# Volcano Scan Update and MTRDR Effects

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# Overview

- Some general comments about volcano scan artifacts

- Some discussion of specific volcano scan related features appearing in the MTRDR evaluations

# Volcano scan artifacts

- Shift artifact
  - Small temperature dependent shift of spectrum on detector
  - $CO_2$ absorption edges = very sharp gradient
  - If VS shift mismatched with observation then dividing leads to spikes at $CO_2$ slopes
- "Spectroscopic" artifact
  - Shape of $CO_2$ absorption depends on pressure, temperature, etc.
  - Dividing Olympus Mons plains by summit is combining $CO_2$ spectra with different shapes
  - Resulting transmission estimate deviates systematically from any real observation
  - Result is the bowl-shaped artifact around 2.0 microns
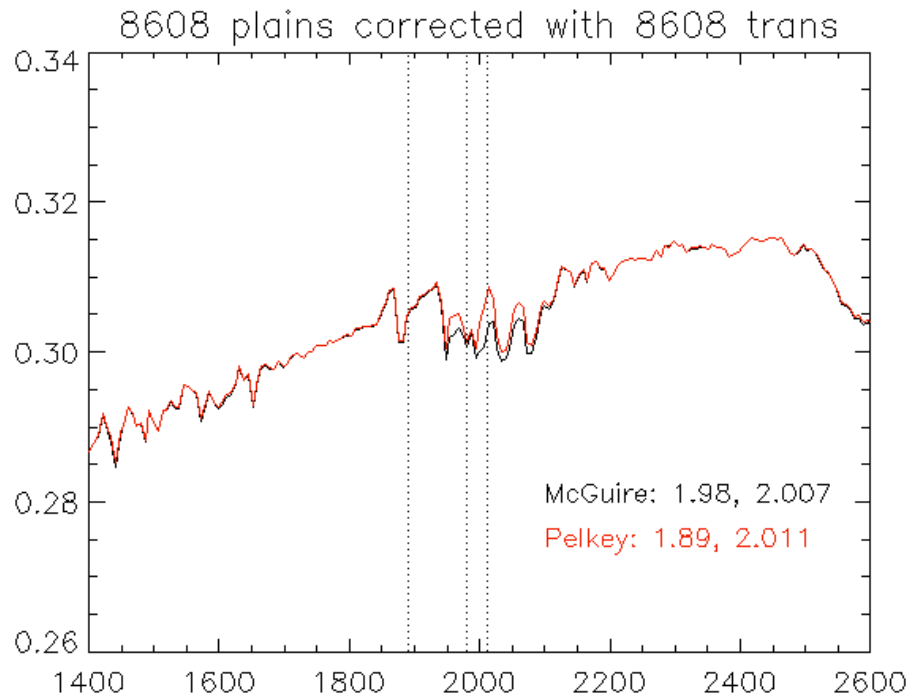
# Spectral shift artifact
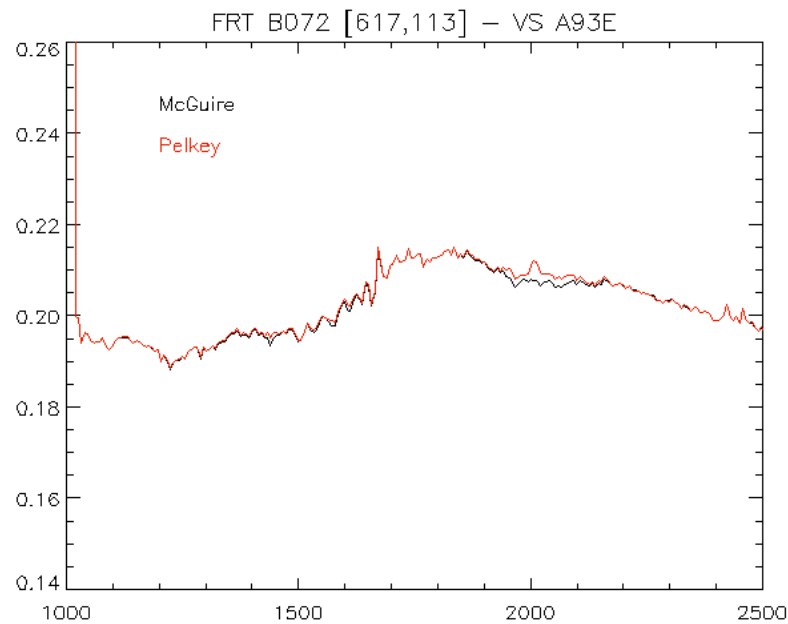


