PACE Atmospheric Correction

focusing on adaptation of NASA's heritage algorithm

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Much of our progress was captured in this published manuscript:

Ibrahim, A., B.A. Franz, Z. Ahmad, K. Knobelspiesse, R. Healy, B-C. Gao, C. Proctor, and P-W. Zhai (2017).

Atmospheric correction for hyperspectral ocean color retrieval with application to the Hyperspectral Imager for the Coastal Ocean (HICO)

Rem. Sen. Env, 204, doi:10.1016/j.rse.2017.10.041.

NASA Heritage AC Algorithm

Based on Gordon & Wang 1994 with aerosol models from Ahmad et al. 2010

Two-step process:

1. determine the atmospheric contribution, making minimal assumptions on water-leaving reflectance contribution
2. subtract atmosphere to retrieve spectral water-leaving reflectance

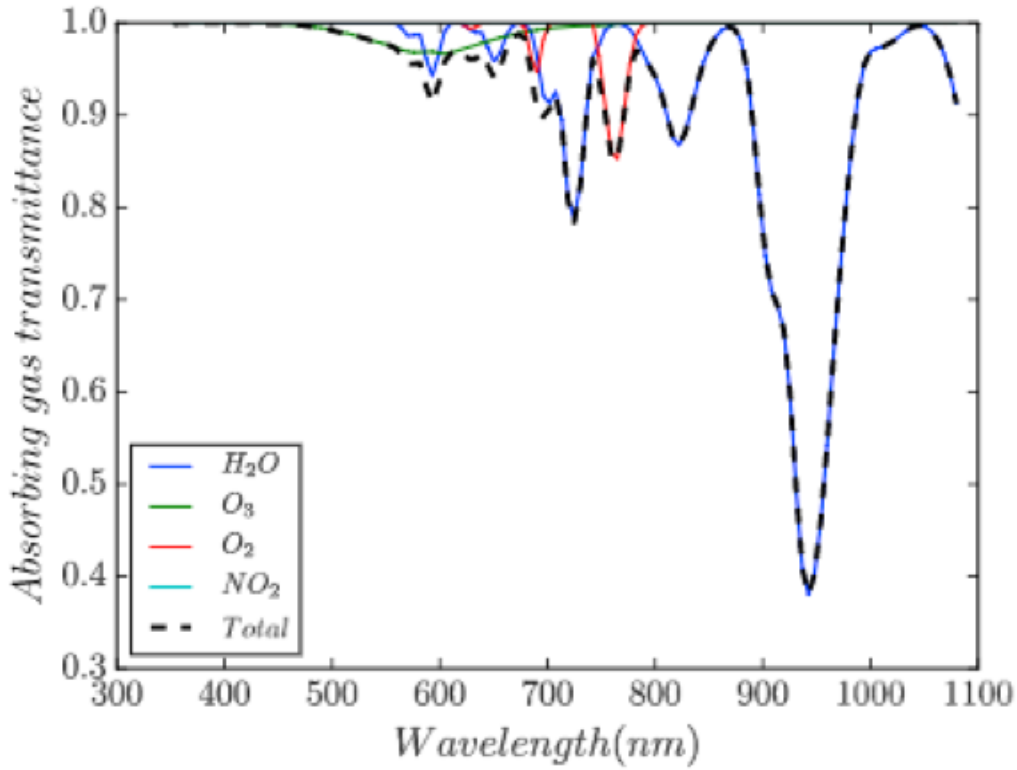
Uses two bands in NIR or SWIR (where water contribution can be assumed zero or accurately estimated) to select the aerosol model and scale the aerosol reflectance contribution

Developed for multi-spectral instruments, where spectral regions of strong atmospheric gas absorption (e.g., H2O, O2) are avoided by design

Primary goal is to extend algorithm to hyperspectral Rrs(λ) retrieval, including spectral regions (> 600nm) where water-vapor absorption is significant

