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Title: The Circulation Response to Volcanic Eruptions

Abstract: Proxy data and observations suggest that large tropical volcanic eruptions induce a poleward shift of the North Atlantic jet stream in boreal winter. However, there is far from universal agreement in models on this effect and its mechanism, and the possibilities of a corresponding jet shift in the Southern Hemisphere or the summer season have received little attention. Using a hierarchy of simplified atmospheric models, this study examines the impact of stratospheric aerosol on the extratropical circulation over the annual cycle. In particular, the models allow the separation of the dominant shortwave (surface cooling) and longwave (stratospheric warming) impacts of volcanic aerosol. It is found that stratospheric warming shifts the jet poleward in both summer and winter hemispheres. The experiments cannot definitively rule out the role of surface cooling, but provide no evidence that it shifts the jet poleward.

Further study with simplified models demonstrates that the response to stratospheric warming is remarkably generic and does not depend critically on the boundary conditions (e.g., the planetary wave forcing) or the atmospheric physics (e.g., the treatment of radiative transfer and moist processes). It does, however, fundamentally involve both zonal-mean and eddy circulation feedbacks. The timescales, seasonality, and structure of the response provide further insight into the mechanism, as well as its connection to modes of intrinsic natural variability. These findings have implications for the interpretation of comprehensive model studies and for post-volcanic prediction.