Section 4

Using the Hyperion Data

. . . Dr. Pamela Barry
TRW Space & Electronics Group

Hyperion Details

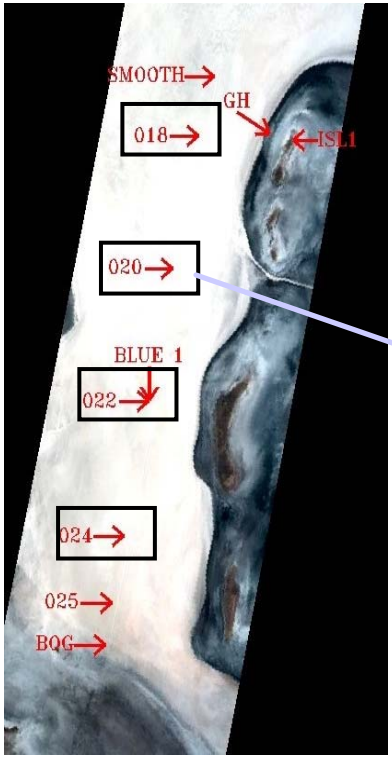
- ***Absolute Radiometry***
  - ***What does the unit represent***
  - ***Will the results be repeatable***
  - ***Will the results be accurate***
  - ***How will the results compare with Landsat***
  - ***What is the detectable radiance range***
  - ***What is the SNR, how does that compare***
- ***Spectral Calibration***
- ***Optical Quality***

Data Unit

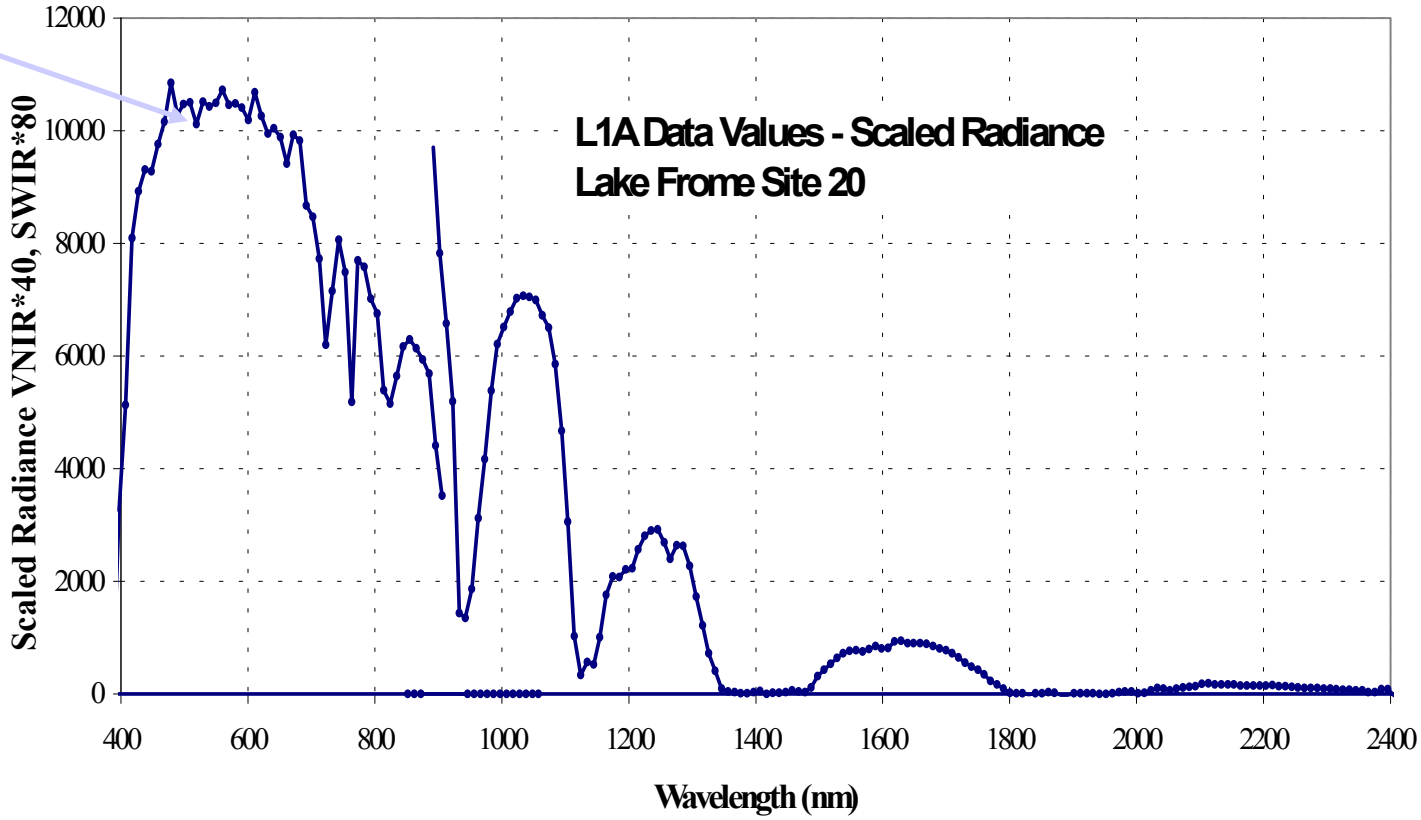
- ***Level 1B is in scaled radiance W/(m2-um-sr) scaled to maximize precision, VNIR *40, SWIR *80***
- ***To obtain Top-of-the-Atmosphere (TOA) Radiance W/(m2-um-sr)***
  - ***Divide bands 1–70 by 40 and bands 71-242 by 80***
  - ***For units of uW/(cm2-nm-sr) Divide by 400 and by 800***

Lake Frome Example

Data Unit



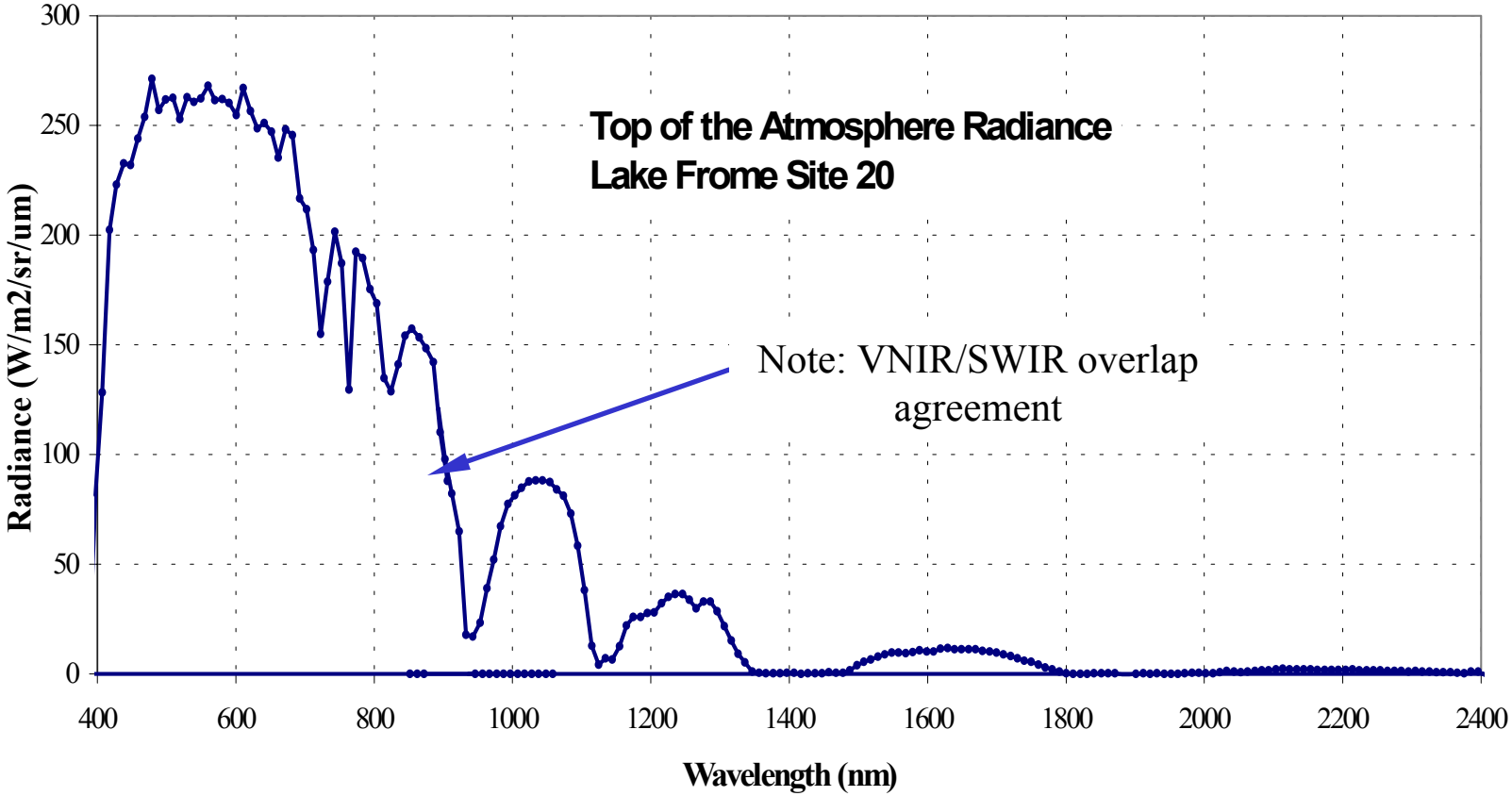
*Level 1 data is top of the absolute radiance scaled to maintain maximum precision: VNIR*40 and SWIR*80*



