Use of Lake Frome Ground Truth Campaign as a Cross-Calibration of the Hyperion Instrument

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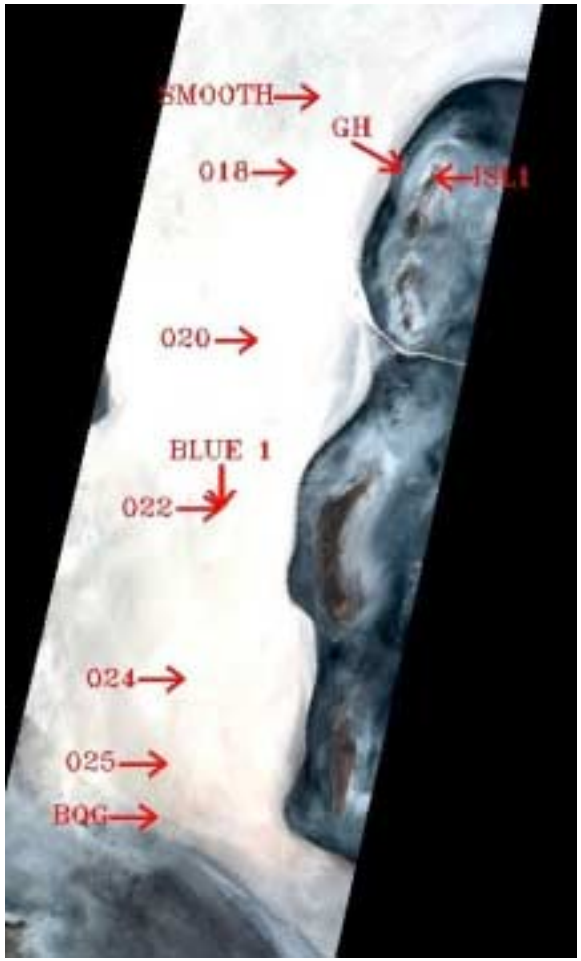

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Presented by: Dr. Pamela Barry

Introduction

Hyperion Instrument and Data Cube

Calibration Approach

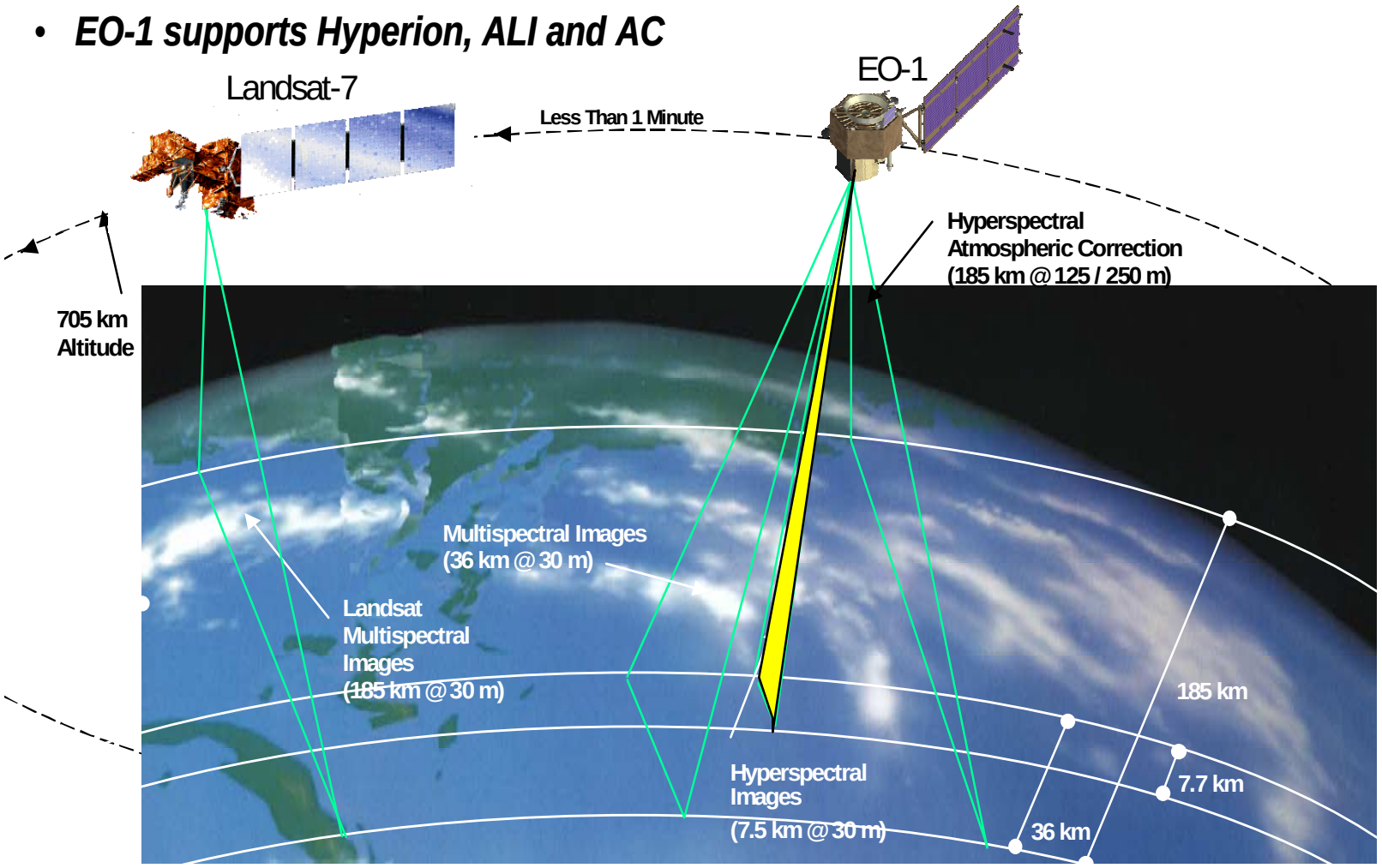
Lake Frome Ground Truth Process for Comparison

