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Observation and Quantification of CO₂ passive degassing at sulphur Banks from Kilauea Volcano using thermal Infrared Multispectral Imaging

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The formation of Earth atmosphere and oceans have been primarily deeply influenced by volcanic emissions. In addition, the planet radiative balance and stratospheric chemistry can be affected by materials injected into the atmosphere by large explosive eruptions. Volcanic emission often contain water vapor (H₂O), carbon dioxide (CO₂), and depending on the type of volcano they may contain varying proportions of toxic/corrosive gases such as Sulphur dioxide (SO₂), hydrogen fluoride (HF) and silicon tetrafluoride (SiF₄). CO₂ is generally the most abundant gas with the lowest solubility among the volatile compounds of magmatic liquids and the less susceptible than most other magmatic substances such as SO₂ and HF. Thanks to those properties, the volcanic CO₂ emission rates could play an important role for assessing volcanic hazards and for constraining the role of magma degassing in the biogeochemical cycle of carbon. However, measurements of CO₂ emission rates from volcanoes remain challenging, mainly due to the difficulty of measuring volcanic CO₂ against the high level of CO₂ in the atmosphere. Thermal Infrared (TIR) imaging is now a well-established tool for the monitoring of volcanic activity since many volcanic gases such as CO₂ and SO₂ are infrared-active molecules. High speed broadband cameras give valuable insight into the physical processes taking place during volcanic activity, while spectrally resolved cameras allow to assess the composition of volcanic gases.

In this work we conducted TIR imaging and quantification of CO₂ passive degassing at Sulphur Banks from Kilauea volcano using Telops Midwave Infrared time-resolved multispectral imager. The imager allows synchronized acquisition on eight channels, at a high frame rate, using a motorized filter wheel. Using appropriate spectral filters measurements allows estimation of the gas emissivity parameters in addition to providing selectivity regarding the chemical nature of the emitted gases. Our results show CO₂ measurements within the volcano's plume from its distinct spectral feature. Quantitative chemical maps with local CO₂ concentrations of few hundreds of ppm was derived and mass flow rates of few g/s were also estimated. The results show that thermal infrared multispectral imaging provides unique insights for volcanology studies.