



# CRISM Data Users' Workshop CAT Tutorial

March 22, 2009

Frank Morgan, Frank Seelos, Scott Murchie  
and the CRISM Team

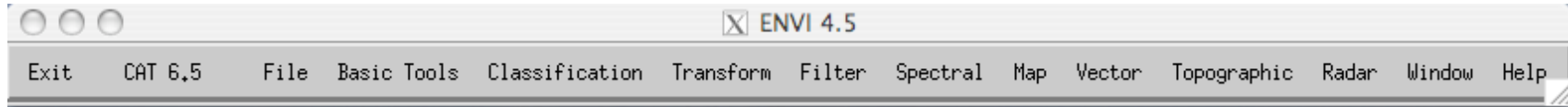
- Tools to:
  - Open and display CRISM images
  - Apply certain standard corrections
  - Produce summary parameters
- Programming initiated by Shannon Pelkey and others at Brown University; continuing contributions by many
- Runs as extension to ENVI (ITT VIS)
- This presentation will cover basic CAT mechanics
  - Subsequent presentations cover application to CRISM data interpretation and science

- Collection of IDL/ENVI procedures, CRISM calibration data files, miscellaneous reference data files
- Detailed installation instructions in `cat_setup.pdf` (at download site)
  - Details vary by OS
  - Root of the CAT directory tree is `CAT_ENVI`, which may be a top level directory, subdirectory, or symbolic link, depending on OS and user preference
- Download site linked at:  
<http://pds-geosciences.wustl.edu/workshops>

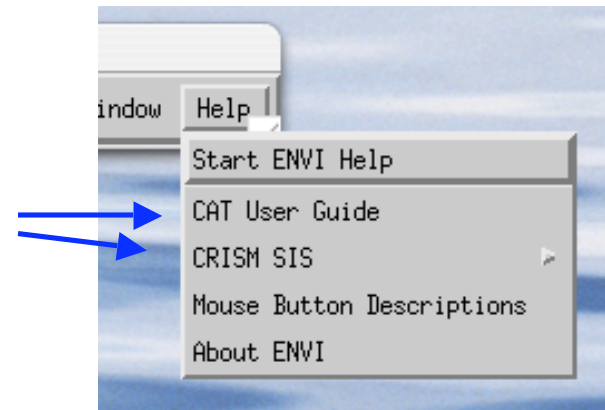
- IDL/ENVI procedures for CAT are found under:
  - CAT\_ENVI/save\_add/CAT\_programs
- Calibration Data Records (CDR):
  - CAT\_ENVI/aux\_files/CDRs/
- Ancillary Data Records (ADR):
  - CAT\_ENVI/aux\_files/ADR/
- User manuals, CRISM SIS:
  - CAT\_ENVI/aux\_files
- Default CAT output:
  - CAT\_ENVI/out
- CAT temporary file output:
  - CAT\_ENVI/tmp
    - Nominally CAT will clean up; files may be left in event of a crash; can be deleted after a session

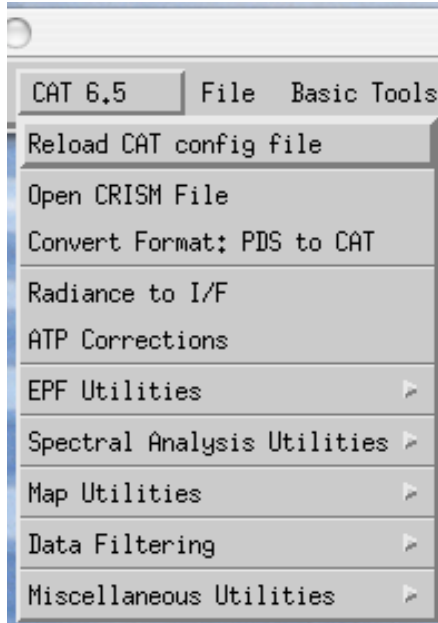


- ENVI config file:
  - Need envi.cfg in CAT\_ENVI
  - Can copy from one of the defaults, envi\_win.cfg, envi\_unix.cfg according to OS
  - Useful things it specifies: tmp file directory, default output directory, spectral library directory, default data directory (where it looks first to open files)
- CAT config file:
  - CAT\_ENVI/catconfigs/crismcat\*.cfg
    - Replace \* with any text, or omit
    - Can have multiple configs (multiple users, customized analysis, etc)
      - select at startup, reload during session if desired
    - Not required
    - PDS path, aux\_files path, default volcano scan



- When CAT installed, ENVI starts with CAT menu added
  - includes CAT version number
- Additional CAT-specific items added under Help and Display/Tools menus



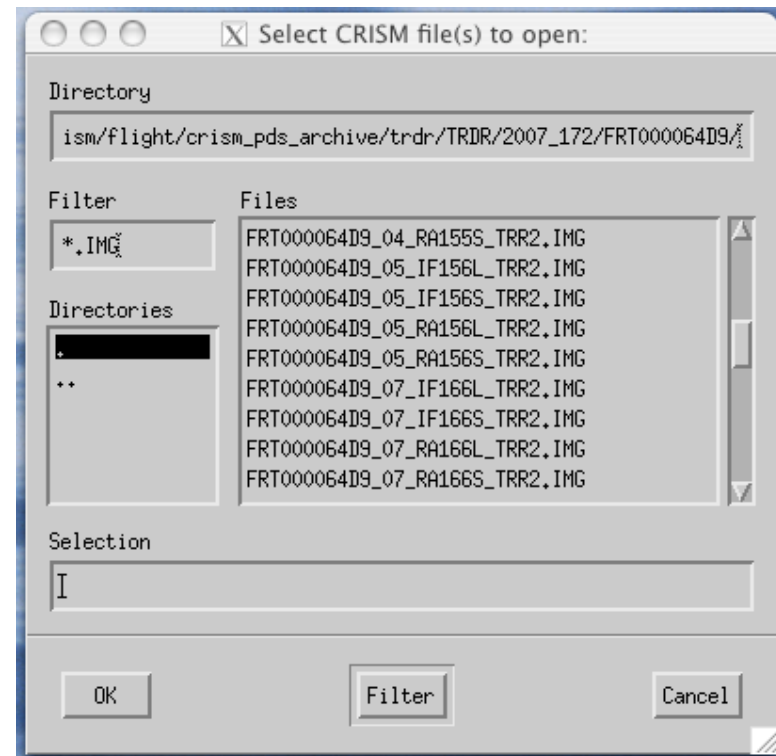


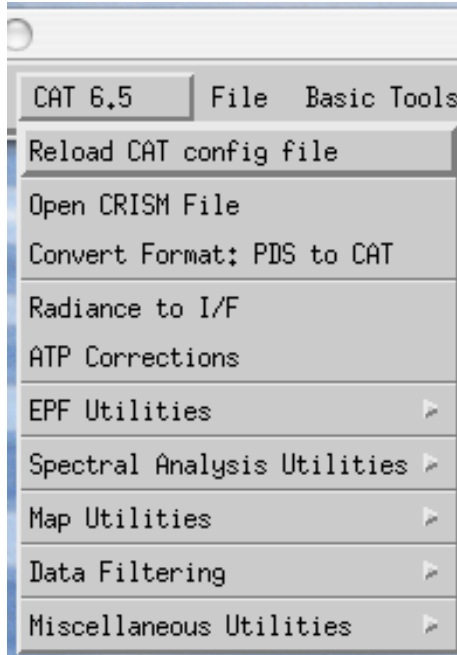
## INPUT DATA:

