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On the influence of volcanic eruptions on decadal predictions

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Short-term climate predictions are an active topic of research. Predictability at decadal scales arises from the climate response to predictable changes in boundary conditions (e.g. future greenhouse gas emissions), from the adjustment to previous changes in external forcing, and – through the initialization – from long timescale internal variability. Unpredictable future changes in external forcing such as major volcanic eruptions or changes in solar irradiance, on the other hand, limit predictability at decadal scales and thus may prevent decadal predictions from being useful. Here we analyze the effect of volcanic eruptions on decadal predictability.

To study this effect, we analyze hindcast simulations with global climate models for the past 1000 years. We define a forecast score from the temperature variability in the forecast period and contrast the distribution of scores with eruptions in the forecast period with those without eruptions. Furthermore, we test the sensitivity to volcanic eruptions for different levels of forecast skill, defined as the predicted fraction of variance in the forecast period. Preliminary results suggest that for global mean temperature, the effect of volcanic eruptions is a fairly homogeneous shift of the forecast scores to larger values (i.e. to more unpredicted variability in the forecast period). Also, the effect of eruptions is stronger for predictions with more skill. Without much predictive skill, the risk of a very bad global average temperature prediction is 2-5 times as large when an unforeseen eruption occurs and up to 20 times as large for skillful predictions. For smaller scale regions, however, the signal-to-noise ratio of the volcanic response is generally lower and the deteriorating effect of volcanic eruptions on decadal-scale predictions is reduced.