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The Canadian new Air Quality Health Index, 2008 Evaluation

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Background

The Air Quality Health Index (AQHI) is a new toll develops by Health Canada and Environment Canada in partnerships with health and environment agencies to better inform Canadian population about health impact of air quality and to help individuals take steps to protect their health. The AQHI incorporate the sum of health risks of three concurrent pollutants exposures: Ground-level ozone (O3), particulate matter (PM2.5/PM10) and nitrogen dioxide (NO2). The values of AQHI range in a linear scale from 1 to 10+. The AQHI values are also grouped into health risk categories. The maximum likely AQHI is predicted during the giving period forecast. In 2008 the new AQHI was implemented in 5 different provinces; British Colombia, Ontario, Nova Scotia, New Brunswick and Québec.

$$AQHI = K(e^{(AxO3)} - 1) + K(e^{(BxPM2.5)} - 1) + K(e^{(CxNO2)} - 1)$$

Sum of health impact of 3 pollutants (NO_2, $PM_{2.5}/PM_{10}$,O_3) into 10 different levels.
3 hours running average

1	2	3	4	5	6	7	8	9	10	+
Risk:	Low (1 - 3)			Moderate (4 - 6)			High (7 - 10)			Very High (Above 10)

General information's

AQHI forecast issued twice a day (Forecast Max value) at around 5:00 AM for :
- Today time issued (6:00 AM) to 6:00 PM
- Tonight 6:00 PM to 6:00 AM
- Tomorrow 6:00 AM to midnight 24:00 PM

at around 4:00 PM for :
- Tonight time issued (6:00 PM) to 6:00 AM
- Tomorrow 6:00 AM to midnight 24:00 PM

Distribution of AQHI observed

Provinces	Categories of risk observed		
	Low	Moderate	High
B. C.	96,5%	3,5%	0,02%
N. B.	97,5%	2,5%	0,00%
N. S.	98,1%	1,8%	0,06%
Ontario	82,8%	17,0%	0,18%
Québec	92,8%	7,2%	0,00%
Canada	92,5%	7,5%	0,07%

During the year of 2008, Environment Canada had forecasted AQHI for 25 differences location across Canada. Most of the time (92%) AQHI values are in the low category in Canada except for Ontario with 83% in this category. High health category remains rare even accounting for less then 0.07% except 0.18% for Ontario. Greatest variability in AQHI values is observed during summer season mainly due to more predominance ozone production.

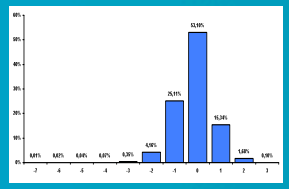
AQHI observations & forecasts availability in 2008

Provinces	Forecasts & Obs available	Missing Forecast	Missing Obs	Missing Forecast & Obs
British Colombia	67,8%	1,6%	31,6%	1,0%
New-Brunswick	86,5%	3,3%	11,5%	1,3%
Nova-Scotia	80,9%	4,8%	16,6%	2,3%
Ontario	95,8%	0,8%	3,5%	0,1%
Québec	36,6%	30,6%	40,3%	7,4%
Total	74,8%	1,8%	24, 3%	0,9%

Performance indicator

PC: Percentage Correct (ideal value 1)	$PC = \frac{All\ Hits}{Total\ Forecast}$
POD: Probability of Detection (ideal value 1)	$POD = \frac{Hits}{Hits + Misses}$
FAR: False Alarm Ratio (ideal value 0)	$FAR = \frac{FA}{Hits + FA}$
CSI: Critical Success Index (Threat Score) (ideal value 1)	$CSI = \frac{Hits}{Hits + Misses + FA}$

Distribution AQHI forecast error for 2008 All Canada



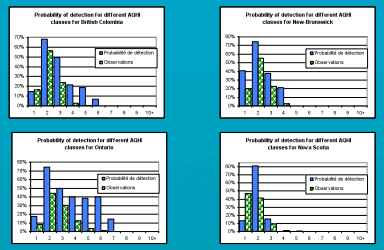
Differences between time emission of forecast bulletin

