EGU24-17768, updated on 20 May 2024
https://doi.org/10.5194/egusphere-egu24-17768
EGU General Assembly 2024

Collective attribution of historical heatwaves to anthropogenic climate change

Yann Quilcaille[1], Lukas Gudmundsson[1], Thomas Gasser[2], and Sonia I. Seneviratne[1]
[1]ETHZ, USYS, Zürich, Switzerland (yann.quilcaille@env.ethz.ch)
[2]International Institute for Applied Systems Analysis, Laxenburg, Austria

Event attribution has significantly developed over the past years, with an increasing number of events being attributed to human-induced climate change. Typical event attribution studies focus on the assessment of individual events of high societal relevance. While this allows for a detailed analysis and a comprehensive interpretation, it also implies that the influence of anthropogenic climate change is not assessed for many extreme events. Here, we present the first collective attribution of 149 historical heatwaves reported over the 2000-2021 period. We apply a well-established extreme weather attribution approach (Philip et al., 2020; van Oldenborgh et al., 2021) to heatwaves in the EM-DAT database (EM-DAT, 2023). Each of these heatwaves were reported for severe societal impacts, making them relevant for attribution. For each listed heatwave, we identify the event in observational data (ERA5, BEST) and CMIP6 data, then we estimate the probability distribution conditional on global mean surface temperature, deduce the occurrence probabilities of the events for present and pre-industrial climate conditions. We discuss the method and the choices made to systematize the definition of the event, the evaluation of the probabilities and the selection of the datasets. The results of this framework is consistent with existing attribution studies, albeit with limits. This work calls for a more systematic reporting of heatwaves, and paves the way for the use of these results in climate litigation cases.

Furthermore, we calculate the contributions in global mean surface temperature of 110 fossil fuels and cement companies using their CO_2 and CH_4 emissions (Heede, 2014) and the reduced-complexity Earth system model OSCAR (Gasser et al., 2017). This collective attribution allows to extend these contributions to the analyzed historical heatwaves. The majority of heatwaves are made substantially more probable and intense due to six carbon majors that represent 0.30°C of global mean surface temperature. Though, other carbon majors cannot be neglected, as their sole contribution may be enough to make some heatwaves possible. We suggest that extending attribution studies to the actors could consolidate their applicability for climate litigation.

EM-DAT, CRED / UCLouvain: www.emdat.be, last access: 09.01.2024.

Gasser, T., Ciais, P., Boucher, O., Quilcaille, Y., Tortora, M., Bopp, L., and Hauglustaine, D.: The compact Earth system model OSCAR v2.2: Description and first results, Geoscientific Model

Development, 10, 271-319, 10.5194/gmd-10-271-2017, 2017.

Heede, R.: Tracing anthropogenic carbon dioxide and methane emissions to fossil fuel and cement producers, 1854–2010, Climatic Change, 122, 229-241, 10.1007/s10584-013-0986-y, 2014.

Philip, S., Kew, S., van Oldenborgh, G. J., Otto, F., Vautard, R., van der Wiel, K., King, A., Lott, F., Arrighi, J., Singh, R., and van Aalst, M.: A protocol for probabilistic extreme event attribution analyses, Adv. Stat. Clim. Meteorol. Oceanogr., 6, 177-203, 10.5194/ascmo-6-177-2020, 2020.

van Oldenborgh, G. J., van der Wiel, K., Kew, S., Philip, S., Otto, F., Vautard, R., King, A., Lott, F., Arrighi, J., Singh, R., and van Aalst, M.: Pathways and pitfalls in extreme event attribution, Climatic Change, 166, 13, 10.1007/s10584-021-03071-7, 2021.