# Targeted Empirical Record (TER)
# Map-projected Targeted Reduced Data Record (MTRDR)
# Data Product Suite

F. Seelos and the CRISM Team

3rd Planetary Data Workshop

CRISM Breakout

06/12/2017

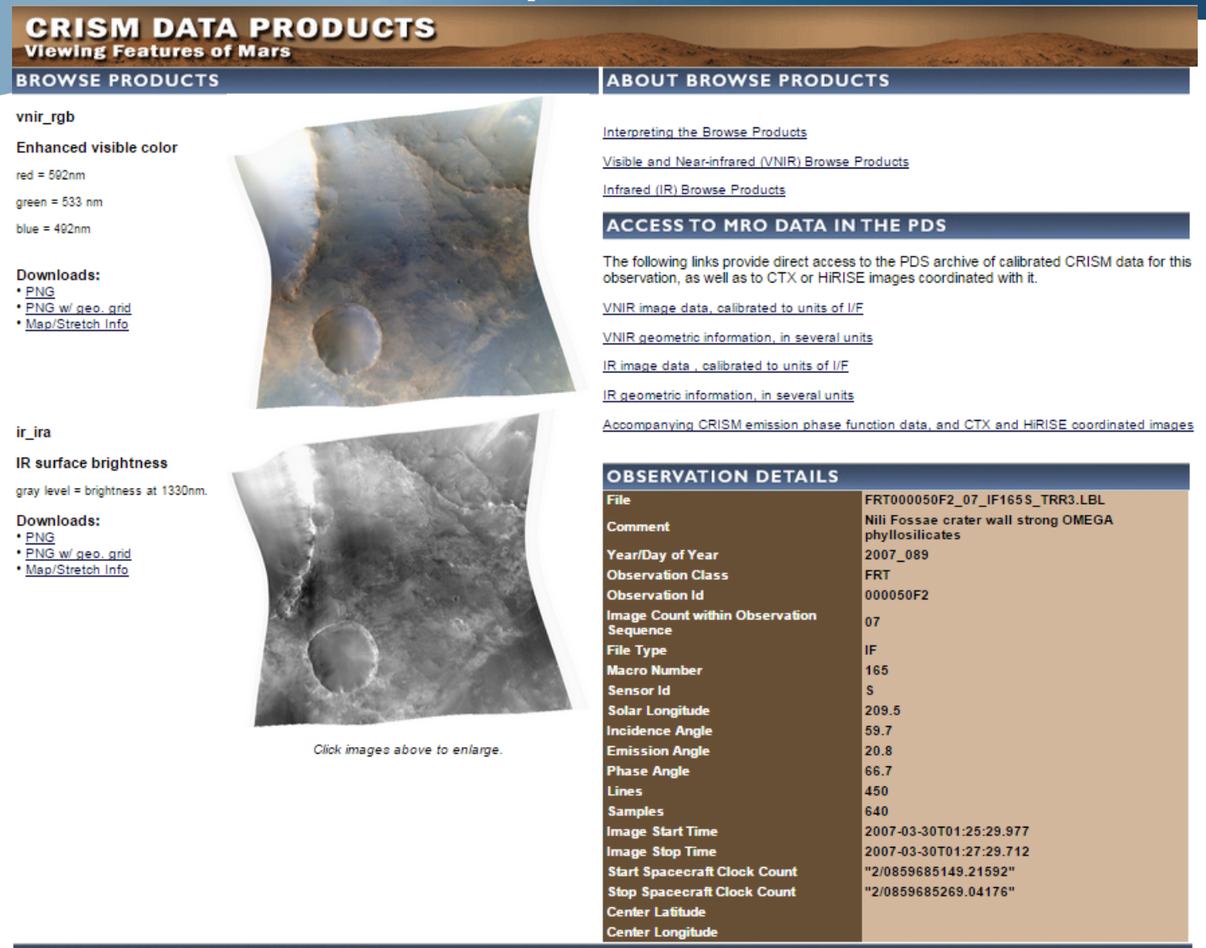
# Overview

- The TER/MTRDR data product suite is a set of high level analysis and visualization products that will ultimately be generated and released for the majority of CRISM classic hyperspectral targeted observations
  - FRT, HRL, HRS class types
  - New CRISM targeted observation class types (FRS, ATO, ATU) under consideration/development
- The TER/MTRDR data processing chain seeks to characterize and mitigate components of the targeted observation spatial/spectral variability that are not directly related to the surface, and accommodate instrument operational characteristics that complicate surface spectral analysis:
  - Solar illumination angle
  - Atmospheric gas absorptions (IR only)
  - Continuously varying observation geometry (gimbal motion)
  - Spectral smile (optical artifact)
  - VNIR (S-detector) / IR (L-detector) spatial reconciliation
  - Noise residuals

This is a superset of the typical CAT data processing workflow

- The TER/MTRDR data product suite will improve the accessibility of the CRISM hyperspectral targeted observation data set and is expected to become the main point-of-entry for the majority of the Mars science community

# CRISM Spectral Information Content Visualizations



**CRISM DATA PRODUCTS**
Viewing Features of Mars

**BROWSE PRODUCTS**

**vnir_rgb**

**Enhanced visible color**

red = 592nm

green = 533 nm

blue = 492nm

**Downloads:**
- PNG
- PNG w/ geo. grid
- Map/Stretch Info

**ir_ira**

**IR surface brightness**

gray level = brightness at 1330nm.

**Downloads:**
- PNG
- PNG w/ geo. grid
- Map/Stretch Info

*Click images above to enlarge.*

**ABOUT BROWSE PRODUCTS**

Interpreting the Browse Products

Visible and Near-infrared (VNIR) Browse Products

Infrared (IR) Browse Products

**ACCESS TO MRO DATA IN THE PDS**

The following links provide direct access to the PDS archive of calibrated CRISM data for this observation, as well as to CTX or HiRISE images coordinated with it.

VNIR image data, calibrated to units of I/F

VNIR geometric information, in several units

IR image data , calibrated to units of I/F

IR geometric information, in several units

Accompanying CRISM emission phase function data, and CTX and HiRISE coordinated images

**OBSERVATION DETAILS**

| | |
|---|---|
| File | FRT000050F2_07_IF165S_TRR3.LBL |
| Comment | Nili Fossae crater wall strong OMEGA phyllosilicates |
| Year/Day of Year | 2007_089 |
| Observation Class | FRT |
| Observation Id | 000050F2 |
| Image Count within Observation Sequence | 07 |
| File Type | IF |
| Macro Number | 165 |
| Sensor Id | S |
| Solar Longitude | 209.5 |
| Incidence Angle | 59.7 |
| Emission Angle | 20.8 |
| Phase Angle | 66.7 |
| Lines | 450 |
| Samples | 640 |
| Image Start Time | 2007-03-30T01:25:29.977 |
| Image Stop Time | 2007-03-30T01:27:29.712 |
| Start Spacecraft Clock Count | "2/0859685149.21592" |
| Stop Spacecraft Clock Count | "2/0859685269.04176" |
| Center Latitude | |
| Center Longitude | |

**VISIBLE AND IR DERIVED PRODUCTS**

**vnir_fem**

**Oxidized iron minerals**

red = BD530 (ferric minerals)

green = SH600 nm (coatings)

blue = BDI1000nm (variety of iron minerals)

*Click image above to enlarge.*

**Downloads:**
- PNG
- PNG w/ geo. grid
- Map/Stretch Info

**ir_maf**

**Mafic mineralogy**

red = OLINDEX (olivine or iron phyllosilicates)

green = LCPINDEX (low-Ca pyroxene)

blue= HCPINDEX (high-Ca pyroxene)

*Click image above to enlarge.*

**Downloads:**
- PNG
- PNG w/ geo. grid
- Map/Stretch Info

**ir_phy**

**Hydroxylated silicates**

red = BD2300 (Fe/Mg phyllosilicate)

green = BD2210 (Al phyllosilicate or hydrated glass)

blue=BD1900 (hydrated sulfates, clays, glass, or water ice)

*Click image above to enlarge.*

**Downloads:**
- PNG
- PNG w/ geo. grid
- Map/Stretch Info

**ir_hyd**

**Bound water**

red = SINDEX (water-containing minerals or water ice)

green = BD2100 (monohydrated sulfates or water ice)

blue = BD1900nm. (hydrated sulfates, clays, glass, or water ice)

*Click image above to enlarge.*

**Downloads:**
- PNG
- PNG w/ geo. grid
- Map/Stretch Info

**ir_ice**

**Water and CO2 ice**

red = BD1900 (water ice or hydrated sulfates, clays, or glass)

green = BD1500 (water ice)

blue=BD1435 (CO2 ice)

*Click image above to enlarge.*

**Downloads:**
- PNG
- PNG w/ geo. grid
- Map/Stretch Info

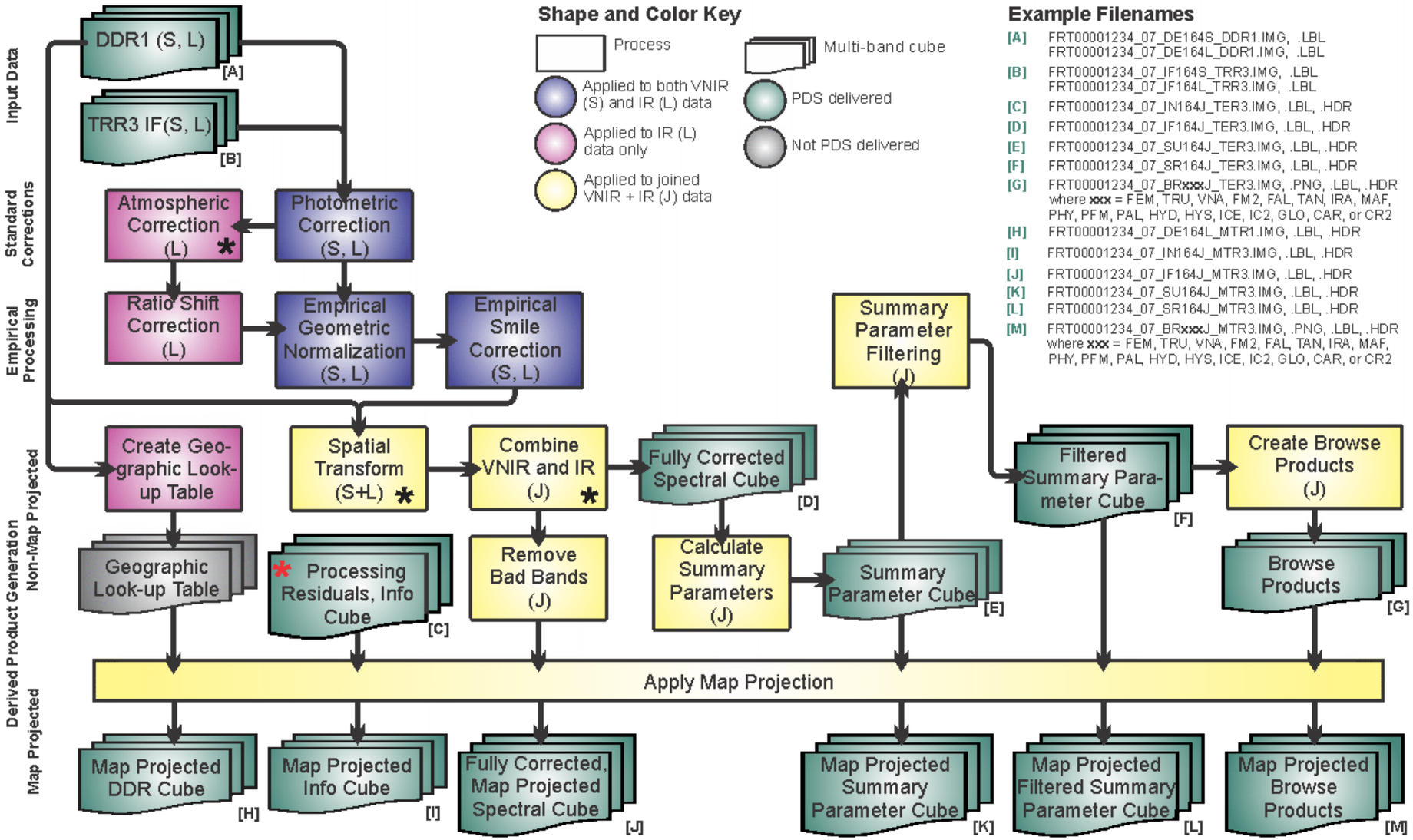
- Initial incarnation
  - CRISM-MAP Visualizations
  - Inherited by PDS Geosciences Node (ODE)
- Rolling replacement by TER/MRDR and revised TRDR visualizations

# Slide Set Guide

- The next slide is a flowchart that illustrates the TER/MTRDR data processing workflow
- The subsequent slides show examples of TER/MTRDR PDS-deliverable products (or visualizations of PDS-deliverable products that are included as ‘EXTRAS’) with the corresponding flowchart element, PDS filename, and relative PDS archive path location

# CRISM TER/MTRDR Workflow

## CRISM TRR3 I/F to MTRDR: Pipeline Processing and Derived Products

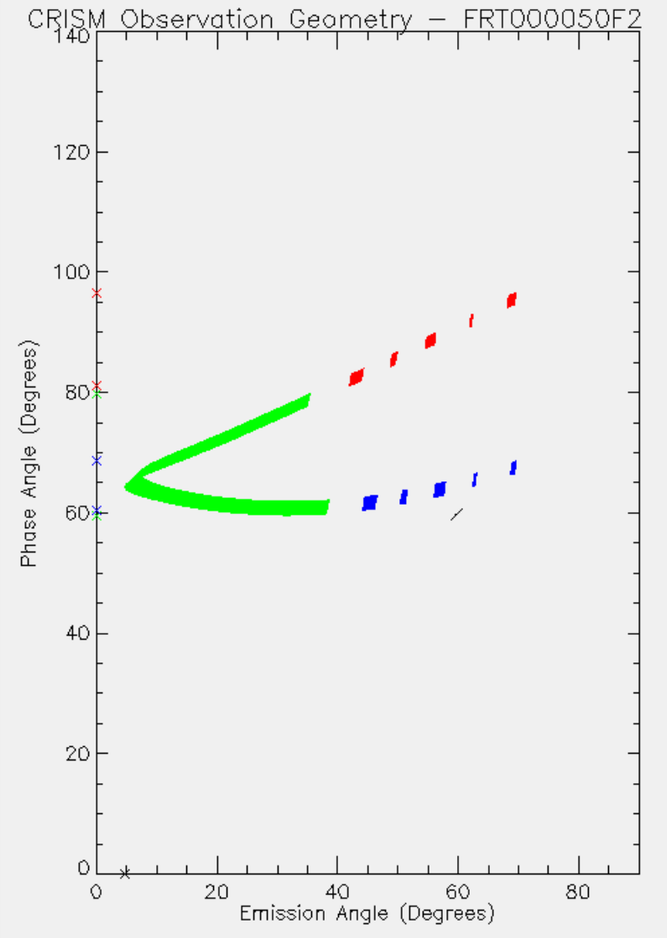



* The data processing information (IN) cube preserves traceability and residual information for multiple procedures, including the atmospheric correction, spatial transform, and VNIR+IR combination steps.

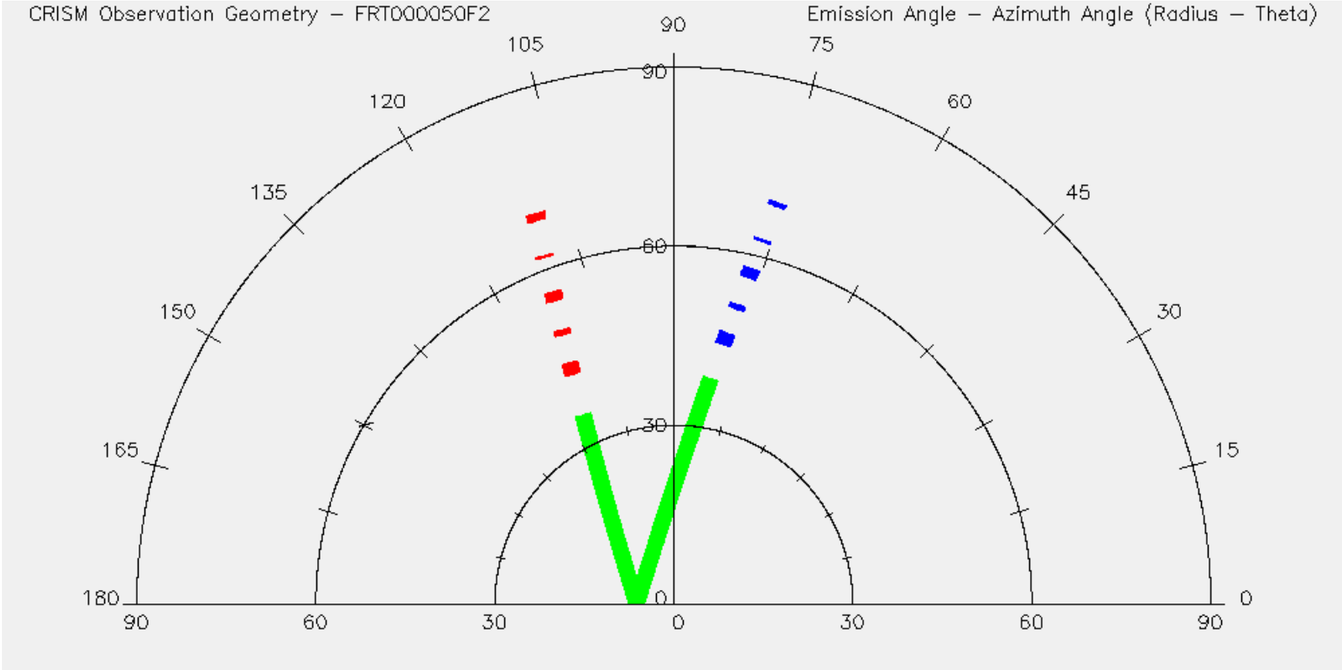
# DDR Visualizations – [i,e,g,ψ]

DDR1 (S, L)

TRR3 IF(S, L)




FRT000050F2_L_TRR3_PHA_EMI.PNG



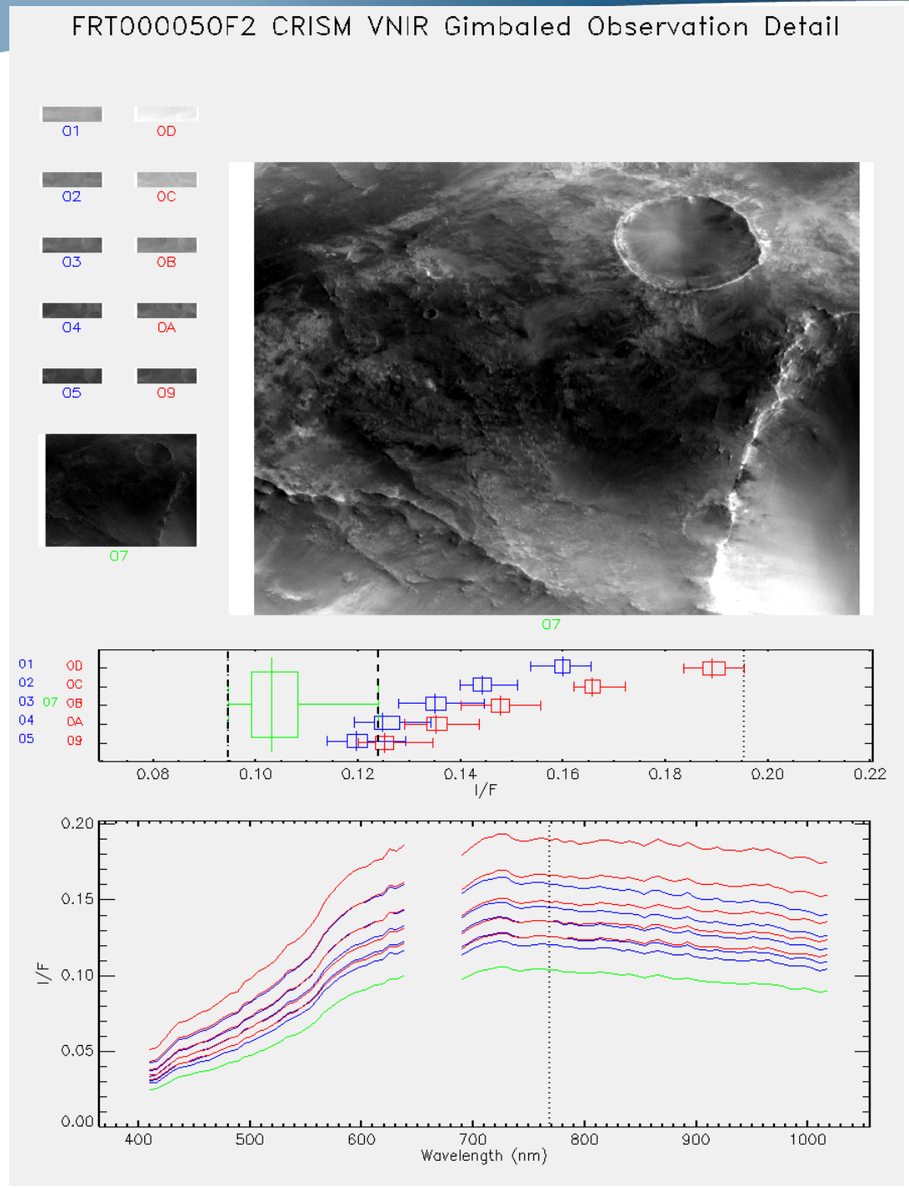

FRT000050F2_L_TRR3_EMI_AZI.PNG

./trdr/EXTRAS/

# TRDR Visualizations - Gimbaled

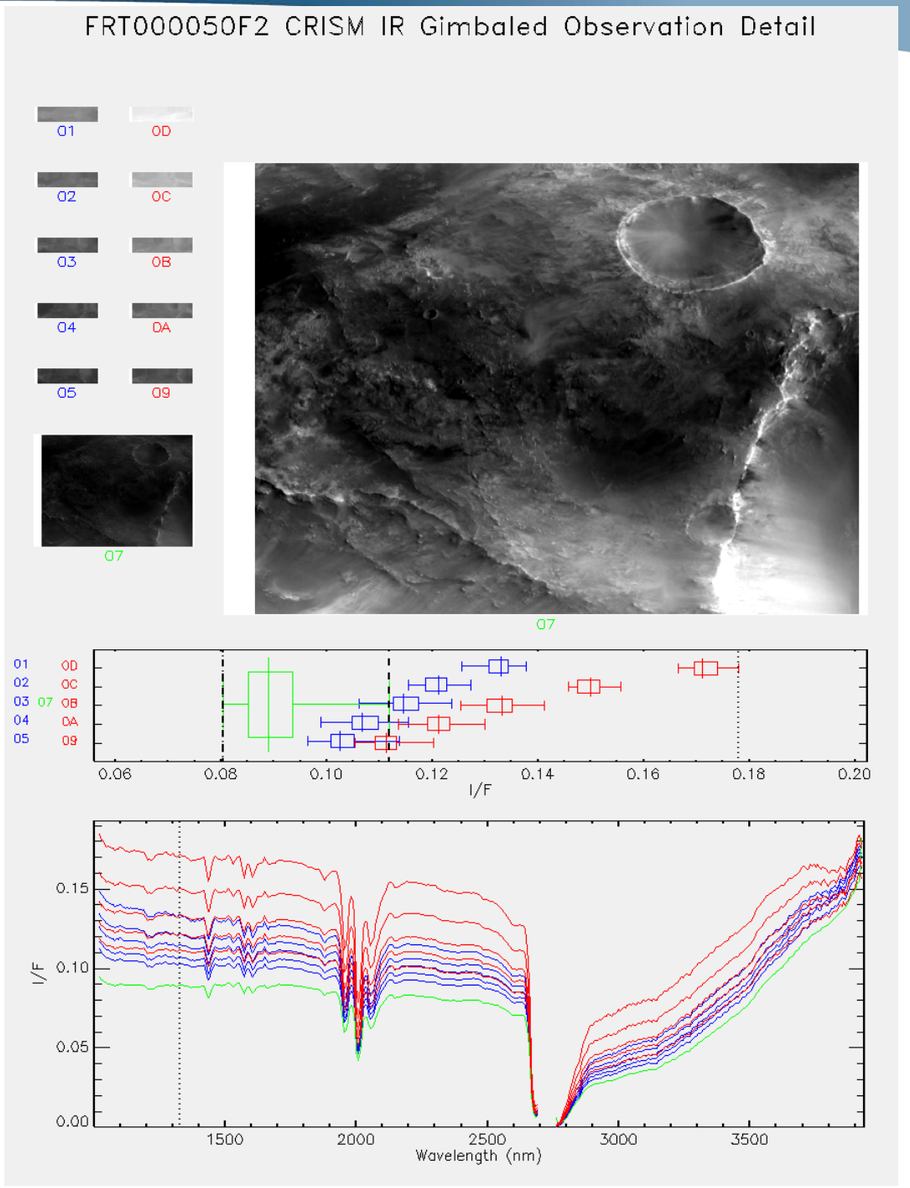
DDR1 (S, L)

TRR3 IF(S, L)




