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The climatic effects of the direct injection of water vapour into the stratosphere by large volcanic eruptions

M. M. Joshi[1] and G. S. Jones[2]
[1]NCAS Climate, University of Reading, UK
[2]Hadley Centre for Climate Change, Met Office, UK

Abstract. We describe a novel mechanism that can significantly lower the amplitude of the climatic response to certain large volcanic eruptions and examine its impact with a coupled ocean-atmosphere climate model. If sufficiently large amounts of water vapour enter the stratosphere, a climatically significant amount of water vapour can be left over in the lower stratosphere after the eruption, even after sulphate aerosol formation. This excess stratospheric humidity warms the tropospheric climate, and acts to balance the climatic cooling induced by the volcanic aerosol, especially because the humidity anomaly lasts for a period that is longer than the residence time of aerosol in the stratosphere. In particular, northern hemisphere high latitude cooling is reduced in magnitude. We discuss this mechanism in the context of the discrepancy between the observed and modelled cooling following the Krakatau eruption in 1883. We hypothesize that moist coignimbrite plumes caused by pyroclastic flows travelling over ocean rather than land, resulting from an eruption close enough to the ocean, might provide the additional source of stratospheric water vapour.

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