Response to article in GSNZ Newsletter #149 (July 2009) by A. Bricknell "Global Warming: Geology and Astronomy Perspective"

***Scott Nodder, Jim Renwick, Brett Mullan** , 30 Sept 2009*

We are writing in response to the article by Alistair Bricknell, published in the July 2009 edition of the Geological Society of New Zealand Newsletter (#149), entitled "Global Warming: Geology and Astronomy Perspective". While purporting to present a geological and astronomical perspective on the question of anthropogenic-induced climate change, the data and conclusions presented are at best mischievous and at worse entirely misleading.

For clarity, all of us are employed at the National Institute of Water and Atmospheric Research (NIWA), with two of us working as climate scientists with an accumulation of 50 years experience (Renwick and Mullan), while one of us is a marine geologist and oceanographer with 20 years experience (Nodder) and an interest in the effects of environmental change on marine ecosystems. Renwick and Mullan have also been involved actively in the Intergovernmental Panel for Climate Change (IPCC), as lead authors and contributors to various chapters in the recent IPCC 4th assessment and earlier reports.

All of the concepts presented in the Bricknell article are well known to the climate science community and have been investigated and largely refuted by published, peer-reviewed scientific research. Clearly, data collected on geological and astronomical time-scales can provide interesting perspectives on aspects of climate change, but this does not necessarily mean that such data can fully explain (or indeed, predict) what the future response will be in the current period of global warming that the planet is experiencing. Below we present information that refutes one by one all of the claims made by Bricknell in his article.

(1) **Claim 1:** That there is no correlation between increasing temperature trends and rising CO_2 levels, and global temperatures, as derived from microwave sounding data, may have stabilised or even cooled since 2002.

Answer:
It is disingenuous to expect that a monotonic increase in carbon dioxide will lead to monotonic increases in atmospheric temperatures. The anthropogenic greenhouse effect overlays other natural climate changes such as those associated with volcanic activity and the El Niño-Southern Oscillation, as well as other human induced climate changes (such as the "dimming" or cooling effect of aerosols released by industry during and after WWII, and subsequently reduced in the 1970s amidst concerns about acid rain).

There are also significant lags in the climate system, so we should not expect a direct correlation between CO_2 and global temperature on the scale of individual

years. Over centuries and millennia, however (the "geological perspective"), the correlation is very high indeed. As indicated by numerous scientific papers and in the IPCC reports, some of the warming in the early part of the 20th Century was likely due to natural causes, consistent with observed solar, volcanic, greenhouse gas and aerosol changes. However, the latest IPCC reports indicate that at least half of the surface temperature rise that has occurred in the last three decades is very likely (at least 90% probability) due to human activities, associated primarily with the burning of greenhouse gases and landuse changes, especially deforestation. The IPCC reports also indicate that aerosol cooling has been an important process, but has not been significant enough to offset the enormous contribution to global temperature rise due to increasing greenhouse gas concentrations in the atmosphere.

(2) **Claim 2:** That the rate of sea-level rise has not increased over the 20th Century.

Answer: This has also been investigated in the literature through study of observations and with model simulations. A paper published in 2006 by one of the world experts in sea-level data analysis actually did claim an acceleration during the 20th Century (Church, 2006, Geophysical Research Letters 33, L01602, doi:10.1029/2005GL024826, and the IPCC noted that the average rate of sea-level rise was faster over 1993-2003 than over 1961-2003. However, this was a fairly new result at the time of the IPCC 4th Assessment Report and the sea-level chapter (with 13 lead authors) concluded that the apparent acceleration could reflect decadal variability, rather than an increase in the longer-term trend (a good example of how the IPCC consensus approach leads to cautiously worded conclusions.

The IPCC 4th Assessment report noted that the absence of an acceleration of the rate of sea-level rise during the 20th Century is not inconsistent with model results. Because of the large thermal inertia of the oceans there is a lag between air temperature and sea-level changes, with sea-level continuing to rise for hundreds of years after global temperature has stabilised, so the actual observations are not unexpected.

(3) **Claim 3:** That reductions in global glacier extent is unrelated to increasing hydrocarbon use, and that the rate of glacier length shortening has not increased over the 20th Century.

Answer: As with other components of the climate system, glacier fields have different time lags depending on their size and location. Some glaciers respond more strongly to precipitation than to temperature (up to a point), which can mask a warming signal. Results summarised in the IPCC 4th Assessment Report (notably Figures 4.13 and 4.15) suggest that glacier melt world-wide has indeed accelerated in the 20th Century, especially in the last few decades.

A basic concept drummed into students of statistics is that correlation does not necessarily indicate a causative relationship. Bricknell seems to have failed to observe this concept with the plotting of glacial length and industrial carbon use and his conclusion that these parameters are unrelated. The very fact that glacial extent

has continued on a significant trend of increasing reduction in length over the last 150 years is an alarming statistic in itself.

(4) **Claim 4:** That a period of low solar activity (e.g., sunspot number and cycle length) is correlated well with global temperature, not CO_2 levels, and may account for Claim 1 above.

Answer: Studies by climate researchers have shown that solar radiation impacts on the observed global temperature rise over the 20th Century is inconsequential compared to that due to increasing greenhouse gas concentrations, with the greenhouse gas contribution in the order of 5 to 8 times larger. Indeed, since about 1950 the combination of solar and volcanic activity changes has likely acted to cool the globe. It is also notable that Bricknell's figure shows sunspot cycle length plotted against the (global?) temperature anomaly and CO_2 concentration despite the known observation that the length of a sunspot cycle is not a good indication of the sun's energy output. In addition, the figure does not show temperature or solar radiation changes over the last fifteen years when this is the period of highest quality data and a period where the basic data show little or no relationship between solar radiation and global temperature.

The rate of increasing anthropogenic CO2 levels and effects on global temperatures over the last 150 years is unprecedented (see also Peter Ballance's letter to the editor in Newsletter #149). While debate over such significant issues is warranted, and scientific scepticism is to be encouraged, it is important to realise that reporting from the IPCC is a synthesis based on data, research, and interpretations that represent our state-of-the-art understanding of how the global climate system works. While there will always be uncertainty (as that is the nature of science), there is sufficient certainty around the basic ideas to warrant serious consideration by policy makers. From a risk-management point of view, the existence of uncertainty does not negate the responsibility of scientists to articulate and warn the global community when the ramifications of not doing so are so severe, as is the case with human-induced global warming.