HICO ON-ORBIT CALIBRATION AND DATA CORRECTIONS

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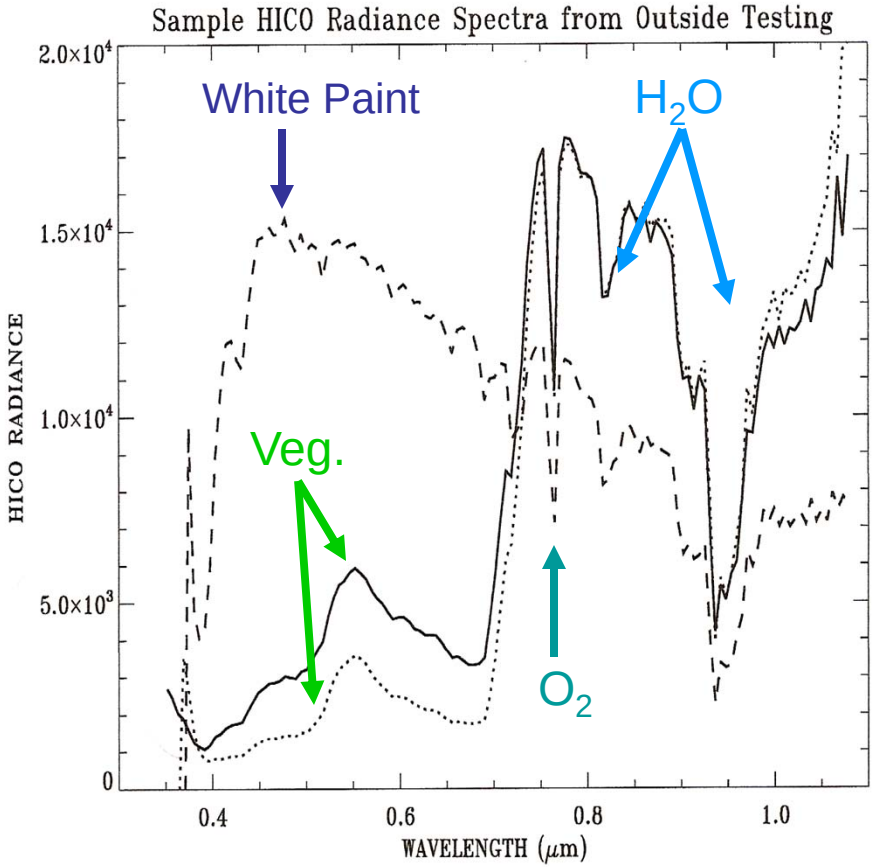
OUTLINE

- HICO pre-launch wavelength and spectral resolution calibrations by fitting atmospheric water vapor and oxygen bands
- HICO post-launch vicarious calibrations
  - Wavelength and spectral resolution calibrations
  - 2nd order light correction based on the analysis of shallow underwater features
  - Absolute radiometric calibrations through inter-satellite data comparisons, mainly with the Terra and Aqua MODIS data
  - Additional scaling using white clouds
  - Spectral smoothing to decrease the etaloning effects and residual wavelength shifts
- Summary

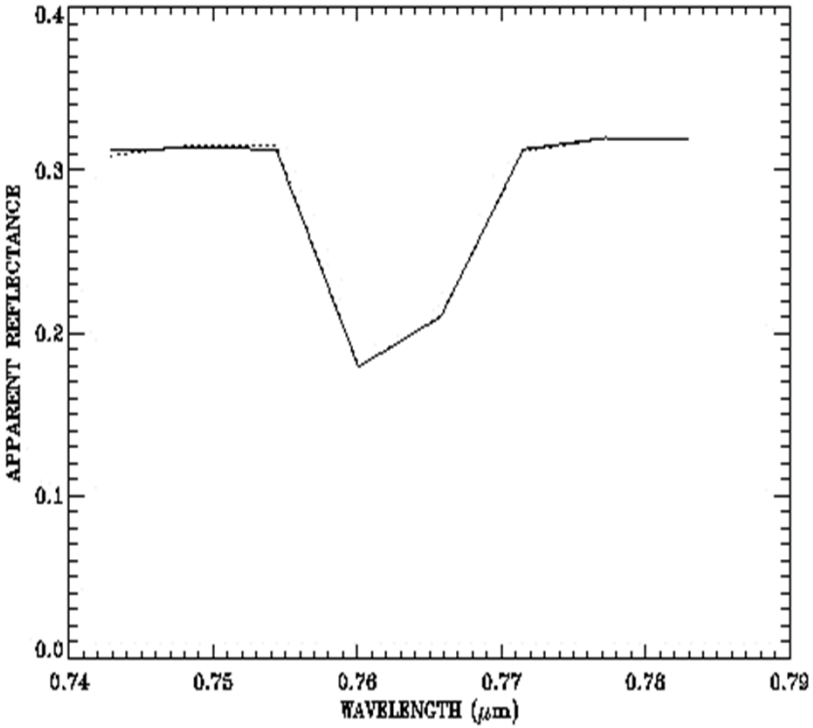
Pre-launch Vicarious Calibrations

A HICO image measured from ground
(Rotated by 90 degrees)

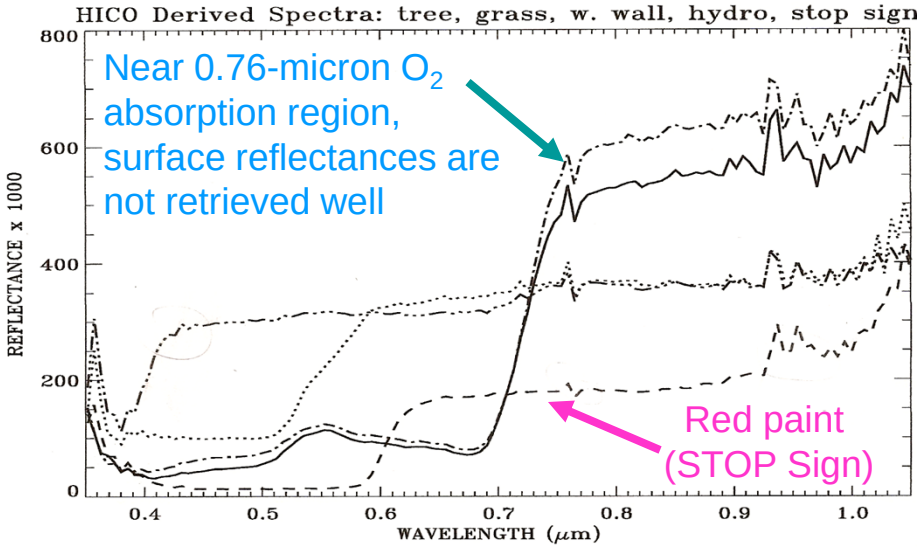


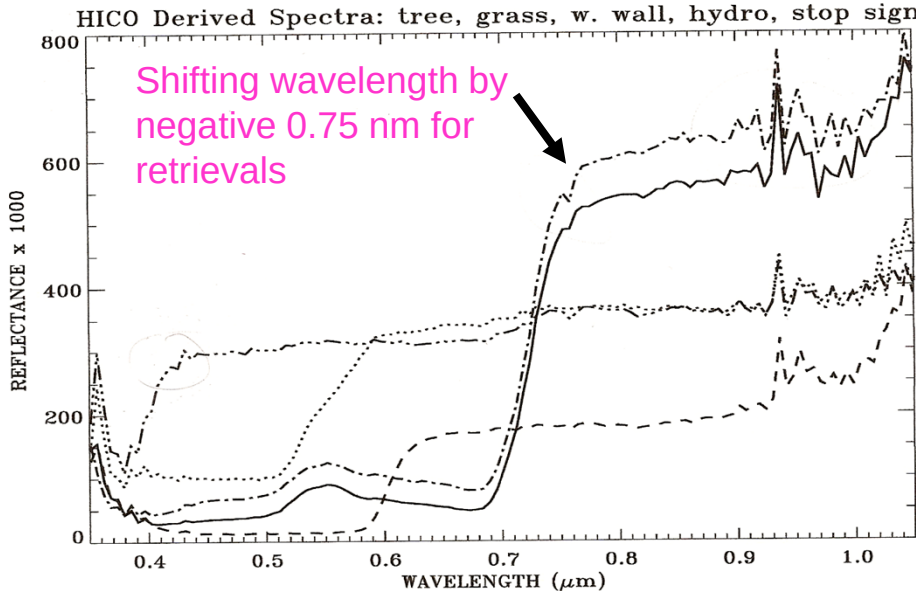
Spectrum-Matching for Wavelength & Spectral Resolution Calibrations

