Demonstration of a technique for the end-to-end attribution of climate change

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Background

Studies of the detection and attribution of climate change have tended to focus on the problem of large scale changes (e.g. Stott et al. 2000; Mitchell et al. 2001). However, most important potential impacts are local and sporadic in nature and unlikely to scale with, for instance, global mean temperature. After an extreme weather event we are currently left only being able to say that "while this event may be expected to be more likely under human-induced global warming, we cannot attribute this single event to human activities."

The issue is that current detection and attribution work uses a deterministic approach, which cannot be applied to individual events since these occur already in an unperturbed climate. The solution is to adopt a probabilistic approach, as initiated by (Palmer and Räisänen 2002), whereby the probabilities of the event occurring in perturbed and unperturbed climates are compared. The result is a distribution function of the attribution, rather than a single numerical value. Such a probabilistic approach would also allow uncertainty in both the forcing and the observational measurements to be taken into account.

Objectives

This subproject aims to develop and test a technique for probabilistic detection and attribution capable of relating the occurrence of individual events to external forcings. The goals are:

- To develop the technique of probabilistic end-to-end attribution;
- To test the technique on the (Lorenz 1963) model, a simple nonlinear system permitting a high number of simulations and thus a reasonable sampling of the probability space;
- To test the technique on the detection and attribution of external climate forcing on the occurrence of extreme monthly precipitation events at specific locations using the CMIP2 ensemble as an approximation of real climate. For compatibility with other projects, Northwest Europe and Southeast Asia will be among the areas examined.

Methodology

The requested data is monthly mean precipitation from the full CMIP2 ensemble, both from the control and perturbed simulations. The testing of the technique with this ensemble is planned as follows. The change in probability of passing a given threshold will be evaluated at a specific geographic location (e.g. Oxford, UK, and Bangkok, Thailand) from the end segments of a single perturbed simulation of one of the CMIP2 models. This will be used to represent the real observed change. It should be stressed that this test is for evaluation and illustrative purposes only, and thus the precise results should not be assumed to properly represent the real world. The remaining perturbed simulations from the CMIP2 ensemble will be used to estimate the change in probabilities of extreme events occurring in the perturbed climates. The control simulations will be used to estimate the uncertainty in the models' projected climates due to internal variability, while the ensemble of perturbed simulations will be used to determine the uncertainty due to the limits in our knowledge of the climate system. This ensemble may not properly sample the probability space Allen and Ingram (2002), but for the testing purposes here the sampling can be assumed to be adequate. The probabistic end-to-end attribution technique will then be applied and demonstrated on these probability functions.

References

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