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The Urban Heat Island Effect in Winnipeg

Ground-based temperature measurement problematic at best

By David Seymour and Joseph Quesnel

If your net is full of two inch holes, you should not conclude there are no fish smaller than two inches just because you fail to catch any –anonymous.

Executive Summary

- The surface temperature record is held by many, including the International Panel on Climate Change (IPCC), to be a clear indicator of what is happening to global temperature.
- However there are serious problems with the surface temperature record relating to differences in human activity near each measuring station.
- Two weather measurement stations in one city, Winnipeg, show differences in temperature that are bigger than the entire temperature change of last century.
- The average low temperature recorded at the more isolated and exposed Winnipeg airport location was 2.73 degrees cooler than those recorded at the Forks, in downtown Winnipeg.
- The average high temperature recorded at the more isolated and exposed Winnipeg airport location was 1.57 degrees cooler than those recorded at the Forks, in downtown Winnipeg.
- Closing the airport measurement station would create the illusion of a sudden "warming" by these temperature differences in Winnipeg.
- There is a strong case to be made that changes in the locations of measuring stations and the human activities taking place near them can explain the differences in records.
- The IPCC have made indecisive attempts at demonstrating that the surface measured data they use is reliable.
- Changes in surface measured temperatures are significantly different to more reliable satellite measurements.

Background

Across the world scientists, pressure groups, politicians, and the media are promoting a hypothesis that greenhouse gases emitted by industrialized society, especially carbon dioxide, are raising the average global temperatures. It is then speculated that this temperature rise threatens to make agriculture unviable, species extinct, sea levels higher, and the weather more violent and unpredictable.

Controversy rages over the hypothesis from the extent of warming that has actually occurred to the extent greenhouse gas emissions are actually responsible, to the reliability of link between temperature increases and the secondary effects above. This paper focuses on the reliability of temperature records.

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Measurement of global average temperatures is central to the hypothesis. Only with reliable records can we say that temperature is rising or that these rises coincide with causes like greenhouse gas emissions, or effects like dramatic weather events.

Estimates of past and present temperatures come from three sources. For periods prior to the 1860's 'proxy' indicators, like the thickness of tree rings, sedimentary soil layers, and layers of ice that are said to reflect temperatures. Since 1860, the records also come from ground based thermometers, while since the late 1970's more sophisticated satellite methods have been used to measure the temperatures of air in the Earth's atmosphere.

It is worth noting that the surface temperature record is widely touted as an important indicator of global temperature. For example, the 2007 IPCC report claims "The warmest years in the instrumental record of global surface temperatures are 1998 and 2005… Eleven of the last 12 years…rank among the 12 warmest years on record since 1850."[1]

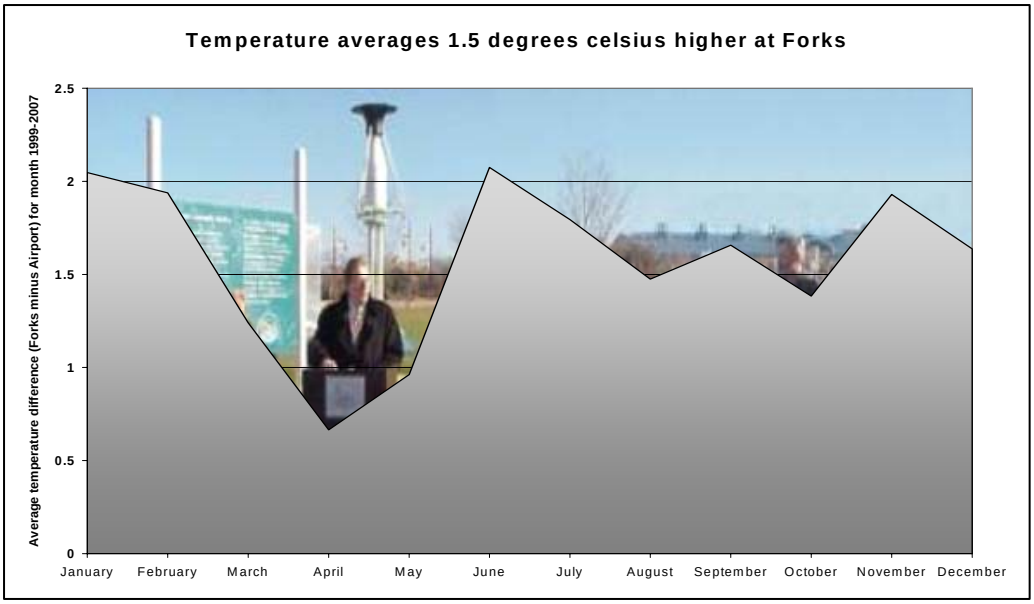

Figure 1 Monthly mean temperature differences between Forks and International Airport. Data is sourced from Environment Canada and listed in Appendix A.

