A new strategy for sensitivity analysis when modelling extreme events in the geosciences

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Natural hazard models - used to predict and evaluate extreme events like prolonged droughts, floods, windstorms, etc. - are affected by unavoidable and potentially large uncertainty.
Uncertainty sources are manifold, including simplifying assumptions in the model structure (e.g. coarse spatial resolution), uncertain parameter values, measurement errors, etc. Global Sensitivity Analysis (GSA) can be used to assess the relative contributions from these different sources to the uncertainty in the model predictions.
By providing insights into the model behavior and potential for simplification, GSA indicates where further data collection and research is needed or would be beneficial, and enhances the credibility of the modelling results.

In this work we present a novel Regional-Global approach for Sensitivity Analysis. The method is "global" in the model inputs and "regional" in the output, that is, it considers variations of the uncertain inputs across their entire feasibility range but can be focused on their effects on a specific region of the model response, e.g. extreme values. The method is therefore especially promising for natural hazard applications where the focus in on the effect of uncertain inputs on specific range of values of the model output. The main underlying idea is to measure sensitivity by the distance between the unconditional distribution of the model output (i.e. when all input factors vary) and the conditional distribution when one of the input factors is fixed. Such sensitivity measures can be computed either over the entire range of the output distribution or tuned to consider only a sub-range, for instance the tail of the distribution. We use several natural hazards examples to demonstrate the approach and compare it to other widely applied GSA methods like Sobol and Regional Sensitivity Analysis.