Volcanic eruption monitoring by thermal image correlation: Pixel offsets show episodic dome growth of the Colima volcano

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Estimating the magnitude of dome eruptions is one of the main challenges in volcano monitoring. Although modern monitoring networks are in place at many dome-building volcanoes, the type and occurrence of explosive activity and the scale of the eruptions are commonly estimated by visual inspection. Quantifying the deformation of dome-building volcanoes and the occurrence of explosions is highly valuable, not only for enabling the provision of early warnings but also for facilitating an understanding of the physics of explosive volcanoes, as demonstrated by this study of one of the most active volcanoes in Mexico. The Volcan de Colima is currently experiencing a phase of viscous dome growth, which is associated with daily episodic Vulcanian eruptions and rock falls. Little is known about the dynamics of this dome, its growth rates, or the scale of the associated explosions. We present the results from an analysis of nighttime time-lapse infrared images and compare these data with local seismic amplitude recordings. For detected digital image correlation, we track temperature features in infrared images. Images taken before and after the explosions reveal the location of the hot dome to be subject to significant and systematic lateral pixel offsets. Dome deformation is shown to occur intermittently every 3-4 h, with lateral displacements exceeding 0.3 m within periods of less than 120 s. Only the thermally elevated regions of the western dome, which may represent a coulee-like flow, are displaced and are often, but not always, associated with seismic amplitude peaks. Therefore, our analysis of the infrared image correlation suggests the occurrence of aseismic dome-deformation episodes, thereby challenging the current understanding of dome growth and the appropriateness of commonly used volcano surveillance techniques.