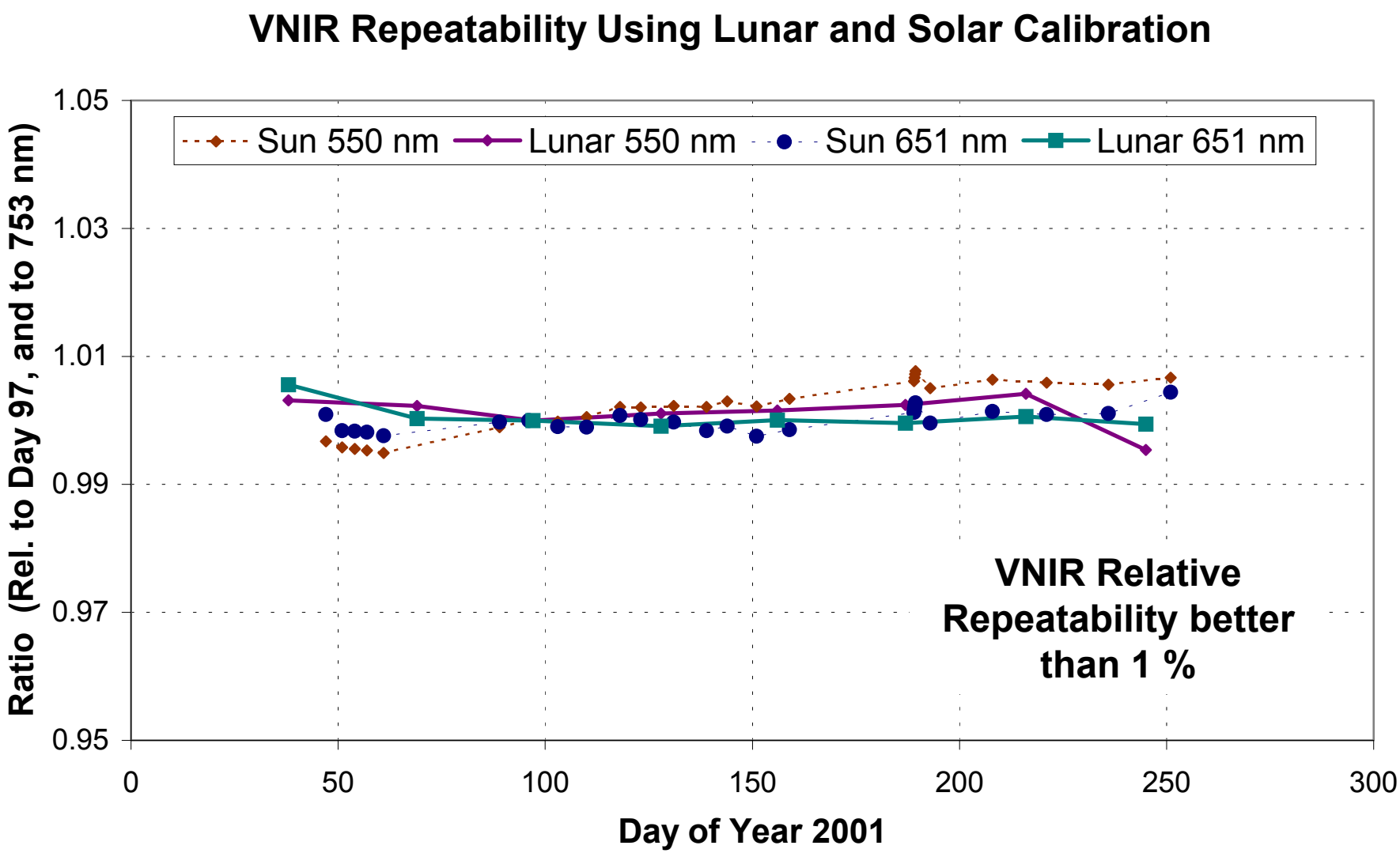
Example of a subset and georectified scene

Data Unit

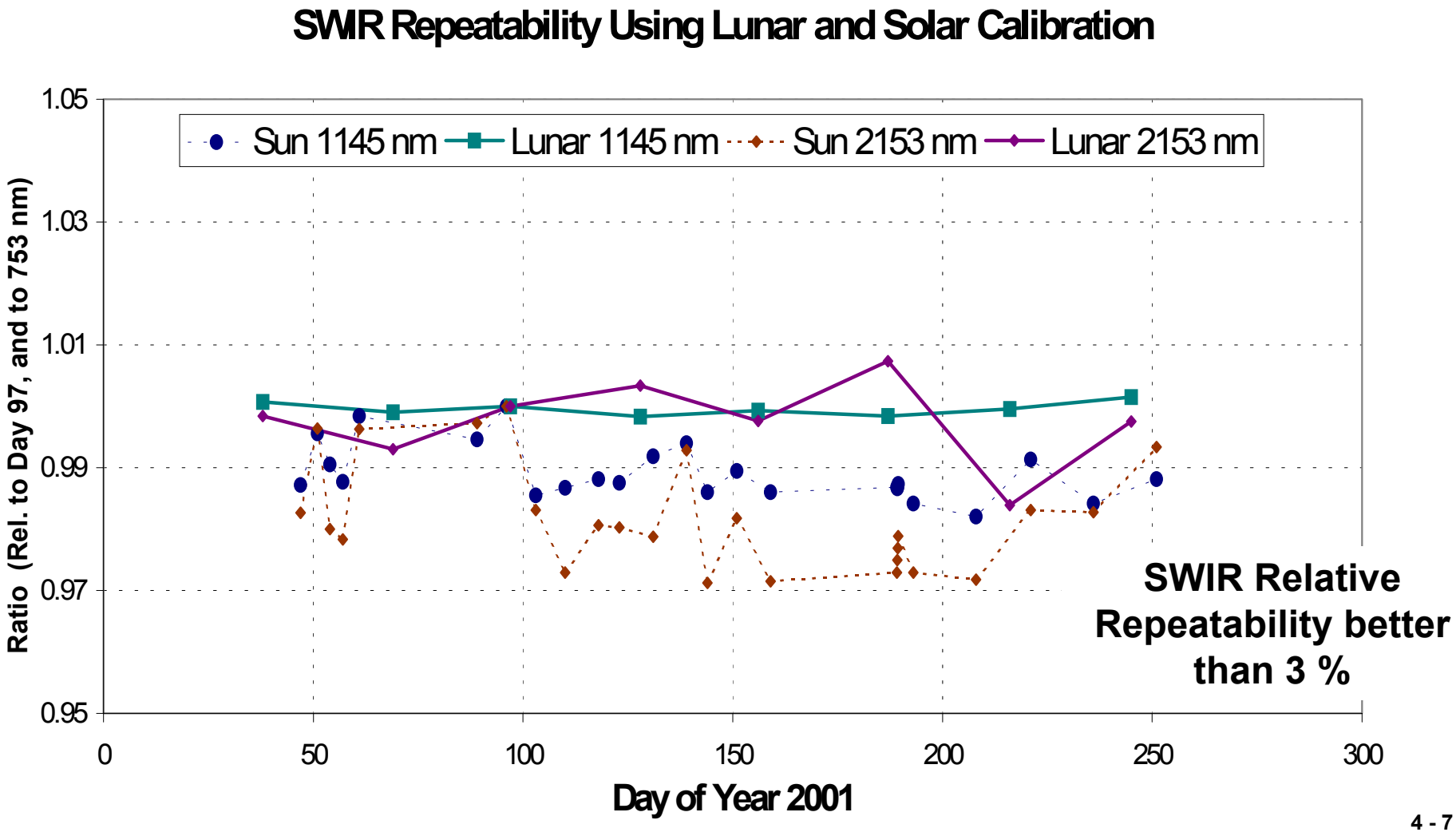
Return to absolute radiance (W/(m2-um-sr)
divide VNIR by 40.0 and SWIR by 80.0