A93e – *good match*
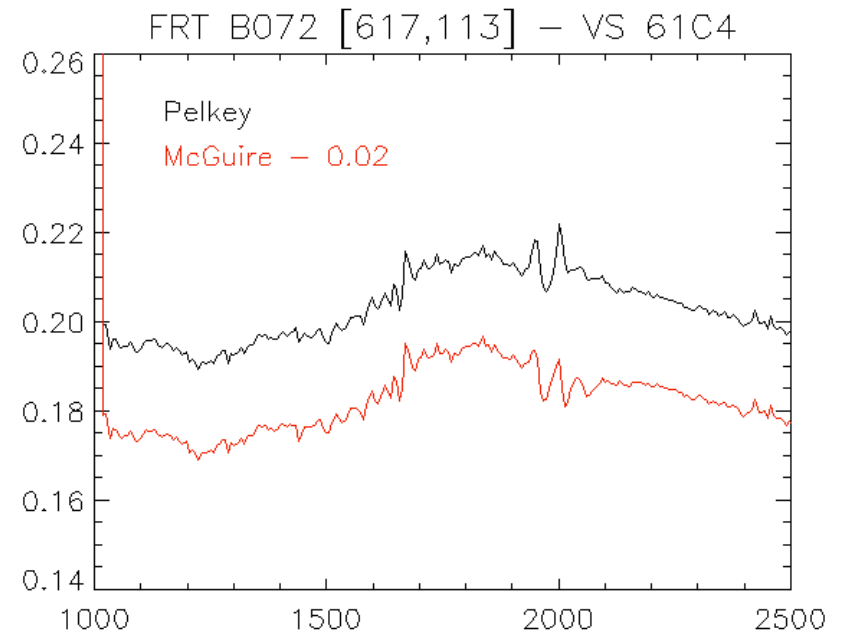
61C4 – *poor match*

Mitigation: *Select a volcano scan with spectral shift that matches the observation*
(there's not always a good one available)

# Spectroscopic artifact



8608 plains corrected with 8608 trans

McGuire: 1.98, 2.007
Pelkey: 1.89, 2.011

- Correcting volcano scan spectrum with itself leaves the spectroscopic artifact
- Present with either set of scaling wavelengths
- Mitigation: artifact patch

ARTIFACT PATCH:
- Correct volcano scan with itself
- Draw continuum between 1.76 and 2.24
- Subtract VS correction from this continuum estimate... = artifact spectrum
- Scale by optimized factor, add into standard VS corrected observation
  - Scaling factor set to zero the correlation with artifact spectrum (more on this later)
- May have problems with $CO_2$ ice, maybe others

# Pelkey vs. McGuire

FRT B072 [617,113] — VS A93E
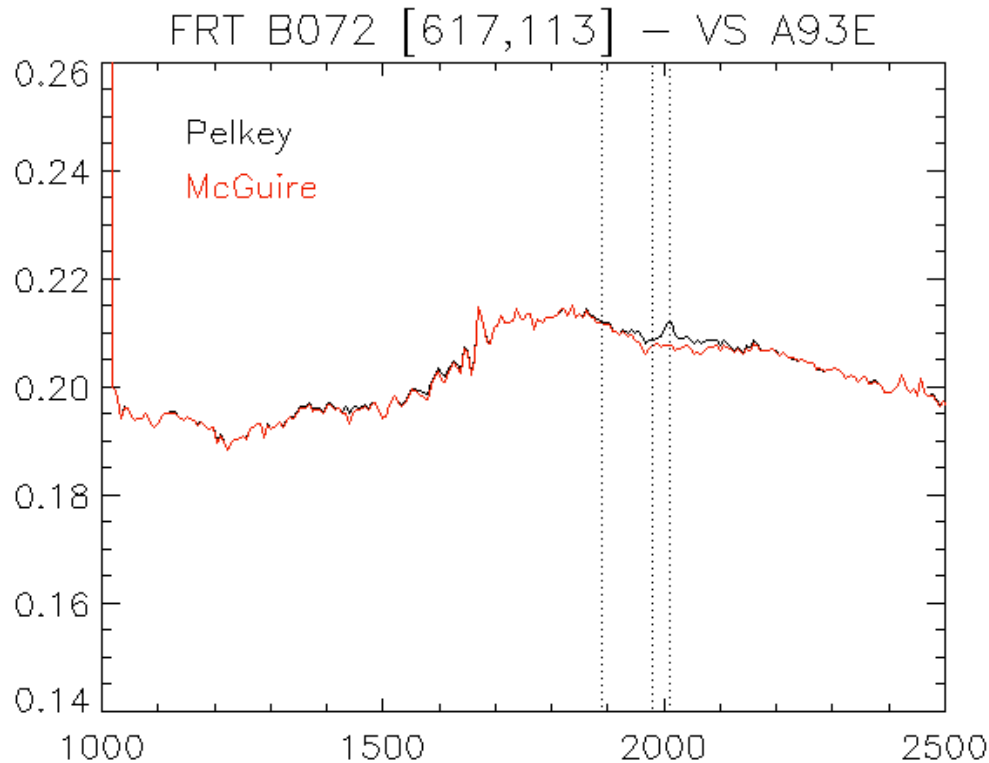
Pelkey
McGuire

B072 corrected with A93E + artifact correction

- Correction with McGuire or Pelkey gives very similar result
- Pelkey leaves spike near 2.01 because it's driving 2.011 up to match 1.89, which in this spectrum is higher
- McGuire is smoother because its scaling wavelengths are closer and more similar, so 2.007 is not driven up as severely as Pelkey's 2.011
- Similar difference expected whenever spectrum has curvature in 2 micron region
- *Or when there's a real feature near 1.89*

*(sorry for swapping the color code from last slide...)*

# Volcano scan history in CAT

- CAT6.7
  - Original 7 volcano scans; McGuire or Pelkey
  - Selection by AT CDR only (thermal period)
- CAT 7.0
  - New selection method: temperature-derived spectral shift match
  - Add 2 new VS: 11d87, 1b815
- CAT 7.1
  - Add artifact correction
- CAT 7.2
  - Select VS that minimizes shift artifact for specific observation
  - 3 new VS: 12b2c, 103d6, 11739
- MTRDR is like CAT 7.2