Secondary goal is to exploit the expected additional spectral capabilities of PACE/OCI in the NIR/SWIR to further improve the performance of the two-step approach

Atmospheric Gas Transmittance

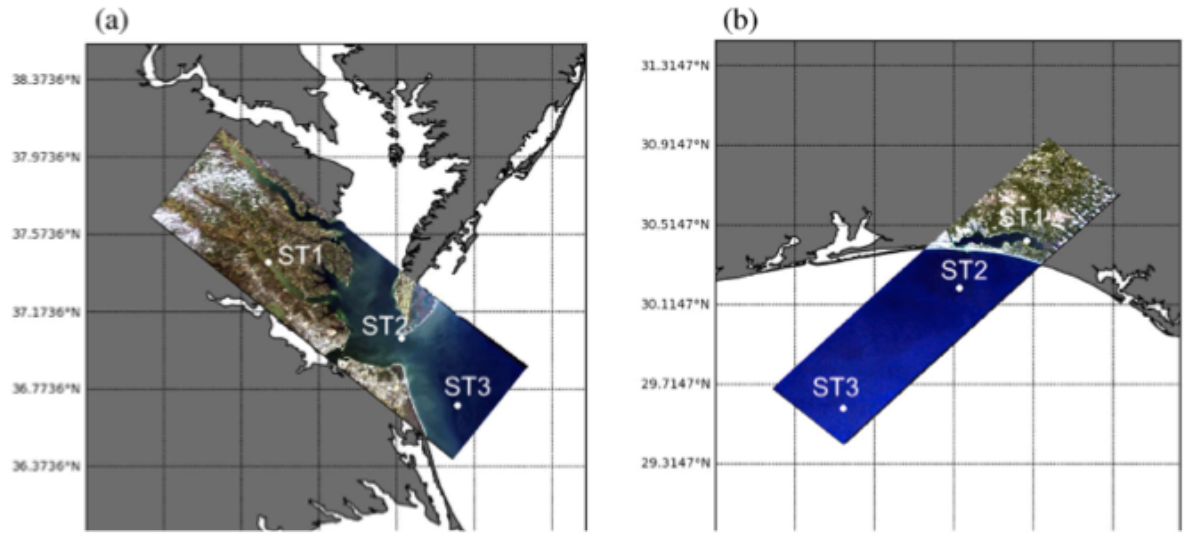


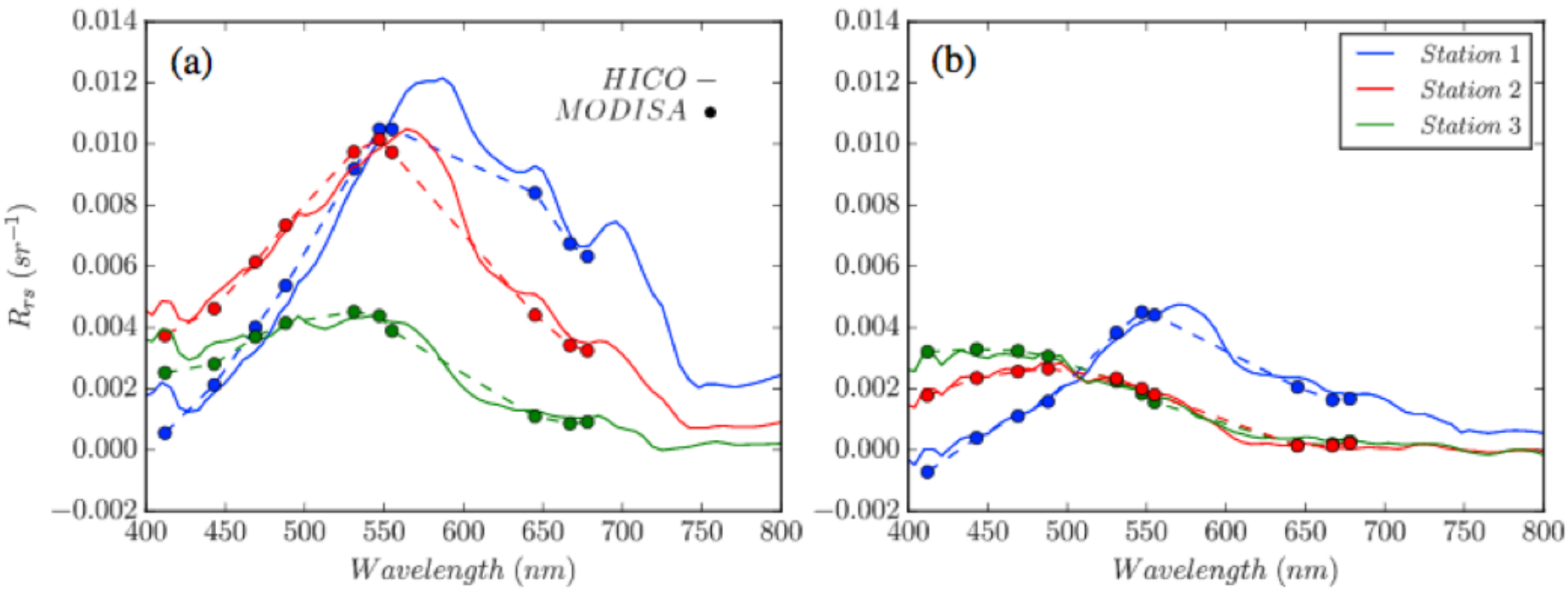
Line by line gas transmittance corrections based on ATREM code (Gao) were integrated into the NASA algorithm, implemented in l2gen.

Significant improvements in efficiency were also developed, making the method viable for application to a satellite swath with widely varying geometry.

