CRISM Map Projected Targeted Reduced Data Records (MTRDRs) – High Level Analysis and Visualization Data Products. F. P. Seelos, M. F. Morgan, H. W. Taylor, S. L. Murchie, D. C. Humm, K. D. Seelos, O. S. Barnouin, C. E. Viviano, and The CRISM Team, Johns Hopkins University Applied Physics Laboratory, 11100 Johns Hopkins Road, Laurel MD, 20723 (frank.seelos@jhuapl.edu).

Introduction: The Mars Reconnaissance Orbiter (MRO) Compact Reconnaissance Imaging Spectrometer for Mars (CRISM) team is finalizing software, specifications, and definitions for a new high level analysis and visualization data product suite – the Map Projected Targeted Reduced Data Record (MTRDR) product family. The MTRDRs are derived from CRISM hyperspectral targeted observations - Full Resolution Targeted (FRT), Half Resolution Long (HRL), Half Resolution Short (HRS), and Along Track Oversampled (ATO) – with the image cubes processed through a series of standard and empirical spectral corrections, spatial transforms, parameter calculations, and renderings. The MTRDR product suite represents a major advance in the accessibility of CRISM-derived spectral information and is expected to become the preferred entry point into the CRISM targeted observation data set for a large portion of the Mars science community.

MTRDR Motivation: CRISM PDS-delivered targeted observation TRR3 (Targeted Reduced Data Record version 3) data products accurately report the observed spectral radiance (or apparent I/F) but include a number of characteristics traceable to the instrument configuration or operational scenario (separate VNIR and IR detectors, gimbal motion), minor radiometric calibration residuals (spectral smile), and observational circumstances (illumination geometry, atmospheric state) that complicate the visualization, intra-scene evaluation, and inter-observation comparison of surface spectral variability.

Standard Corrections. The MTRDR pipeline (Figure 4) includes two standard corrections - a basic photometric (Lambertian) correction (PHT), and an updated 'volcano scan' atmospheric correction based on the application of empirically derived atmospheric transmission spectra (ATM) [1]. The revised volcano scan correction includes a large selection of reference atmospheric spectra that track subtle shifts in the instrument wavelength calibration, and procedural improvements that minimize spectral and spatial correction residuals. The latter includes the post-correction application of the Ratio Shift Correction (RSC) to mitigate the reintroduction of along-track column striping.

Empirical Corrections. CRISM targeted observations are acquired with a continuously varying emission and phase angle geometry due to the requisite gimbal image motion compensation. This typically results in an asymmetric, wavelength-dependent, along-track gradient primarily related to variation in atmospheric path length and aerosol scattering. These effects are addressed by the Empirical Geometric Normalization (EGN) procedure that characterizes the geometric dependencies across all segments of a targeted observation (central scan bounded by reduced spatial resolution higher emission angle images), and normalizes the central scan to a reference geometry.

Spectral smile is an optical artifact whereby the wavelength calibration shifts as a function of spatial position. The CRISM radiometric calibration has a small residual related to spectral smile that appears as a wavelength-dependent cross-track gradient. This is addressed by the Empirical Smile Correction (ESC) which characterizes intra-channel wavelength sampling dependencies and normalizes the data to a reference wavelength vector.

The aggregate effect of the standard and empirical corrections [2] on a representative CRISM targeted observation is shown in Figure 1 and Figure 2.

Geometric Reconciliation. The CRISM VNIR and IR optical designs were individually optimized – as a result a given source (ground location) is sampled differently and mapped to different coordinates on the two detectors. The MTRDR VNIR/IR sensor space transform uses the known ground location of every VNIR and IR pixel to construct a spatial transformation that maps the VNIR data into the IR reference frame. This transformation allows for the integration of VNIR and IR spectral information and the generation of full spectral range sensor space and map projected data products (e.g. Figure 3).

Summary Parameters and Browse Products. Spectral summary parameters are band math calculations that quantify diagnostic or indicative spectral structure. CRISM browse products are RGB composites of thematically related summary parameters. The spectral summary parameter code library implemented in the MTRDR pipeline has been updated to consistently and appropriately make use of the targeted observation hyperspectral sampling. The resulting suppression of spectral noise in the parameter calculations, in combination with the addition and revision of selected parameter formulations, has resulted in a suite of standard data visualization products with expanded scope and improved fidelity.

MTRDR Product Status. The motivation, generation, application, nomenclature, and data availability plan for the MTRDR family of high level data products will be presented. The pipeline generation and subsequent PDS-delivery of MTRDRs for all CRISM hyperspectral targeted observation that meet a set of data quality and completeness criteria is slated to begin in late 2012. Selected prototype MTRDR data products were made available in association with the 2012 CRISM Data Users' Workshop and are hosted at the PDS Geosciences Node [3].