Results of Comparison and Contribution to Early Performance Verification

Continuing Effort

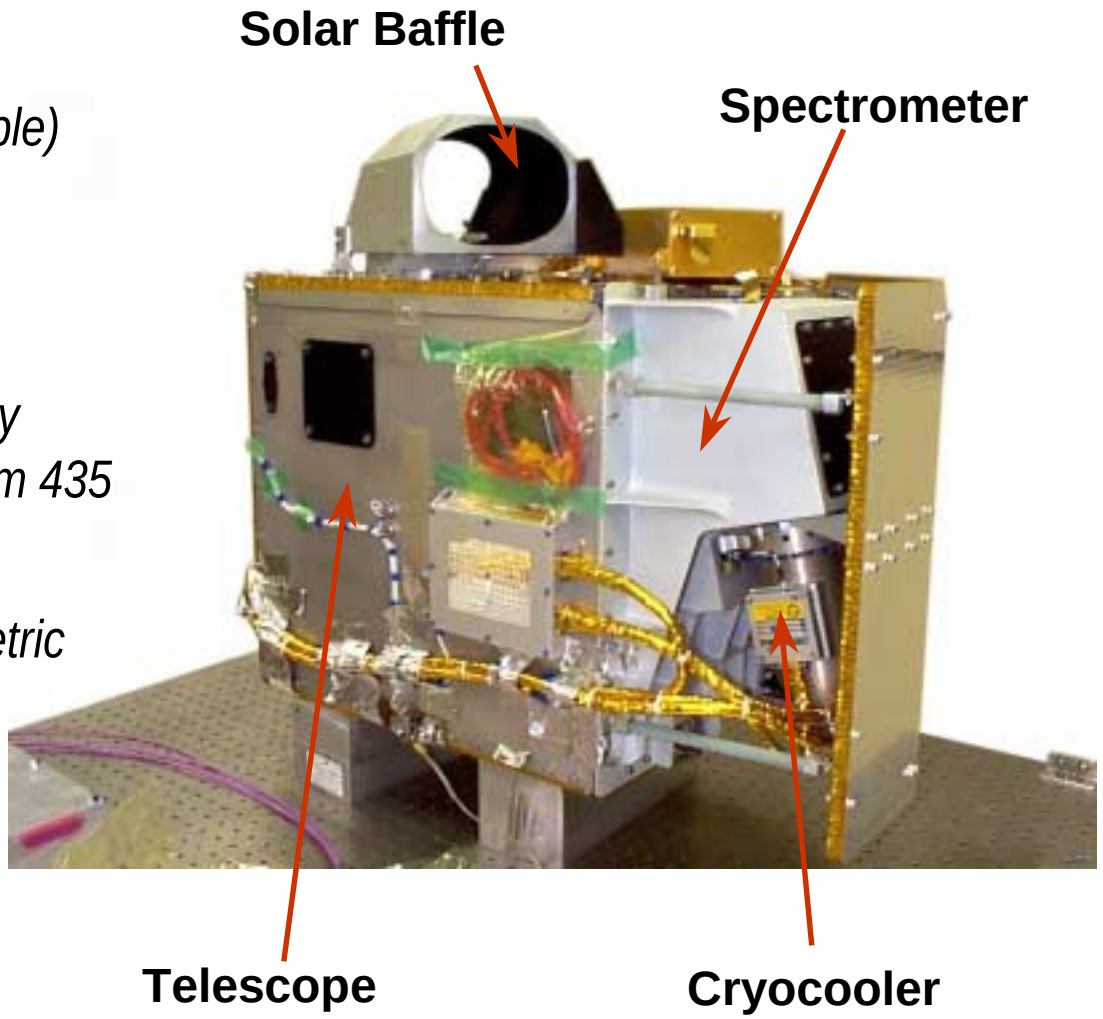
Hyperion Instrument – EO-1 Launch and Orbit

- *EO-1 Spacecraft launched November 21, 2000 from Vandenberg Air Force Base*
- *EO-1 orbit is one minute behind Landsat-7*
- *EO-1 supports Hyperion, ALI and AC*



Hyperion Image Overview

- *7.7 km swath width*
- *160 km swath length (time variable)*
- *30 meter spatial resolution*
- *10 nm spectral resolution*
- *200 radiometrically and spectrally calibrated continuous bands from 435 nm to 2400 nm*
- *Better than 6% absolute radiometric accuracy*

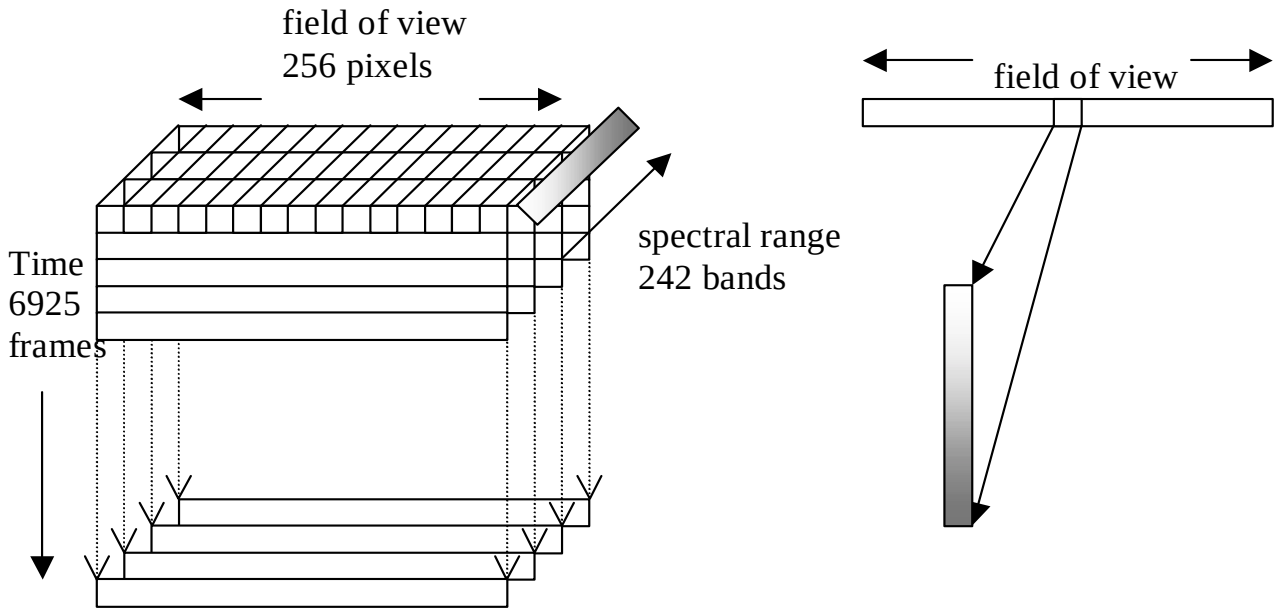


Hyperion Data Cube

Pushbroom configuration, entire swath width collected each frame sampled every 4.5 ms, or 223.4 frames/second.

Common fore-optics, dichroic filter reflects 400 nm to 1000 nm to the VNIR and transmits 900 nm to 2500 nm to the SWIR.