Demonstration of HICO Hyperspectral Rrs(λ) Retrieval

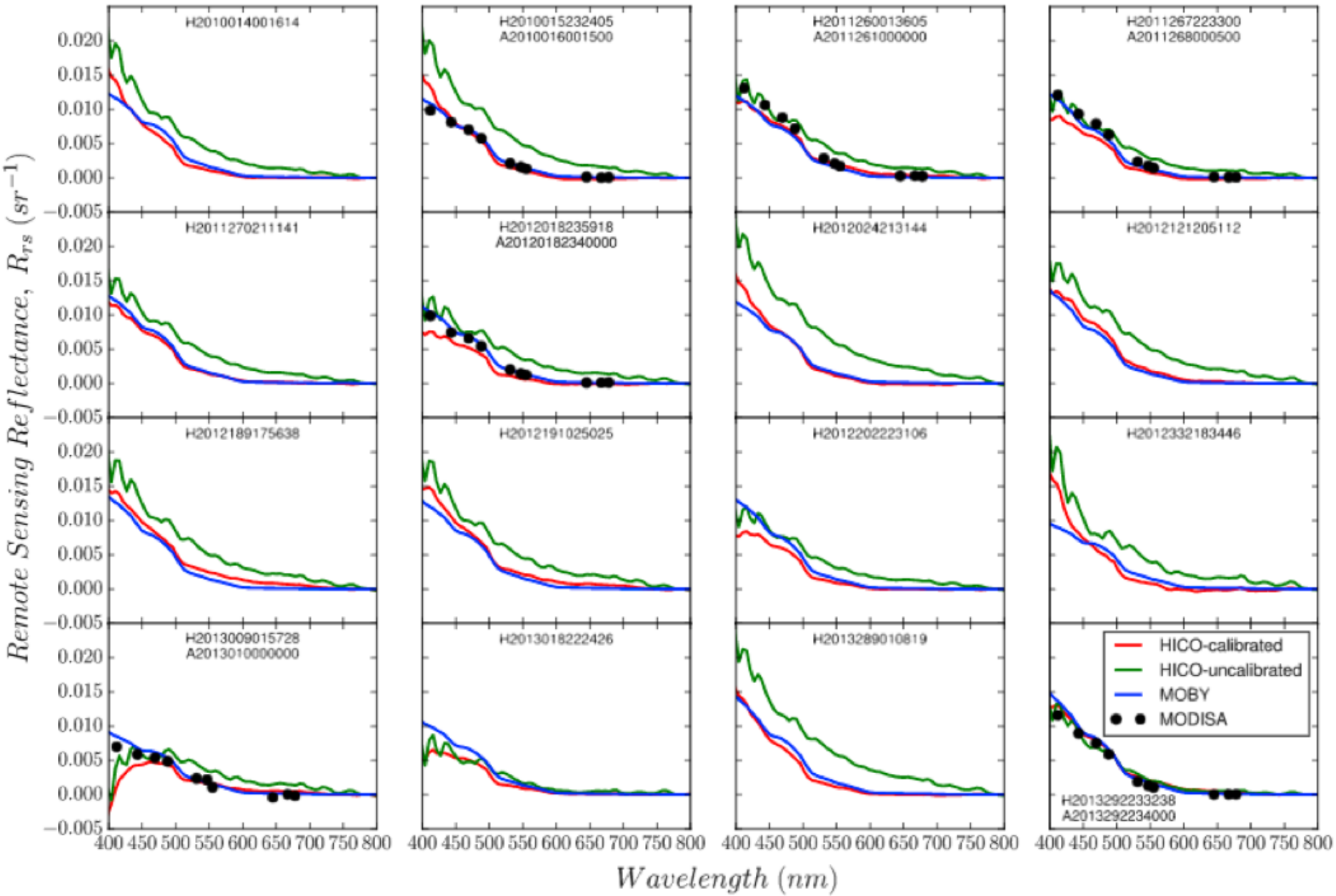
with comparison