Improving IOP measurement uncertainties for PACE ocean color remote sensing applications

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Collaborators: David McKee & Rudy Röttgers
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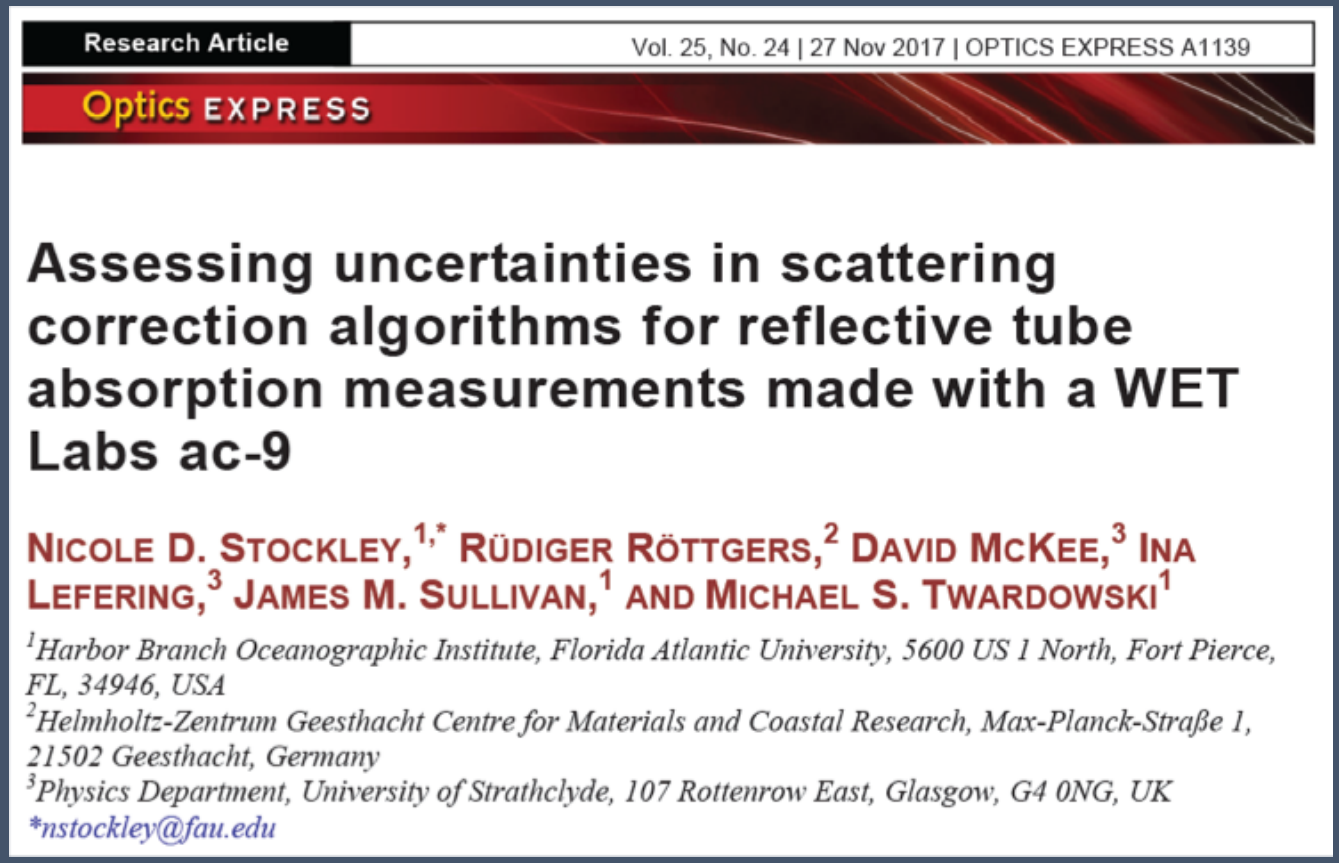
Project Objectives:

1. Quantify and improve uncertainties (scattering error) in absorption measurements using ac devices.

2. Determine uncertainties associated with different values of the depolarization ratio for pure seawater backscattering (b_{bsw}).

Project Results:

Objective 1. Quantify and improve uncertainties (scattering error) in absorption measurements using WET Labs ac devices.



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Assessing uncertainties in scattering correction algorithms for reflective tube absorption measurements made with a WET Labs ac-9

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Table 1. Summary of scattering correction methods.

