PACE Science Team: Atmospheric Correction over Bright Water Targets with Non-negligible Radiances in the Near Infrared

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What causes “Bright Water”

- Whitecaps & Foam
- Sea Ice
- Floating Vegetation
- Floating Plastics etc..
- Bubbles
- Cyanobacteria, Trichodesmium, Red Tides
- Sediment (turbid water)
- Calcite (PIC): Coccoliths
- Seafloor (Optically Shallow)
Floating Vegetation: Seagrass Wrack

Dierssen et al. submitted RSE
What can appear like “Bright Water”, but isn’t water at all

- Thin Clouds
- Atmospheric dust
- Sun Glint
- Land/Ocean Adjacency
Current NASA AC processing removes highly reflective waters

Glint, Whitecap, and Rayleigh first

Cloud Mask

Aerosol Retrieval

Glint & Mod. Whitecap removed

Low/Moderate Remains

Very High Removed

Low Residual Remains

Mod High Backscattering Removed

Errors are not simple “quantitative” numbers.
Error of Omission excluding from one category
Error of Commission adding this stream to another category
2 - Algorithm Description

Inputs:

- Two-band approach
  - $nLw(443)$
  - $nLw(550)$
- Three-band approach
  - Spectral top-of-atmosphere reflectances
  - Reflectance due to Rayleigh scattering in the absence of aerosols
  - Diffuse transmittance of atmosphere from sun to sea surface and from sea surface to sensor
  - Three wavelengths from avelengths from $\sim 670$ to $\sim 865$ nm
- The 3-band method is implemented when the 2-band method fails.

Output:

- $pic$, the concentration of particulate inorganic carbon in mol m$^{-3}$
Example of “Bright Water” being masked
Chlorophyll

Fluorescence Line Height

PIC

Aerosol Optical Thickness 865 nm
Windspeed is not an accurate predictor of Whitecap coverage

Photo by Scott Freeman

Field Experiments:
UCONN
Rrs (350-2500 nm) above water
In-water reflectance
LISST
Critical angle backscattering

Data from Chris Zappa
760-780 nm oxygen absorption feature

Wood Fjorden Svalbard
Bubbles separate from whitecaps

(1) Strongly enhance the upwelling irradiance field (Stramski and Tegowski, 2001)

(2) Bubble mediated gas transfer of low solubility gases (Broecker, 1983; Woolf & Thorpe, 1991)
Bubbles (Stage B whitecaps)
Implement more nuanced masks and screens

• Identify spectral features early:
  – Vegetation
    • Red Edge Reflectance (all concentrated vegetation)
    • Chlorophyll fluorescence peak
  – Sediments
  – Glint using water, oxygen or other absorption features
  – “White” objects need to be discriminated
    • Whitecaps, Sea Ice, PIC