to MODIS/Aqua





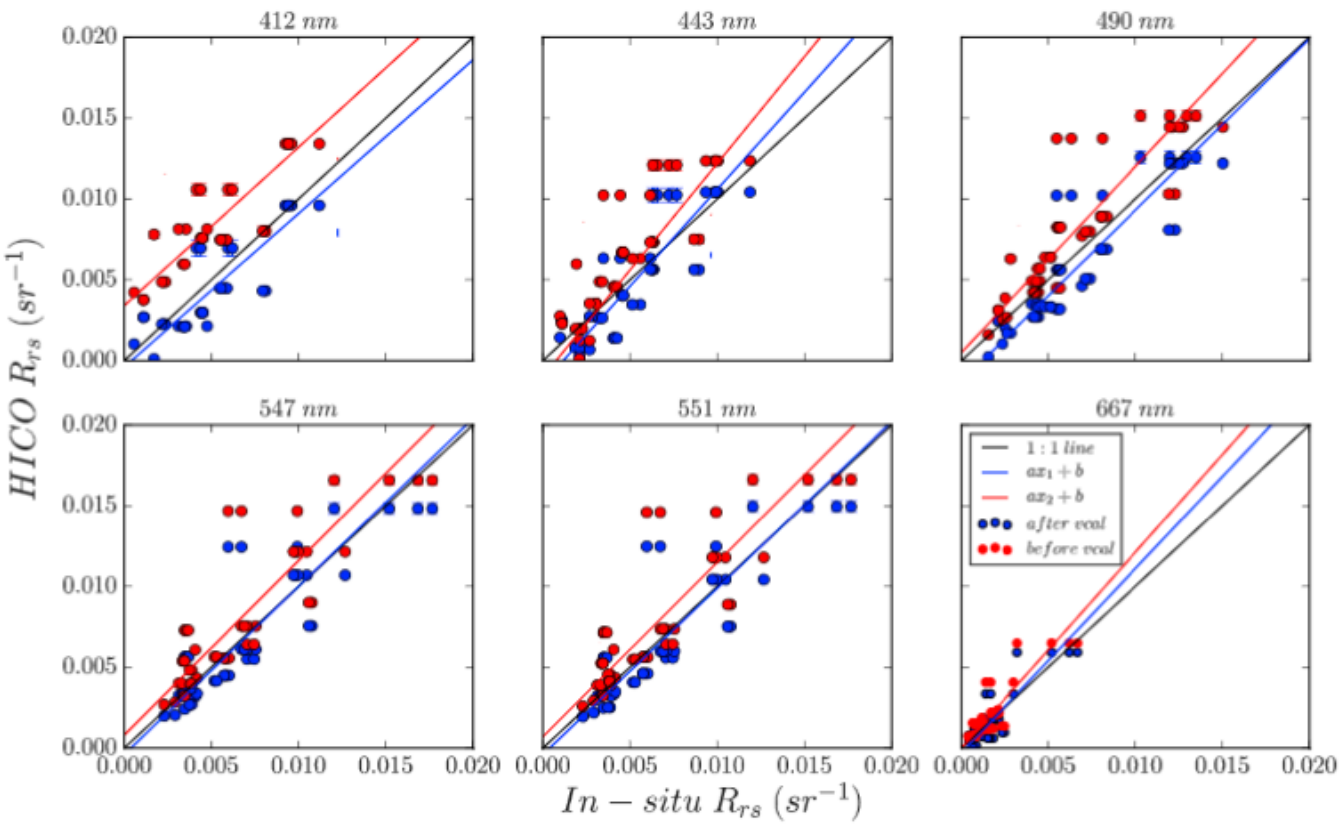
Demonstration of HICO Hyperspectral Rrs(λ) Retrieval