./trdr/EXTRAS/

FRT000050F2_S_TRR3_GIMBALED.PNG

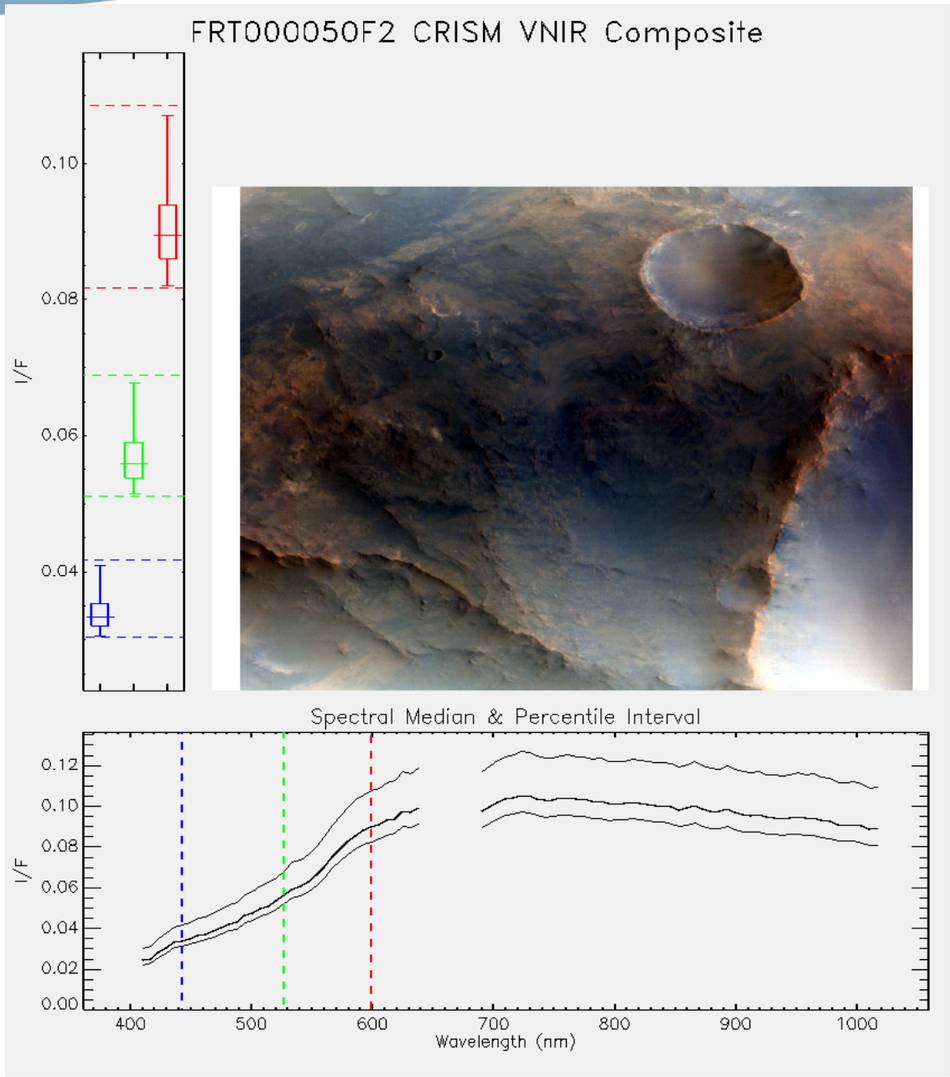



FRT000050F2_L_TRR3_GIMBALED.PNG

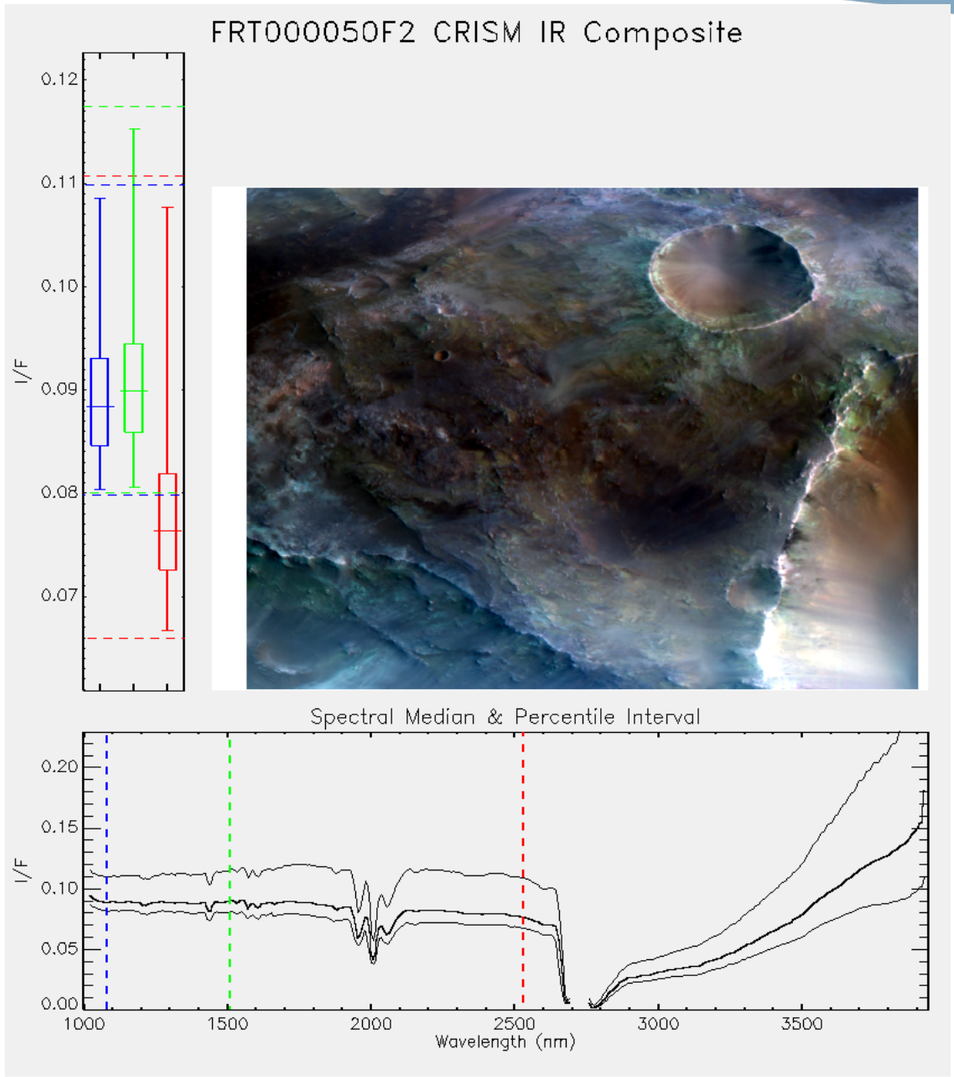
# TRDR Visualizations - Composite

DDR1 (S, L)

TRR3 IF(S, L)




FRT000050F2_S_TRR3_COMPOSITE.PNG



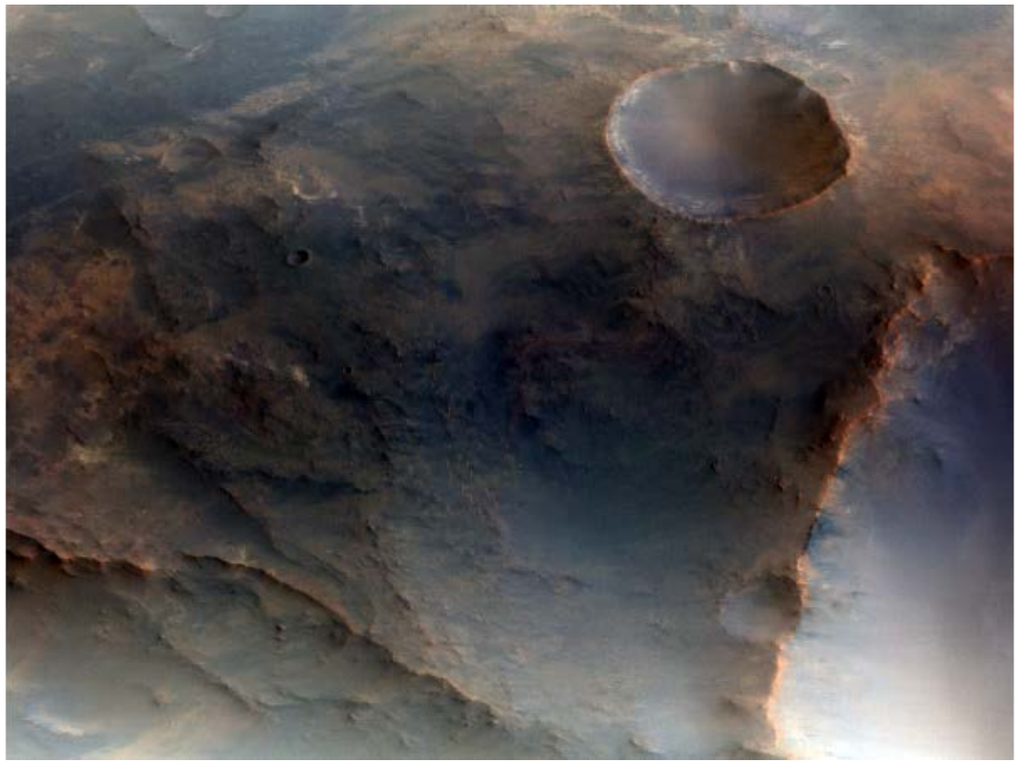

FRT000050F2_L_TRR3_COMPOSITE.PNG

./trdr/EXTRAS/

# TRDR Browse Products

DDR1 (S, L)

TRR3 IF(S, L)



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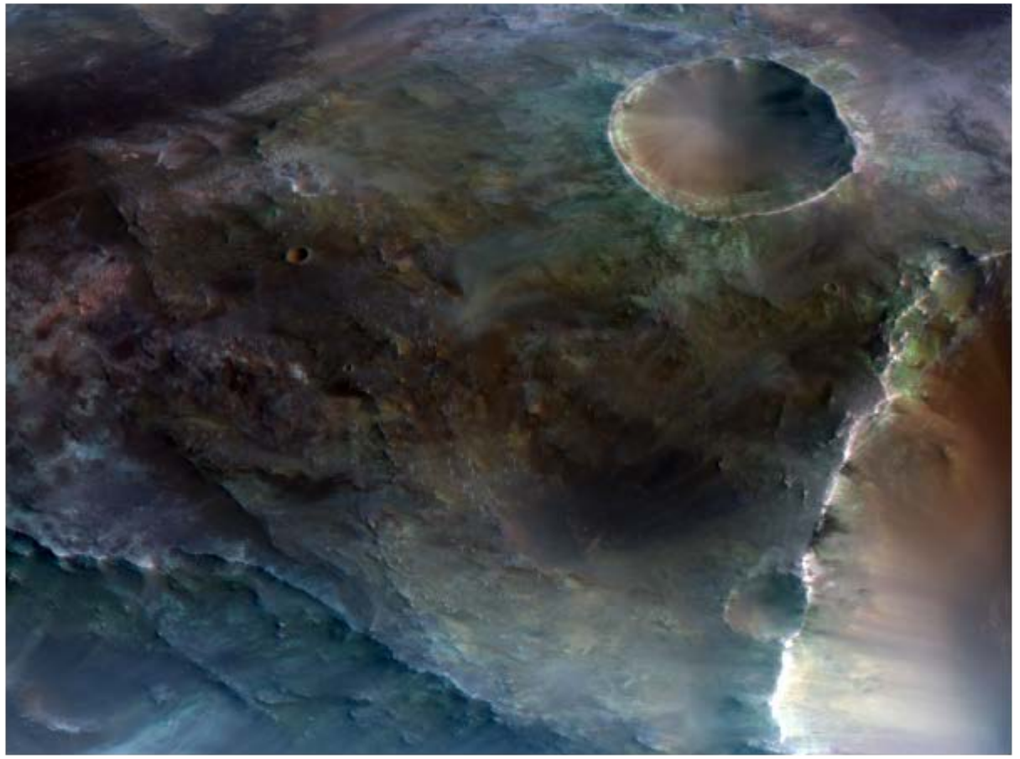
FRT000050F2_07_BRTRUS_TRR3.IMG
FRT000050F2_07_BRTRUS_TRR3.HDR
FRT000050F2_07_BRTRUS_TRR3.LBL



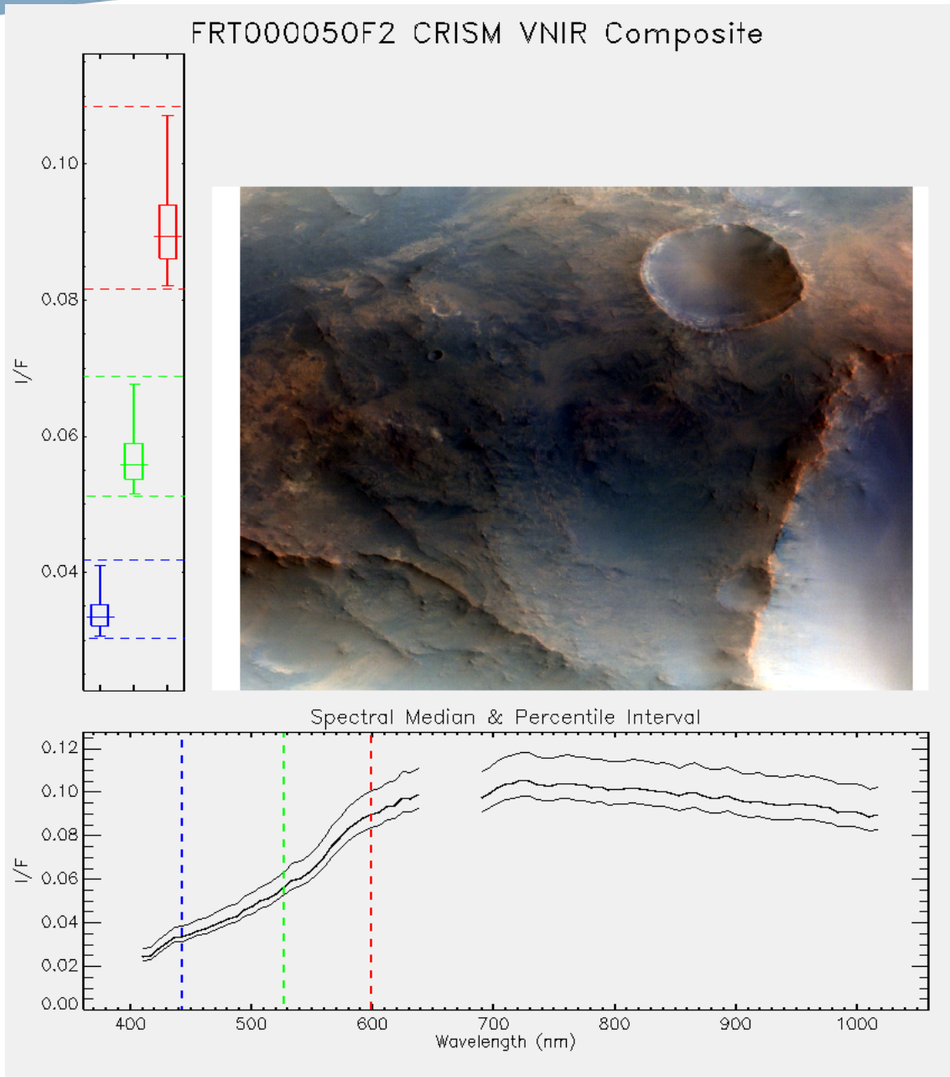
FRT000050F2_07_BRFALL_TRR3.PNG
FRT000050F2_07_BRFALL_TRR3.IMG
FRT000050F2_07_BRFALL_TRR3.HDR
FRT000050F2_07_BRFALL_TRR3.LBL

./trdr/BROWSE/

Browse Product File Quartets

# TER VNIR Progression – 1/4

Photometric Correction (S, L)

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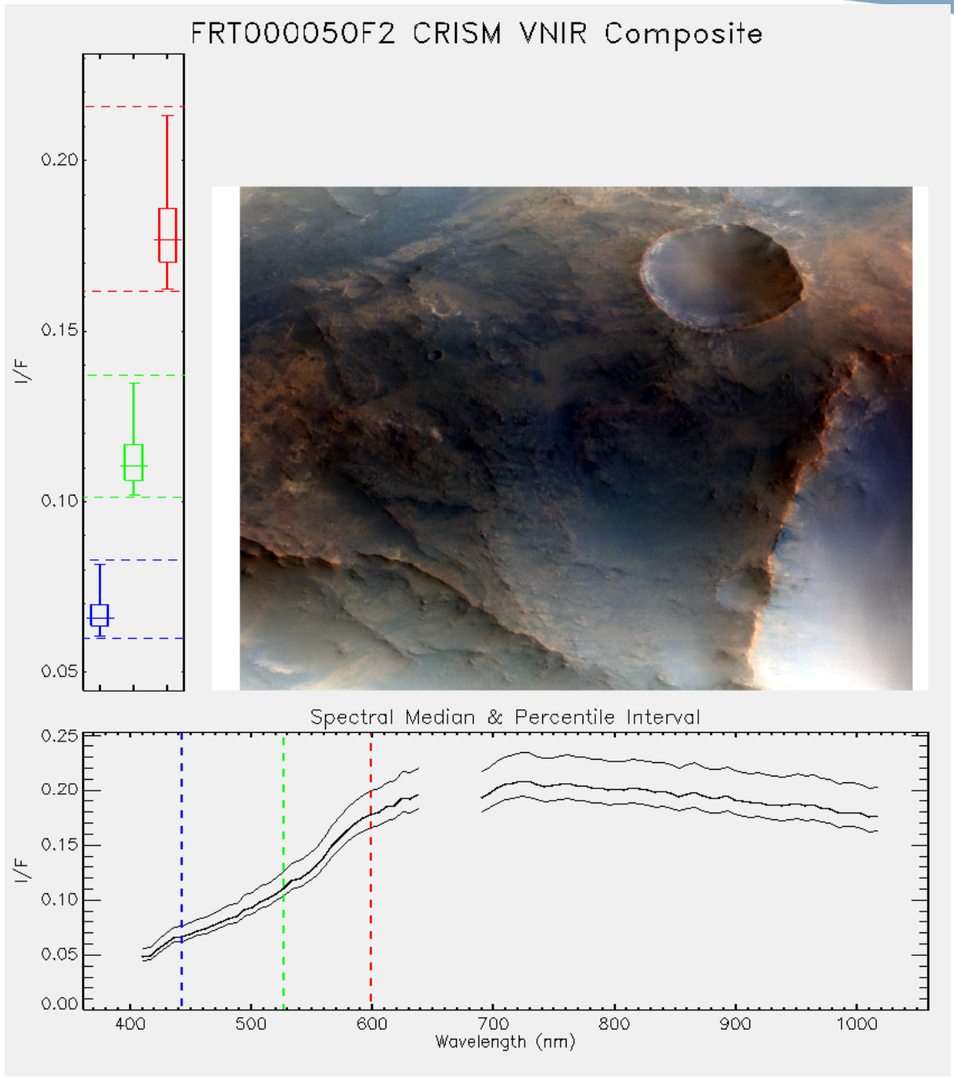
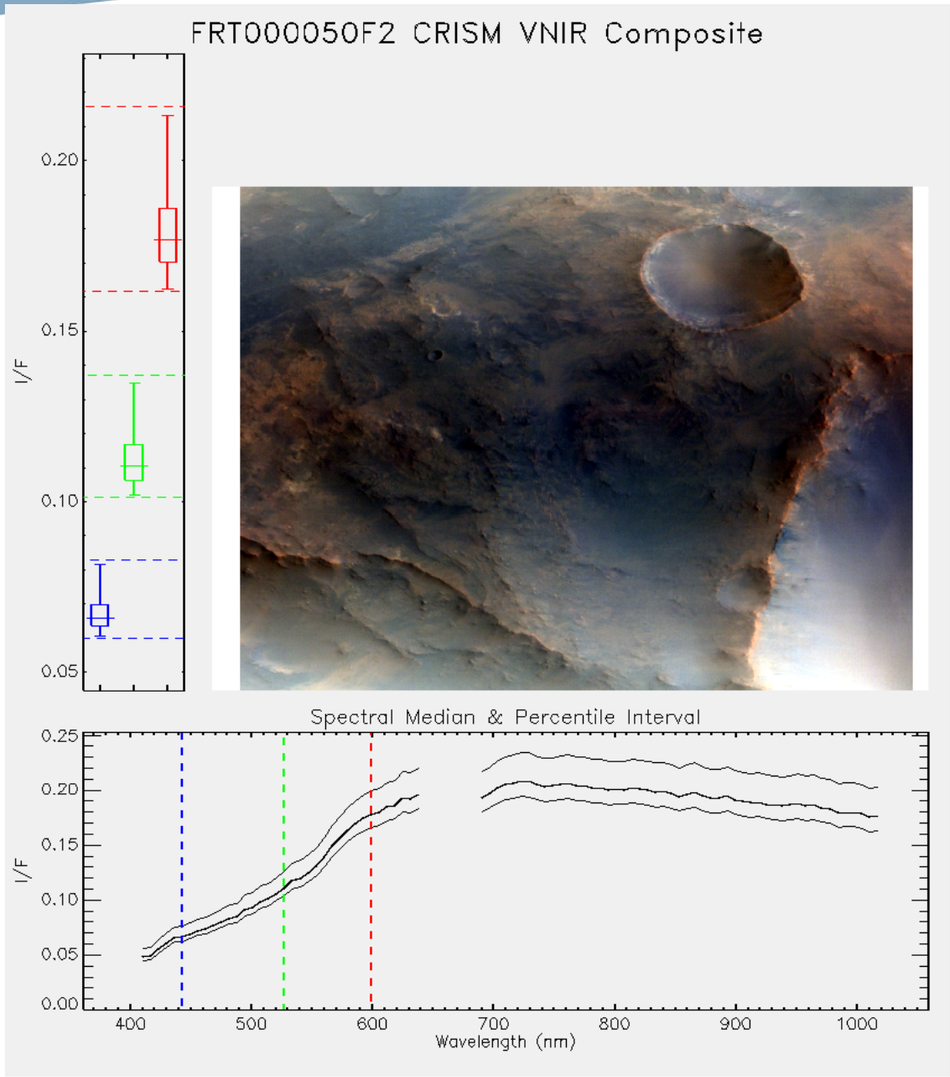



FRT000050F2_S_COMPOSITE_02.PNG

./ter/EXTRAS/

# TER VNIR Progression – 2/4

Empirical Geometric Normalization (S, L)

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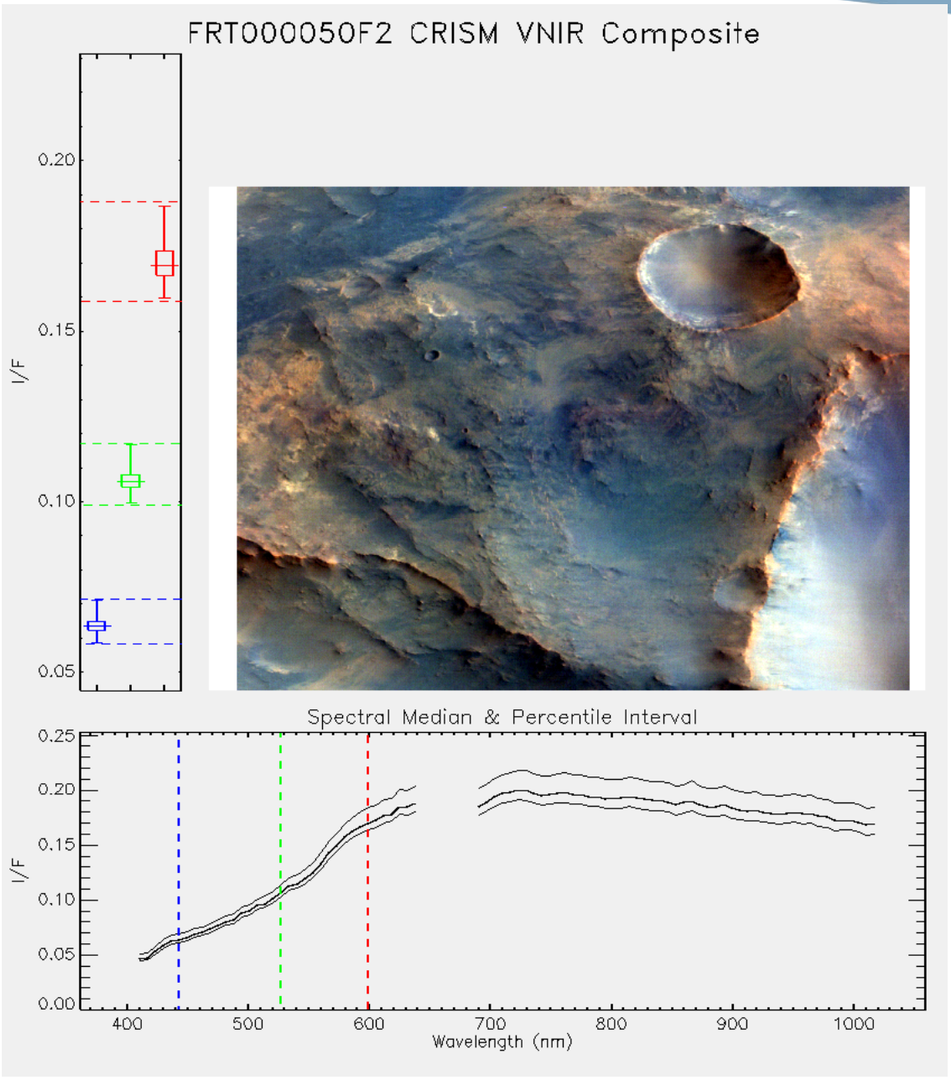
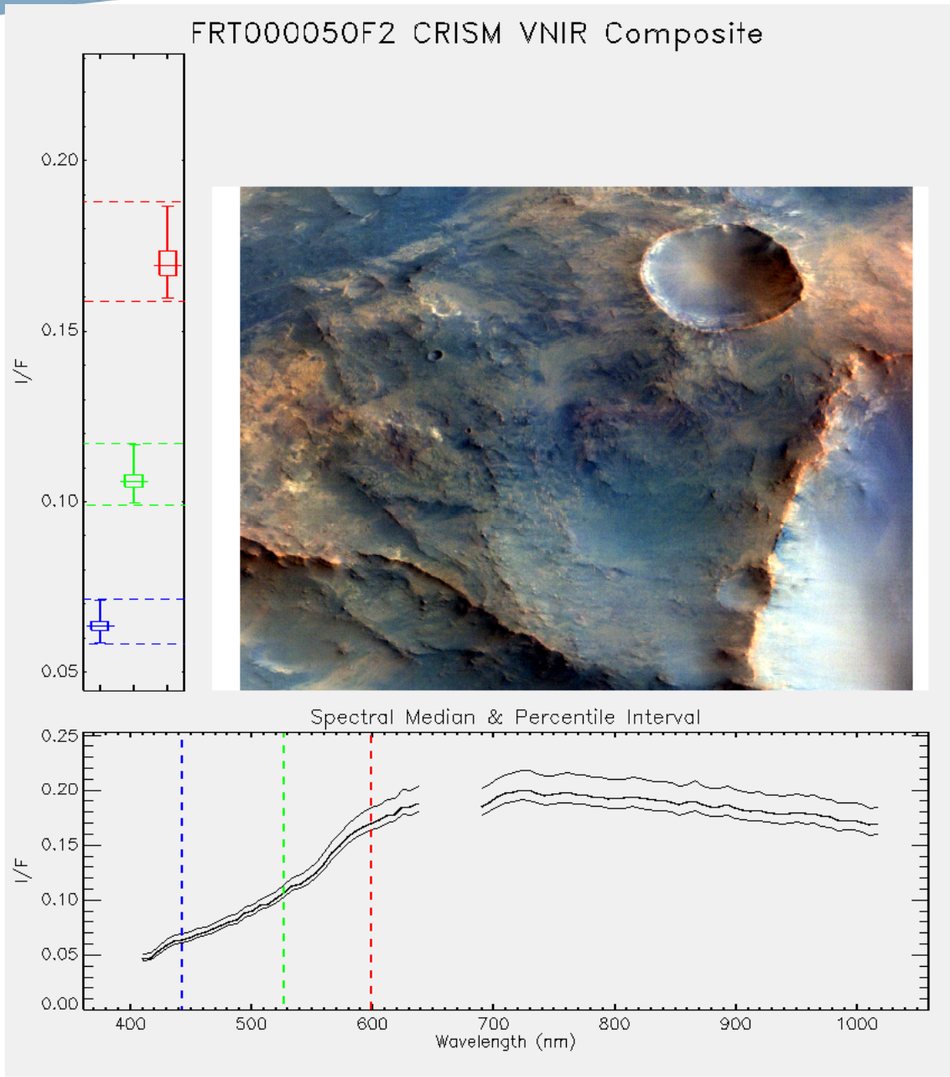



