Improving IOP measurement uncertainties for PACE ocean color remote sensing applications

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HARBOR BRANCH
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Proposed research:

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 ($b_{bsw}$).
Proposed research:

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

AC-S (hyperspectral)
LVF filter split (~ 550 nm)
LVF registration errors (4 - 5 nm)
LVF $\lambda$ bandwidth smoothing (14 – 19 nm FWHM)

AC-9 (multispectral)
IF $\lambda$ bandwidth smoothing (10 nm FWHM)

AC-S & AC-9
instrument calibration drift (PW blank, internal T)
$c$ acceptance angle (0.93°) (~ 20 - 30% underestimate of “$c$”)
$a$ scattering error (overestimate, ~ 20% of “$b$”)
“$b$” ($c - a$) can easily be 50% lower than actual $b$
1. Quantify and improve uncertainties (scattering error) in absorption measurements using ac devices.

\[ TIR = 41.7^\circ \]

\[ \varepsilon = \int_0^{\pi \ (180^\circ)} 2\pi \sin(\theta) \beta(\theta) \, d\theta \]

\[ \theta_{TIR} \ (41.7^\circ) \]
1. Quantify and improve uncertainties (scattering error) in absorption measurements using ac devices.

~ 5 - 6 correction methods

- baseline subtraction using ref $\lambda$ (Zaneveld 1)
- constant % of $b$ (Zaneveld 2)
- % of $b$ using ref $\lambda$ (Zaneveld 3)
- ref $\lambda$ with % absorption removed (Röttgers)
- iterative with $b_b/b$ (McKee)
- independent with VSF (Twardowski)

No community consensus

issues:

- $a$ at ref $\lambda$
- spectral dependency ($b$, VSF)
- $a$ tube reflectivity variability
Reflectivity of a flow tubes

McKee et al. 2013

variable $a$ with different aged flow tubes

theory: reflectivity decreases with age/use (96 – 98%)

Need to confirm/quantify reflectivity variability
BaSO$_4$ experiments (non-absorbing scattering solution)

- 2-3% methodological uncertainty
- 5% max reflectivity difference (new vs old)
- probable 2-3% reflectivity reduction for used tubes

$\varepsilon \sim 18 - 21\%$ of total $b$

~60% reduction
North Sea data comparisons

>30 different scattering correction methods compared with independent validation of absorption (56 stations).

PSICAM (Röttgers) integrating cavity (no scattering error)
North Sea data comparisons

<table>
<thead>
<tr>
<th>NAME</th>
<th>TYPE</th>
<th>METHOD</th>
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<tbody>
<tr>
<td>RZ1</td>
<td>baseline using ref</td>
<td>Zaneveld 1</td>
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<td>RZ1-RR1</td>
<td>baseline w/ ref a corr</td>
<td>Zaneveld 1 MOD</td>
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<tr>
<td>RZ2-5</td>
<td>variable percentage</td>
<td>Zaneveld 2</td>
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<td>RZ2-10</td>
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<td>RZ2-18</td>
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<td>RZ3</td>
<td>proportional</td>
<td>Zaneveld 3</td>
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<td>RZ3-RR1</td>
<td>proportional w/ ref a corr</td>
<td>Zaneveld 3 MOD</td>
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PSICAM (Röttgers) integrating cavity (no scattering error)

Independent correction with concurrent VSF measurements & tube $W(\theta)$
Scattering corrected ac data - best fits to PSICAM

**depth = 5.1 m**

- **psicam**
  - $\lambda$ (AC9-271)
  - $a_{\text{pg}}$ (m$^{-1}$)

- **psicam**
  - $\lambda$ (ACS-19)
  - $a_{\text{pg}}$ (m$^{-1}$)
Scattering corrected ac data - best fits to PSICAM

depth = 5.6 m

\[ \text{psicam}_{716} = 0.062 \]
This year:

Continue ac data analysis – best practices for community
develop paper dealing with ac methods and uncertainties

Validation of ac corrections with independent measurements
leverage more data collections…
ICAM, PSICAM, OSCAR, filter pad

Depolarization ratio work - understand uncertainties in retrievals
related to uncertainties in pure water backscattering

Participate with subgroups

* NASA VSF protocols