- CRISM PDS image file (\*.IMG)
- Corresponding PDS label (\*.IMG)
  - example: FRT000064D9\_07\_IF166L\_TRR2.IMG
  - FRT000064D9\_07\_IF166L\_TRR2.LBL

select input file in the ENVI dialog box that pops up

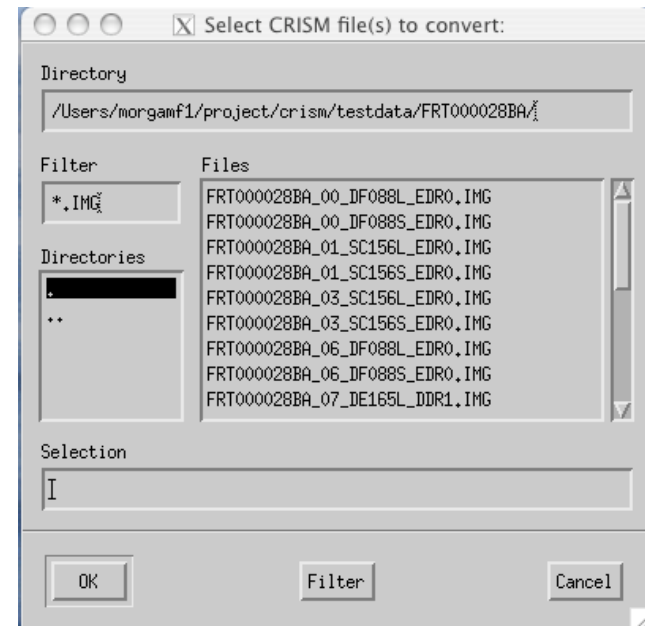
Opens CRISM data in Available Bands and in Display window





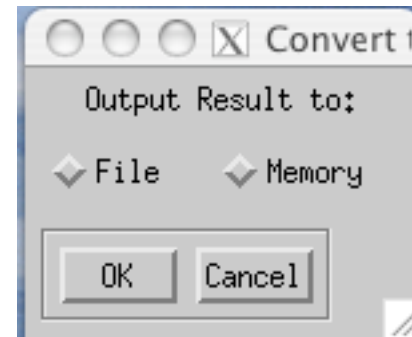
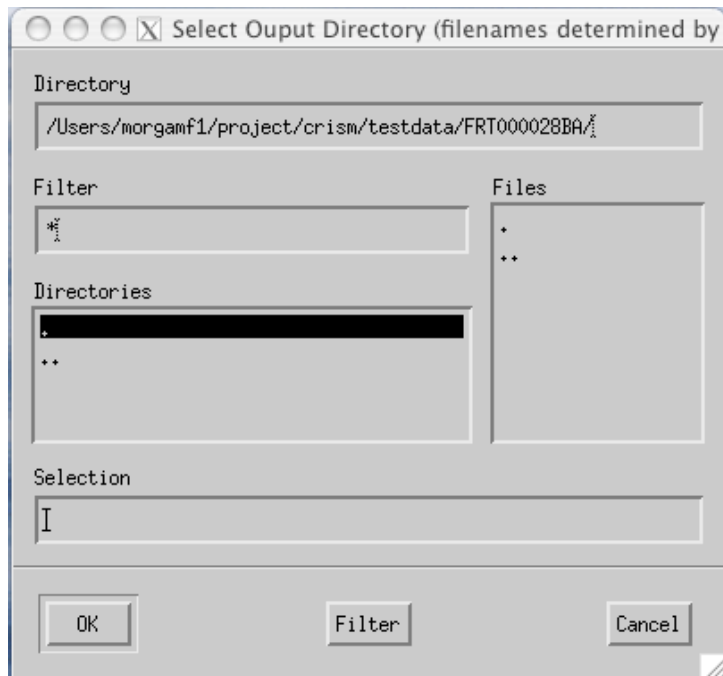
- Convert to file with ENVI header
- CRISM PDS data for IR channel:
  - Spectrum stored long-to-short
  - Last wavelength 65535 (CRISM invalid data code)
- Convert Format: PDS to CAT
  - Reverses order of IR spectrum
  - Replaces the 65535 wavelength with 4.0 microns

Select input PDS file to convert here →



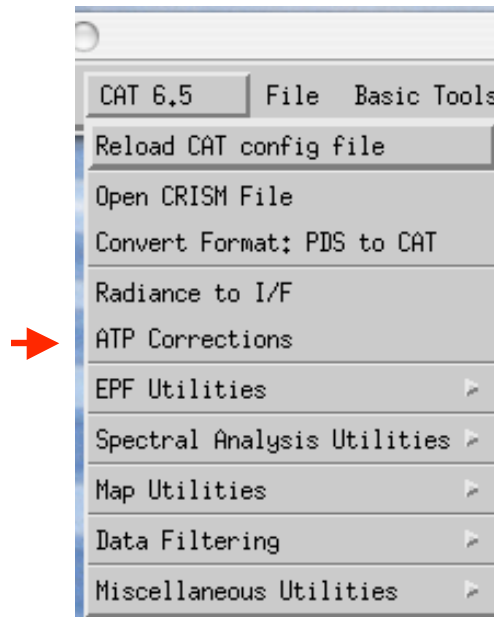
## Common CAT question: Output to file or memory?

Select “File,” then select an output path and, usually, filename via the ENVI dialog:

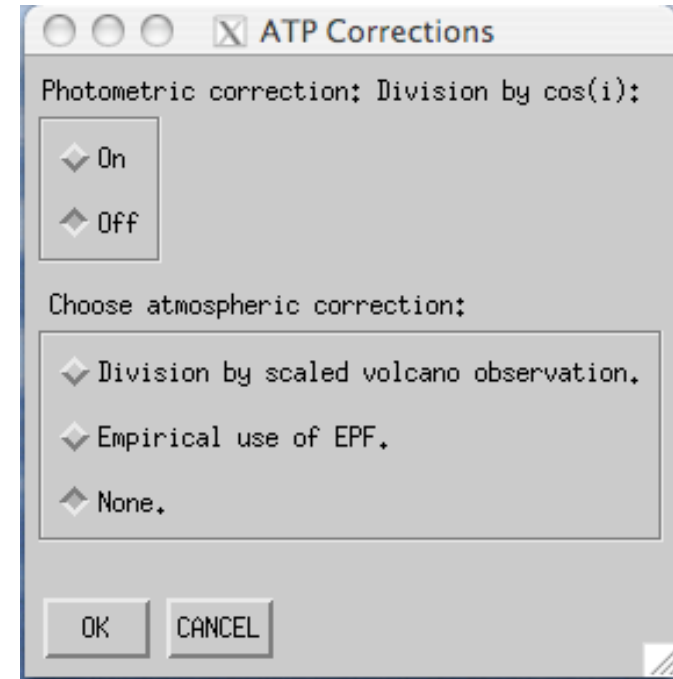


OR...

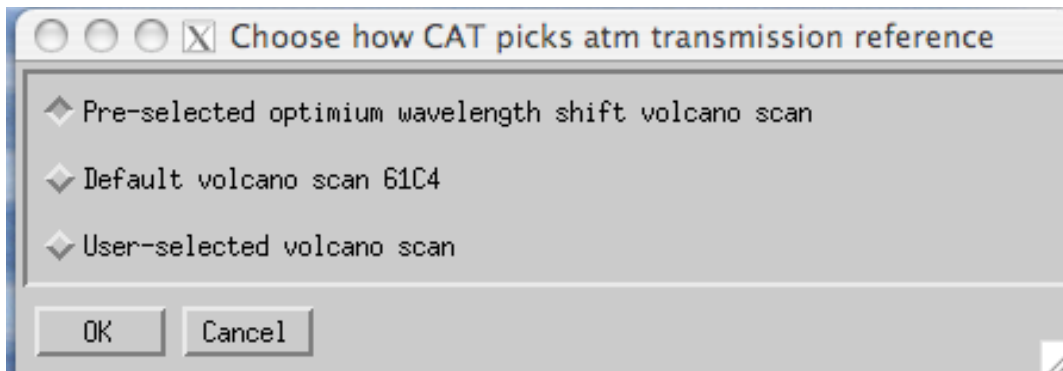
Select “Memory” and computation proceeds, with output to Available Bands and Display window



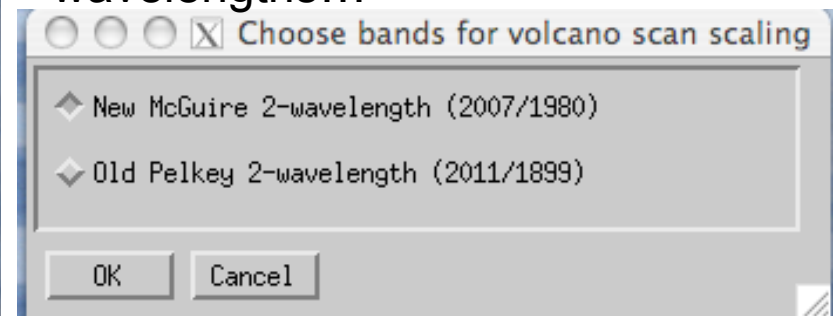
File selection dialog...  
then select corrections



Then pick a volcano scan selection method...



