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Absence of causality between seismic activity and global warming

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Abstract. There is no more consequential scientific matter today than global warming. The societal and policy implications, however, hinge upon the attribution of that warming to human activity, and specifically, continued societal reliance on the burning of fossil fuels. It was recently suggested that this warming can be explained by the non-anthropogenic factor of seismic activity. If that were the case, it would have profound implications. We have accessed the validity of the claim using a statistical technique (the method of conditional dispersion) that evaluates the existence of causal connections between variables, finding no evidence for any causal relationship between seismic activity and global warming.

The anthropogenic cause of planetary warming during the industrial era is well established (e.g., Stocker et al, 2014). That does not mean, however, that alternative hypotheses challenging an anthropogenic cause of observed warming shouldn't be evaluated on their merit. It has been recently proposed that the warming (particularly in polar regions) can be attributed to tectonic waves caused by large earthquakes and by the subsequent destruction of the microstructure of gas hydrates and release of the methane (Lobkovsky et al, 2022). To test this hypothesis, we apply the Method of Conditional Dispersion (Čenys et al., 1991, Verbitsky et al, 2019) to explore a potential causal relationship between temperature and global seismic activity. Briefly, the method assumes that if two variables are dependent (or in other words, the causality in Wiener's definition exists), then they belong to the same dynamical system and therefore if points of the first variable (e.g., seismicity index) are close, the synchronous points of the second variable (e.g., temperature) should also be close. Thus, the dependence of the conditional dispersion $\sigma(\varepsilon)$ of the temperature variable upon the distance ε between synchronous points of the seismic-activity variable becomes a signature of causal relationship between the temperature and the seismic activity. Specifically, if the seismic activity is the cause of warming, then the conditional dispersion $\sigma(\varepsilon)$ of the temperature variable should decrease when the distance ε between synchronous points of the seismic-activity variable decreases.

In Figure 1 we present the results of the conditional dispersion calculations together with the data. Specifically, we use the earthquake magnitude data (Ammon et al, 2010) supplemented by the most recent fragment from the IRIS DMC database (https://ds.iris.edu/wilber3/find_event). These data were converted to an annual seismicity index calculated here as a number N of earthquakes with magnitude $M \geq 7$. The Global Land-Ocean Temperature Index (Hansen et al, 2010, Lenssen et al, 2019, https://data.giss.nasa.gov/gistemp/) has been used as the global temperature data T_{GI}.

It can be seen that the conditional dispersion of global temperature anomalies $\sigma(\varepsilon)$ is independent of ε where ε is the distance between synchronous points of the number of earthquakes. In other words, ***there is no causal relationship between seismic activity and global warming***. The conditional dispersion of seismic activity is also independent of the distance between synchronous points of the global temperature, meaning that the seismic activity is not dependent on global temperature, but this indeed may be anticipated.

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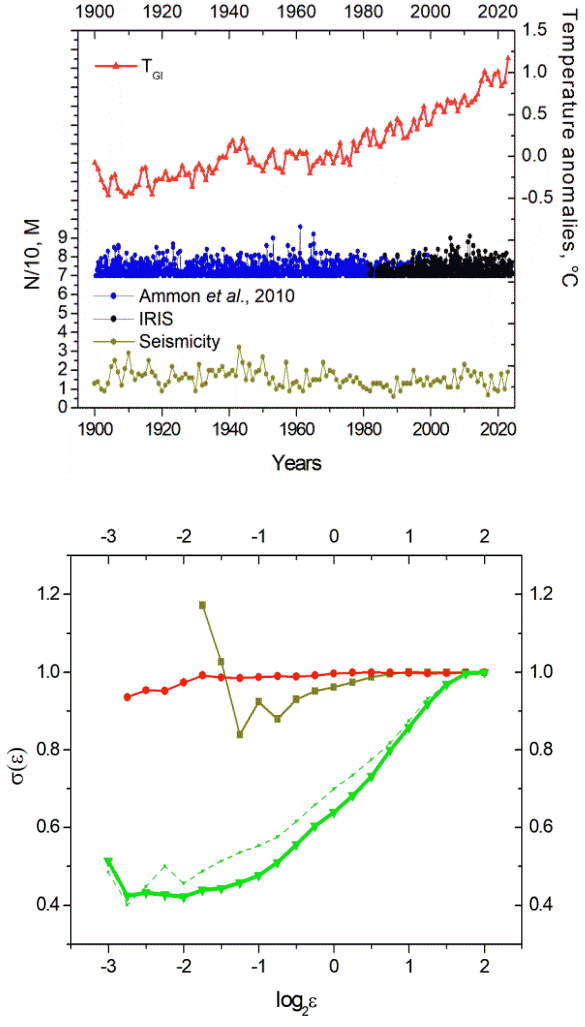

Figure 1. ***Top*****:** Global temperature anomalies data (**red**), earthquake magnitudes (**blue and black**) converted to annual seismicity (**brown**); ***Bottom*****:** Conditional dispersion of global temperature anomalies σ(ε), where ε is the distance between synchronous points of the seismic-activity variable (**red**); Conditional dispersion of the seismic-activity variable σ(ε), where ε is the distance between synchronous points of global temperature anomalies (**brown**); Conditional dispersion of global temperature anomalies σ(ε), where ε is the distance between synchronous points of atmospheric CO_2 concentration (**green solid line**); Conditional dispersion of Northern Hemisphere temperature anomalies σ(ε), where ε is the distance between synchronous points of atmospheric CO_2 concentration (Verbitsky et al, 2019) (**green dashed line**).

For comparison, we show in Figure 1 the conditional dispersions of global temperature anomalies and of Northern Hemisphere temperature anomalies (the latter is adopted from Verbitsky et al, 2019), where in both cases ε is the distance between synchronous points of atmospheric CO_2 concentration. The

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causality between atmospheric carbon dioxide concentration and temperature anomalies, by contrast, is clear.

In conclusion, there is no statistical support for the proposition that seismic activity is a cause of large-scale warming in recent decades. A parallel analysis of CO_2 and temperature supports the prevailing hypothesis that this warming is substantially caused by an increase in greenhouse gas concentrations from fossil fuel burning.

Data availability

This paper refers exclusively to published research articles and their data. We refer the reader to the cited literature for access to data.

Author contributions

MYV conceived the research, DV performed the computations. MYV, MEM, and DV jointly discussed the findings and contributed equally to writing of the manuscript.

Competing interests

The contact author has declared that the authors have no conflict of interest.

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