This Frontier Backgrounder takes a look at the reality of measuring temperature from the ground close to home, at two weather stations located in Winnipeg, Manitoba. The differences between temperatures measured in two parts of Winnipeg, at the more isolated and exposed airport and in the densely populated centre city, are greater than the entire temperature rise being claimed since the surface temperature records began.

Further, dramatic changes and reductions in the number and location of measurement stations around the world is meaning that something similar to closing one of the Winnipeg stations then claiming the average temperature has changed is occurring all over the world.

Measuring temperature close to home

Winnipeg has two major weather stations. One is located at the Forks, in the centre of the city. In line with the theory of the Urban Heat Island Effect, this location is protected from the wind by the city and heated by the vehicles, buildings, and sun trapping tarmac nearby.

The other location is at the Winnipeg Airport. While one might expect the tarmac and traffic activity there to have similar effects, there are dramatic differences in recorded temperatures. Because few, if any, geographical features distinguish the Forks from the Airport –both are ultimately on the undulating Prairie- human land use differences must explain this difference. The Forks are significantly warmer, a fact stated by environment Canada when they unveiled the new station in 1999.[2]

If the weather station at Winnipeg International Airport were to suddenly close down, temperature readings would show the city had warmed, as the city would be relying on the measurements from one weather station rather than two.

The impact of the urban heat island effect on temperature is widely documented. A recent study by the American Geophysical Union found that temperatures in urban areas like Atlanta, Georgia and Houston, Texas were artificially raised by as much as 10 degrees in the summer due to concrete and concentrations

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of human activity. In fact, it has been shown that the urban heat island effect can artificially raise temperatures in communities with populations as small as 1,000 people.[3]

Rather than being an objective reality, temperature is whatever we measure it to be. It is a reflection of our measuring equipment as much as the actual temperatures. Like a fisherman's catch depends on the holes in his net, a meteorologist's temperature depends on the location of her weather stations.

Measurement difficulties across the world

It seems difficult to believe that the scientific community would make such an elementary error. While we will cover their attempts to account for it in the next section, it is worth noting just how common the opening and closing of weather stations in different areas is.

In a previous Frontier Policy Series Paper, Dr Vincent Gray, an expert reviewer for the Intergovernmental Panel on Climate Change (IPCC), made the case that all of the changes in the surface record could be explained by changes in the placement of weather stations:

- From 1860 to 1910 the system was becoming established in the large industrial cities and spreading over the globe. Equipment was being moved from the sides and roofs of buildings to protected enclosures, leading to a slight fall in the average.
- From 1910 to 1940 the cities expanded, together with their energy use. Thermometers still suffered from an upwards bias because of the shrinkage of the thermometer glass. The First World War closed many stations which were rebuilt with better facilities, still mainly in large cities.
- From 1940 to 1975 many stations were moved to airports and others were set up in rural areas, so causing an average fall in temperature.
- From 1975 to 2000 airports expanded to become "heat islands" and better heating took place everywhere.[4]