Then finally, select scaling wavelengths...

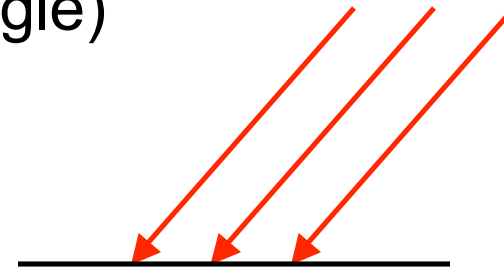




## Photometric Correction...

First order correction to radiance for  
non-normal solar incidence:

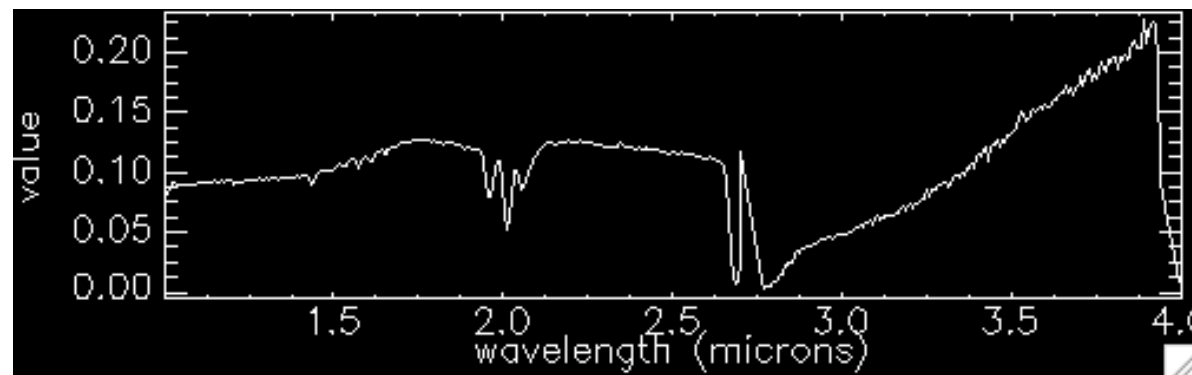
Divide by  $\cos(\text{incidence angle})$



*Gets incidence angle at aeroid from  
DDR (ancillary data file)*

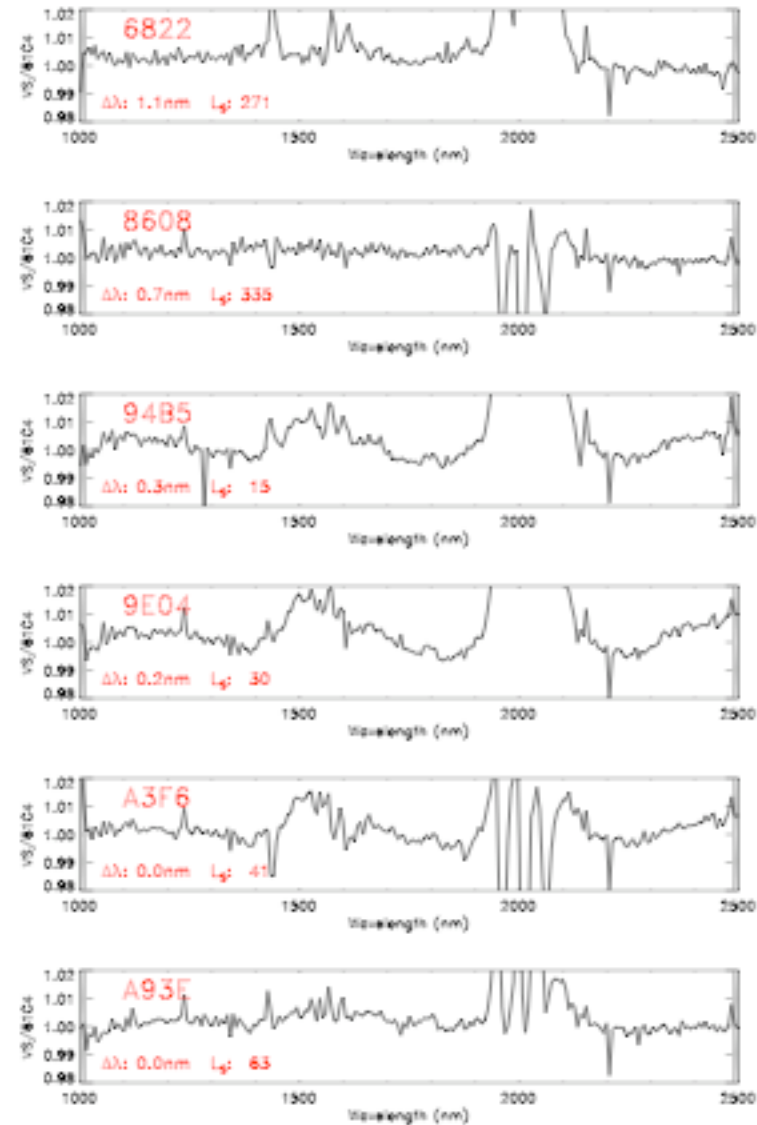


- Atmospheric Correction: Need to correct spectrum for absorption by CO<sub>2</sub> (IR only)
  - Volcano scan: special observation viewing nadir on traverse across Olympus Mons
  - Estimate atmospheric transmission =  
(base spectrum) / (summit spectrum)
  - Correct a scene spectrum by scaling the volcano scan transmission to match the scene at 2 wavelengths near the CO<sub>2</sub> 2-micron band, then divide
    - One wavelength near absorption peak, one in wings
    - Adjusts for variable atmospheric optical depth- elevation, season...



## Selecting Volcano Scans...

- Spectrum drifts  $\sim 1\text{nm}$  with optical bench temperature
  - Need transmission spectrum at matching shift to avoid artifacts at  $\text{CO}_2$  band edges
- Volcano scans:
  - 7 processed so far
  - Contamination (water ice?) in 3
  - Drop A3F6; contaminated, shift nearly identical to A93E
  - Keep 94B5, 9E04;
  - no other scans near 0.2, 0.3 nm shift
  - Individual volcano scans accessible via VS ADRs
  - (61C4  $\Delta\lambda=0.9\text{ nm}$ )



- 3 choices...
  - Pre-selected optimum wavelength shift (normally recommended)
    - CAT picks AT CDR based on SCLK
      - the AT incorporates the volcano scan with spectral shift that's the best match to the observations within a "thermally stable time period" (demarcated by cooler switches, safe modes, etc.)
      - For MRRDRs: CAT finds appropriate scans for each location based on SCLK of the individual component observations within the tile
  - Default volcano scan XXXX
    - XXXX = volcano scan observation ID
    - Default scan set in config file
      - Default default = 61C4; canonical clean scan, first used
  - User-selected volcano scan
    - Pick from a list of available VS ADR's
      - VS ADR = volcano scan transmission data
      - Identical to AT CDR's, but stored by volcano scan instead of SCLK
    - Might use this option to check contamination effects