# Volcano Scan Data

| VS ID | CO2 position | CO2 depth |
|-------|-------------|-----------|
| 000061C4 | 283.813 | 0.580 |
| 00006822 | 283.833 | 0.522 |
| 00008608 | 283.808 | 0.576 |
| 000094B5 | 283.714 | 0.565 |
| 00009E04 | 283.693 | 0.591 |
| 0000A3F6 | 283.676 | 0.590 |
| 0000A93E | 283.647 | 0.598 |
| 000103D6 | 283.761 | 0.597 |
| 00011739 | 283.769 | 0.607 |
| 00011D87 | 283.769 | 0.579 |
| 00012B2C | 283.789 | 0.582 |
| 0001B815 | 283.703 | 0.606 |

By ID

| VS ID | CO2 position | CO2 depth |
|-------|-------------|-----------|
| 0000A93E | 283.647 | 0.598 |
| 0000A3F6 | 283.676 | 0.590 |
| 00009E04 | 283.693 | 0.591 |
| 0001B815 | 283.703 | 0.606 |
| 000094B5 | 283.714 | 0.565 |
| 000103D6 | 283.761 | 0.597 |
| 00011739 | 283.769 | 0.607 |
| 00011D87 | 283.769 | 0.579 |
| 00012B2C | 283.789 | 0.582 |
| 00008608 | 283.808 | 0.576 |
| 000061C4 | 283.813 | 0.580 |
| 00006822 | 283.833 | 0.522 |

By CO2 position
(proxy for spectral
shift match)

*Shift artifact ~1% for 0.02 pixel position shift*
*Colder temperature reduces pixel position*
*Lots of observations out of VS range beyond A93E*

# MTRDR & Volcano Scan

- Look at some features noted in MTRDR evaluations
- Show some aspects of volcano scan behavior involved
- Format:
  - Slide stolen from an MTRDR evaluation presentation
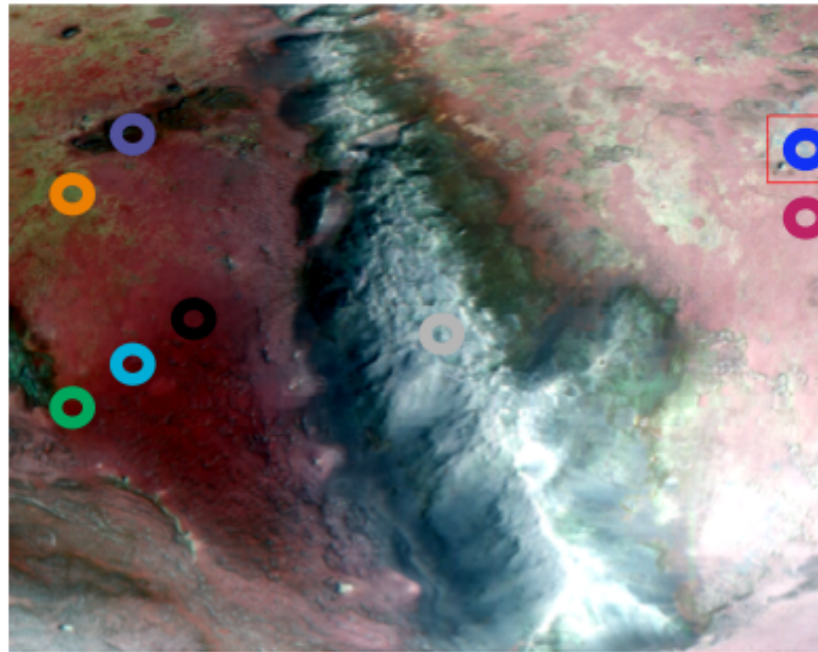  - Slide or two of my own creation discussing related volcano scan behavior