An Illustration of Spectrum-Matching Technique



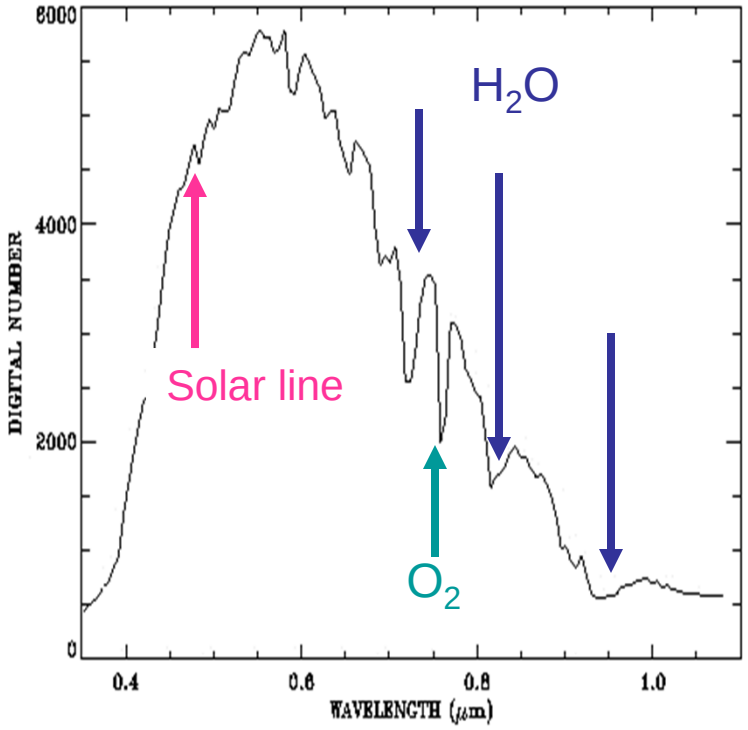
Sample Surface Reflectance Retrievals

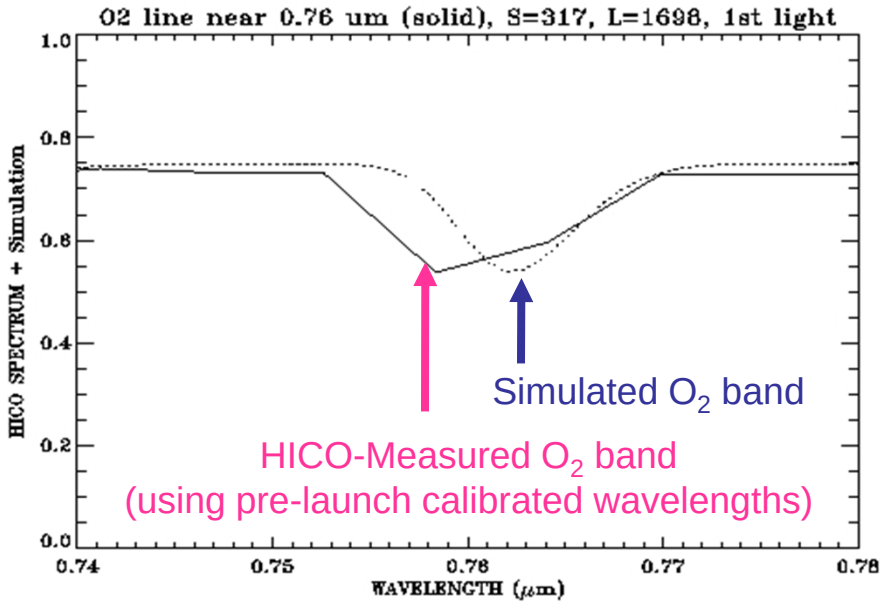




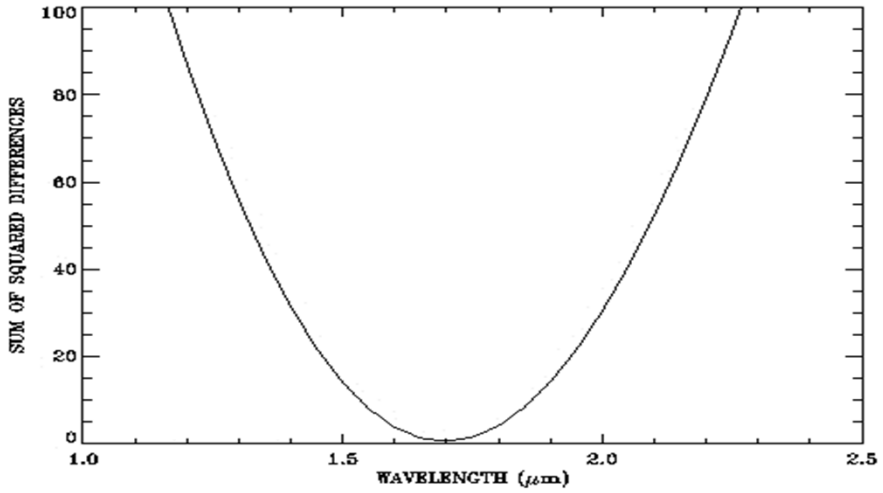
Post-launch Vicarious Calibrations – Wavelength & Spectral Resolution

A Sample ISS HICO Spectrum





HICO Post-Launch Wavelength Shift (~1.7 nm)