- So which volcano scan am I actually using when I let CAT pick?
  - CAT prints the AT CDR filename it selects at the ENVI command line

Using wavelengths from:

```
..CAT_ENVI/aux_files/CDRs/WA/CDR410803692813_WA0000000L_3.IMG
```

Using atmospheric transmission from:

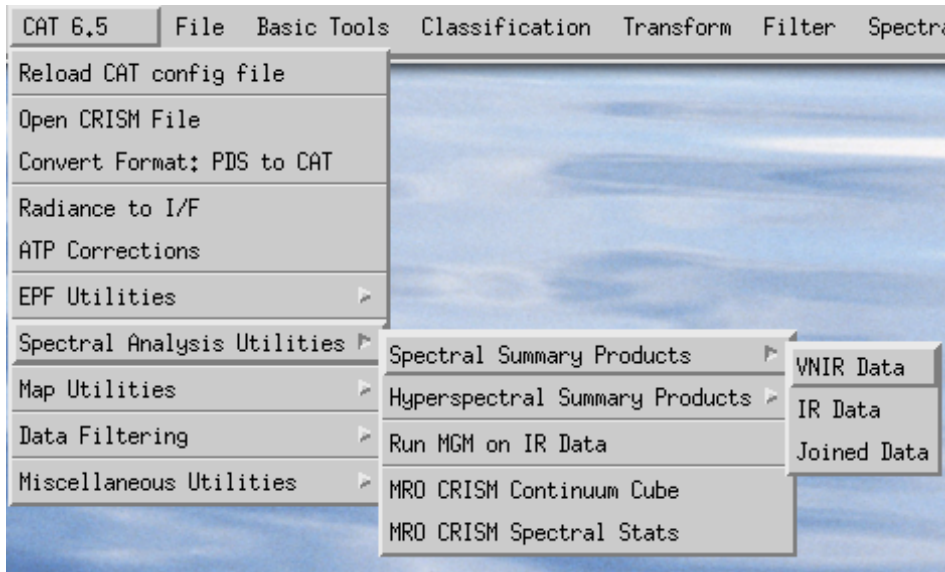
```
..CAT_ENVI/aux_files/CDRs/AT/CDR430873156619_AT0000000L_5.IMG
```

- The label for that CDR lists the volcano scan ID in a comment

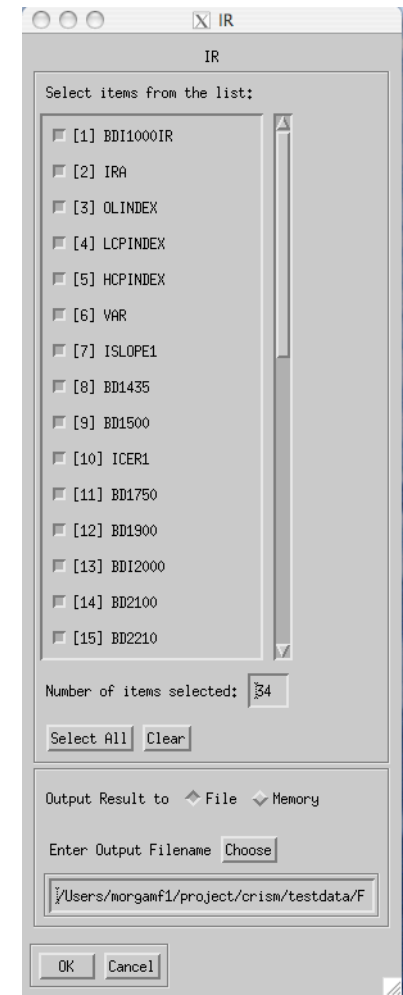
```
/* This AT CDR is derived from volcano scan  
observation ID 8608. */
```

- Selecting scaling wavelengths: 2 options...
  - McGuire 2-wavelength (2007/1980) [recommended]
    - 2007 nm near absorption peak
    - 1980 nm in wing, but close to 2007 to reduce systematic error in presence of broad mineralogical absorptions near 2 microns
  - Pelkey 2-wavelength (2011/1899)
    - Original wavelengths in CAT
    - Closer match to OMEGA correction
    - Occasional artifacts from scaling errors caused by mineralogical absorption affecting 2011 but not 1899

- Summary Parameters: Efficiently calculated indication of where in a scene particular mineralogical spectral features might be observed

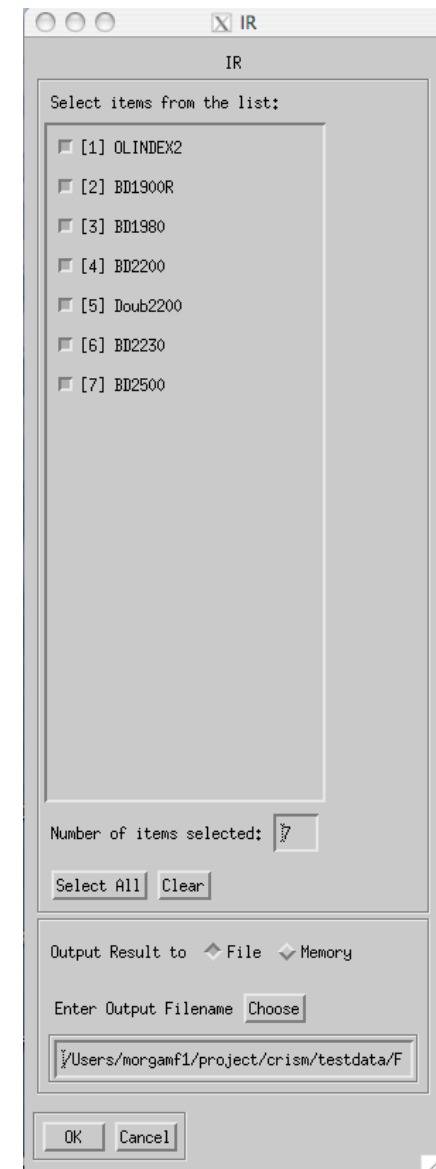


Pelkey et al, 2007, JGR 112,  
doi:10.1029/2006JE002831



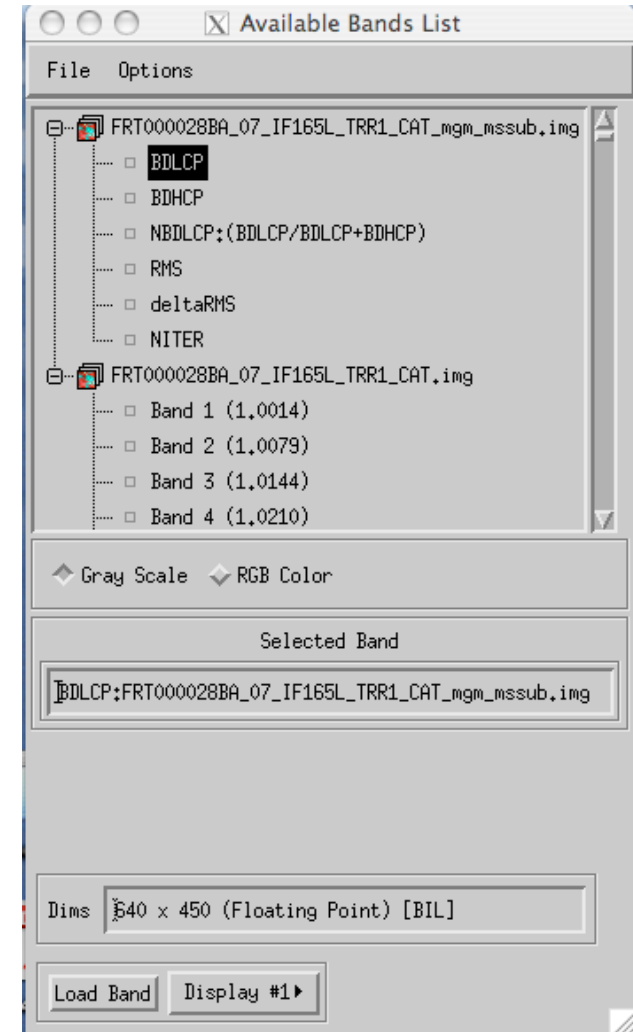
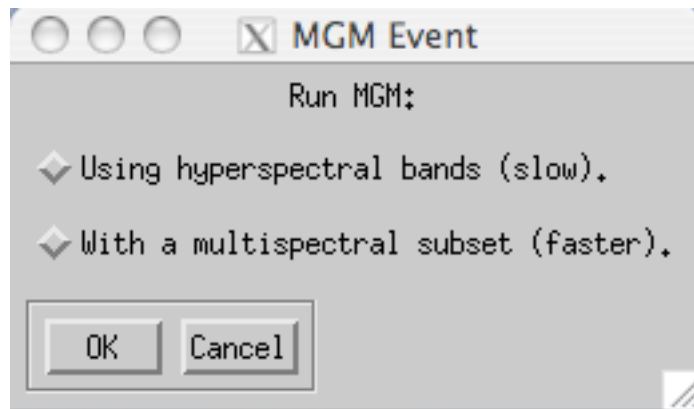