Method	Description	Scattering error, $\varepsilon(\lambda)$
BL	Equation (3)	$a_m(\lambda_{ref})$
BL-IC	From Eq. (7), spectrally extrapolated using Eq. (3)	$a_m(715)-a_{IC}(715)$
BL-RR	From Eq. (6), spectrally extrapolated using Eq. (3)	$a_m(715)-0.212a_m(715)^{1.135}$
BL-VSF	From Eq. (8), spectrally extrapolated using Eq. (3)	$2\pi\int_0^{\pi}\sin(\theta)\beta(\theta,658)W(\theta)d\theta$
FRAC	Equation (4)	$F(c_m(\lambda)-a_m(\lambda))$
PROP	Equation (5)	$a_m(715)\left(\frac{c_m(\lambda)-a_m(\lambda)}{c_m(715)-a_m(715)}\right)$
PROP-IC	From Eq. (7), spectrally extrapolated using Eq. (5)	$(a_m(715)-a_{IC}(715))\left(\frac{c_m(\lambda)-a_m(\lambda)}{c_m(715)-a_m(715)}\right)$
PROP-RR	From Eq. (6), spectrally extrapolated using Eq. (5)	$\left(a_m(715)-0.212a_m(715)^{1.135}\right)\left(\frac{c_m(\lambda)-a_m(\lambda)}{c_m(715)-a_m(715)}\right)$
PROP-VSF	From Eq. (8), spectrally extrapolated using Eq. (5)	$\left(2\pi\int_0^{\pi}\sin(\theta)\beta(\theta,658)W(\theta)d\theta\right)\left(\frac{c_m(\lambda)-a_m(\lambda)}{c_m(650)-a_m(650)}\right)$