# MTRDR Eval: B072 (Edwards)



Raw I/F Spectra
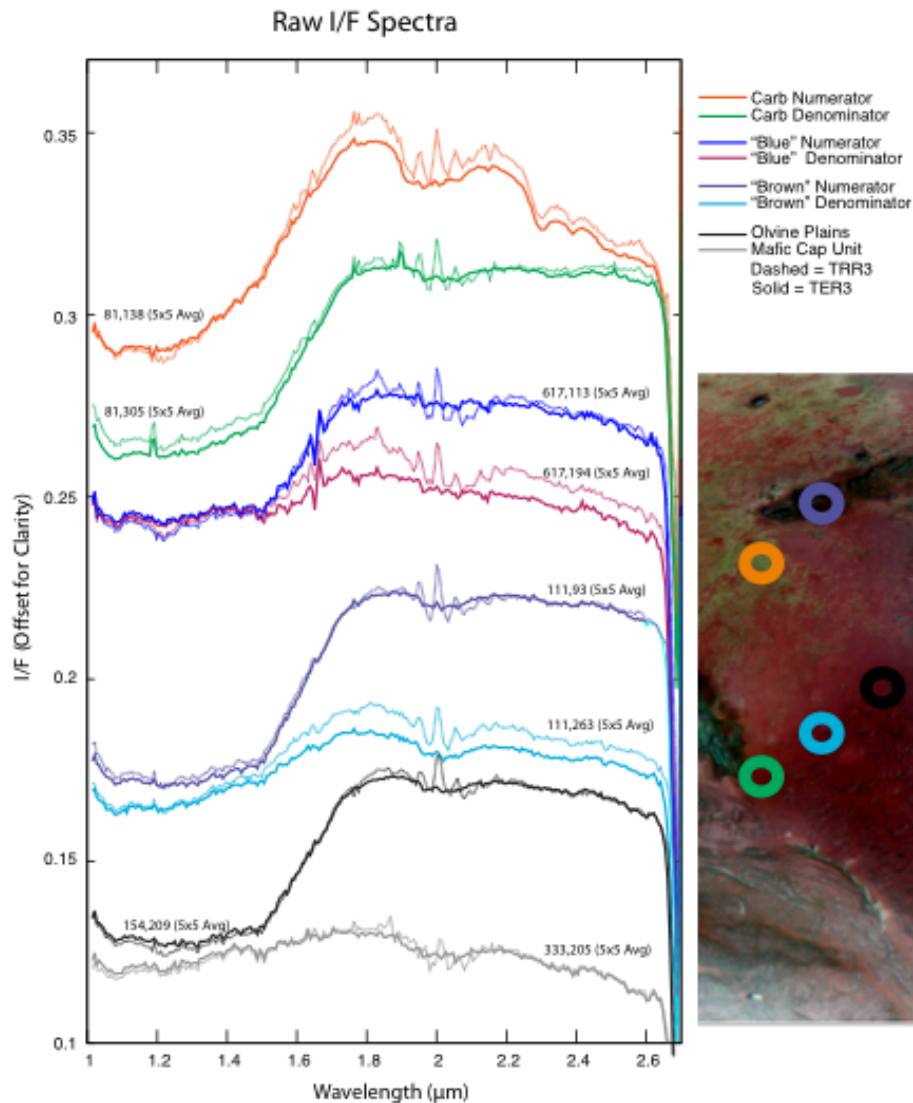
FRT0000B072

Comments

1) Significantly better ATM removal at ~2μm

2) Lower "random" noise

# Volcano scan: B072

- Some B072 plots show what looks like bad spectral shift artifact
- Current CAT does not produce this (next slide)
- Picking the wrong VS will cause shift artifact
  - Thermal period: 1B815  (283.70)
  - Bench temp: 1B815
  - Optimum: A93E  (283.65)
- B072 co2 position = 283.64
  - Slightly beyond VS range
  - A93E is the best VS match
  - Even A93E a bit too long, expect 1B815 to be noticeably worse
- Correcting with 61c4 (almost worst choice at 283.81) gives artifact like the plots