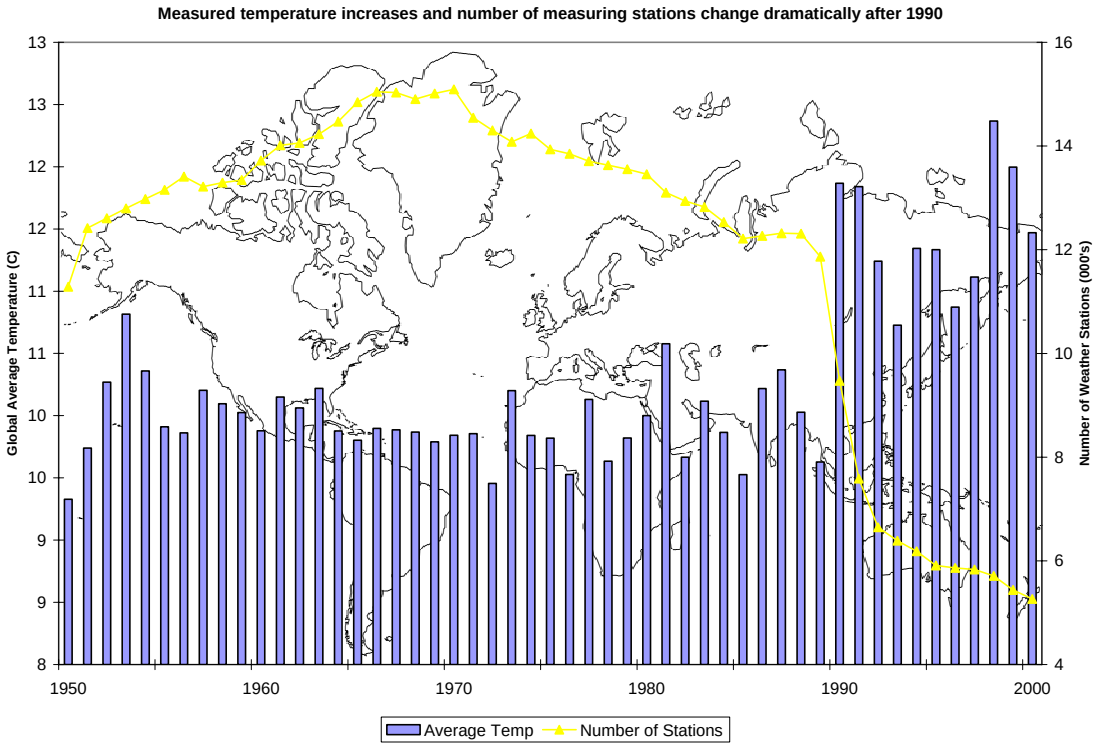

Figure 2 Average global temperature measured by surface stations (bars) and number of weather stations (line) from 1950-2000. The greatest change in recorded temperature occurs at the same time as the greatest change in the number of stations used to record it.

While Gray alludes to several trends in the placement of weather stations since 1860, this chart captures a dramatic shift in the number of stations around 1990. Some of this can be attributed to political upheaval around the collapse of the former Soviet Union. Environmental Economist Ross McKitrick and Environmental Scientist Patrick Michaels identify costs, lack of skilled meteorologists, particularly in remote locations, as having led to the decline in the number of weather stations.[5]

With these considerations in mind, it seems plausible that the rise in measured temperature reflects isolated weather stations closing, leaving proportionately more in urban areas affected by human activity.

Figure 3 This picture shows how a weather station in Marysville, CA is affected by nearby human activity as well as changes in global temperature. (Picture courtesy of www.surfacestations.org)

Are these difficulties being accounted for in the surface temperature record?

It is natural to assume that such dramatic differences in location would somehow be accounted for by the scientific community with the billions of dollars that have gone into climate change research in the past two decades.

A number of studies claim to have debunked the Urban Heat Island Effect, finding that when overall statistics are compiled, the readings from urban environments are not noticeably warmer than those from rural areas, so the land use affects can be ignored.

However the McKitrick and Michaels' paper is a more comprehensive study of how local factors nearby to weather stations affect the temperatures recorded. By sampling 218 individual stations from 93 countries, they were able to explore whether patterns in temperature results bore any resemblance to patterns of wealth, literacy, humidity levels, economic activity and other factors across the globe.

They found:

> Surface temperature data, including the IPCC gridded cell series, should not be interpreted as if they only measure 'climate.' They reflect the influence of many things, including a complex blend of local economic and social factors. Some of these exert an indirect influence on local temperatures but have nothing to do with the global climate, while others have nothing to do with temperature at all but instead affect data quality control. This study provides evidence that after controlling for these, the observed rate of temperature change is

noticeably lower in a global sample, and depending on how economic influences are removed, could be as low as that observed in the satellite record.[6]

In other words, different temperatures are recorded in different places partly because different human activities mean that the temperatures near weather stations *are* different, and partly because social economic conditions affect the chances of getting accurate readings. However, if we could take these differences away, the observed warming would be much less.

This is significant because they used IPCC data to arrive at these findings. The same data that the IPCC has claimed is immune to localized biases in temperature recording.

