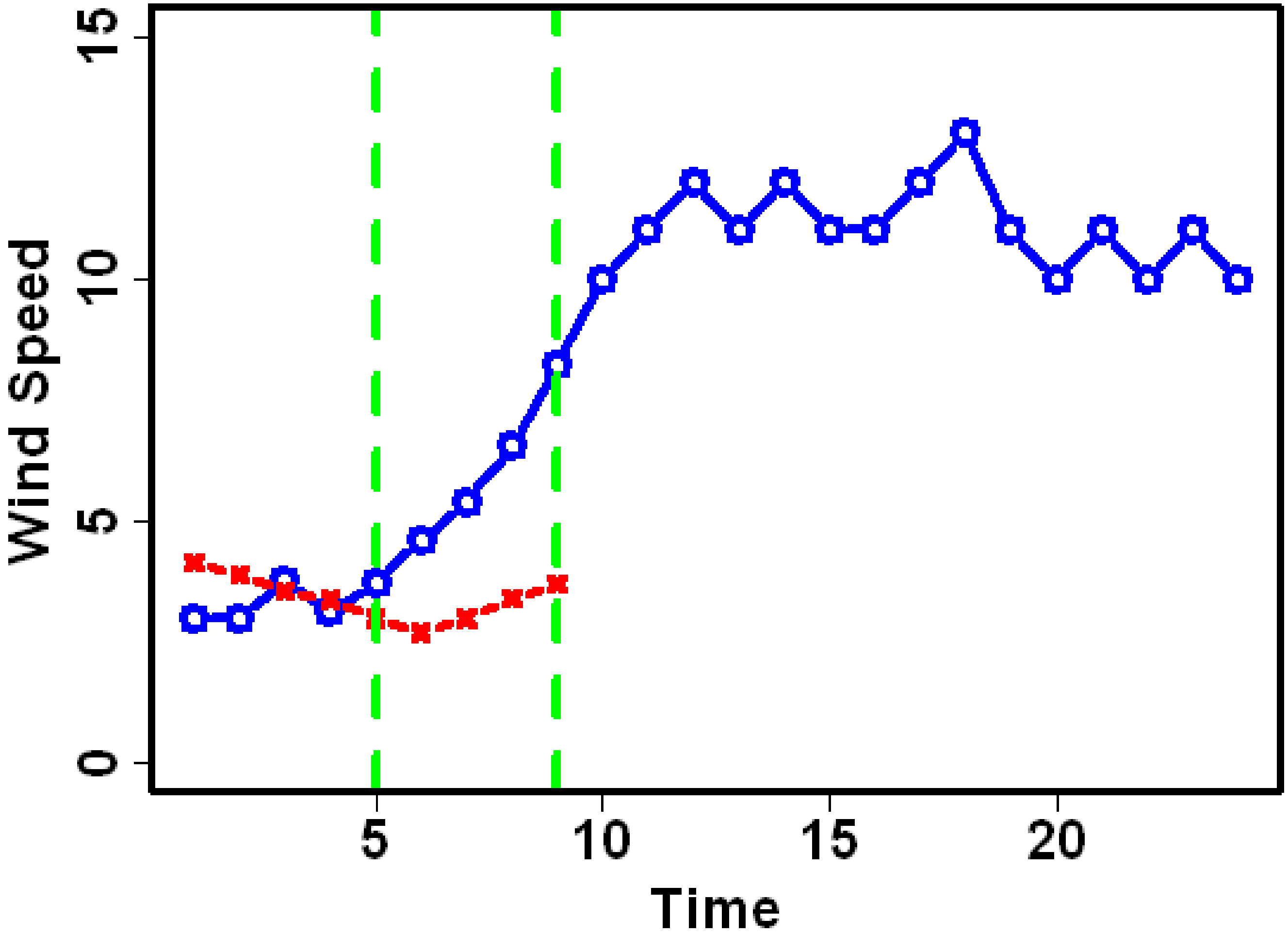

