BO session: Phytoplankton Diversity from Remote Sensing

Synthetic data sets from modelling with Hydrolight, GIOP and coupled atmosphere-ocean RTM SCIATRAN

Astrid Bracher\(^1,2\), Hongyan Xi\(^1,3\), Aleksandra Wolanin\(^1,4\), Martin Hieronymi\(^3\), Rüdiger Röttgers\(^3\)

\(^1\) Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research, Bremerhaven, Germany
\(^2\) institute of Environmental Physics, University of Bremen, Bremen, Germany
\(^3\) Institute of Coastal Research, Helmholtz-Zentrum Geesthacht, Geesthacht, Germany
\(^4\) Helmholtz Center Potsdam, GFZ German Research Center for Geosciences, Potsdam, Germany
HydroLight simulated hyper. Rrs for phytoplankton group identification (Xi et al., 2015, 2017)

- Main goal is to identify dominant phytoplankton groups in natural waters
- C2X database – HydroLight simulated with 100,000 diverse water optical conditions with five phytoplankton groups included

Approach test with in-situ datasets

Successful at most optical occasions except for waters
- with low phytoplankton contribution to the total non-water absorption
- dominated by non-algal particles
GIOP – Ocean color Inversion models for PFT retrieval with synthetic Rrs (hyper- / multi-spectral)

GIOP for retrieving diatoms and noctiluca (Werdell et al. (2014))

Spectral band requirements for PFT retrievals (Wolanin et al. 2016)

1. Hyperspectral data most beneficial for multiple PFTs
3. No single bands setting led to best retrievals for all PFTs.
4. Adding bands to OLCI to enable optical retrievals of this 3 PFTs
5. Choice of band settings depends on chosen method/internal variability of the dataset/different PFTs (drive different spectral changes)

- Able to separate the N. miliaris and diatoms;
- Biased absolute estimates even under perfectly controlled conditions.
Coupled ocean-atmosphere RTM for testing sensitivity of hyperspectral PFT retrievals: Examples SCIATRAN used for PhytoDOAS*

SCIATRAN
Rozanov et al. 2002, 2014 & 2017
http://www.iup.uni-bremen.de/sciatran/
Spectral range: 0.18–40μm

Rayleigh scattering
Absorption & scattering by aerosols & clouds
Absorption by gases
Surface effects (roughness)
Particle scattering
Elastic & inelastic scattering and absorption of water
CHL & DOM fluorescence
CDOM, CHL or PFT-CHL absorption
Ocean-Atmosphere interaction

Effec of variation in solar zenith angle

doi.pangaea.de/10.1594/PANGAEA.870486

Summary

• Major achievements
  – Synthetic data can represent well various optical conditions with multiple phytoplankton groups
  – PFT identification using synthetic data (e.g. HL) sets is possible
  – RTM is an effective way to test the sensitivity of PFT retrieval from hyperspectral data

• Gaps and questions
  – Though under well controlled conditions, absolute quantitative PFT retrievals remain challenging
  – Spectral resolution: band study shows the spectral requirements to obtain PFT from ocean colour data are beyond current multispectral sensors specifications
  – Limited knowledge of backscattering properties of PFTs. Complete data set for $b_{bph}$ measurements from various phytoplankton types?
  – High similarity in $a_{ph}$ spectra from different phytoplankton groups limited the capability of semi-analytical algorithms (e.g. GIOP) in accurately decomposing the phytoplankton absorption, resulting in unstable retrievals with > 2 PFTs as unknowns
  – Determination of $a_{ph}^{*}$ for phytoplankton groups ($a_{ph}^{*} = a_{ph}/C_{chl-a}$): amplitude influenced by $C_{chl-a}$?
  – Satellite hyperspectral data versus synthetic data