The Circulation Response to Volcanic Eruptions: The Key Roles of Stratospheric Warming and Eddy Interactions

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Proxy data and observations suggest that large tropical volcanic eruptions induce a poleward shift of the North Atlantic jet stream in boreal winter. There is far from universal agreement in models, however, and the potential effect of volcanic aerosol on the austral circulation and mechanism(s) by which they impact the jets are unclear. This study examines the impact of stratospheric aerosol on the circulation using a hierarchy of simplified atmospheric models. 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 the cooling effect of surface darkening has little impact on the circulation, while stratospheric warming decisively shifts the jet poleward in both summer and winter hemispheres.

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.

Key words: volcanic eruptions, atmospheric dynamics, idealized models, natural variability, annular modes

References

DallaSanta, K. and Coauthors, 2018: submitted to *Journal of Climate.*