



OUR PLANET FROM SPACE

INGV CONTRIBUTES TO THE DEFINITION AND DEVELOPMENT OF THE NEXT GENERATION SENSORS AND SPACE MISSIONS

INGV collaborates with relevant space agencies such as Italian Space Agency (ASI), European Space Agency (ESA) and NASA-Jet Propulsion Laboratory (JPL), to support the development of future sensors.

INGV is collaborating with the ASI and NASA-JPL to perform the mission study definition for next MWIR-LWIR spectral range sensor.

INGV is also working with ESA to develop R&D activities in order to define the next Hyperspectral sensor, in the spectral range from 0.4 to 2.5 μm and belonging to the Copernicus Satellite constellation.



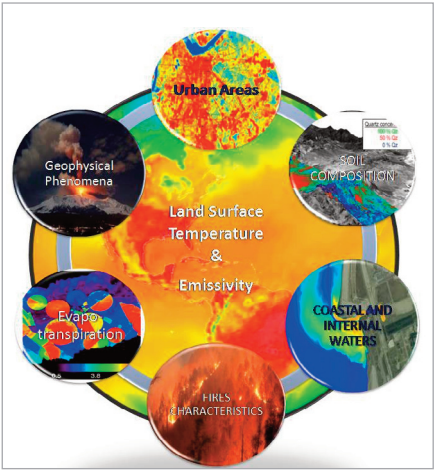
INGV contributes to the definition and development of next generation sensors and **SPACE MISSIONS**

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The MWIR-LWIR Space Mission: a new mission for High Temperature Events

The goal of current and future generations of Earth Observation missions is the understanding of the changing Earth through the analysis of the complex interactions of different terrestrial processes. These missions use a large part of the EM (VIS-microwave) spectrum. New space missions using high spatial resolution SWIR-MWIR-LWIR sensors (<100 m) is proposed to be dedicated to the study of

volcanic phenomena, fires and industrial emissions. In particular, these sensors will permit the measurement and mapping of the surface temperature in case of areas interested by High Temperature Event (HTE) such as active lava flows, fire fronts and industrial flairs for the characterization of volcanic gases. These studies are supported by ASI and NASA-JPL space agencies.



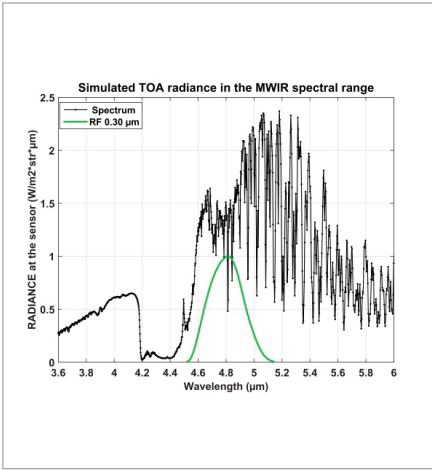
CO₂ concentrations on the gas sources (i.e. volcanoes, fires, industrial emissions) measured from Space

In the frame of the new MWIR-LWIR space mission the employing of the CO₂ absorption band at 4.8 μm (in the MWIR spectral range) has been specifically studied for High Temperature Events. Up to now operative spaceborne sensors have not the channel at 4.8 μm .



The ESA-CHIME Copernicus Proposed Space mission

In the frame of next ESA mission CHIME (Copernicus Hyperspectral Mission), INGV works on data processing applying specific algorithms to improve the detection of the soil composition in terms of chemical species (named 'raw material'). The proposed CHIME hyperspectral sensor characteristics are: 210 continuous bands with 10 nm of spectral resolution between 0.4-2.5 μm .



The at-sensor radiance simulations were performed for a set of surface temperatures, in the range 300-1000 K, with the aim to characterize the channel performance in case of HTEs. The at-sensor radiance sharply increases for increasing temperatures, ranging from 1 to 2 $\text{W/m}^2\cdot\text{sr}\cdot\mu\text{m}$ (in the "standard condition") to more than 1200 $\text{W/m}^2\cdot\text{sr}\cdot\mu\text{m}$ (in the warmest case). The FWHM parameter is very important to detect changes in the gas concentration: two values (0.15 and 0.30 μm) are considered. The narrower function leads to best challenges in order to detect gas emissions because of higher values of NEDT calculated for this case. So, model simulations supply the sensitivity necessary to appreciate carbon dioxide

variations and then retrieve its concentration from a space sensor. A variation of 10 ppm in gas concentration was considered as target; this value is equivalent to about 2 Kg/m^2 more in the columnar abundance XCO₂. Best values of NEDT are obtained considering the FWHM equal to 0.15 μm ; in this case, the parameter ranges from 0.045 to 0.560 K depending on the ground temperature. However, other TIR channels generally have a NEDT less than 0.1-0.2 K. Considering our results, the current space technology could be able to detect changes of tens ppm in CO₂ concentration, for "standard condition" (at 300 K), and very little changes on HTEs emitting the greenhouse gas.

For more information
on MWIR-LWIR Space Mission:
<https://www.asi.it/event/mwir-lwir-mission-study/>

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