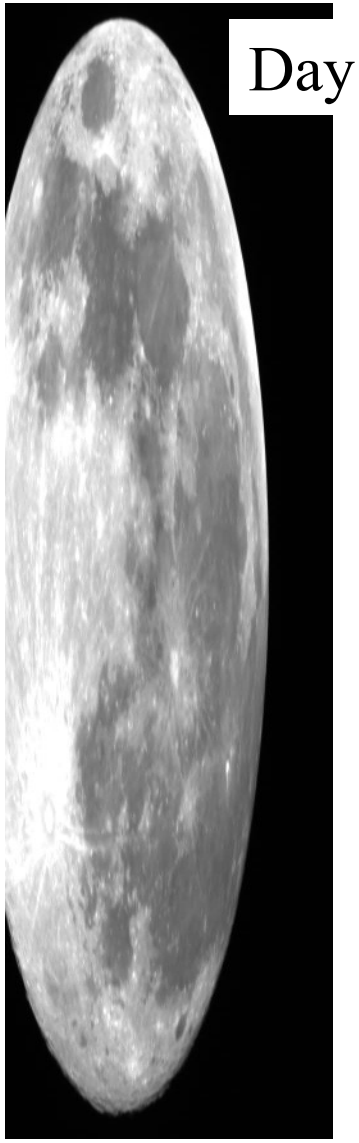
VNIR Relative Repeatability

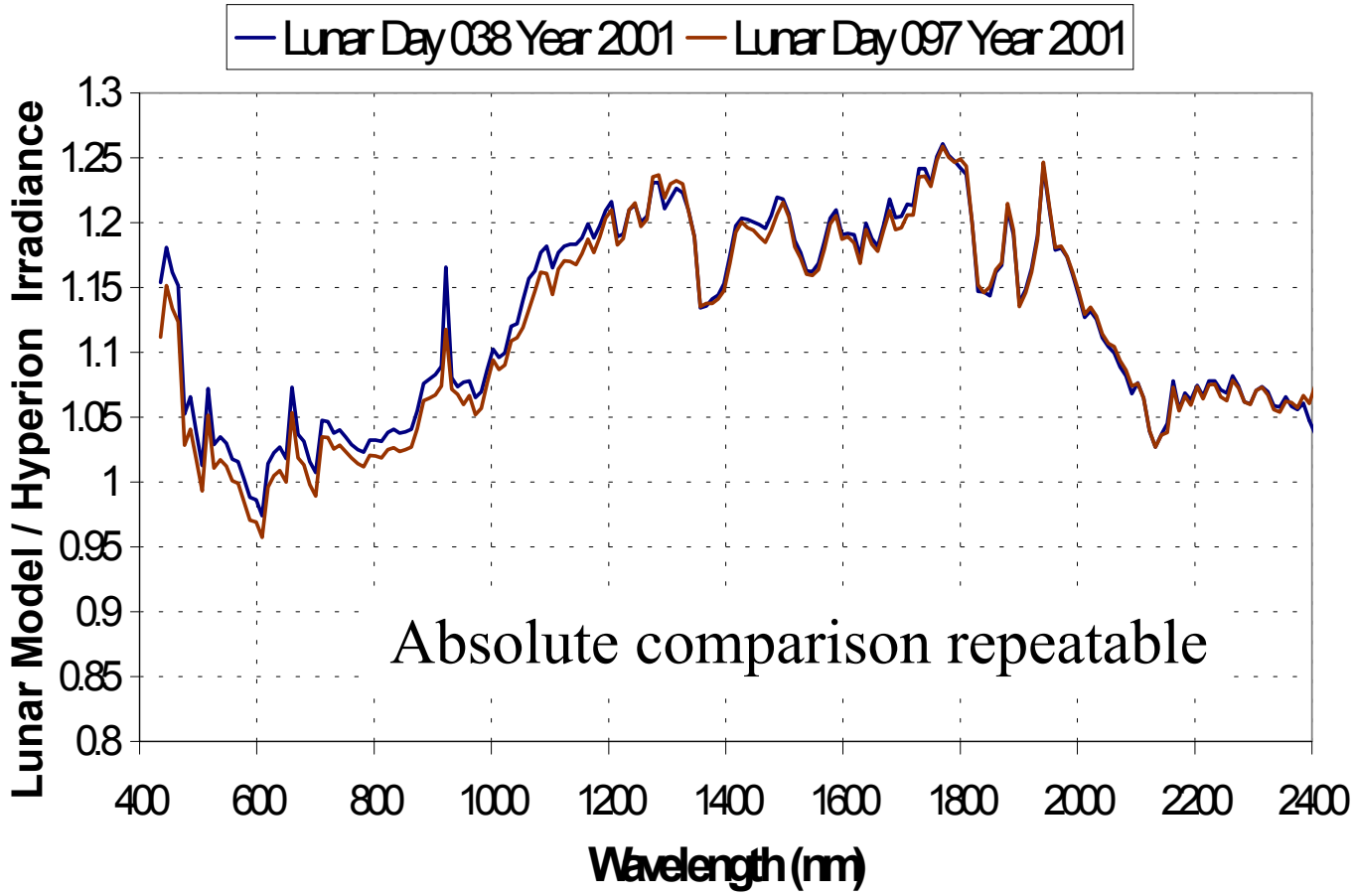


SWIR Relative Repeatability



Absolute Repeatability



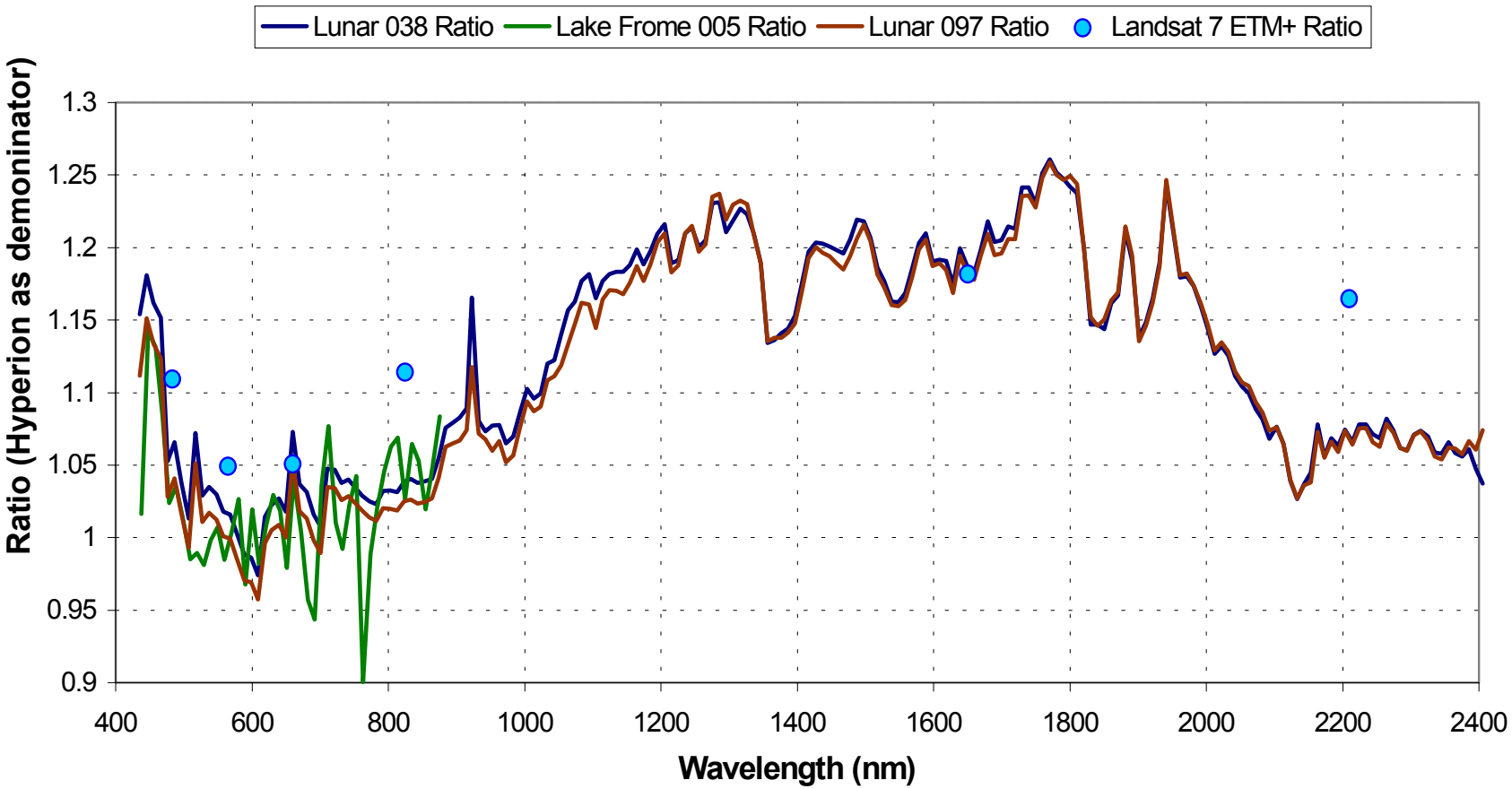


End-to-End Budget

	VNIR	SWIR
Total Measurement Error (% 1σ)	2.95	3.39
Absolute (Systematic) Error	2.49	2.49
– Primary Standard		
– Cal Panel Assy		
– Ground Calibration		
– Responsivity change on launch		
Precision Error	1.60	2.30
– Pixel-to-pixel variation		
