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Sensitivity in the Correction of Long-Range Ground-Based Thermal Data.

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Ground-based thermal remote sensing is a valuable tool for the study and monitoring of volcanoes and their hazards. However, permanent monitoring installations often require the camera to be positioned at relatively long ranges from the target (i.e. $>$1000 m). These types of long-range deployments have been seldom analysed quantitatively due primarily to factors such as atmospheric attenuation and across-image variations in the target path-length resulting in substantial uncertainty in the derived surface temperatures.

Here we examine the sensitivity of measurements at three different apparent temperatures (400, 500 and 600 K) to uncertainty in the atmospheric conditions and type of path for the INGV-Catania (Etna, Sicily) permanently installed thermal camera. The camera is located at Mount Cagliato at an elevation of 1154 m asl and looks to the summit area at $\sim$3000 m asl, over a distance of $\sim$8.5 km. Analysis was carried out using MODTRAN to calculate atmospheric transmittance and upwelling radiance values for the different scenarios. We then calculated corrected surface temperatures by applying an atmospheric correction using two different temperature-to-radiance methods: a top-hat wavelength integrated based method supplied by FLIR Systems in their ThermaCam Researcher software and a mid-wavelength value method using the Planck equation. Results indicate that calculated surface temperatures between the two methods differ by as much as 382.5 K over a path-length of 8.5 km. Over path lengths between 1 and 8.5 km, changing the atmospheric temperature to 288.15 (15 ^{o}C), 293.15 (20 ^{o}C) and 298.15 K (25 ^{o}C) resulted in increases in calculated surface temperatures of 1.7–72.4 K using the FLIR top-hat method and 1.4–205.5 K using the mid-wavelength method. For relative humidities of 40, 50 and 60 %, increases in calculated surface temperatures of 1.0–58.7 K and 1.0–148.9 K using the FLIR top-hat and mid-wavelength methods, respectively. We also found that calculated surface temperatures differed by up to 69.9 K for an apparent temperature of 600 K with the use of the MODTRAN 'Rural, Visibility = 23 km' aerosol model over a path-length of up to 8.5 km. We were unable to get MODTRAN's slant-path option to work correctly for the oblique geometry characteristic of terrestrial cameras. As a practical alternative, we propose the use of multiple stacked horizontal sub-paths to represent the along-path changes in atmospheric condition with elevation. For the INGV-Catania scenario we explore the effects of using different numbers of sub-paths in comparison to the results from MODTRAN's horizontal path results.