OUR PLANET FROM SPACE

HYPERSPECTRAL SYSTEM ANALYSIS FOR GEOPHYSICAL APPLICATIONS: THE PRISMA ASI-AGI PROJECT

PRISMA (PRecursore IperSpettrale of the application mission) is the first Italian Earth Observation hyperspectral space mission of the Italian Space Agency launched on orbit in March 2019 with on board an innovative electro-optical instrumentation which combines a hyperspectral sensor with a panchromatic, medium-resolution camera.

In this frame INGV coordinates the scientific project ASI-AGI (Analisi Sistemi Iperspettrali per le Applicazioni Geofisiche Integrate) to develop specific algorithms and products for various geophysical applications.

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Hyperspectral system analysis for geophysical applications: the PRISMA ASI-AGI project

PRISMA is the first Italian Earth Observation hyperspectral space mission and INGV developed algorithms and products for geophysical applications.

The ASI-AGI project has the following main objectives: 1) improving the scientific understanding of natural phenomena and in particular geophysical phenomena: volcanic activity and tectonic processes, forest fires; 2) development of innovative techniques based on image spectroscopy and focused on the PRISMA system characteristics that operates an hyperspectral camera and a panchromatic camera.

PRISMA data Simulation

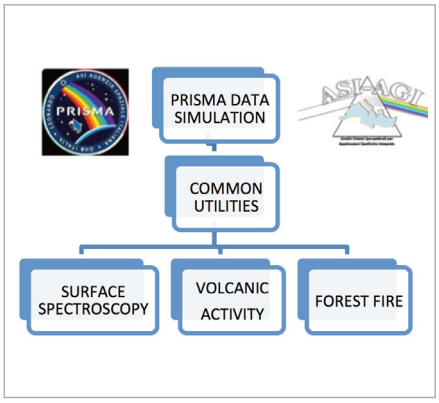
Hyperspectral data simulator has been developed following the PRISMA characteristics. The synthetic TOA radiance (top of the atmosphere) for the single pixel has been obtained fixing the reference surface (in terms of albedo, height of the object observed), the characteristics of the atmosphere (atmospheric model, columnar content parameters, aerosol model) and the general information of the sensor such as the flying height, day and time of acquisition, viewing angles.

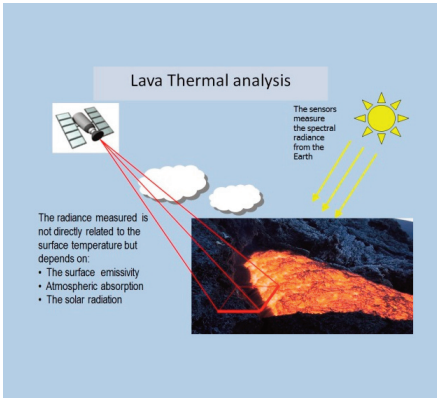
Pan Sharpening

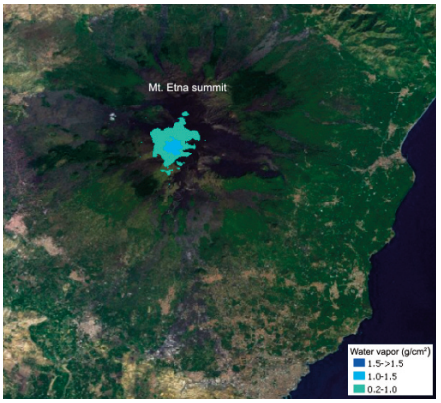
It is the synthesis of hyperspectral images to the higher spatial resolution of the panchromatic image. The main goal of the work is to maintain both the spatial and the spectral detail, thus we decided to apply several methods such as principal components, wavelet transforms and the so-called "hybrid methods".

Forest Fire

A multiple scale approach was used to explore the detection of K emission of flaming biomass. We focus on the use of the spectral NIR feature of gases to extend and adapt Dennisson indices to PRISMA hyperspectral features







Surface Characterization

Segmentation and Clustering has been performed in order to generate an "improved" surface classification; both high spatial resolution (ensured by panchromatic camera) and hyperspectral information have been used. The combination is based on the HSWO (Hierarchical StepWise Optimization), HSEG (Hierarchical SEGmentation); RHSEG (Recursive Hierarchical SEGmentation): obtaining so called Multiscale Recursive Segment Classification.

Active Lava Flow

Fire Pixel dimensions of satellite data often exceed the width of lava bodies. Where a pixel is wider than the hot feature, a three components model is required to describe the sub-pixel thermal structure. The thermal components are the hot fractures, the cooler crusted lava and the surrounding ground at ambient temperature. However, because the number of unknowns (temperatures) far exceeds the number of equations (bands), three thermal components model requires several critical assumptions to be satisfied. Hyperspectral sensors allow for estimate sub-pixel temperature parameters using a large number of bands.

Volcanic gas emissions

The main gases emitted from summit craters to be monitored are H_2O, CO_2, SO_2, HCL. While SO_2 is measured using UV and TIR data, volcanic CO_2has been retrieved by using hyperspectral airborne data in the infrared spectral range (1.9 - 2.1) μm, where CO_2 absorption lines are present. Measuring from space the volcanic emission of CO_2 remains a challenge due to the high and incremental atmospheric background and the low SNR of hyperspectral data in SWIR spectral range due also to water vapour absorption. The mission requirement for PRISMA instrument in the SWIR has been derived to make possible the use of such hyperspectral bands.

For more information about the ASI-AGI project
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