FRT000050F2_S_COMPOSITE_05.PNG

./ter/EXTRAS/

# TER VNIR Progression – 3/4

Empirical Smile Correction (S, L)

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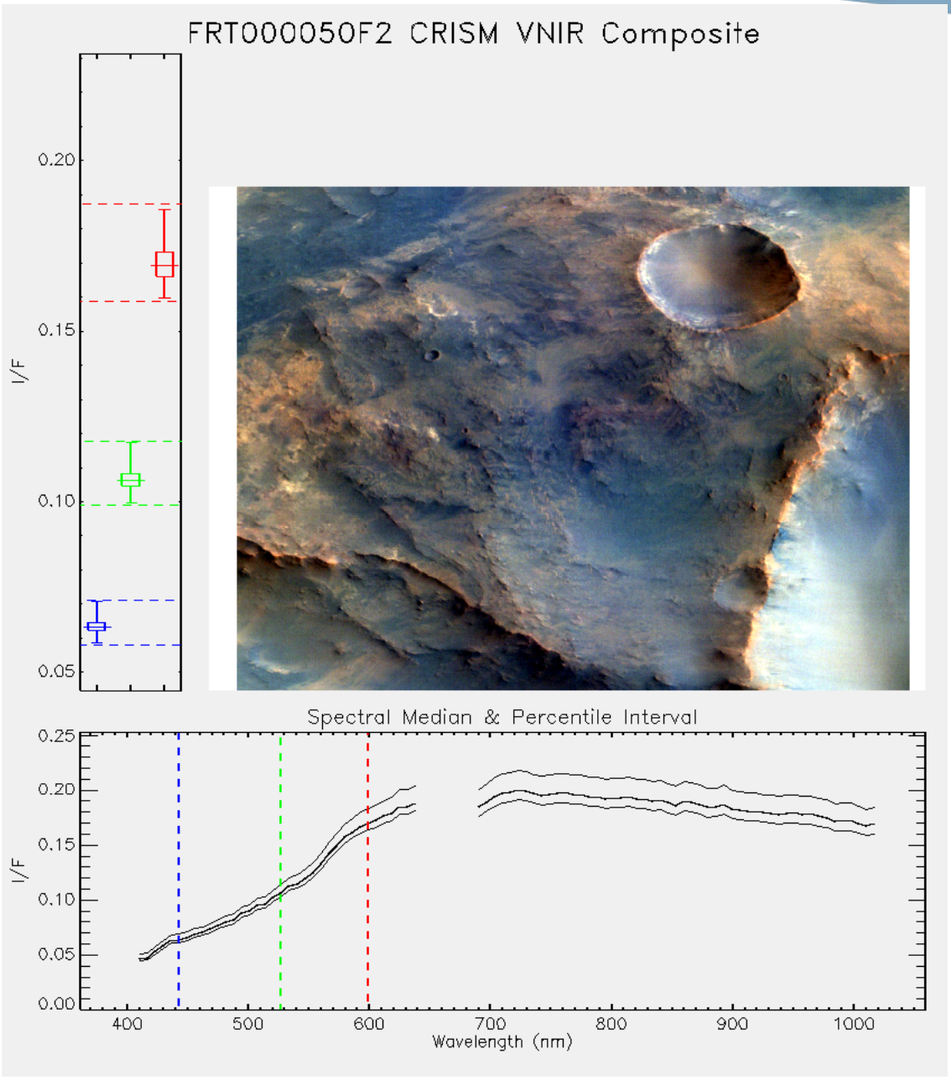
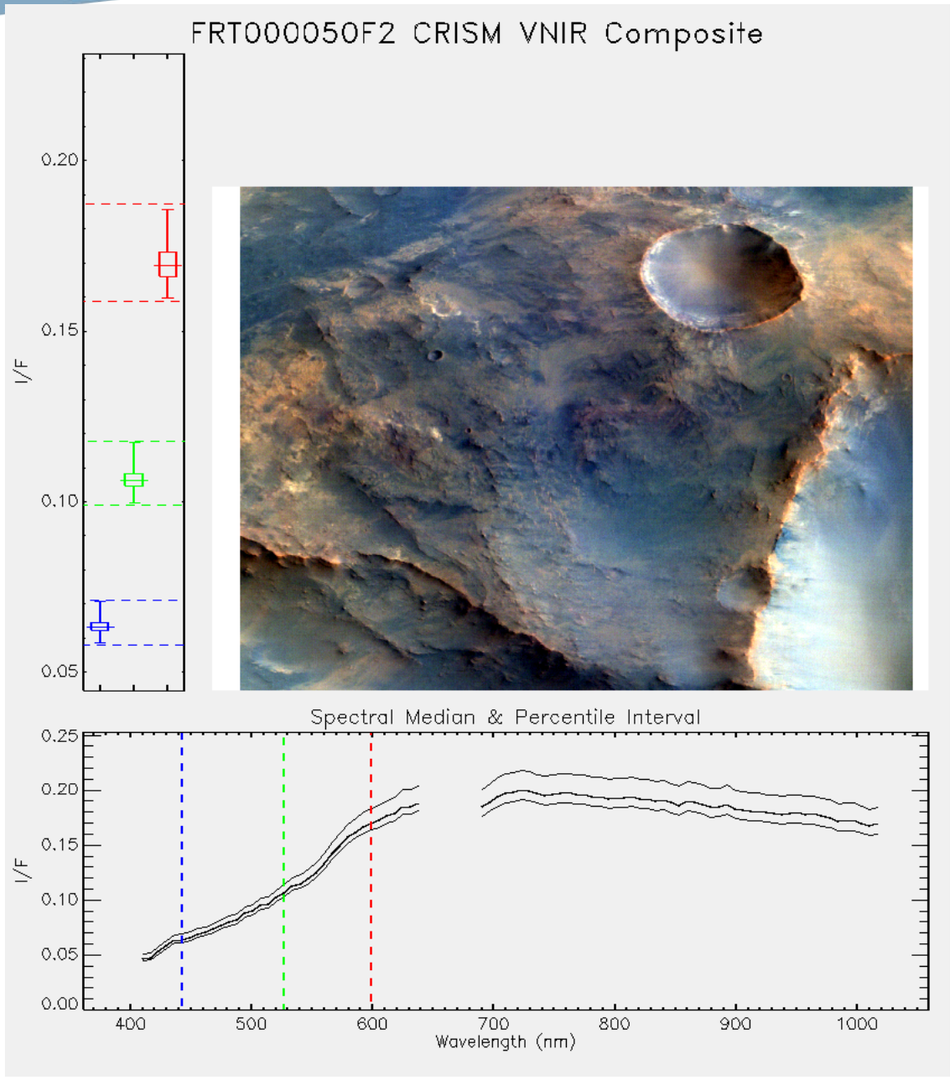



FRT000050F2_S_COMPOSITE_06.PNG

./ter/EXTRAS/

# TER VNIR Progression – 4/4

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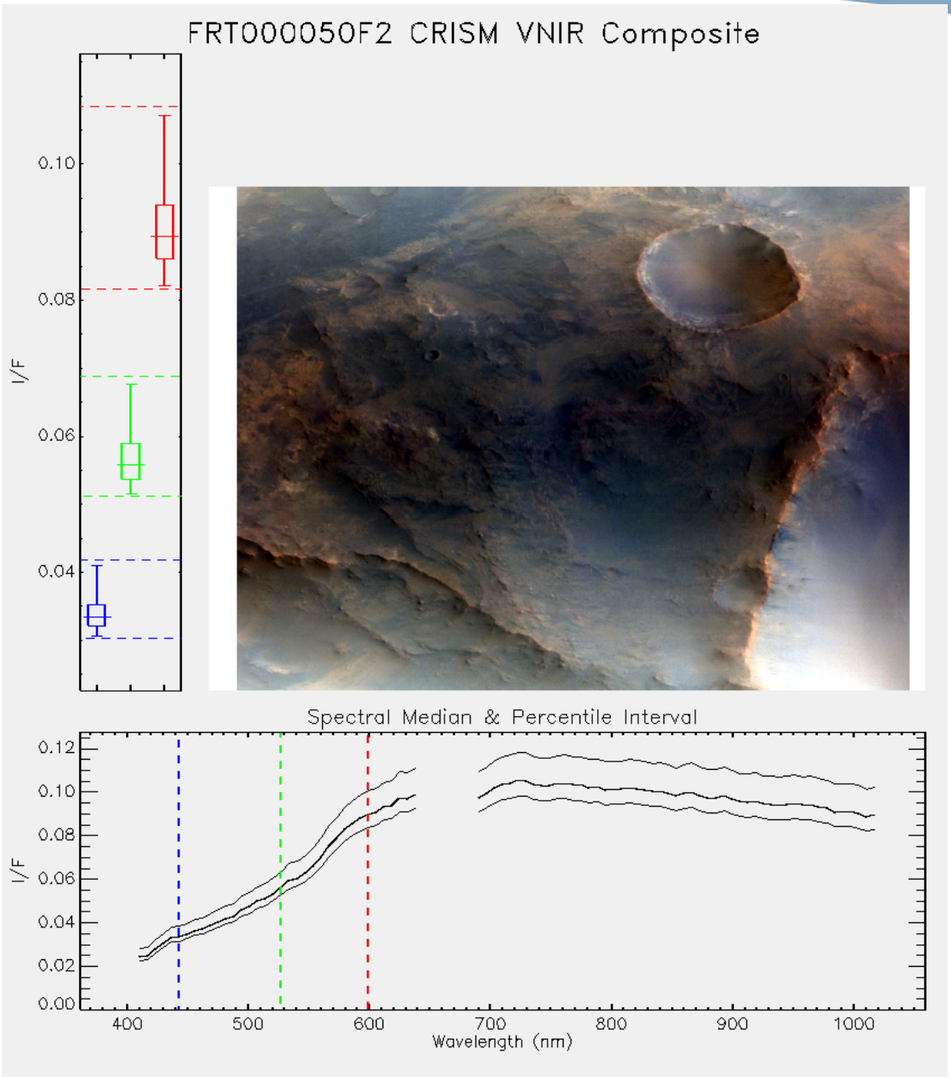
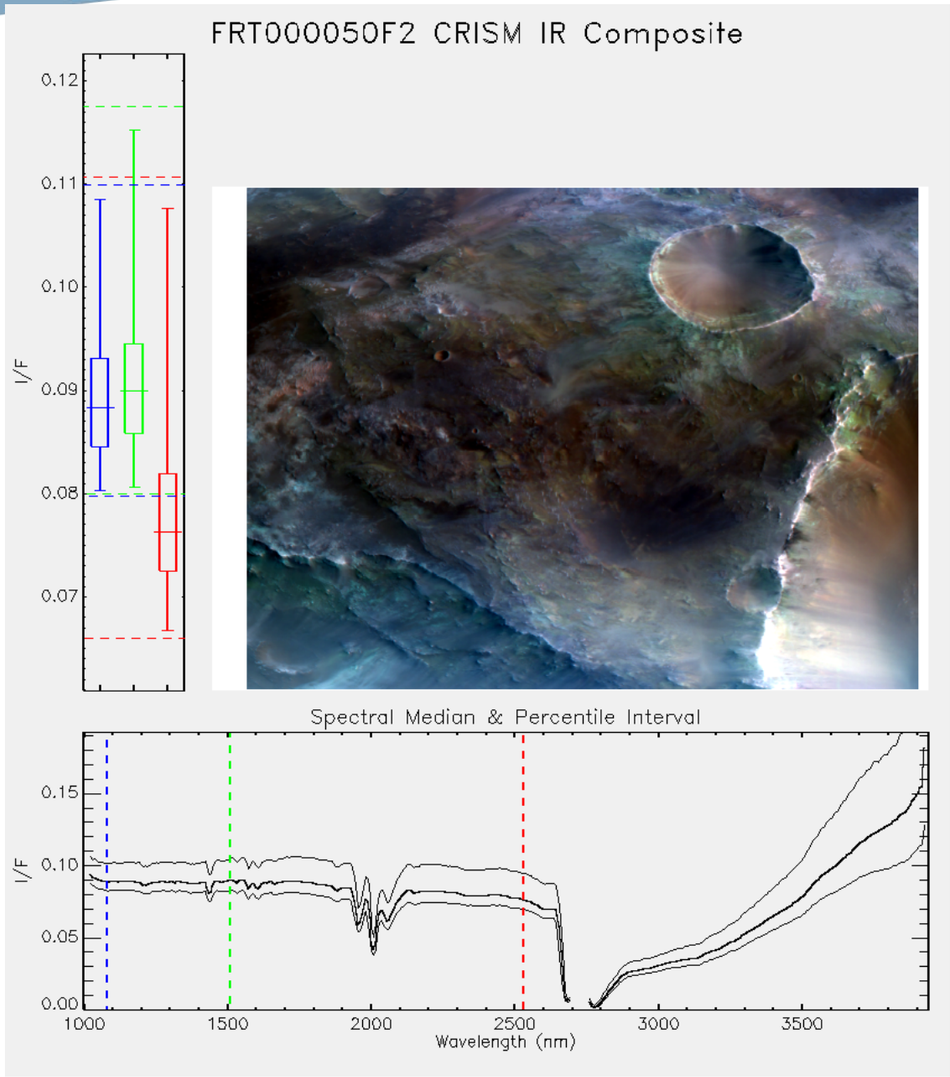



FRT000050F2_S_COMPOSITE_01.PNG

./ter/EXTRAS/

# TER IR Progression – 1/6

Photometric Correction (S, L)

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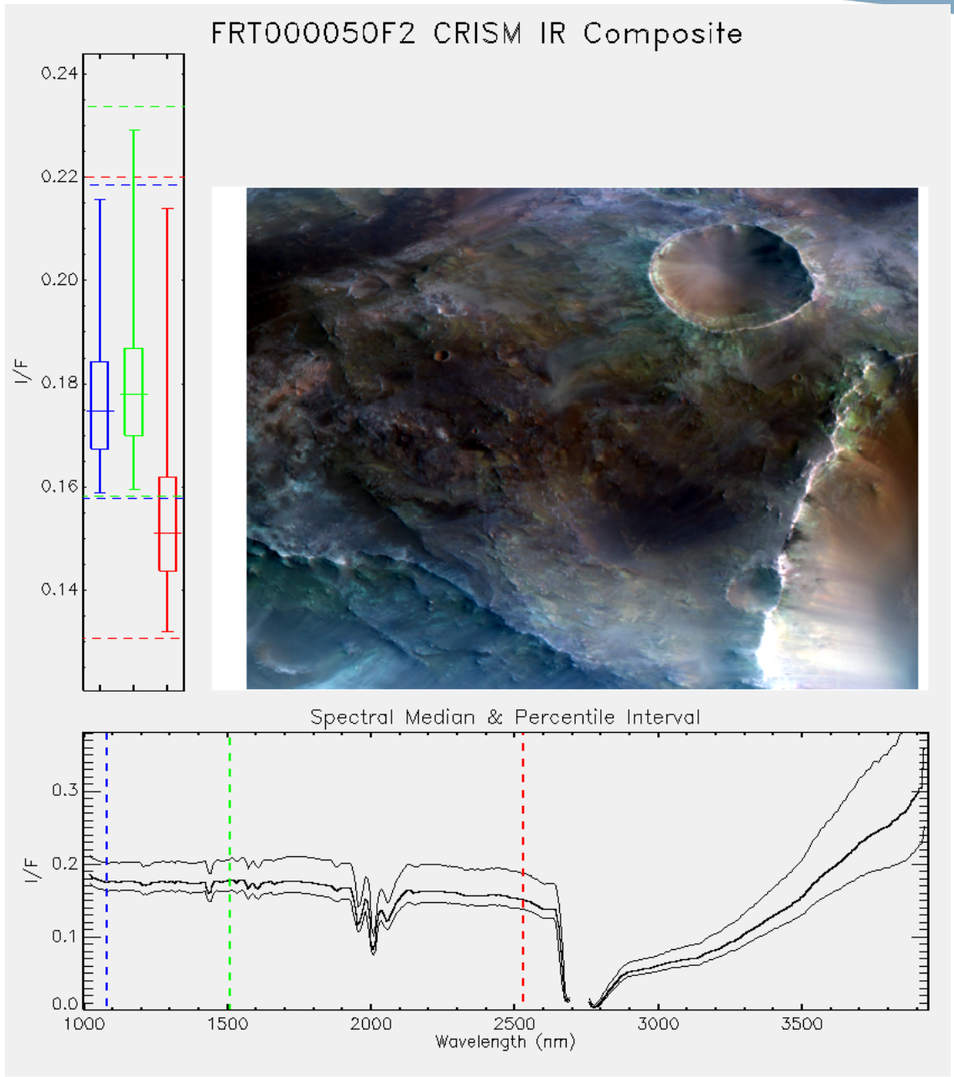
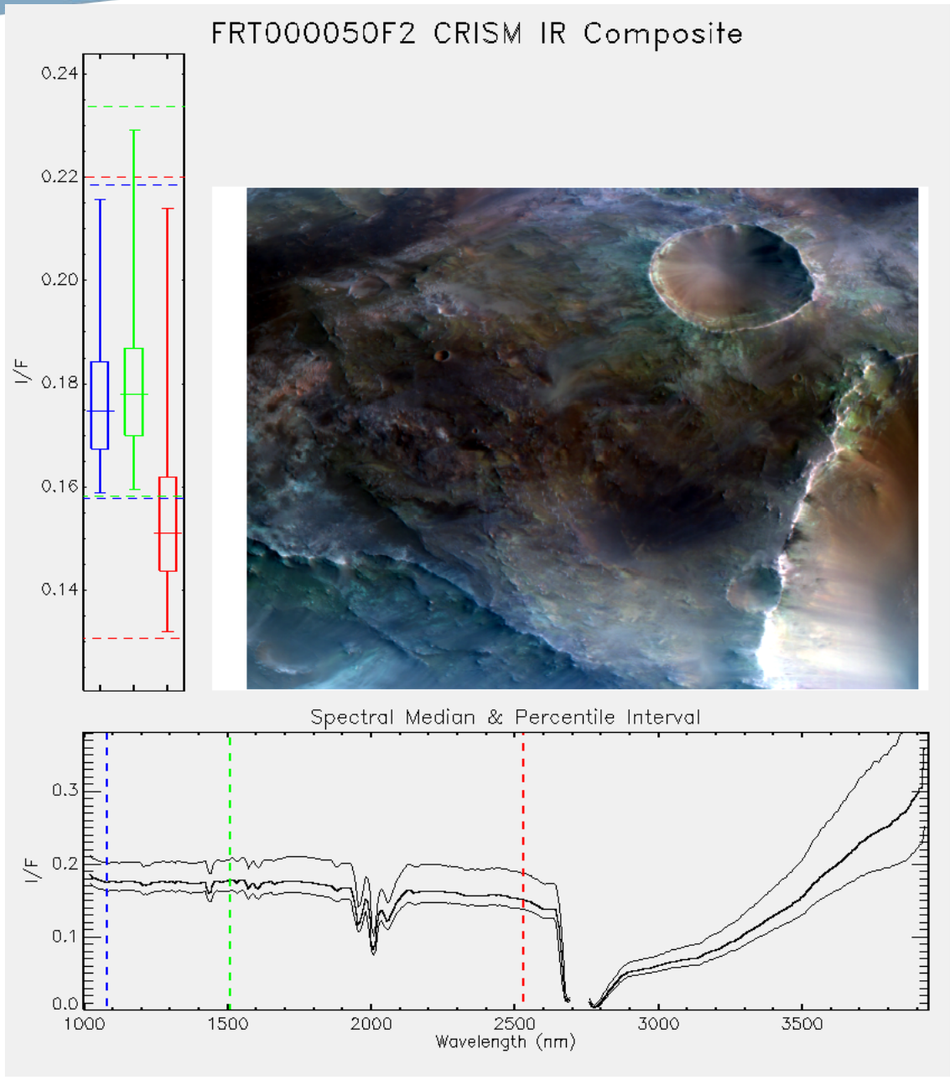



FRT000050F2_L_COMPOSITE_02.PNG

./ter/EXTRAS/

# TER IR Progression – 2/6

Atmospheric Correction (L)

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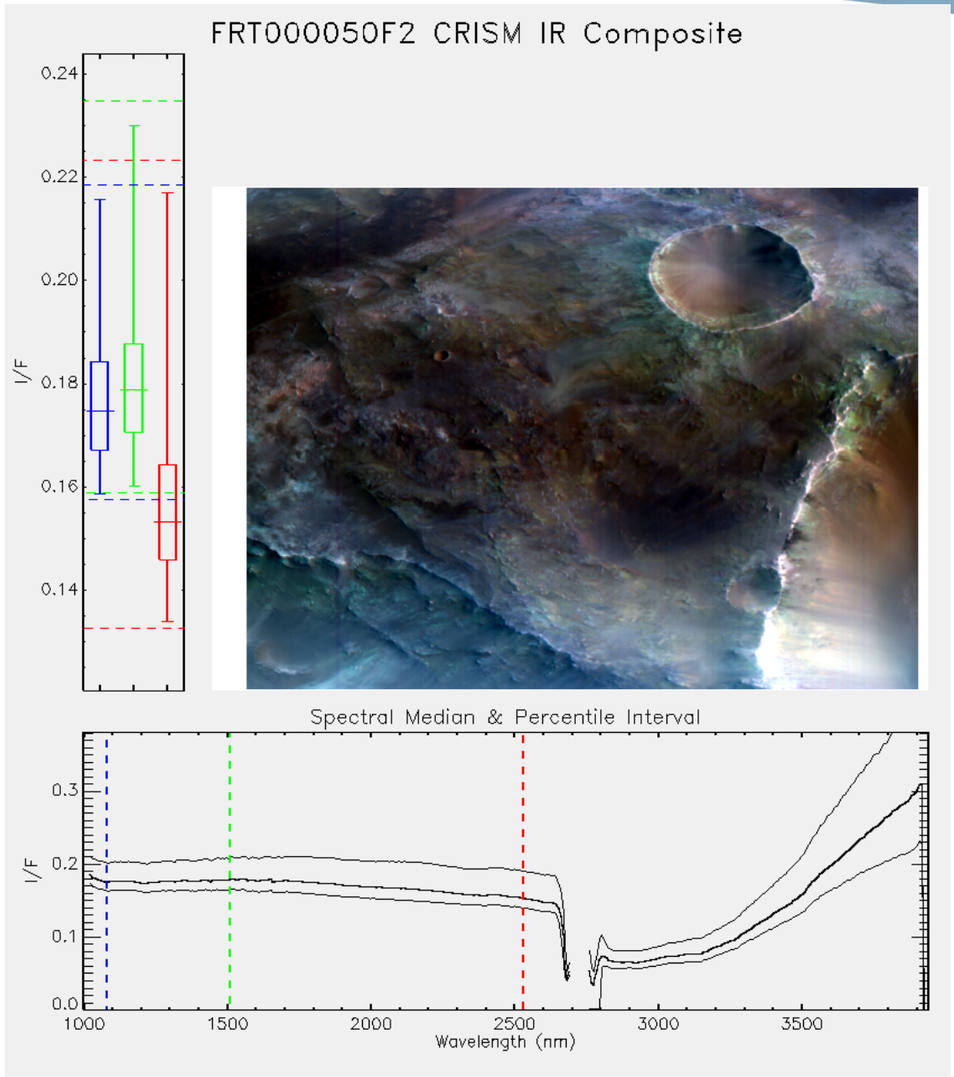
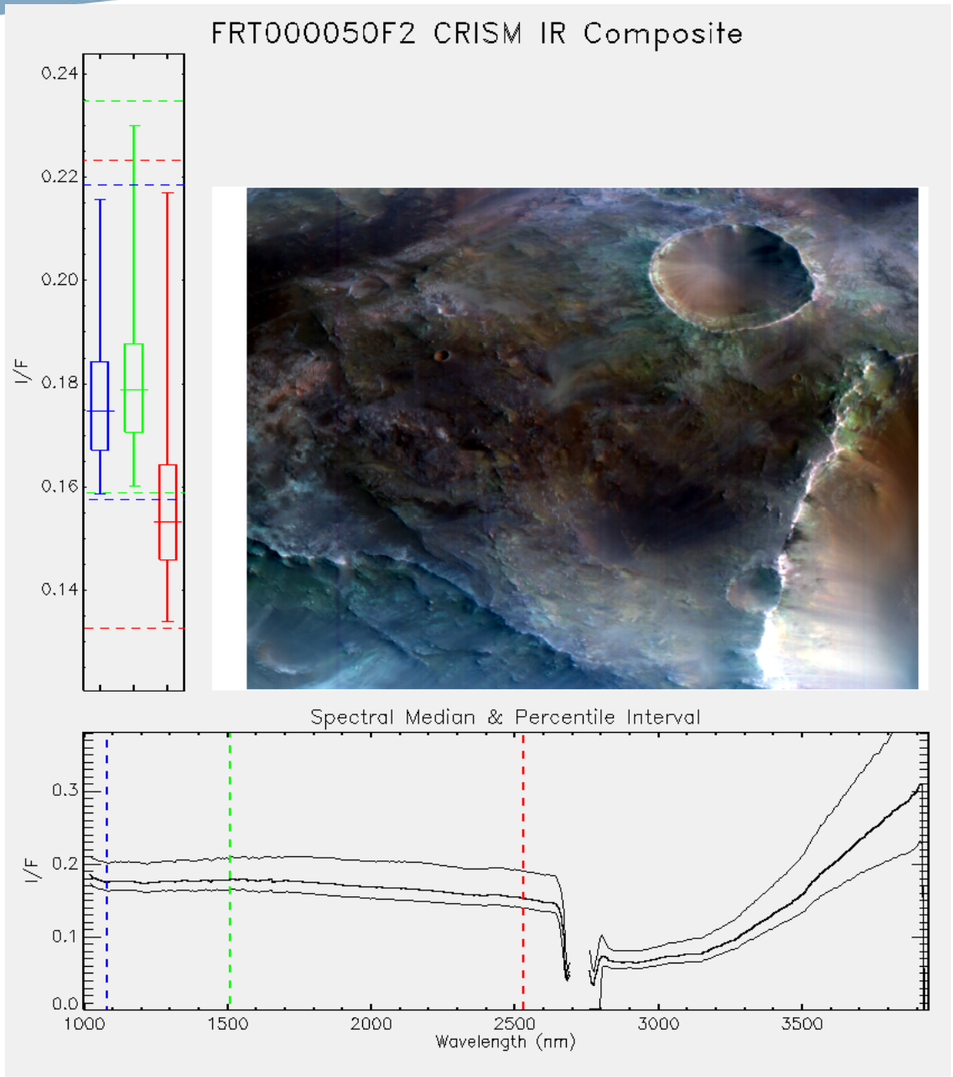