– DCE-DCE Variation		
– Calibration drift		
– Residual Radiometer Artifacts		
– Dark Removal		
– Single Sample Noise		

Absolute Comparisons

Comparison of Results

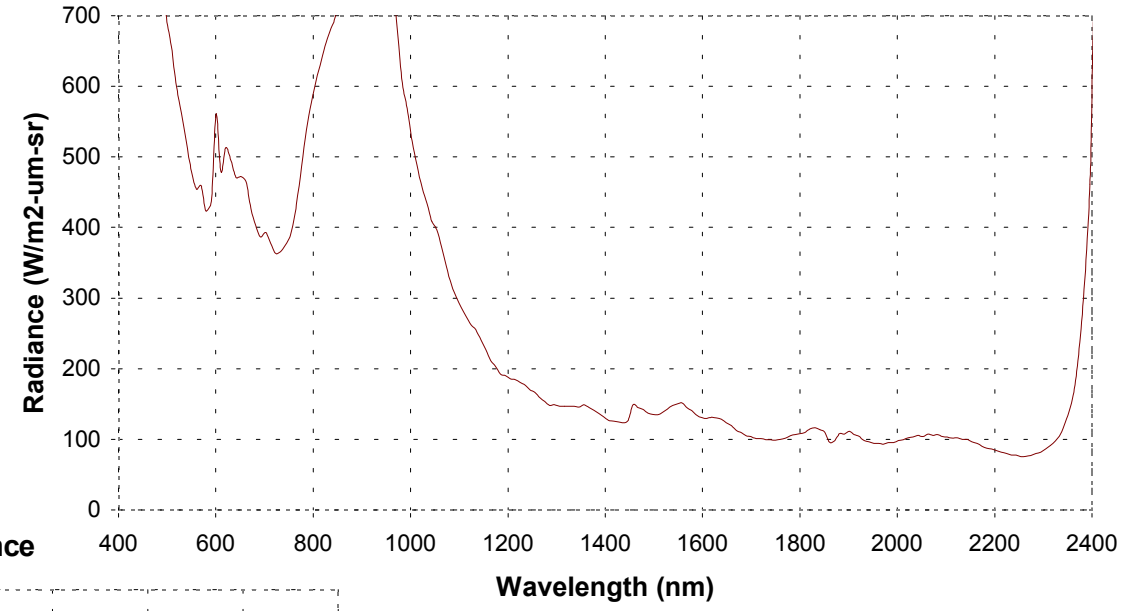


Lunar results from Hugh Keiffer et al, USGS
Lake Frome results frome David Jupp et al., CSIRO

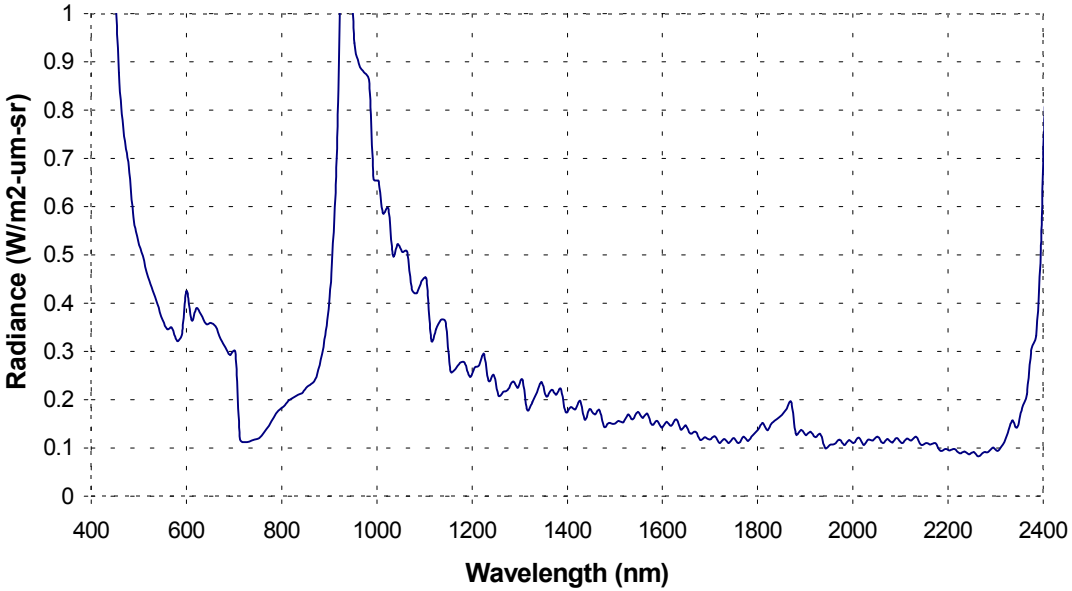
Radiance Measurement Range

CWL (nm)	VNIR Max W/(m2-um-sr)	NER W/(m2-um-sr)
500	656	1.00
600	560	0.85
800	600	0.40

