CRISM MULTISPECTRAL AND HYPERSPECTRAL MAPPING DATA – OBSERVING MODES, ACCUMULATED COVERAGE, DATA PRODUCTS, AND TILE MOSAICS

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Timeline of Observing Modes: Mapping

- **2007**: Began VNIR-only observing modes (both mapping and targeted types)
- **2012**: 5x binned mode suspended
- **2015**: Hyperspectral mapping modes

**MSW, MSV** = 5x binned = 100 m/pix
**MSP, HSV, HSP** = 10x binned = 200 m/pix
Mapping Modes

100 m/pix

**MultiSpectral Window (MSW)**

**MultiSpectral VNIR (MSV)**

200 m/pix

**MultiSPectral Mapping (MSP)**

**HyperSPectral Mapping (HSP)**

**HyperSPectral VNIR (HSV)**

All mapping mode observations can vary in length:
- 15, 60, 180 seconds
- ~45, 180, 540 km
Summary: Current Observing Mode Spectral Sampling

number of bands:

<table>
<thead>
<tr>
<th>VNIR</th>
<th>IR</th>
</tr>
</thead>
<tbody>
<tr>
<td>19</td>
<td>55</td>
</tr>
<tr>
<td>107</td>
<td>154</td>
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<td>107</td>
<td>436</td>
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</table>

VNIR-only modes:

HSV/FRS/ATO/ATU

MSV

90    0

Shaded areas show select zones of increased spectral sampling for HSP vs MSP/MSW in the IR.
<table>
<thead>
<tr>
<th>Class Type</th>
<th>Pixel Size (m/pxl)</th>
<th>VNIR Bands</th>
<th>IR Bands</th>
<th>Observations [Target IDs]</th>
<th>VNIR Segments</th>
<th>IR Segments</th>
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<tbody>
<tr>
<td>MSP</td>
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<td>40564</td>
<td>61752</td>
<td>61834</td>
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<td>47026</td>
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EDR archive

Segment Total: 276523
(03/20/2017)
• MSP is the only mapping mode that has been active for the duration of the MRO mission
• Structure of the MSP observation count as a function of latitude and time plot highlights:
  • Mapping exclusion zones
  • Evolving CRISM mission priorities
  • S/C safing events
  • CRISM cryosystem status
• Geometric seasonal dependence
IR HSP MRO/CRISM Mission History

- HSP acquired in tandem with MSP since mid-2011
- Preferred mode for tracking southern seasonal polar cap recession
- Focused acquisition for high priority regions
MSV has been the dominant VNIR-only mapping mode since its inception in early 2012.
IR MRDR (MSP/HSP) Data Accumulation

- MSP/HSP class type observations are the source data for Multispectral Reduced Data Record (MRDR) map tiles
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IR Mapping Coverage Example

MSP: Blue
HSP: Green
MSW: Red
MRDR Data Processing Workflow

- MSP TRR3 I/F
- MSP Data Filtering
- RT Transform
- Radiometric Reconciliation
- MSP TRR3 Filtered I/F
- MSP TRR3 I/F*
- MSP DDR1 DE
- Calculate Parameters
- MSP TRR3 Balanced I/F*
- MSP I/F* Parameters
- MSP I/F* Browse
- Map Tile Assembly

Space Exploration

APL
Radiometric Reconciliation - MTRDR Mosaic Heritage

Optimization Reference FRT000047A3

Optimization Reference FRT000047A3

B

MTDR Mosaic Optimization – Weighted Product Chi-Square

\[\chi^2 \text{ (Product Index)} = 1189.44\]

C

D
MSP Empirical Radiometric Reconciliation
Jezero Crater Example – TOA @ 770 nm

CRISM MSP, HSP, HSV
Jezero Crater mosaic (770 nm) prior to inter-observation optimization. Observations stacked in acquisition order.

CRISM MSP, HSP, HSV
Jezero Crater mosaic (770 nm) after inter-observation optimization. Observations stacked in acquisition order.

CRISM ~200 m/pixel VNIR mapping observation coverage count map for the Jezero Crater Mars 2020 candidate landing site (linear stretch over the interval [0,7]).

\[ X' = P[0] + P[1] \times X^P[2] \]

Non-linear least squares
Overlap Area CDF Optimization
CRISM VNIR ~200 m/pixel Mapping  
Proximal Optimization - Nili Fossae

$X' = P[0] + P[1](\bar{X} - X) + \bar{X}$

- Linear least squares
- Proximal Relationship Distribution
- Centroid and Spread Optimization

$P[0]$ and $P[1]$ Independent
Mapping Mosaic Prototype Product Example – Margaritifer Terra (Kim’s PGMM Talk)
Current Framework and Mapping Mosaic Products

- Production Configuration:
  - Composite optimization figure of merit:
    - Overlap area nonlinear CDF discrepancy buttressed by proximal relationship summary statistics discrepancy
    - Implemented by relationship type weighting and/or selection
  - Graph theory (adjacency matrix) provides insight into mosaic connectivity and constituent observation ‘importance’

- MRDR Map Tiles
  - I/F* (RT corrected spectral reflectance)
  - Empirical correction of RT residuals

- MSV Map Tiles
  - I/F TOA
  - Relative atmospheric (and photometric) correction

- Coverage and Connectivity
  - Can’t have too many mapping strips!

- Multispectral Reduced Data Records (MRDR Map Tiles):
  - ~200 m/pixel
  - VNIR + IR
  - 72 channels
  - MSP, HSP
  - CRISM PDS standard data product suite

- Hyperspectral Survey Study Area Mosaics:
  - ~200 m/pixel
  - VNIR + IR
  - 259 channels
  - HSP

- MSV Map Tiles
  - ~100 m/pixel
  - VNIR
  - 89 channels
  - MSV
  - EM4 Priority

- Custom local/regional mosaic products
  - Candidate landing sites
  - Regional mapping projects
  - Variable wavelength range and channel selection