9 different forms of scattering corrections and > 30 actual corrections examined

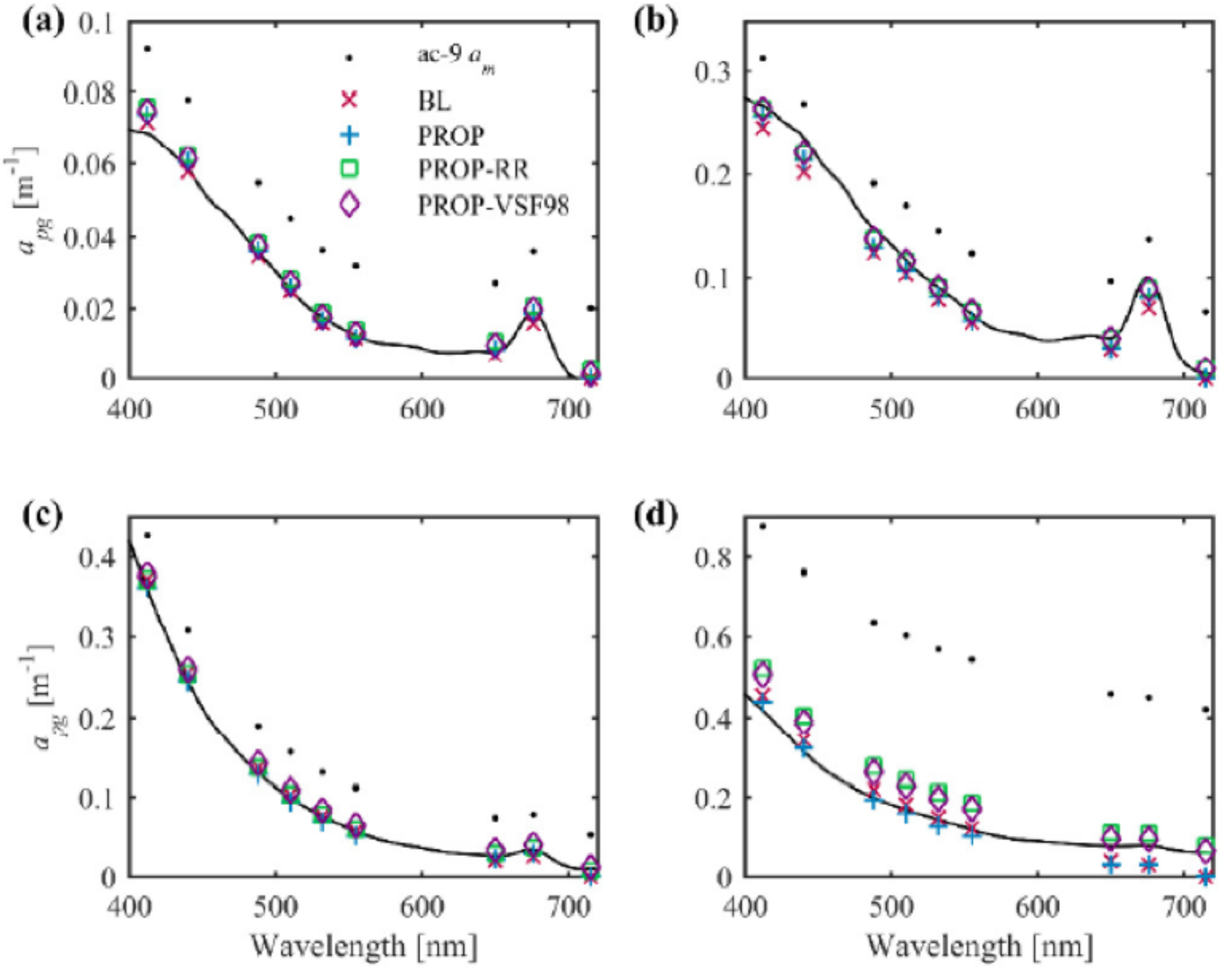


Fig. 5. Representative station from each of the four water type groups: (a) negligible $a_{pg}(716)$; (b) low $a_{pg}(716)$; (c) moderate $a_{pg}(716)$; (d) high $a_{pg}(716)$, showing the spectral fit for selected scattering correction methods. Solid line is the FWHM-weighted PSICAM a_{pg} spectrum.

Corrections applied to field data representing a wide array of water types

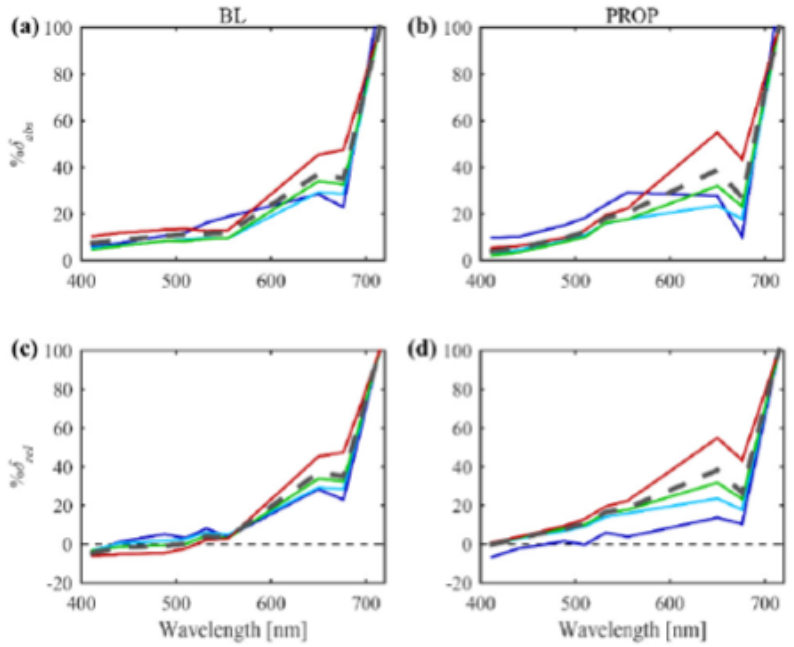


Fig. 6. (a) $\%\delta_{abs}$ for BL method; (b) $\%\delta_{abs}$ for PROP method; (c) $\%\delta_{rel}$ for BL method; $\%\delta_{rel}$ for PROP method. See Fig. 3 for color legend and text for group descriptions. Dashed gray line is for the entire data set ($n = 54$).