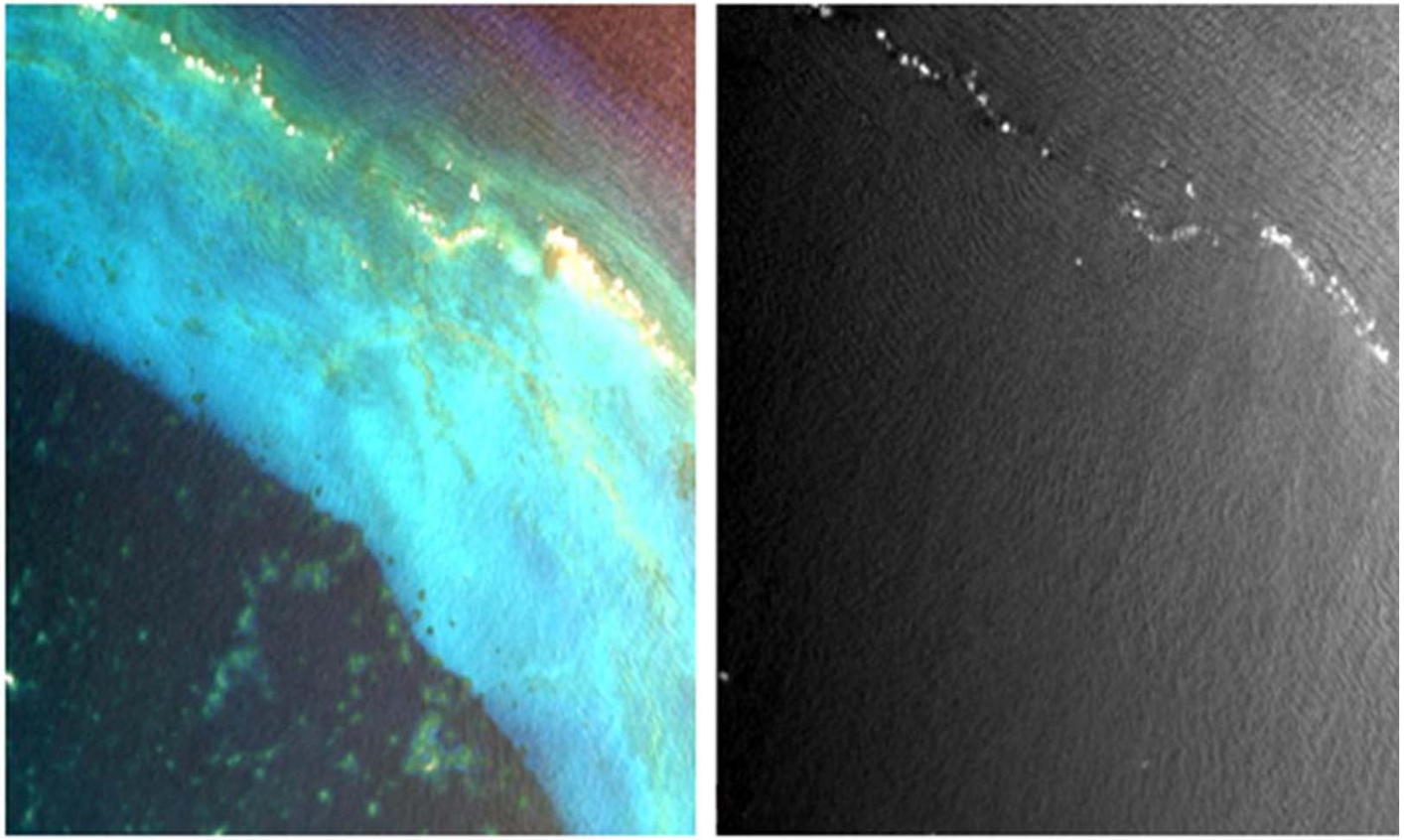


Post-launch FWHM remained the same

Post-launch Vicarious Calibrations – 2nd Order Light Removal (through analysis of shallow underwater objects)

An AVIRIS RGB Image Over French Frigate Shoals

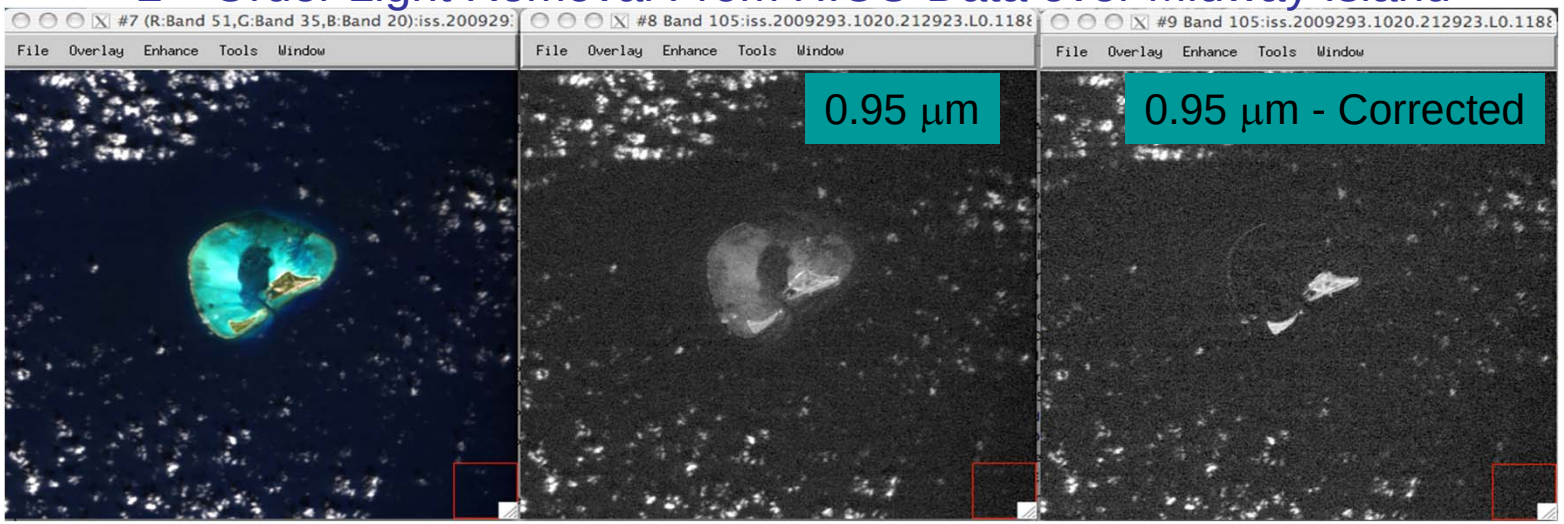
AVIRIS 1-μm Channel Image Over the Same Area



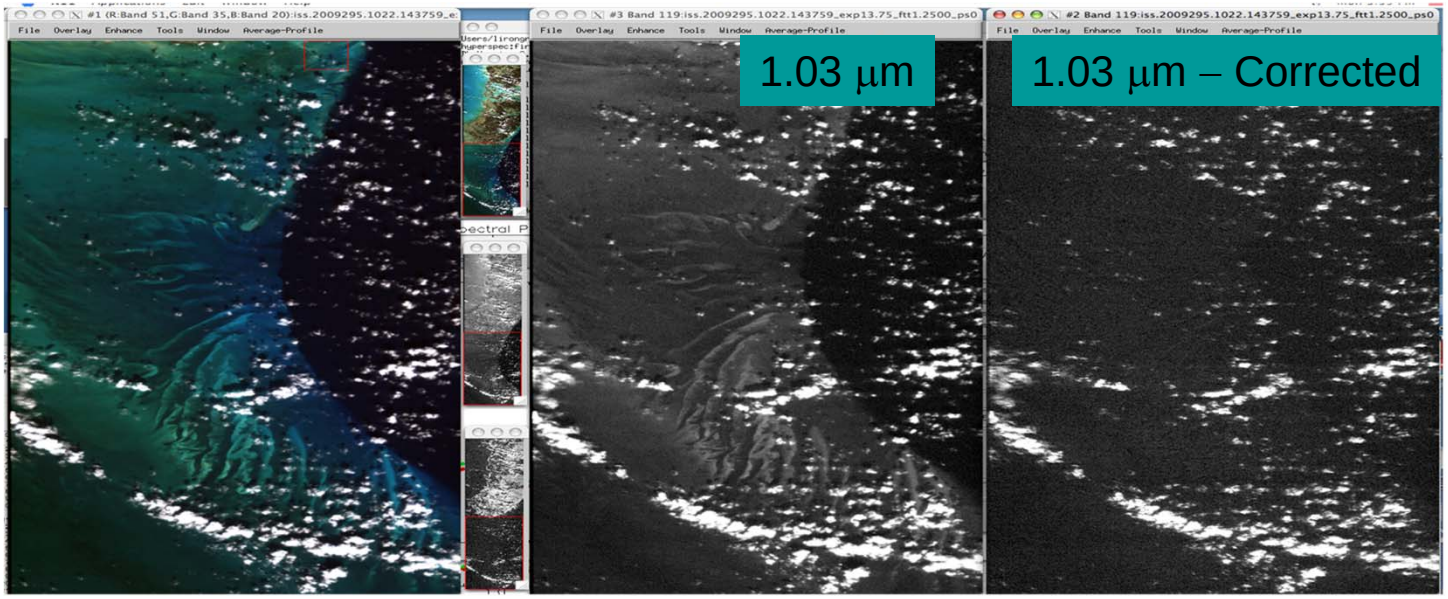
Shallow underwater objects are not detectable in AVIRIS images above ~0.85 micron because of strong absorption by liquid water. Using this property, we have developed an empirical technique to remove the 2nd order light effects from HICO data.

