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Atmospheric transport and deposition of Indonesian volcanic emissions

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Abstract. A regional climate model has been used to study the transport and deposition of sulfur (SO_2 and SO_4^{2-}) and $PbCl_2$ emissions from Indonesian volcanoes. The sensitivity of the atmospheric loss of these trace species to meteorological conditions and their solubility was examined. Two experiments were conducted: 1) volcanic sulfur released as primarily SO_2 and subject to transport, deposition, and oxidation to SO_4^{2-}; and 2) $PbCl_2$ released as an infinitely soluble passive tracer subject to only transport and deposition. The first experiment was used to calculate SO_2 loss rates from each active Indonesian volcano producing an annual mean loss rate for all volcanoes of 1.1×10^{-5} s^{-1}, or an e-folding rate of approximately 1 day. SO_2 loss rate was found to vary seasonally, be poorly correlated with wind speed, and uncorrelated with temperature or relative humidity. The variability of SO_2 loss rates is found to be correlated with the variability of wind speeds, suggesting that it is much more difficult to establish a "typical'' SO_2 loss rate for volcanoes that are exposed to changeable winds. Within an average distance of 70 km away from the active Indonesian volcanoes, 53% of SO_2 loss is due to conversion to SO_4^{2-}, 42% due to dry deposition, and 5% due to lateral transport away from the dominant direction of plume travel. The solubility of volcanic emissions in water is shown to influence their atmospheric transport and deposition. High concentrations of $PbCl_2$ are predicted to be deposited near to the volcanoes while volcanic S travels further away until removal from the atmosphere primarily via the wet deposition of H_2SO_4. The ratio of the concentration of $PbCl_2$ to SO_2 is found to exponentially decay at increasing distance from the volcanoes. The more rapid removal of highly soluble species should be considered when observing SO_2 in an aged plume and relating this concentration to other volcanic species. An assumption that the ratio between the concentrations of highly soluble volcanic compounds and SO_2 within a plume is equal to that observed in fumarolic gases is reasonable at small distances from the volcanic vent, but will result in an underestimation of the emission flux of highly soluble species.

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