



## **Recent observations of carbon and sulfur gas emissions from Tavorvur, Bagana and Ulawun (Papua New Guinea) with a combination of ground- and air-borne direct and remote sensing techniques**

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Satellite observations reveal that volcanoes from Papua New Guinea contributed with ca. 15% of the global emission of volcanic sulfur dioxide ( $\text{SO}_2$ ) during the period 2005-2014. Relatively little is known about their carbon dioxide ( $\text{CO}_2$ ) outputs and more recent levels and dynamics of degassing activity. During September 2016 we conducted measurements of the  $\text{CO}_2/\text{SO}_2$  ratio and the  $\text{SO}_2$  flux from Tavorvur, Bagana and Ulawun volcanoes using a combination of remote sensing and direct sampling techniques. Tavorvur exhibits low-level passive degassing from a modestly active vent and few other intra-crater fumaroles, which made access possible for direct measurements of the  $\text{CO}_2/\text{SO}_2$  ratio with a compact Multi-GAS instrument. A wide-field of view pointing DOAS monitor was deployed for longer term monitoring of the  $\text{SO}_2$  flux from a distance of about 2 km. Bagana degasses continuously with occasional emissions of ash, and its  $\text{SO}_2$  flux, plume velocity and height was constrained by simultaneous scanning and dual-beam DOAS measurements. Molar ratios in the plume of Bagana were measured by the compact Multi-GAS aboard a multi-rotor UAV, up to a height of 1.6 km above ground. Ulawun showed continuous passive degassing and measurements with the UAV, up to an altitude of ca. 1.8 km, and mobile-DOAS traverses from a car were used to constrain its gas emission. Here we present an overview of the challenging conditions, measurement strategies and results of this campaign that forms part of the ongoing international effort DECADE aiming to better quantify the global gas emission of carbon- and sulfur containing species from volcanoes.