Relative and absolute spectral errors/uncertainties were examined for all scattering corrections

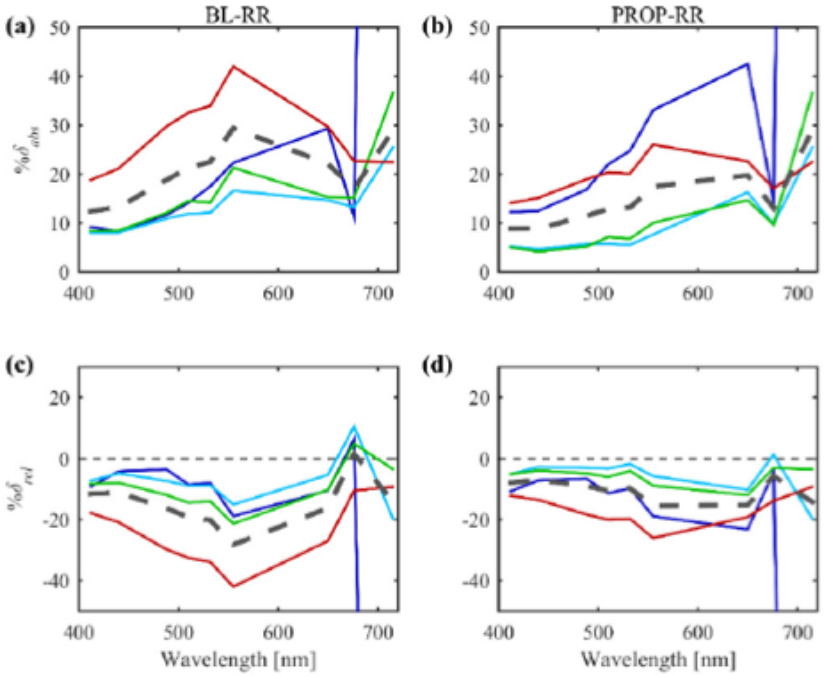


Fig. 8. (a) $\%\delta_{abs}$ for BL-RR method; (b) $\%\delta_{abs}$ for PROP-RR method; (c) $\%\delta_{rel}$ for BL-RR method; $\%\delta_{rel}$ for PROP-RR method. See Fig. 3 for color legend and text for group descriptions. Dashed gray line is for the entire data set ($n = 54$).

Conclusions

There is currently no single scattering correction that will “perfectly” apply in all water types.

Two scattering correction methods performed best: a modified proportional correction that integrates an empirical relationship for absorption at the scattering correction wavelength (originally based on work by collaborator Röttgers), and an independent correction derived from concurrent VSF measurements.

Even the best performing scattering correction methods could have residual errors of 20% or greater with varying spectral dependencies.

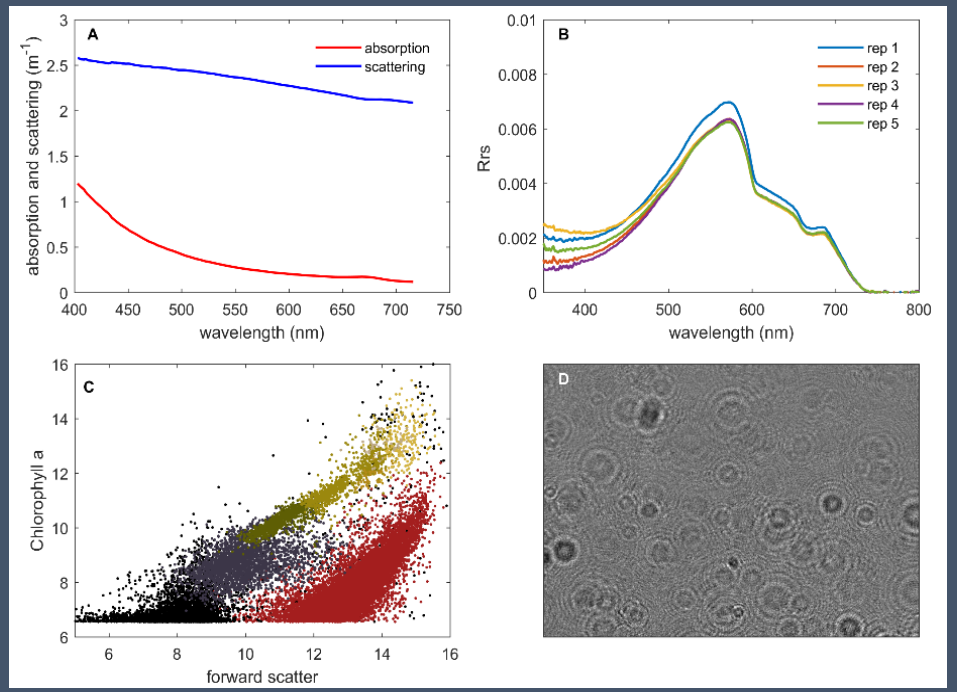
Further effort is needed to develop and evaluate empirical or independent corrections, however, a concurrent approach of developing new *in situ* instrumentation with minimal scattering errors should be pursued.