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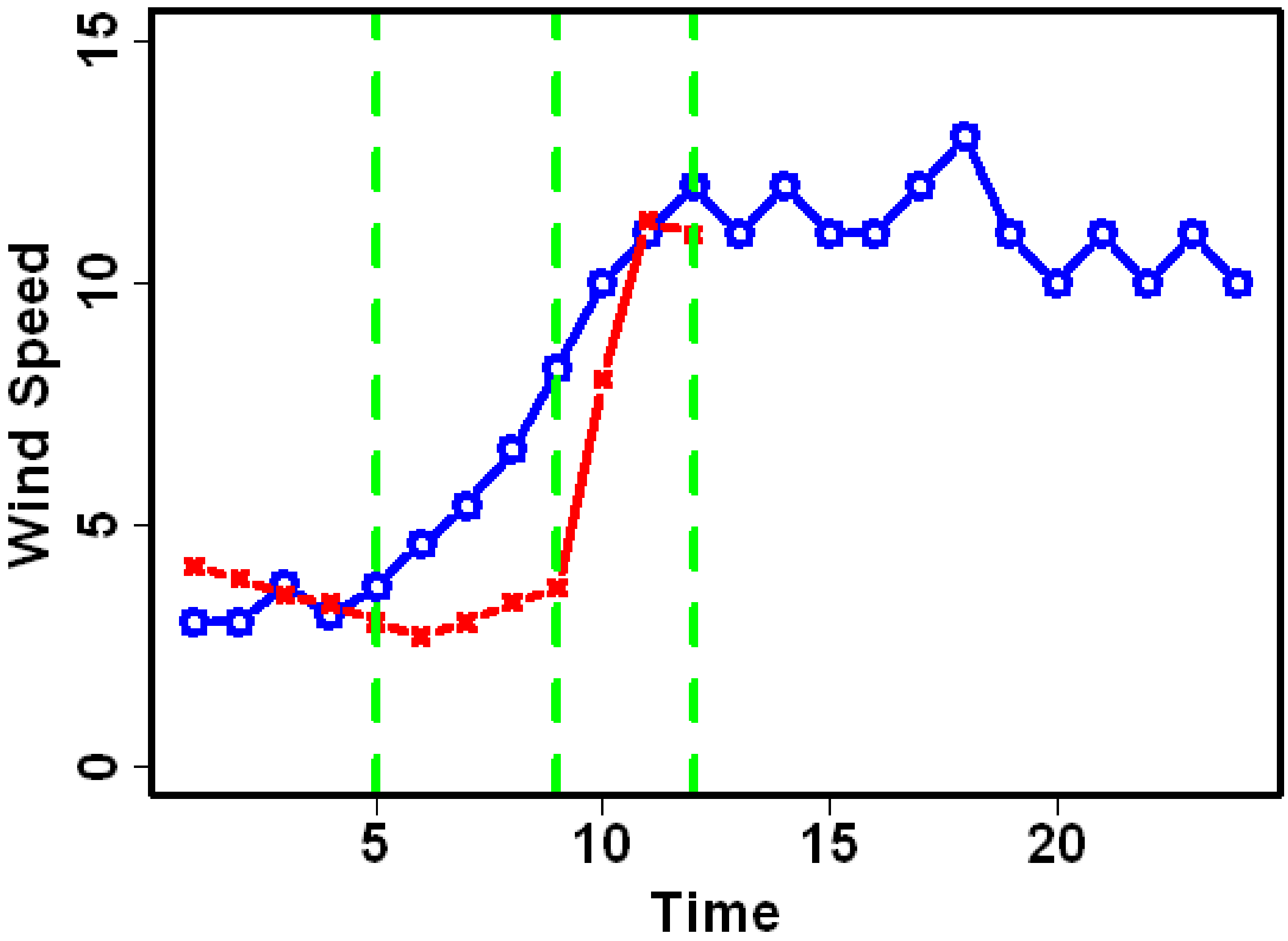

