
*Preliminary Wind Thresholds for
Power Outages on Vancouver Isl.*

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Environment Canada



Coastal winter wind storms are associated with major outages



B.C.'s Stanley Park loses 1,000 trees after storm

Source: *CTV.ca News Staff*

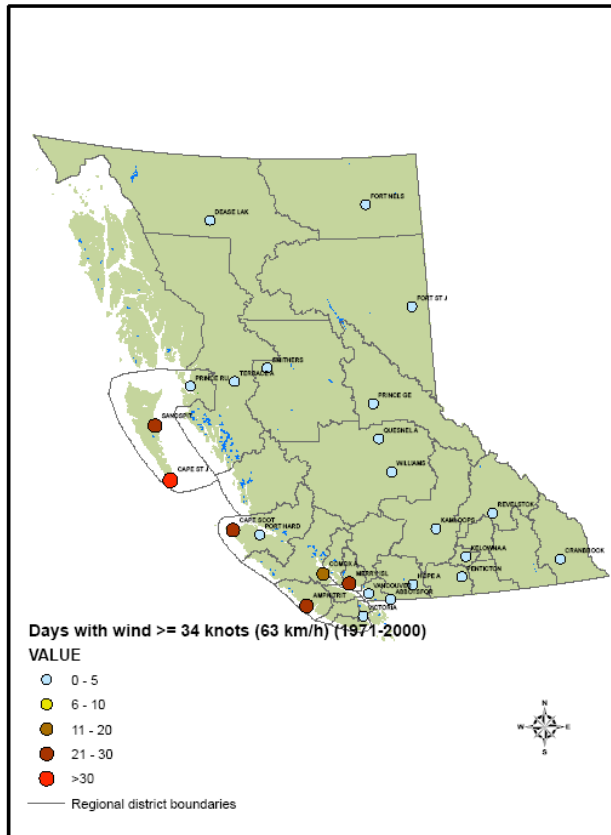


Tens of thousands still in dark after massive B.C. storm

Source: *CBC.ca News*

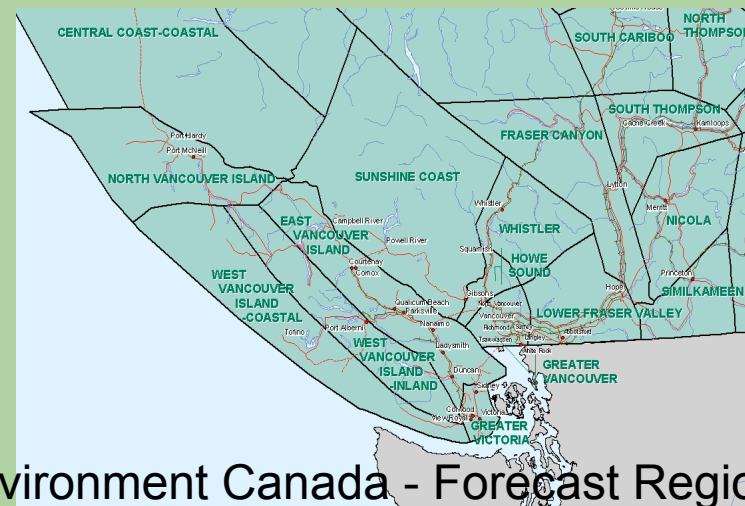


Environment Canada's Wind Warnings



South Vancouver Island
65 km/hr (gust 90 km/hr)

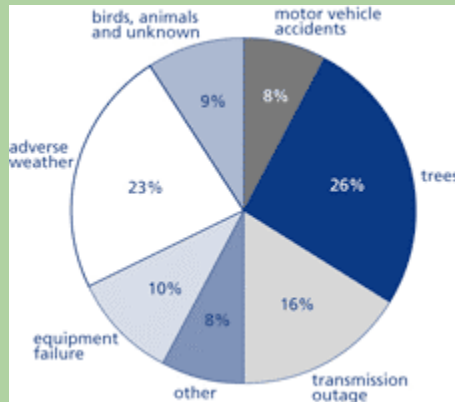
North Vancouver Island if E - SE
85 km/hr (gust 110 km/hr)



Environment Canada - Forecast Regions



BC Hydro Outages



Almost half of all power outages are caused by adverse weather and trees

Outage Search

Current and Planned Outages	
Central Interior	0
Lower Mainland / Sunshine Coast	2
Northern	9
Okanagan / Kootenay	1
Thompson / Shuswap	2
Vancouver Island, North	0
Vancouver Island, South	0

Detailed Outage Search

Region:

Municipality:

Current and Planned Outages

Today

Current and 2 weeks planned

Restored Outages

Past 24 hours

Past 3 days

Past 14 days

<http://www.bchydro.com/outages/>



BC Hydro Outage Data

- Date of outage
- Region affected
- Cause of outage
- Wind speed
- Number of customers affected
- Hours of power interruption
- Cost of service recovery

BC Hydro defines events as “major” based on the severity of service interruption and the cost to restore power, i.e. a threshold is already implicit in the data.



