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Limitations of event attribution statements based on prescribed SST simulations

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Attribution statements on extreme events are often based on large models ensembles using prescribed sea surface temperatures. Thereby these experiments do not sample the full range of possible ocean internal variability. Consequently, the variability within in a certain climate state may be underestimated and the calculated risk ratios between different levels of warming biased high.
We here compare risk ratios between different levels of warming in a time-window approach in a coupled model large ensemble vs. time-slice experiments using prescribed SST experiments. Both fully-coupled model simulations and AMIP-style prescribed SST experiments are performed with the Community Earth System Model CESM, which allows for a direct comparison of the two setups. We demonstrate that while the forced response is consistent across the two model setups, there are large differences in the variability of the two model experiments particularly over the tropics and for multi-day events. We demonstrate that this has important consequences for statements on the risk ratios and return period changes between different levels of warming. For some types of extremes like single-day heat and cold extremes in the extratropics that are primarily controlled by atmospheric variability, the differences are smaller and the two experiments yield similar risk ratios. In summary, depending on region and type of event, statements on the human influence on extreme events based on prescribed SST experiments tend to be overconfident compared to fully-coupled Earth System Model experiments.