Comments on: "The application of machine learning for evaluating anthropogenic versus natural climate change by John Abbot, Jennifer Marohasy"

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This paper compares proxy temperature series before and after 1830 to attempt to attribute warming to natural and anthropogenic causes. The authors attempt to distinguish natural and anthropogenic industrial epoch warming. To do this, they use a handful of pre 1830 proxies to predict the same proxies post 1830 and claim that the prediction represents the natural component of the industrial epoch proxy change. They conclude that most of the industrial epoch warming is natural, not anthropogenic. None of the claims are based on instrumental temperatures, only this small number of proxies are considered.

There are many problems, a basic summary follows.

Data:

Geographical distribution, and global representativity of the data:

Out of an admittedly large choice of thousands of possible proxies, the authors choose two from the northern hemisphere (one from a site in Canada and one from Switzerland) and two from the southern hemisphere (a site in New Zealand and one in Australia). In addition, in order to have greater geographic distribution, they used two multiproxies. One is called a "Northern hemisphere composite" but (according to the reference they cite), the 4 or 5 proxies that constitute the "multi" all come from the same small Icelandic lake. The "Southern south America multiproxy" is indeed a multiproxy in the conventional sense, but it is restricted to southern South America, also a very small geographical area. These six local series are presented as though they represent the entire globe.

Temporal coverage, resolution, recent decline:

It is highly significant for this study that all of the six proxies chosen had proxy temperatures that declined or were at best constant after 1975, underscoring a combination of proxy problems (e.g. dendrochronology) and the unrepresentativeness of the proxy choices. In the "Northern hemisphere composite" (from the Icelandic lake), the temperature even decreases by a whopping 0.3 ^{o}C since 1980 - yet from the authors' description - one could be forgiven for thinking that this behaviour was somehow representative of the actual northern hemisphere temperature.

Rather than using the original data, the authors scanned the published graphs and used very low resolution versions of the data. From their graphs, it would seem that the resolutions they obtain are between 20 – 50 years (more on this later). This is a shame since in many cases the original data had annual resolution.

These geographic and temporal resolution issues are underlined since they turn out to be fundamental. For example, a dozen or so globally or hemispherically representative pre-industrial multiproxies exist, each based on hundreds or thousands of individual proxies – not just 6. They show that the pre-industrial global temperature series has decadal scale oscillations that are close to ±0.1 ^{o}C and this is supported by pre-1900 instrumental data. The true decadal global scale fluctuations are thus about ten times smaller than the local series analyzed by Abbot and Marohasy.

Methodology:

Rather than analyze the proxies themselves, for each series the authors replace the proxies by regressions using between 21 and 30 parameters each. These are fit over periods of about 1000 years (some a bit more, some a bit less) up until 1830, the end of their pre-industrial era. The choice of the regression functions is sine waves, but the method cannot be called Fourier analysis since the frequencies as well as the amplitudes and phases of the sinusoids are fitted parameters. This choice of basis function is arbitrary (e.g. polynomials would probably do just as well) and the number of parameters is very close to the number of degrees of freedom (the number of low resolution data points in each series), so the procedure is really an elaborate but ill-defined smoothing operation. All the frequencies are lower than $(40 \text{ years})^{-1}$ (except for the short Swiss series with a $(25 \text{ years})^{-1}$ highest frequency).

If they authors had taken their regression seriously, they would have used them to extrapolate from 1830 to the present in order to make their forecast. We can only presume that this didn't give the result they sought, they therefore took the regression output and used it as input to yet another regression algorithm, this time from the commercial black box software called "Neurosolutions Infinity" that itself uses 7 different sub black boxes including 5 different Artificial Neural Network (ANN) algorithms. We are not told in any detail why they chose a particular sub black box, but they eventually settled for one of the ANN's, so we will describe these. ANN's are effectively nonlinear multiparameter regression algorithms, typically involving large numbers of parameters. The input to the ANN was not the actual proxies but rather the (heavily) fitted sinusoids. The ANN then performed an additional fit (albeit using "machine learning" methods, but still a fit) using the proxies to 1830 to obtain optimum predictor models (one for each proxy). This black box predictor model was then used to predict the *proxies* (but NOT the temperatures!) in the post 1830 period.

It is important to note that the skill was assessed using the proxy industrial epoch temperatures - not the actual temperatures – and that these typically stopped some time ago (years: 1950, 1975, 1980, 1995, 2000, 2000), i.e. often before the bulk of the anthropogenic warming. In any case, as mentioned above, all the proxies that were selected showed stable or cooling trends over the last decades.

Comments

From the above description, the paper is flawed at many, many levels. I won't even discuss their speculations about water vapour or the possibility of using laboratory spectrometry to determine the Equilibrium Climate Sensitivity.

The most important point is that they committed the common but fundamental error of scale, in time, but here, mostly in space. As the authors themselves comment on multiple occasions, that on multidecadal time scales, the proxy temperatures fluctuate about ±1 ^{o}C. This is normal since each proxy only represents the behavior of a tiny region. When the IPCC claims that the industrial epoch temperature has increased by about 1 ^{o}C, they are referring to the *globally averaged surface air temperature*, and this – as we have mentioned varies only by about ±0.1 ^{o}C (over decadal time scales). The authors – being apparently unfamiliar with climate science - seem to have missed the factor of 10 discrepancy. And the explanation for the difference is simple. In the pre-industrial epoch, local temperatures varied by ±1 ^{o}C over decadal scales, but the variations over different parts of the world *tended to cancel out*, hence the far lower global variability. However – and this can indeed be seen by careful superposition - even of the authors' hand picked proxies - that in the last century there is a tendency for the local fluctuations to fluctuate *together* (and upwards!) - rather than tending to cancel each other out.

That's the essence of global warming – it's not local, it's *global*!

-Shaun Lovejoy, Sept. 6, 2017