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Stochastic Simulation of the Volcanic Forcing in Future Climate Scenarios

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Externally forced natural climate variability played an important role over a large part of the 20th century. During this time period, the dominant influence shifted from mostly natural, in the early part, to the rapidly increasing anthropogenic factors. Projecting forward, climate change simulations for the 21st and 22nd century generally employ various assumptions following possible story lines of human socio-economic development with associated emissions to the atmosphere, and thus of radiative forcing. Unfortunately, these projections do not include the natural components but focus on anthropogenic elements only. Although anthropogenic forcing is expected to be dominant, the lack of natural variations is a clear deficiency in regard to uncertainty estimates of future climates. To reduce this deficiency, we focus on the stochastic modeling of volcanic forcing. A probabilistic model that reproduces the occurrences and the amplitude of very large explosive volcanic eruptions will be presented. The distribution of largest volcanic eruption magnitude will be shown to follow a a Generalized Extreme Value distribution. From past time periods, we can estimate all the parameters of our probabilistic model, and consequently, we are able to stochastically simulate the occurrences and the magnitudes of future large explosive volcanic events. Here, we present a statistical approach to generate scenarios of volcanic forcing that allow an evaluation of natural uncertainty during periods when no such forcing data exists. All scenarios are based on the statistical properties of volcanic forcing as estimated in ice core-based reconstructions covering the last millennium. General statistical properties of the volcanic forcing are discussed. If used in concert with anthropogenic forcing projections, natural forcing scenarios can evaluate the role of nature in perturbing future climate change estimates.