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Assessing uncertainties in remotely sensed lava flow emplacement – results from an indoor analog experiment

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Infrared satellite images are an easily accessible data source for monitoring the radiant power (RP) emitted from lava flows during effusive eruptions in close to real time. Although not necessary for RP estimations, lava temperature is a crucial parameter in the determination of the flow's convected heat. In conjunction with the flow's spatial extent it assists the identification of potentially threatened areas and thereby the overall lava inundation hazard assessment.

The accurate determination of the flow's size and temperature is however afflicted with uncertainty as the lava occupies only a small fraction (< 1 %) of a typically resolved target pixel (e.g. from Landsat 7, MODIS). Conventionally this is overcome by comparing observations in at least two separate infrared spectral wavebands (Dual-Band method). We investigate the resolution limits of this thermal un-mixing technique by means of an uniquely designed indoor analog experiment.

Therein the volcanic feature is simulated by an electrical heating alloy of 0.5 mm diameter installed on a plywood panel of high emissivity. Two thermographic cameras record images of the artificial heat source in wavebands comparable to those available from satellite data. These range from the short-wave infrared (1.4–3 μm) over the mid-wave infrared (3–8 μm) to the thermal infrared (8–15 μm).

In the conducted experiment the pixel fraction of the hotspot was successively reduced by increasing the camera-to-target distance from 2 m to 38 m. On the basis of an individual target pixel the expected decrease of the hotspot pixel area with distance at relatively constant wire temperatures corresponding to barely glowing (experiment 1), glowing (experiment 2) and strongly glowing (experiment 3) was confirmed. The deviation of the hotspot's pixel fraction yielded by the Dual-Band method from the theoretically calculated one was found to be within the expected limits given that the hotspot is larger than about 3 % of the pixel area, a resolution boundary most remotely sensed volcanic hotspots fall below.