Maximum Detectable Radiance



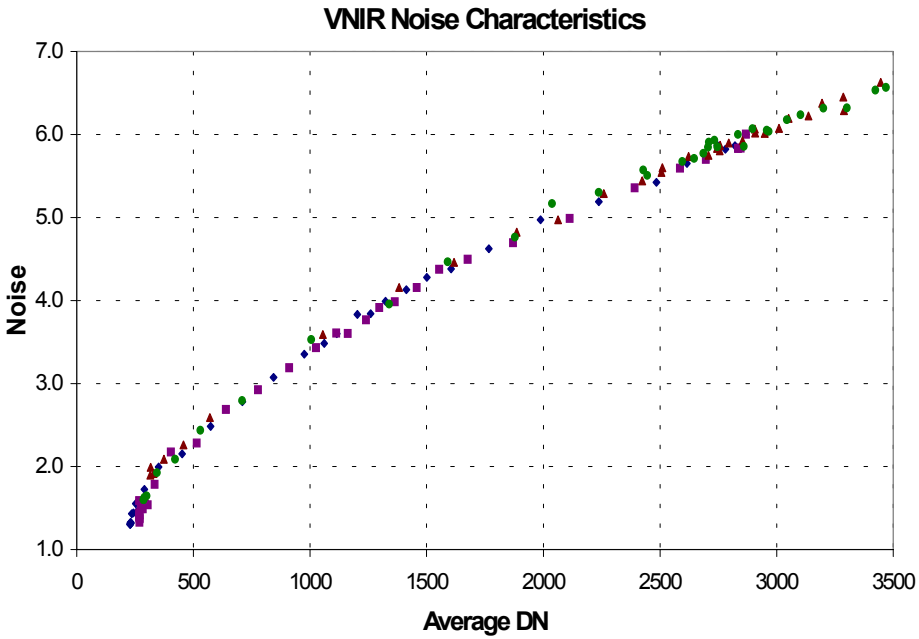
Noise Equivalent Radiance

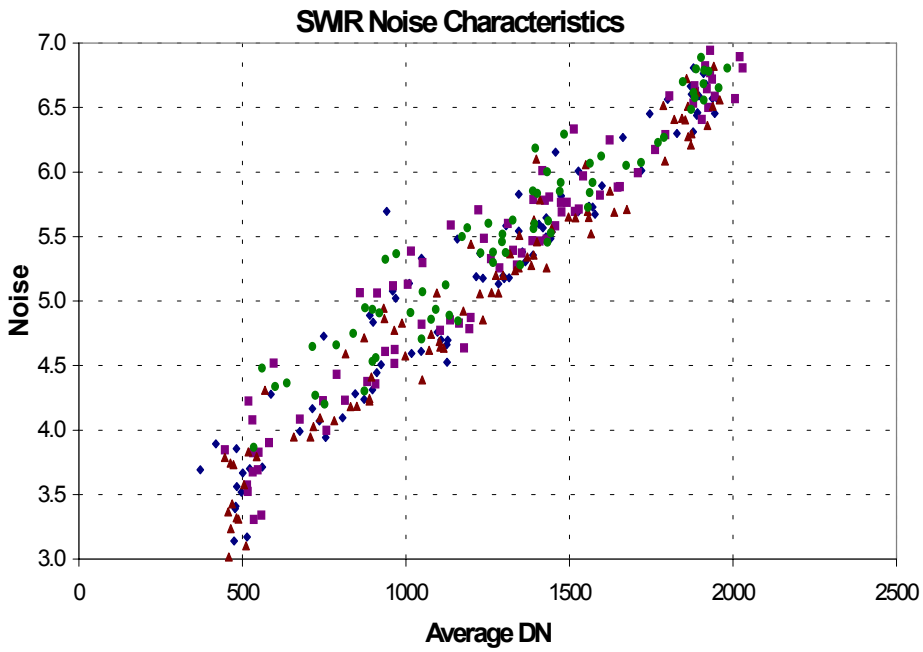


CWL (nm)	SWIR Max W/(m2-um-sr)	NER W/(m2-um-sr)
1000	522	1.31
1200	185	0.53
1400	126	0.37
1600	129	0.31
1800	108	0.27
2000	98	0.22
2200	84	0.20
2300	86	0.19

VNIR & SWIR Noise Characteristics

VNIR and SWIR Noise level as a function of signal level, not dark subtracted.





Used to define the SNR for a defined signal level.

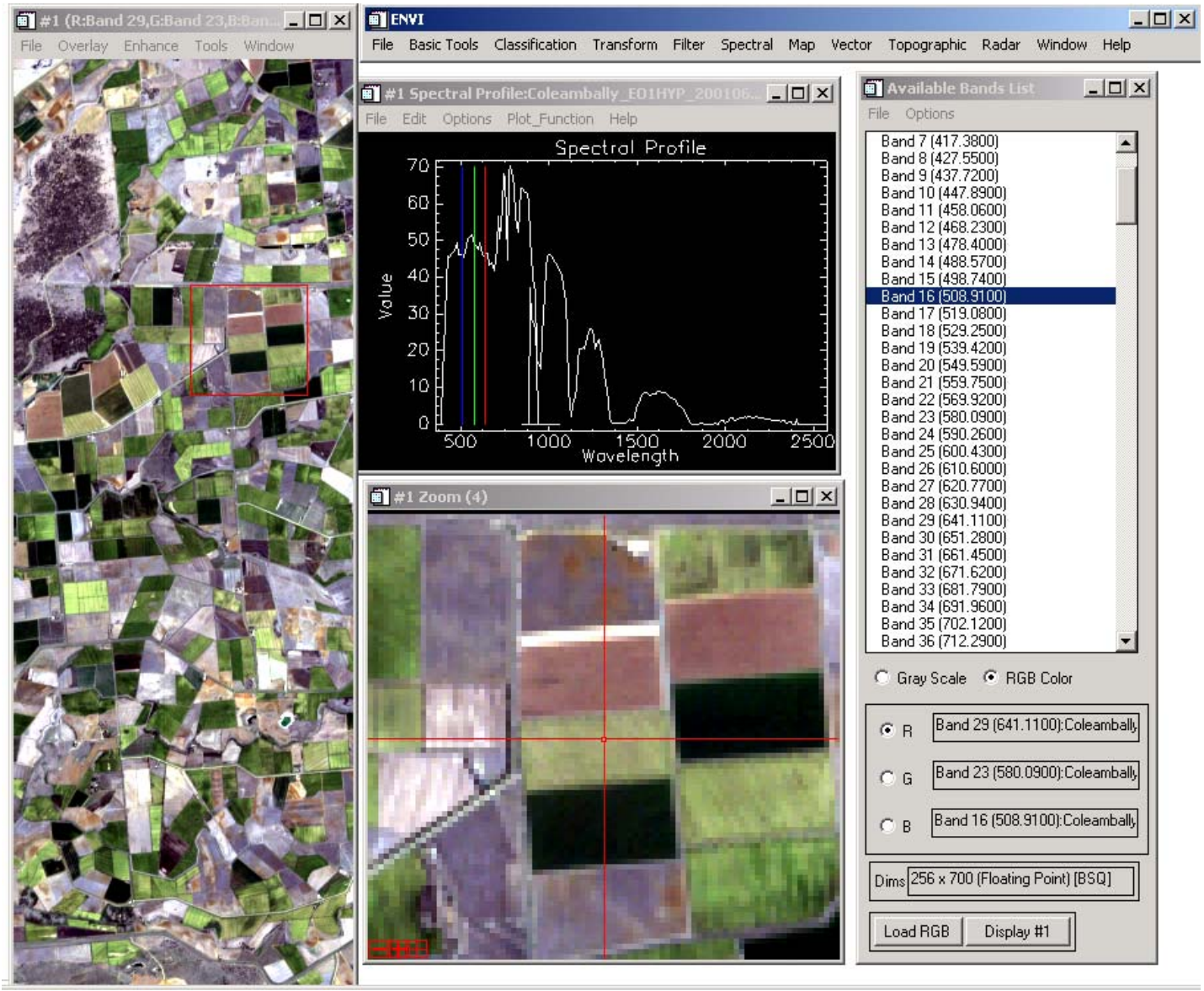
Signal Level defined as 60 degree Solar Zenith angle, 30% albedo, standard scene