Gratings disperse light onto two focal planes



- ***Produces a three dimensional data cube 256x6925x242 in 30 seconds!***

Hyperion Radiometric Calibration

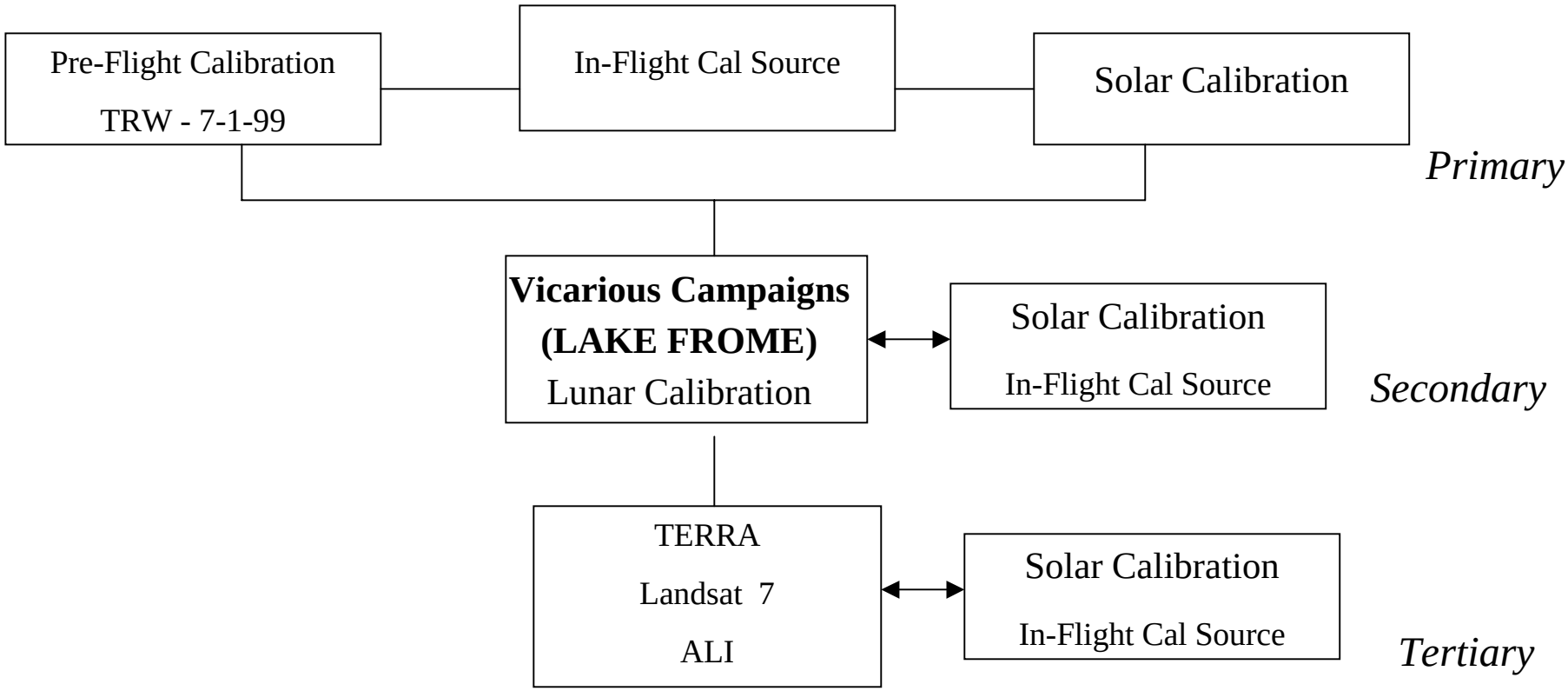
Approach was to apply the pre-flight absolute radiometric calibration to on-orbit operations and verify absolute calibration via cross-comparisons

Primary absolute radiometric standard is tied to high quantum efficiency photodiode trap detectors and calibration panel assembly at TRW used to derive the pre-flight calibration

In general, the accuracy of calibration effort should be an order of magnitude more accurate than absolute requirement.

Cross-comparison techniques used to verify the absolute calibration on-orbit include: Solar Calibration, **Lake Frome Campaign**, *Lunar Calibration, Cross-Instrument, Cross-Platform*

Hyperion Radiometric Calibration

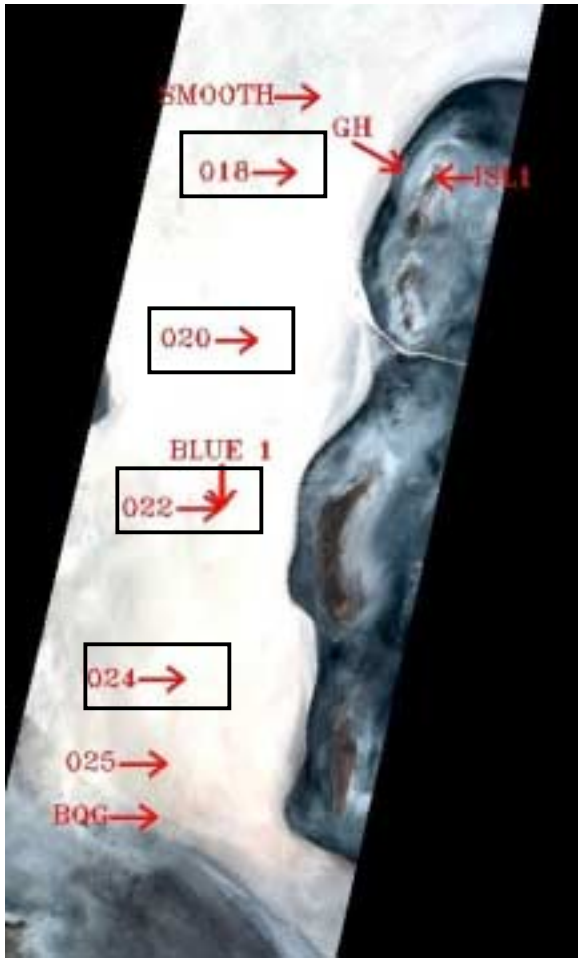


Pre-Flight calibration tied to LANDSAT, ALI, U of Arizona

Key Factors Impacting Calibration

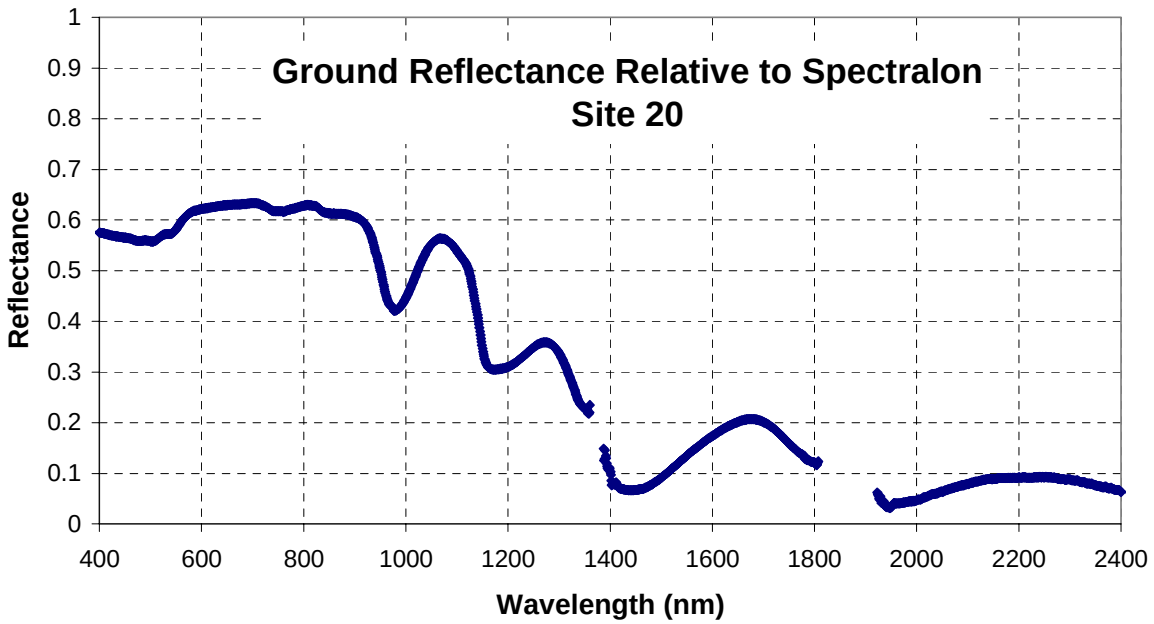
	Absolute Knowledge	***Intermediate Properties***	***Spacecraft Pointing***	***Strengths***
Solar Calibration	*Models avail to community* *VNIR more accurate then SWIR*	*Diffuse reflectance of Hyperion cover*	*Critical to modeling intermediate properties*	*Uniform across field-of-view* *Constant*
Lake Frome (vicarious)	*Based on ground truth measurements*	*Atmospheric effects must be modeled*	*Depends on surface*	*User oriented effort*
Lunar Calibration	*Based on Lunar models*	*none*	*Spacecraft scans moon. Relative moon, sun, sat angle*	*No intermediate properties. Constant*

