A Comparative Study and Intercalibration Between OSMI and SeaWiFS

KOMPSAT-1

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ORBVIEW-2

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Abstract

Since 1996, following in the success of CZCS, a fleet of space-borne sensors with global ocean color capability have been put into operation by various research institutions throughout the world. The NASA SIMBIOS Project has been funded to evaluate the consistency of oceanic optical properties retrieved by these various missions, with the ultimate goal of merging data from multiple missions to enhance temporal, spectral, or spatial resolution of the global dataset. The work presented here is a collaborative effort between the Korea Aerospace Research Institute (KARI) and the SIMBIOS Project to compare and improve the consistency between two such missions: the Ocean Scanning Multi-spectral Imager (OSMI) operated by KARI, and the Sea-viewing Wide Field-of-view Sensor (SeaWiFS) operated by NASA and the OrbImage Corporation.

SeaWiFS was launched on 1 August 1997 into a 705-km sun-synchronous polar orbit with a descending equatorial crossing time near local noon. The instrument is a scanning filter radiometer collecting data in eight spectral channels between 400 and 900 nm, with a surface resolution at nadir of approximately 1-km and a swath width of 2800 km. OSMI is a whisk-broom scanning Charge Coupled Device (CCD) with 96 detectors oriented along track and six programmable spectral channels in the visible and near infrared. The instrument has a ground resolution of approximately 1 km, with a swath width of 800 km. OSMI was launched on 21 December 1999 into a 685 km sun-synchronous polar orbit with an ascending equatorial crossing near 10:50 a.m. local time.

Using the pre-launch calibration and standard atmospheric correction software developed for OSMI, it was found that the sensor was not able to retrieve reasonable ocean optical properties. To allow for meaningful comparisons between OSMI and SeaWiFS, it was necessary to first modify the standard SeaWiFS atmospheric correction software to accept and process the OSMI data, thereby ensuring consistent and proven algorithms. The SeaWiFS normalized water-leaving radiance measurements were then used as truth data to enable a vicarious calibration of the 96 independent CCD elements of each OSMI spectral band. The results of this cross-calibration will be presented, and remaining difficulties will be discussed.

Purpose of Work

Investigate the potential for merging of OSMI ocean color retrievals with SeaWiFS and other sensors.

No meaningful oceanic optical property retrievals possible using prelaunch calibration and existing processing software.

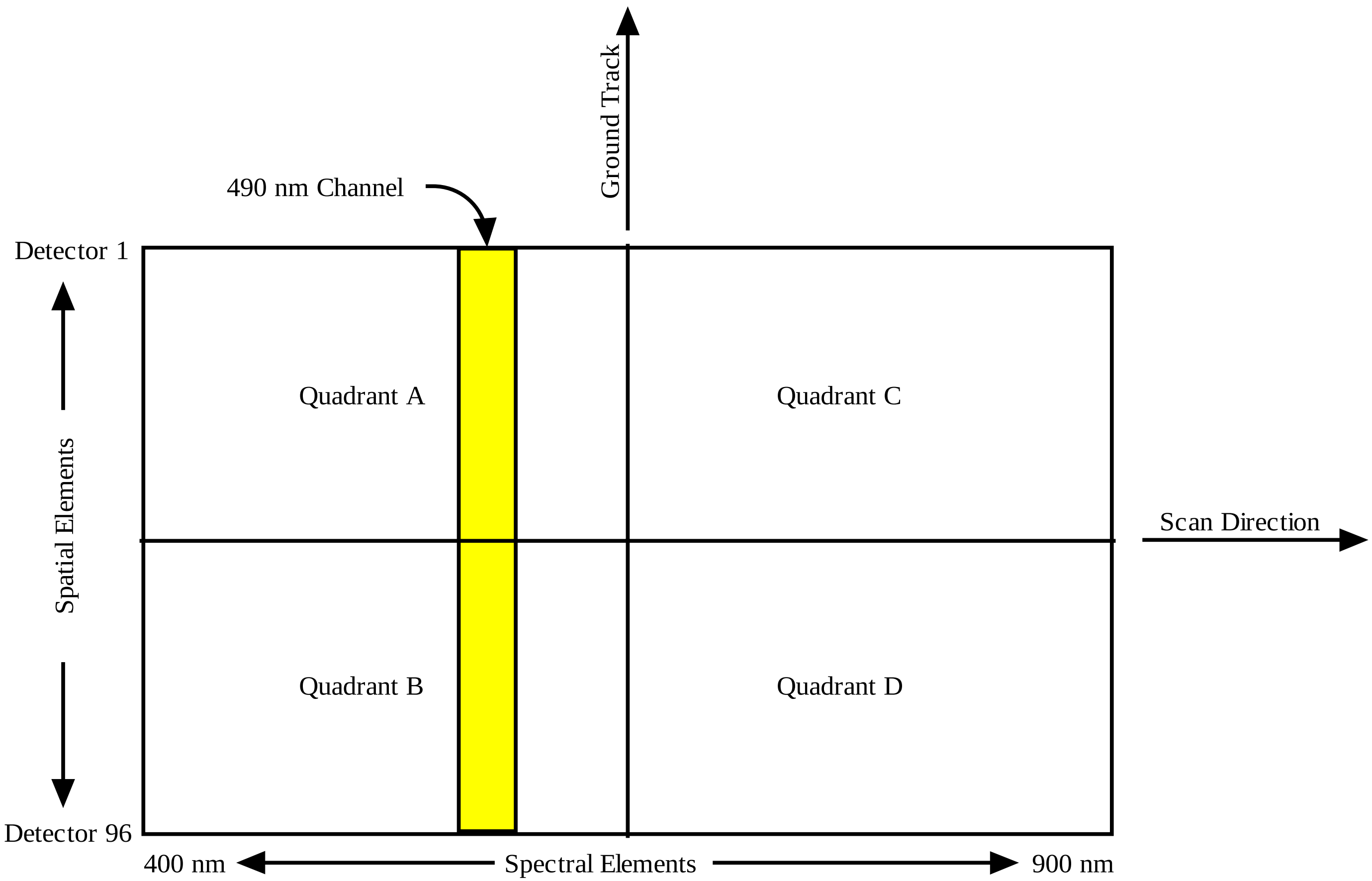
In collaboration with KARI, SIMBIOS agreed to:

- evaluate TRW pre-launch calibration of OSMI.
- adapt SIMBIOS software (MSL12) to process OSMI data and retrieve oceanic optical properties.
- develop OSMI vicarious calibration to *in situ* (MOBY) and/or another sensor (SeaWiFS).
- evaluate quality of derived ocean color products.