# Volcano scan: B072 CAT 7.2 (A93E)



FRT B072 [617,113] — VS A93E

McGuire

Pelkey
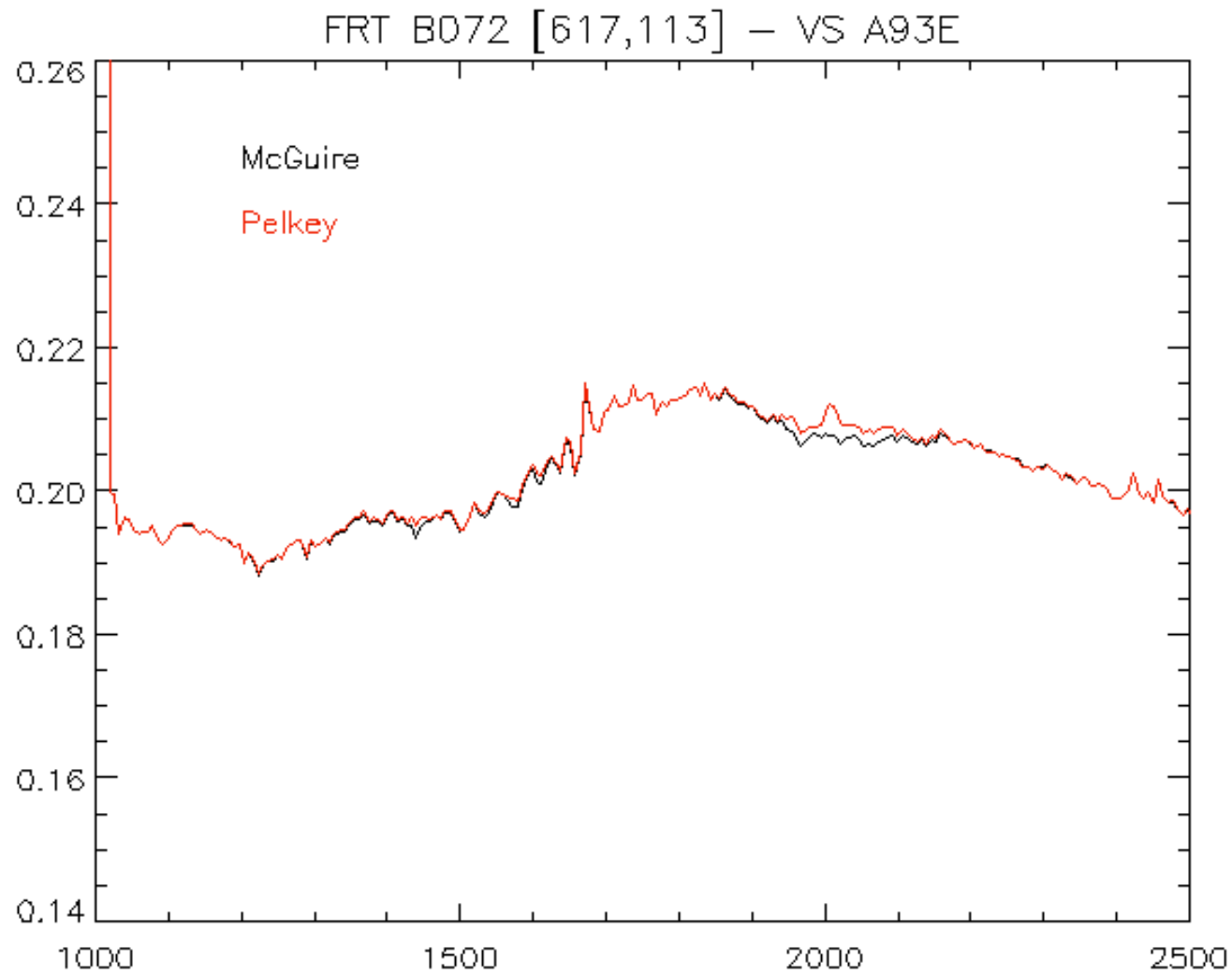
# Volcano scan: B072 with 61C4



FRT B072 [617,113] — VS 61C4
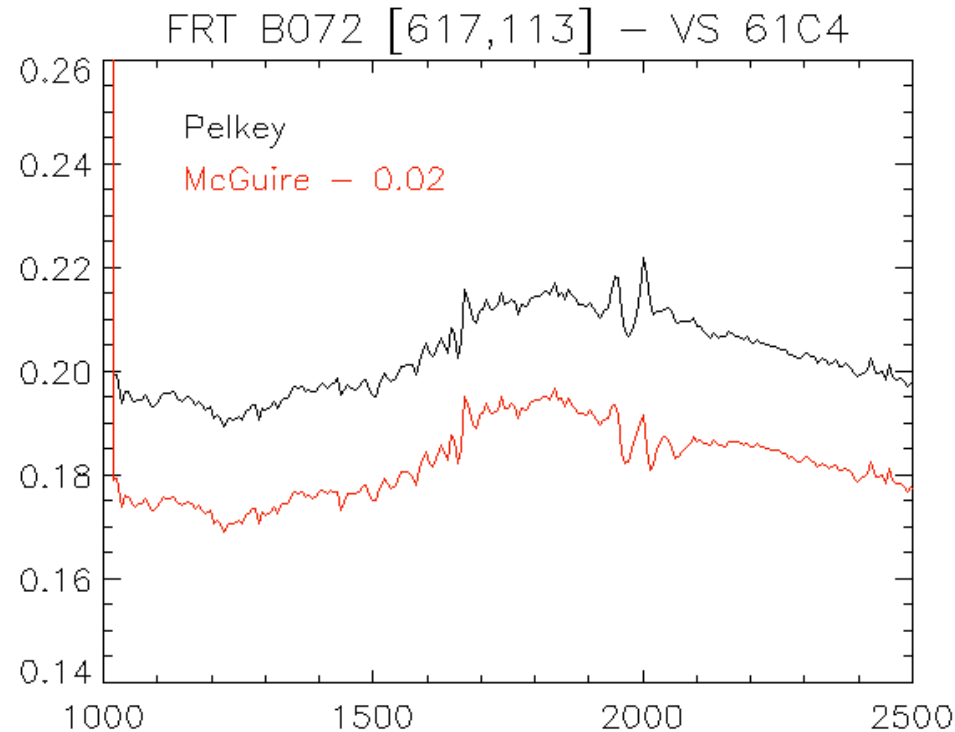
- Correcting with 61c4 gets artifact similar to presentation
- *61c4 at opposite end of shift spectrum from best VS (A93E)*
    - Expect shift artifact ~49%/pixel * 0.2 pixels ~ 10%
- Underscores importance of VS selection

# MTRDR Eval: 3FB9 and A09C (Wiseman)



Overlapping coverage (same spot, 2 different times of year)

# Volcano scan: 3fb9 and a09c



3FB9 (vs 11739) and A09C (vs A93E)

