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Volcanic submarine hydrothermal activity from satellites : regional mapping and temporal evolution in shallow water systems

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Risk assessment at active volcanic islands link to populated areas is of first importance. We evaluate the potential of satellite imagery to map and monitor the activity of shallow-water hydrothermal systems, which are often found at volcanic islands. For this study, we used publicly available data and proprietary WorldView-2 satellites images, with spectral bands that can penetrate up to water depths of 30 m. Shallow water hydrothermal sites are visible on satellite imagery, primarily with publicly available data, demonstrating the potential of satellite imagery to study and monitor shallow water hydrothermal activity. We focus our work on volcanic islands, showing intense near-shore, shallow-water hydrothermal activity, and distinct styles of hydrothermal venting. Satellite imagery constrains regional outflow geometry and the temporal variability or stability of these systems. Milos Island shows hydrothermal outflow associated with reflective mineral precipitates and/or bacterial mats, which are stable over time (2010-2014). These outflows locally define polygonal patterns likely associated with hydrothermal convection in porous media. In Kueishantao Island individual hydrothermal plumes charged with particles are visible at the sea surface, and display great variability in intensity and distribution of plume sources (2002-2019). Worldwide we have identified ~15 shallow water hydrothermal sites with satellite imagery, that are similar to either the Milos system (e.g., Vulcano and Panarea, Italy), or the Kueishantao system (numerous sites in Pacific volcanic islands). This study demonstrates that satellite imagery can be used to map and monitor different types of shallow-water hydrothermal systems, at regional scale, and monitor their evolution. Satellite data provides not only regional and temporal information on these systems, unavailable to date, but also the regional context for follow-up in situ field data and observations (e.g., instrumental monitoring, sampling, observations and mapping with divers or AUVs) to understand both the nature and dynamics of these systems, and ultimately the associated fluxes.