Provinces	Percentage correct					
	Forecast for Tonight 18h à 6h			Forecast for Tomorrow 6h à 24h		
	AM issue	PM issue	Δ	AM issue	PM issue	Δ
British Colombia	52,9%	59,4%	6,5%	48,2%	48,6%	0,4%
New-Brunswick	58,4%	63,1%	4,8%	58,2%	59,3%	1,2%
Nova-Scotia	48,3%	62,5%	14,2%	42,1%	47,4%	5,3%
Ontario	50,1%	57,6%	7,5%	47,8%	53,1%	5,3%
Québec	33,3%	25,6%	-7,7%	38,9%	41,0%	2,1%

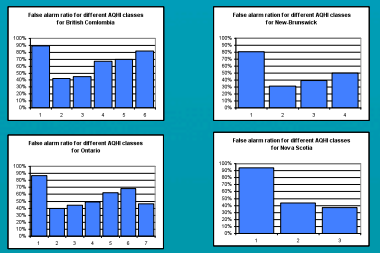
Verification again observations had showed that accuracy of AQHI forecast is correct at 50 to 60% of the time depending of the period forecast. As not surprise the accuracy increase as the period forecast get closer of the time forecast issue. Considering tolerance forecast error of plus or minus one AQHI digit, the forecast accuracy rise to nearly 92% in Canada, well above of the threshold of 80% in the SOP. The only province how doesn't meet the criteria is Quebec with tolerance ± 1 of only 73% mainly due to the lack of data.

Time Issue	Period of forecast	Provinces	N	Tolerance error			
				0	+/-1	+/-2	+/-3
05:00 AM Local time	Today	Colombie-Britannique	3925	54,3%	94,2%	99,4%	99,8%
		Nouveau-Brunswick	187	58,8%	97,9%	99,5%	99,5%
		Nouvelle-Ecosse	59	54,2%	93,2%	98,3%	98,3%
		Ontario	1687	59,1%	97,1%	100,0%	100,0%
		Québec	17	23,53	70,6%	100,0%	100,0%
	Tonight	Colombie-Britannique	3568	52,9%	92,3%	99,3%	99,9%
		Nouveau-Brunswick	185	58,4%	95,1%	99,5%	100,0%
		Nouvelle-Ecosse	58	48,3%	91,4%	98,3%	98,3%
		Ontario	1686	50,1%	94,6%	99,8%	100,0%
		Québec	15	33,3%	66,7%	93,3%	100,0%
	Tomorrow	Colombie-Britannique	3331	48,2%	90,8%	98,7%	99,7%
		Nouveau-Brunswick	184	58,2%	95,7%	99,5%	99,5%
		Nouvelle-Ecosse	57	42,1%	91,2%	98,3%	100,0%
		Ontario	1596	47,8%	91,1%	99,1%	99,9%
		Québec	18	38,9%	55,6%	100,0%	100,0%
16:00 PM Local time	Tonight	Colombie-Britannique	3302	59,4%	95,5%	99,7%	99,9%
		Nouveau-Brunswick	179	63,1%	97,8%	100,0%	100,0%
		Nouvelle-Ecosse	56	62,5%	100,0%	100,0%	100,0%
		Ontario	1632	57,6%	97,9%	100,0%	100,0%
		Québec	39	25,6%	82,1%	97,4%	100,0%
	Tomorrow	Colombie-Britannique	3245	48,6%	91,8%	99,1%	99,8%
		Nouveau-Brunswick	182	59,3%	96,70%	99,4%	100,0%
		Nouvelle-Ecosse	57	47,4%	94,7%	100,0%	100,0%
		Ontario	1621	53,1%	93,7%	99,9%	100,0%
		Québec	39	41,0%	74,4%	100,0%	100,0%

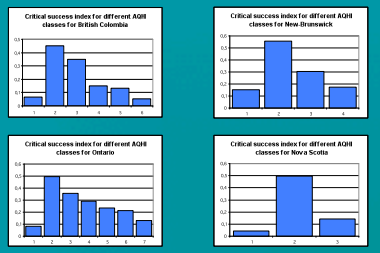
Probability of detection (POD)



False Alert Ratio (FAR)



Critical Success Index (CSI)



Conclusion

Tolerance forecast error of ± 1 is met at 90% of the time except for Quebec region mainly due to insufficient data. The POD generally decrease as AQHI values get higher except in Ontario where POD remains at around 40% for AQHI from 3 to 6. The most predominant AQHI value is 2 with POD ranging from 65 to 80%. FAR trend to increase with AQHI value except for AQHI of 1 where it's over forecasted.

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