3fb9 [220,21] 3x3
a09c [52,110] 3x3
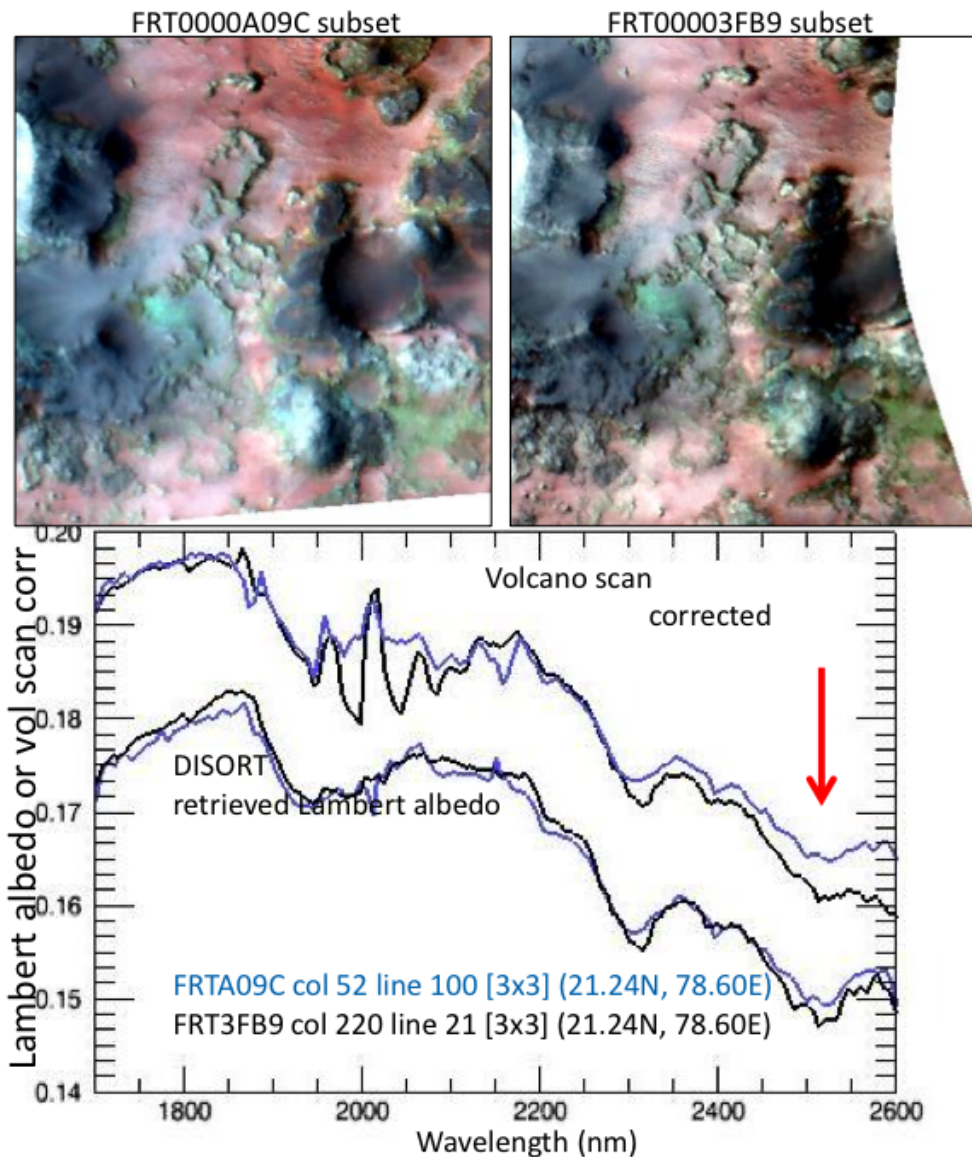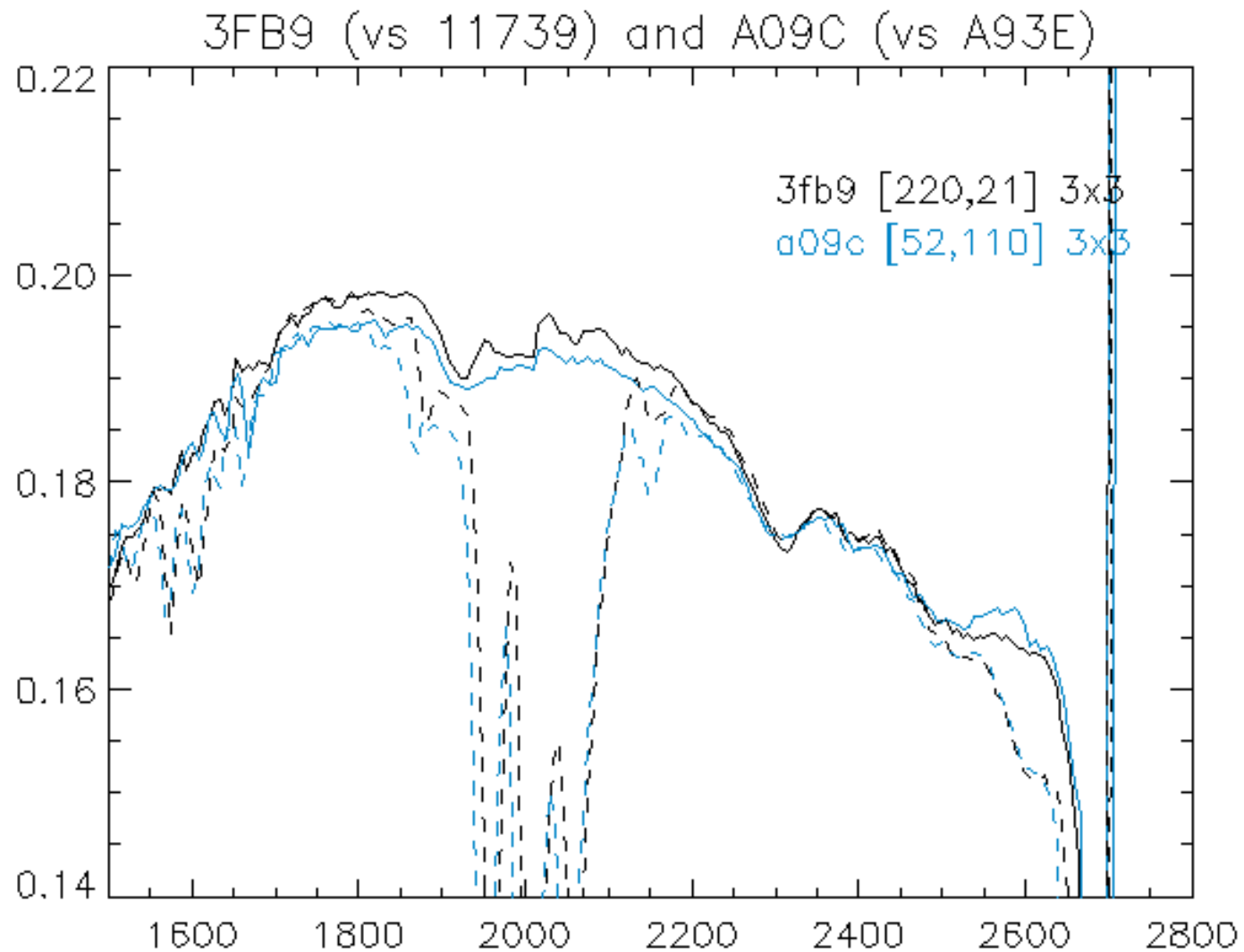
Corrected spectra use McGuire wavelengths & include artifact patch

