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Mars Express Visual Monitoring Camera: New Operations and Data Processing for more Science

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Abstract

The Visual Monitoring Camera (VMC) on board the European Space Agency's (ESA) Mars Express (MEX) orbiter was originally designed as an engineering camera whose purpose was to monitor the separation of the Beage-2 lander. Following the use of VMC data for scientific analysis [1] VMC was designated a scientific instrument in 2016 and new technical and scientific contracts were established to boost the scientific output of the instrument. This abstract provides an updated overview of the operations and data processing of the VMC instrument that have been running routinely at the European Space Astronomy Centre (ESAC) in Spain since Spring 2018, maximising the number of observations and the scientific output of the instrument.

1. Introduction

The Visual Monitoring Camera (VMC) is a 640x480 pixel camera which takes information in a stream of 8 bits, with a field of view (FOV) of ~40 x 31°. This wide FOV allows the camera to capture global images of the planet and therefore allows the study of regional and global scale atmospheric phenomena.

Several possible avenues for scientific analysis had already been identified as possible for the VMC, these being: cloud morphology and dynamics; aerosols related to specific surface features; physics and evolution of dust storms; and monitoring of the seasonal evolution of the polar ice caps [2]. Analysis using VMC data for these topics has already been presented at previous conferences, namely concerning the global dust storm [3], cloud morphology and dynamics [1], [4], [5], and elongated clouds associated with volcanos will also be presented at this congress [6].

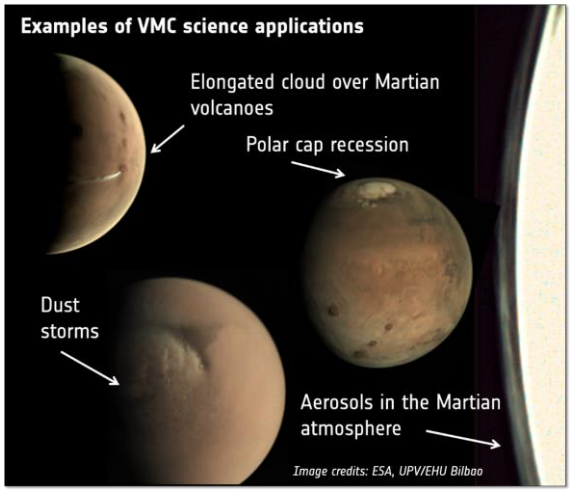

Figure 3: Examples of science applications using VMC data. Image credits goes to ESA, UPV/EHU Bilbao.

2. VMC Instrument Operations

For many years the VMC operations were planned on an opportunistic basis, adding extra commands after all the science planning was finished. In April 2018, following the implementation of the new MEX Gyroless mode, VMC planning was moved to ESAC and integrated with all the other science payload processes, increasing the amount of observations up to ~2000 images per month. Observations are scheduled directly by the Science Ground Segment Team at ESAC, following the scientific priorities agreed with the VMC Science Team at the University of the Basque Country (UPV/EHU), who also optimise the exposure times for each science case. The main types of observations are mars atmosphere monitoring from the apocentre, or detailed limb observations from the pericentre.

The VMC takes images roughly 48 seconds apart, and follows the same procedures as other MEX science instruments, with the exception that VMC observations are conducted when all other instruments are OFF, mainly before and after spacecraft maintenance blocks.

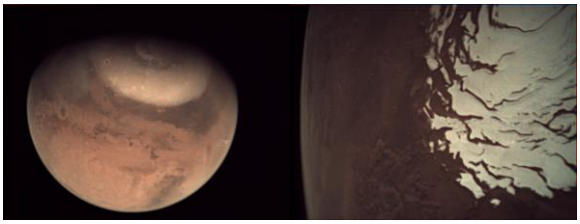

Figure 2: Examples of VMC images taken at apocentre (left) and pericentre (right). Images have been processed for enhanced colour but are not scientifically calibrated yet. Image credit ESA.

3. Data processing

3.1 Data Calibration

No on ground calibration exists for the MEX VMC, thus the VMC team has been working on in-situ calibration of the camera. Currently the science team at UPV/EHU, with support from the team at ESAC, is in the process of creating a master dark current image from observations of dark sky, and creating a master flat-field image from observations taken at pericentre over flat portions of Mars. The boresight offset of VMC is also being calculated using comparisons of the location of stars in VMC images (e.g. the Orion constellation) using the SPICE geometry information system, with the stars known positions.

3.2 Data processing and archiving

The implementation of the data processing pipeline was provided by Dias Almeida Processing Systems, based in Python and utilising the Luigi package designed for batch processing. This pipeline is now run operationally on ESAC servers and made available to the science team. The VMC data will then be stored in the Planetary Science Archives (PSA) for public distribution. Data from the VMC will continue to be available on Twitter and Flickr for outreach purposes (@esamarswebcam, Flickr: https://www.flickr.com/photos/esa_marswebcam/).

4. Conclusion

The integration of VMC science planning within the Science Ground Segment has boosted the number of observations in the past year. The VMC pipeline implemented at ESAC with the support of the science team is improving the quality of the data for scientific analysis, which will be made available to the Mars community via the archive.

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