- **Hyperspectral Summary Parameters:**  
Utilize additional bands from hyperspectral data for improved identification of spectral features
  - CAT mechanics similar to standard summary parameters

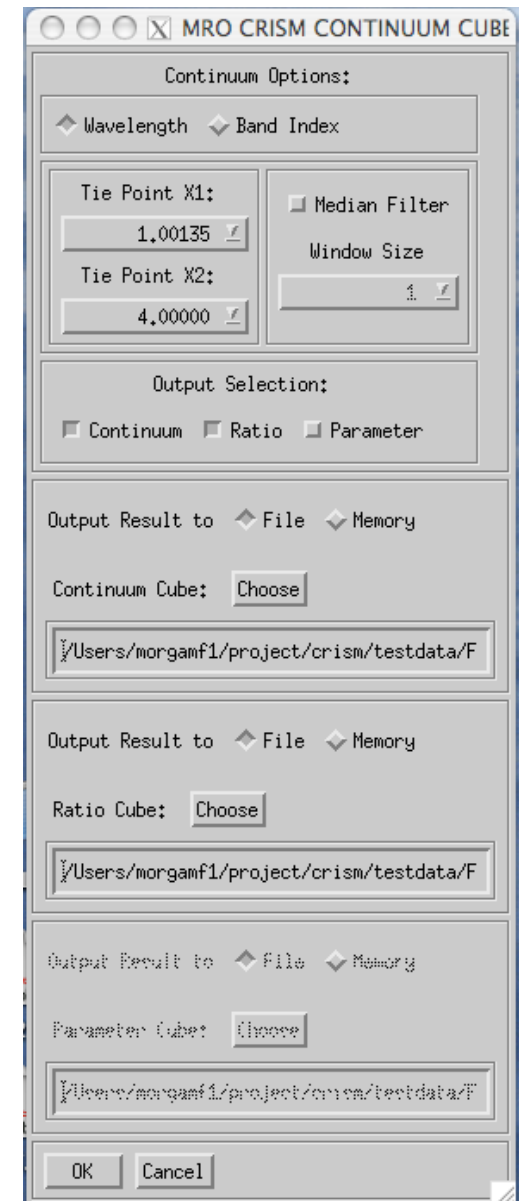




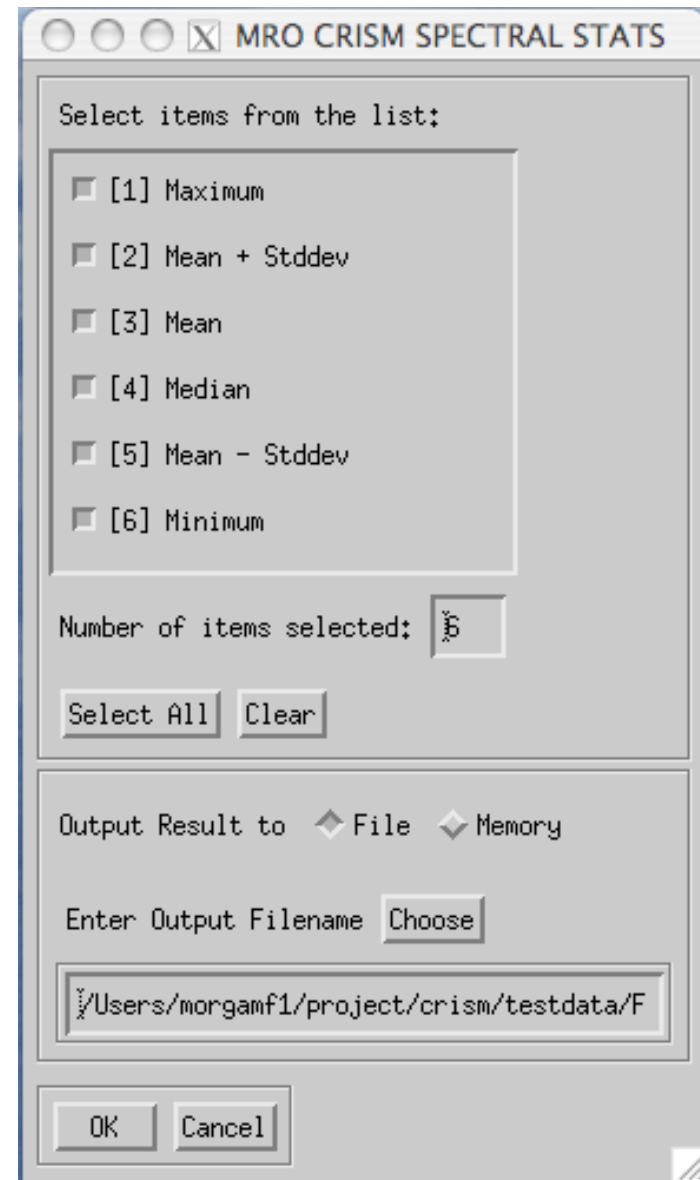
- **MGM:** Modified Gaussian Model
  - Spectral fit to mafic absorption bands



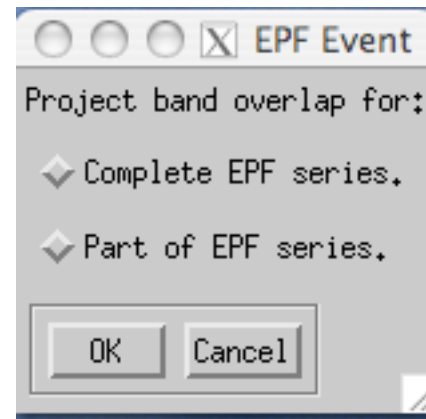
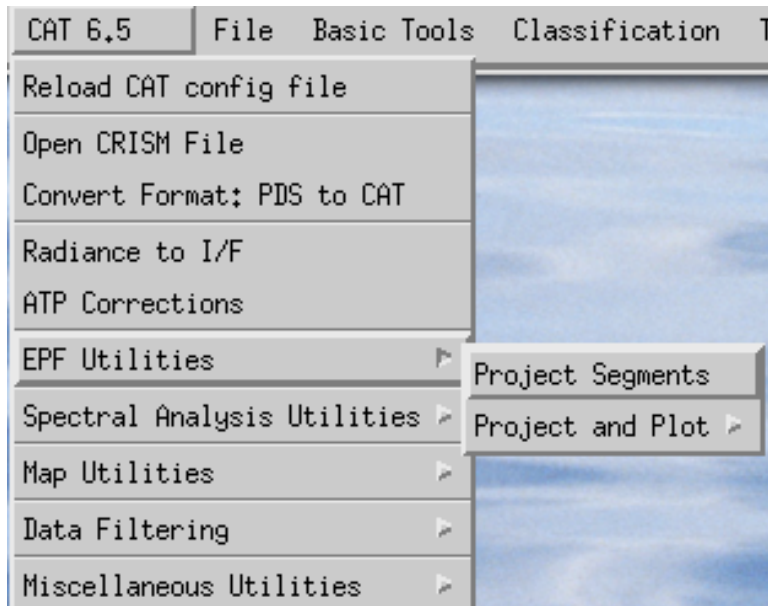
- MRO CRISM Continuum Cube
  - Linear continuum between tie points at two selected wavelengths
  - Also produces the ratio to the calculated continuum and fit parameters
- Often useful with joined data (VNIR + IR)
  - VNIR helps determine continuum over the mafic bands at 1 and 2 microns