Lake Frome Comparison Process



High resolution ground reflectance measurements referenced to spectralon

Convolved with Hyperion Bandwidth and sampled at Hyperion center wavelength

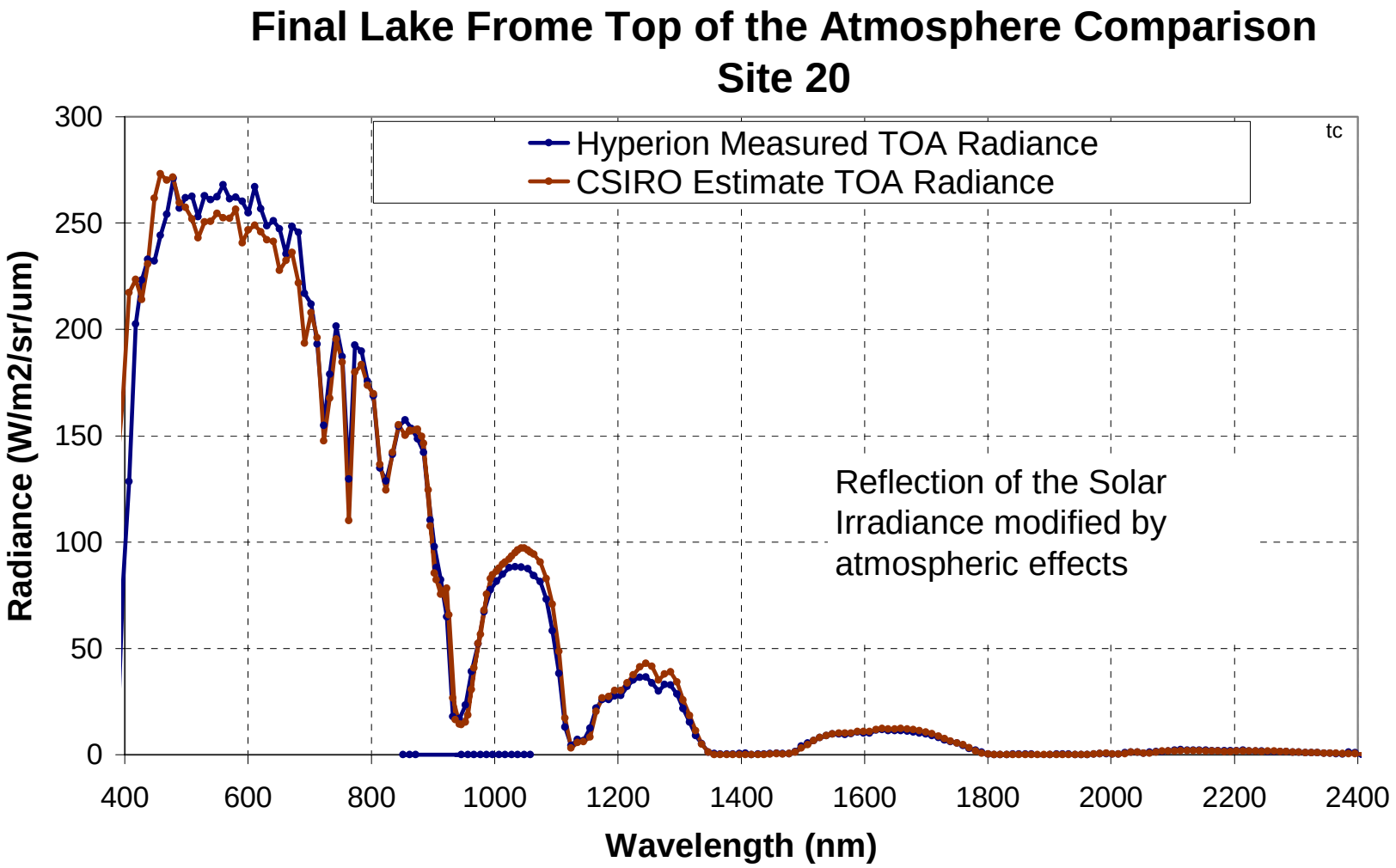


Sites 18,20,22,24 used for preliminary comparisons.
Fall along the same cross track pixel.

Lake Frome Comparison Process

Modeling of atmosphere enabled transfer to Top Of the Atmosphere Comparison

Geo-location identified Hyperion pixel location



Lake Frome Comparison Process

Name	Date	Lat.	Lon.
018	Uniform Salt	-30.80	139.68
020	Uniform Salt	-30.83	139.67
022	Mixed Salt and Mottle	-30.87	139.66
024	Uniform Salt	-30.90	139.65

Ground Location

Hyperion image was geo-located with the ground control points to enable direct comparison