References: [1] Morgan M. F. et al. (2011) LPSC XLII, Abstract #2453. [2] Seelos, F. P. et al. (2011) LPSC XLII, Abstract #1438. [3] MRO/CRISM 2012 Data Users' Workshop (2012) [PDS Geosciences Node] [APL]

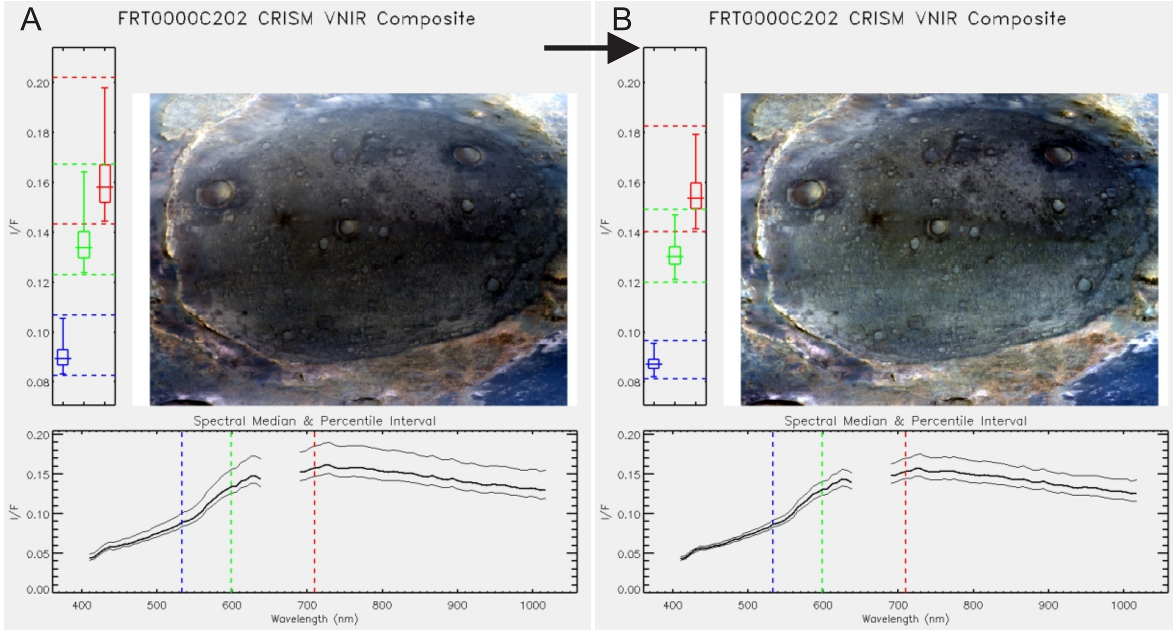

Figure 1. FRT0000C202 MTRDR VNIR spectral processing - three panel composites. (A) TRR3 VNIR image cube after photometric correction (PHT). (B) TRR3 VNIR image cube after all subsequent MTRDR systematic spectral processing (EGN, ESC). The spectral and boxplot scales in (A) and (B) are identical, allowing for a direct evaluation of the MTRDR data processing. The most obvious change between (A) and (B) - the mitigation of the wavelength-dependent along-track gradient - is the result of the EGN procedure.