Post-launch Vicarious Calibrations – 2nd Order Light Removal

2nd Order Light Removal From HICO Data over Midway Island

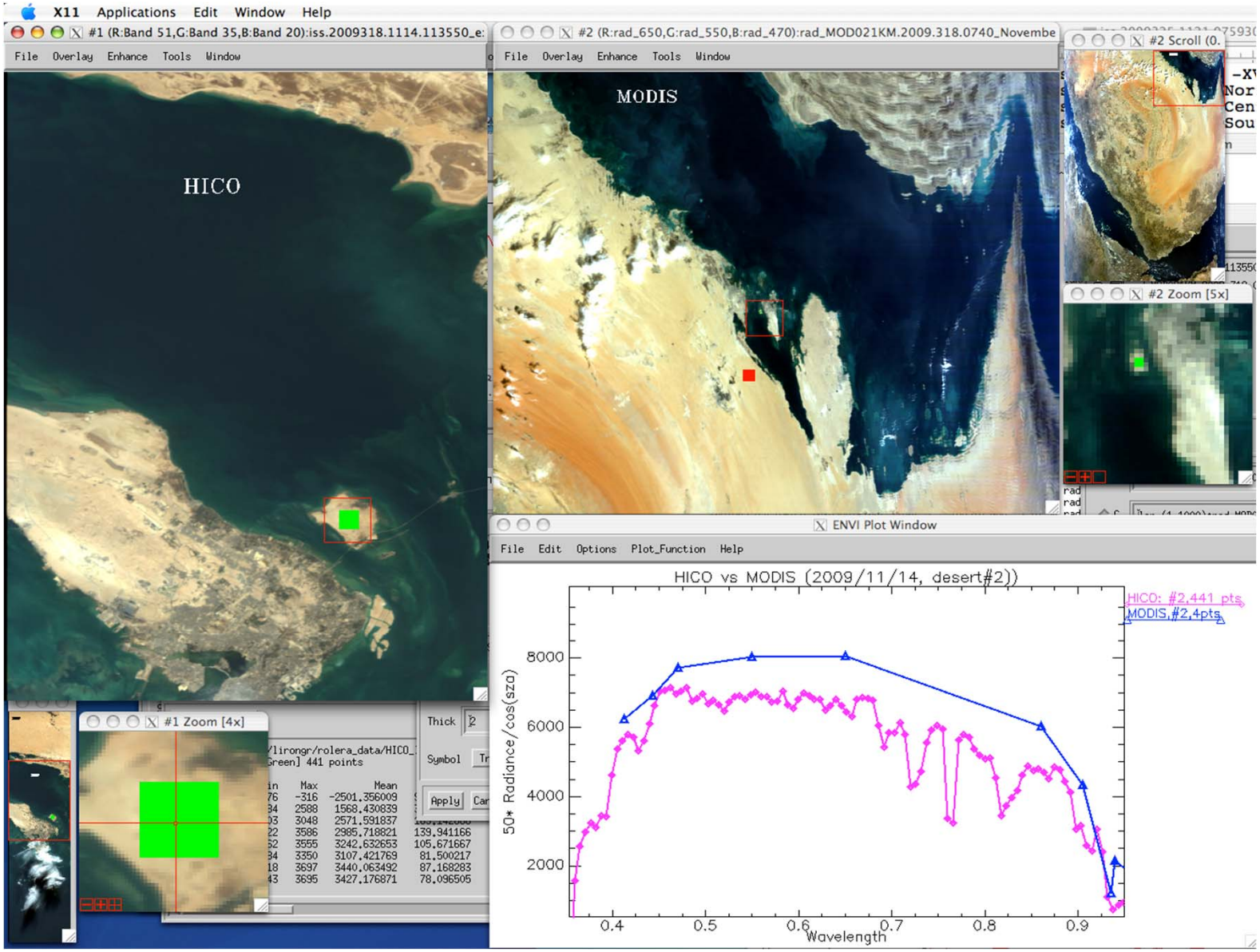


2nd Order Light Removal From HICO Data over Bahamas Banks



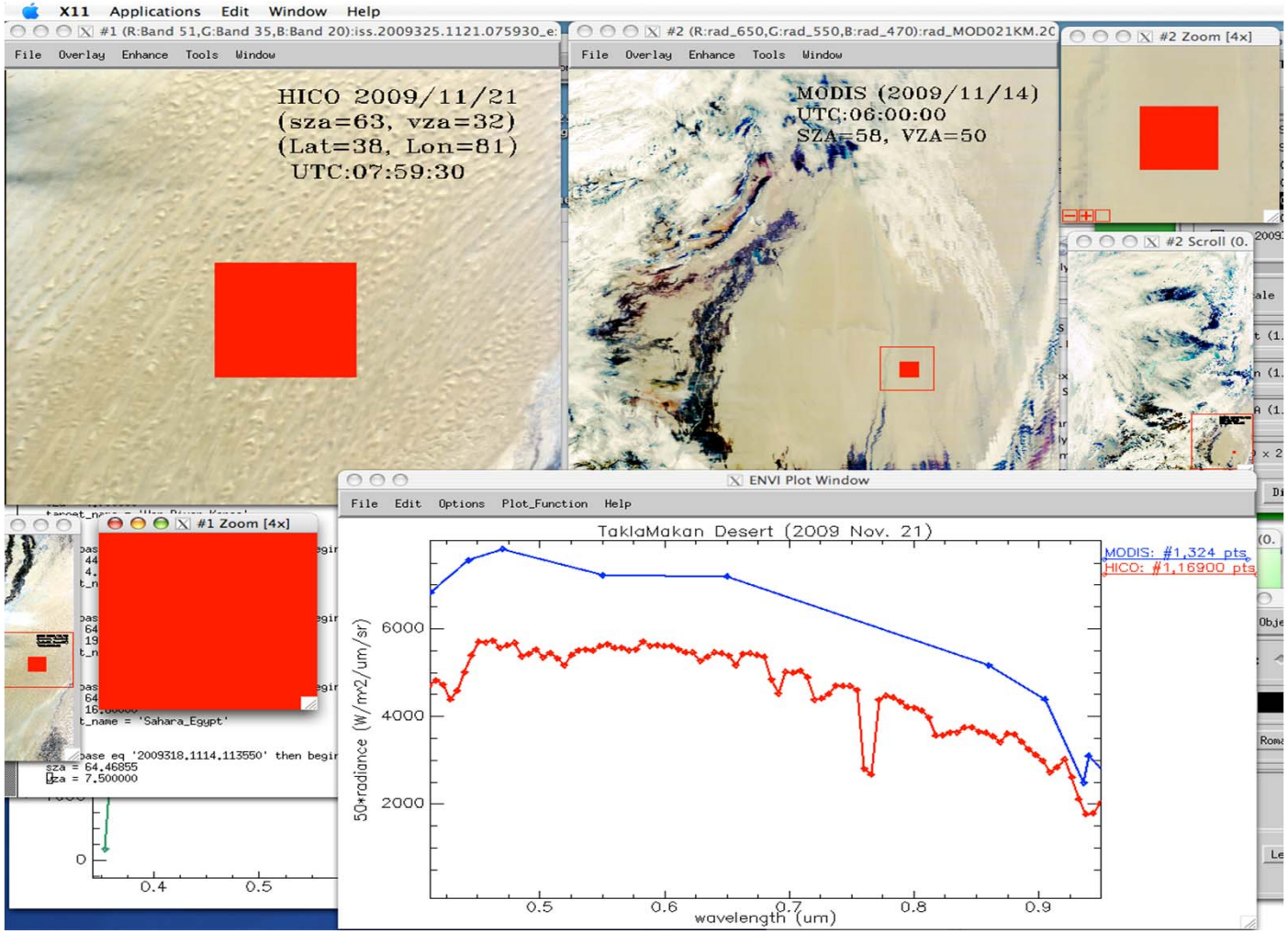
Post-launch Vicarious Calibrations – Absolute Radiometry

