UV-VIS imager to maximize the International Mars Ice Mapper (I-MIM)

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The International Mars Ice Mapper (I-MIM) mission concept was developed by a multilateral team comprising space agencies from five countries: Canada, Italy, Japan, the Netherlands, and the United States. The primary goal of I-MIM is to map and characterize accessible, near-surface (within the uppermost 10 m) water ice and its overburden in mid-to-low latitudes to support planning for the first potential human surface missions to Mars.

Identifying adequate and accessible water-ice reserves enables the identification of candidate sites for potential scientific discoveries worthy of sending humans. It also enables the identification of water-ice resources to meet human operational needs on the Martian surface. The I-MIM partner Agencies also seek to maximize the mission’s return on investment by supporting community-based scientific investigations, as a “supplemental value goal”. To refine the mission concept and to define measurements with a set of prescribed tasks, the Agencies assembled a Reconnaissance/Science “Measurement Definition Team” (MDT) (see the Final Report of I-MIM MDT; https://science.nasa.gov/researchers/ice-mapper-measurement-definition-team).

MDT reports the findings on potential high-value, prioritized reconnaissance, science, and engineering augmentations that are synergistic with the anchor payload, an L-band, polarimetric Synthetic Aperture Radar (SAR) and Sounder, and might maximize the mission’s return on investment within established mission boundary conditions. The MDT Atmosphere Group found that the anchor radar payload can address three major atmospheric science topics of wide interest: surface/subsurface volatile inventory and variability, recurring slope linear, and upper atmospheric processes, especially ionospheric irregularities. Atmospheric science would further benefit from either or both of the MDT-identified complementary payloads (VHF sounder and a high-resolution imager). In addition, several supplemental payloads could contribute vital information about past and present climatology, weather, and space weather. The group developed a prioritized list of such instruments, with the three highest priority being: sub-millimeter sounder, thermal infrared (TIR) atmospheric limb sounder, and ultraviolet (UV) - visible (VIS) imager.

Here we focus on the potential contribution of UV-VIS imager. UV-VIS imager provide 2D maps of the airglow, aurora, and dust. These images provide essential information relevant to the objectives recognized by the MDT. The investigation for the instrument includes ionospheric irregularities, space weather and crustal magnetic field effects on the upper atmosphere as well as the atmospheric structure, dynamics, vertical coupling and loss to space. It is well known that ionospheric irregularities cause distortions of L-band SAR images on Earth. In order to remove ionospheric noise from SAR images, it is necessary to understand and characterize ionospheric irregularities. These irregularities cause disruptions

to surface-orbit communications including future potential global positioning (GPS) systems that might be envisioned for Mars. A 2D UV-VIS image of the Martian aurora could be used to visualize the distribution of penetrating energetic particles. Continuous observations at the same altitude would unambiguously differentiate the effects of lower atmospheric activities such as dust storms and atmospheric gravity waves; solar activities including solar extreme events; and, crustal magnetic fields mainly localized in the southern hemisphere. A dayglow imaging could provide the 2D structure of the atmospheric wave activities independently from SAR and might help calibrate out ionospheric interference in SAR data. Human exploration of the Moon and Mars introduces new challenges for space-weather research and operations. Enhancement of capabilities for the characterization and forecasting of the space-radiation environment outside of the protection of Earth’s atmosphere and intrinsic magnetic field is a timely and important research subject, as it will be vital to protect astronauts exploring Mars. The I-MIM orbiter is suited to new measurements of spatial distribution of energy inputs from space. Global observation of dust reflectance will also help for weather forecast and dust hazard at the Science for Human Exploration.

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