OSMI and SeaWiFS Mission Characteristics

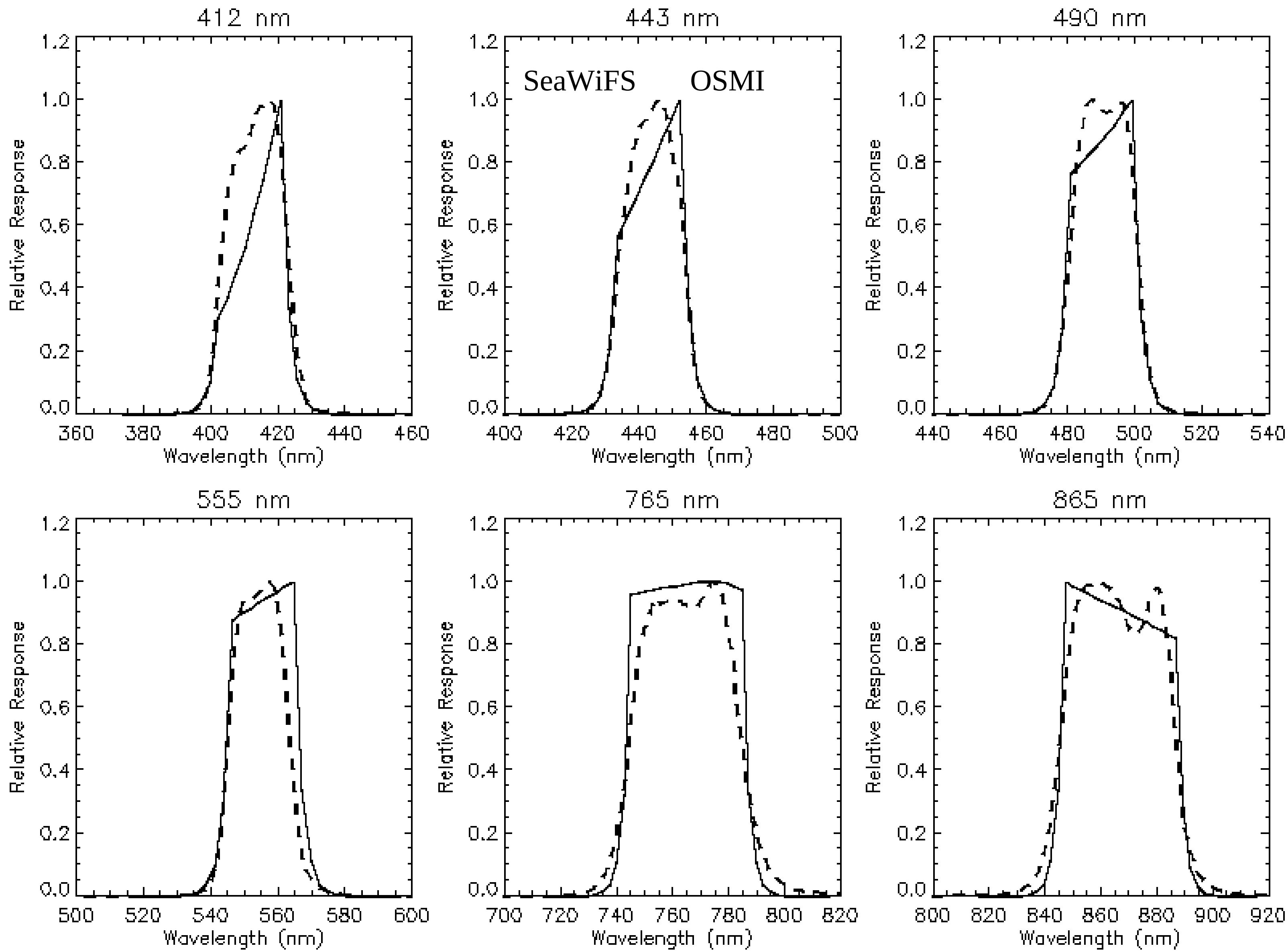
	OSMI	SeaWiFS
Launch Date	Dec. 1999	Aug. 1997
Nadir Resolution (km)	0.85	1.1 (4.5 GAC)
Swath Width (km)	800	2800 (1500 GAC)
Imaging Duty Cycle	20 min/orbit	46 min/orbit
Tilt Capability (deg)	None	+/- 20
Equator Crossing	10:50 a.m. Ascending	12:00 p.m. Descending
Spectral Range (nm)	400-900	402-885
Spectral Channels	6 (selectable)	8
Band Width (nm)	20-40	20-40
Samples per Channel	96	1