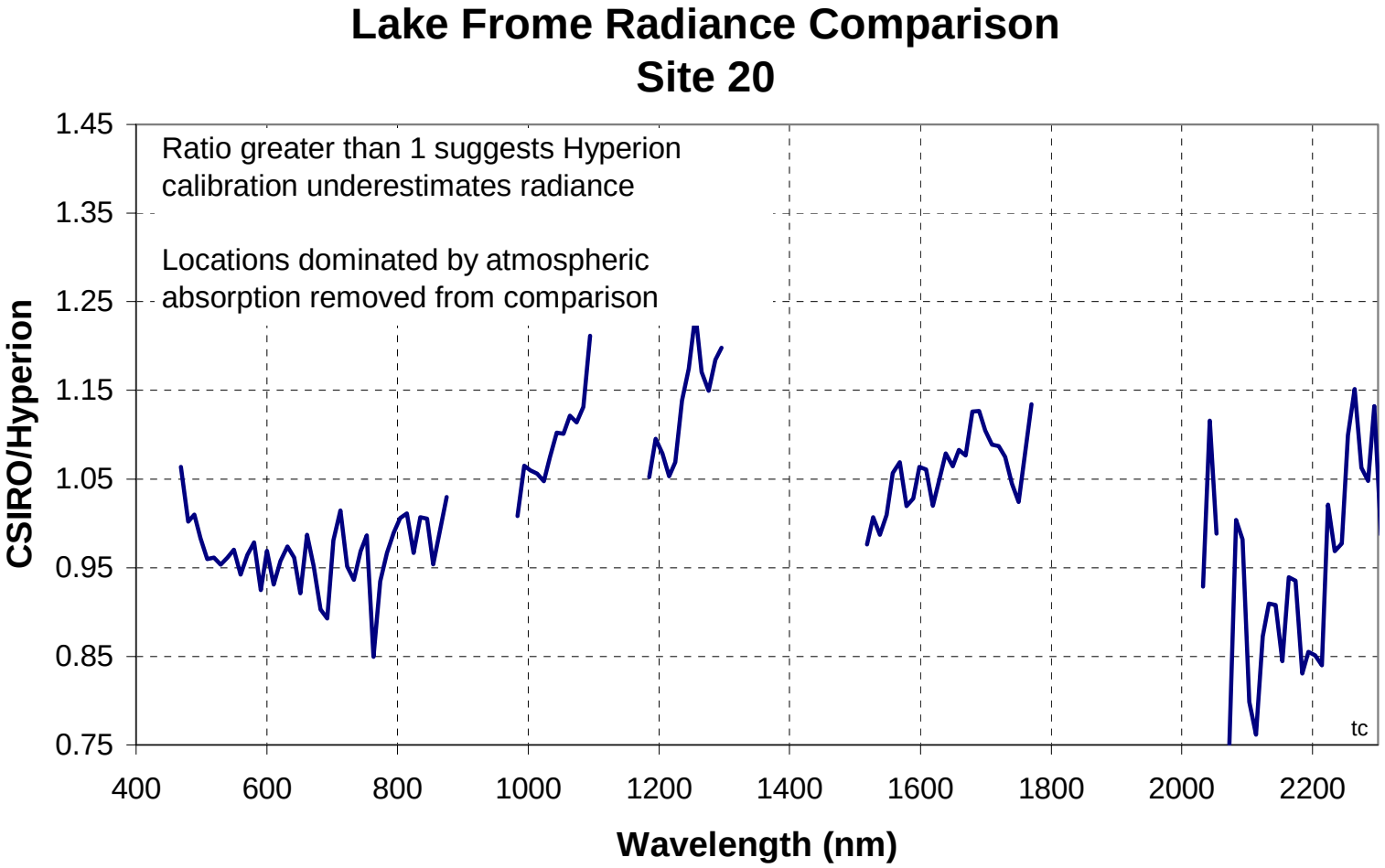
Corresponding Hyperion Pixel

	VNIR Pixel	***VNIR Line***	***SWIR Pixel***	***SWIR Line***
Site 18	107	2219	108	2219
Site 20	107	2343	108	2434
Site 22	107	2467	108	2467
Site 24	108	2592	109	2591

Lake Frome Comparison Process

Top of the Atmosphere Comparison sampled at the Hyperion center wavelength used to make radiance comparison