with comparison to MODIS/Aqua and MOBY (at MOBY site)



Validation of HICO retrievals relative to AERONET-OC

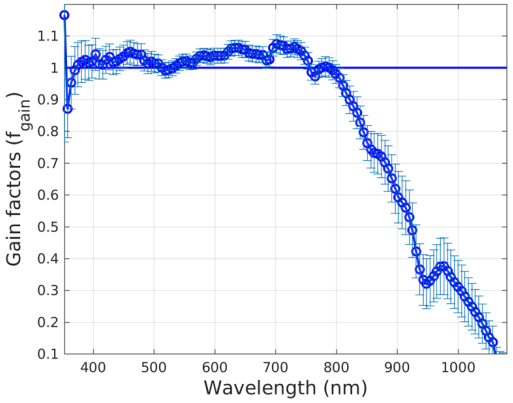
including influence of vicarious calibration at MOBY



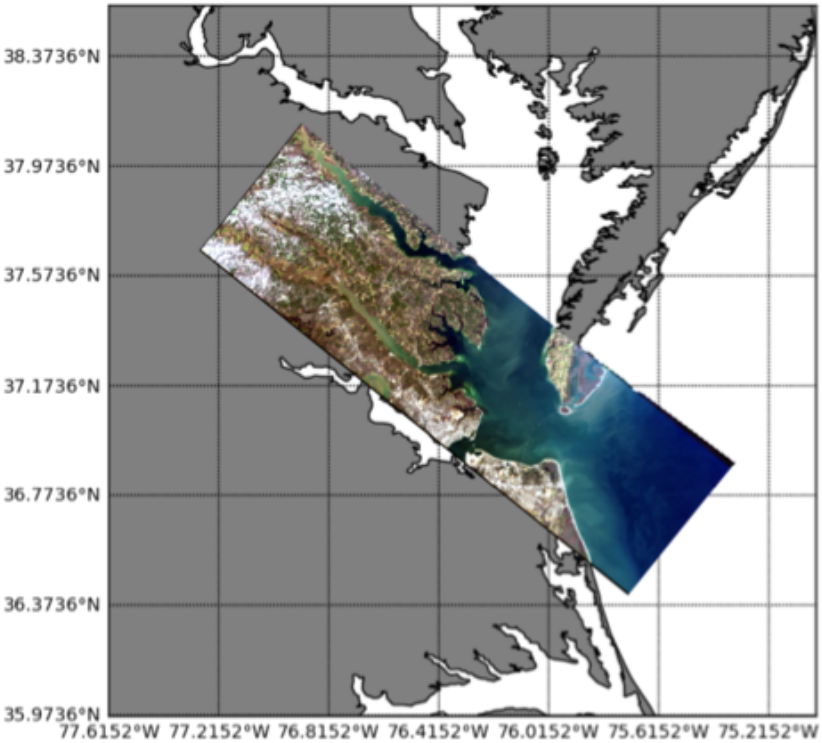
+/- 2 hour window

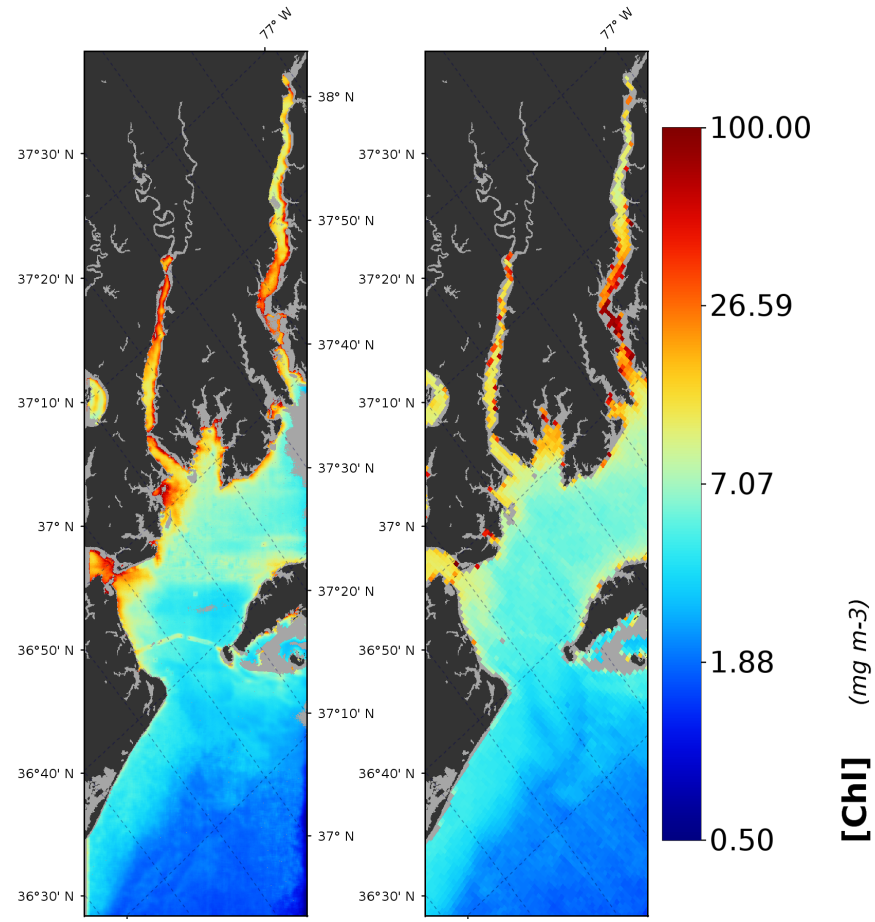
Parameter	Wavelengths (nm)					
	412	443	490	547	551	667
N	46	70	72	49	71	43
R2	0.71 (0.53)	0.63 (0.45)	0.80 (0.66)	0.77 (0.72)	0.76 (0.68)	0.75 (0.74)
RMSE	0.0065 (0.022)	0.0078 (0.0092)	0.0095 (0.01)	0.0016 (0.0086)	0.0034 (0.0088)	0.0003 (0.0023)
m	0.94 (0.96)	1.13 (1.29)	0.98 (1.03)	1.03 (1.09)	0.97 (0.98)	1.14 (1.21)
b	-0.0005 (0.003)	-0.0016 (-0.0004)	-0.001 (0.001)	-0.0004 (0.0006)	-0.0002 (0.0012)	-0.0003 (0.00001)

