Detection of volcanic CO2 in the August 2008 Kasatochi eruption plume by SCIAMACHY measurements

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Volcanic emissions likely dominate the carbon dioxide (CO_2) flux from the Earth's deep interior to the surface, and yet current estimates of global volcanic CO_2 emissions are highly uncertain due to the temporal and geographical limitations of volcanic gas measurements. The only means to fully monitor gas emissions from the approximately 1500 active volcanoes globally and on a regular basis are space-borne remote sensing observations. To our knowledge, direct detection and quantification of volcanic CO_2 from satellites has not yet been reported. Here we take a step toward this goal and report for the first time on statistically significant enhancements of dry-air columnar averaged CO_2 mixing ratios (XCO_2) derived from SCIAMACHY (SCanning Imaging Absorption SpectroMeter for Atmospheric CHartographY) measurements found in the August 2008 eruption plume of Kasatochi volcano (Alaska). Applying a threshold on coincident SO_2 retrievals allows us to discern plume pixels from background pixels in the SCIAMACHY data set. We find that over the study region of North America (30–85N, 50–175W) the XCO_2 of the Kasatochi plume pixels significantly exceed those of the background pixels. Evidence that volcanic CO_2 was detected by SCIAMACHY is found by focusing on individual days when the plume was located over North America. For example, while the XCO_2 enhancement is stable over time SO_2 decreases due to its much shorter atmospheric lifetime. We observe statistically significant correlations between SO_2 and XCO_2 in the plume for almost every day but CO_2:SO_2 ratio increases with time depicting the faster chemical loss of SO_2 in the atmosphere. Using alternative SO_2 products to classify plume/background pixels from GOME–2 and OMI leads to the same findings. We roughly estimated the amount of the Kasatochi released CO_2 based on the remote sensing data and found a significantly higher mass burden compared to bottom-up estimates, for example from analyzing melt inclusions. The sources of this discrepancy are currently under further investigation. Taken together, we conclude that the observed enhancement XCO_2 in the volcanic plume pixels can very likely be attributed to CO_2 emissions from the August 2008 eruption of Kasatochi volcano. Further research, including a combination of ground-based measurements and inverse atmospheric modeling as well as a dedicated sensitivity analysis is required to refine and validate our estimates of CO_2 emissions.