Compare results with results obtained with the solar calibration

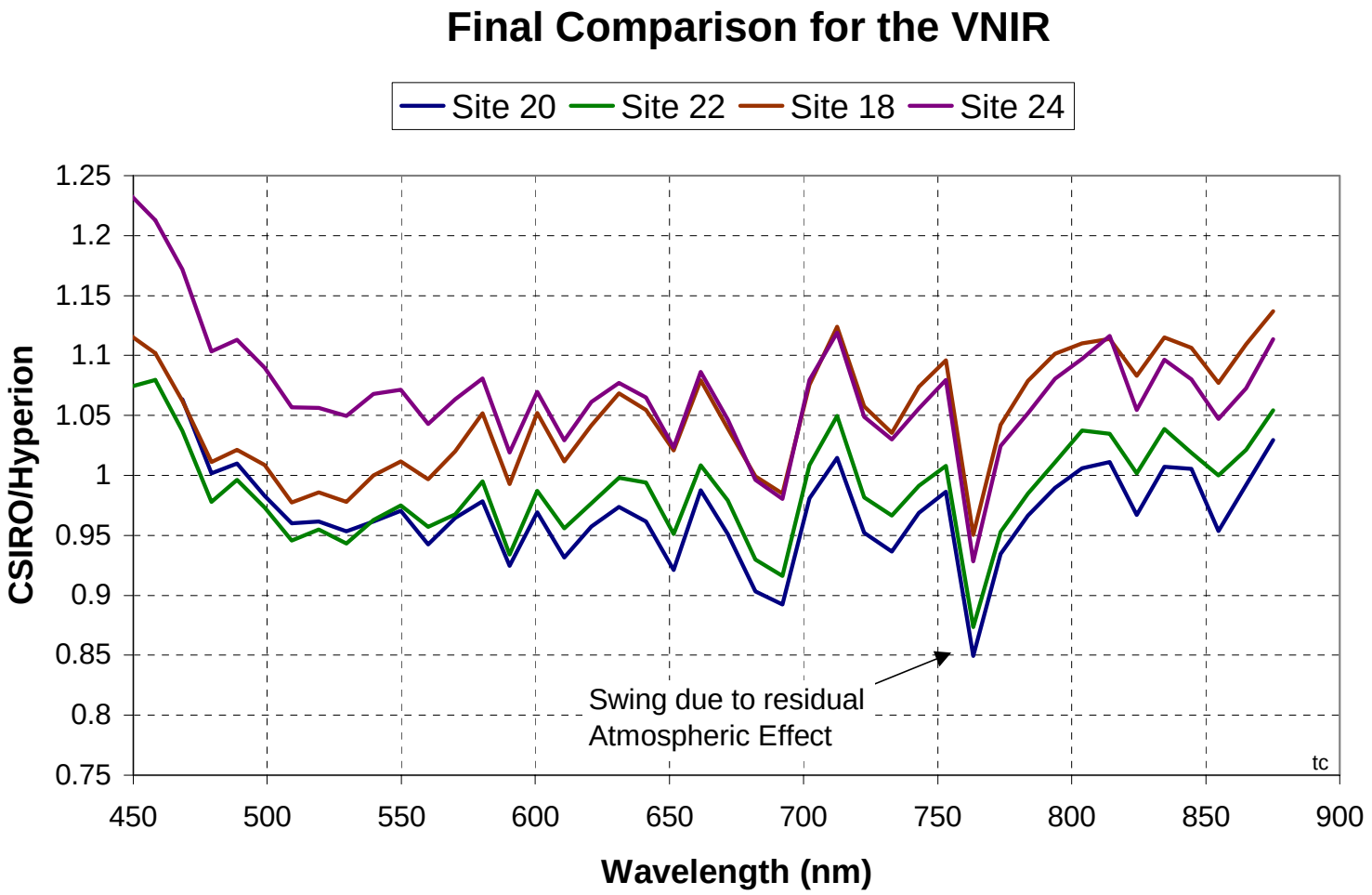


Comparison in the VNIR

Site 20&22 suggests Hyperion high, Site 18&24 suggest Hyperion low, Range +- 5%

Hyperion agreed to solar profile to +- 2%

Lake Frome verification at +-5% level in the VNIR

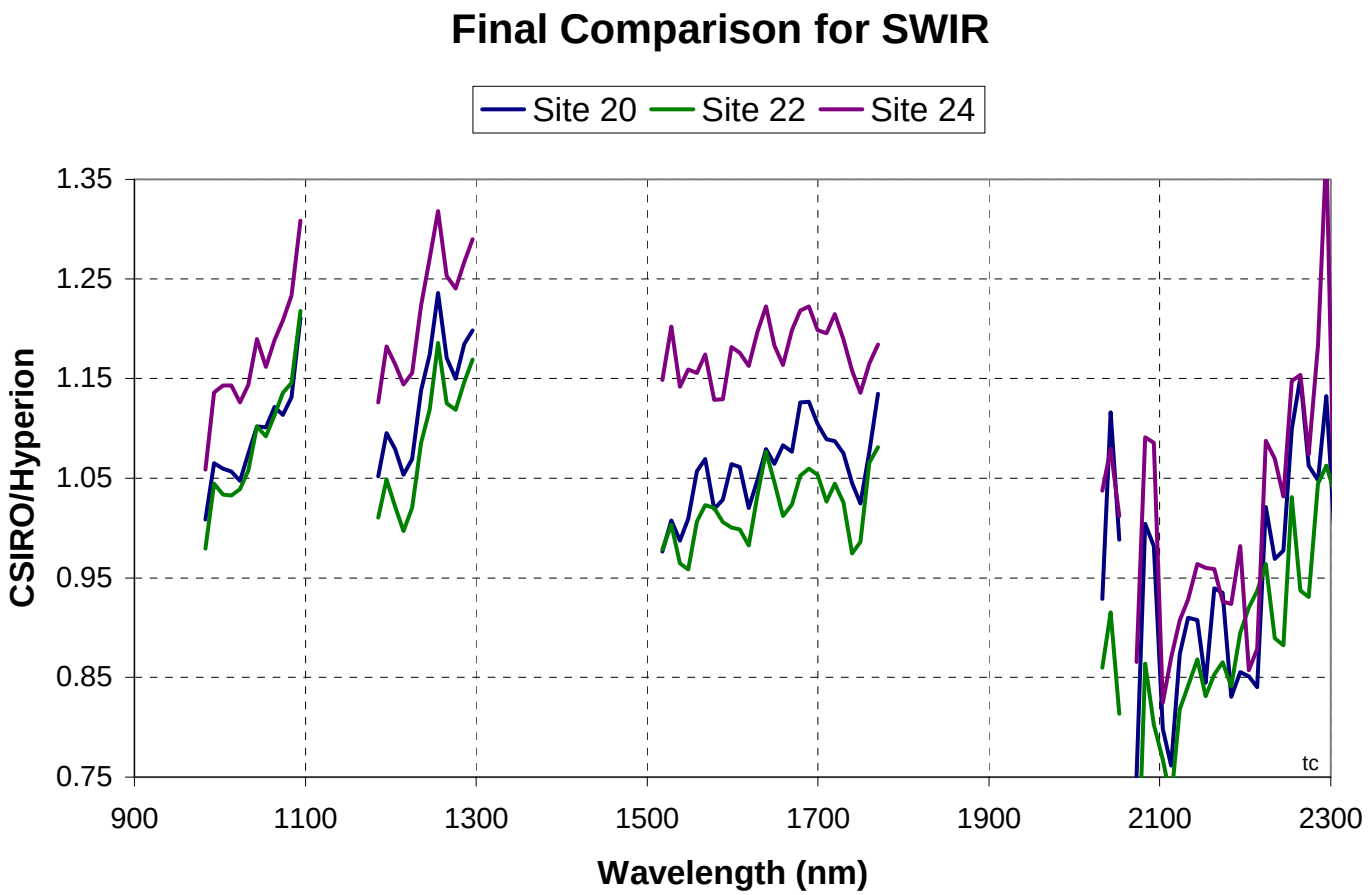


Comparison in the SWIR

Results vary based on Site and wavelength

Suggest variability in Ground Truth measurement since single field-of-view location

Hyperion was 5-8% lower the solar profile



Ground Error sources: BRDF variations, impurity of site, water content, measured reflectance, site percent variation

Not Coincident collect: Ground truth performed 12-19-01 and Hyperion pass was 1-05-01, weather conditions different. Atmospheric correction based on atmosphere measurements made on 1-05-01.

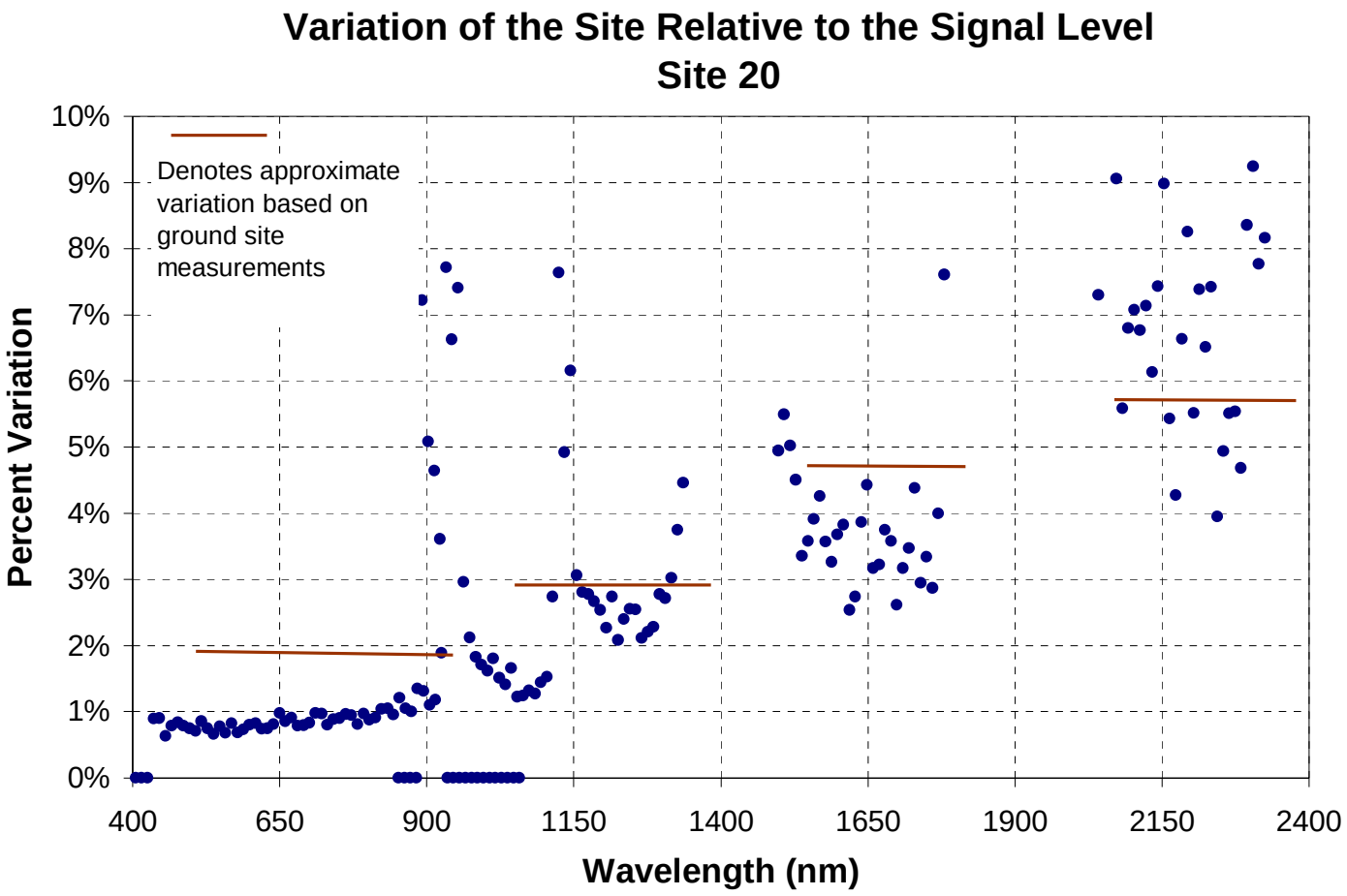
Atmospheric Estimate Based on a Solar Constant