FRT000050F2_L_COMPOSITE_03.PNG

./ter/EXTRAS/

# TER IR Progression – 3/6

Ratio Shift Correction (L)

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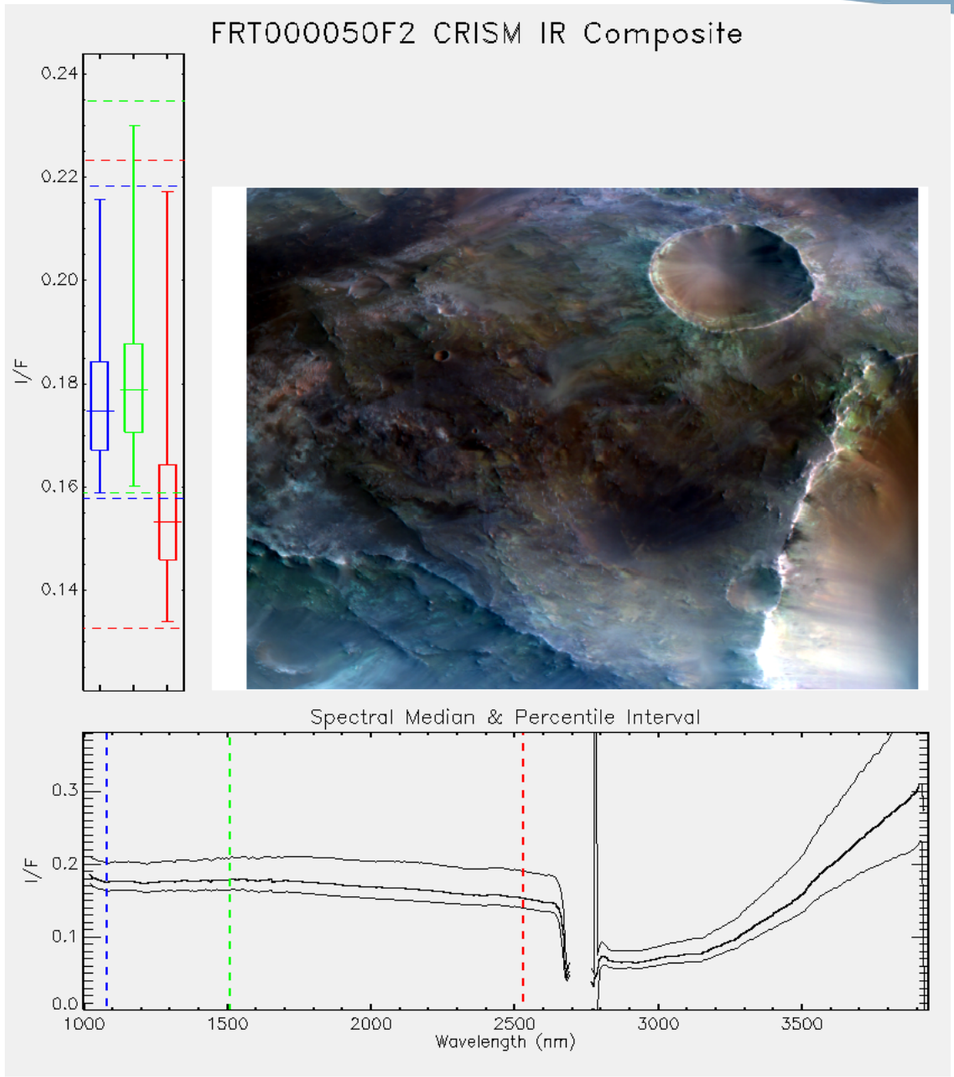
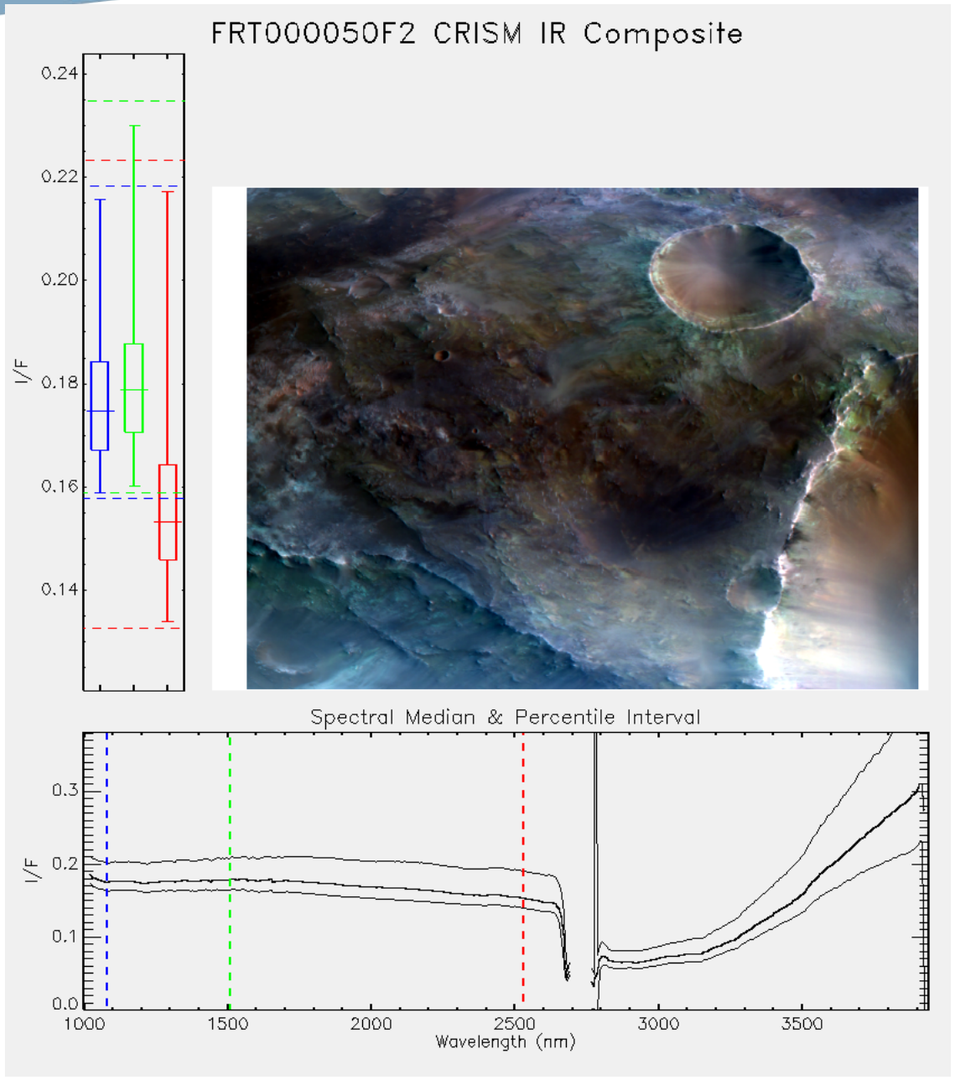



FRT000050F2_L_COMPOSITE_04.PNG

./ter/EXTRAS/

# TER IR Progression – 4/6

Empirical Geometric Normalization (S, L)

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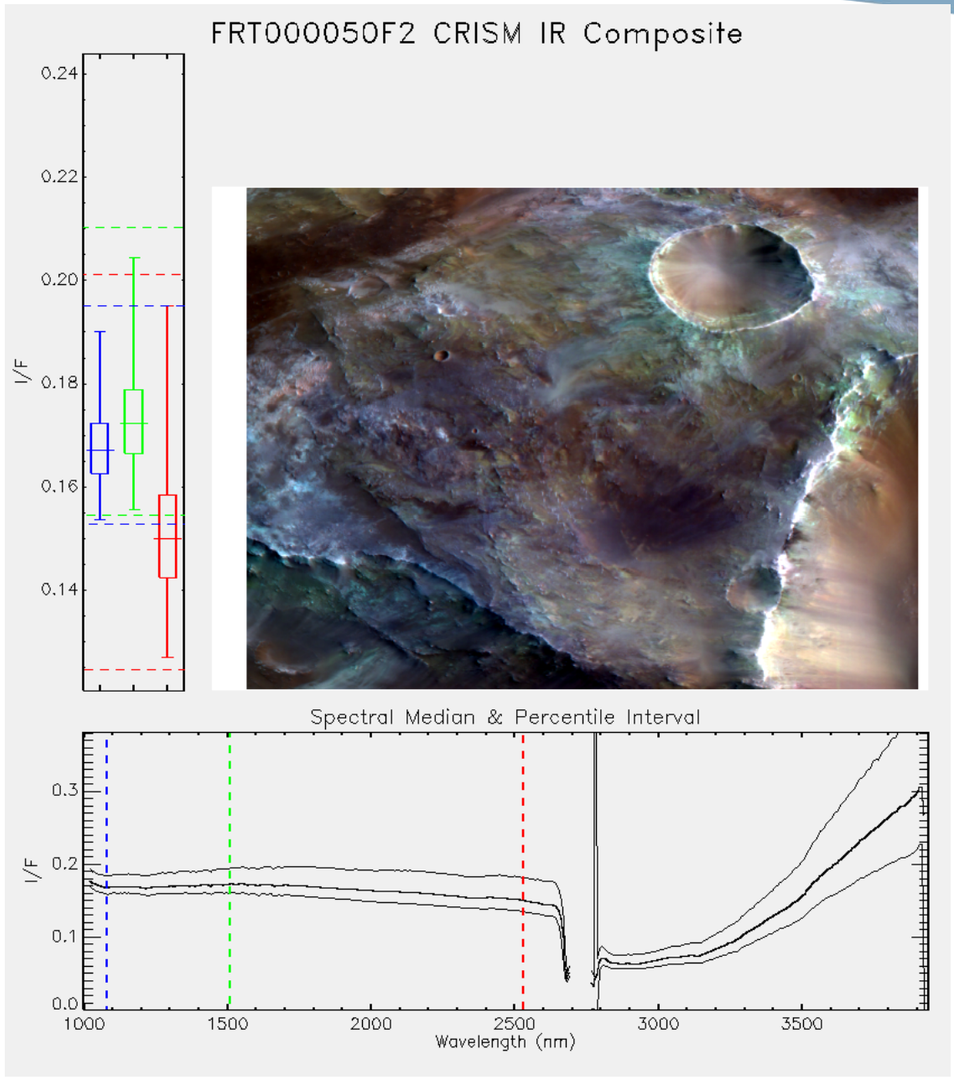
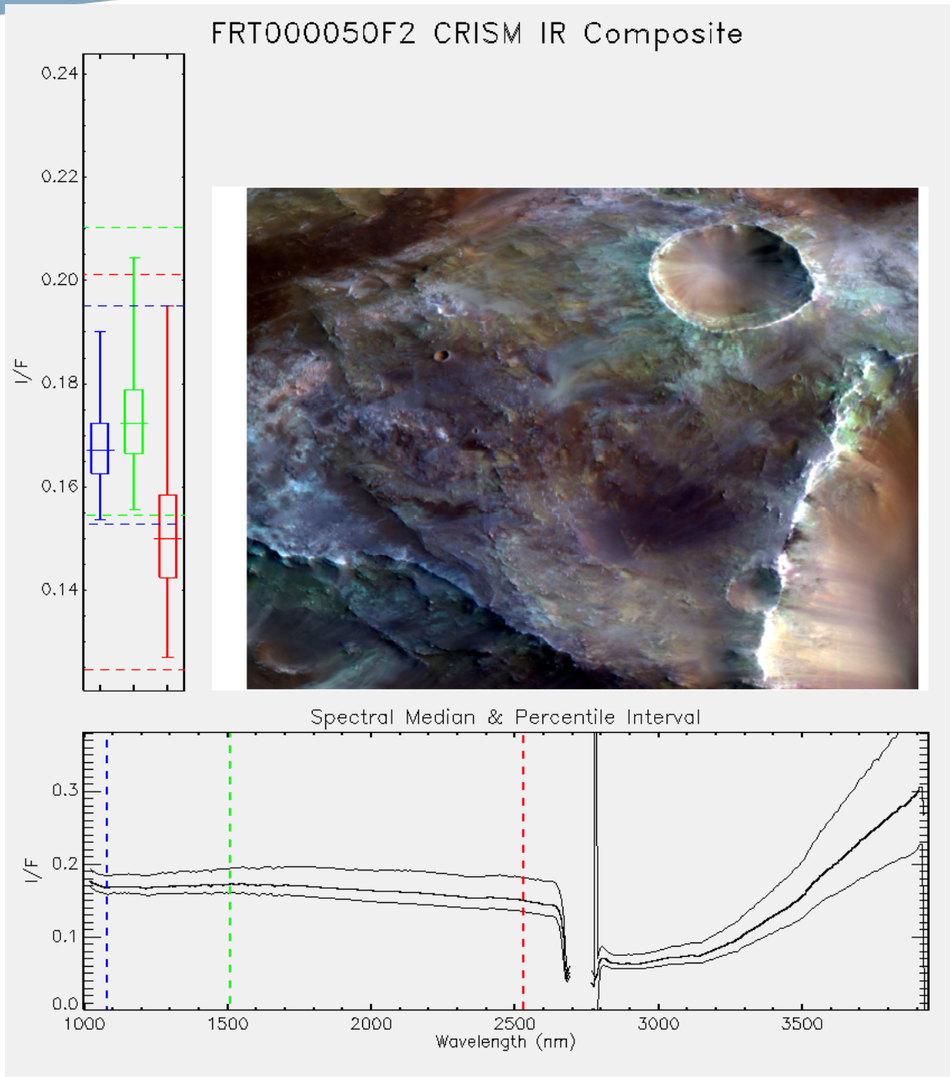



FRT000050F2_L_COMPOSITE_05.PNG

./ter/EXTRAS/

# TER IR Progression – 5/6

Empirical Smile Correction (S, L)

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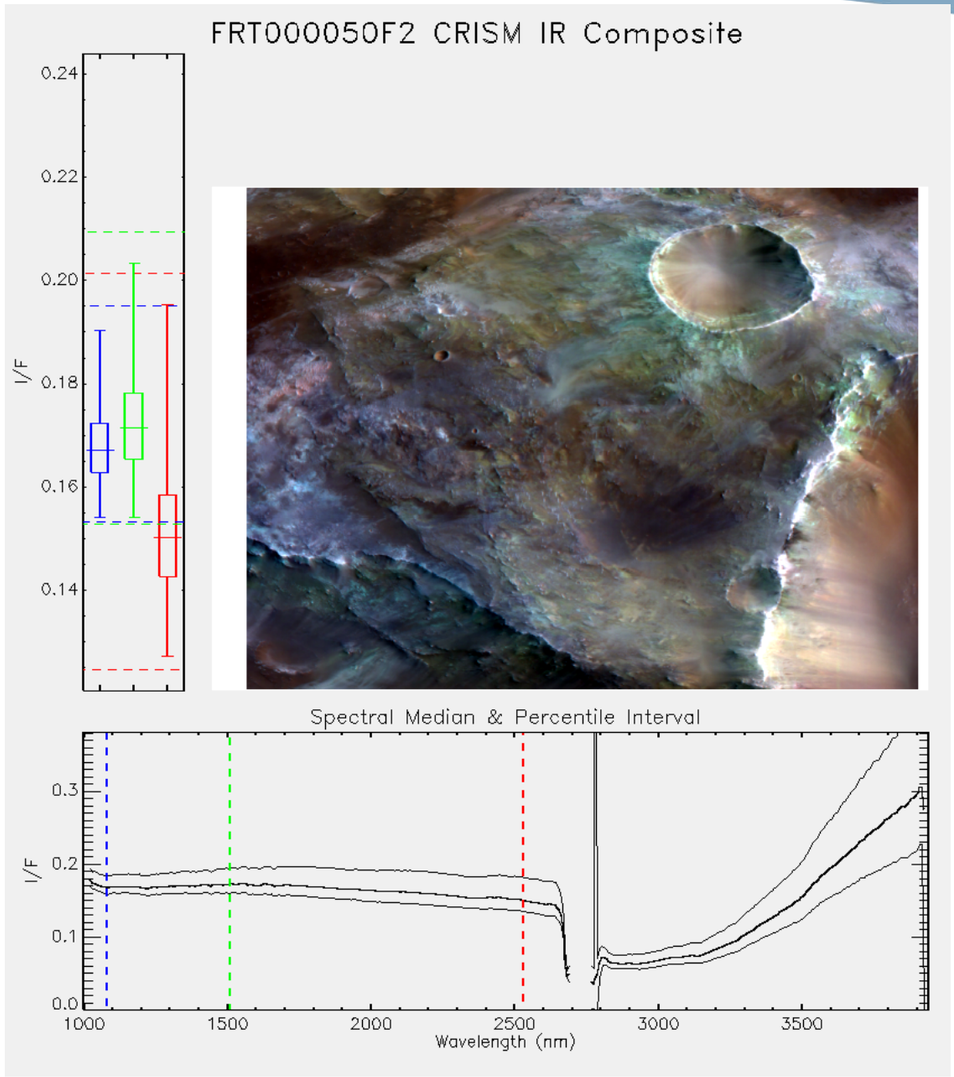
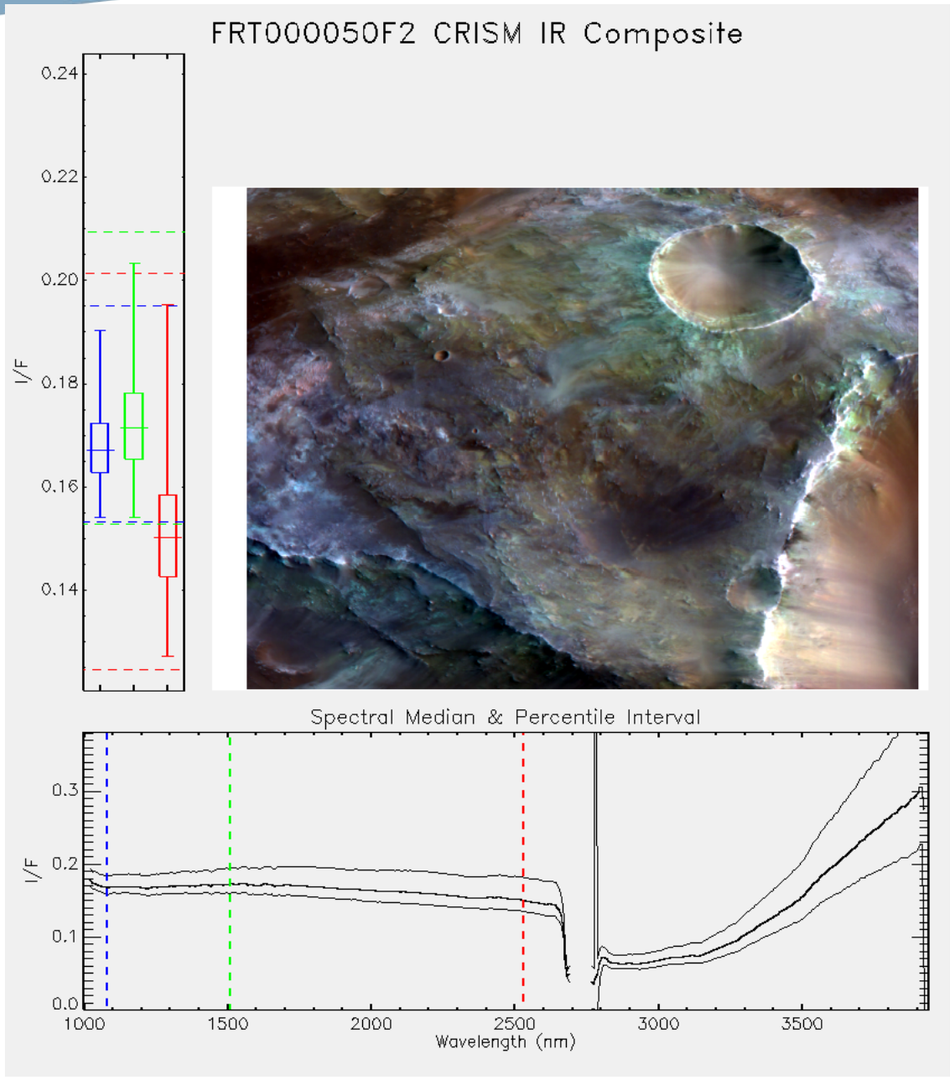



FRT000050F2_L_COMPOSITE_06.PNG

./ter/EXTRAS/

# TER IR Progression – 6/6

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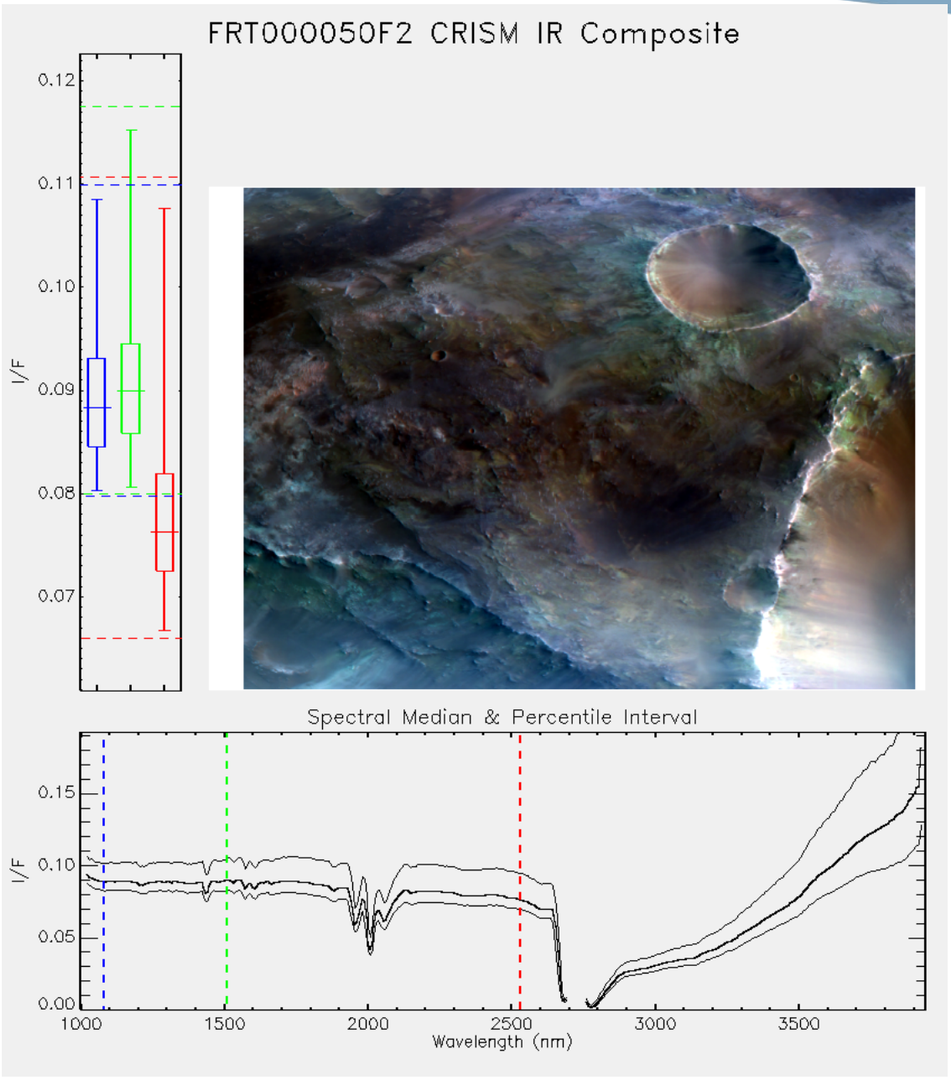
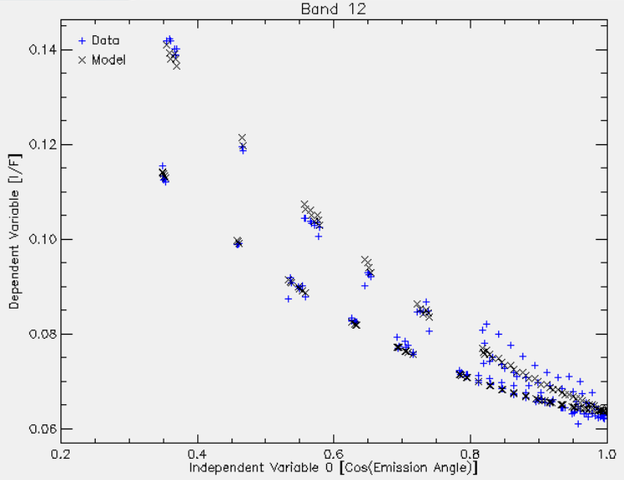



FRT000050F2_L_COMPOSITE_01.PNG

./ter/EXTRAS/

# TER VNIR EGN - Detail

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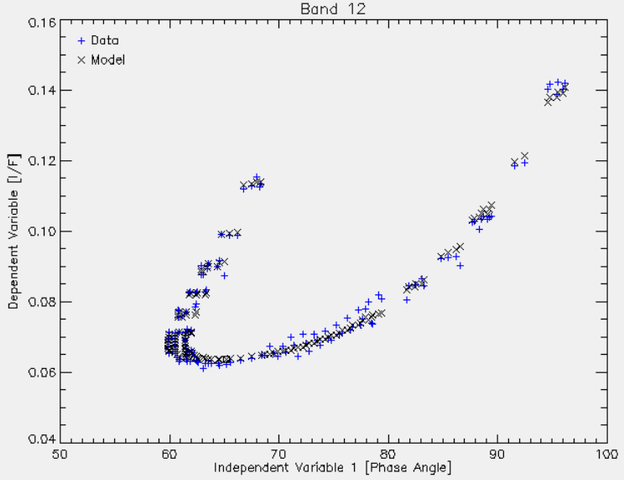