# Volcano scan: 3fb9 and a09c

- Using 11739 for 3fb9 and a93e for a09c, I do not get the bad shift artifact Sandra got for 3fb9
- Also do not see the I/F disconnect between A09C and 3FB9 across all wavelengths longward of ~2.3
- There is discrepancy between 3FB9 and A09C in the 1.7-2.2 region; this must be due to VS correction differences (possibly artifact patch scaling)
- There is also a difference due to VS correction at ~2.5-2.6; water vapor?
  - Uncorrected I/F in 3FB9 and A09C agree through here
  - If it's water vapor, variability must be mostly in VS, not Nili Fossae

# Volcano scan transmission
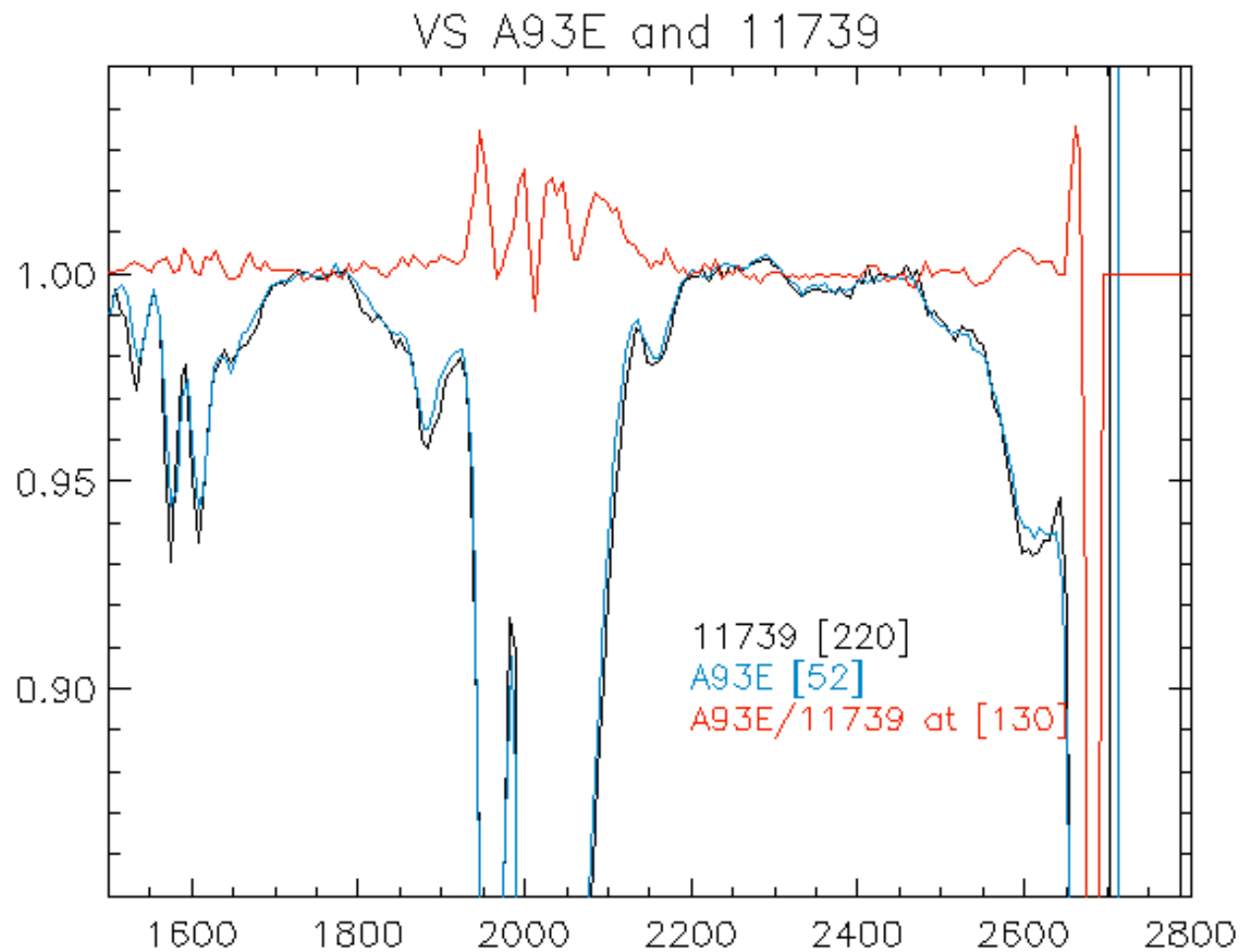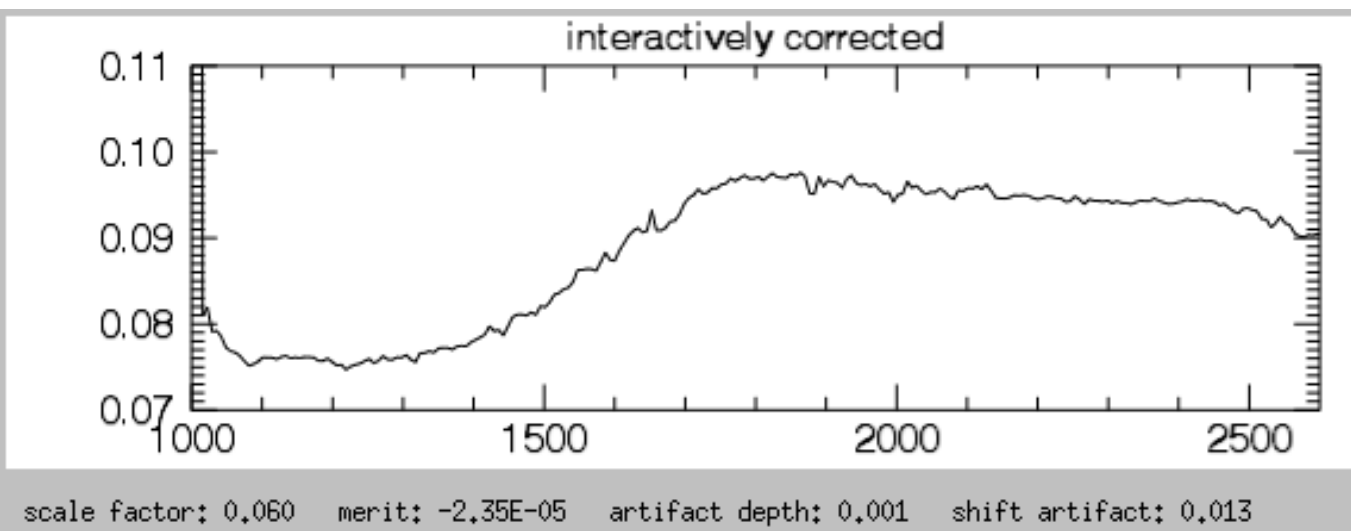
# Volcano scan: 3fb9 and a09c

