



## Pathways and pitfalls in extreme event attribution

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The science of extreme event attribution has progressed rapidly over the last years. We can now often estimate how much the probability of extreme weather events has changed and how much of this change is due to climate change. Classes of events that have been successfully attributed in the World Weather Attribution collaboration are heat and cold waves, high and low precipitation events and wind storms. We will outline our current procedure: trigger, event definition, trend detection, model evaluation, multi-method multi-model attribution, synthesis and communication. This includes some stages that were not thought of when we started doing this but proved to be necessary in practice.

However, performing dozens of extreme attribution studies, both rapid and slow ones, also surfaced potential pitfalls in the procedure. Examples are the dependence of the results on the trigger procedure and the event definition. Both depend critically on the end user requirements and need to be chosen carefully. Changes in observing procedures and missing data rates in the observations can induce spurious trends, which need to be estimated and when possible subtracted from the apparent trends. Climate model output needs to be carefully evaluated before use, examples will be given of unacceptable biases in simulations of extreme events by models that perform well for more average weather. The synthesis of the observed detection and multi-method multi-model attribution still is an area of active research on which some progress has been made. This includes the consideration of non-climate trends that are not or incompletely included in climate models. A final hurdle is the clear communication of the results to different audiences: the scientific community, science-literate intermediaries and end users such as the general public but also the people making decisions how to increase resilience after a disaster. Language, form and time scales have to be adapted to successfully reach these target audiences.