

Wind Extreme Projection in a Changing Climate
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Prepared by Boris Weisman, PhD, International Climatic Evaluations (ICE) Inc.

The S37 Code and the NBCC are starting to require that consideration be given to the implications of Climate Change on extreme wind projection.

The changes to the extreme wind and its recurrence interval are expected to arise from a number of factors, including

- 1 Change in the intensity of severe weather events (eg. deeper extra-tropical depressions)
- 2 Change in the frequency of such events which determines the mean recurrence interval
- 3 Change in the intensity and types of precipitation events
- 4 Validity of the stationarity assumption in performing the statistics

Scientists at the World's main Meteorological Prediction Centres (NWS NOAA for US, ECC for Canada and ECMWF for Europe) have developed Global Atmospheric circulation models coupled with Ocean circulation models and applied future GHG (Green House Gas) concentration forcing in an effort to produce a simulation of the future behaviour of the Earth's atmosphere. These models have been run with several alternative RCP (Representative Concentration Pathways) scenarios to produce hourly weather data out to the end of the century. Each RCP pathway represents a projection of alternative emission reduction strategies over the next 50 to 100 years, producing different amounts of Global Warming.

Because the atmosphere is a chaotic system, any model run out to past 8 or so days is not expected to represent an actual outcome but rather a realistic potential outcome. Nevertheless scientists assume that 10 to 30 year runs have a semblance to reality, and that it makes sense to statistically compare a parameter such as temperature (max or mean), wind statistics or precipitation amounts and types in the future to the present case.

At ICE we use the Canadian Environment and Climate Change Model gridded output data from the high resolution regional runs for North America to extract the maximum monthly surface wind speed over a 30 year period starting in 2070 and for the same location extract the 30 year monthly maximum wind dataset for the current (historical model run) period. We then perform statistical analysis to determine the 50 yr return wind for each of these and calculate the relative change in return period wind. This relative change is then applied to the site specific wind derived from historical airport data for the site to project the airport derived extreme wind to the future climate period.

In this approach, the relative change is based on the use of the same model (or ensemble of models) with the same starting conditions, and should therefore be free from confounding factors from the use of different models.

In performing the statistics for the return period it was assumed that the 30 year set of monthly maximum values is from a stationary stochastic process for each of the periods. If there is a significant trend in the wind statistics, this would have to be incorporated into the derivation of return period wind.

Procedures are available to incorporate linear trends in data into the return period analysis. Since the trends are location specific, the analysis would need to be done for each location of interest.

ICE tested this approach for two sites located in Ontario, one outside Ottawa and one near Sudbury separated by a distance of 400 km.

The data for these sites as well as the historical data extreme are shown in Tables 1 and 2 below.

For Ottawa the model predicts a 2.2 m/s **increase** in the 50 yr return (13% increase in speed, 28% increase in pressure). For Sudbury the model predicts a 0.7 m/s **decrease** in the 50 yr return (3.5% decrease in speed, 7% decrease in pressure).

The results in the table are for the RCP 4.5 scenario runs from ECC (considered most likely if there is no major reduction in emissions till mid-century). The derivation can be run for other emission scenarios by just using the appropriate scenario model run produced by ECC.

As the models evolve or new scenarios are developed, the procedures remain unchanged and can be applied to update the climate change prediction in the future.

Table 1 Site near Ottawa predicted change in 50 yr and 10 yr return wind from last 30 yr period to 2070-2100

Parameter	Site	Exposure Adjusted	95% Conf (%)	Expected	95% Conf (%)	Climate Change	95% Conf (%)
50 year return							
Wind hrly (m/s)	18.8	17.0	-4, 8	17.0	-4, 8	19.2	-5, 9
10 year return							
Wind hrly (m/s)	17.3	15.7	-3, 7	15.7	-3, 7	17.7	-4, 8

Table 2 Site near Sudbury predicted change in 50 yr and 10 yr return wind from last 30 yr period to 2070-2100

Parameter	Site	Exposure Adjusted	95% Conf (%)	Expected	95% Conf (%)	Climate Change	95% Conf (%)
50 year return							
Wind hrly (m/s)	21.4	18.5	-5, 9	20.0	-5, 9	19.3	-5, 9
10 year return							
Wind hrly (m/s)	19.5	16.9	-3, 7	18.3	-3, 7	18.1	-4, 8