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Support to the CO_2 Cloud Observations by Mars Express with the VMC Visual Monitoring Camera

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Abstract

This paper discusses the possibilities for using the non-scientific Visual Monitoring Camera (VMC) [1] to contribute to this scientific objective of the Mars Express mission, complementing and supporting the data obtained from the scientific payload. The contribution of VMC is that it can image the planet with a large field of view, providing the context for the other experiments which operate at lower altitudes, close to the pericenter. The VMC data would also allow providing useful information such as cloud altitude (thanks to the shadow) morphology, relative reflectivity and dynamics. These are important parameters in the characterization of the CO_2 cloud population.

1. Introduction

The OMEGA (Observatoire pour la Mineralogie, l'Eau, les Glaces et l'Activite´) mapping and imaging near-IR and visible spectrometer has been making observations of CO_2 clouds on Mars since 2004. VMC is a small 640x480 pixel CCD camera with Bayer filter for colour reconstruction. On Mars Express it provided visual confirmation of the deployment of the Beagle-2 Lander. It was reactivated in 2007 to provide opportunistic imaging of Mars for public relations purposes.

2. CO_2 Cloud Observations with OMEGA on Mars Express

Mesospheric CO_2 ice clouds have been detected, characterized and imaged for the first time in the Martian atmosphere by the Mars Express experiment OMEGA (Figure 1) and indirectly also by HRSC, PFS, and SPICAM [2, 3, 4 & 5].

The shadow of the CO_2 clouds can be seen because of the cloud density. From the shadow we can deduce their altitude. The altitude of the CO_2 cloud observations with OMEGA can be performed at any time in the spacecraft orbit, with an altitude range of ~300km at pericentre to ~10,000km at apocentre.

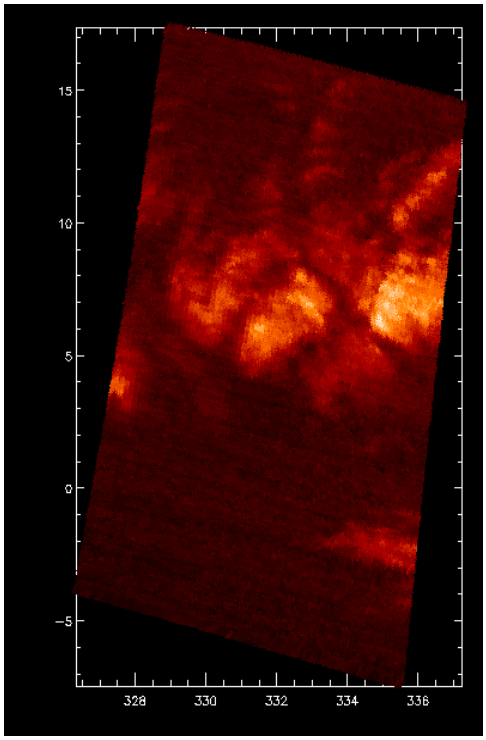

Figure 1: CO_2 Clouds, orbit 8020 (OMEGA) – Axes are latitude and longitude [E]

3. Cloud Observations with VMC

The VMC camera was first used for a dedicated scientific observation in 2009 (Figure 2) to observe cloud and haze layers in a study related to possible atmospheric sounding probes on Mars [6].

Subsequently, a series of observations between January and March 2010 was targeted at cloud formations over the Hellas region. The observations, acquired at different altitudes and local times over the same region on Mars, have revealed typical cloud formations as they appear during the Martian day.

The VMC spatial resolution is sufficient to distinguish cloud and haze features well enough to characterize them, even for full planet images. Mars Express is therefore capable of acquiring full-disk images with a low enough data volume to allow the creation of multi-image stop-motion-animated time-laps movies in colour. These can reveal how clouds form, travel and dissolve over the course of hours. For the foreseeable future, this capability of weather observation will remain unique to Mars Express.

However, VMC images by themselves do not reveal the cloud composition (H_20 or CO_2). A coordinated OMEGA / VMC observation campaign can therefore combine the benefits of both instruments to allow new types of observations.

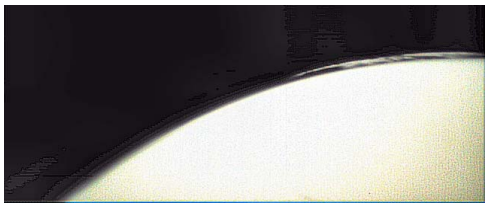

Figure 2: VMC H_2O Cloud Limb Observation, Orbit 7631 on 15-Dec-2009 over Gusev Crater & Maadim Vallis

4. Coordinated Campaign

Realising *a posteriori* the scientific value of some VMC images resulted in a need for coordination, as another step towards doing more science in quantity and diversity with the same mission, rather than stagnating in routine data takes or even reducing due to spacecraft aging. Initiated as a technology demonstration, VMC operations expanded based on strict non-interference with the science mission, without impact on planning effort (via automation) or spacecraft resources (thanks to priority rules).

A specific CO_2 Cloud Monitoring campaign has been approved, and will be coordinated, from the technical and scientific point of view, by the Science Ground Segment (ESAC). The VMC observation requests are coordinated with the Mission Operations Centre in ESOC.

5. Summary and Conclusions

The VMC was proven to possess unique observation capabilities, providing full-disk images of the current weather on Mars with a data rate low enough to allow continuous series of observations over relevant time spans.

Historical observations of the same clouds, taken with VMC and OMEGA, exist, but are rare. The few studied prove that a coordinated investigation is worthwhile. First coordinated observations between OMEGA and VMC will take place from apocentre between November 2011 and January 2012.

References

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