(Comparisons with MODIS Data Measured Over Bahrain on 11/14/2009)



Post-launch Vicarious Calibrations – Absolute Radiometry

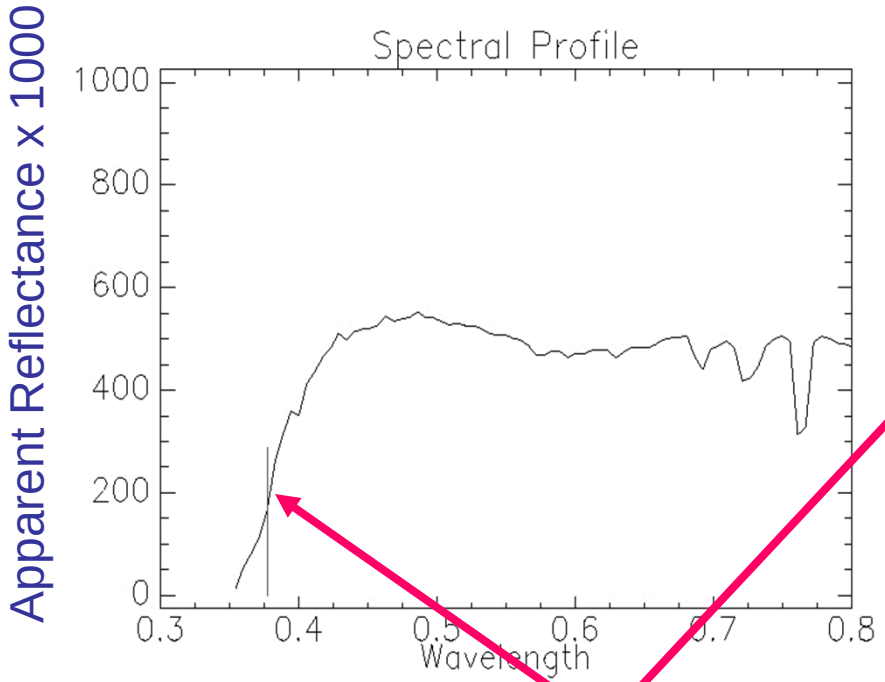
(Comparisons with MODIS Data Over TaklaMakan Desert on 11/21/2009)

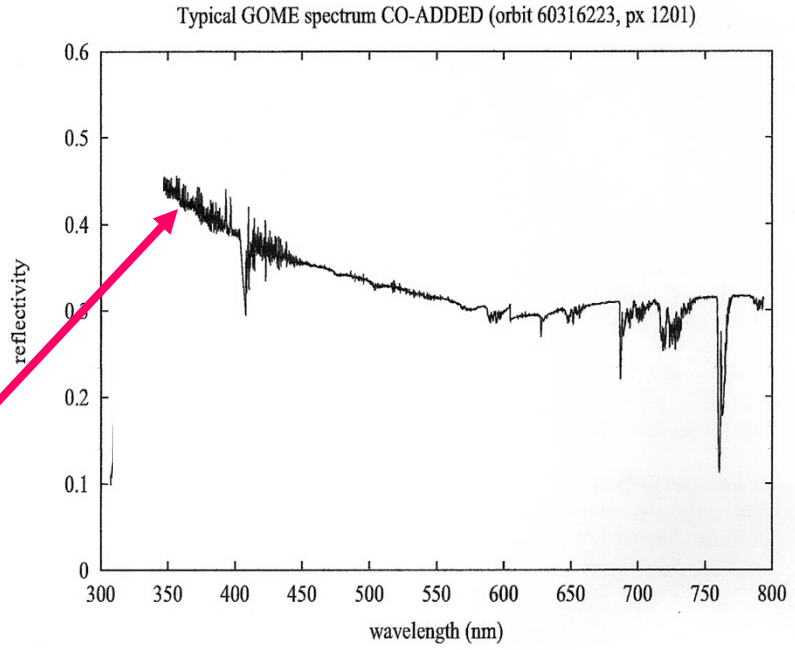


Through a number of comparisons between HICO data and MODIS data near 0.66 and 0.86 micron, we derived an average scaling factor of 1.32 for adjusting the HICO radiometric calibration coefficient

Post-launch Vicarious Calibrations – Additional Scaling Based on Cloud Modeling

Comparison Between a HICO Cloud Spectrum & a GOME Cloud Spectrum





The HICO reported cloud reflectance decreases rapidly with decreasing wavelengths, while the opposite is true for the GOME cloud spectrum (at a much finer spectral resolution). GOME is an European satellite instrument. In order to make the HICO cloud spectra to have the same shape as that of the GOME spectrum in the 350 – 450 wavelength interval, the HICO gain factors need to be increased significantly.

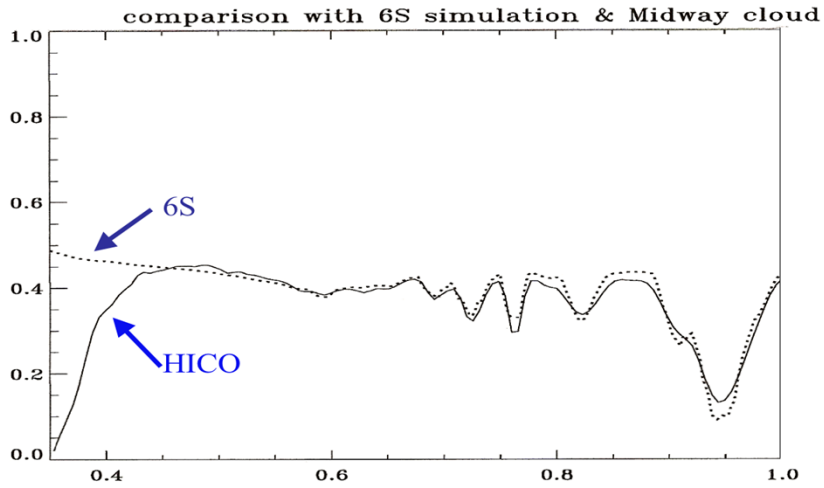
The shape of the HICO cloud spectrum in the 450 – 800 nm range is fine.

