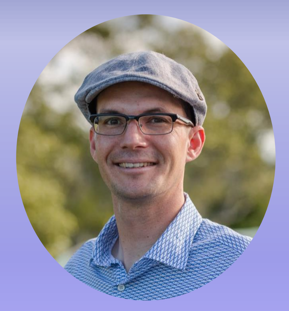

Support for the evolution of IOP retrievals in the PACE era

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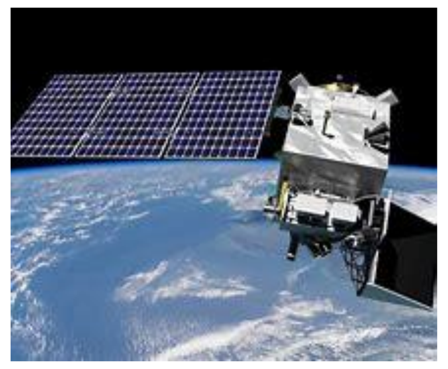
IOPs and Ocean Carbon From Space

Satellite-derived inherent optical properties (IOPs; spectral absorption and scattering coefficients) are used as inputs to models that estimate marine parameters such as: primary productivity, particulate organic carbon, and phytoplankton community composition.

The continual improvement of IOP algorithms (*diagram to the right*) is thus critical to the study of ocean carbon.

The PACE Mission



NASA's Plankton, Aerosol, Cloud, ocean Ecosystem (PACE) mission will carry the first dedicated global hyperspectral ocean color radiometer, the Ocean Color Instrument (OCI), as well as two multi-angle polarimeters (SPEXOne and HAPR2). PACE is scheduled to launch in early 2024.

For the PACE era, NASA will extend beyond legacy IOP algorithms and consider innovative methods that take advantage of PACE's advanced capabilities.

Table 1: Required OCI IOP Data Products
Phytoplankton absorption (400 – 600 nm) [units: m^{-1}]
Non-algal particle plus dissolved organic matter absorption (400-600 nm) [units: m^{-1}]
Particulate backscattering coefficient (400 – 600 nm) [units: m^{-1}]

Uncertainties for each IOP data product are also to be produced.

Identify PACE Mission Capabilities

- Hyperspectral radiometry: 340 – 865 nm, 5nm resolution
- 7x SWIR channels
- UV capabilities
- Multiangle polarimetry

Review Required Data Products

Required IOP products (see Table 1)

Example desired data products

- CDOM absorption
- Particulate backscattering slope

Review Legacy Algorithm(s)

Algorithm:
- Generalized Inherent Optical Properties Framework (GIOP) [1]
- Semi-analytical spectral matching algorithm

Model configuration:
- Default parameterization per [1]

Recent features/improvements:
- Temperature-salinity dependent b_{bw} [2]
- Raman scattering correction per [3]
- Optically shallow flag introduced [4]
- Improved standard uncertainty estimates [5]

Identify New Contributions

PACE Science and Applications Team (Sat)

D. Stramski (Scripps/UCSD)
- *Partitioning the absorption coefficient*

M. Twardoswki (HBOI/FAU)
- *ZTT semi-analytical inverse model*

B. Barnes (USF)
- *Optically Shallow water*

N. Pahlaven (SSAI/NASA GSFC)
- *Optically complex freshwater*

Other community innovations
- *Optimal estimation*
- *Bayesian approaches*
- *Machine Learning*
- *Coupled atmosphere-ocean retrievals*

1. Discover Improvement potential

2.Analyze The Current Methods

3. Generate Original Ideas

4.Develop an Implementation Plan

5.Implement the Plan

6. Evaluate the New Method

IOP Product Evolution as a Continual Improvement Concept

PACE Science Data Product Selection Plan I

Formal NASA procedure for Science Data Product Lifecycle [6]

- Product Change Request (PCR) is Submitted
- The Science Operations Team (SOT) review type of change (minor of major) and determine
- If enough information is provided, the SOT authorized testing by the PACE Science Data Segment (SDS)

PACE Science Data Product Selection Plan II

SDS performs preliminary assessment

- Test product is generated
- SOT works with Contributor to collect Product and Algorithm Description Document (PADD)
- Resource requirements identified
- Preliminary assessment is provided to Science Operations Board (SOB)

PACE Science Data Product Selection Plan III

The SOB reviews test product, including:
- PCR, PADD, and associated materials
- The computing resources required to generate a product

Following a positive review, the SOB authorizes the product to be generated as a "provisional" product by SDS.

The Approved Product List (APL) is amended to reflect the change.

Acknowledgments:
Support for this work was provided by the NASA Plankton, Aerosol, Cloud, ocean Ecosystem (PACE) Project.

Ocean Carbon From Space Workshop

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References:

[1] Werdell, P. J., et al. (2013). *Generalized ocean color inversion model for retrieving marine inherent optical properties*. Applied Optics, 52(10), 2019–2037. doi: 10.1364/AO.52.002019

[2] Zhang, X., et al. (2009*). Scattering by pure seawater: effect of salinity*, Opt. Express, 17(7), 5698–5710. doi: 10.1364/OE.17.005698

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[4] McKinna, L.I.W. and P.J. Werdell. (2018). *Approach for identifying optically shallow pixels when processing ocean-color imagery*, Opt. Express, 26(22), A915-A928. doi: 10.1364/OE.26.00A915

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[6] Werdell , P.J. and B.A. Franz . (2019). *PACE Science Data Product Selection Plan (Draft 1, 14 March 2019), NASA GSFC.*

Additional Reading:

Data Maturity Levels | Science Mission Directorate

PACE_Validation_Plan_DRAFT_version_13July

NASA PACE - Science and Applications Team

McKinna, L.I.W., et al. (2021) *Development and validation of an empirical ocean color color algorithm with uncertainties: a case study with the particulate backscattering coefficient*, JGR: Oceans, 126 (5) e2021JC01723, doi: 10.1029/2021JC017231

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