The 2007 IPCC report attempts to brush McKitrick and Michaels' study aside with the assertion that other effects relating to human activity trump the causes that McKitrick and Michaels cite,[7] this is exactly the point that the study makes, it is not clear that the IPCC has grasped its sophistication.

More telling is the difference between satellite and surface temperature measurements.

What about the satellite measurements?

Regardless of whether McKitrick and Michaels or the IPCC are right about the true cause of the recent rise in temperature from surface records, we should expect the surface records to be the same as the satellite records.

Satellite recordings are a recent phenomenon, dating back to 1979, compared to 1860 for surface temperature. There are also reasons to believe that they would give more reliable results than ground stations. They are independent of civilization, being equally able to fly over land and sea, inhabited and uninhabited locations.

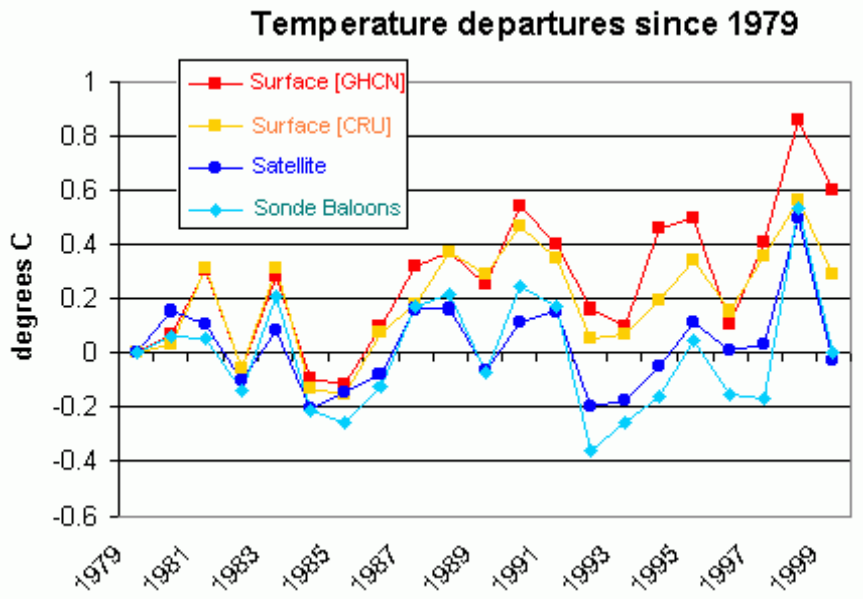

Figure 4 Temperature figures from surface, weather balloon and satellite.[8]

As this chart from Vincent Gray's earlier paper shows, there has been significant divergence between surface and satellite measurements since 1990, when we know there was a dramatic change in the number of stations available to record data.

Moreover, Gray also established that other ways of measuring global temperature have been shown to be inaccurate. Readings from proxy measurements (tree rings, sediments, etc), weather balloons (radiosondes) and satellites (MSU Units) have not been shown to conclusively indicate global warming (Gray, 2001).

Conclusion

This paper ties together a number of observations of what scientific experts are saying in the field. Despite clamouring cries that there is a consensus and the science of climate change is settled, we have not had to peel the debate back very far to find that there is ample room to be skeptical about this 'consensus.'

We have found that the temperature in Winnipeg varies more than the entire global variation claimed for last century, depending on where you measure it. Worse, the locations where temperature is measured have changed dramatically over the past fifty years. Over two thirds of the surface weather stations operating in 1970 are no more, while new ones have opened in places like down town Winnipeg by people who know that higher temperatures will be recorded there.

The pre-eminent body responsible for climate science appears either unable or unwilling to remove these biases from the data that they use to arrive at their conclusions and drive the multi-billion dollar research, lobbying and media industry that has become modern climate change concern.

However, when we see the variation between recently available satellite data and that recorded by the surface stations we have described, it appears they should.

In the mean time it appears that the consensus and authority of science on the subject of climate change is a very thin veneer. Public policy should recognize this and acknowledge the possibility that the man made global warming hypothesis is wrong, and all the sacrifices many would like to see us make to our economy will be in vain.

If land-based temperatures can be biased so easily by the urban heat island effect, it would be logical that the data upon which proponents of human-caused global warming reply for their arguments is seriously flawed and cannot be relied upon to prove their case.