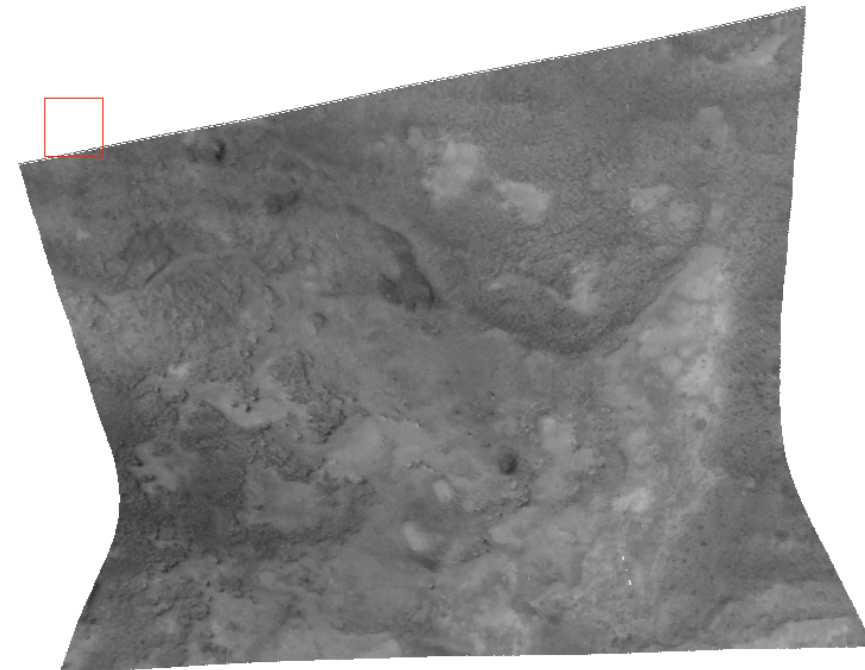
- MRO CRISM Spectral Stats
  - Calculate spectral statistics for data cube and user-defined mask band
  - Includes median; not available in built-in ENVI ROI stats