Wavelength (nm)	550	650	700	1025	1225	1575	2125
on-orbit	192	140	140	65	96	64	38

Things you need to know when using the data

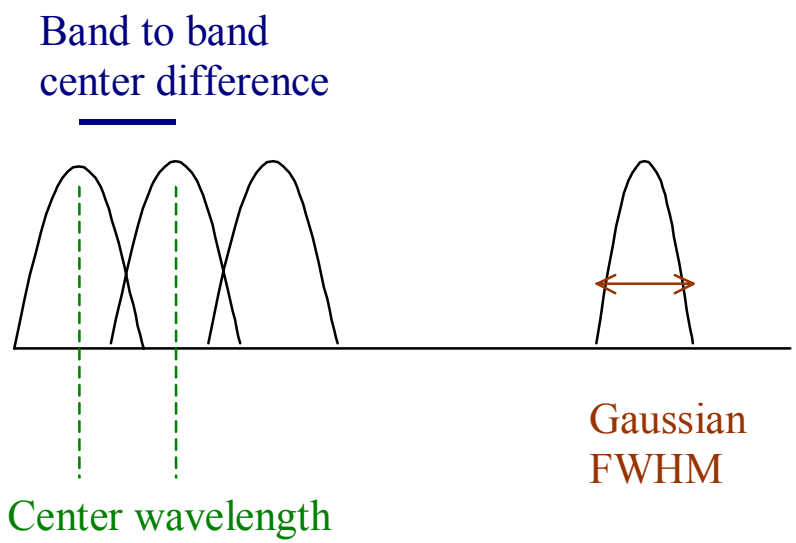
- ***Absolute Radiometry***
- ***Spectral Calibration***
  - ***What is the spectral response function?***
  - ***What is the wavelength per band?***
  - ***What is the wavelength variation across the field of view?***
- ***Optical Quality***

Sample RGB Combination



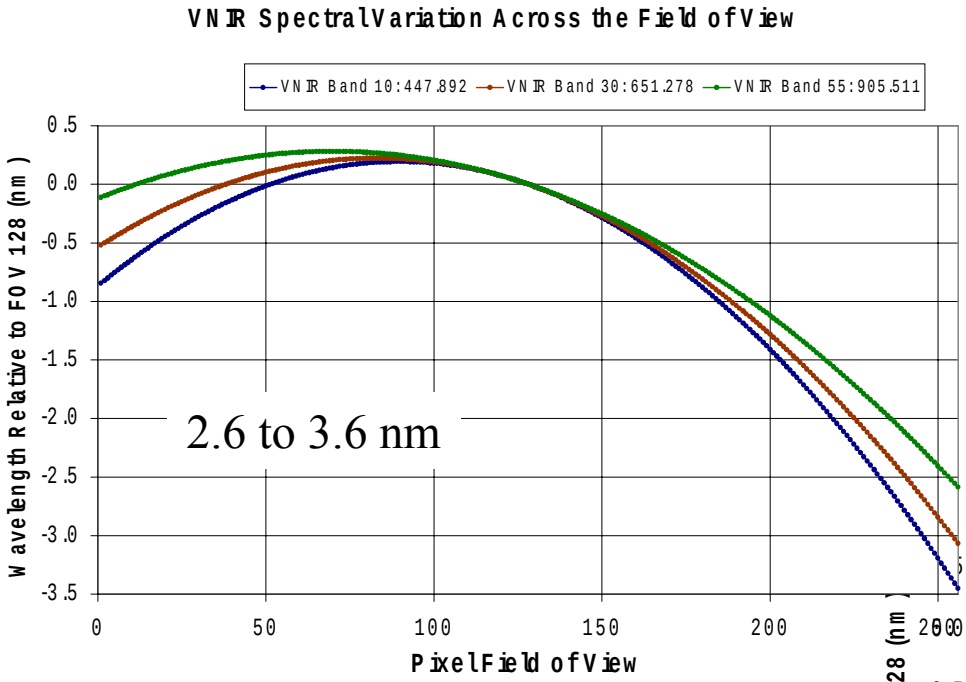
Spectral Calibration

- ***Defined by a center wavelength an assumed Gaussian full width half max***

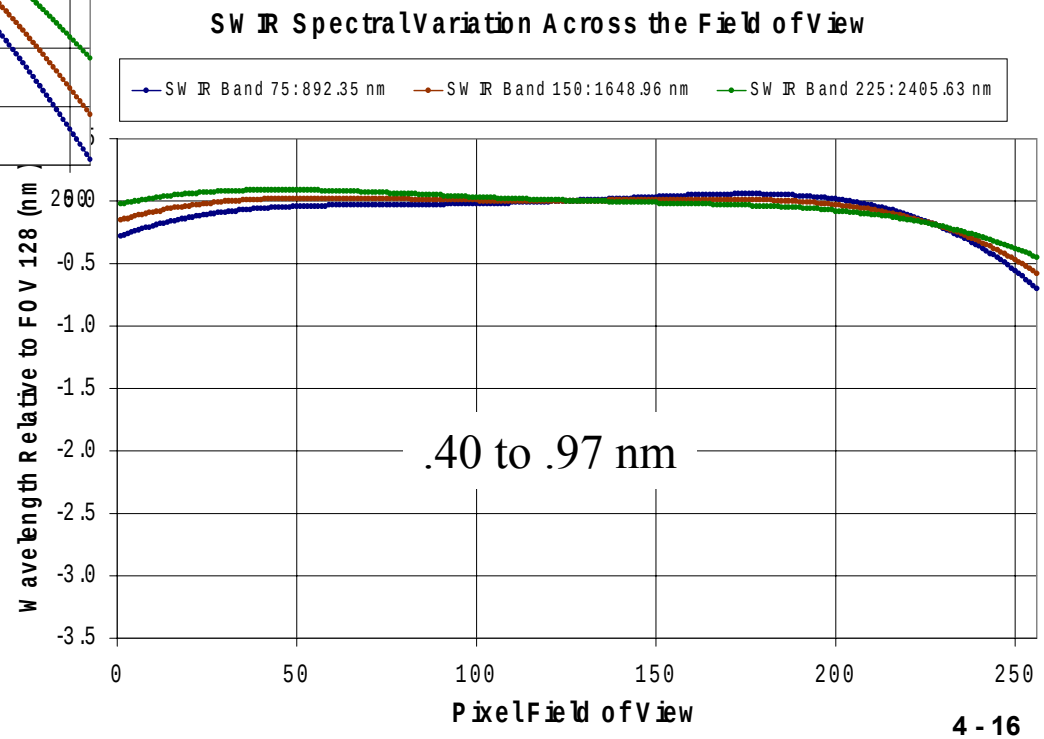


- ***Header File attached to Level 1 data products.***
- ***Full Spectral Calibration Files on center wavelength and bandwidth for EVERY pixel (256x242)***
- ***Hyperion Spectral Calibration File is Static – does not vary with collect***

Characteristics of Spectral Calibration



- ***Cross-track spectral error***
  - ***maximum variation of the center wavelength across the field-of-view***



