Underestimated passive volcanic degassing implies overestimated aerosol forcing

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Abstract

The Arctic has warmed at least two times faster than the global average warming rate since 1980. An estimated sixty percent of greenhouse-gas-induced warming in the Arctic has been offset by aerosols in the past century. However, aerosols are the largest uncertainty in estimating radiative forcing largely due to unknown preindustrial aerosol abundance. Here we quantify the relative importance of natural sources of Arctic sulfate during the preindustrial from the concentration and sulfur isotopes of sulfate in ice-core samples from Summit, Greenland. Passive volcanic degassing contributes 62 ± 10% of preindustrial sulfate, approximately twice the contribution from marine dimethyl sulfide. A global model, which uses the same volcanic emissions inventory as most climate models, underestimates preindustrial passive volcanic degassing emissions in regions affecting the Arctic by a factor of three. Enhanced passive volcanic emissions of sulfur dioxide and hydrogen sulfide based on ground-based observations reconciles the discrepancy between the model and observations. Higher preindustrial volcanic sulfur emissions reduce the cooling effect of anthropogenic aerosol by up to a factor of two in the Arctic (+0.11 to +0.29 W m^{-2}), suggesting that underestimating passive volcanic emissions has significant implications for Arctic radiative forcing.