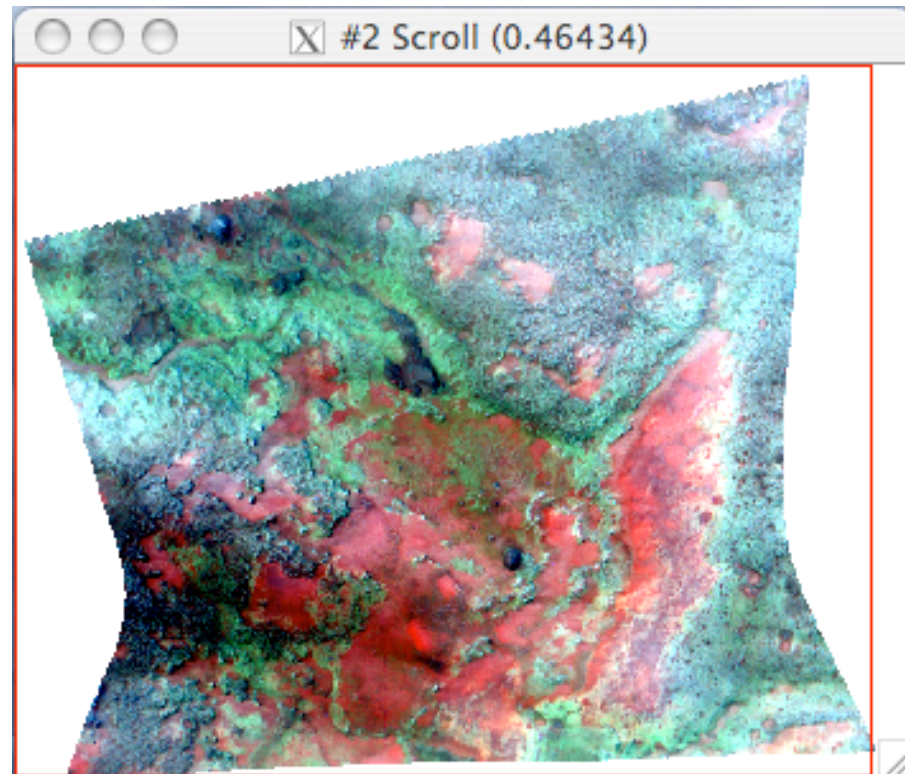
- Project Segments



Select from the 11 images in an EPF series, or run all

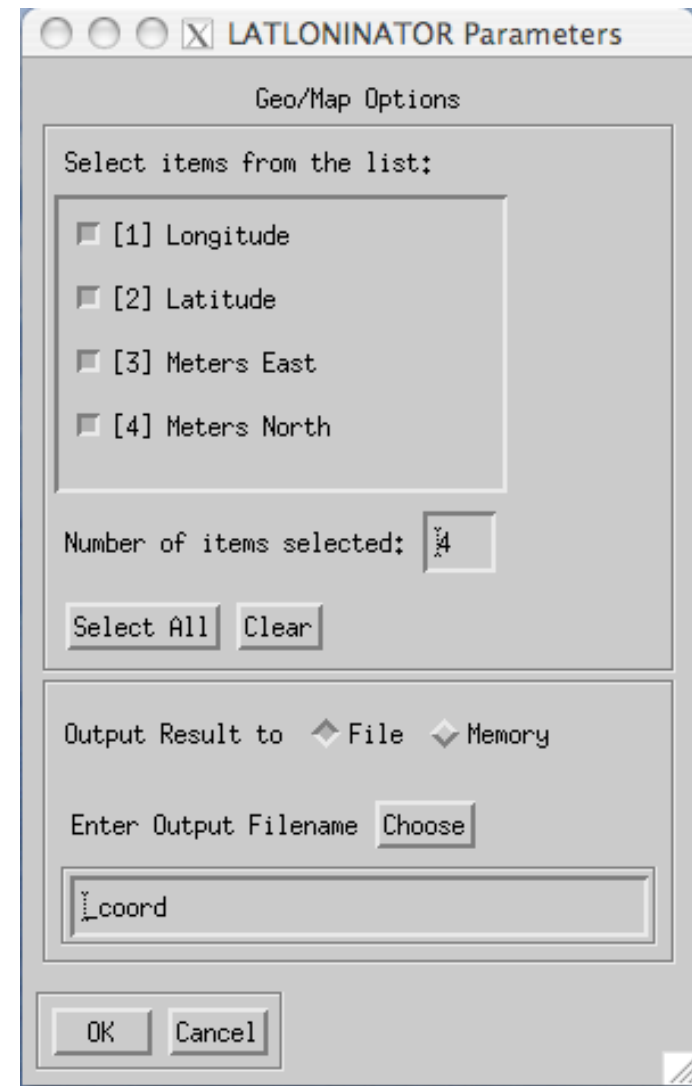


- ***Project Single Cube Data***
  - Map projection using coordinates from DDR

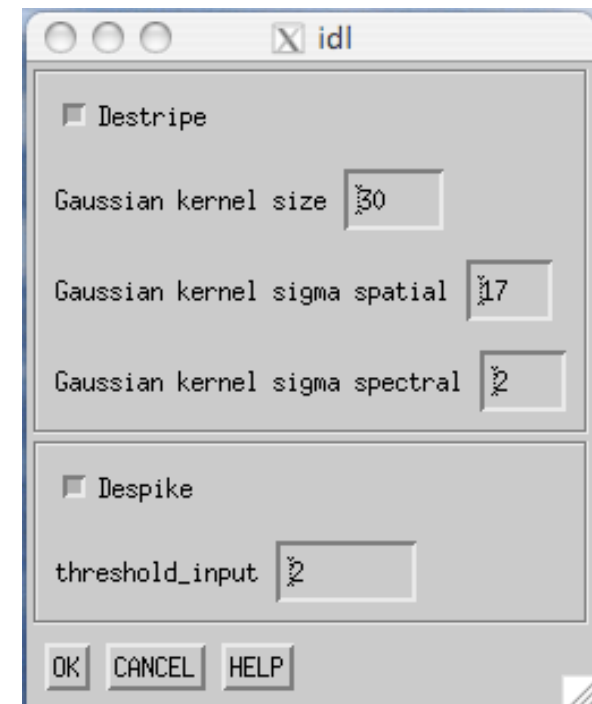
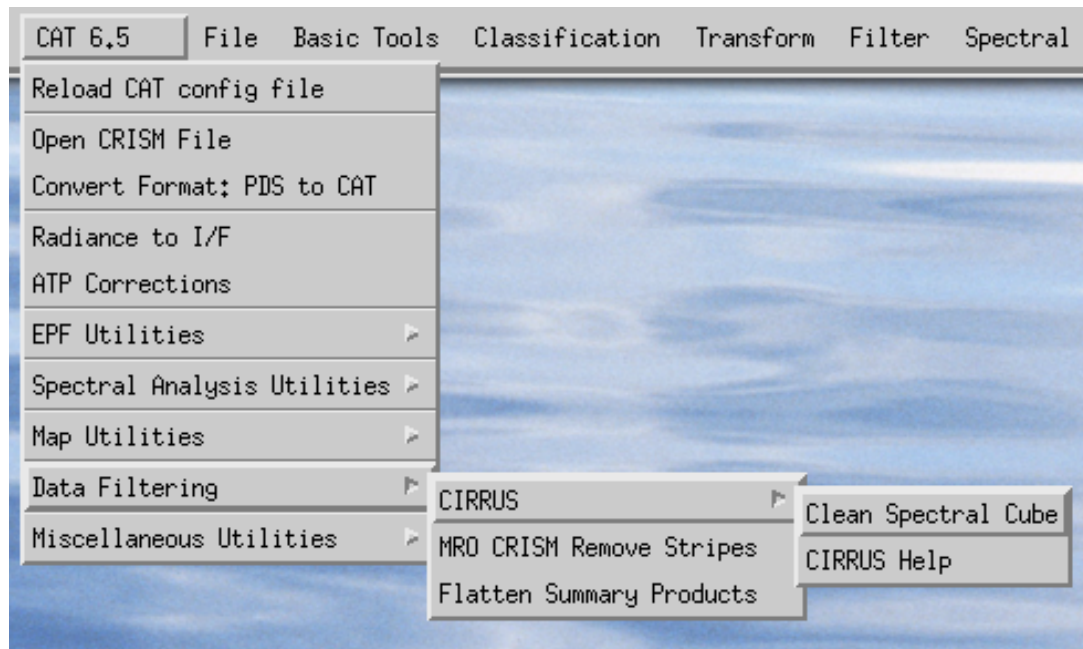




- ***LATLONINATOR***
  - Compute latitude, longitude, meters east and north for an already georeferenced image

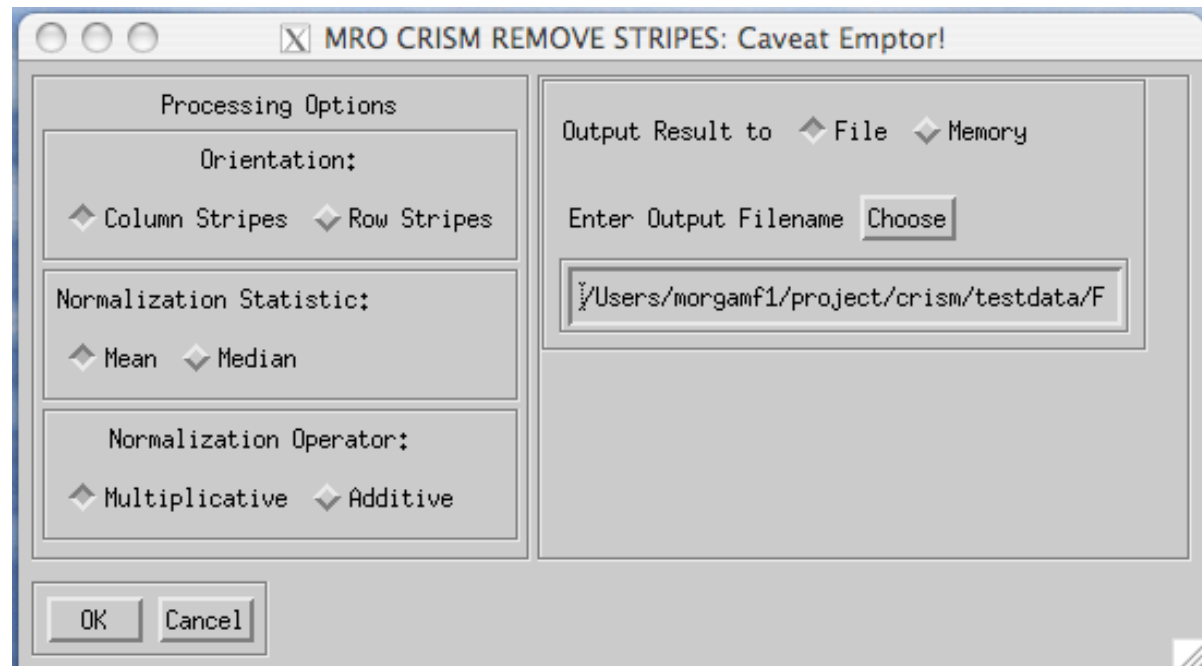


- CIRRUS
  - Despiking (removing isolated noise spikes)
  - Destripping (correcting column bias)





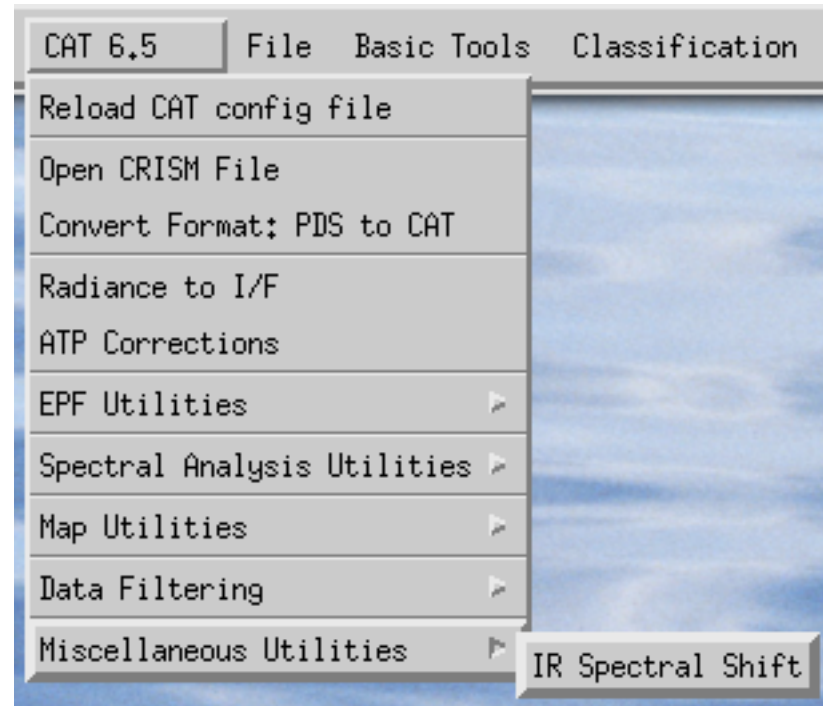
- ***MRO CRISM Remove Stripes***
  - Alternate stripe removal algorithm
  - Generally, CIRRUS destripe preferred
  - But, Remove Stripes offers control over multiplicative vs. additive correction



