

CONTEXT CAMERA (CTX) UPDATED IN-FLIGHT CALIBRATION AND DATA DISSEMINATION

HIGHLIGHTS

► We provide calibration files in a public repository to correct the well-known "frown" effect of the CTX instrument:

<https://dx.doi.org/10.17169/refubium-37236>



► A map-server interface with the complete set of corrected CTX images for visualisation and (in the future) for download is available here:

<https://maps.planet.fu-berlin.de/ctx>



INTRODUCTION

► The push-broom Context Camera (CTX) on board NASA's Mars Reconnaissance Orbiter (MRO) is in orbit since 2006 and has delivered more than 130.000 images [1].

► It's one of the most popular datasets for planetary geologists: global coverage, good spatial resolution, good contrast.

► Images show annoying darkening effect increasing across-track from center towards borders (see Figure 1 top left).

► It's known as "frown" effect for its symmetric decrease in reflectance plots (see Figure 1 bottom left).

► The frown effect is caused by pixel-to-pixel non-uniformity variations [2].

BACKGROUND

► The software pipeline *Integrated Software for Imagers and Spectrometers* (ISIS) tries to compensate for the frown effect by applying an in-flight flatfield correction during the standard calibration routine *ctxcal* instead of the pre-flight flatfield calibration as described in [2].

► The flatfield file provided with ISIS is based on the first year of the mission only, and does not sufficiently remove the frown effects for the remaining images of the mission, as shown in example from Figure 1.

► Solutions to the problem have been presented, but are not fully reproducible and calibration files are not publicly available [e.g., 3–5].

► In these existing solutions, "double-calibrations" are performed where an additional flatfield is applied over the one performed by *ctxcal*.

METHODS

► First we create a special flatfield file with all values set to one.

► With this file, we perform the ISIS standard calibration (*ctxcal*) on all valid image files, but with disabled flatfield correction.

► For each month of the mission we create a separate flatfield calibration file, using the ISIS command *makeflat* on all single images of that month (the mission month, also called mission phase descriptor, is designated by the first three characters of the product id).

► To apply the calibration to a single final image, the respective flatfield file is handed over to *ctxcal* as a parameter, resulting in a corrected image (see Figure 1 right).

FLATFIELD FILES IN THE REPOSITORY

► We provide the resulting flat-field files that can be used directly in the ISIS environment permanently under this repository: <https://dx.doi.org/10.17169/refubium-37236>.

► The repository contains two ZIP-compressed archives:

+ One archive containing the flat-field files, ready for the application in ISIS *ctxcal*, together with a sample script to apply the correction

+ One supplementary archive containing the configuration for the creation of the flatfield files for full reproducibility.

DATA DISSEMINATION

► In addition, we are in the process of updating our "integrated Mars Analysis and Research System" (iMars) to include the full amount of frown-corrected CTX images, readily processed and available for download in GIS-ready formats.

► As with the previous system [6], users can select footprints and visualize the image data directly in the map view, e.g. by cycling through several layers of multiple coverage (see Figure 2).

► Special tools for switching between images of surface areas with multiple coverage provide an excellent infrastructure for analyzing surface changes and seasonal or interannual variations.

► We provide a complete overhaul of the graphical interface, which is accessible under <https://maps.planet.fu-berlin.de/ctx>.