Absorption closure cruise

When and Where: January 2017 - southeast coast of Florida

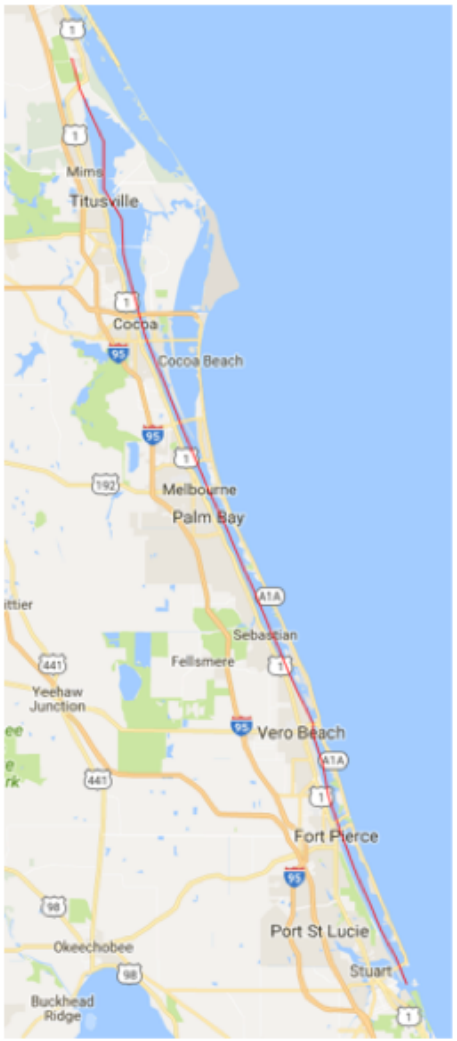
Who: Drs. Sullivan, Twardowski, Roesler, Stramski, McKee & Röttgers

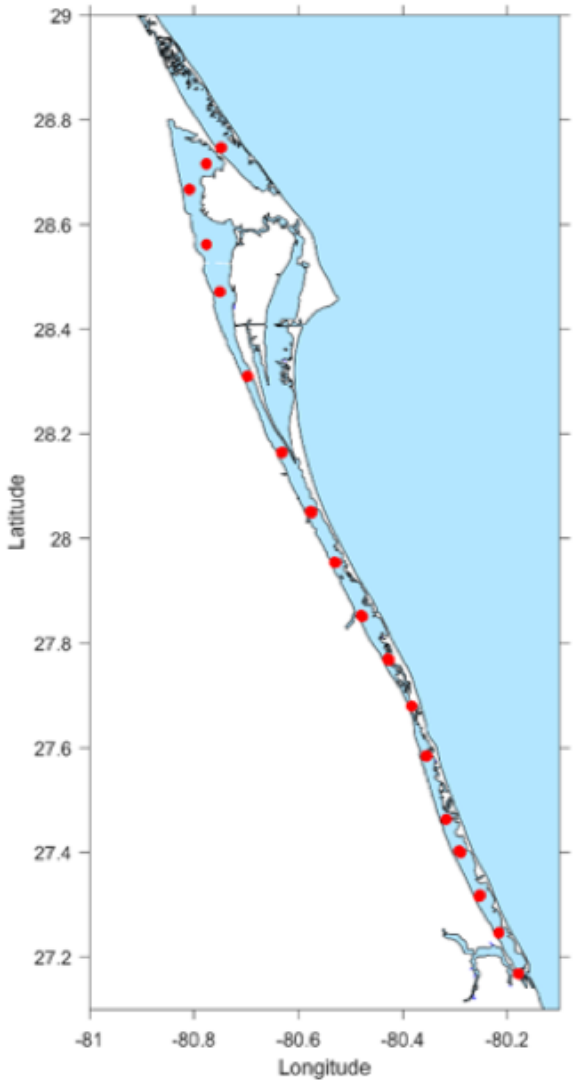
What: side by side comparison of current state-of-the-art methods to determine the absorption coefficient (ac devices, PSICAM, ICAM, filter pad, AOP inversion) over a large gradient of conditions.