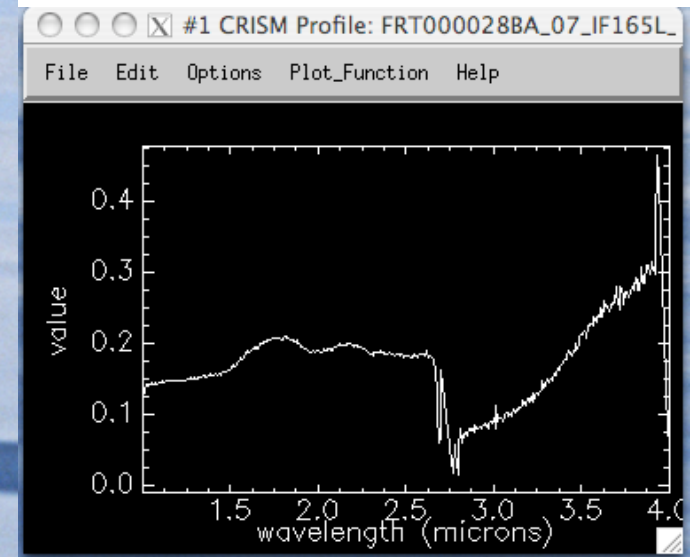
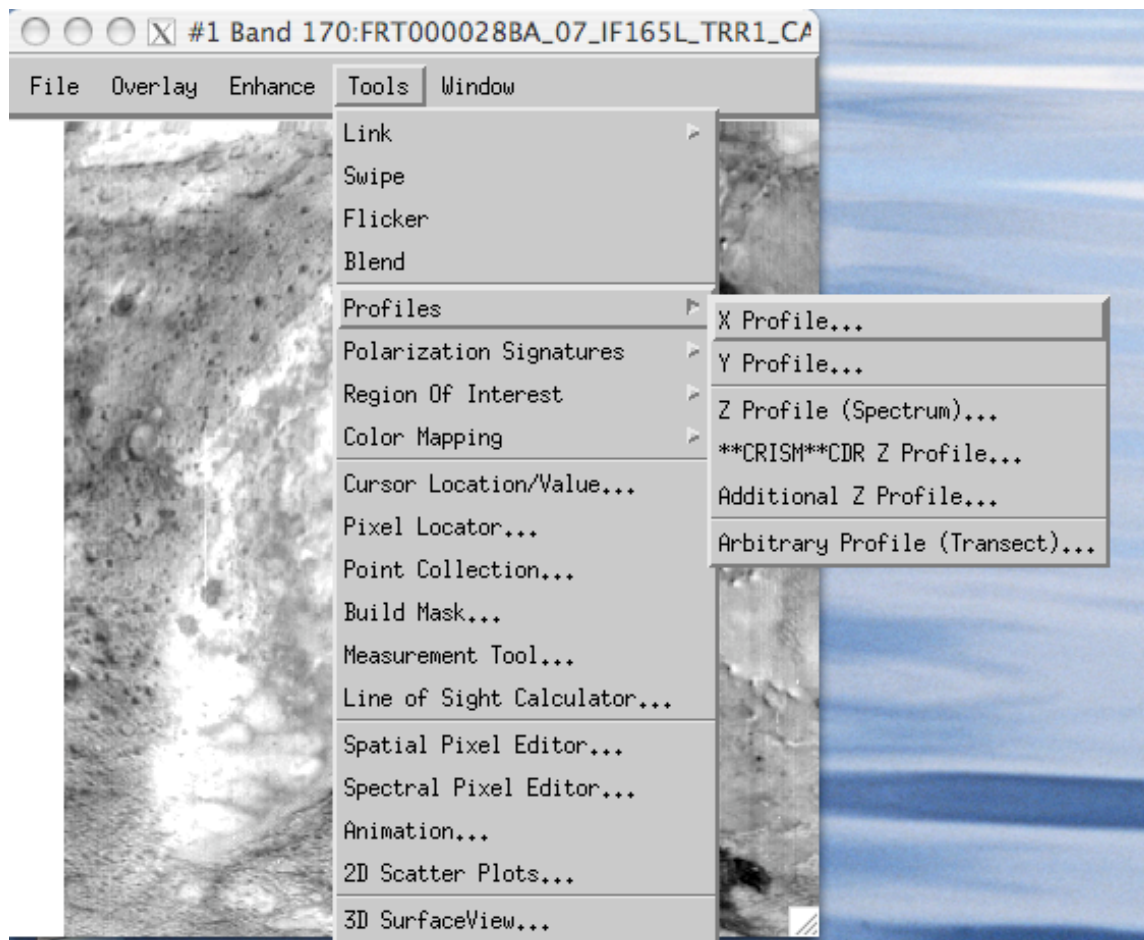
- ***Flatten Summary Products***
  - Removes banding along lines in summary product images
  - Post-processing correction of spectral smile

- ***IR Spectral Shift***

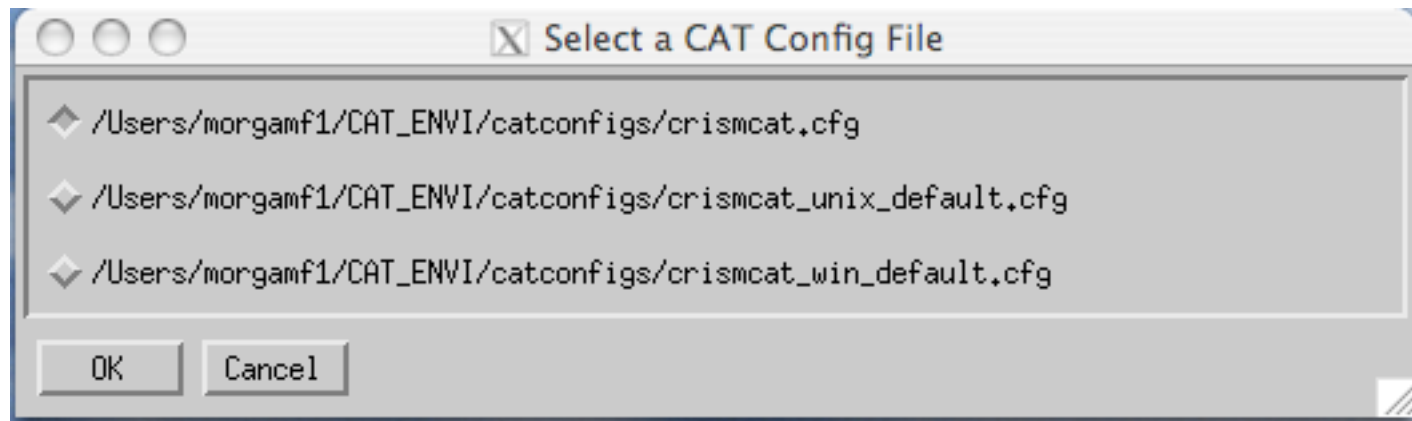
- Computed for an observation from optical bench temperature in the PDS label
- Select an open file; routine gets inputs for shift given filename



- Plot CRISM spectrum
- Access under display “Tools / Profiles” menu



- ***Can load a new CAT configuration file during a session***
  - Changing user, different investigation, etc.



- ENVI starts without CAT menu
  - Make sure you have an envi.cfg in CAT\_ENVI directory with default save\_add directory pointed at CAT\_ENVI