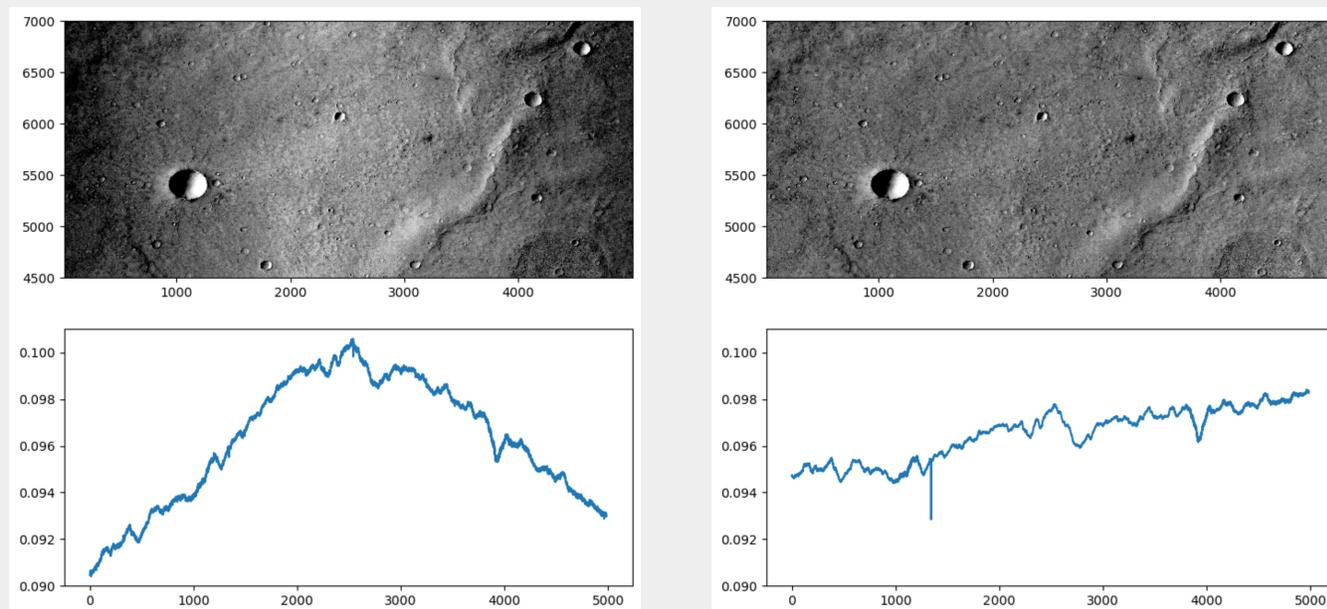


Figure 1: Left column: subset of CTX image N05_064260_1638 (top) together with a line plot of the reflectance samples averaged over all lines (bottom), after nominal ISIS calibration. The image (top left) shows darkening towards the along-track image borders, the average plot of the samples (bottom left) shows the "frown" effect. Right column: same subset, corrected for the "frown" effect by applying the additional flatfield correction (mission month N05).

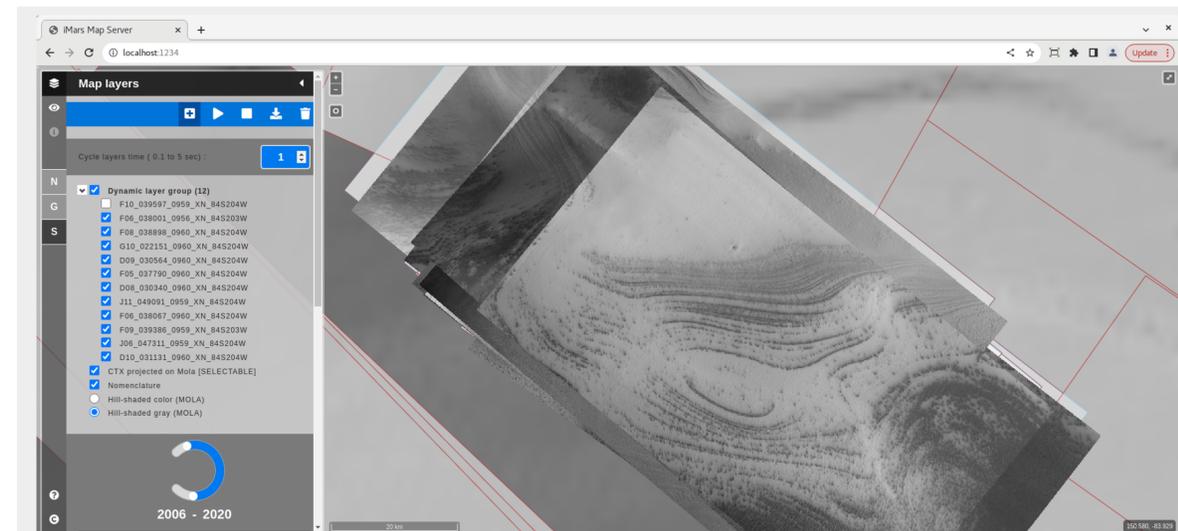


Figure 2: Screenshot of the new Mapserver application currently under development.

REFERENCES

- [1] M. C. Malin et al., *JGR Planets* (E5 2007). [2] J. F. Bell III et al., *Mars Journal* (2013), 1–14. [3] S. J. Robbins et al., *LPSC 52*, #2066. [4] S. J. Robbins et al., *Earth and Space Science* 3 (2023), e2022EA002443. [5] J. L. Dickson et al., *LPSC 49*, #2480. [6] S. H. G. Walter et al., *Earth and Space Science* 7 (2018), 308–323.

ACKNOWLEDGEMENTS

This work is supported by the German Space Agency (DLR Bonn), grant 50 OO 2204, on behalf of the German Federal Ministry for Economic Affairs and Climate Action. This research has made use of the USGS Integrated Software for Imagers and Spectrometers (ISIS). We thank the HPC Service of Freie Universität Berlin for computing time.