OSMI Focal Plane

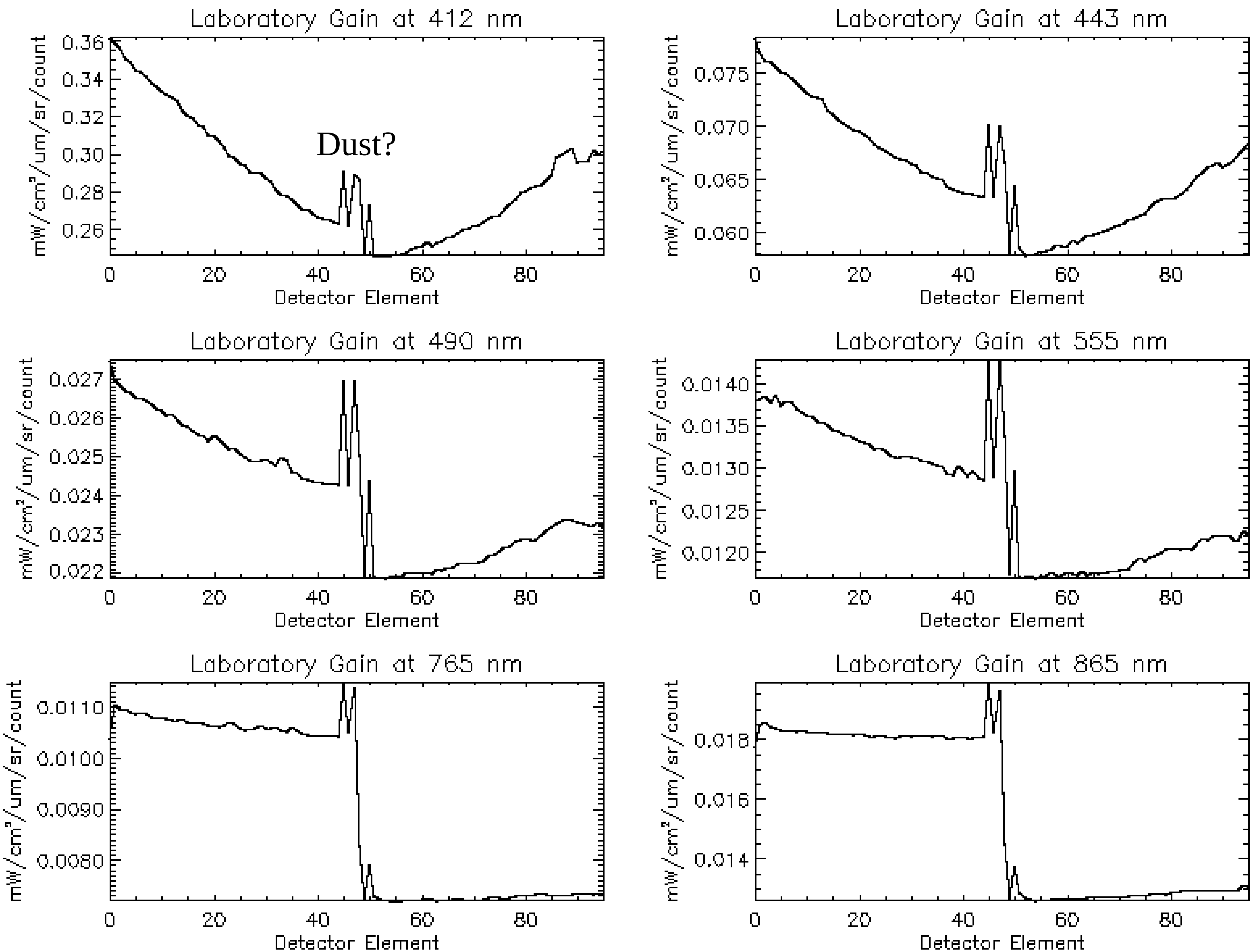


OSMI and SeaWiFS Spectral Response

used in derivation of Rayleigh reflectance, solar irradiance, etc.



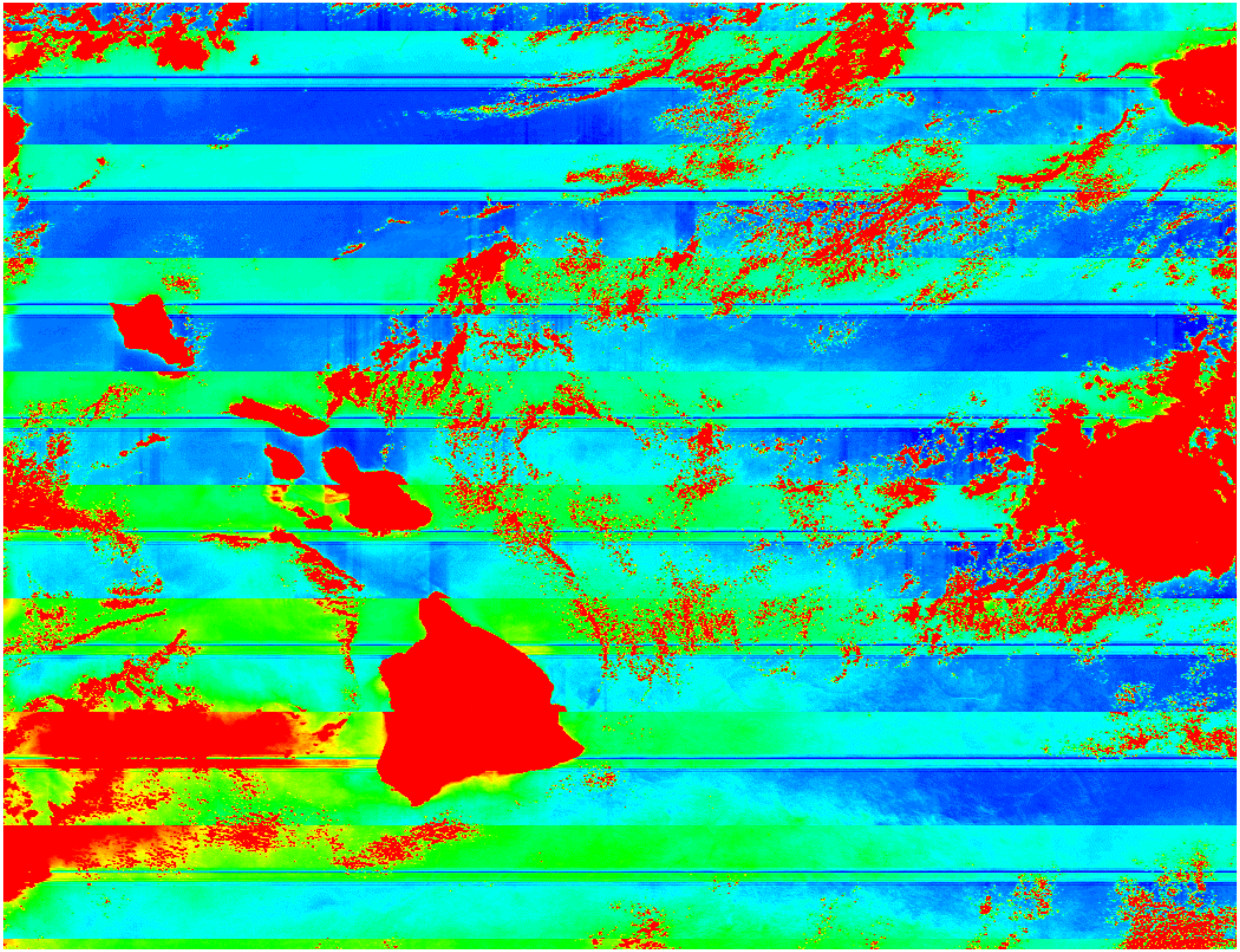
OSMI Pre-Launch Calibration Gains



OSMI Raw Counts in 865nm Channel

banding due to differences in upper and lower focal-plane quadrants

low response in vicinity of bright sources (electronic saturation)



