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Analysis of GOSAT XCO_2 in explosive volcanic plumes

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In this study, we analyze columnar averaged dry air mole fraction of CO_2 (XCO_2) in volcanic gas plumes after major eruptions using space-borne near-infrared measurements from the Japanese Greenhouse gas Observing SATellite (GOSAT). Volcanic emissions are assumed to dominate the flux from the deep Earth to the surface but those global emissions as well as the partitioning between eruptive and non-eruptive emissions are to date highly uncertain. Satellite measurements are an indispensable complement to ground-based measurements of volcanic CO_2 emissions because they are performed globally and regularly and they therefore have the potential to significantly broaden our knowledge of volcanic CO_2 releases. However, the remote sensing of volcanic CO_2 is challenging for various reasons, including the increasingly high atmospheric background, relatively coarse spatial resolution and/or sampling, and scattering effects of aerosols and clouds. We mined existing standard product level 2 GOSAT XCO_2 data sets for a volcanic CO_2 signal in the gas plumes of the largest volcanic eruptions since GOSAT's launch in 2009. These eruptions include the Volcanic Explosivity Index (VEI) 4 events of Sarychev Peak (Kuril Islands, Russia) in June 2009, Nabro (Ethiopia) in June 2011, and Puyehue-Cordon Caulle (Chile) in June 2011. GOSAT background and plume soundings are distinguished using corresponding Ozone Monitoring Instrument (OMI) SO_2 retrievals taking advantage of the usually low atmospheric SO_2 background abundance. A volcanic CO_2 signal in the GOSAT products can subsequently be found by comparing GOSAT XCO_2 for the plume and background soundings. Possible XCO_2 enhancements in the volcanic plumes are converted to an estimated CO_2 release of the investigated eruptions. Based on this analysis, the current capabilities and added value of GOSAT TANSO-FTS to detect and quantify CO_2 emissions from explosive volcanism are outlined.