1. There were two methods used to rank the models: using absolute differences and GF Confidence Index. Before discussing the methods, the exposure unit assigned for my analysis was Icy Days (T < 0°C) for months September, October, and November.

   For absolute differences, it was between the observed average Tmax data and model average baseline temperature data for 1971-2000 and 1981-2010. The observed data values used are summarized in the table below. Average baseline temperature values were determined for each model using excel integrated functions.

	Tmax For 1971 - 2000	Tmax For 1981 - 2010
Average	12.66666667	12.9
Std. Dev	0.794087346	0.816214982

   After determining the absolute difference for each model, the list of values was ordered from smallest to largest with their associated models. The top 3 ranked values would be the top 3 smallest absolute difference value.

   The GF Confidence Index is defined as and calculated using:

$$GF = \frac{\left| \begin{matrix} Obse\ Avg \\ Tmax \end{matrix} - \begin{matrix} Model\ Avg \\ Baseline\ Temperature \end{matrix} \right|}{\begin{matrix} Std. Dev\ of \\ Observed\ Tmax\ data \end{matrix}} = \frac{Abs\ \Delta T}{\begin{matrix} Std. Dev\ of \\ Observed\ Tmax\ Data \end{matrix}}$$

   Where if GF > 1 the value is considered suspect and if GF < 0.5 then one can have confidence that the value is acceptable

   Below is a summary table of the top 3 ranked models with their associated GF index values and absolute difference values. It is worth nothing that the GF index is proportional and related to the absolute difference values. Therefore, the model with the smallest absolute difference would also have the smallest GF index value.

Data Set	Model	Avg Baseline (degC)	Abs ΔT	Ranking	GF index	GF Confidence Index
AR4 - 1971-2000	CGCM3T47(Run 3)	12.7905	0.123833333	1	0.155944222	Confident
	CGCM3T47(Run 5)	12.4851	0.181566667	2	0.228648231	Confident
	CGCM3T47(Mean)	12.4484	0.218266667	3	0.274864809	Confident
AR4 - 1981-2010	CGCM3T47(Mean)	12.89853333	0.001466667	1	0.001796912	Confident
	CGCM3T47(Run 5)	12.89773333	0.002266667	2	0.002777046	Confident
	CGCM3T47(Run 1)	12.9266	0.0266	3	0.032589453	Confident
AR5 - 1971-2000	MIROC5(Run 2)	12.6156	0.051066667	1	0.064308627	Confident
	ACCESS1-3(Run 1)	12.7343	0.067633333	2	0.085171151	Confident
	MIROC5(Mean)	12.8292	0.162533333	3	0.204679415	Confident
AR5 - 1981-2010	ACCESS1-3(Run 1)	13.133	0.233	1	0.285464008	Confident
	FIO-ESM(Run 3)	12.649	0.251	2	0.307517021	Confident
	FIO-ESM(Run 1)	12.540725	0.359275	3	0.440172023	Confident

   As it can be seen in the table that absolute difference values are not the same as the GF index values for each associated modelling method. The top 3 ranked values describe how good the model is at being close to real world data.

In terms of which ranking method is most robust, it really depends on whether it was AR4 or AR5 assessment since the values stem from a certain kind of assessment. According to the paper written by Vuuren (2011), AR5 is a compressive assessment and it was the most recently developed compared to AR4. To be more specific about each assessments process, AR4 uses SRES models while AR5 uses RCP models. In addition, AR5 uses average surface temperature whereas AR4 uses average global temperature. Both assessment methods incorporate the affects of the increasing amounts of greenhouse gases (GHG) in their models. However, the advantage of AR5 is that it integrates anthropogenic forcing's and its model is more sensitive to the effects of GHG on the climate. These advantages are not offered when using AR4 assessment method. In summation, AR5 considers more complex parameters the world inherently has which would ultimately make future temperature estimates more realistic.

2. A model that was common for both AR4 and AR5 was FGOALS_g1.0 and FGOALS_g2, respectively; assuming the numbers just indicate a new version of the same model. The values associated with the two models are summarized in the table below:

Assessment	Model	Avg Baseline (degC)	Abs ΔT	Ranking	GF index	GF Confidence Index
AR4	FGOALS-g1.0	11.1409	1.5258	22	1.921409	Suspect
AR5	FGOALS-g2	7.7306	4.9361	109	6.216025	Suspect