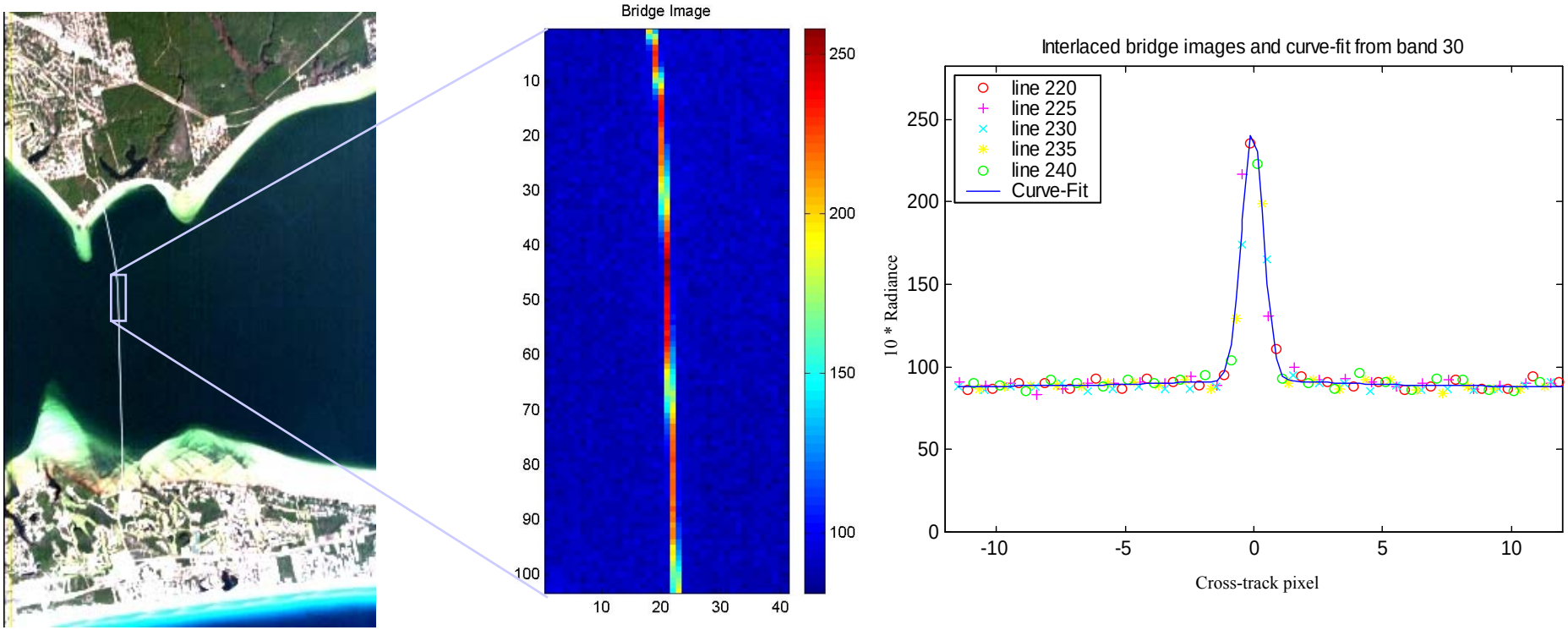
User should determine if the header is sufficient or if the calibration file is required for the specific science application

Hyperion Details

- ***Absolute Radiometry***
- ***Spectral Calibration***
- ***Optical Quality***
  - ***What is the spatial response function?***
  - ***Can the image be sharpened?***
  - ***What is the spatial relation between the VNIR and SWIR?***

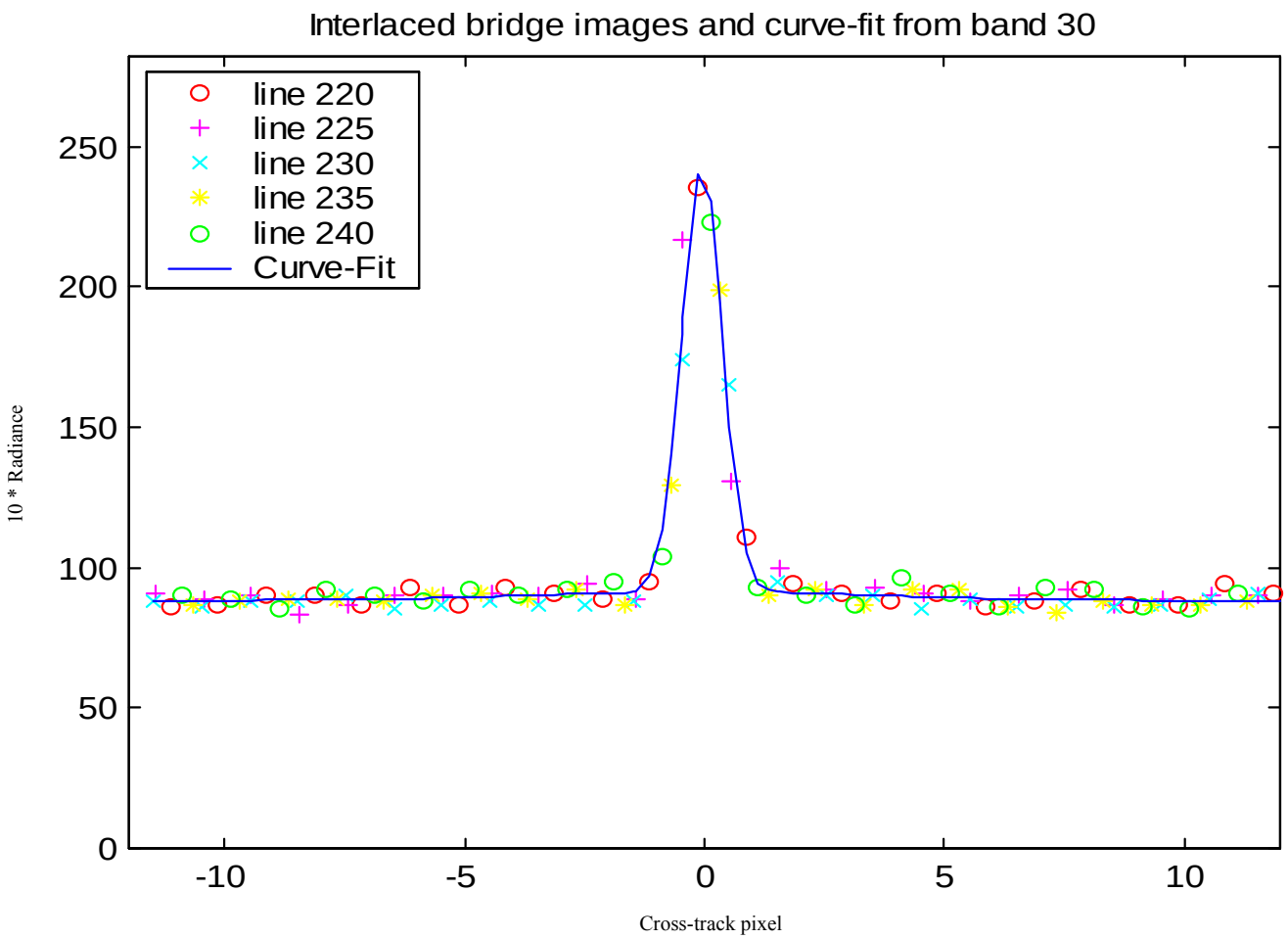
Cross-Track MTF

- ***Port Eglin, Dec 24, 2000. Bridge is the Mid-bay bridge near Destin, Florida.***
- ***Bridge width (13.02 m) acquired and utilized in the MTF processing.***
- ***Bridge angle small, every 5th line used to develop high resolution bridge image.***
- ***MTF result at Nyquist is between 0.39 to 0.42 while the pre-flight measurement was 0.42.***



Cross-Track MTF

- ***Bridge angle small, every 5th line used to develop high resolution bridge image.***