Data issues

- Spatial: site of wind observation is usually different than location of outage
 - *Find a representative station, i.e. site location & exposure, wind regime – e.g. Victoria Intl Airport*
 - *Point (wind) vs. area (outage) data*
- Temporal: timing of outage not concurrent with daily peak wind or maximum gust
 - *Time of onset of power outage not included in BC Hydro data*
 - *Limitations of daily wind data*



Goal: Detect threshold for wind and antecedent rainfall

- Predictand: Power Outage
- Predictors:
 - *Wind*
 - *daily peak wind*
 - *peak gust*
 - *Antecedent rainfall*
 - *percent above normal*
 - *n-day accumulations prior to outage*



Forecast Skill Scores (contingency table)

	Above Wind Threshold	Below Wind Threshold
Outage	Hit (a)	Miss (b)
No Outage	False Positive (c)	 (d)

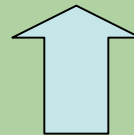


Date	MaxGust	BC Hydro Event
13-Dec	98	Y
31-Jan	96	Y
3-Nov	85	Y
17-Jan	85	
1-Jan	78	Y
15-Dec	78	Y
28-Jan	76	Y
11-Dec	76	Y
09-Jan	74	Y
12-Mar	74	
29-Jan	72	
1-Feb	72	Y
16-Feb	72	Y
10-Nov	72	
05-Jan	72	Y
26-Jan	70	
12-Nov	70	
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17-Feb	69	
15-Nov	69	Y
12-Dec	69	Y
08-Dec	67	
4-Feb	67	Y
19-Nov	67	
20-Dec	67	

Estimating thresholds – a process of trade-offs

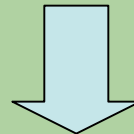
Raising the threshold

- reduces false positives
- increases misses



Lowering the threshold

- fewer misses – more outages accurately forecasted
- increases false positives



Forecast Accuracy Measures

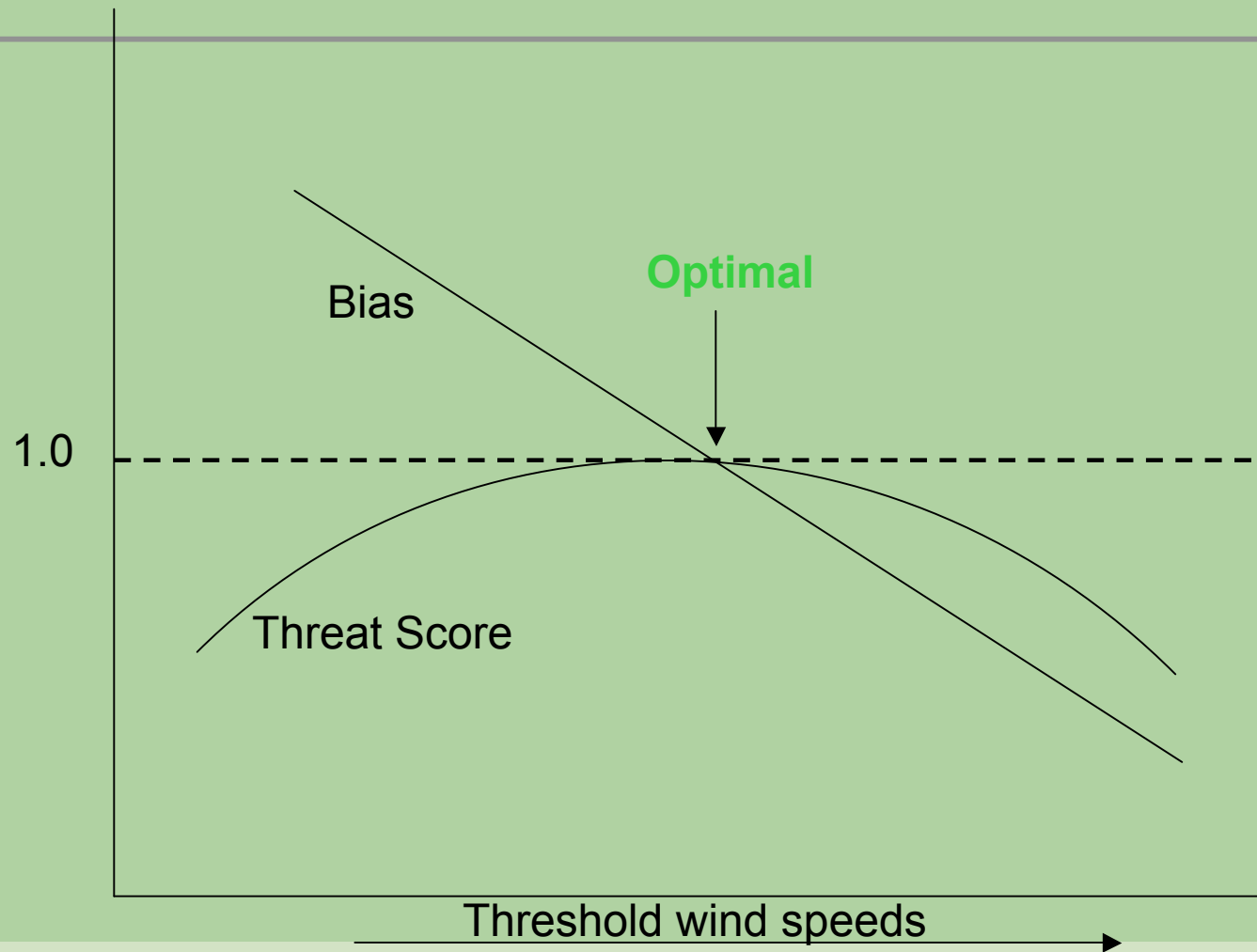
- Threat Score – $a/(a + b + c)$
Proportion correct after removing non-events
Used for low frequency events
Threat Score from 0 (worst) to 1 (best)
- Bias – $(a + c)/(a + b)$
Ratio of average forecast to average observation
Unbiased forecast, $B = 1$