MSL12 Atmospheric Correction

The SeaWiFS Correction Algorithm (Gordon & Wang, 1994)

$$L_{\mathrm{t}} = L_r + L_a + L_{ra} + tL_{wc} + TL_g + tL_w$$

- TL_g is avoided or corrected via Cox and Munk.
- tL_{wc} is estimated from wind speed and geometry.
- L_r is computed "exactly" using pre-computed tables as function of geometry, windspeed, and band pass.
- $L_a + L_{ra}$ are estimated using aerosol models.

OSMI Vicarious Calibration to SeaWiFS

The cross-calibration procedure for a colocated scene segment

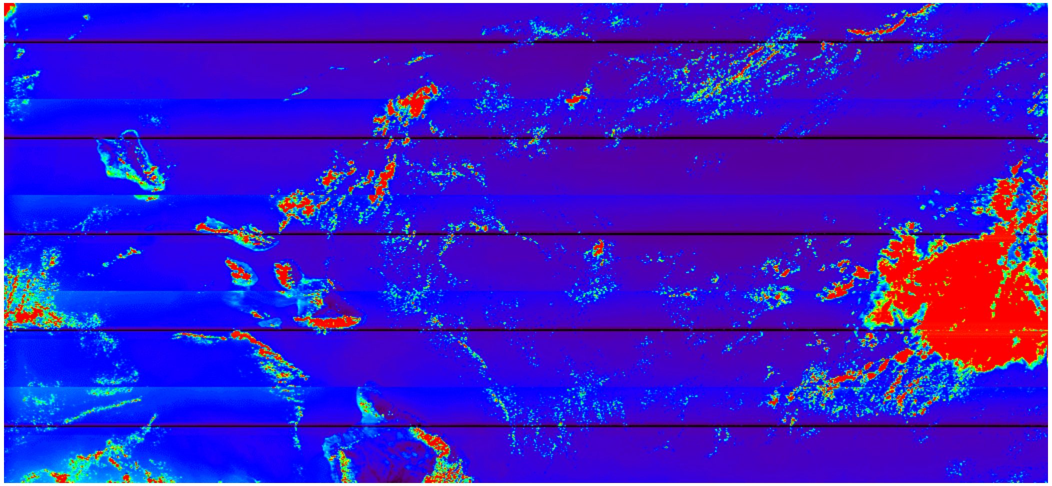
- Resample SeaWiFS derived aerosol model type and AOT(865) to OSMI geolocation, combine with OSMI viewing and Solar geometry to compute $L_a + L_{ra}$ for each OSMI observation in scene.
- Resample SeaWiFS derived nLw to OSMI geolocation, combine with OSMI viewing and Solar geometry to compute tL_w for each OSMI observation in scene.
- Compute remaining components and sum to yield L'_t, the TOA radiance OSMI should see based on SeaWiFS derived aerosol and oceanic optical properties.

$$L'_\mathrm{t} = L_r + L_a + L_{ra} + tL_{wc} + TL_g + tL_w$$

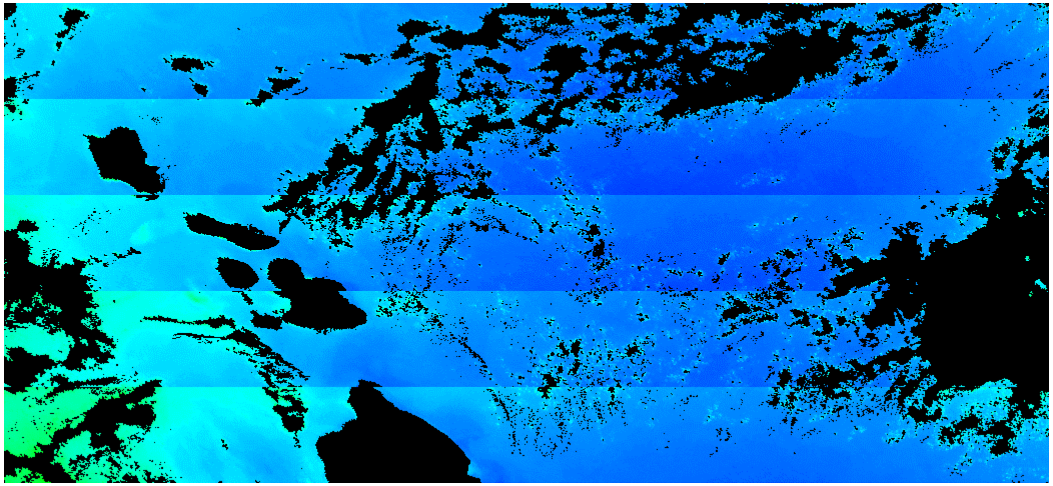
- Vicarious gain is then simply $\mathrm{L'_t/L_t}$.