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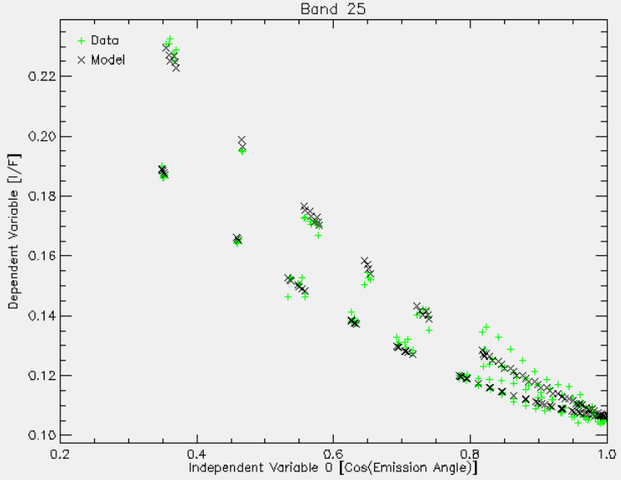


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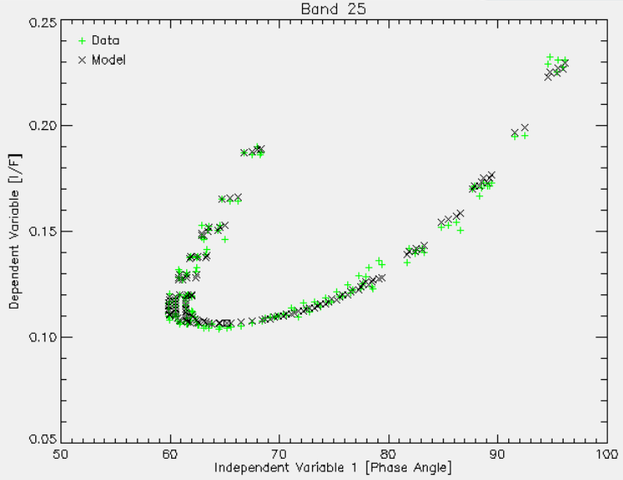


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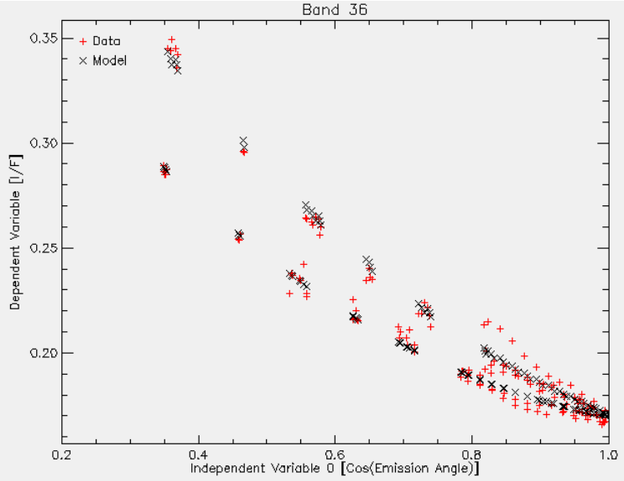


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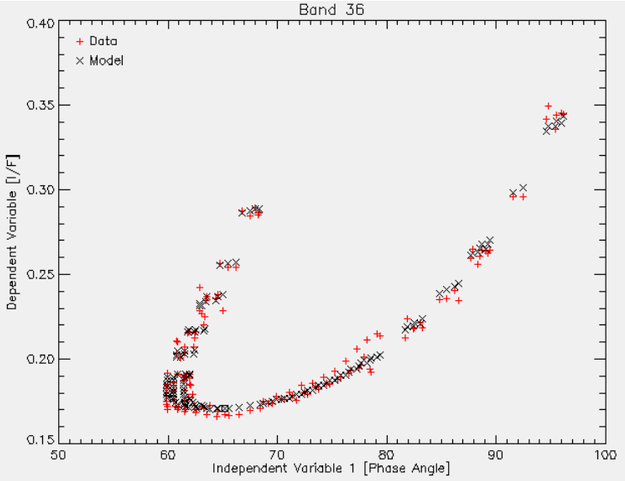


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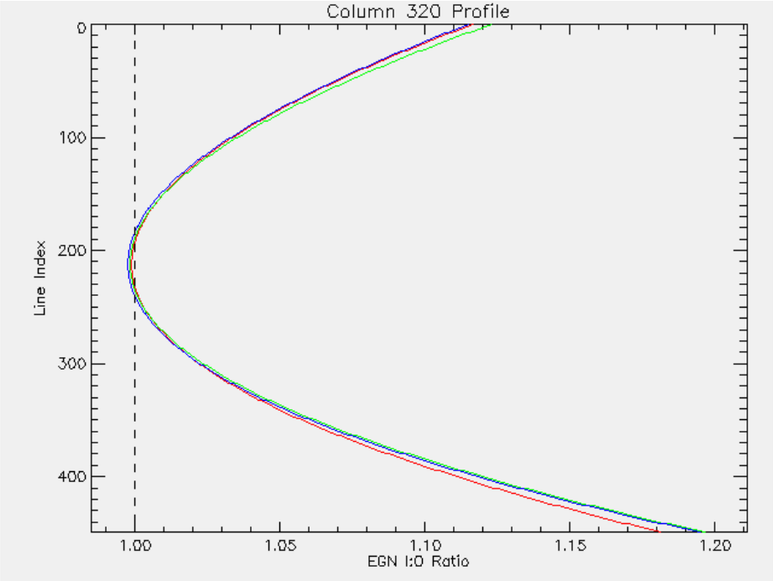
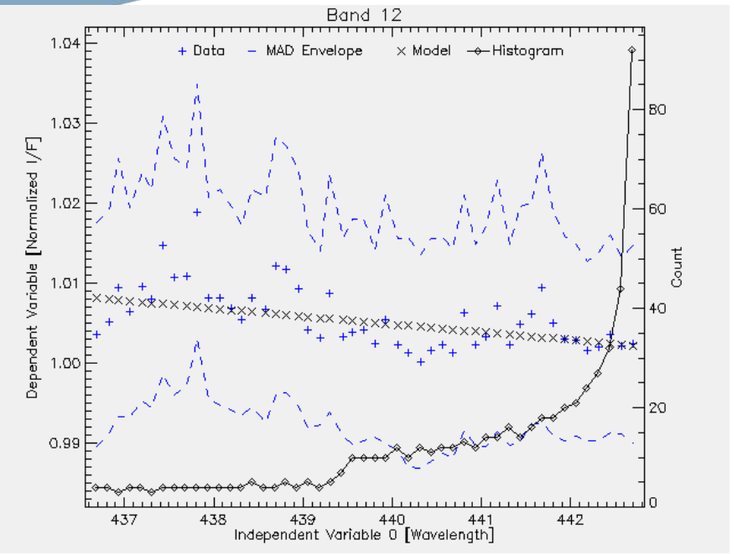
./ter/EXTRAS/




FRT000050F2_S_EGN_PRO.PNG

Empirical Geometric Normalization (S, L)

# TER VNIR ESC - Detail

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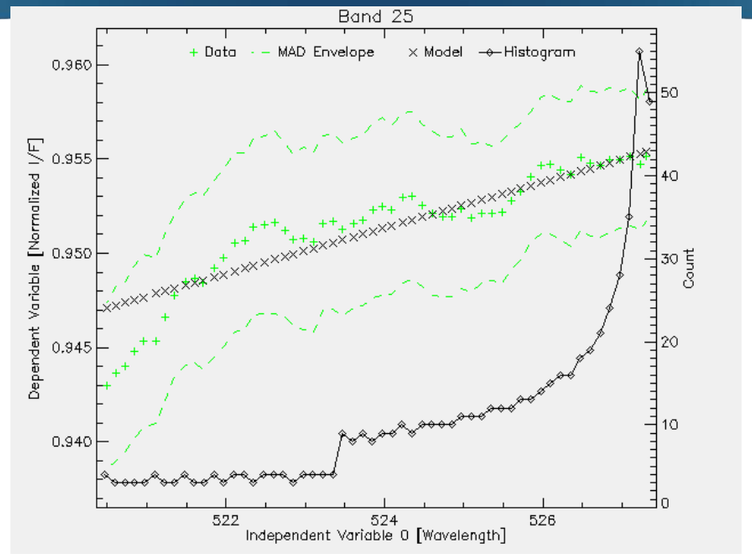


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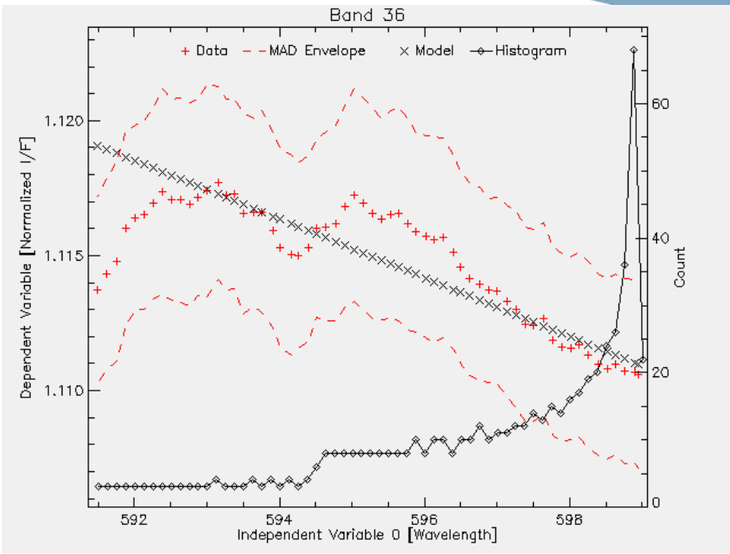


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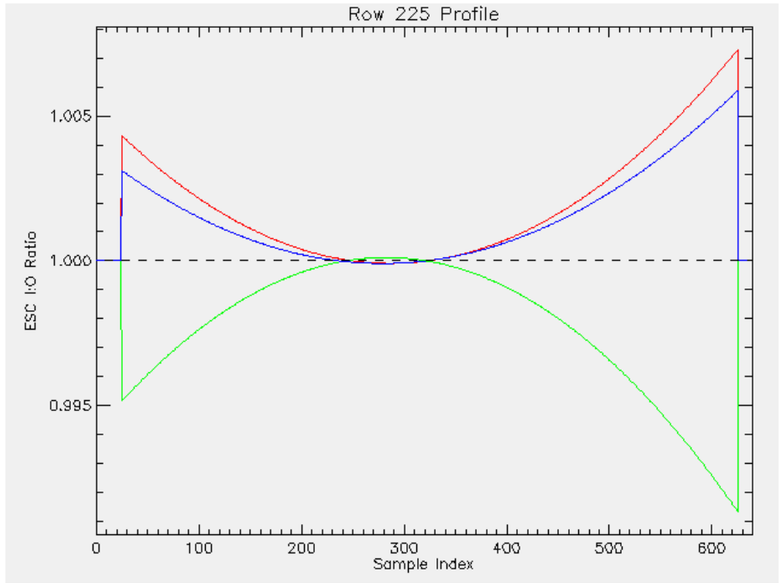
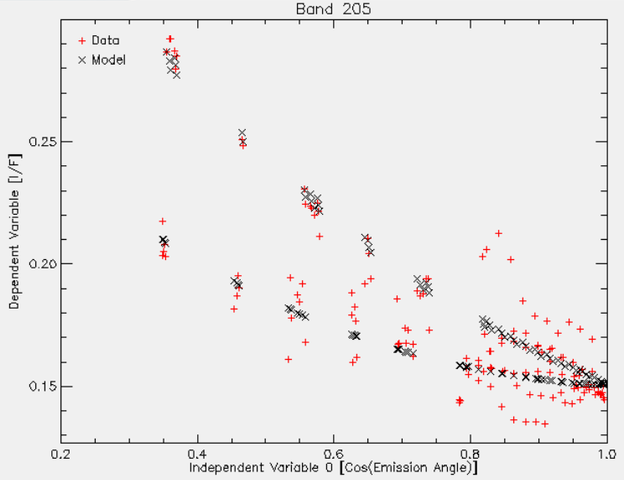



FRT000050F2_S_ESC_PRO.PNG

Empirical Smile Correction (S, L)

./ter/EXTRAS/

# TER IR EGN - Detail

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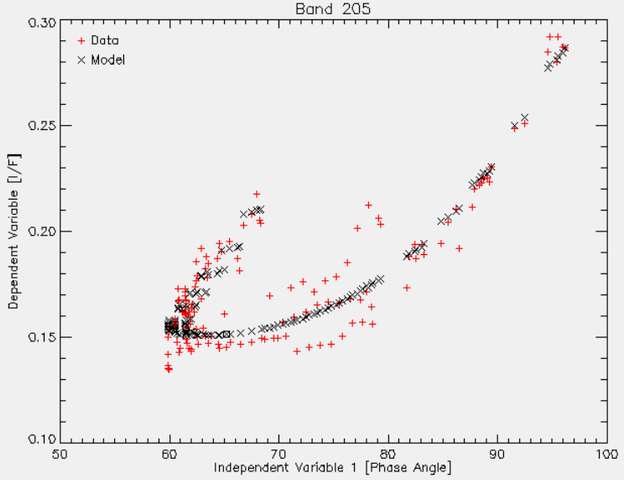


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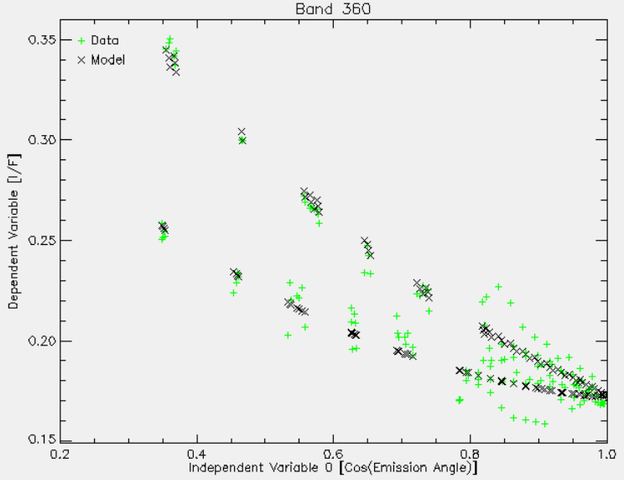


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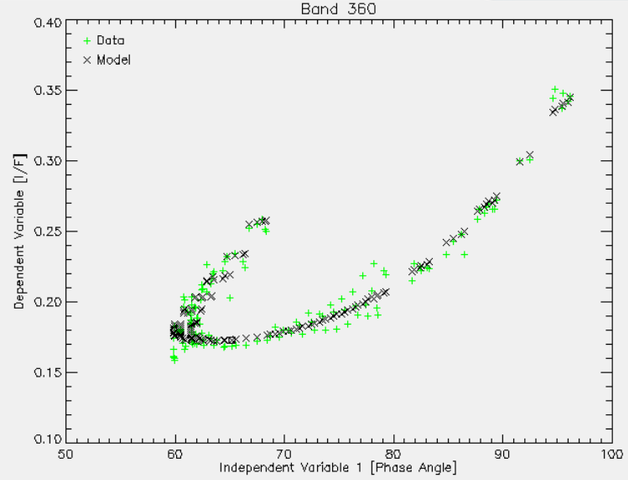


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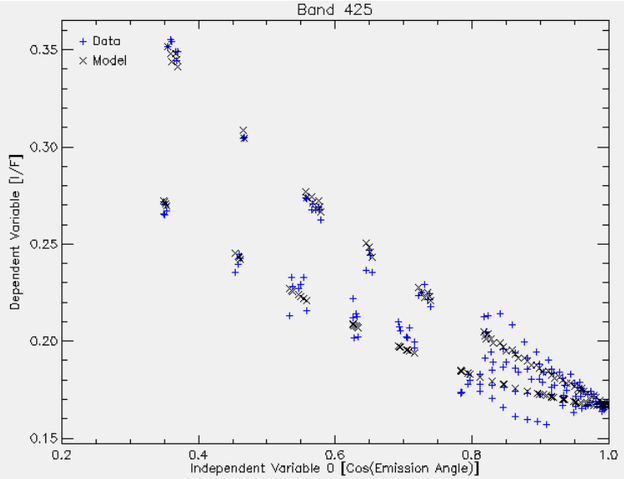


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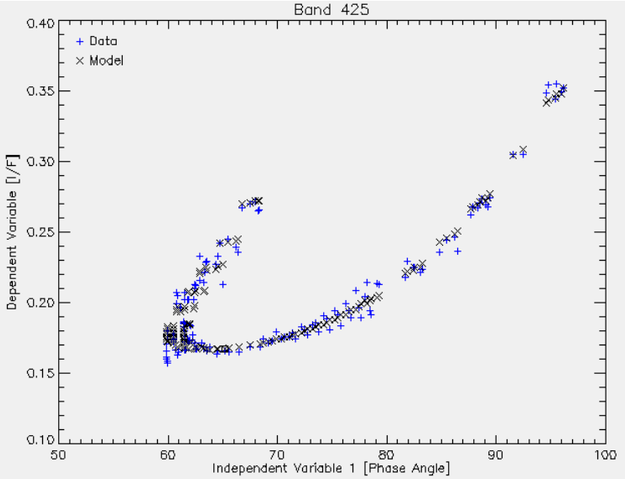


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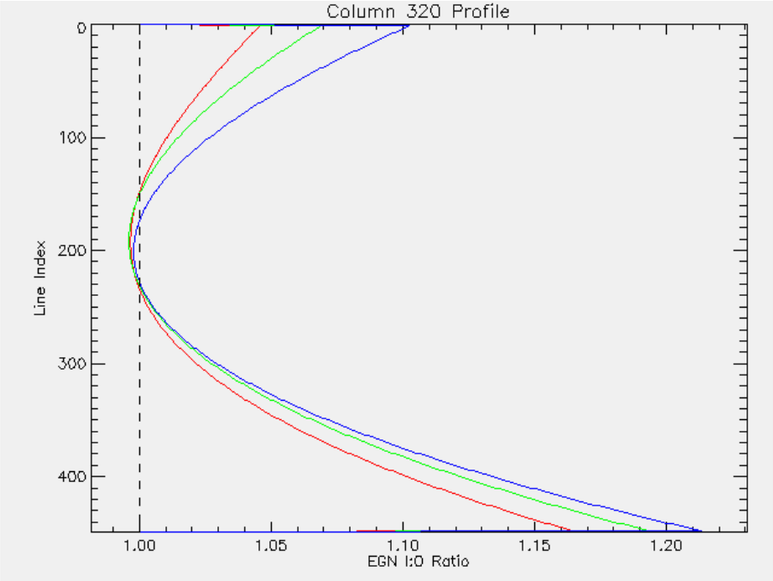
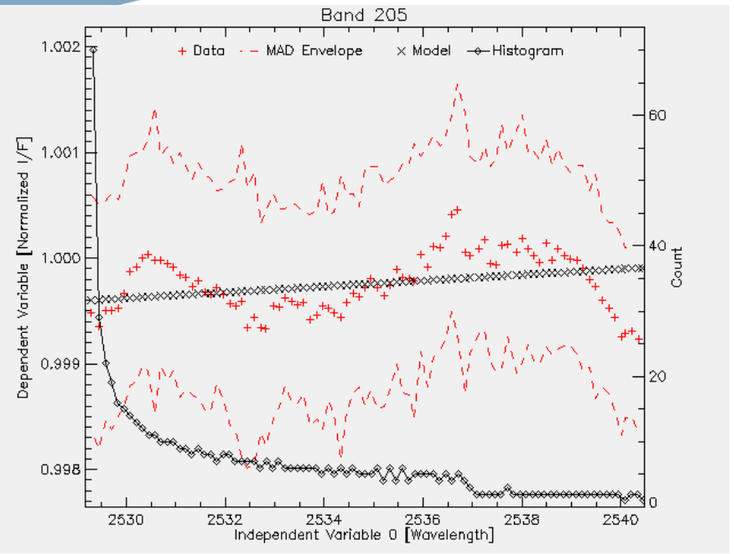
./ter/EXTRAS/




FRT000050F2_L_EGN_PRO.PNG

Empirical Geometric Normalization (S, L)

# TER IR ESC - Detail

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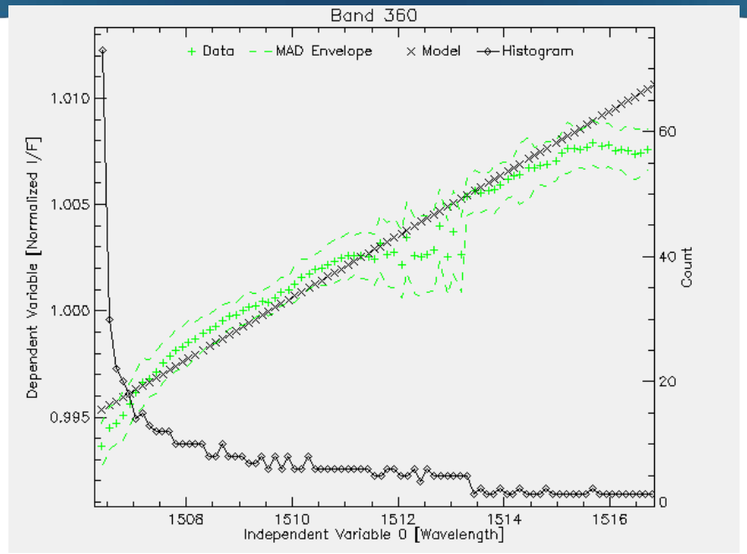


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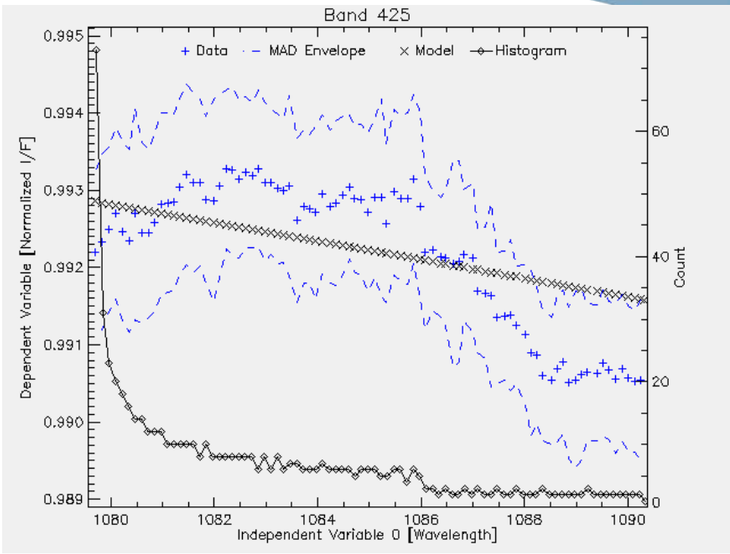


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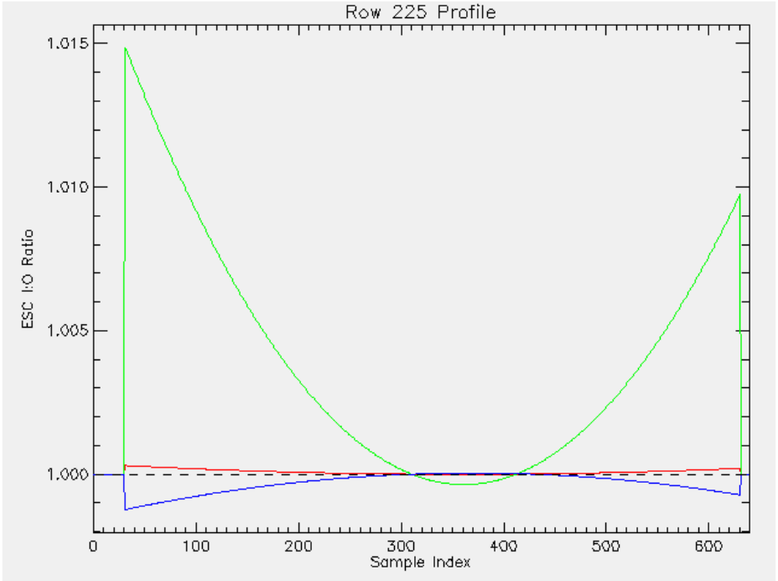
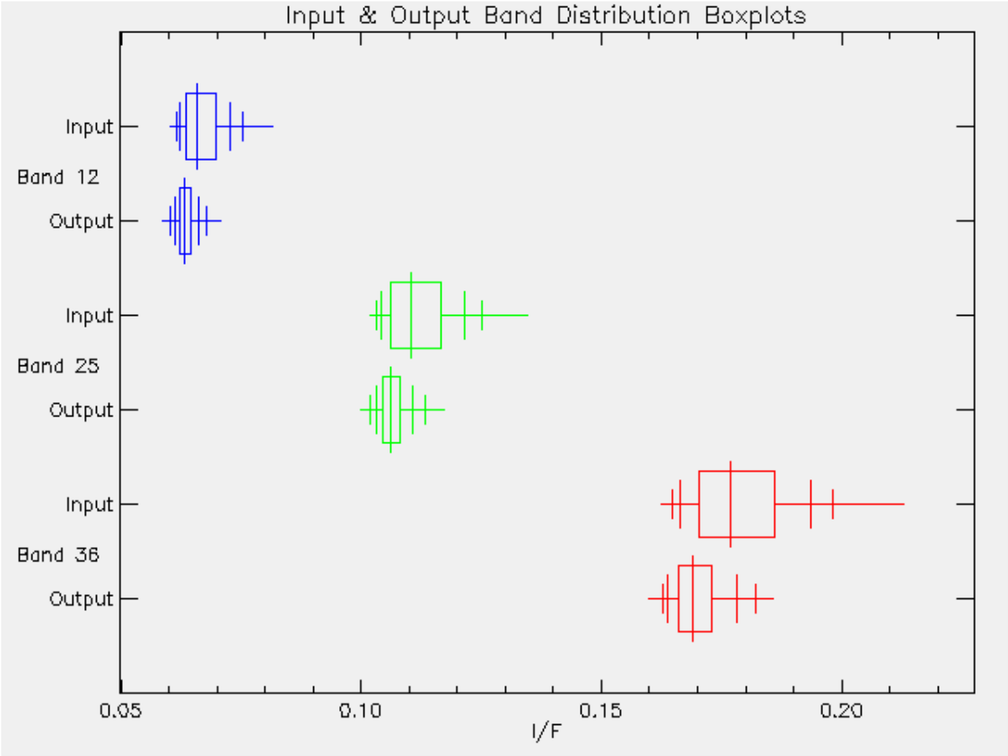