- This points up a simmering issue…
  - Volcano scan scaling is set entirely by CO2
  - Water vapor:
    - potentially present in VS and/or corrected spectrum
    - partly independent of CO2 abundance
  - Volcano scan will not in general correct for water vapor properly
- Should we:
  - Accept the probably usually partly correct H2O correction?
  - Or force volcano scan transmission to 1.0 at H2O wavelengths?
  - Or rescale VS at H2O and do separate correction?
    - That's another research project

# Artifact patch: Alternative scaling

3FB9 [227,229] (IDL) - Sandra noted overcorrection suggests band
at 2140 here.      11739/McGuire/Artifact patch...



scale factor: 0.960    merit: -4.10E-07    artifact depth: -0.016    shift artifact: 0.013
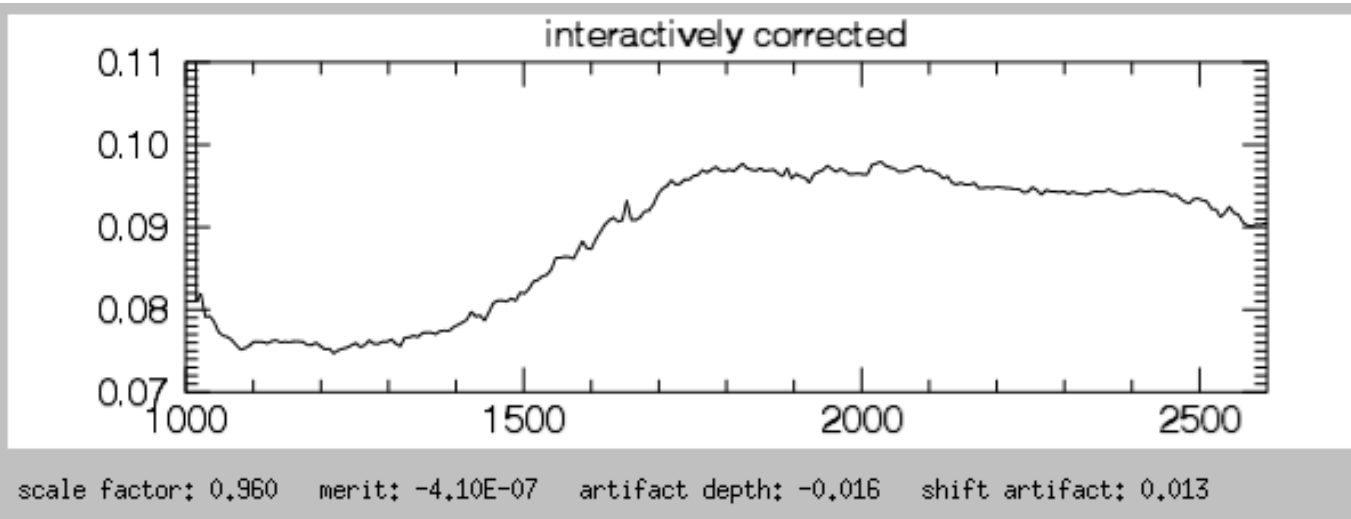
Scale factor 0.96
- Close to correlation-based selection



scale factor: 0.060    merit: -2.35E-05    artifact depth: 0.001    shift artifact: 0.013

Scale factor 0.06
- Close to value that minimizes artifact depth

# Alternative scaling: 3192 [200,200]