Geophysical Research Abstracts
Vol. 21, EGU2019-3087, 2019
EGU General Assembly 2019

New concept for a space mission aiming at improving Earth surface diurnal thermal sampling and spatial resolution

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In the recent years Italian Space Agency has open a couple of calls concerning new space missions and new earth observation sensors. The present paper aims at describing the proposal submitted by the authors having the objective to develop a new concept of MIR/TIR satellite mission capable to overcome some of the limits of the actual optical sensors operating in the thermal region of the electromagnetic spectrum. These limits can be synthetized in:
- low spatial resolution;
- inaccurate surface temperature estimate;
- limited diurnal sampling.
At present spatial resolution and LST retrieval are relatively low and relatively inaccurate. Relatively means that even if significant progress has been done on the performances of thermal sensors on board of satellite systems the improvement is still not adequate for many applications become of interest in recent years. In fact, the spatial resolution of presently flying systems is not better than 90 m whereas the surface temperature estimate (Land and Sea Surface Temperature, LST, SST) is limited by the not perfect knowledge of the atmospheric characteristics at the time of the image acquisition. Another problem is represented by the uncertain knowledge of the surface emissivity for some type of coverage.
An alternative way to increase image resolution is to design the sensor system to acquire images at a lower resolution and use the sensor system's pointing capabilities to allow collection of multiple low-resolution images within a short time span as the sensor travels over a target area. Then, image processing methods to fuse the multiple low-resolution images into a single high resolution image may be used. However, applying these resolution enhancement algorithms to satellite imagery acquired by rapid pointing maneuvers adds considerable complexity to the problem.
All EO missions share the types of orbits used, i.e. a Sun-synchronous orbit (SSO). This is a great advantage in the case of sensors operating in the VIS/NIR/SWIR spectral regions because it minimizes changes in the acquired scene induced by the change in solar illumination conditions. On the other hand, however, this condition may represent a limit in the case of sensors operating in the MIR/LWIR range except for the two typical observations at about 12 hours of difference from the SSO. In fact, from the analysis of the diurnal variation of the surface temperature, in principle it is possible to retrieve the thermal characteristics of the material / soil sub-surface or to detect anomalies at the sub-surface level through the observation of the diurnal variation of the temperature, which is related aside from the surface albedo to the material thermal characteristics (e.g., thermal conductivity and heat capacity) which magnitudes vary with the materials composing the sub-surface layer.
Therefore, the paper focuses on proposing an innovative satellite mission capable to contribute to fill an observational gap in existing EO systems. The temporal and spatial sampling characteristics of the proposed mission could represent a significant innovation as such resolutions (spatial and temporal) are excluded from the current panorama of EO missions.