Variation of Site

Variation in VNIR regime varies < 1% of signal

Variation in SWIR regime increases as with wavelength

Typical percent variation of each site



Significant Performance Verification Contributions

Precise geo-location was critical in finalizing the Hyperion VNIR – SWIR coregistration

Geo-location with other platforms enables cross comparisons. January 20th collect to be used for cross-platform comparisons

Effort revealed the importance of identifying the solar model used in the atmospheric modeling codes

Analyzed data set from user perspective

Lake Frome Conclusions

Lake Frome supported the VNIR calibration, details of the SWIR comparison continue to be reviewed

Used to confirm VNIR-SWIR co-registration and enables cross-platform comparisons with Landsat 7 and potential others

Large site with a strong signal in the VNIR and lower signal in the SWIR, complements other calibration sites

Work in process with additional cross-platform comparisons planned and additional measurements scheduled for September

Support of CSIRO on Lake Frome effort and contributions to early orbit check out greatly appreciated

BACK UP / REFERENCE

Lake Frome Collection Notes

Site 020: 12/16/00 15:00 – 16:00, medium haze, 20% clouds, very clear hard surface

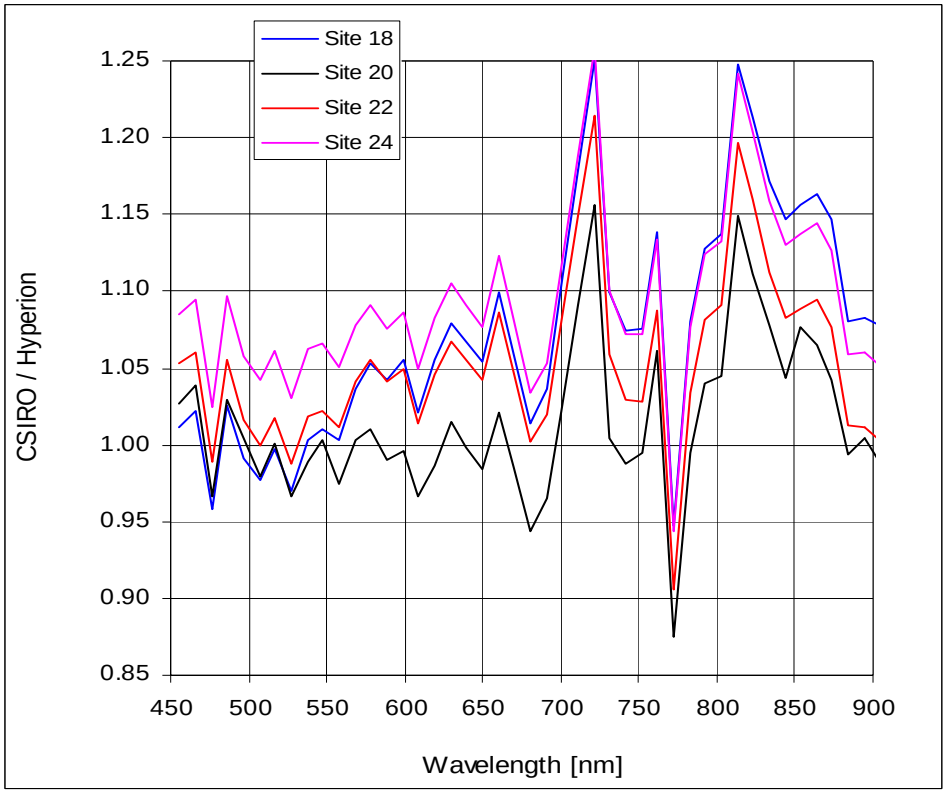
Site 022: 12/19/00 11:49-11:51, low-medium haze, 0% clouds, very hot, hard, surface

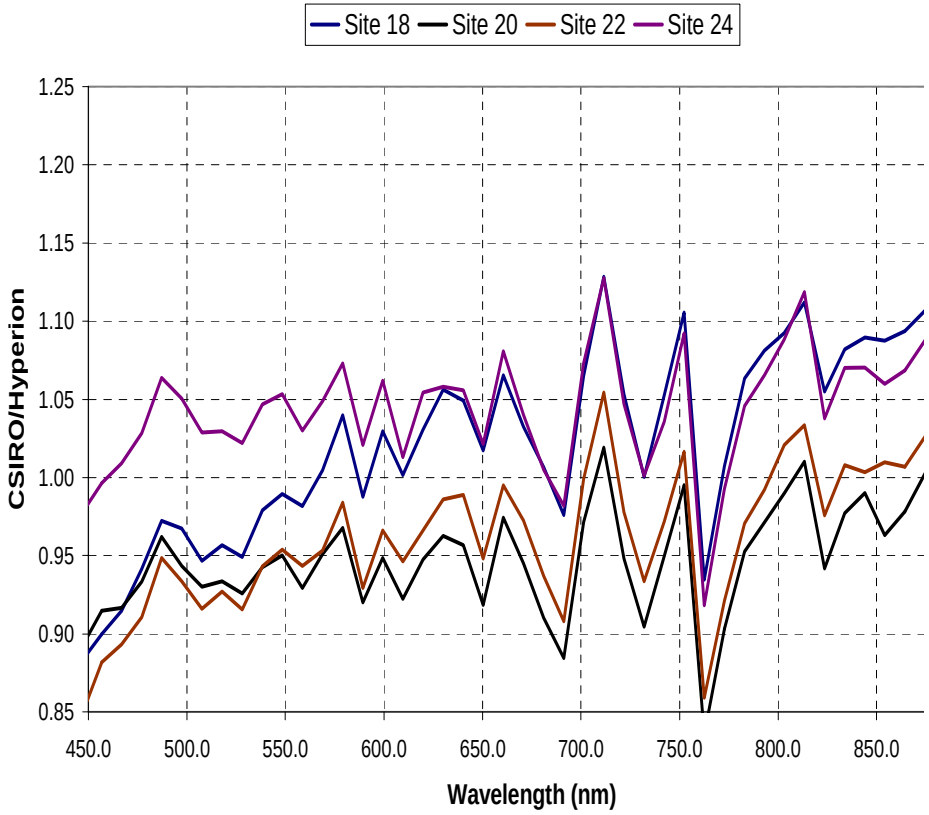
Site 018: 12/18/00 13:37- 14:04, medium-high haze, 50% clouds, molted area with significant changes in brightness

