Forecasting experts' simple model leaves expensive climate models cold

A simple model was found to produce forecasts that are over seven times more accurate than forecasts from the procedures used by the United Nations Intergovernmental Panel on Climate Change (IPCC).

This important finding is reported in an article titled "Validity of climate change forecasting for public policy decision making" (http://kestencgreen.com/gas-2009-validity.pdf) in the latest issue of the *International Journal of Forecasting*. It is the result of collaboration among forecasters J. Scott Armstrong of the Wharton School, Kesten C. Green of the University of South Australia, and climate scientist Willie Soon of the Harvard-Smithsonian Center for Astrophysics.

In an earlier, paper (http://www.forecastingprinciples.com/files/WarmAudit31.pdf), Armstrong and Green found that the IPCC's approach to forecasting climate *violated 72 principles of forecasting*. To put this in context, would you put your children on a trans-Atlantic flight if you knew that the plane had failed engineering checks for 72 out of 127 relevant items on the checklist?

The IPCC violations of forecasting principles were partly due to their use of models that were too complex for the situation. Contrary to everyday thinking, complex models provide forecasts that are *less accurate* than forecasts from simple models when the situation is complex and uncertain.

Confident that a forecasting model that followed scientific forecasting principles would provide more accurate forecasts than those provided by the IPCC, Green, Armstrong and Soon used a model that was more consistent with forecasting principles and knowledge about climate.

The forecasting model was the so-called "naïve" model. It assumes things will remain the same. Being such a simple model, people are generally not aware of its power. In contrast to the IPCC's central forecast that global mean temperatures will rise by 3˚C over a century, the naïve model simply forecasts that temperatures next year, the year after, and so on for each of 100 years into the future would remain the same as the temperature in the year prior to the start of the forecasting exercise. Picture a graph of temperature over time: the naïve forecasts would appear as a flat line.

The naïve model approach is confusing to non-forecasters who are aware that temperatures have always varied. Moreover, much has been made of the observation that the temperature series that the IPCC uses shows a broadly upward trend since 1850 and that this coincides with increasing industrialization and associated increases in manmade carbon dioxide gas emissions.

To test the naive model, we started with the actual global average temperature for the year 1850 and simulated making annual forecasts from one to 100 years after that date – i.e. for every year from 1851 to 1950. We then started with the actual 1851 temperature and made simulated forecasts for each of the next 100 years after that date - i.e. for every year from 1852 to 1951. This process was repeated over and over starting with the actual temperature in each subsequent year, up to 2007, and simulating forecasts for the years that followed (i.e. 100 years of forecasts for each series until after 1908 when the number of years in the temperature record started to diminish as we approached the present). This produced 10,750 annual temperature forecasts for all time horizons, one to 100 years, which we then compared with forecasts for the same periods

from the IPCC forecasting procedures. It was the first time that the IPCC's forecasting procedures had been subject to a large-scale test of the accuracy of their forecasts.

Over all the forecasts, the *IPCC error was 7.7 times larger* than the error from the naïve model.

While the superiority of the naïve model was modest for one to ten-year-ahead forecasts (where the IPCC error was 1.5 times larger), its superiority was enormous for the 91- to 100-year-ahead forecasts, where the IPCC error was 12.6 times larger.

Is it proper to conduct validation tests?

In many cases, such as the climate change situation, people claim that: "Things have changed! We cannot use the past to forecast." While they may think that their situation is unique, there is no logic to this argument. The only way to forecast the future is by learning from the past. In fact, those who are proclaiming the dangers of global warming also base their assumptions on their analyses of the past.

Could one improve upon the naïve model? While the naïve model is much more consistent with forecasting principles the IPCC's approach to forecasting climate, it does violates some principles. For example, the naïve model violates the principle that one should use as long a time series as possible, because it bases all forecasts on simply the global average temperature for the single year just prior to making the forecasts. It also fails to combine forecasts from different reasonable methods. The authors planned to start simple with this self-funded project and to then obtain funding to undertake a more ambitious forecasting effort to ensure that *all* principles were followed. This would no doubt improve accuracy. However, the forecasts from the naïve model were very accurate. For example, the mean absolute error for the 108 fifty-year-ahead forecasts was only 0.24˚C. It is difficult to see any economic value to reducing such a small forecast error.

We concluded our most recent paper with the following thoughts:

Global mean temperatures have been remarkably stable over policy-relevant horizons. The benchmark forecast is that the global mean temperature for each year for the rest of this century will be within 0.5C of the 2008 figure.

There is little room for improving the accuracy of forecasts from our benchmark model. In fact, it is questionable whether practical benefits could be gained by obtaining perfect forecasts. While the Hadley temperature data relied upon by the IPCC drifts upwards over the last century or so, the longer series shows that such trends can occur naturally over long periods before reversing.

Moreover, there is concern that the upward trend observed over the last century and half might be at least in part an artifact of measurement errors rather than a genuine global warming.

Even if one accepts the Hadley data as a fair representation of temperature history (and that is debatable, especially given the recent revelations about possible irregularities in

temperature data handling by the Climate Research Unit at the University of East Anglia), our analysis shows that errors from the naive model would have been so small that decision makers who had assumed that temperatures would not change would have had no reason for regret.

For further information contact J. Scott Armstrong (http://jscottarmstrong.com or Kesten C. Green (http://kestencgreen.com/)]

J Scott Armstrong is a professor at the Wharton School of the University of Pennsylvania and Kesten Green is a senior lecturer at the International Graduate School of Business at the University of South Australia. They are leading researchers on forecasting.