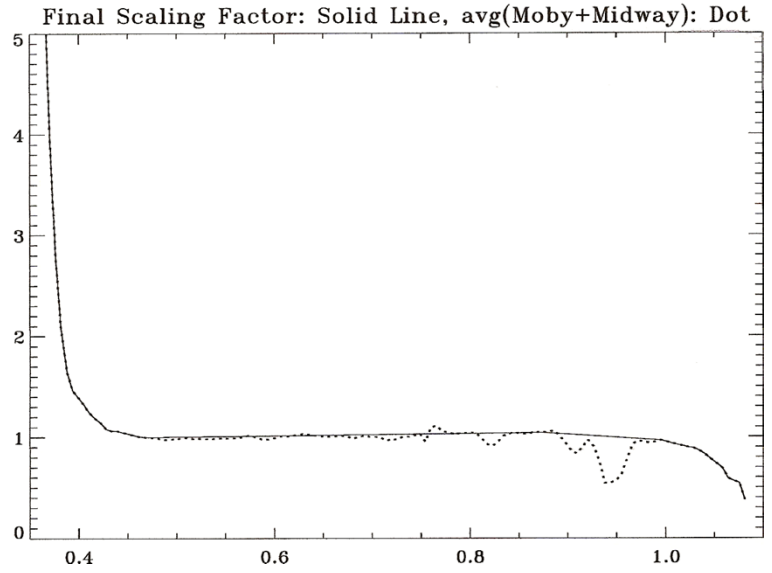
Post-launch Vicarious Calibrations – Additional Scaling Based on Cloud Modeling (by assuming cloud reflectances in the 0.35 – 1.1 μm range are spectrally constant)

Midway Islands

MOBY

Comparison of smoothed 6S simulated apparent reflectance with HICO Apparent Reflectance





Post-launch Vicarious Calibrations – Spectral Smoothing to Decrease Etaloning Effects and Residual Wavelength Shifts

Two Plots from A CCD Array Vendor

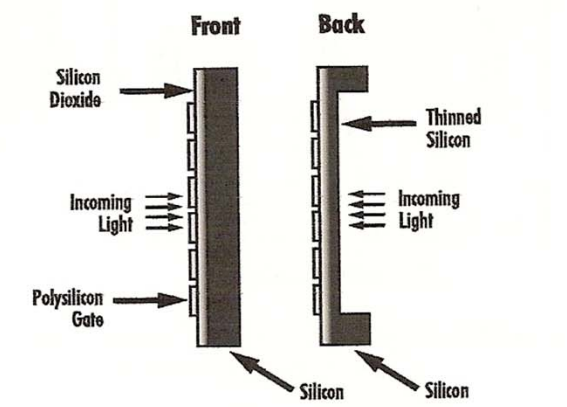


Figure 1. Comparison of front-illuminated and back-illuminated CCD.

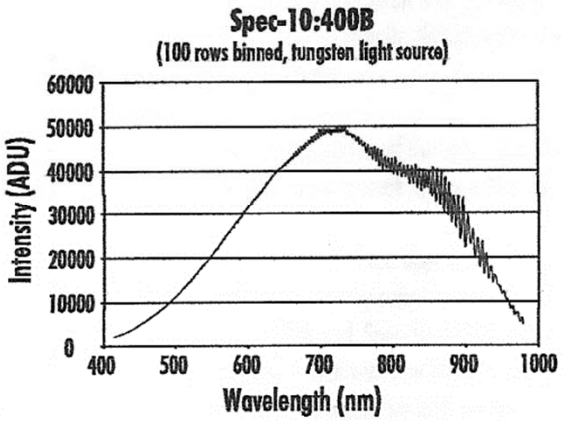
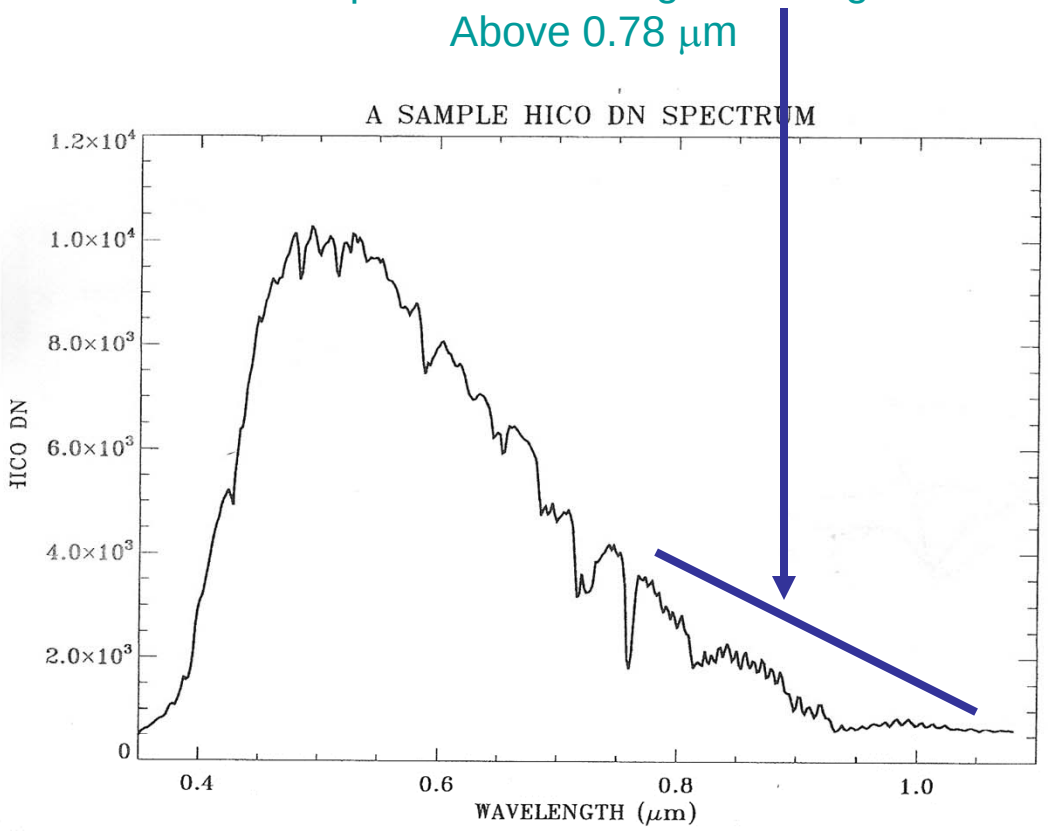


Figure 6. Spectrum of a tungsten light source using a back-illuminated CCD camera system. The etaloning becomes most pronounced between 800 nm and 1 μm, but is apparent even at 700 nm. ADU=arbitrary data unit.