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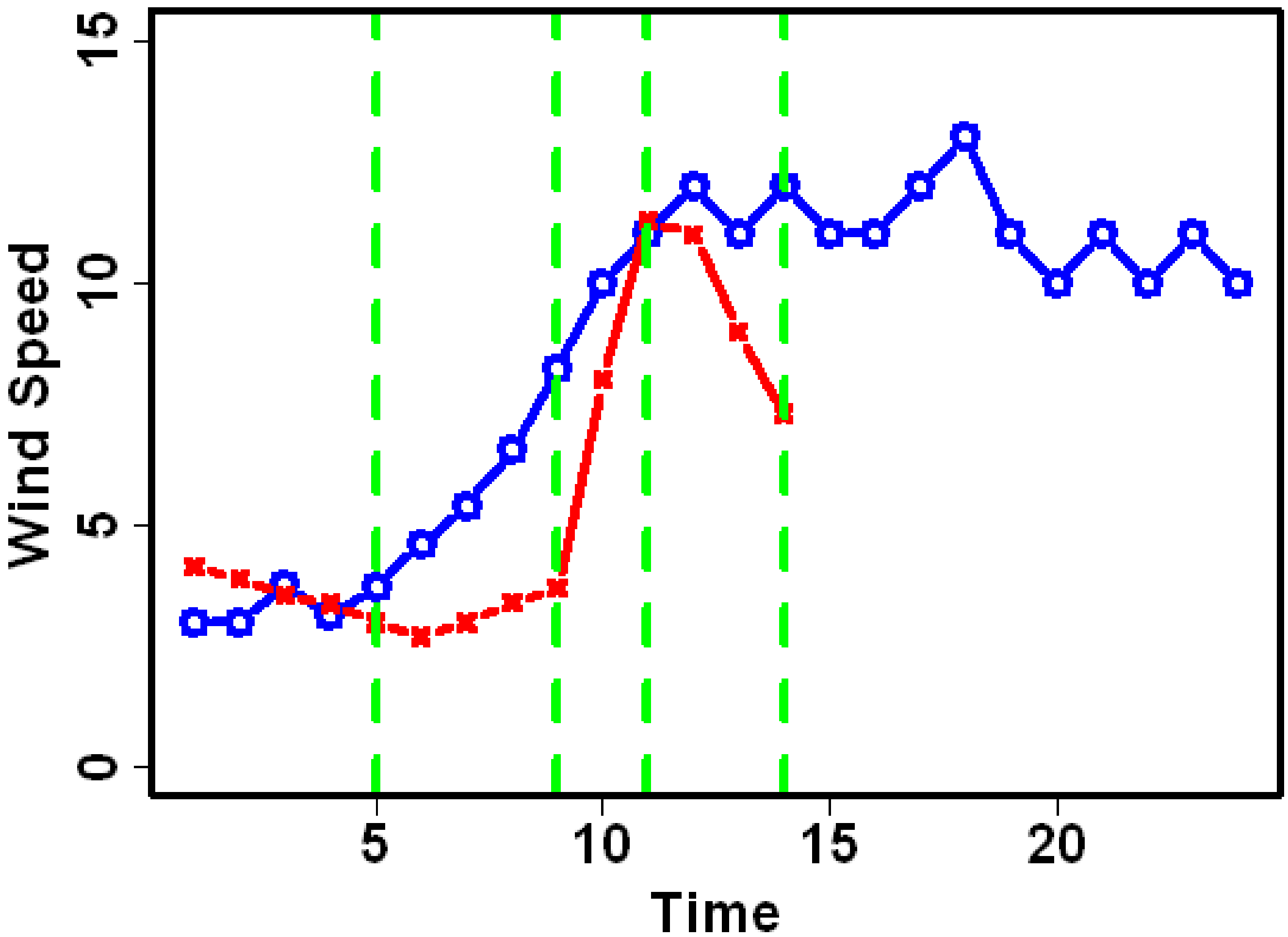