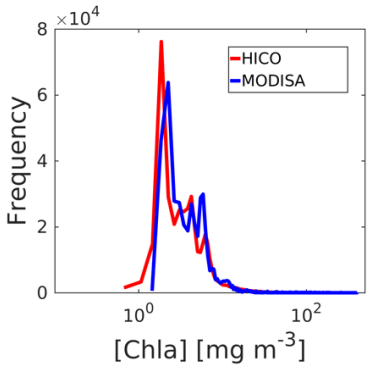
Vicarious Calibration Gains

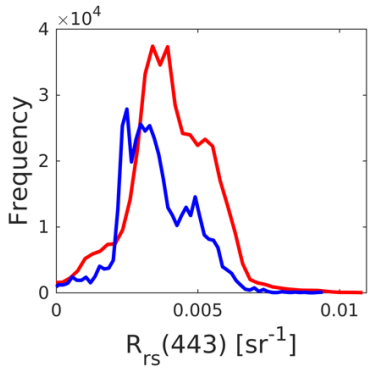


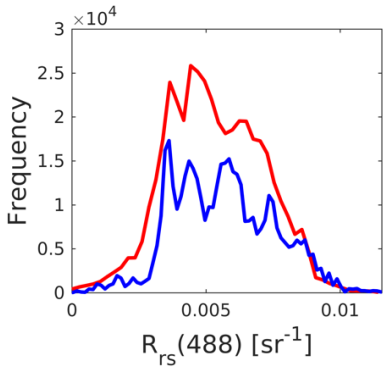
Verification of HICO retrievals relative to MODIS-Aqua

