Geophysical Research Abstracts, Vol. 8, 00308, 2006
SRef-ID:

Atmospheric loss rates of Indonesian volcanic emissions: dependency on compound solubility and meteorological conditions

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A regional climate model study has been conducted to investigate the transport and atmospheric loss rates of Indonesian volcanic emissions. Volcanic sulfur was released as primarily SO_2 that oxidized within the aged plume to SO_4^{2-} considering the major tropospheric chemical reactions and $PbCl_2$ was released as an infinitely soluble passive tracer. SO_2 loss rates calculated from each volcano result in an annual mean loss rate for all volcanoes of 1.1×10^{-5} s^{-1}, or an e-folding rate of approximately 1 day. This is quite reasonable compared with measurements of SO_2 loss rates performed at other volcanoes. Atmospheric loss rate of volcanic emissions are found to be dependent on meteorological conditions and the solubility of the released emissions. The 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 inconsistent winds. Within an average distance of 69 km away from the active Indonesian volcanoes, 53% of SO_2 that is lost from the plume is lost due to conversion to SO_4^{2-}, 42% due to dry deposition, and 5% is lost due to lateral transport away from the dominant direction of plume travel. Solubility of the volcanic emissions is demonstrated to have a major influence on 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. This finding has im-

plications for remote sensing observations of SO_2 within an aged volcanic plume that are related to other volcanic species. An assumption that the ratio between the concentrations of highly soluble volcanic compounds and S within an aged plume is equal to that observed in fumarolic gases will result in an overestimation of the atmospheric concentration of highly soluble species.