Site 024: 12/19/00 13:54-14:04, low-medium haze, 10% clouds, very hard, drier surface

Hyperion: 01/05/01 10:30, low haze, 0% clouds, dry

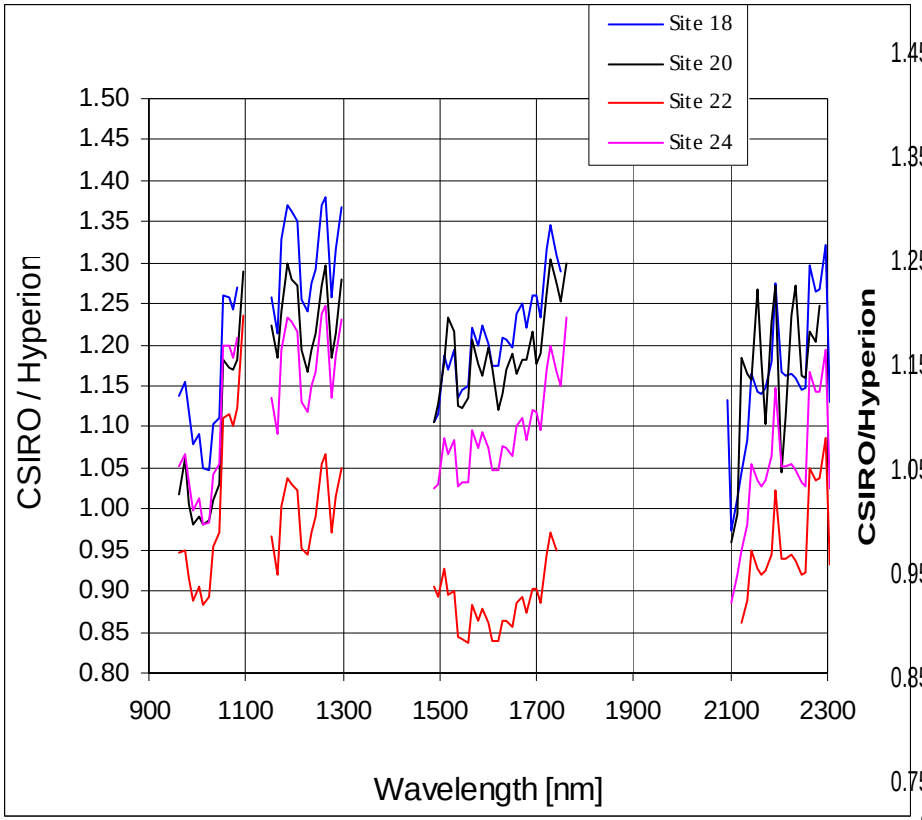
VNIR Comparison

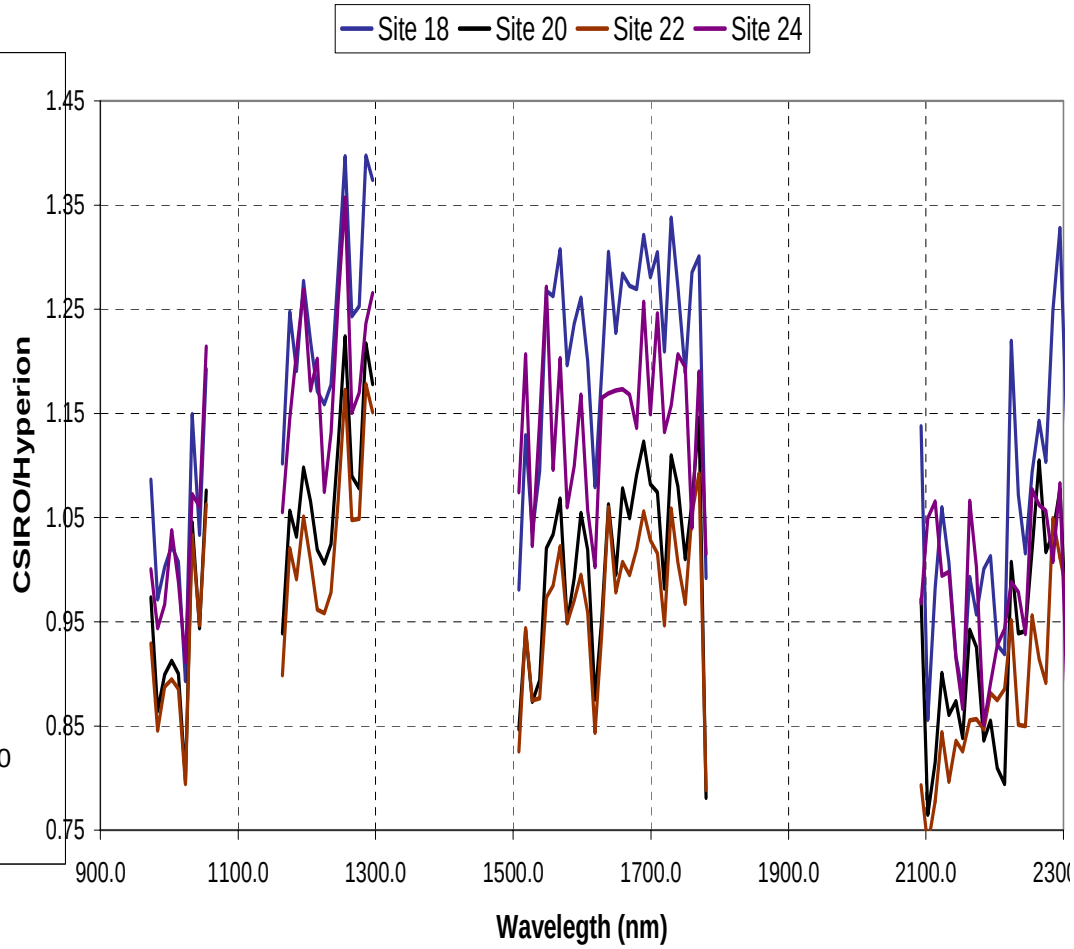




Initial results Hyperion 2-10% low,
Final results, smaller swing near atmosphere line, agreement +-5%
Results grouped by site, Site 20&22 (Hyp_hi) and Site 18&24 (Hyp_lo)

SWIR Comparison





Initial results:Sites 18,20&24 (Hyp_lo), Site 22 (Hyp_hi),
Final results, Results grouped by site, Site 20&22 (Hyp_hi) and Site 18&24 (Hyp_lo)