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DUST PHASE FUNCTION FROM NAVCAM AND HAZCAM IMAGES ON MSL

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Abstract

The Mars Science Laboratory (MSL) Engineering Cameras were designed for supporting the rover surface operations, but their wide field sky images provide useful information for constraining the aerosol physical properties at Gale Crater. We have developed a DISORT-based radiative transfer model for retrieving such information from the sky brightness measured by these instruments.

1. Introduction

Although not designed for this specific purpose, images taken by the Mars Science Laboratory (MSL) Engineering Cameras can be used for retrieving the dust optical depth and aerosols physical properties at Gale Crater. Dust size distribution and particle shapes can be constrained by evaluating the sky brightness as a function of the scattering angle obtained by MSL cameras [7].

2. MSL Engineering Cameras

The MSL Curiosity rover is equipped with 12 engineering cameras which are built under the same design as the Mars Exploration Rovers (MER) [3]. The goal of these cameras is to support the surface operations of the rover by providing tactical views of the near-field surrounding terrain; in order to detect and avoid hazards, characterize the rover position and orientation, as well as supporting the robotic arm operation [4].

MSL Navigation Cameras (*Navcam*) consist of four mast-mounted cameras with a 45-degree square field of view and a broadband response span of 600 to 850 nm. The Hazard Avoidance Cameras (*Hazcam)* are rover chassis-mounted tactical cameras located in the front and the rear of the vehicle, with a 124-degree square FOV. They have also a broadband coverage of 600-800 nm. Complete technical specifications of the MSL Engineering cameras can be found in [4], while information on the performance of the optics is shown in [3].

3. Observations

The sky radiance as a function of the scattering angle provides useful information for constraining the shape and size distribution of aerosols in the atmosphere. MSL Engineering Camera images were used to determine the scattering properties and phase function of the Martian dust.

Navcam sky surveys cover a wide range of angles from the Sun as they were designed to determine the scattering properties of the atmosphere. In addition to these images, this work has also evaluated the wide FOV images provided by *Hazcam* (see Figure 1)

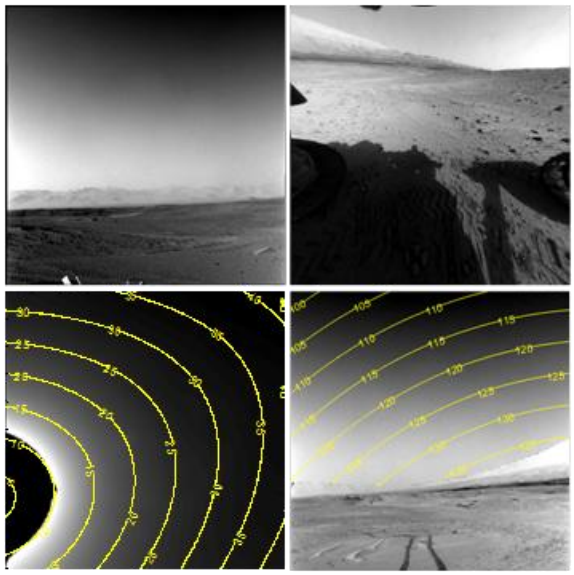

Figure 1: *Navcam* (left) and *Hazcam* (right) surveys. Sample images are shown on top. Scattering angle contours are presented for MSL Sol 669 (bottom)

4. Radiative Transfer model

A radiative transfer model has been developed in order to model the radiation detected by the MSL Engineering Cameras. This model can also be used with other instruments even on-board orbiters.

We use a discrete ordinate method to solve the RT equation (DISORT) [8] in a plane-parallel Martian atmosphere model. The code for setting up the atmosphere and solving the radiative transfer is based on a Python implementation of CDISORT (PyDISORT) [1]. Absorption data for relevant gases are taken from HITRAN [6] and transformed into correlated-k tables. Local and seasonal atmospheric profiles and composition have been retrieved from the Mars Climate Database [2, 5].

The current aerosol model implementation allows to use spherical (Mie approximation) and irregular (T-matrix based) particles.

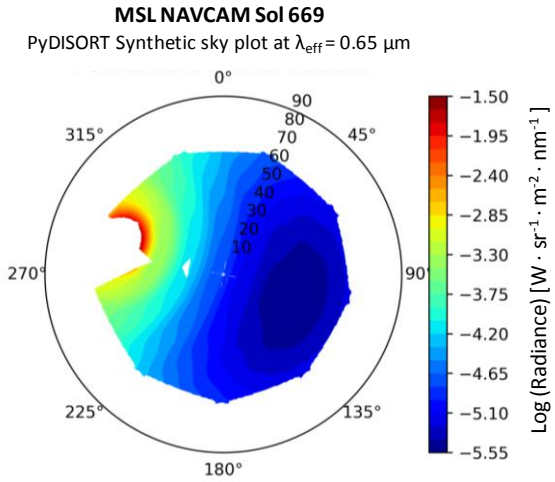

Figure 2: Synthetic sky plot with PyDISORT for MSL-*Navcam* Sol 669 retrieved images at instrument effective wavelength 0.65 µm.

5. Conclusions

We are using the image data sets obtained by the Engineering Cameras (*Navcam* and *Hazcam*) on board the Mars Science Laboratory rover to study the dust characteristics. The sky radiances and dust aerosol phase function are retrieved and processed with a radiative transfer model for constraining the dust physical properties. This is a work in progress report and the latest results for a number of characteristic situations during the Martian year will be presented.

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