FRT000050F2_L_ESC_PRO.PNG

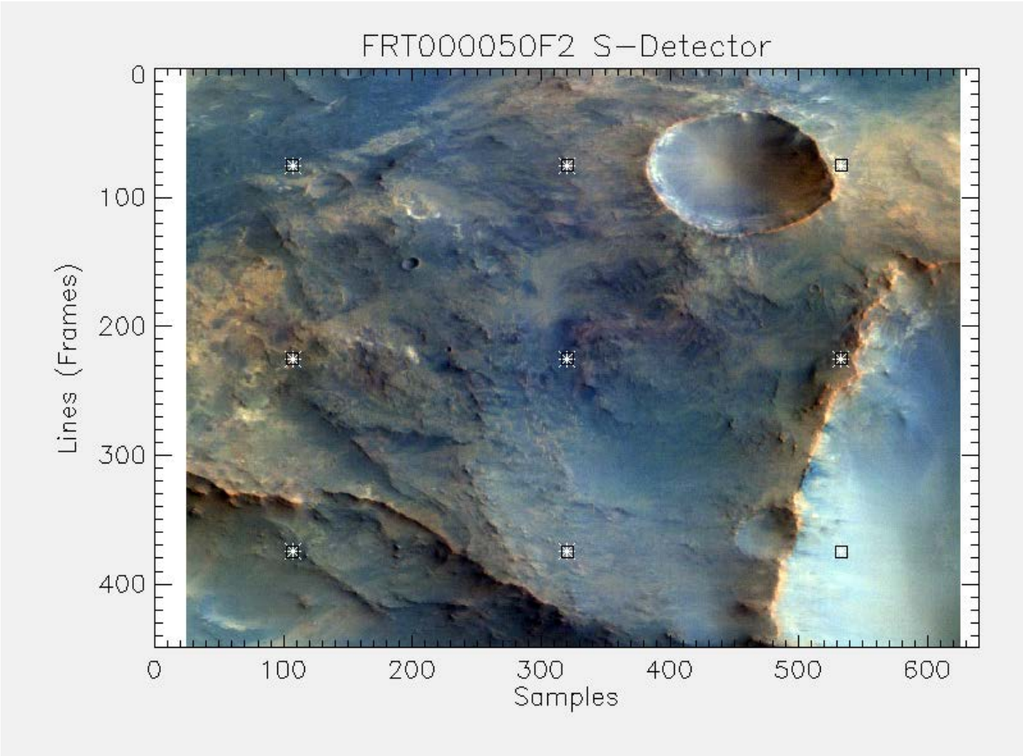
Empirical Smile Correction (S, L)

./ter/EXTRAS/

# TER VNIR ENG/ESC - Impact




FRT000050F2_S_EGN_ESC_DST.PNG



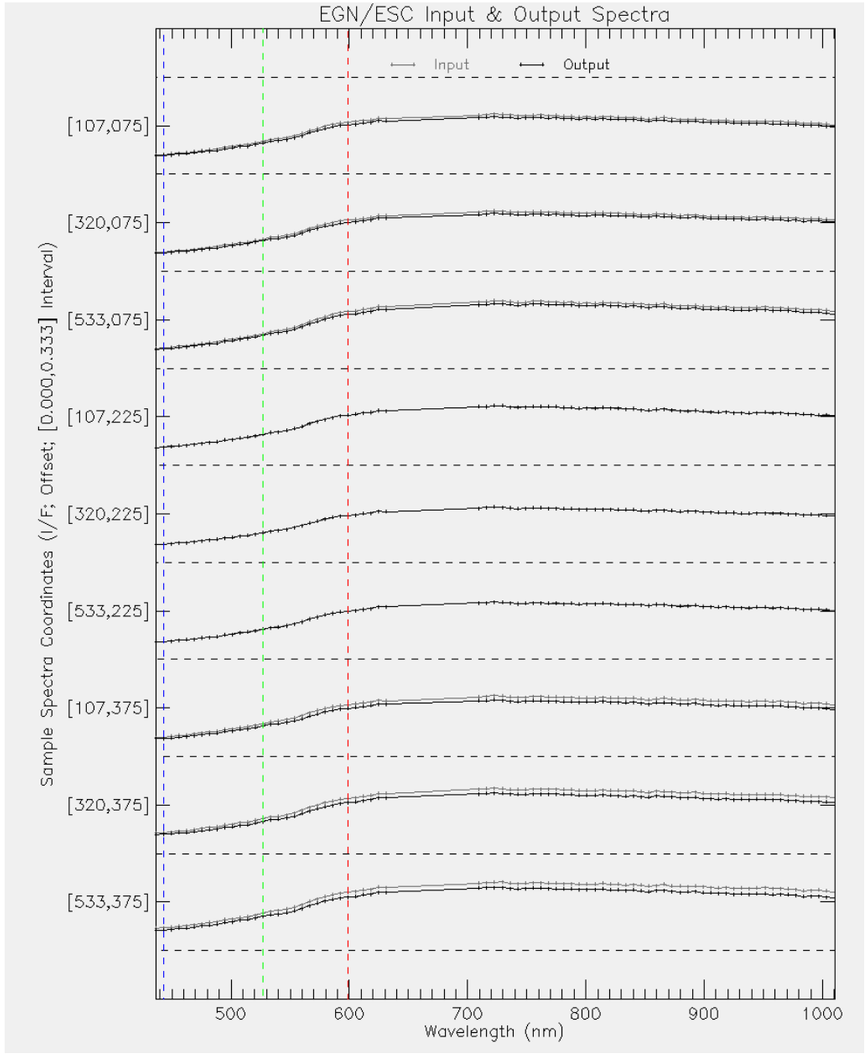

FRT000050F2_S_EGN_ESC_GRD.PNG
(TER TRU RGB Composite)

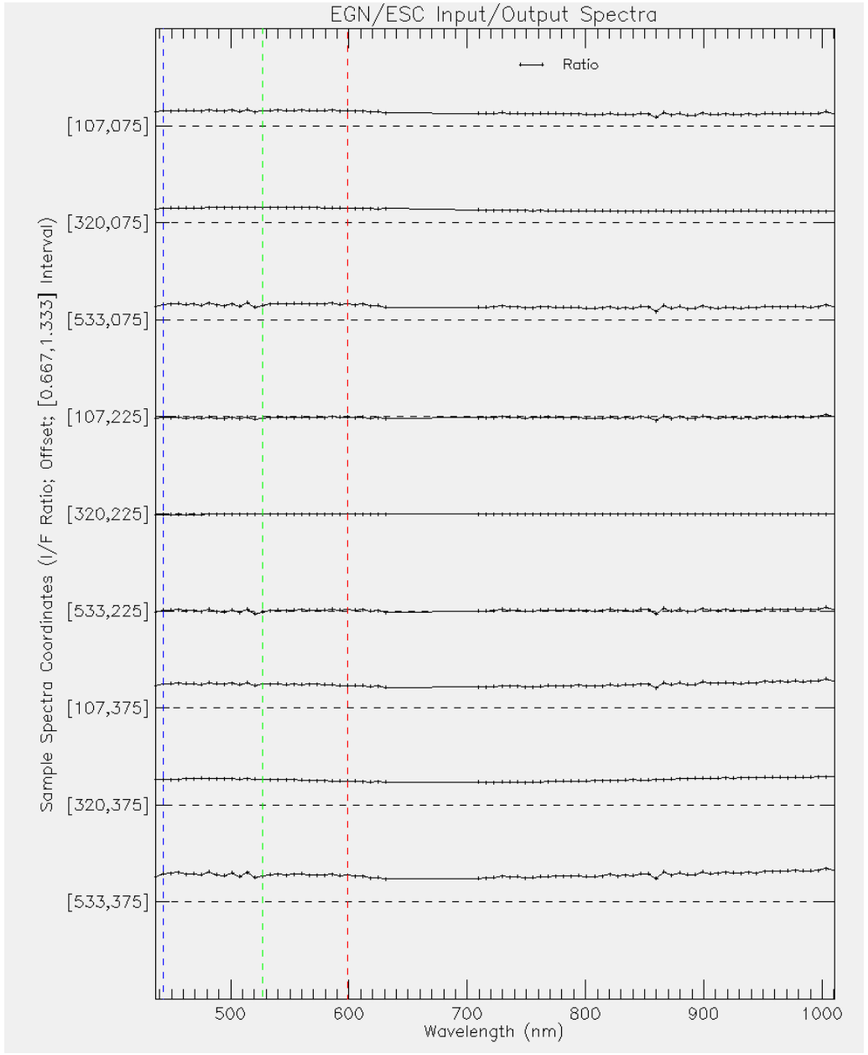
Empirical Geometric Normalization (S, L)

Empirical Smile Correction (S, L)

./ter/EXTRAS/

# TER VNIR ENG/ESC - Impact




./ter/EXTRAS/

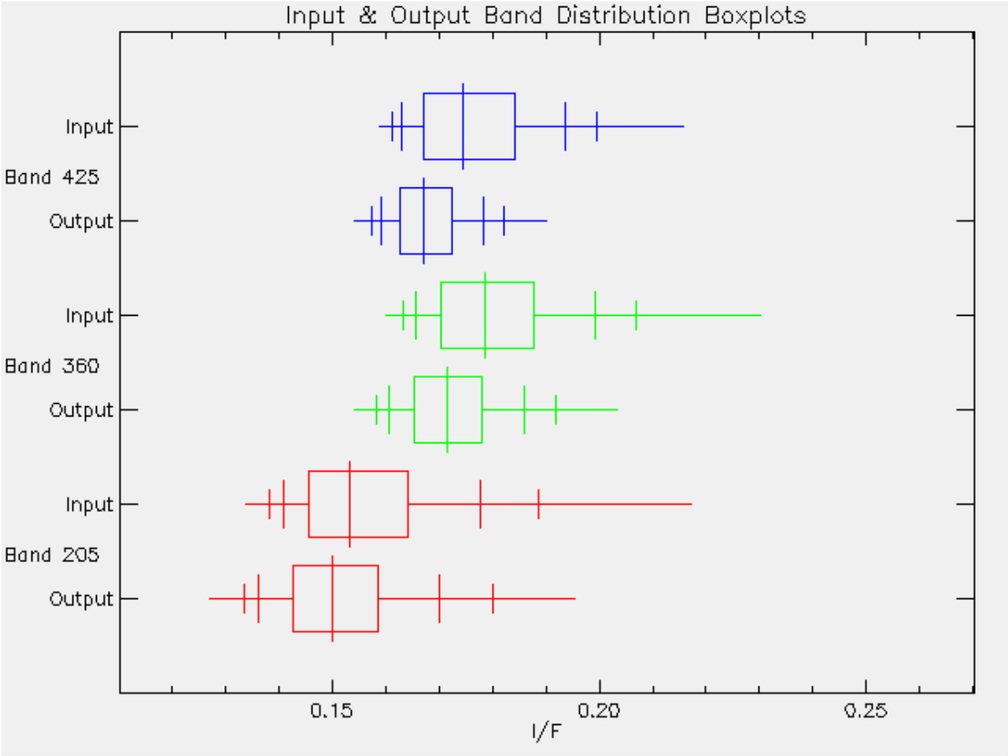
FRT000050F2_S_EGN_ESC_IOS.PNG

FRT000050F2_S_EGN_ESC_IOR.PNG

Empirical Geometric Normalization (S, L)

Empirical Smile Correction (S, L)

# TER IR ENG/ESC - Impact

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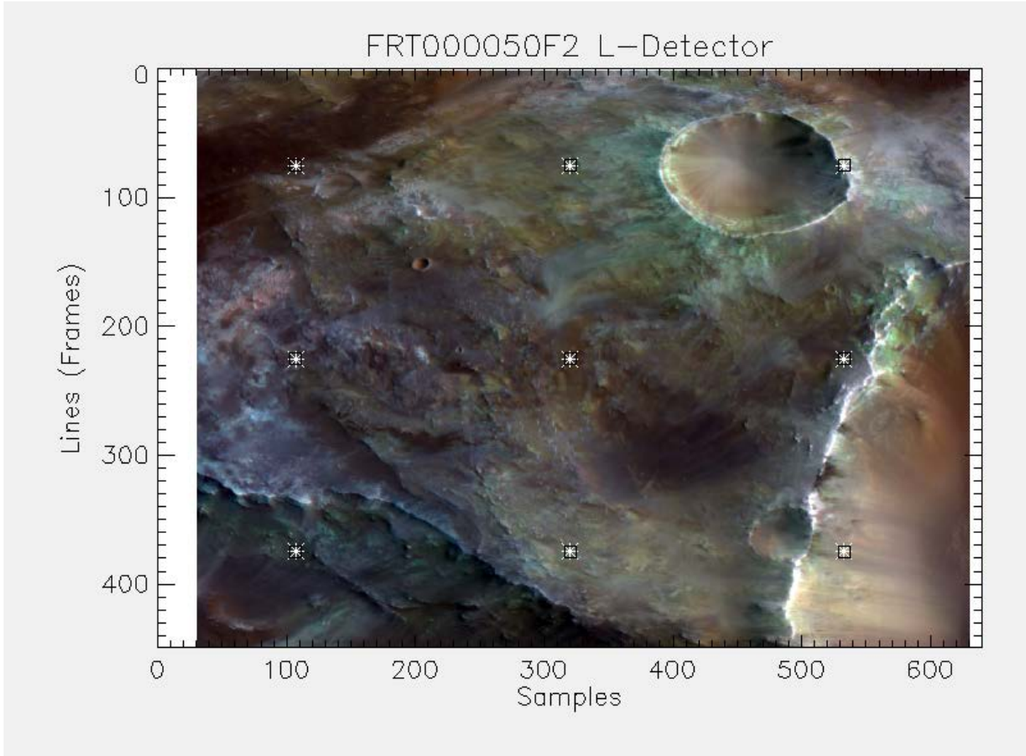


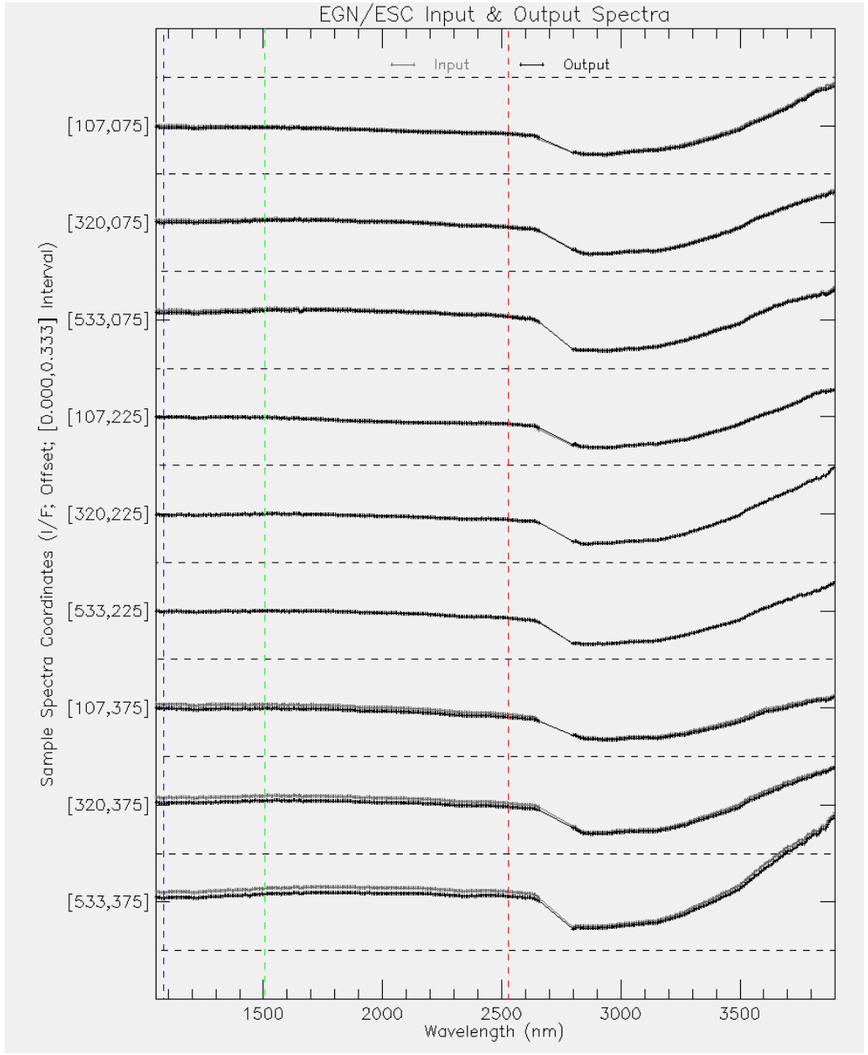

FRT000050F2_L_EGN_ESC_GRD.PNG
(TER FAL RGB Composite)

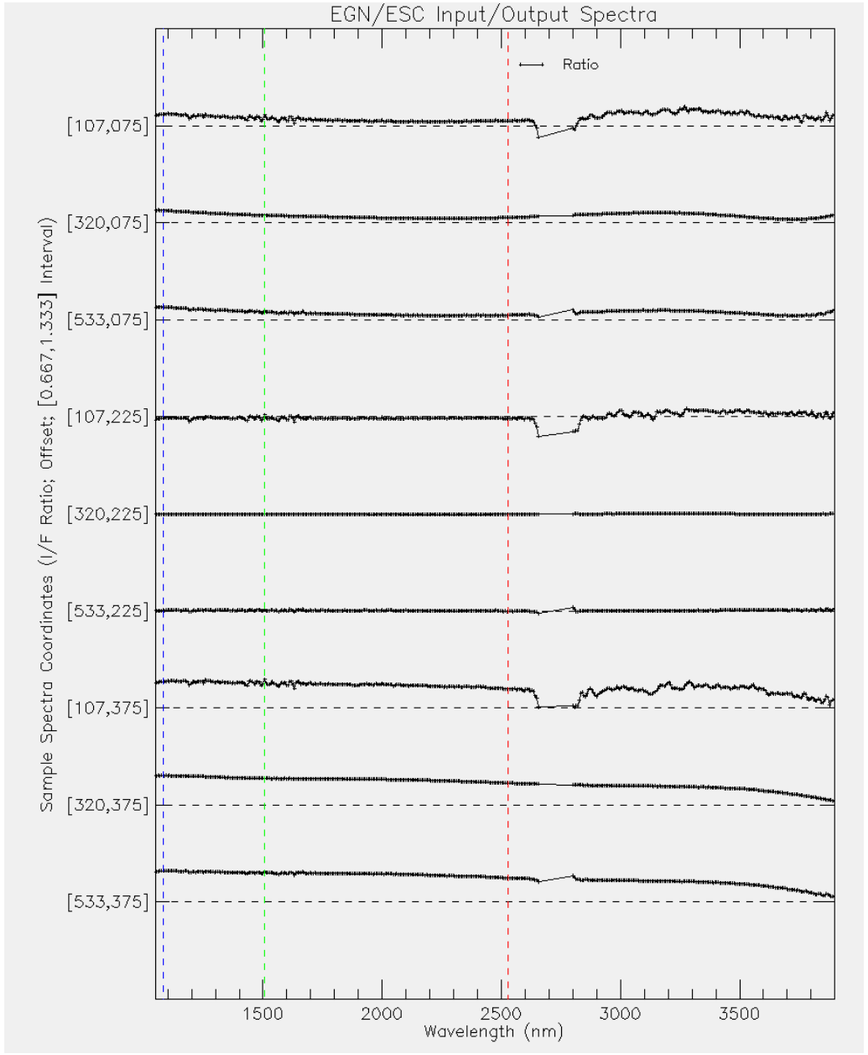
Empirical Geometric Normalization (S, L)

Empirical Smile Correction (S, L)

./ter/EXTRAS/

# TER IR ENG/ESC - Impact




Empirical Geometric Normalization (S, L)

Empirical Smile Correction (S, L)

./ter/EXTRAS/

FRT000050F2_L_EGN_ESC_IOS.PNG

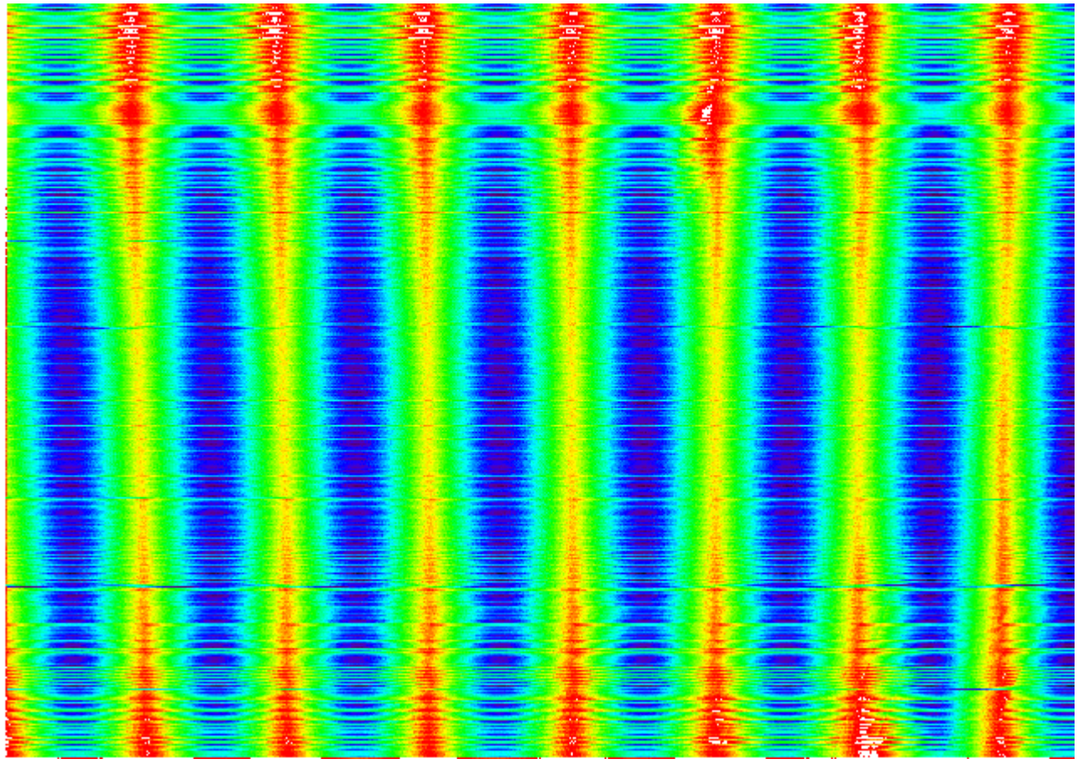
FRT000050F2_L_EGN_ESC_IOR.PNG

# VNIR + IR Concatenation

Spatial Transform (S+L)

Combine VNIR and IR (J)

Processing Residuals, Info Cube



TER IN Band 8 – VNIR/IR Ground Sampling Offset

TER IN Band 9 – VNIR/IR Mask

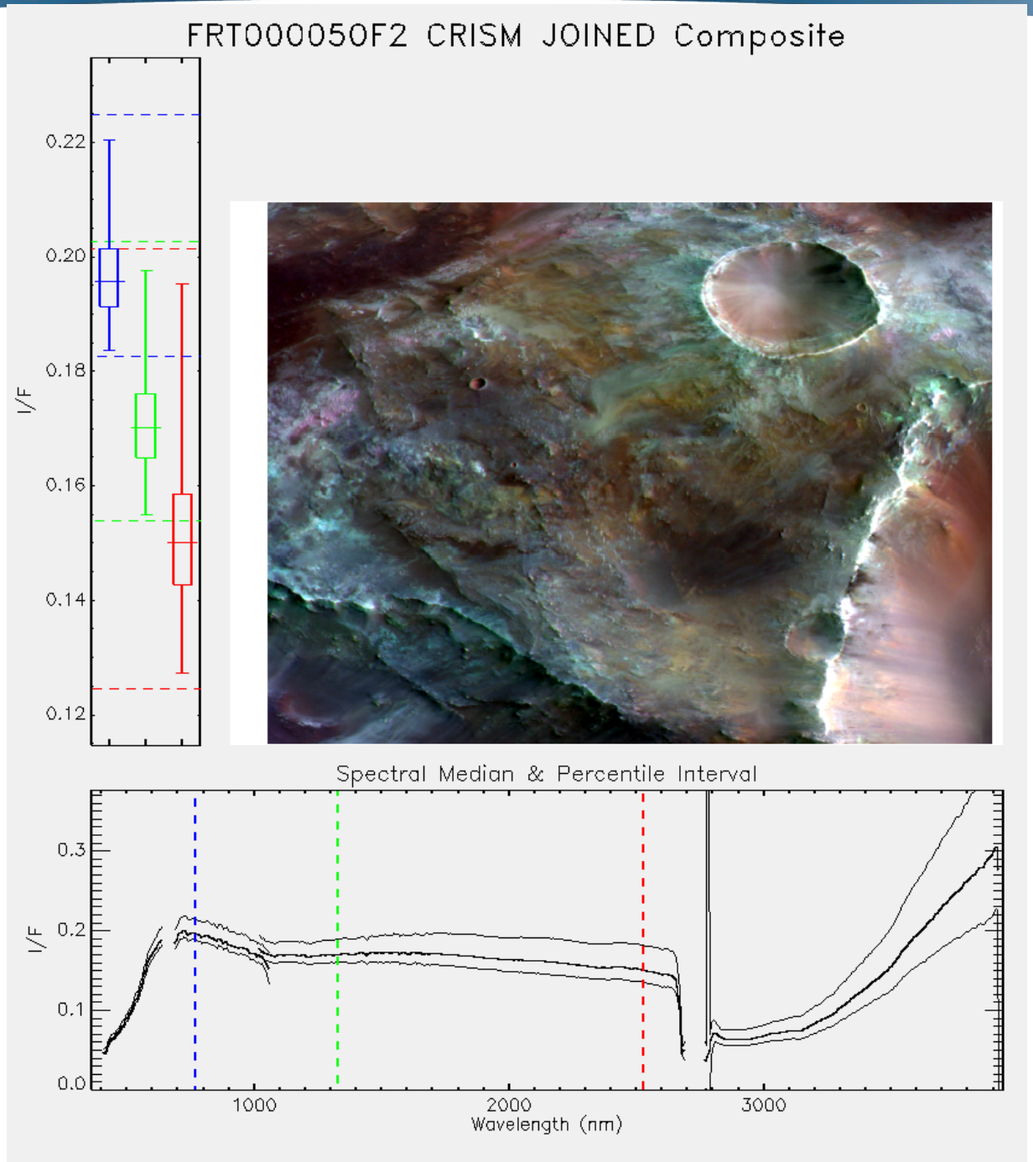
FRT000050F2_07_IN165J_TER3.IMG
FRT000050F2_07_IN165J_TER3.HDR
FRT000050F2_07_IN165J_TER3.LBL

./ter/TER/

# TER Spectral Data Product

Fully Corrected Spectral Cube

FRT000050F2_07_IF165J_TER3.IMG
FRT000050F2_07_IF165J_TER3.HDR
FRT000050F2_07_IF165J_TER3.LBL
FRT000050F2_07_WV165J_TER3.TAB
FRT000050F2_07_WV165J_TER3.LBL