As temperature in Winnipeg has been shown to have been distorted by as much as two degrees Celsius by the urban heat island effect, then the cumulative effect of disregarding this biasing effect on the IPCC report is a massively biased sample that erroneously shows warming on a global scale.

Clearly, policy makers should not make policy decisions on global warming using this flawed data.

About the Authors

David Seymour BA BE -joins the Centre from New Zealand as a policy analyst working out of the Centre's Regina office. He holds degrees in Electrical Engineering and Philosophy from the University of Auckland, where he also taught Economics. After working as an engineer in New Zealand he is applying his passion for high performance government to policy issues on the Prairies.

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Month	Mean Maximum Temperature (Degrees Celsius)		
	International Airport	Forks	Difference
January	-10.64	-9.74	0.91
February	-8.39	-8.15	0.24
March	-0.50	-0.19	0.31
April	11.92	11.34	-0.58
May	17.56	17.24	-0.31
June	22.84	22.74	-0.10
July	26.44	26.76	0.32
August	25.09	25.09	0.00
September	19.34	19.89	0.54
October	10.33	10.26	-0.07
November	2.50	2.54	0.04

Table 1 Mean of maximum monthly temperatures

Month	Mean Average Temperature (Degrees Celsius)		
	International Airport	Forks	Difference
January	-15.82	-13.78	2.05
February	-13.87	-11.93	1.94
March	-5.98	-4.74	1.24
April	5.32	5.99	0.67
May	10.87	11.83	0.96
June	15.81	17.89	2.07
July	19.86	21.66	1.79
August	18.53	20.00	1.48
September	13.13	14.79	1.66
October	4.69	6.07	1.38
November	-3.11	-1.19	1.93
December	-11.59	-9.95	1.64
Average	**3.15**	**4.72**	**1.57**

Table 2 Mean of average monthly temperatures

Month	Mean Minimum Temperature (Degrees Celsius)		
	International Airport	Forks	Difference
January	-20.9444	-17.75	3.19
February	-19.2889	-16.3	2.99
March	-11.4111	-9.3	2.11
April	-1.32222	0.6125	1.93
May	4.155556	6.385714	2.23
June	10.3	12.97143	2.67
July	13.2625	16.51429	3.25
August	11.925	14.88571	2.96
September	6.7875	9.642857	2.86
October	-0.975	1.857143	2.83
November	-7.8625	-4.91429	2.95
December	-16.6	-13.8125	2.79
Average	**-2.66**	**0.07**	**2.73**

Table 3 Mean minimum monthly temperatures

Appendix A

Each table contains average temperatures for the two Wininipeg weather stations, one at the Forks downtowwn and one at the Airport. Table 2 was used for the chart in Figure 1.

The temperatures are 'averages of averages' wherein the average monthly temperature for given a month is calculated then combined with averages from the same month from other years to give an eight year (1999-2006) average for that month.

For example the figure for September Mean Minimum at the Forks is the average of the minimum temperatures on all the days in the eight Septembers from 1999-2006.

The difference column gives the difference between the two stations. Positive values indicate warmer temperatures at the Forks, negative values indicate warmer temperatures at the airport.

With the exception of four months where the maximum temperature is higher at the airport, all figures indicate warmer temperatures at the airport.

Trenberth, K.E., P.D. Jones, P. Ambenje, R. Bojariu, D. Easterling, A. Klein Tank, D. Parker, F. Rahimzadeh, J.A. Renwick, M. Rusticucci,B. Soden and P. Zhai, 2007: Observations: Surface and Atmospheric Climate Change. In: *Climate Change 2007: The Physical Science Basi*s. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA

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[5] **McKitrick, Ross and Patrick J. Michaels (2004). A Test of Corrections for Extraneous Signals in Gridded Surface Temperature Data*. Climate Research*, Vol. 2 160-161**

[6] Ibid, 172

[7] Trenberth, K.E., P.D. Jones, P. Ambenje, R. Bojariu, D. Easterling, A. Klein Tank, D. Parker, F. Rahimzadeh, J.A. Renwick, M. Rusticucci,B. Soden and P. Zhai, 2007: Observations: Surface and Atmospheric Climate Change. In: *Climate Change 2007: The Physical Science Basi*s. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 244

[8] From earlier Frontier paper

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