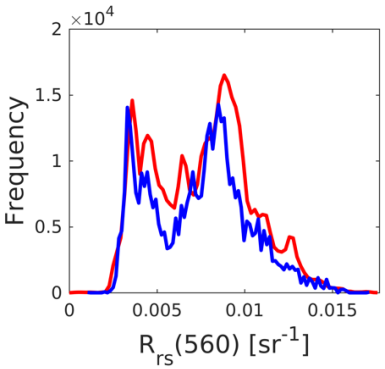




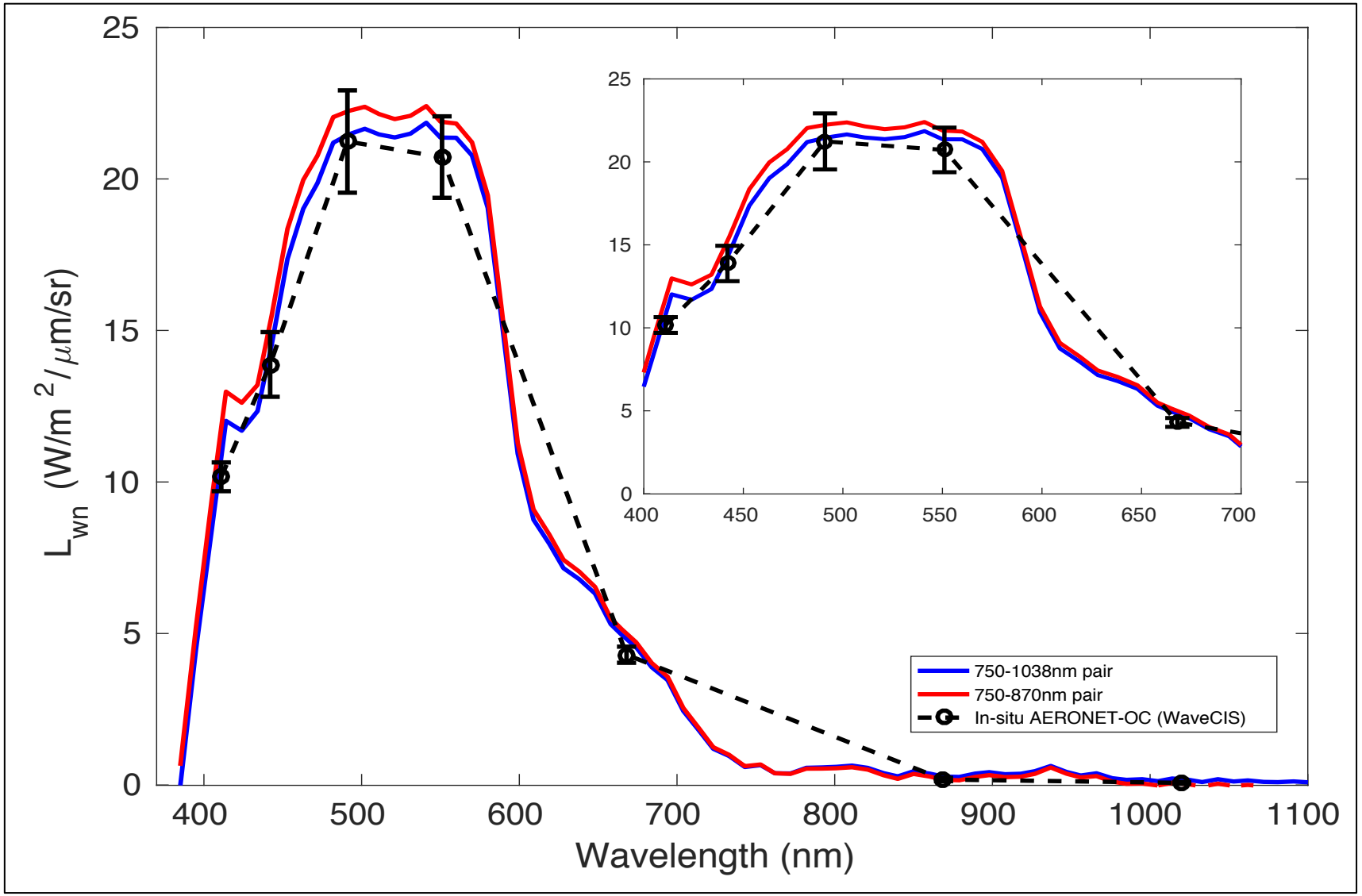








Validation of Hyperspectral Rrs(λ) Retrieval from AVIRIS over AERONET-OC (WaveCIS)



Advancing Heritage AC Algorithm
utilizing additional bands in NIR/SWIR

Use of additional bands in the NIR/SWIR spectral region (versus the traditional two-band approach) for aerosol model selection may:

1. reduce influence of noise in the aerosol contribution
2. improve identification of aerosol spectral shape
3. improve ability to separate atmosphere and water contributions in highly scattering waters

A spectral matching algorithm has been implemented, based on minimizing the least square error between observed and modeled aerosol reflectance in the NIR/SWIR spectral regime.

The algorithm has been implemented and tested for both OCIA (AVIRIS OCI proxy data) and MODIS Aqua (using 748, 859, 869, 1240, 1640, 2130 nm).

Approach has been shown to reduce uncertainty in Rrs retrievals, or to reduce SNR performance requirements on individual bands and still meet Rrs uncertainty requirements.

Summary of Accomplishments

- Adapted NASA standard atmospheric correction algorithm and code (l2gen) to support hyperspectral Rrs(λ) retrieval.
- Implemented retrieval and correction for atmospheric water vapor effects (integration of ATREM algorithm into l2gen).
- Developed hyperspectral processing and vicarious calibration capability for HICO and AVIRIS, as proxy for PACE OCI.
- Demonstrated a fully automated and computationally efficient hyperspectral ocean color retrieval capability as a viable option for PACE OCI at launch algorithm.
- Initiated advancement of the heritage AC algorithm to utilize additional OCI bands in the NIR and SWIR (spectral matching) for determination of aerosol contribution.