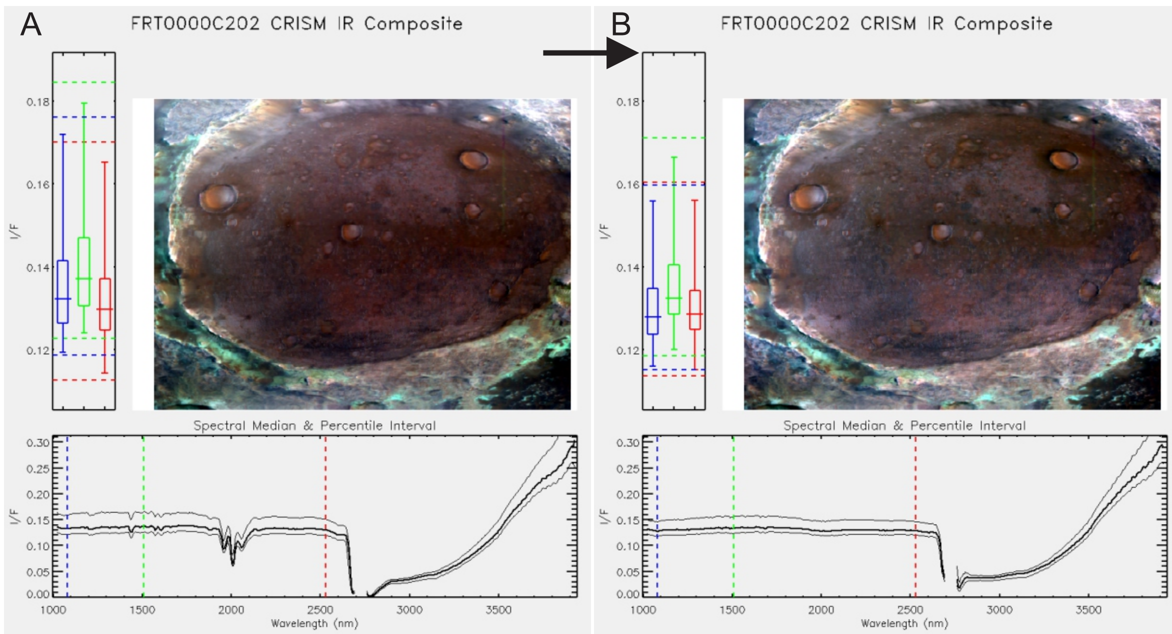

Figure 2. FRT0000C202 MTRDR IR spectral processing - three panel composites. (A) TRR3 IR image cube after photometric correction (PHT). (B) TRR3 IR image cube after all subsequent MTRDR systematic spectral processing (ATM/RSC, EGN, ESC). The spectral and boxplot scales in (A) and (B) are identical, allowing for a direct evaluation of the MTRDR data processing. The most obvious change between (A) and (B) - the correction of the ~2000 nm CO_2 absorption and other minor atmospheric features - is the result of the ATM correction.

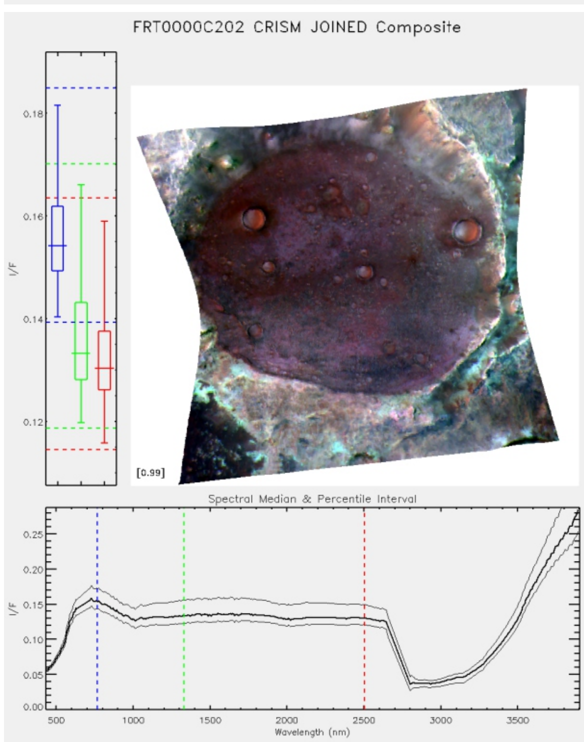

Figure 3. FRT0000C202 MTRDR three-panel composite. The spectral MTRDR data product incorporates all of the VNIR and IR detector-specific data processing (Figure 1, Figure 2) and the VNIR/IR sensor space transform to spatially align the constituent image cubes. The map projection is consistent with the 'rolling equirectangular' MRO standard. Note that the MTRDR RGB composite combines bands that source from both the VNIR (B: ~770 nm) and IR (G: ~1330 nm; R:~2510 nm) detectors.

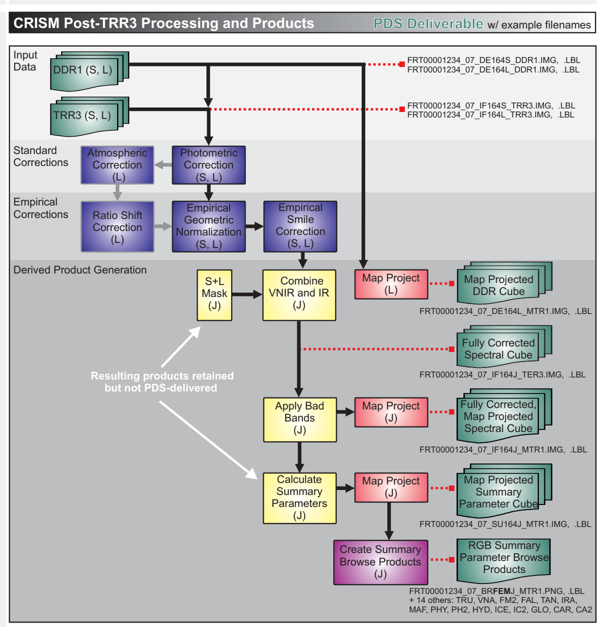

Figure 4. CRISM MTRDR data processing pipeline. PDS-deliverable data products are shown in green. Figure 3 is a visualization of the 'Fully Corrected Map Projected Spectral Cube'.