Challenges and opportunities in hotspots temperature estimation by using PRISMA hyperspectral imagery

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Remote sensing of wildfires, volcanic eruptions, lava lakes and other thermal hotspots on Earth can significantly contribute to increase the understanding of our planet. Eventually, this can help in counteracting dangerous events and managing rescue operations. Indeed, over the last few years, natural disaster such as wildfires have become more severe and destructive, having extreme consequences on local and global ecosystems. Remote sensing analysis of peculiar hotspots such as the Darvaza gas crater can provide useful insight on how to extract meaningful information from remote sensing data.

Among the different remote sensing technologies, hyper-spectral (HS) imagery presents nonpareil features in support to fire detection. In this study, HS images from the Italian satellite PRISMA (*PRecursore IperSpettrale della Missione Applicativa*) will be used. The PRISMA satellite, launched on 22 March 2019, holds a hyperspectral and panchromatic payload which is able to acquire images with a worldwide coverage. The hyperspectral camera works in the spectral range of 0.4–2.5 µm, with 66 and 173 channels in the VNIR (Visible and Near InfraRed) and SWIR (Short-Wave InfraRed) regions, respectively. The average spectral resolution is less than 10 nm on the entire range with an accuracy of ±0.1 nm, while the ground sampling distance of PRISMA images is about 5 m and 30 m for panchromatic and hyperspectral camera, respectively.

This work will investigate how PRISMA HS images can be used to support ground operations. Specifically, the main goal of this study is the temperature retrieval from Earth hotspots such as wildfires, lava lakes, and the Darvaza crater. Some works in literature already discussed the opportunities of using HS imagery for temperature estimations. For instance, (Waigl et al., 2019) has shown applications based on Hyperion EO-1. Spectral indices such as the carbon dioxide Continuum-Interpolated Band Ratio (CO_2 CIBR), the Hyperspectral Fire Detection index (HFDI), and the differential Normalized Burn Ratio (dNBR), can provide insights for detecting active fires within the observed areas of interest. Moreover, the very high signal-to-noise ratio (SNR) of PRISMA in the VNIR and SWIR channels allows to perform accurate estimation of the temperature based on spectral unmixing. Indeed, the spectrum measured at the pixel covering active fires can be modelled as a linear mixture of emitted and reflected components. By using approaches based on least square estimation, percentages of background components (such as vegetation and fire scar) and emitting sources at different temperatures can be evaluated. To this aim, level 2B images (geo-located at-ground spectral radiance) will be used, supported eventually with level 2D reflectance products. Notably, these pre-processing are automatically performed by the online portal and new acquisitions of interest can be required over relevant sites.

References

Waigl, C. F., Prakash, A., Stuefer, M., Verbyla, D., & Dennison, P. (2019). Fire detection and temperature retrieval using EO-1 Hyperion data over selected Alaskan boreal forest fires. *International Journal of Applied Earth Observation and Geoinformation.* https://doi.org/10.1016/j.jag.2019.03.004