These scores can be used conjointly to find the optimal threshold.

(Wilkes, D. 1995: *Statistical Methods in the Atmospheric Sciences*, Academic Press, pp 238-248)

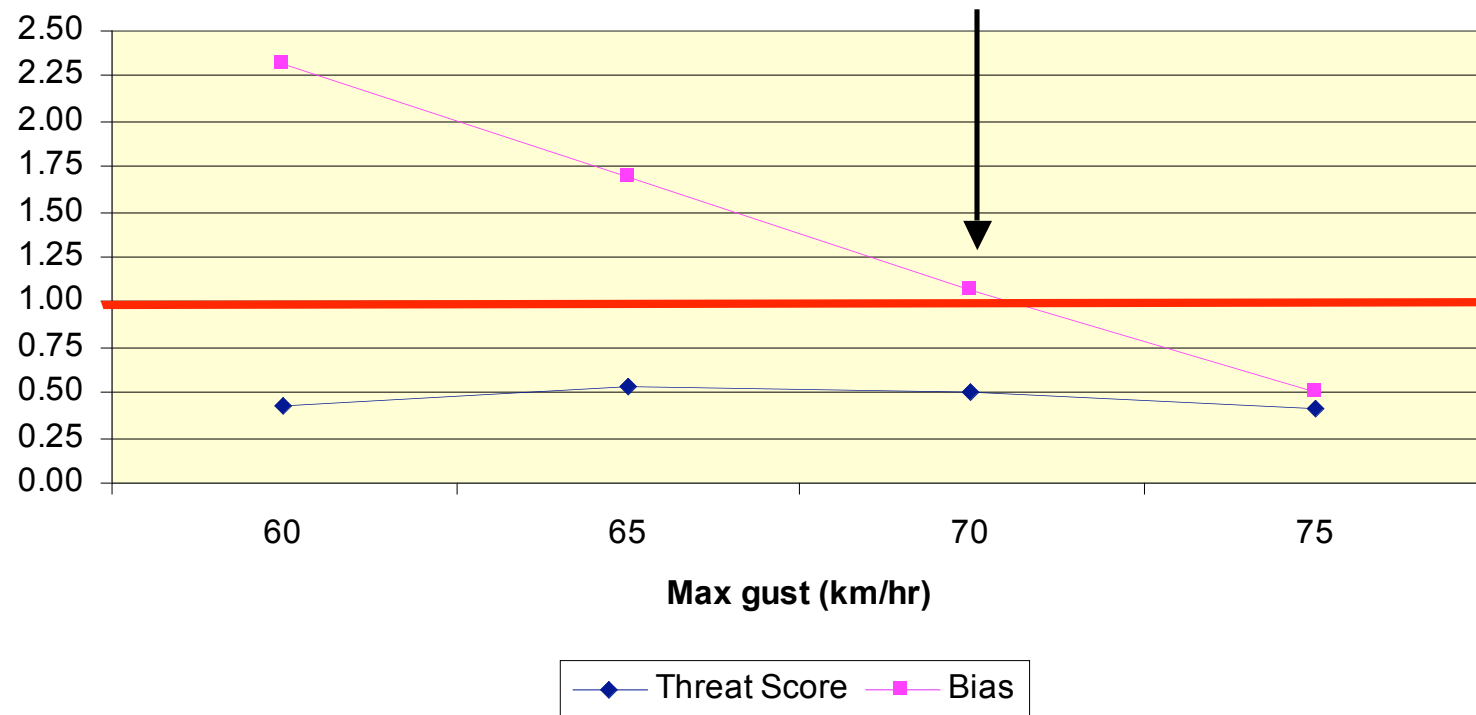


Threshold Detection



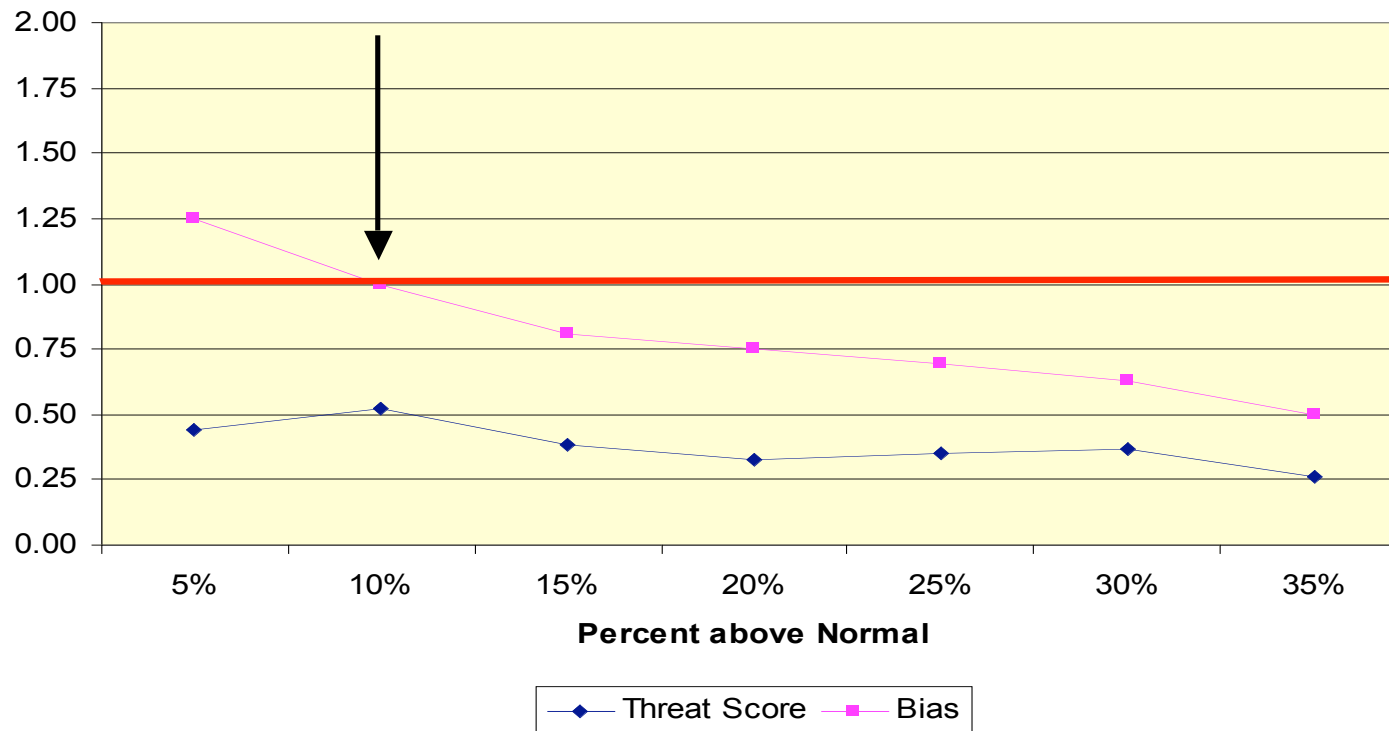
Wind Gust Threshold Estimate

**BC Hydro Outages 2004-07
Daily Max Wind Gust**



Joint Occurrence of Max Gust and Antecedent Rainfall

BC Hydro Outages 2004-07
Daily Max Wind Gust (70 km/hr)
and Excess Rainfall



Conclusion

- Found a good “rule of thumb” for wind thresholds and outages
 - *Victoria Int’l A is a reasonable proxy for Vancouver Island winds*
- Despite spatial and temporal uncertainties in the data, we found ...
 - *The contingency table method is a practical means of exploring wind thresholds (bias and threat score)*
 - *Given a predetermined wind gust threshold, the method is only slightly sensitive to antecedent rainfall amounts*
- Need to explore effect of improved spatial and temporal data (time and location), for both wind and outages
- Need to investigate other methods of threshold identification



Acknowledgements

We are grateful to the staff of the Field Operations Division of BC Hydro for providing outage data.

*Reference: BC Hydro Winter Storm Report,
October 2006 – January 2007.*





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