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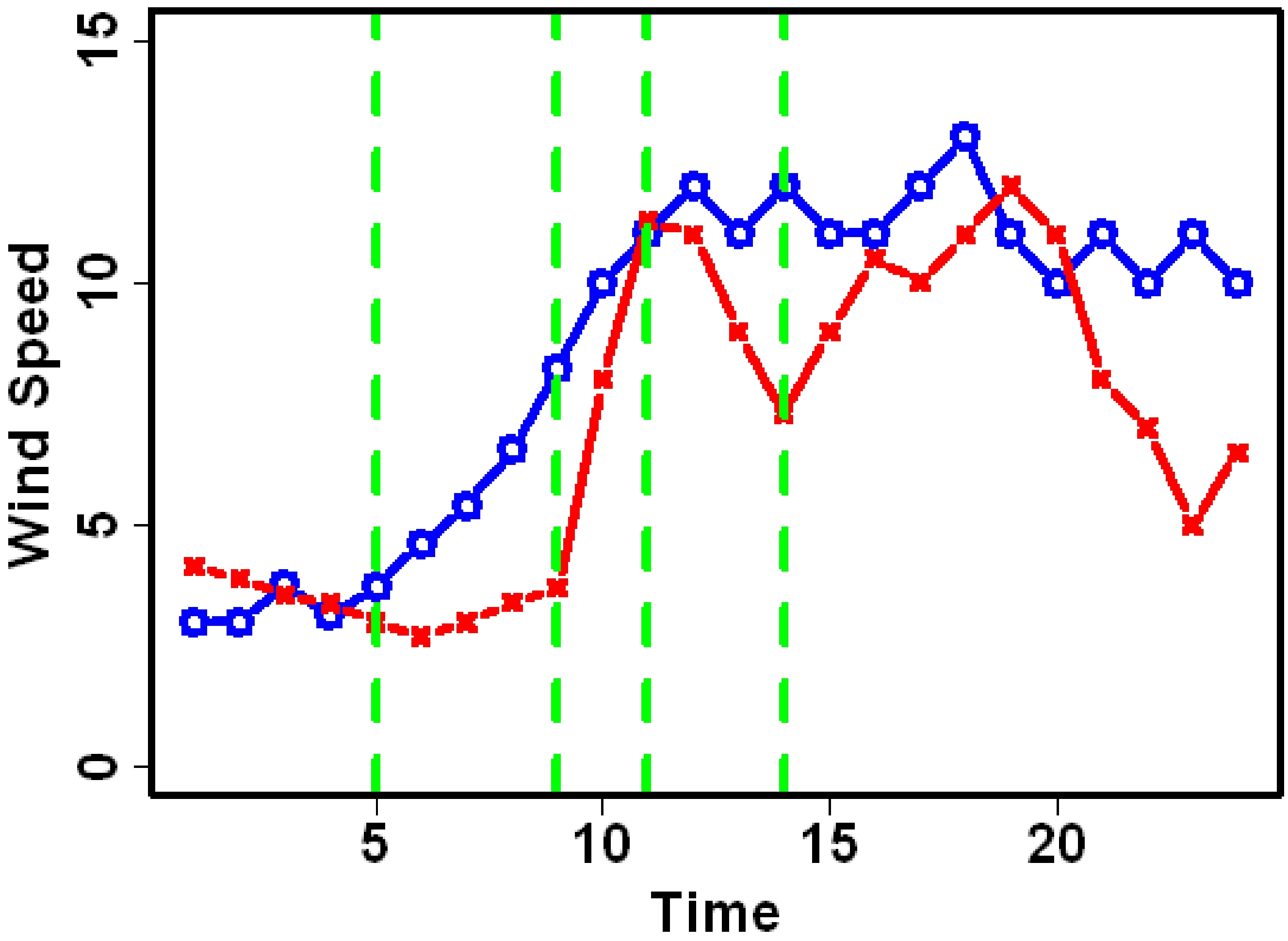

Quantifying accuracy of a ramping event

- In absolute terms, ramping accounts for a very small portion of the day.
- Different consequences for forecast leading observed values vs. observed leading forecast.
- Matching ramps from two time series is not 1:1. One can match by time-error, magnitude error or both.

Identifying Ramping Events

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- Empirically – given a ramp magnitude, duration and rate – ramps can be identified.
- Problem with this it that many users have many different concepts of a ramping event.
- For Example Bonneville Power
  - 10% change in power that persists for more than 30 minutes.
  - Window is defined as +/- 1.5 hours from the time ramp is forecast.