MTF Characterization

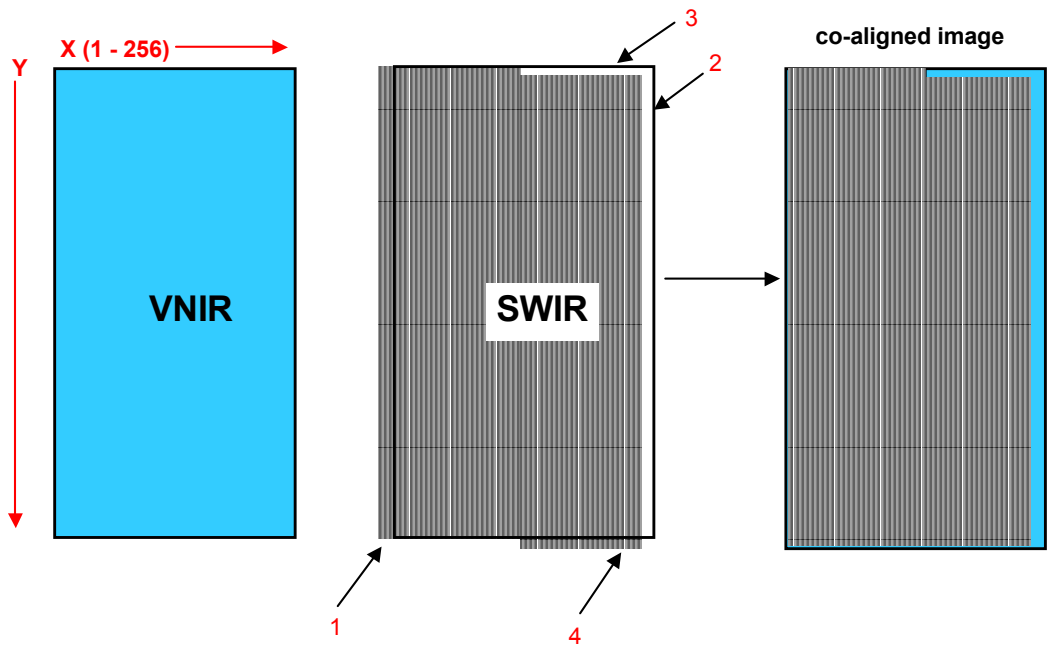
Wavelength (nm)	FOV > 200	Center FOV	FOV < 20
500	0.29	0.27	0.22
630	0.27	0.28	0.22
900	0.24	0.26	0.22
1050	0.28	0.3	0.28
1250	0.28	0.3	0.27
1650	0.27	0.27	0.25
2200	0.28	0.27	0.23

Pre-flight in-track MTF, calculated from the measured cross-track MTF by multiplying by $2/\pi$ which adjusts for the MTF degradation due to spacecraft motion

VNIR – SWIR Alignment

.L1_B co-alignment

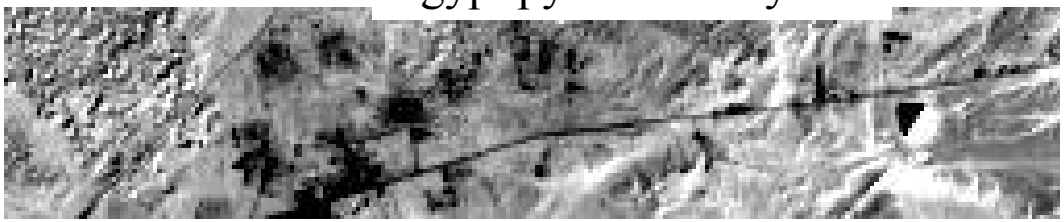
Only SWIR data are shifted into alignment with the VNIR pixels. In the FOV dimension (X), the SWIR pixels are shifted by -1. FOV pixel #1 is removed (1) and pixel #256 is padded with zeros (2). In the along track dimension (Y), FOV pixels 129-256 are shifted by +1 pixel. For frame 1, FOV pixels 129-256 are padded with zeros (3) and the last frame is removed (4).



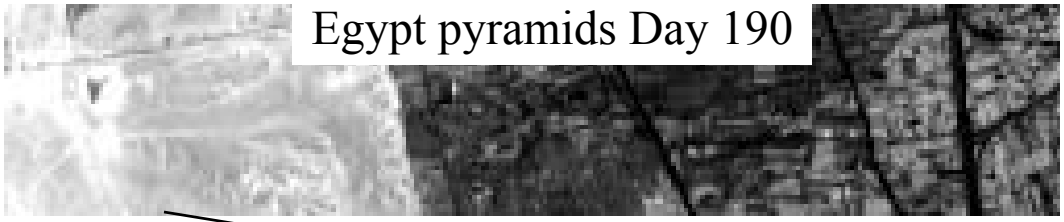
Alignment Verification

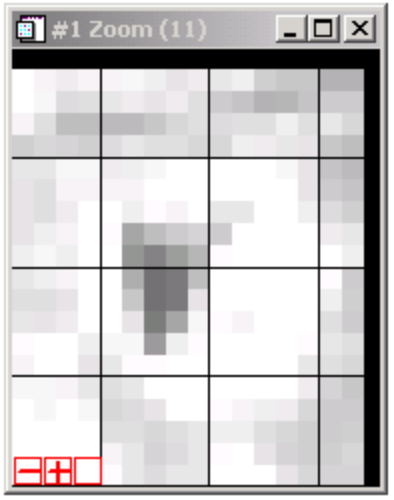
Measured with Lake Frome and Coleambally campaigns, cross checked with pyramids

Egypt pyramids Day 014

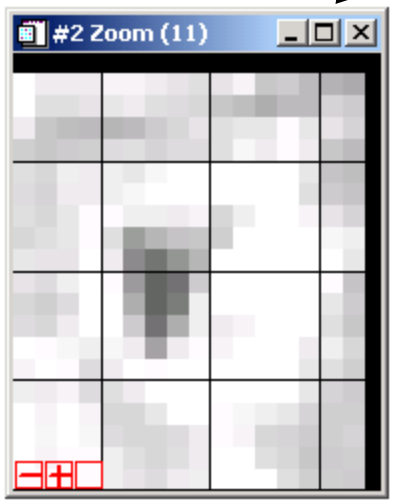


Egypt pyramids Day 190

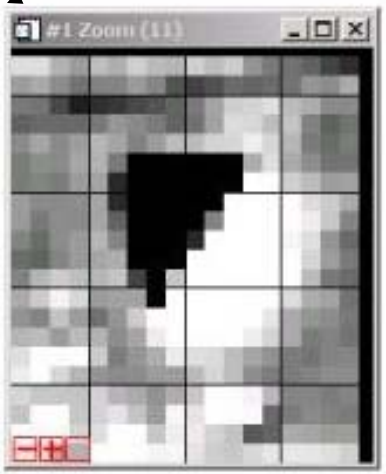




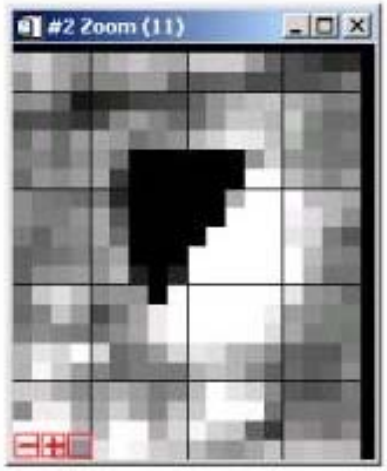
VNIR



SWIR



VNIR



SWIR

Hyperion Data

- ***Absolute Radiometry***
  - ***What does the unit represent ? level 1, scaled radiance (W/m2/um/sr)***
  - ***What are the VNIR, SWIR scale factors? VNIR = 40, SWIR = 80***
  - ***Will the results be repeatable and accurate? Yes, within measured accuracy, better than 6% (3.4 % estimated)***
  - ***How will the results compare with Landsat? Hyperion 5-18% lower, discussed more in part II***
  - ***What is radiance measurement range? Plots provided***
  - ***What is the SNR? 190 to 40 as increase in wavelength***

Hyperion Data

- ***Spectral Calibration***
  - ***What is the spectral response function? gaussian, defined center and FWHM***
  - ***What is the wavelength per band? header provides wavelength for center of the field of view***
  - ***What is the wavelength variation across the field of view? < 1 nm for SWIR, 2.6-3.6 nm for VNIR***
  - ***Does it change? no***

Hyperion Data

- ***Optical Quality***
  - ***What is the spatial response function? MTF .23-.30***
  - ***Can the image be sharpened? Potentially using MTF matrix***
  - ***How do align the VNIR and SWIR? Provided in level 1B***