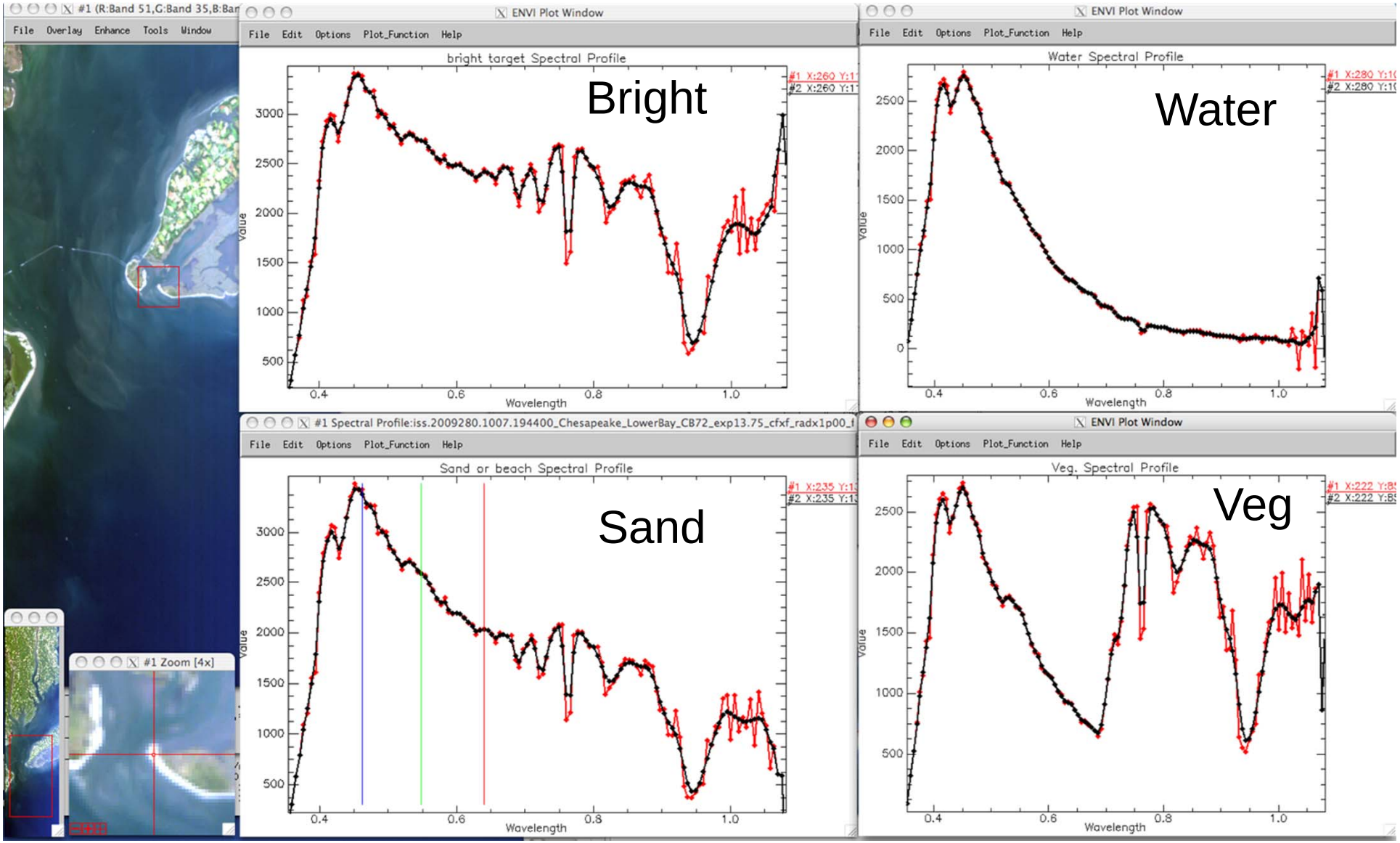
A HICO Spectrum Showing Etaloning Effects Above 0.78 μm



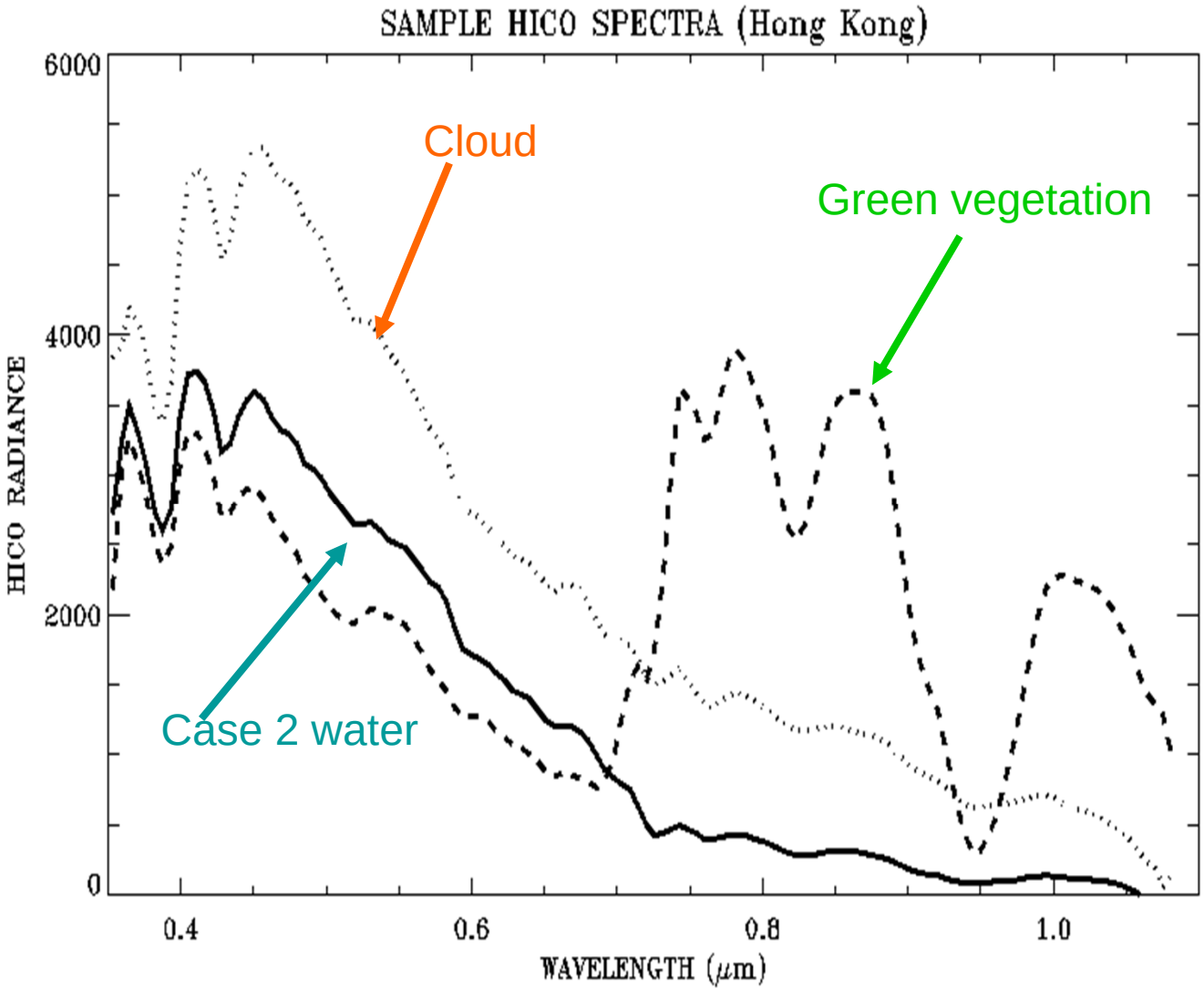
Post-launch Vicarious Calibrations – Spectral Smoothing

(0.35 – 0.745 μm —> 10 nm; 0.746 – 1.08 μm —> 20 nm)