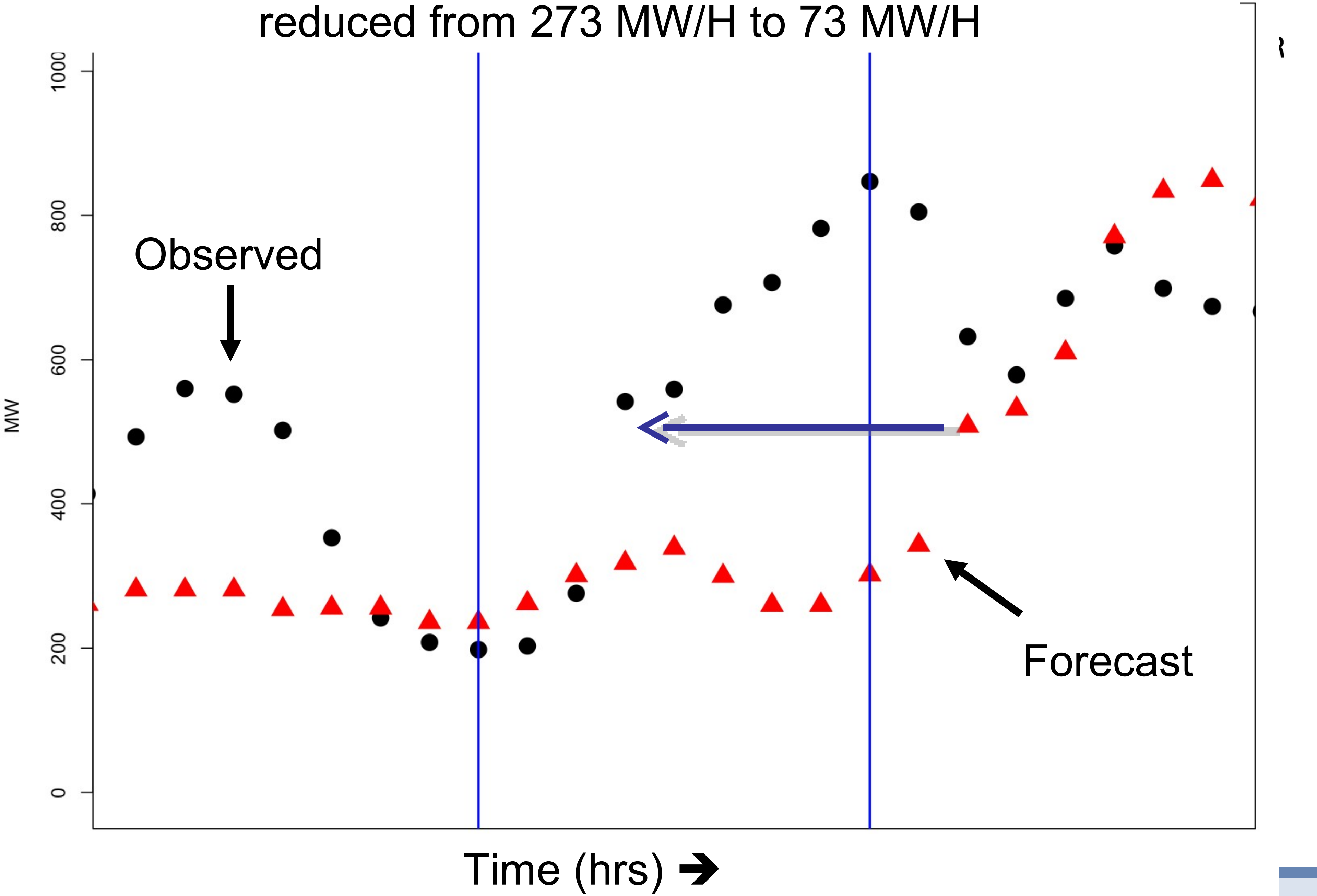
One method of identifying ramps

- With some assumptions – ramps can be identified by magnitude, duration, rate.
- A series of consecutive increases (or decreases) in wind speeds, interrupted by decreases (or increases) of less than a specified magnitude or duration.
  - Requires a minimum magnitude and choices on what constitutes an interuption.

