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Multi-payload Multi-platform Tactical Monitoring and Evaluation of the 2014 Eruption of Fogo, Cabo Verde

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The 2014 eruption on the flank of Pico volcano on the island of Fogo (Cape Verde), started ca. 11h30 UTC on November 23rd. It gave rise to a three-branch lava flow running ca. 4 km to the north, 3 to the west and 2 to the south, totaling about 10 million cubic meters in one month, that destroyed two villages and left about 1,000 homeless among the ca. 37,000 inhabitants of Fogo. This mostly effusive event differs from the much better-known, simultaneous Holuhraun eruption in northern Iceland as its instant (thermal) Radiant Flux barely exceeded 10 GW, whereas the latter peaked over 100 GW. Conversely, whereas the Holuhraun lavas have flowed over uninhabited land, and the associated risk is negligible, the Fogo lavas impacted a populated area and would have produced even greater damage had they escaped the confines of the Mt.Amarelo lateral collapse scar within which Pico do Fogo is located, and flowed down the populated outer slopes of Fogo.
Upon request of INMG in the second day of eruption, we brought immediate remote sensing and modelling support, based on all observation means able to provide estimates of physical parameters related to power released, lava effusion rates and flow distance to run, along with also quantitative evaluations of eruptive trends and styles. As needs were scaled on the immediate near-daily release of coherent information concerning ongoing lava effusion, we considered that multispectral electro-optical sensors were more useful than radar sensors.
We chose to run in parallel a 'tactical' observation line, based on the automated analytical solving of subresolution equation systems in multispectral data with top revisit rates (15 minutes with SEVIRI onboard the geostationary MSG-3, and 4 to 8 hours with MODIS onboard the polar Terra and Aqua) along with a 'strategic' line centred on the automated equation solving in high-to-very high spatial resolution LEO data provided by CEOS (multispectral pixel footprints ranging from 4 m2 of Pleiades-1A HRI, to 900 m2 of Landsat-8 OLI and EO-1 ALI) at low revisit rates, with supervised post-processing.
Overall, about 2,800 images were processed, for total 1 TB in 36 days of 24/7 monitoring, during which : (i) instant effusion rates were analyzed in the light of the largest possible distance to run, leading us to conclude that flow propagation outside the collapse scar was unlikely after November 30, (ii) the analysis of accumulated erupted volumes allowed forerunning by a few days every following phase of declining effusion rate and lava invasion risk. Here, we present the challenges, the solutions and the achievements in monitoring and interpreting a major volcano emergency from abroad, by spaceborne Earth Observation, along with the simultaneous flow of information by the same system from/to three eruptive crises occurring at the same time in distant areas (Holuhraun, Etna, Nyiragongo). These operations are paradigmatic of the possible scientific intelligence support in eruptive crises happening at over 90% of the ca. 1,500 subaerial active (Holocene) volcanoes on Earth, where ground-based monitoring capacities alone are insufficient to support effective crisis management.