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Author contributions

U.B. designed the study with input from W.T., U.S., L.S. and S.E. Analyses were performed by U.B. with support of J.J.C. and E.M.F. All authors contributed to discussion, interpretation and writing.

Additional information

Supplementary information is available in the online version of this paper. Reprints and permissions information is available online at www.nature.com/reprints. Correspondence should be addressed to U.B.

Competing financial interests

The authors declare no competing financial interests.

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CORRESPONDENCE:

Arctic contaminants and climate change

To the Editor — In a recent Letter[1], Ma *et al.* analysed eight persistent organic pollutants (POPs) at an Arctic monitoring station (Mount Zeppelin, 474 metres above sea level, Svalbard). They identified inclines in the latter parts of the linearly detrended concentration time-series (1993–2009). Their interpretation is that many POPs (besides the more volatile polychlorinated biphenyls and hexachlorobenzene) have become remobilized from Arctic repositories into the atmosphere as a consequence of climate change. However, it should be emphasized that other factors can cause the reported inclines, which reflect nonlinearities (or a degree of curvature) within the data.

The eight POPs (α-HCH, γ-HCH, *cis*-NO, *trans*-CD, *o*,*p*′-DDE, *p*,*p*′-DDE, *o*,*p*′-DDT, *p*,*p*′-DDT) analyzed by Ma *et al.* exhibit declining Arctic trends due to reductions in global emissions, modified by processes such as environmental degradation and interchange between atmosphere and surface media. Ma *et al.* used a linear model to detrend the data. Notably, statistical significance of the linear fit does not preclude presence of nonlinearities within the data (indeed such nonlinearities are what lead to the reported inclines), nor does it provide information on the origins of this nonlinearity. Factors other than climate change may also cause nonlinearity or curvature in POP decline. Incline features on linear detrending can result from nonlinear decline of global emissions, nonlinearity that occurs naturally as concentrations decay towards zero or from concentrations declining to levels at which surface-to-air exchange (revolatilization) from legacy POP repositories increasingly occurs as a response to disequilibrium[2,3] (even in the absence of climate change), acting as a buffer and decelerating their declines.

Ma and colleagues' perturbation modelling predicts how enhanced revolatilization induced by climate change acts to relatively enhance Arctic POPs' atmospheric levels, as previously postulated[2,4,5]. The modelled inclines showed correlations to the incline features in the detrended data, but comparison in terms of magnitudes was limited, and some discrepancies exist. For example, interannual variability for the eight POPs appears to co-vary in the model[1] (see ref. 1, Supplementary Fig. S3) but not in the detrended measurements (data visualization; J. Ma, personal communication).

With the data available at present it is very difficult to establish quantitatively which factors (revolatilization induced by climate change, or other factors as outlined above) contribute most to nonlinearity in these eight POPs' declining trends at Mount Zeppelin. Thus, the potential for multiple sources of nonlinearity is emphasized as an important caveat to the reported identification of an observable and widespread warming-induced signature. Full visualization of the summer data analysis behind the statistics (noting differences to Fig. 1[1]) would aid readers' interpretation. ❐

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Ma *et al.* reply — Roberts[1] argues that our linear detrending analysis for the air concentration time-series of persistent organic pollutants (POPs) collected from the Mount Zeppelin Arctic monitoring site may not address nonlinearities within the air concentration data, though the time series of POPs data analysed in our study[2] exhibited statistically significant linear trends.

However, one cannot assume that the overall impact of a combination