TER TAN RGB Composite

./ter/TER/
./ter/EXTRAS/

FRT000050F2_07_IF165J_TER3_Composite.PNG

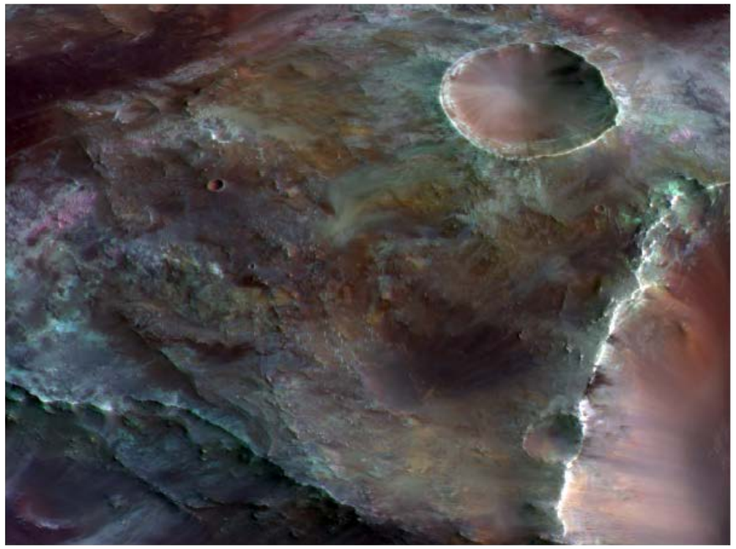
# TER Spectral Summary Parameters

Calculate Summary Parameters (J)

Summary Parameter Cube

Browse Products

FRT000050F2_07_SU165J_TER3.IMG
FRT000050F2_07_SU165J_TER3.HDR
FRT000050F2_07_SU165J_TER3.LBL

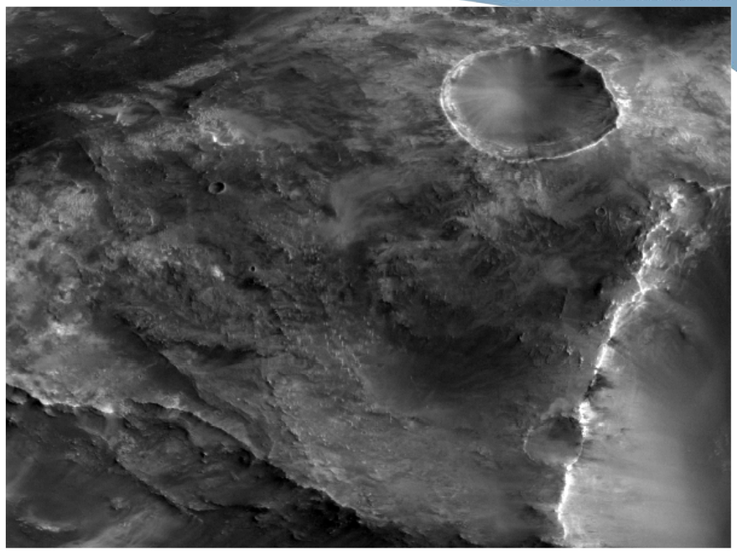


FRT000050F2_07_BUTANJ_TER3.PNG

Spectral band parameters and browse products unchanged in SR/BR vs. SU/BU

./ter/TER/
./ter/BROWSE/

FRT000050F2_07_BUTRUJ_TER3.PNG



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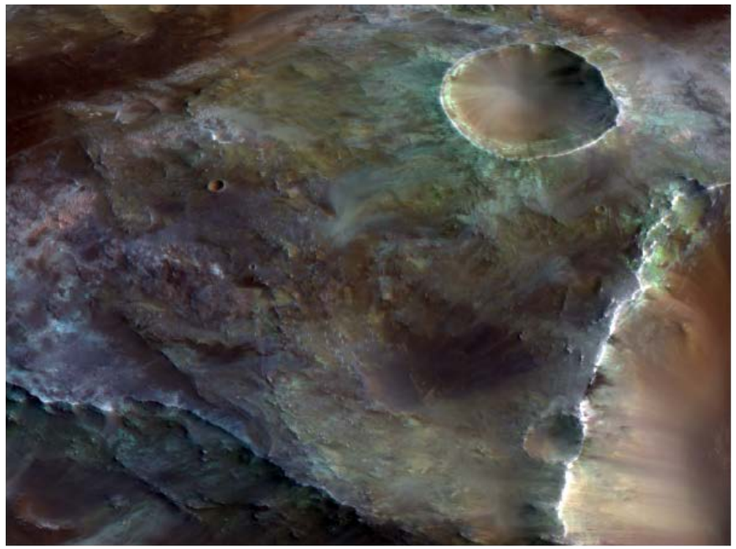

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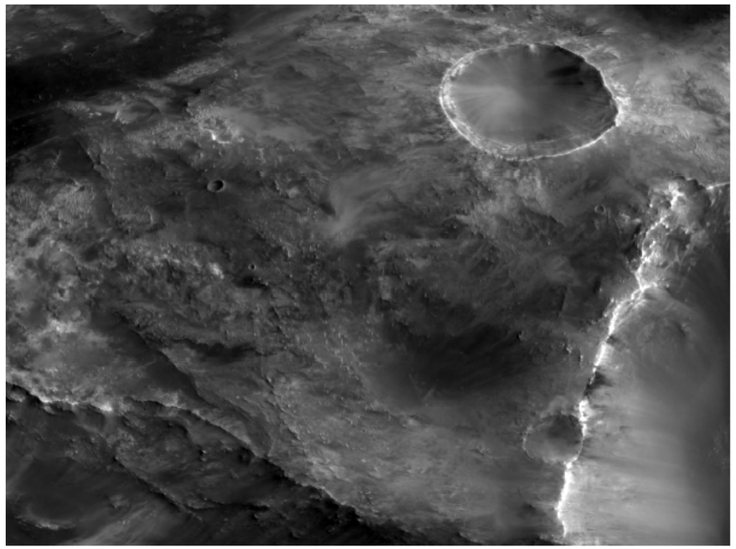


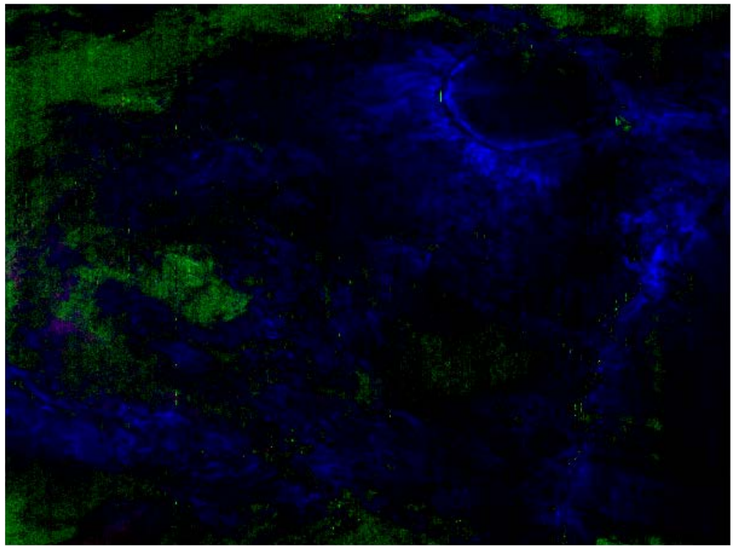
FRT000050F2_07_BUIRAJ_TER3.PNG

# TER Spectral Summary Parameters

Calculate Summary Parameters (J)

Summary Parameter Cube

FRT000050F2_07_SU165J_TER3.IMG
FRT000050F2_07_SU165J_TER3.HDR
FRT000050F2_07_SU165J_TER3.LBL



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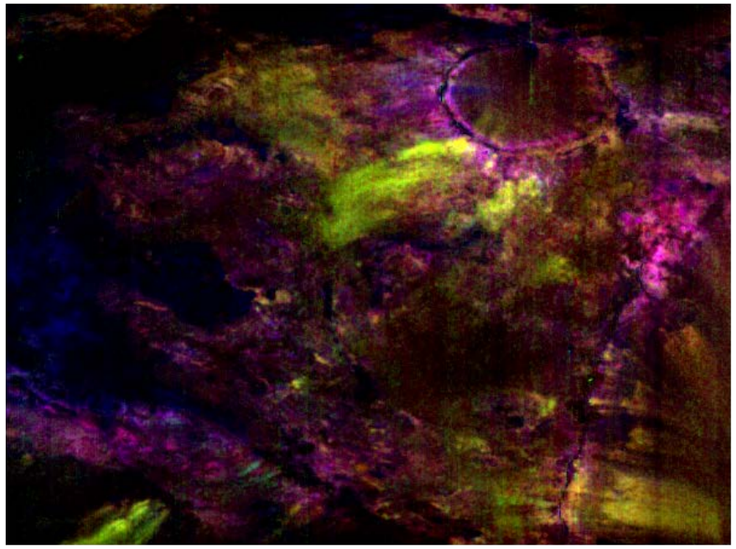

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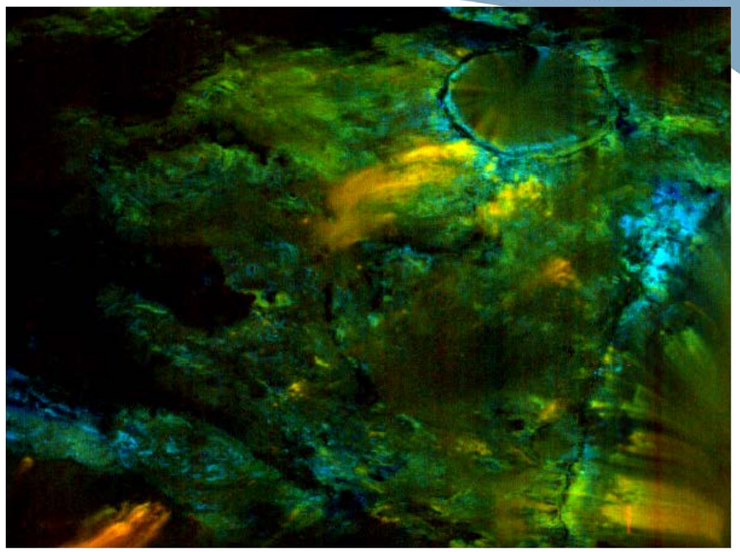

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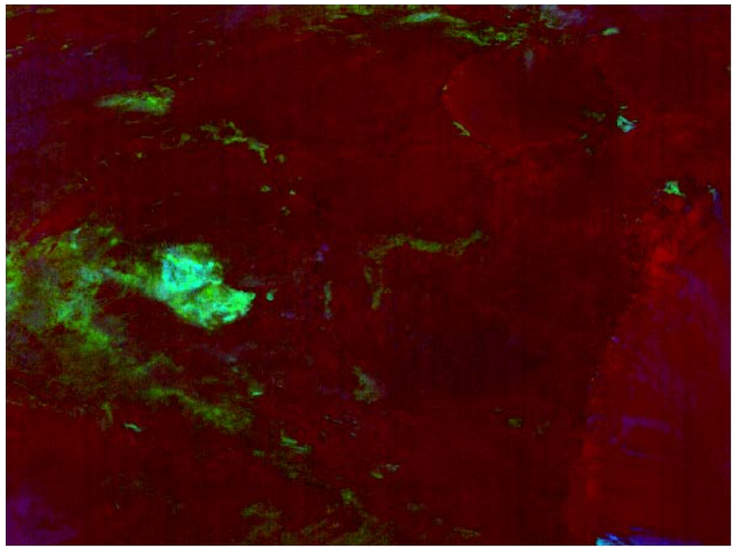

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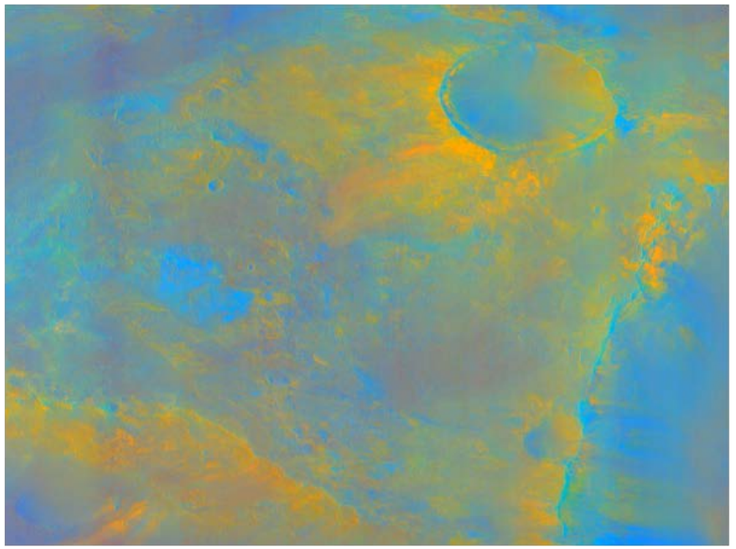


FRT000050F2_07_BUCHLJ_TER3.PNG

./ter/TER/

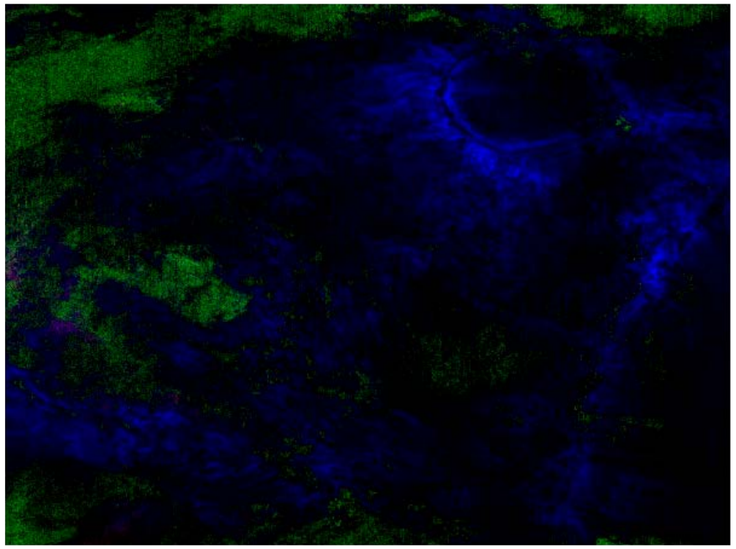
# TER Spectral Summary Parameters

Summary Parameter Filtering (J)

Filtered Summary Parameter Cube

Browse Products

FRT000050F2_07_SR165J_TER3.IMG
FRT000050F2_07_SR165J_TER3.HDR
FRT000050F2_07_SR165J_TER3.LBL



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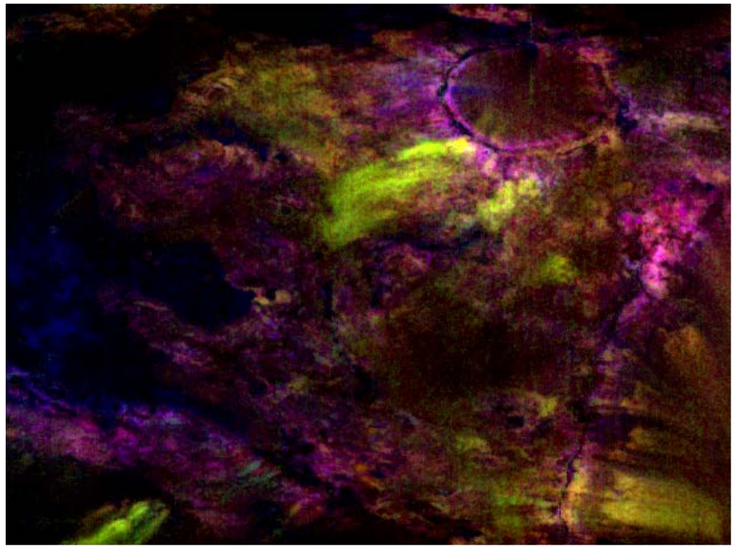

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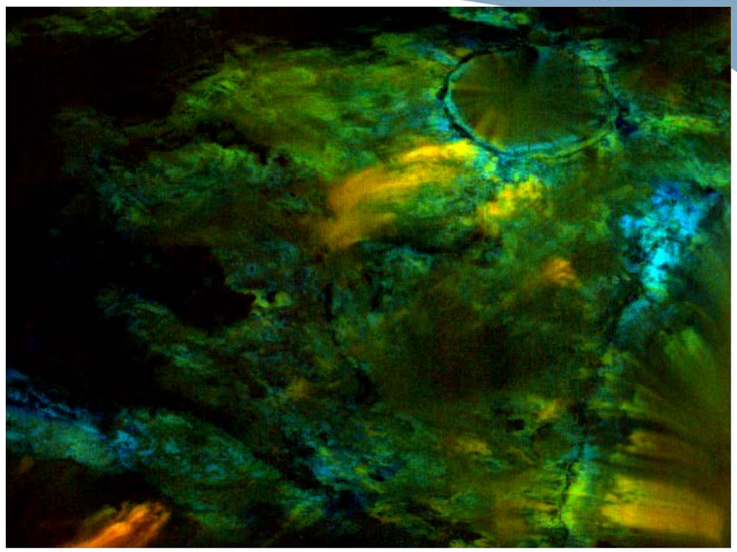

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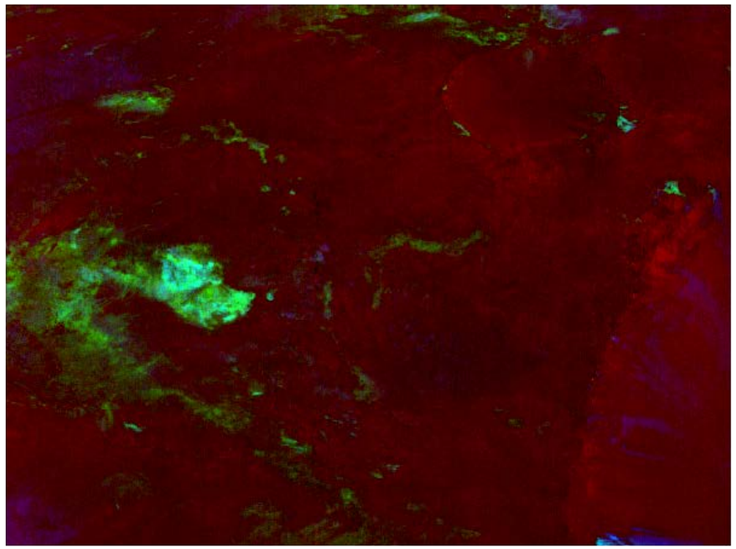

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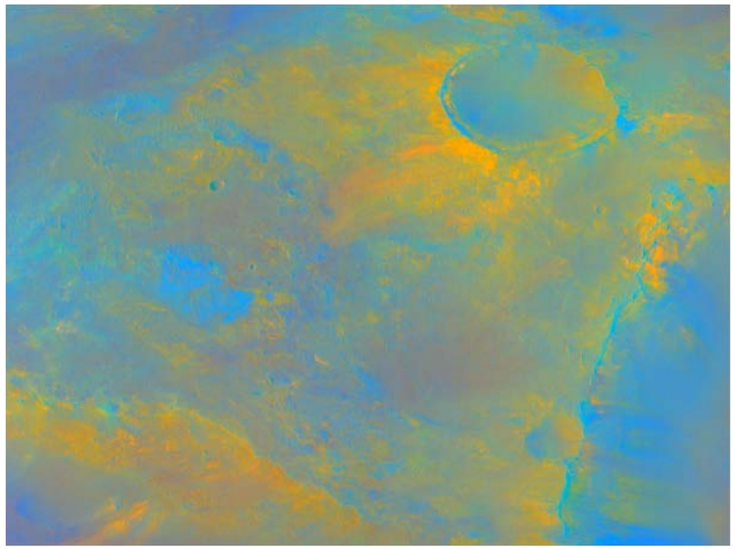
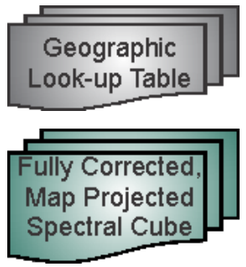


FRT000050F2_07_BRCHLJ_TER3.PNG

./ter/TER/
./ter/BROWSE/

# MTRDR Spectral Data Product

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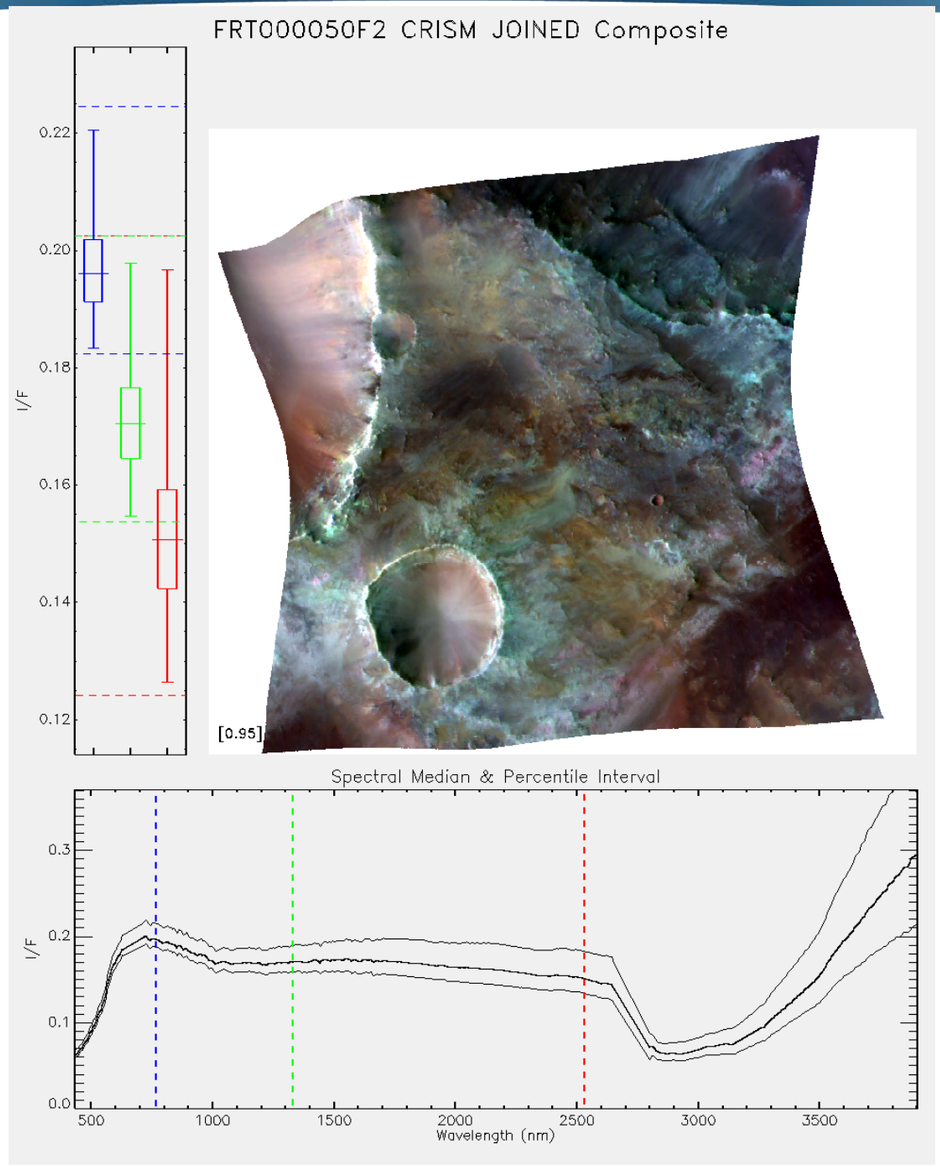
FRT000050F2_07_IF165J_MTR3.HDR
FRT000050F2_07_IF165J_MTR3.LBL
FRT000050F2_07_WV165J_MTR3.TAB
FRT000050F2_07_WV165J_MTR3.LBL

- MTRDR map projection adheres to MRO project standards
- ESRI PE via ENVI APIs
- GIS ready – Mars reference coordinate system string in ENVI header

./mtrdr/TER/
./mtrdr/EXTRAS/

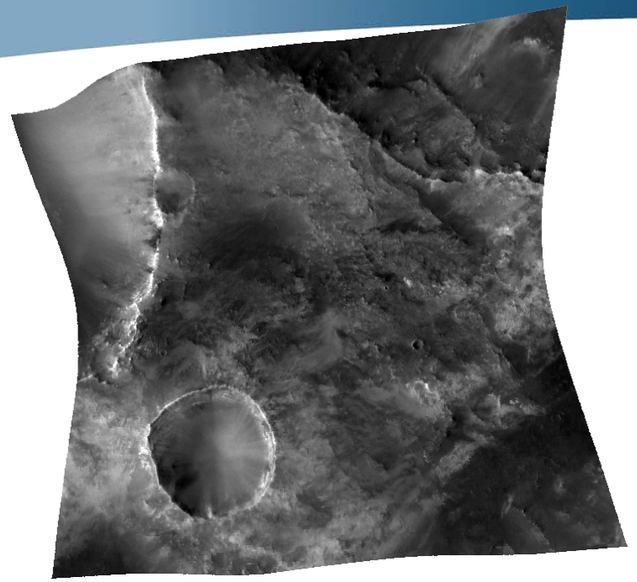



FRT000050F2_07_IF165J_MTR3_Composite.PNG

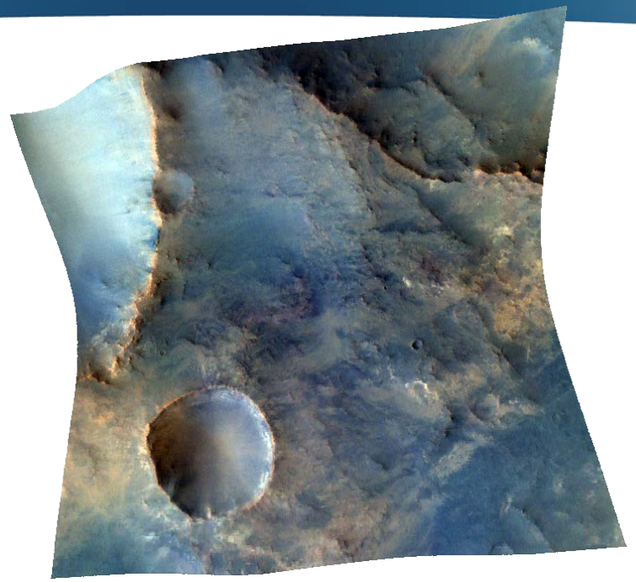
MTR TAN RGB Composite

# MTRDR Browse Products

Map Projected Browse Products



FRT000050F2_07_BRVNAJ_MTR3.PNG



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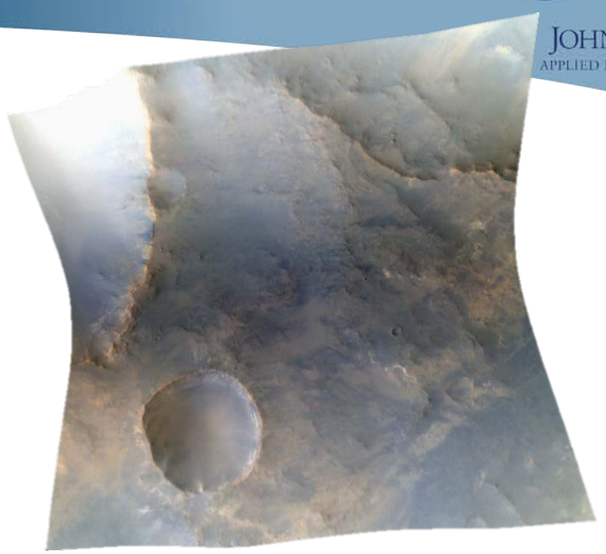
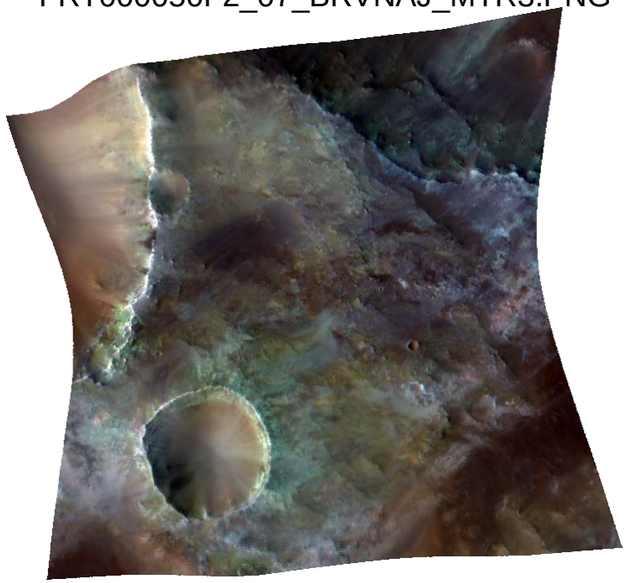


