

# **POLAR WARMING ATTRIBUTION STILL PREMATURE**

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**Using Detection and Attribution (D&A) analysis<sup>1</sup>, Gillett et al. (2008)<sup>2</sup> claim that “polar warming” is due to human activity, by comparing the five-year surface temperature averages in the Arctic and the Antarctic (OBS) to the results of ensembles of Global Climate Models (GCMs). We find their arguments insufficient.**

Using Detection and Attribution (D&A) analysis<sup>1</sup>, Gillett et al. (2008)<sup>2</sup> claim that “polar warming” is due to human activity, by comparing the five-year surface temperature averages in the Arctic and the Antarctic (OBS) to the results of ensembles of Global

Climate Models (GCMs). We find their arguments insufficient, even assuming Gillett's underlying hypotheses as true: that relatively-sparse OBS data are representative of the Polar regions; and that the means calculated over five-year periods give a realistic picture of climate variability.

For the Arctic area, we compare the robustness of Gillett et al.'s results, to what can be obtained from dynamic climatology<sup>3</sup>. Considering the main Arctic climatic determinants, known good proxies are the North Pacific Index (NPI<sup>8</sup>) for the Polar Vortex (PV); and the Pacific Decadal Oscillation (PDO<sup>4</sup>, time series as per Mantua's<sup>5</sup>) and the Atlantic Multidecadal Oscillation (AMO<sup>6</sup>, time series as per NOAA data<sup>7</sup>) for the Ocean-Atmosphere Interactions (OAI),

On that basis, we carry out a linear correlation analysis using the five-year means of the following five regressors for OBS:

(a)  $NAT_{mean}$  and (b)  $ALL_{mean}$ , respectively the mean response to natural only and to natural+anthropogenic forcings, simulated by GCMs as per Gillett et al.'s fig. 1a<sup>2q</sup>

(c)  $AutoC$ , the temperature of the preceding five-year period ( $OBS_{(t-1)}$ ), as the "memory" of the Arctic system

(d)  $AMO\_PDO_{based}$  as per the following formula:  $PDO_t + 0.5 AMO_{nor_t}$  (where  $AMO_{nor_t}$  is the Zscore normalisation of AMO)

(e)  $NPI_{based}$  according to:  $-(0.50 NPI_t + 0.3 NPI_{t-1} + 0.2 NPI_{t-2})$

Formulas for (d) and (e) are empirical "best-fits". As coefficient of determination we adopt Spearman's correlation coefficient  $r^2$  over the whole reference period 1901-99, preferring it to Pearson's as ALL and NAT are not normally distributed on the basis of the Shapiro-Wilk test.

The value of  $r^2$  for  $NAT_{mean}$  (0.06) is small and not significant.  $ALL_{mean}$ 's  $r^2$  (0.19) is larger with significance below 95%, but the post-1979 non-monotonic relationship with observed data in its scatterplot (Fig.1) may be a manifestation of the stationary random Gaussian red noise found by Wunsch in long-running climate time series without a zero crossing<sup>9</sup>.

$AutoC$ ,  $AMO\_PDO_{based}$  and  $NPI_{based}$  show larger absolute values of  $r^2$  (respectively 0.38, 0.43 and 0.53) than  $ALL_{mean}$ , and larger significances (>95%), with monotonic, continuous scatterplot clouds (Fig. 1).

The fact that  $AutoC$  and the dynamic climatology-based indicators outperform them indicates that GCMs could be inadequate, if evaluated on the basis of persistence<sup>10</sup>. Possibly, GCMs may be capturing too small a fraction of the natural and even of the anthropogenic variabilities.

Gillett et al.<sup>2</sup> also state that “the warm anomaly in the 1930s and 1940s is not reproduced [by GCMs], suggesting that this was largely unforced variability, consistent with other analysis”. To verify this assertion, we compute two linear models based on regressors (d) and (e) above, using linear least-squares fit for the period 1925-54 (adopting a wider period than indicate in order to obtain a minimal set of data):

$$(f) \text{ OBS} = 0.2385 * AMO\_PDO_{based} + 0.2398 \quad (r^2=0.6061)$$

$$(g) \text{ OBS} = 0.7372 * NPI_{based} + 0.2356 \quad (r^2=0.4403)$$

The values of  $r^2$  are respectively 0.6061 for (f) and 0.4403 for (g). When we apply (f) and (g) to the period 1955-99,  $r^2$  actually increases respectively to 0.6113 (>99% significance) and 0.5764 (>95%).

This indicates that it is possible to satisfactorily describe the Arctic climate after 1955 even with linear models calibrated on a period that Gillett et al. deem as dominated by internal variability. Internal variability may have been well active at least until the end of the past century, suggesting that a different perspective is needed on the role of anthropic effects.

In conclusion, attribution of “polar warming” in the Arctic to human activity appears premature, as the main macroscale determinants of Arctic surface temperatures (PV and OAI) are not adequately described by GCMs used by Gillett et al.<sup>2</sup>.

## References

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Figure 1 – Scatterplot of the five regressors ( $NAT_{mean}$  (a),  $ALL_{mean}$  (b),  $AutoC$  (c),  $AMO\_PDO_{based}$  (d),  $NPI_{based}$  (e) vs OBS.