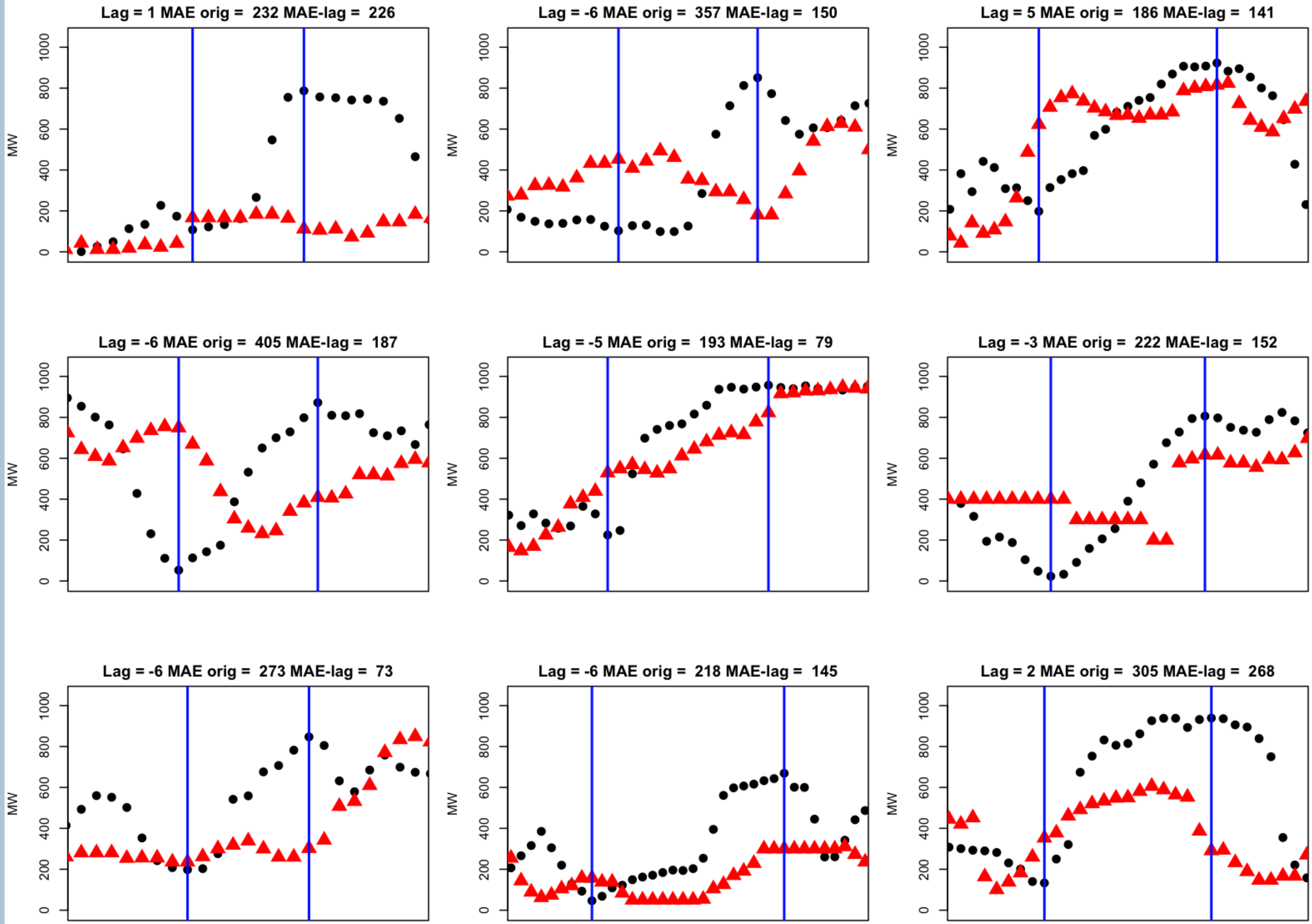
With events defined, we can use contingency table scores

- Contingency table scores
  - Hits, Misses, False Positive, False negative
- However;
  - Varying event definitions make comparisons difficult.
  - Contingency tables focus on single dimensional attributes. (i.e. magnitude or timing.)