FRT000050F2_07_IF165S_TRU1.png
(CRISM-MAP)



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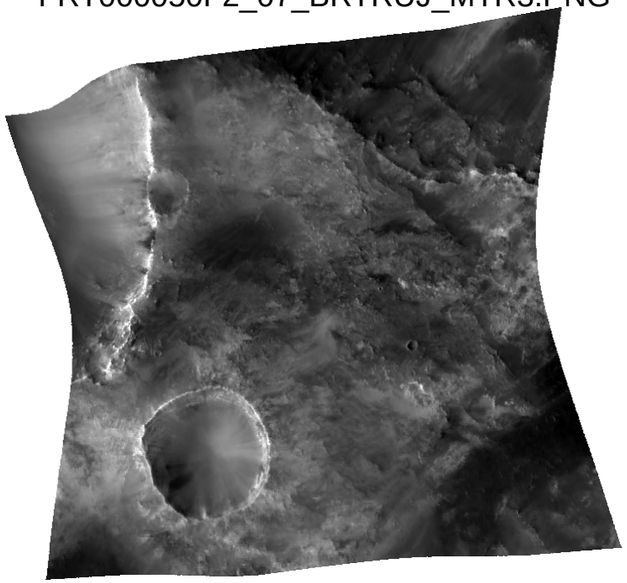

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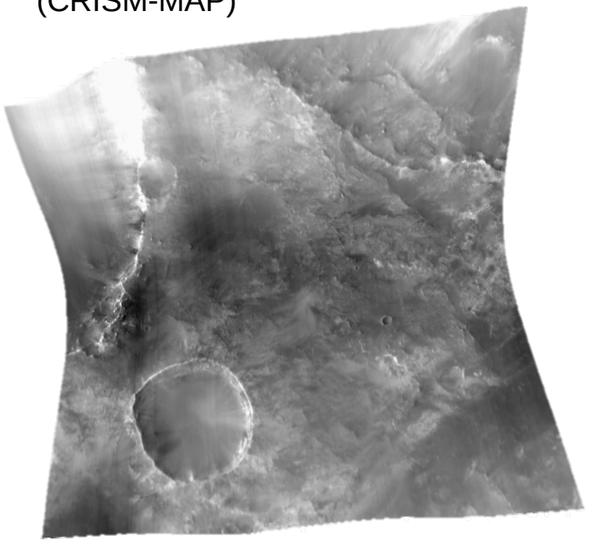
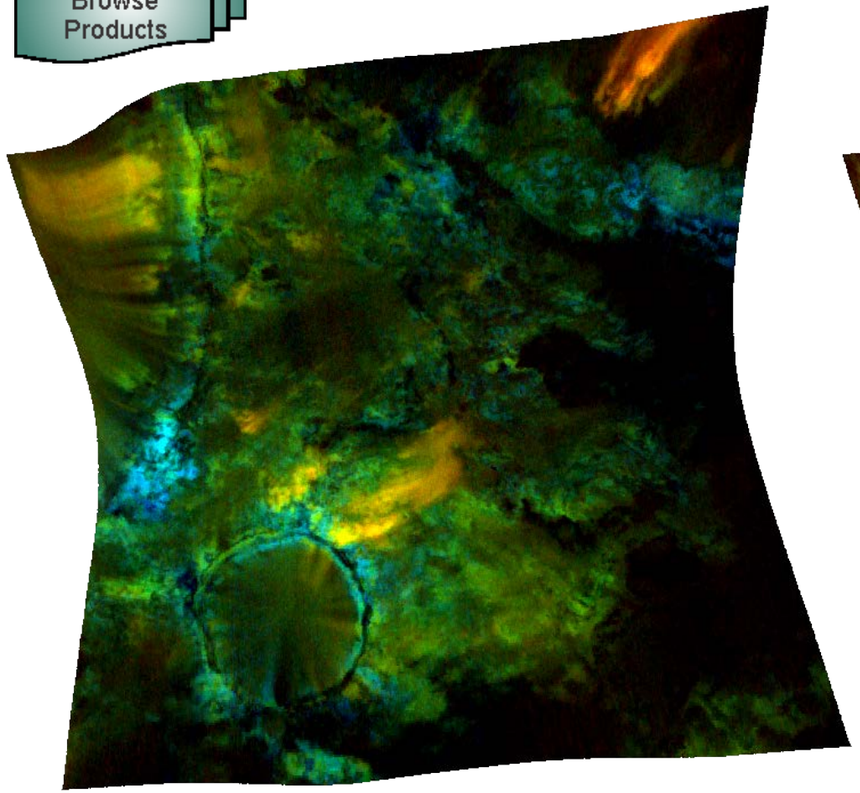


FRT000050F2_07_IF165L_IRA1.png
(CRISM-MAP)

./mtrdr/BROWSE/

# MTRDR Browse Products

Map Projected Browse Products



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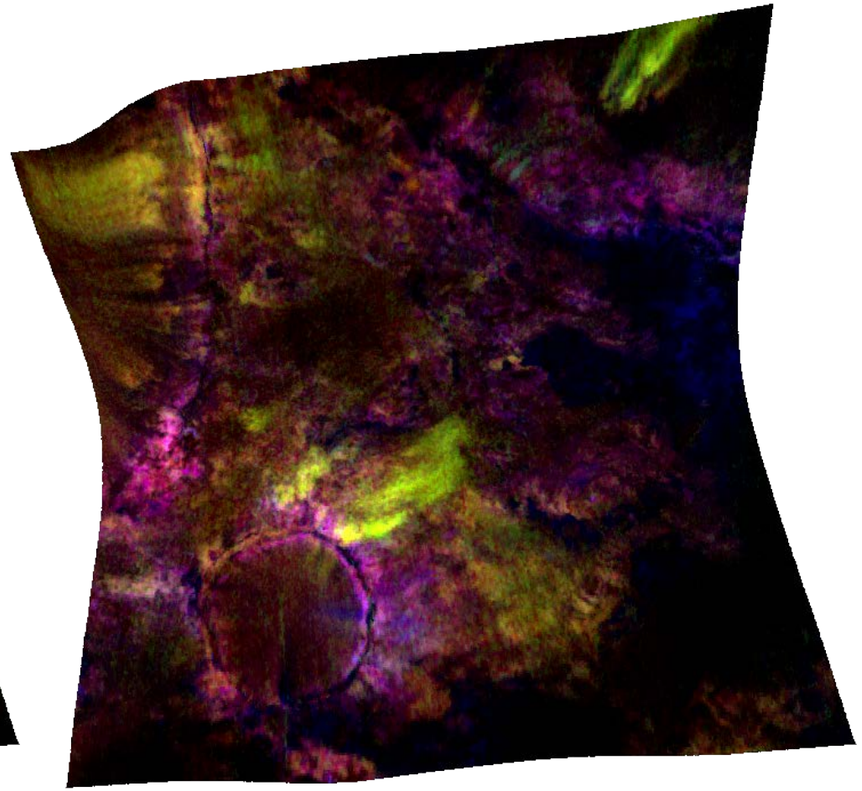

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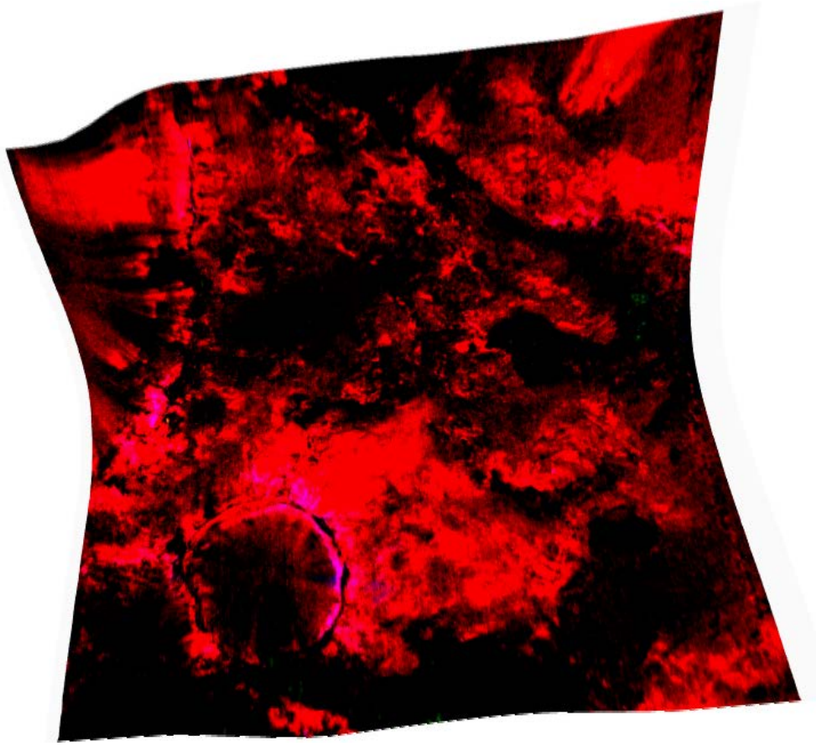

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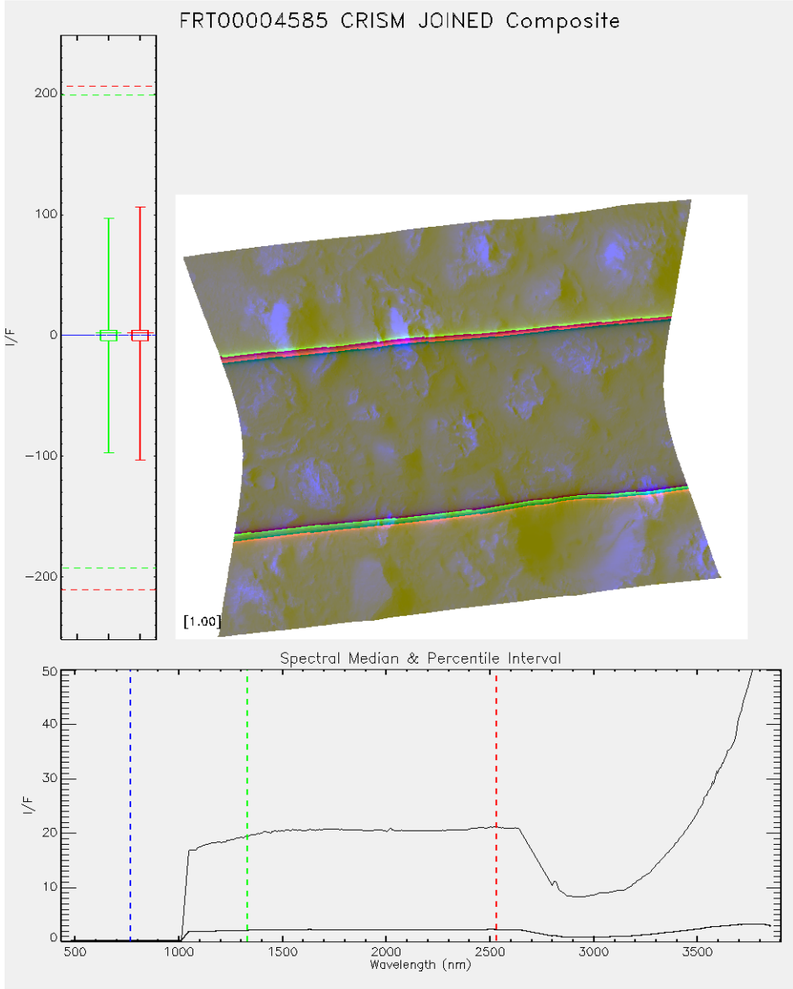
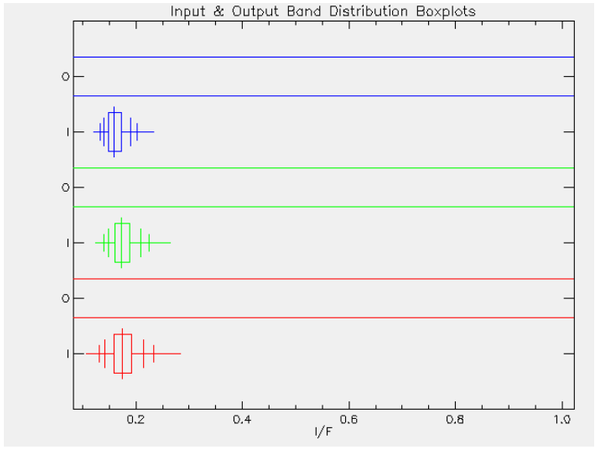
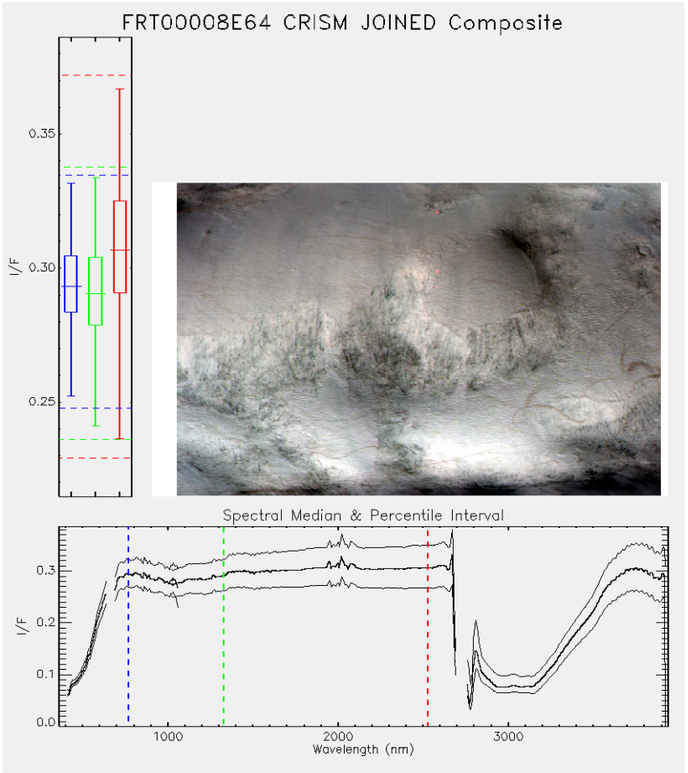
(CRISM-MAP)

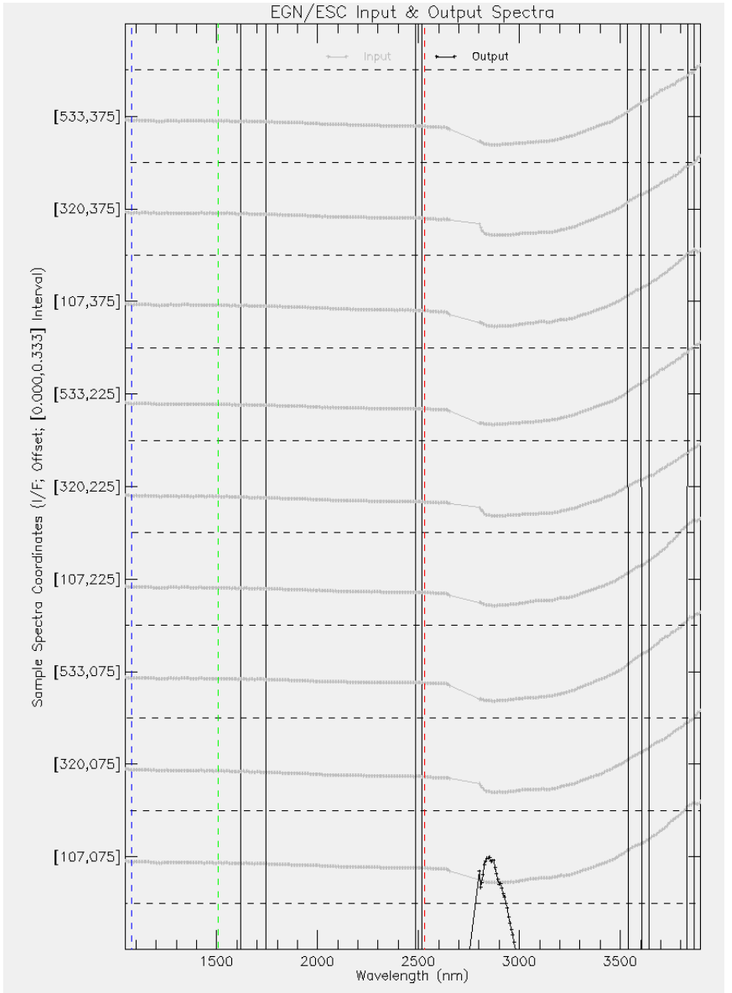
./mtrdr/BROWSE/

# TER/MTDR Processing Wipeouts

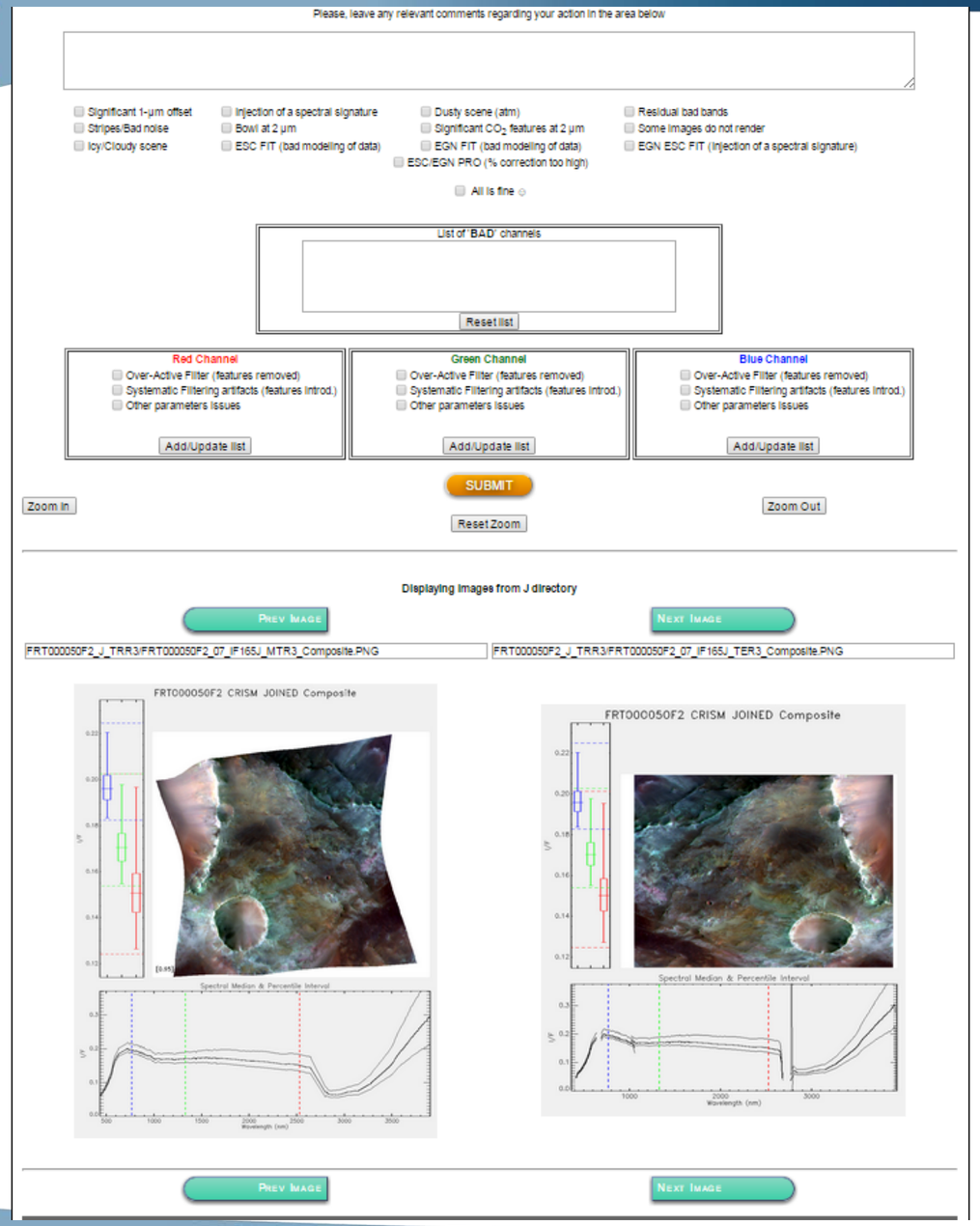


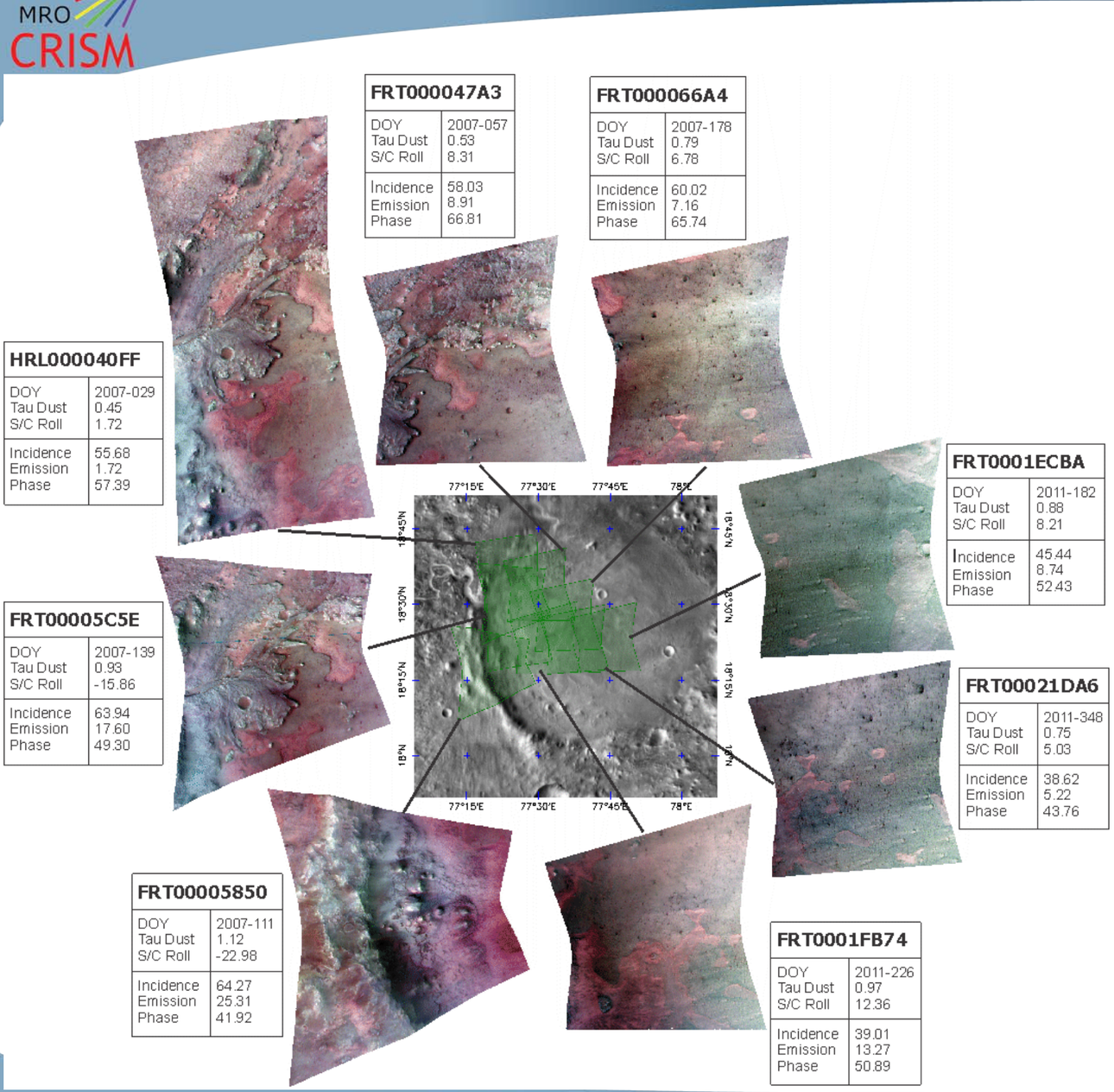



# TER/MTRDR Release Review




- Each TER/MTRDR product set is reviewed prior to PDS release
- Review notes and comments included in delivery

# TER/MTRDR Applications – MTRDR Mosaics



# TER/MTRDR Applications – MTRDR Mosaics