How To Use Statistics To Say What You Want: A Climate Change Example

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# Introduction

In 2010 Phil Jones was asked questions created by climate change skeptics. Among these were question about statistical signific at global warming over the last 14 years, or that over the last 7 years there has been global cooling. Jones’s response to these was the following “The positive trend [from 1995-2009] is quite close to the significance level. Achieving statistical significance in scientific terms is much more likely for longer periods, and much less likely for shorter periods.” and in response to cooling from the past 7 years was “No. This period is even shorter than 1995-2009. The trend this time is negative (-0.12C per decade), but this trend is not statistically significant.”

Questions like these, or rather, statistics like these are always prevalent whenever there is a good argument to win. This article aims to clear up mis-understandings around what statistics are actually saying, and when they are being used specifically to misrepresent the data though a smaller case study of Phil Jones interaction with these questions. This article will cover 1) What does Phil Jones response mean, and was he correct? 2) How the statements were, or might have been interpreted, and Speculation on the origin of the questions. A MATLAB function “climchg” was created to illustrate various points of what is actually being said. The data used for our MATLAB function is the same that Phil Jones and skeptics had on the climate in 2009, both as monthly and annual data.

# Discussion

## Was Phil Jones Correct?

First off, the questions and answers were given in the context of hypothesis testing. The initial question “Do you agree that from 1995 to the [2009] there has been no statistically-significant global warming?” would have the null hypothesis that in that 14 year period in question does not have a positive slope (units being °C per decade) at the 95% confidence level. Phil Jones says that with this null hypothesis we would reject the null hypothesis at the 95% confidence level, but that “Achieving statistical significance in scientific terms is much more likely for longer periods, and much less likely for shorter periods.”

To illustrate this point we will look at the first output of the MATLAB climchg function using the “slope to target” feature (see figure 1). This feature plots the slope from the date to the target year, in this case 2009, with the upper and lower bounds being the 95% confidence level. Figure 1 shows that from any date before 1995 to 2009 there is a statistically significant positive slope. 1995 is the farthest back you can plot a slope to without having the positive slope be statistically significant. It should be noted at this time though at a null hypothesis of an increasing temperature (positive slope), unchanging temperature (slope of zero), and decreasing temperature (negative slope) are all not statistically significant when calculating from 1995-2009 because the 95% confidence margins (red) encompass negative, zero, and positive values. So, you do need Chart, line chart

Description automatically generated with medium confidencelonger periods of time for any hypothesis to have significance.

Another question he was asked was “Do you agree that from January 2002 to the present there has been statistically significant global cooling?”, to which he replied “No. This period is even shorter than 1995-2009. The trend this time is negative (-0.12C per decade), but this trend is not statistically significant.” To confirm what Jones said we return to figure 1. Looking at figure 1 notice that although the slope changes to negative after 2001, the 95% confidence interval encompasses again positive and negative values. It should also be noted that the error bounds are growing rapidly as the length of time that the slope is calculated on gets shorter and shorter.

Figure 1. Graph of regression Slopes from date to 2009. Notably as you take the slope over shorter and shorter periods of time the 95% confidence interval (red) becomes wider and wider. In 1995 the error crosses zero, indicating that you can no longer state if the slope is increasing, decreasing, or staying the same. In 2001 the slopes become negative, but with enormous error bounds both positive and negative.

To look at this another way we wrote a feature into the climchg program to look at how often though history you would be able to see a significant trend given a short interval, like the 1995-2009 (14 years) or 2002-2009 (7 years). This is called slope of interval (see figure 2) and calculates the slope for the past X number of years to the date, again reported in C° per decade. Throughout time there have been few periods that have statistically significant (red 95% confidence interval not straddling zero) when looking at a 14 year period, and only a handful on a 7 year period. To compare, if we took intervals of 50 years (see figure 3) it is notably more common to get statistically significant slopes.

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Figure 2. Graph of slope over a 14 year (left) and 7 year (right) time. With such short time periods most of the time the slope is not statistically significant, as signified by the confidence interval (red) encompassing both positive and negative slope.

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Description automatically generatedFrom these we conclude that what Jones said is correct, but maybe what he said should even be strengthened. It should be strengthened by inserting by clarifying the diference between a saying a trend is “not statistically significant” and saying there is no warming trend, as implied by the questions. To say that something is not statistically significant, is to say the null hypothesis should be rejected, not that the alternative hypothesis is true. Just because there is not a significant slope from 1995 to 2009 (or any other short period of time) does not erase the larger trend. In hindsight it is clear that 1995-2009 was not a trend toward non-global warming. Furthermore, even if it was some sort of climactic shift in around 1995-2009 there simply wasn’t enough data to support claiming against the 40+ year trend of warming with oscillation. This is well illustrated by Figure 4 which shows the trend of the temperature with the 95% confidence interval on either side.

Figure 3. Figure of slope over 50 year time period. Similar to figure 2, but when you increase the number of years you are calculating lobe off the slope is more often statistically significant

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Figure 4. Trend since 1970. The trend since 1970 is clearly positive.

## Interpretations of Statements

Immediately after the interview with Phil Jones news headlines as absurd as “Climategate U-turn as scientist at centre of row admits: There has been no global warming since 1995” appeared. This is likely because the reporters didn’t understand what Phil Jones was trying to convey about needing longer datasets to achieve significance at the 95% confidence interval. This misinterpretation, was likely not isolated to the reporters, though, but rather most people who were not acutely involved in the discussion. Furthermore, this miscommunication likely led many to question the validity of global warming trend as a whole, which we have already stated has been shown to be a statistically significant, and real trend.

The motivation behind how the questions asked to Phil Jones were worded, and the statistics being used is at a core speculation. That being said it is very clear that they chose the longest period they could to first have a positive trend be statistically insignificant, and second to have the farthest back to have a negative trend does lend itself to being maliciously misleading. Those who formulated these statistics could have easily known that climate change skeptics would latch onto it as a number to back their case, and climate change novices would just get confused about what is going on. Although the motivation is not known, I would say that this is a classic example of statistics being used as a weapon against the very point the statistics are actually backing.

# Conclusion

Statistics can be manipulated very easily, as we see with how easily Phil Jones comments were spun inverse of what he actually said. Trends of global warming are easily enough seen (see figure 4), but still statistics like “global cooling over this 7 year period” and “no statistical warming since over the last 14 year period” can be massively confusing to the statistical or subject matter novice. This article aimed to clear up a simple, and possible common data manipulation that will muddy the real meaning of the known data. This is the trend of just selecting the maximum period of time that is short enough to show the trend you want. This is easy with oscillating data like climate but can easily be done with other types of data. One easy way that one might avoid this is to ask, things like “if there is not 95% statistical significance of Y trend, is it significant at 90%?” or “if there is no significance of Y trend over X years, what about X + 10 years? X + 30 years?”