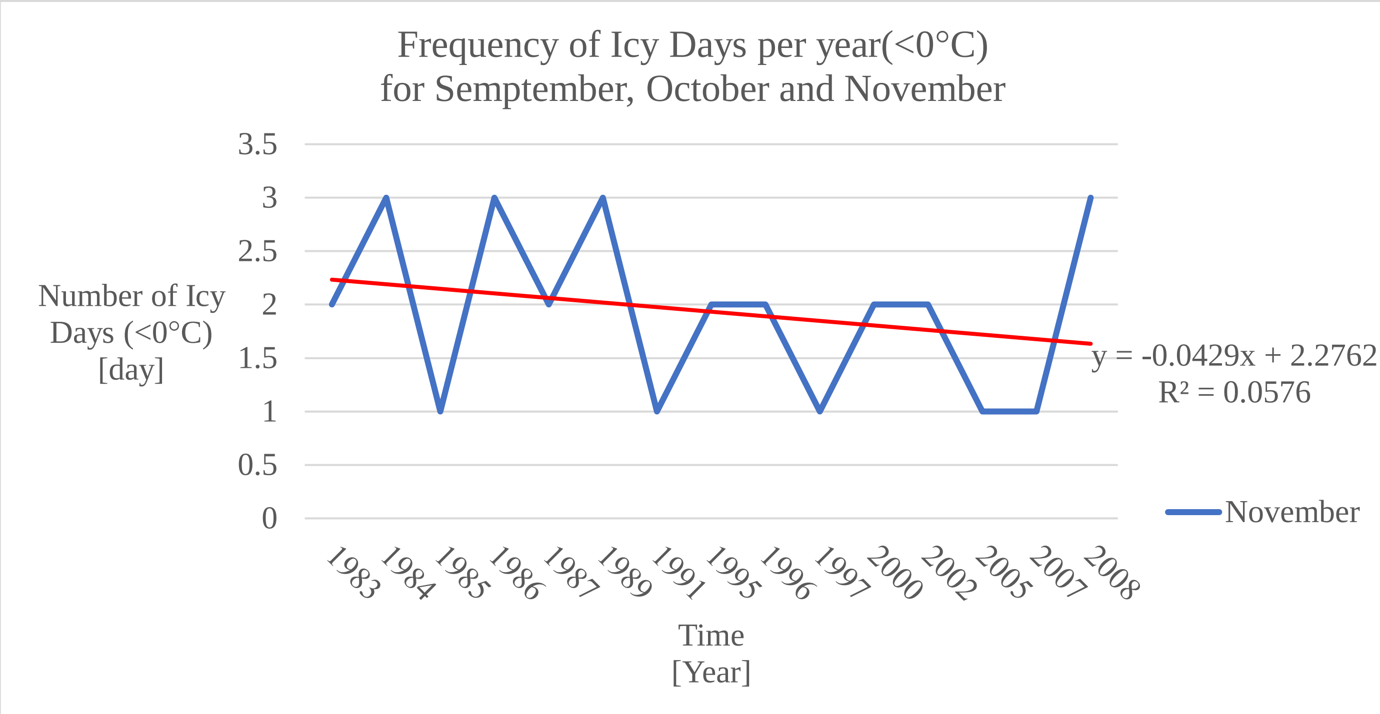
Since AR4 assessments uses SRES models that considers less radiative forcing's and less GHG impacts, then its low absolute temperature difference indicates that AR4 is better at showing that the affects of GHG and radiative forcing's are less severe on the global temperature change. Whereas for AR5 is better at considering the effects of radiative conditions and GHG influences on surface temperatures.

3. One advantage of these ranking methods is that it a direct comparison between observed data and real-world data; any differences will be seen through the calculations immediately. Also, the rankings help indicate which modelling method is best at estimating future climate conditions in comparison to real world temperature data.

   In terms of disadvantages, the models may not have considered the affects of urban heat island effect on the climate around Toronto. In addition, the increasing urbanization of Toronto specifically the suburbs have huge contribution to the increase in overall temperature readings. These factors are key in determining whether a simple difference is enough for ranking climate models or if a more sensitive ranking method should be used instead.

   Picking between AR4 or AR5 assessments depends on the objective of the research. For example, if future temperature projections are being studied than AR5 would be the best option since it uses RCP models that considers more radiative forcing's and GHG influences. The more features AR5 considers, the more accurate and representative the results will be of the real world. However, if studying past climate is the objective than AR4 would be best since it has less emphasis on future projections and more on historic forecasts.

4. My exposure unit is icy days (T < 0°C) for September, October, and November.



Year	November
1983	2
1984	3
1985	1
1986	3
1987	2
1989	3
1991	1
1995	2
1996	2
1997	1
2000	2
2002	2
2005	1
2007	1
2008	3

	November
Mean	1.933333333
Std. Dev	0.798808637
pearson R-value	-0.244674022

	P-value
Intercept	0.359997
X Variable	0.379468

ANOVA					
	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	0.534797369	0.534797369	0.827806873	0.379467624
Residual	13	8.398535964	0.646041228		
Total	14	8.933333333			

In terms of the trend of the data, it shows a decreasing trend in number of icy days for my exposure unit. This is supported by Mohsin's paper where it is said that the increasing urbanization of Toronto is contributing to the increase in winter annual minimum temperature (2009). However, the R^2 value is quite small ($R^2 \sim 0.06$) showing that the line of best fit is not a good representation of the data. However, the Pearson R-value is negative which indicates that there is a small negative linear relationship in the data.In addition, both significance F and P-values are much greater than a 0.05 significance level (or a 95% confidence level). Therefore, this indicates that the data is statistically insignificant.

References

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