Data analysis and synthesis on-going

NASA G-LiHT flight support – March 2017





NASA G-LiHT flight track over the Indian River Lagoon (left panel) and concurrent in situ IOP measurement stations in support of the flight (right panel).

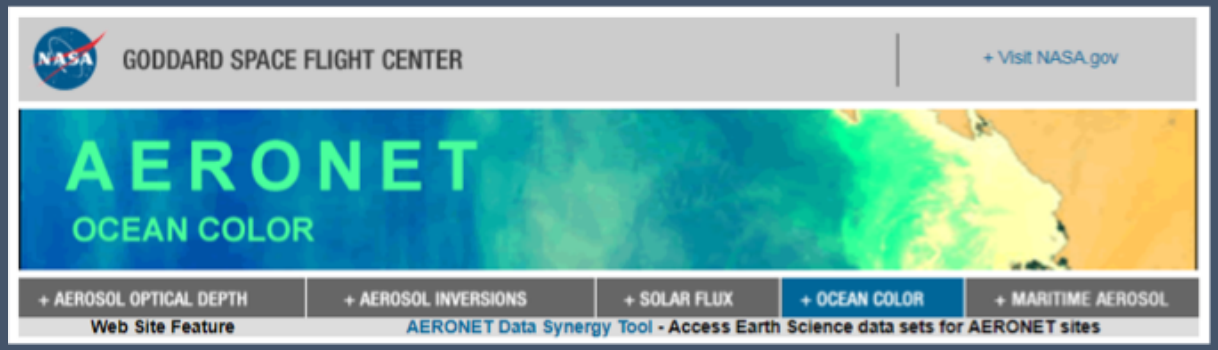
Collaboration with Drs. Nima Pahlevan and Bruce Cook

Coordinated timing of NASA G-LiHT overflight, Landsat 8 overpass and *in situ* IOP measurements in the Indian River Lagoon

Data sets could be useful to PACE project

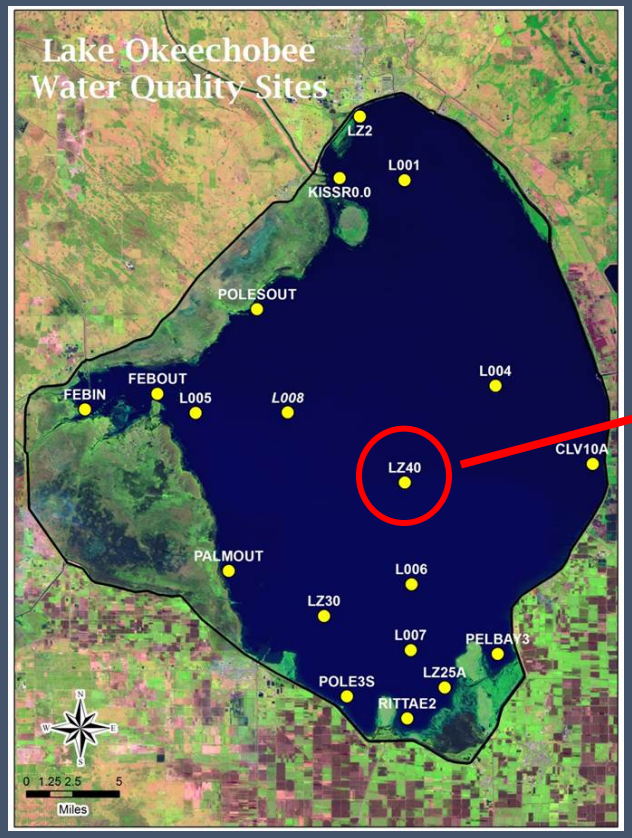
Data analysis and synthesis on-going

Establishing a new AERONET OC site
Lake Okeechobee, FL – starting ~ April 2018



Collaboration with Drs. Nima Pahlevan (NASA) and Tim Moore

Data stream could be useful to future PACE projects



Location: LZ40 water quality tower

Project Results:

Objective 2. Determine uncertainties associated with different values of the depolarization ratio for pure seawater backscattering (b_{bsw}).

Article

The impacts of seawater depolarization on optical properties retrieved from semi-analytic algorithms in the South Pacific Ocean

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‡ These authors contributed equally to this work.

See the second short PowerPoint presentation by Co-PI Moore addressing these results


See you soon!
tobs2005