HICO-ISS Spectrum, Before (Red Line) & After (Black Line) Gaussian Smoothing

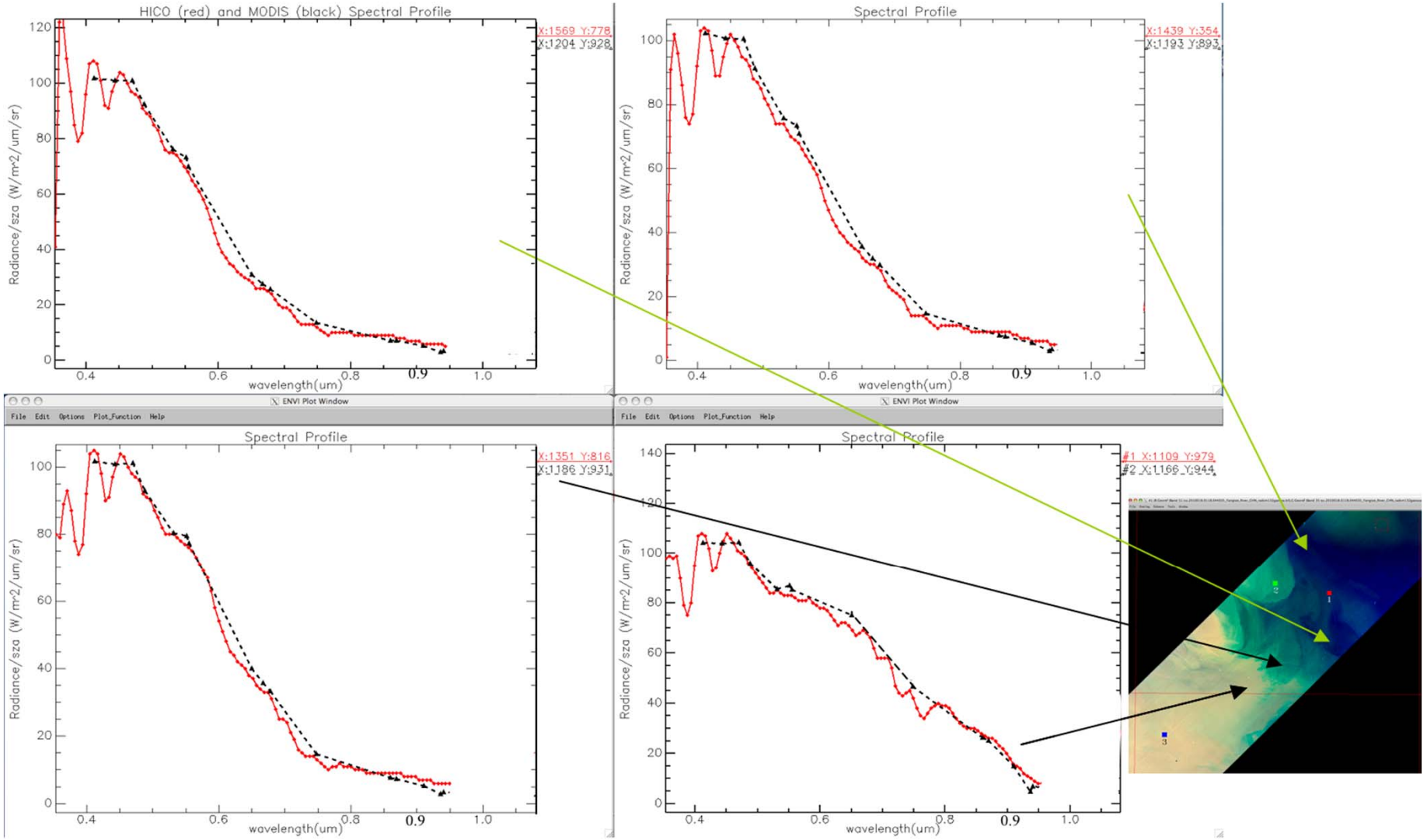


Post-launch Vicarious Calibrations – Sample Results After Applications of All the Correction Factors



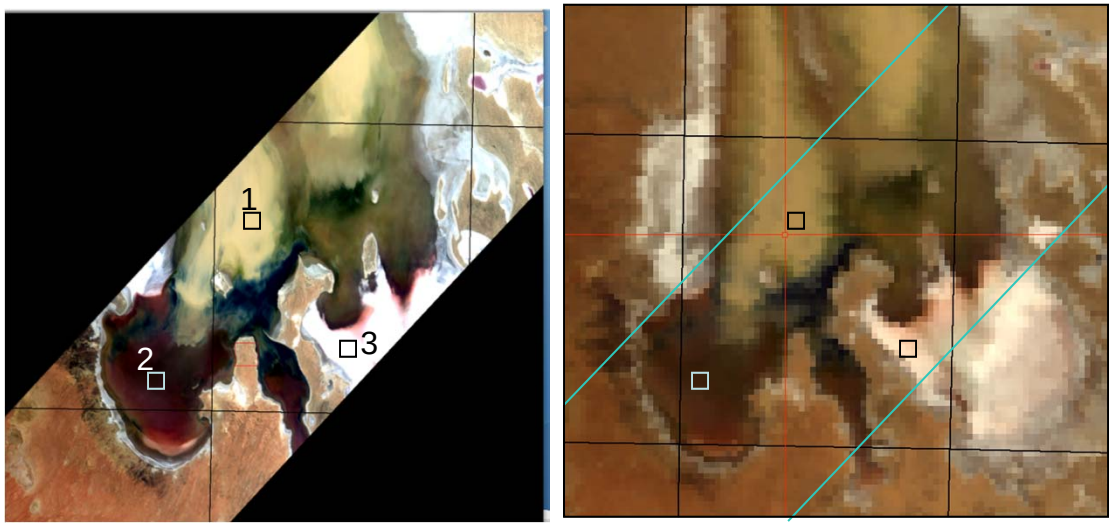
Post-launch Vicarious Calibrations – Verification with MODIS Data Sets Not Used in Vicarious Calibrations

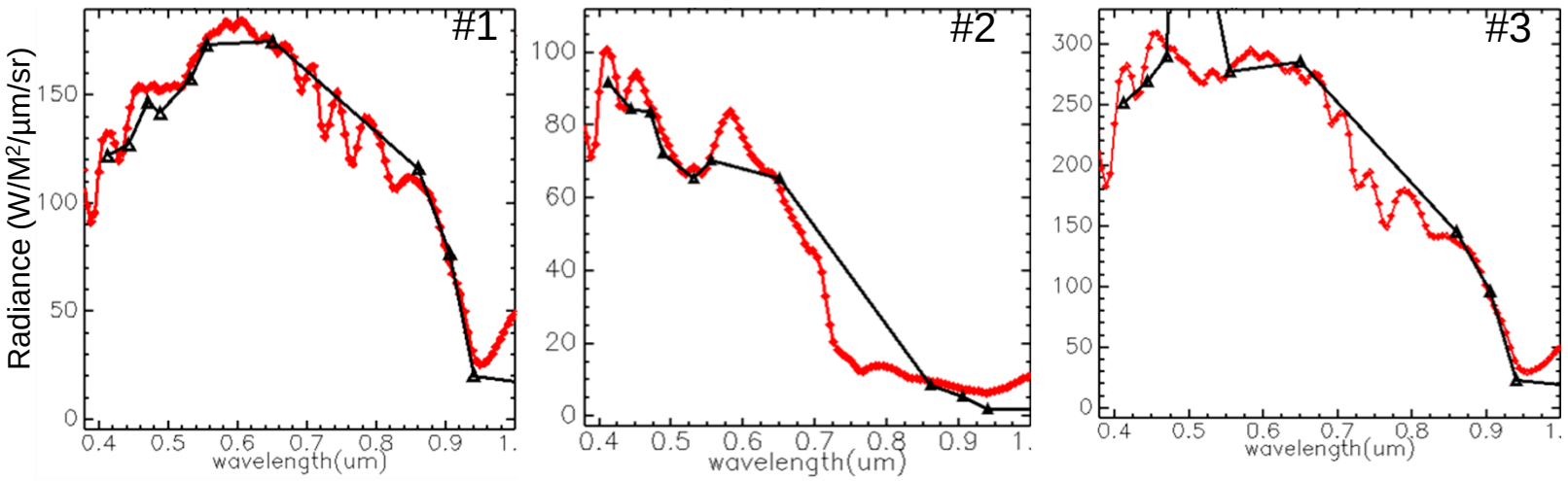
- After all the adjustments, the radiances of HICO and MODIS data acquired over other surfaces, such as waters, agreed quite well.



Post-launch Vicarious Calibrations – Verification with Another MODIS Data Set Acquired over Lake Eyre, Australia

HICO **Terra MODIS**





Summary

- We have made extensive diagnostic analysis of HICO data, and developed techniques for wavelength and spectral resolution calibrations, corrections for the second order light effects using shallow underwater objects, absolute radiometric calibrations based on comparisons between HICO data and Terra and Aqua MODIS data acquired over desert areas, a scaling curve based on radiative transfer modeling of cloud reflectances at the top of atmosphere, and spectral smoothing to decrease the etaloning effects and residual wavelength shifts.

- These techniques have been used operationally for converting the HICO L1A digital numbers to the L1B radiance data.