5 OSMI Scans Near Hawaii, 2000 336

L_t (490)
Observed TOA
Radiance with
Laboratory
Calibration

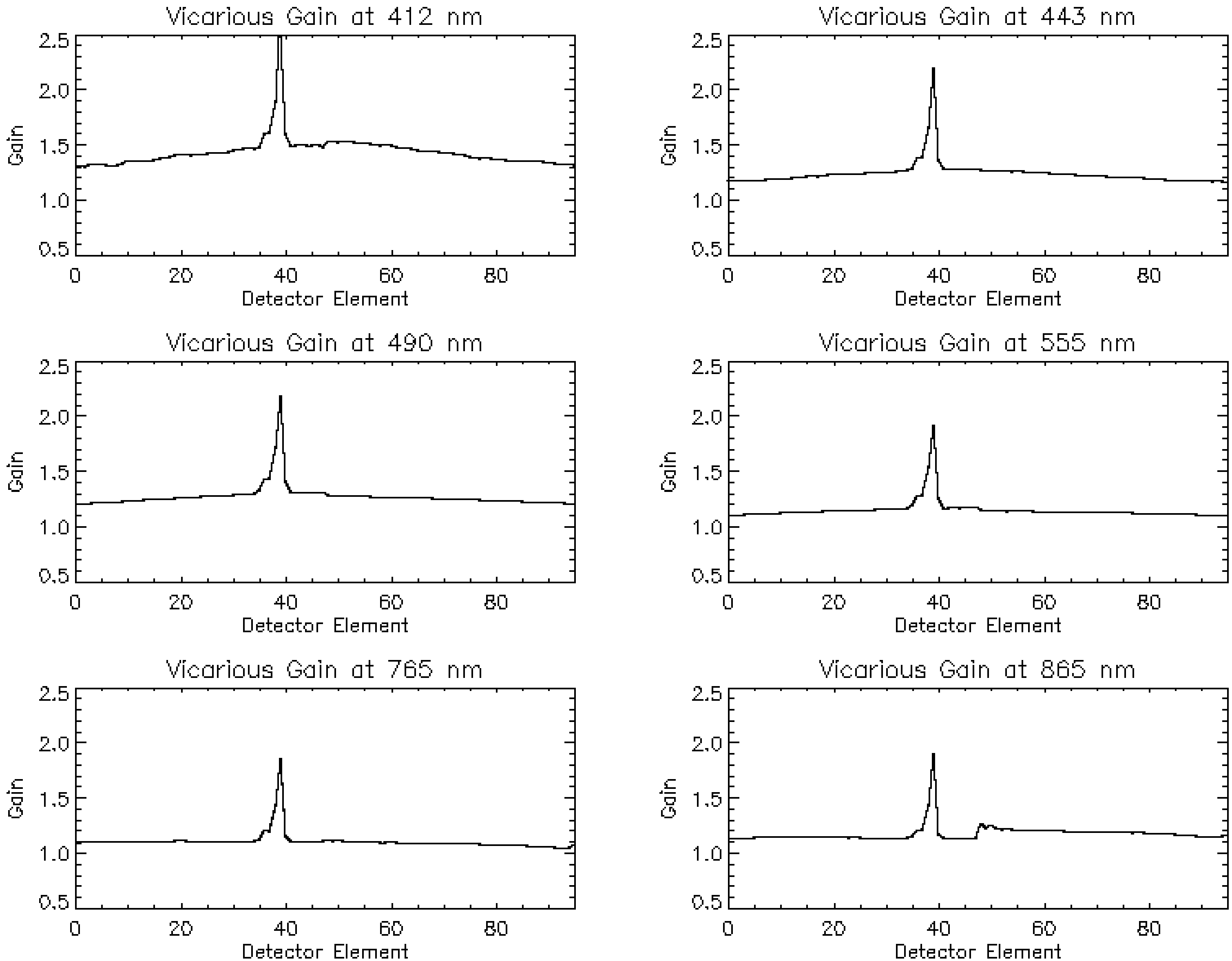


L_t' (490)
Predicted TOA
Radiance Derived
Using SeaWiFS



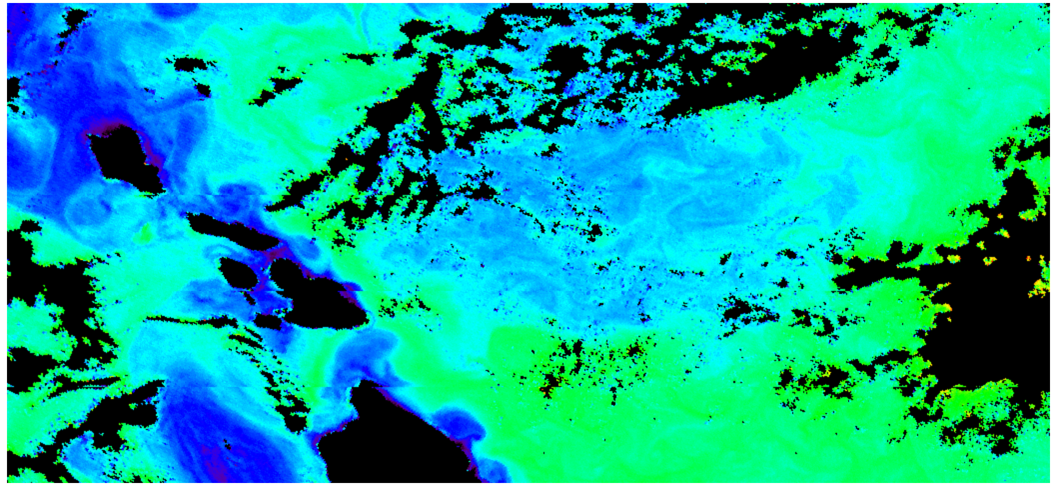
2 - 7 mW cm^{-2} um^{-1} sr^{-1}

OSMI Vicarious Calibration Gains

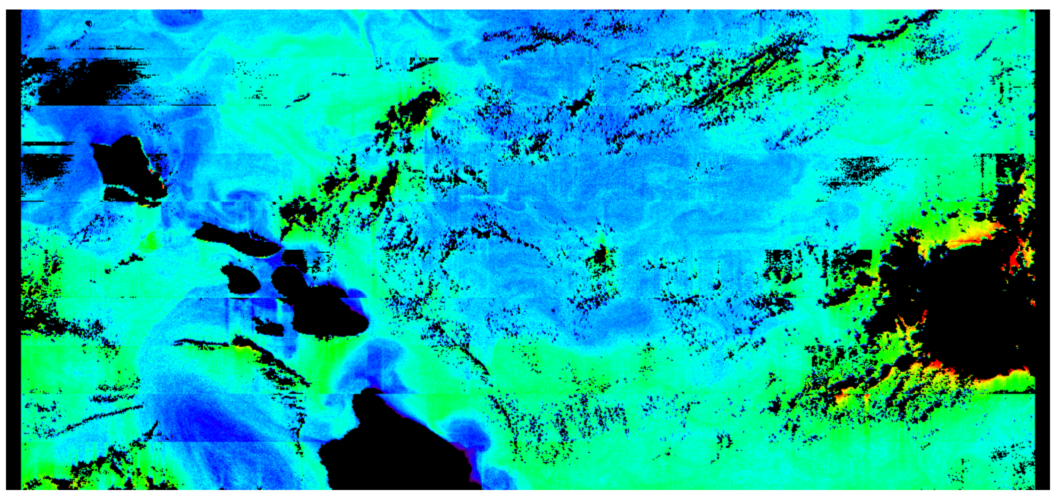


5 OSMI Scans Near Hawaii, 2000 336

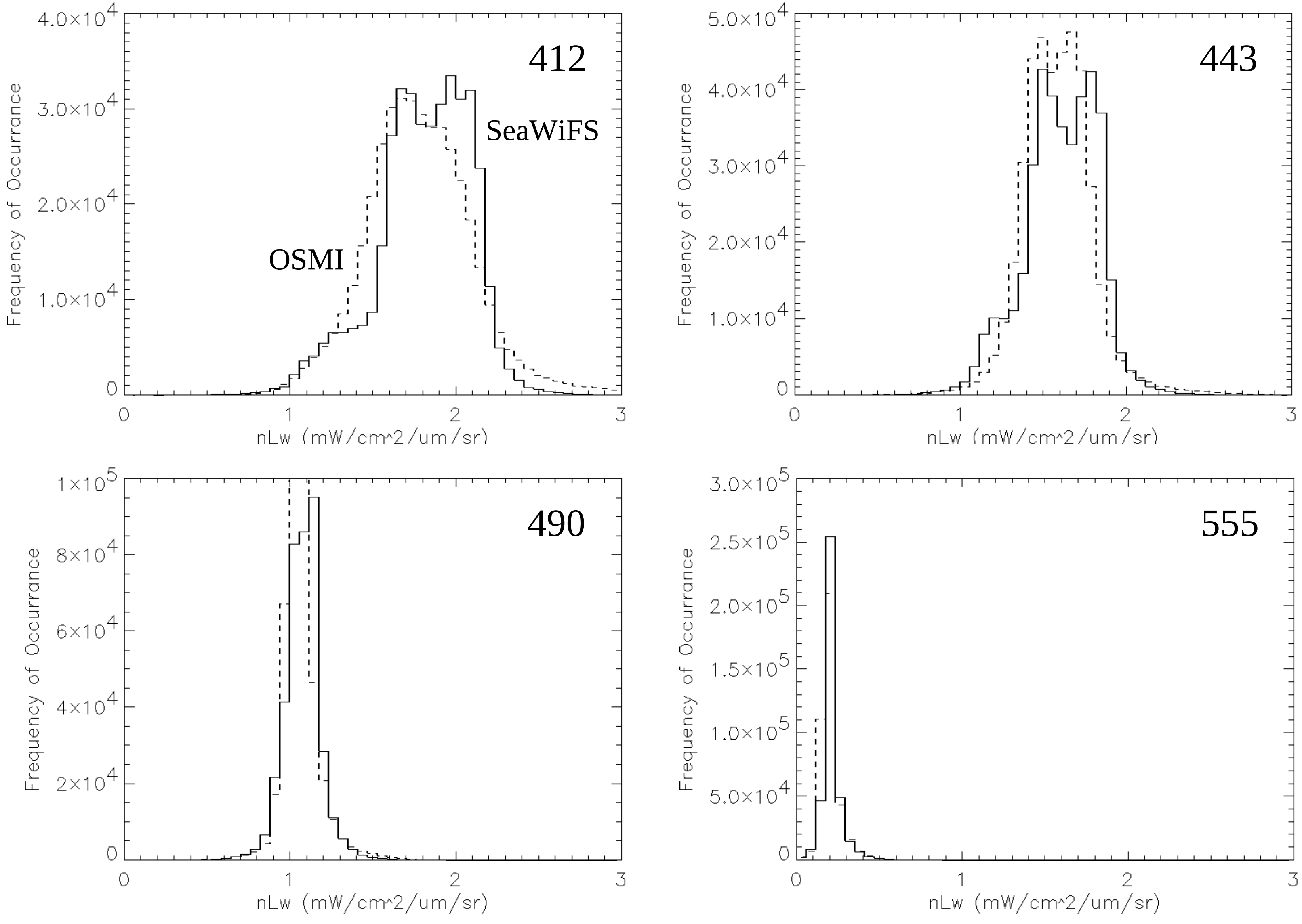