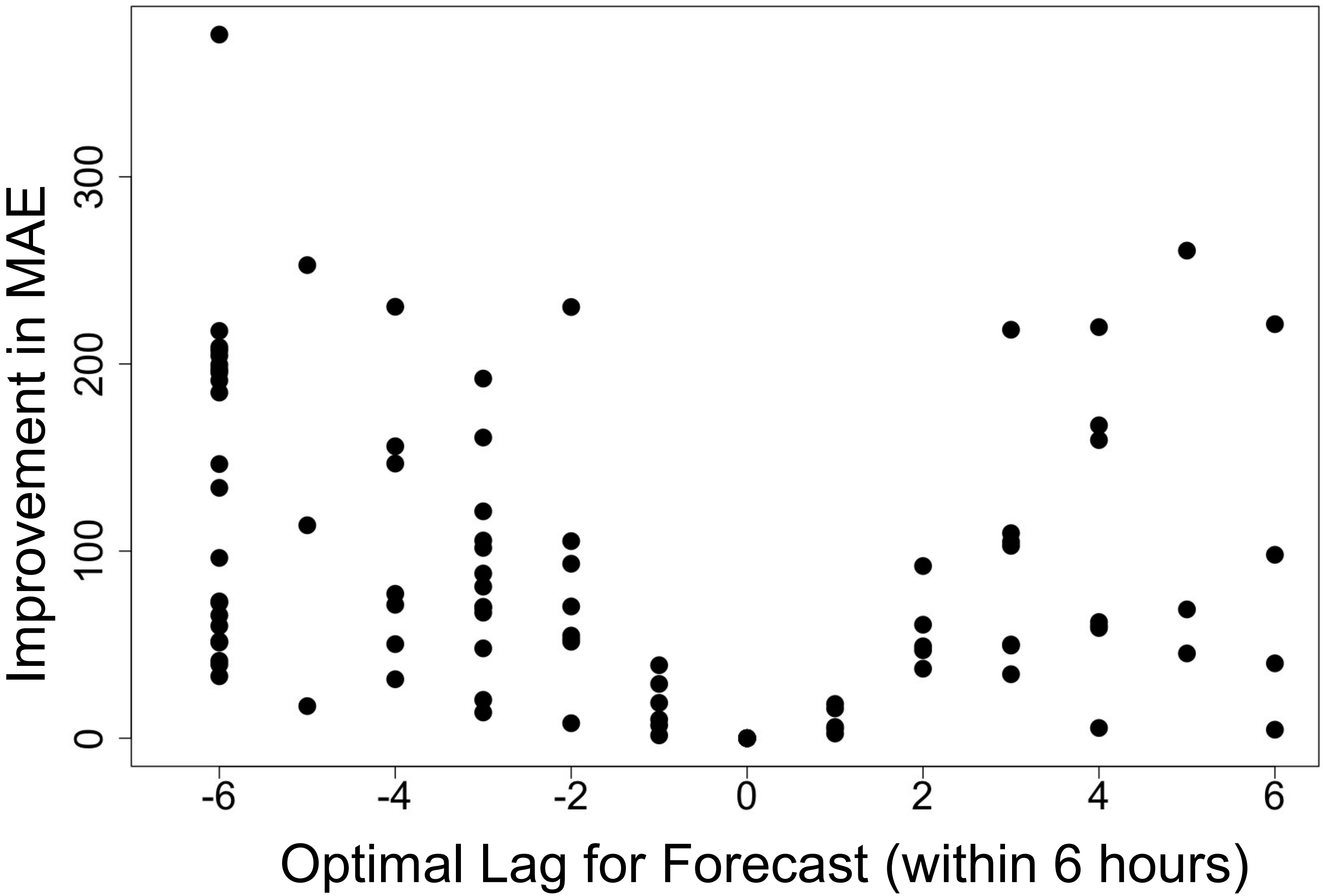
If the forecast were 6 hours earlier, the MAE would be reduced from 273 MW/H to 73 MW/H