nLw (443)
SeaWiFS

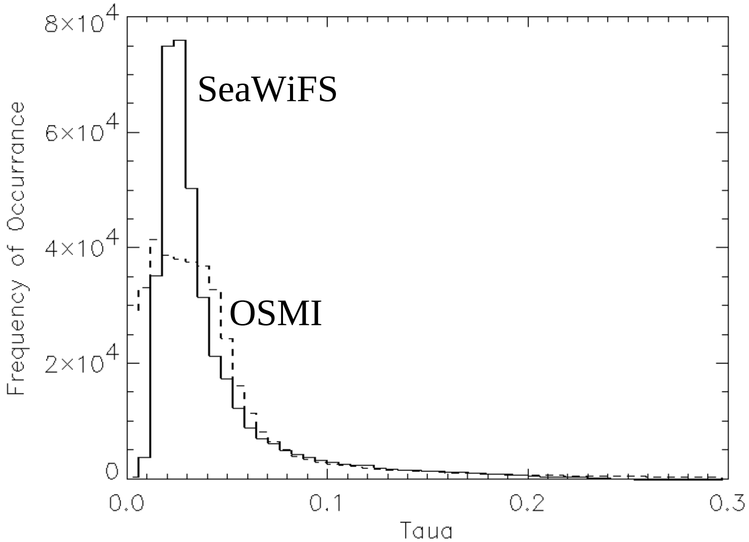


nLw (443)
OSMI

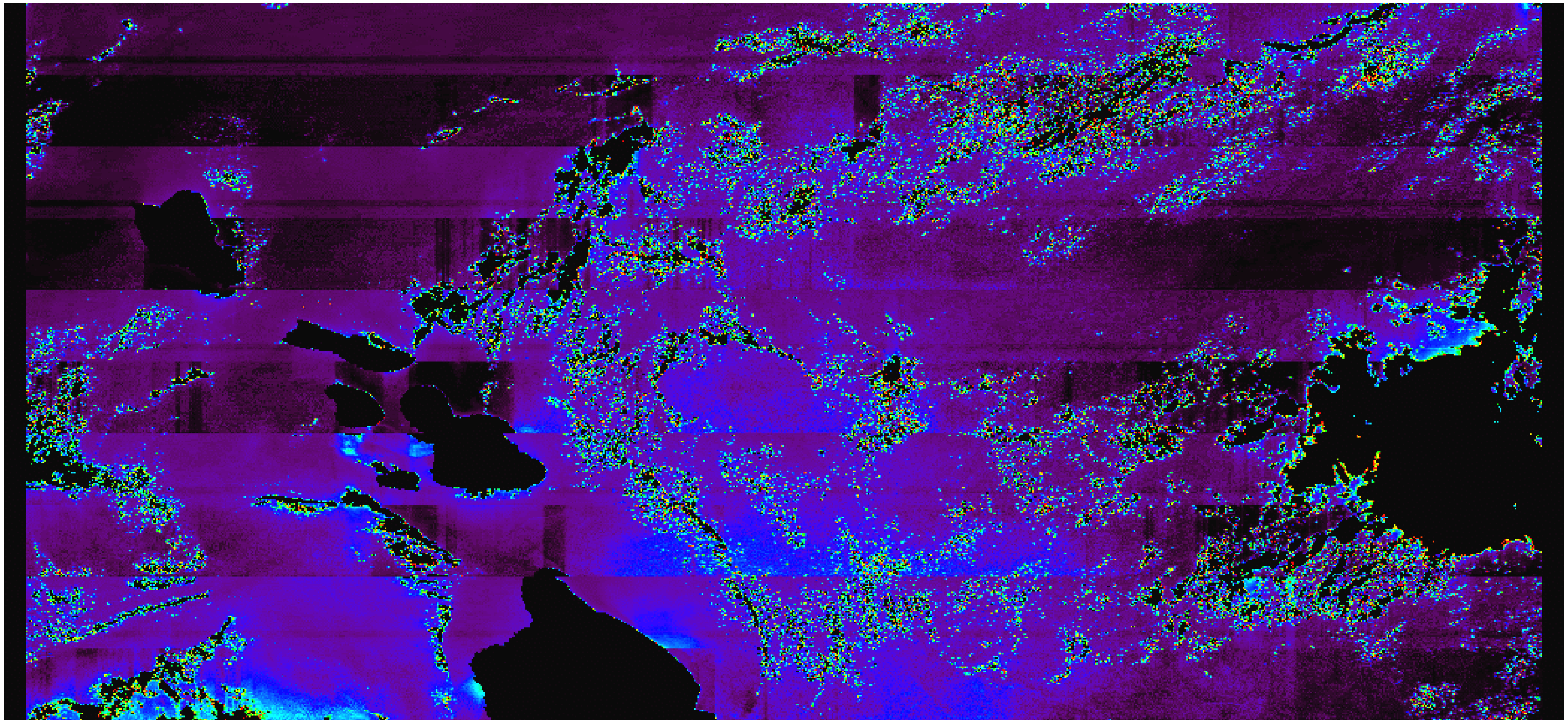


OSMI and SeaWiFS nLw Frequency Distributions Day 336 of 2000 Near Hawaii



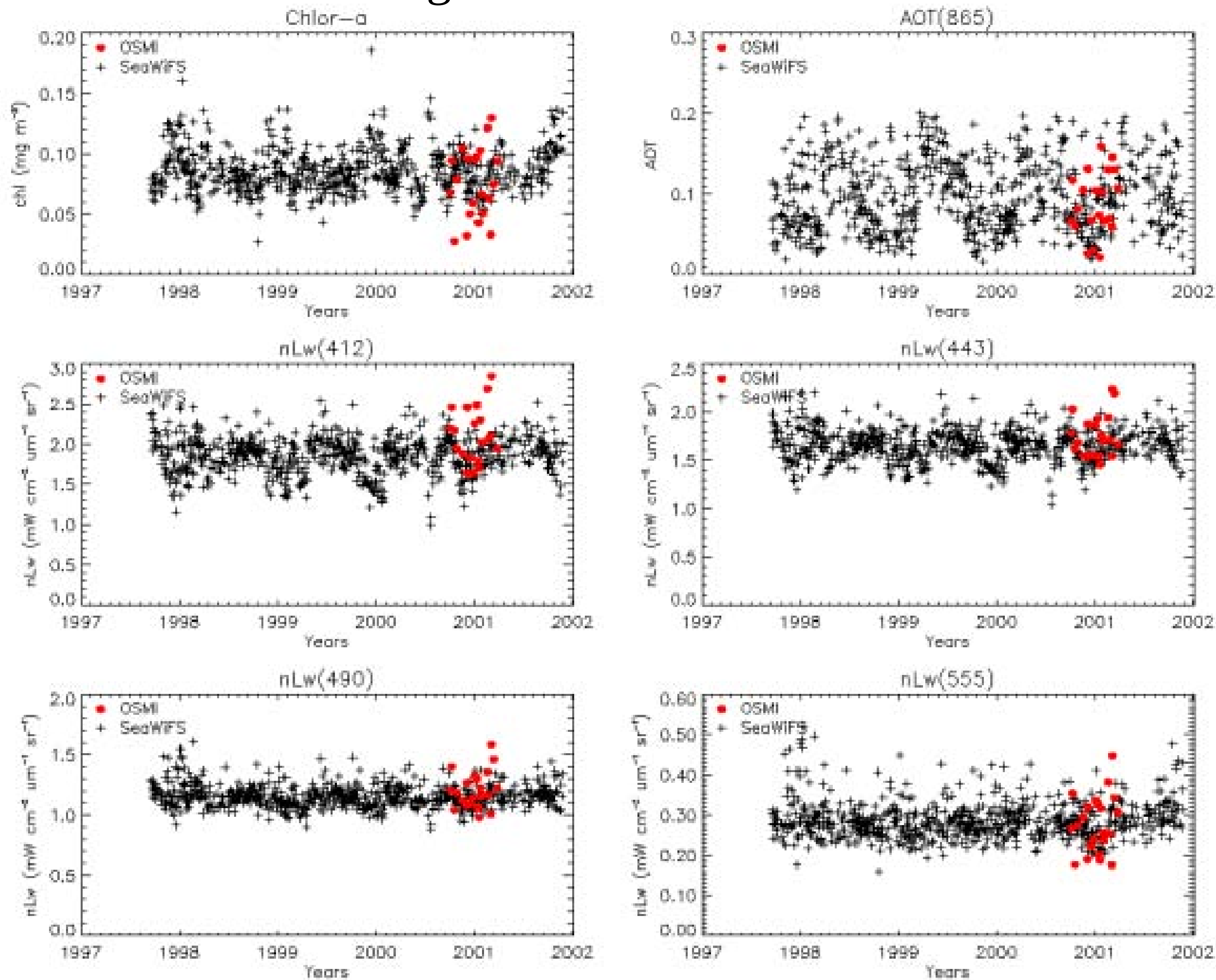


AOT(865)
Day 336 of 2000



OSMI and SeaWiFS Derived Optical Properties

Mean of 1-deg Box Centered on MOBY Site



Summary

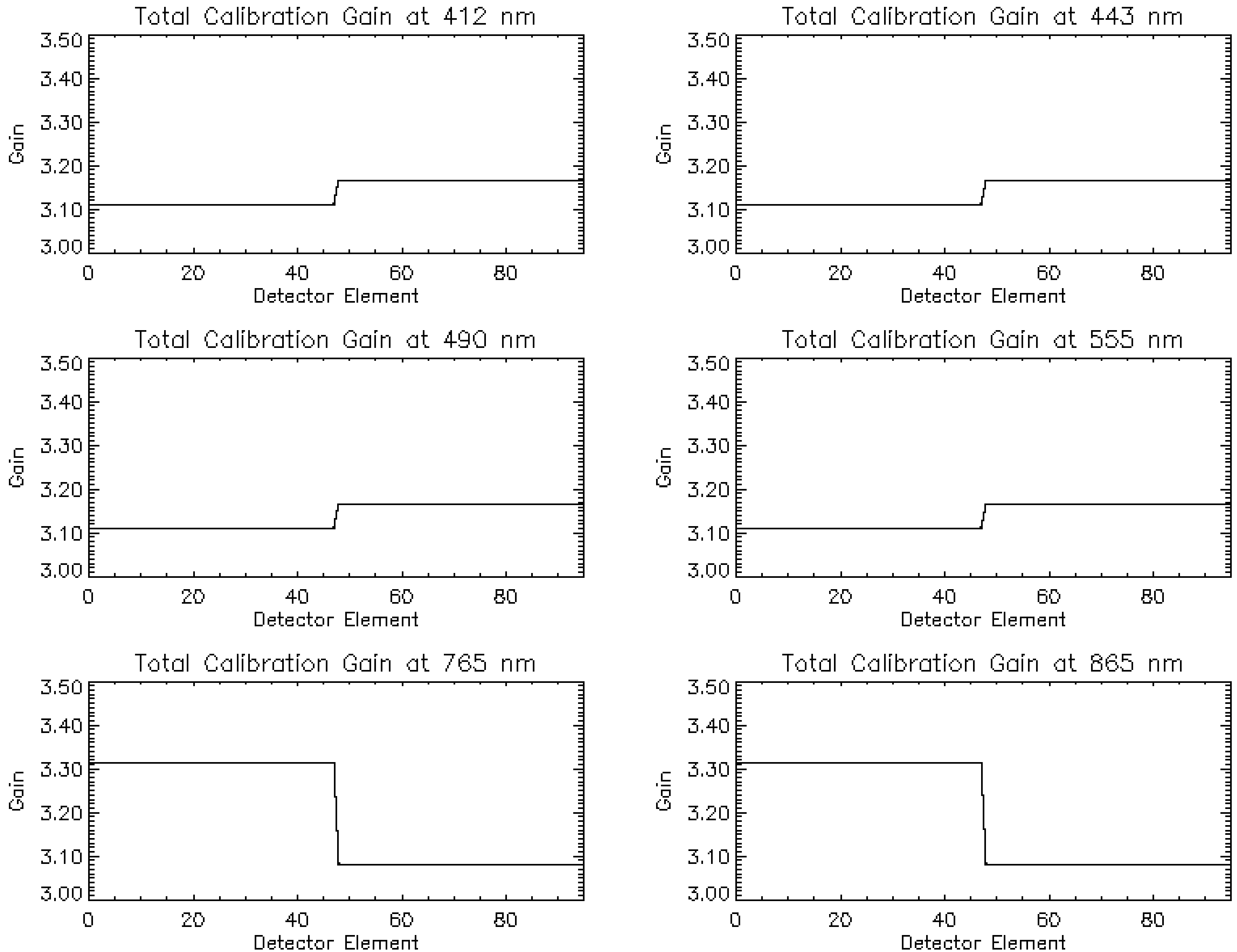
- The Multi-Sensor Level-1 to Level-2 atmospheric correction software, MSL12, was adapted to read and process OSMI Level-1A data.
- A cross-calibration of OSMI to SeaWiFS was performed, to adjust for absolute and detector-relative changes in the post-launch OSMI calibration.
- Using MSL12 and this vicarious intercalibration, it is now possible to derive oceanic and atmospheric optical properties which are in good agreement with SeaWiFS.
- More work is required to understand and correct for systematic artifacts in the OSMI data, and to evaluate the temporal stability of the calibration.

Supporting Slides

OSMI and SeaWiFS Spectral Channels

OSMI nm	SeaWiFS nm	Band Width
412	412	20
443	443	20
490	490	20
	510	20
555	555	20
	670	20
765	765	40
865	865	40

OSMI Electronic Gains



OSMI Dark Counts (2000 336)