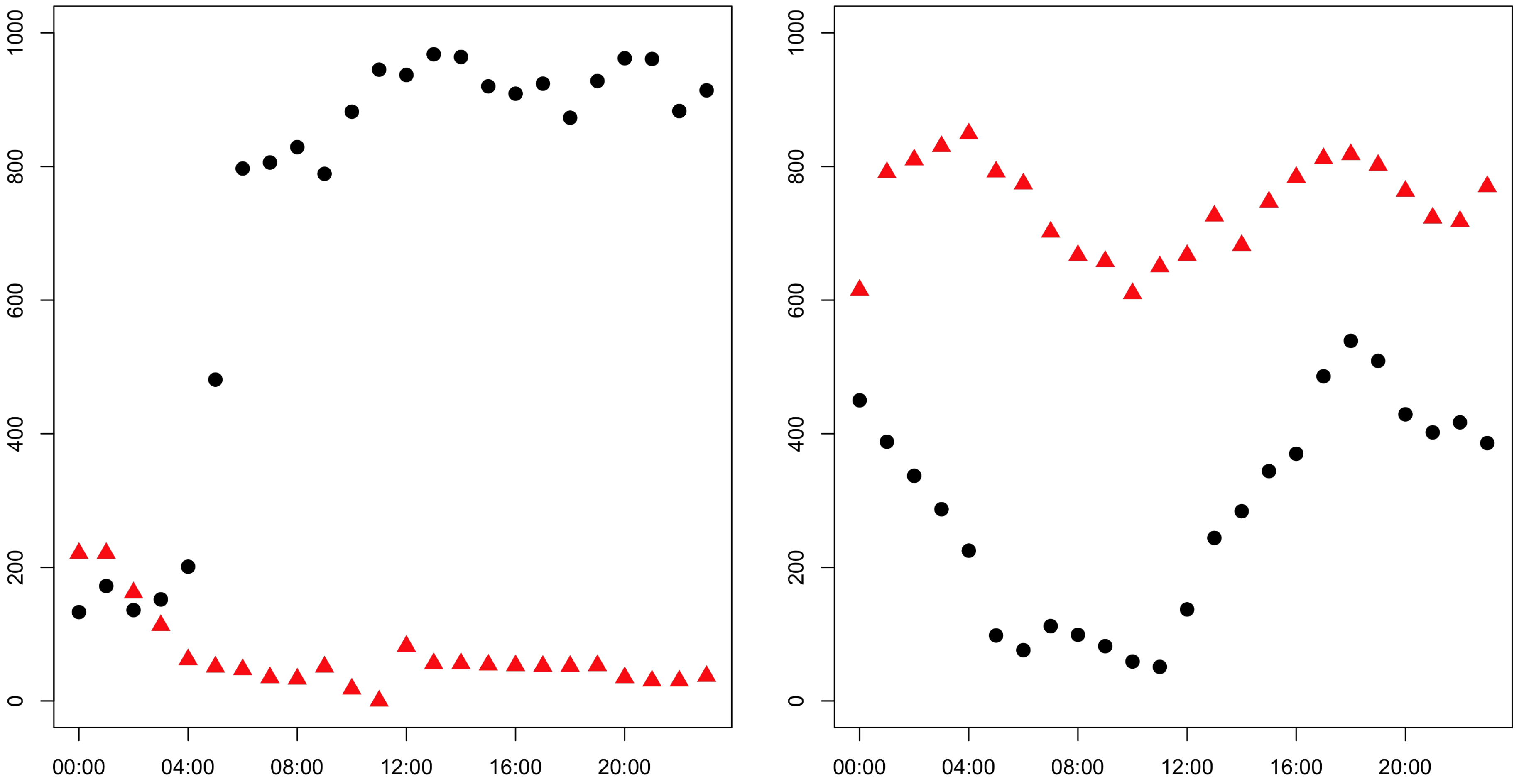
Sample Up Ramp (Events > 800 MW)



Optimal improvements with timing



Largest over and under forecast



Object oriented verification via MODE.

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- Conceptually – choose a threshold.
- Identify objects for both forecasts and observations.
- Possible group objects into single features.
- Match forecasts with observations
- Quantify differences using a number of measures.
    - Length, orientation, offset, lag - lead

Object oriented verification via MODE.

Spatial

- Choose a threshold.
- Identify objects for both forecasts and observations.
- Possible group objects into single features.
- Match forecasts with observations
- Quantify differences using a number of measures.
    - Length, orientation, offset, lag - lead

Wind speed times Series

- Duration and magnitude
- Possible empirically using a series of filters.
- A succession of ramp may be grouped into a single ramp.
- Shift which minimize error. Change in magnitude which minimizes error.

Object oriented verification via MODE (con't)

Spatial

- Match forecasts with observations
- Quantify differences using a number of measures.
  - Length, orientation, offset, lag - lead

Wind speed times Series

- Provide a variety of diagnostic measures.
  - Mean lag
  - Direction error
  - Magnitude errors

Contrarian Perspective

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- Mean Absolute Error is sufficient!
  - Over time, MAE correlates well with costs
  - Forecasts with lower MAE perform better in in other respects.
  - Spatial anomalies across a wind farm tend to average out.
- Methods developed with simulated data or carefully chose case examples need to be verified with long periods of real data.

Comments and conclusions

- Incredible interest in wind energy provides a lot of potential for verification research.
- Energy industry provides an active, involved and potentially sophisticated user of weather forecasts. This creates opportunities for user oriented verification methods.
- Intense amount of research that is being conducted allows for need for model diagnostics and partitioning of effects.

Questions? pocernic@ucar.edu