Workshop on "Recent advancements in remote sensing and modeling of aerosols, clouds and surfaces",
GRASP ACE Summer school,
Lille, France, May 22-26, 2023

Retrieving Water-body Reflectance and Marine Biogeochemical Properties with the GRASP Algorithm

Siyao Zhai[a*], Pavel Litvinov[a], Oleg Dubovik[b], Robert Frouin[c], Jing Tan[c]

[a] *GRASP-SAS, Villeneuve-d'Ascq, France*
[b] *Univ. Lille, CNRS, UMR 8518 – LOA – Laboratoire d'Optique Atmosphérique, 59000 Lille, France*
[c] *Scripps Institution of Oceanography, University of California, San Diego, La Jolla, CA, United States*

***Corresponding author e-mail**: **siyao.zhai@grasp-sas.com**

The Generalized Retrieval of Atmosphere and Surface Properties (GRASP) algorithm has been successfully used for inferring aerosol optical depth and microphysical properties from space-borne spectral multi-angle polarimeters [Dobuvik et al., 2011][Chen C. et al., 2020] and radiometers [Chen C. et al., 2022]. Although the focus has been on retrieving aerosol, the surface properties are retrieved simultaneously in GRASP.

The reflectance spectra of water contain rich information about the biogeochemical state of water. Parameters such as Chlorophyll concentration, particulate backscattering coefficients can be retrieved from water-leaving reflectance [Werdell J. et al., 2018]. These parameters are related to concentrations of phytoplankton and other underwater particles, and can be used for large-scale monitoring of water quality [Matthews M.W., 2014], estimating the global oceanic carbon sources and sinks [Cavicchioli et al., 2019][Behrenfeld et al., 2005], etc. Spectral multi-angle imagers and polarimeters such as POLDER and MODIS have been used to retrieve water-leaving reflectance and the biogeochemical parameters. Various future ocean color satellite missions such as Plankton, Aerosol, Cloud, ocean Ecosystem (PACE) also utilize spectral multi-angle polarimeters extensively [Chowdhary et al., 2019][Frouin et al., 2019].

GRASP inversion is based on the Multi-term Least Square Method (LSM) [Dubovik et al., 2021]. This unique approach unifies various forward models of surface and atmosphere, allows multiple a priori constraints and retrieves an extensive set of parameters. It is designed to take advantage of the excessive information content provided by spectral multi-angle polarimeters. Due to the flexible modular design of the algorithm, we can implement various bio-optical models for the water-leaving reflectance and select an optimal approach. Water-leaving reflectance, chlorophyll concentration, backscattering coefficient and other parameters can be retrieved. Validation against in-situ measurements and existing satellite products will be conducted. Analysis of the results on global open ocean, coastal waters and inland waters will be presented.

Keywords: retrieval algorithm, ocean color, aerosol

References

[1] Dubovik O, Herman M, Holdak A, Lapyonok T, Tanré D, Deuzé JL, et al. Statistically optimized inversion algorithm for enhanced retrieval of aerosol properties from spectral multi-angle polarimetric satellite observations. Atmospheric Measurement Techniques 2011;4:975–1018. https://doi.org/10.5194/AMT-4-975-2011.

[2] Chen C, Dubovik O, Fuertes D, Litvinov P, Lapyonok T, Lopatin A, et al. Validation of GRASP algorithm product from POLDER/PARASOL data and assessment of multi-angular polarimetry potential for aerosol monitoring. Earth System Science Data 2020;12:3573–620. https://doi.org/10.5194/ESSD-12-3573-2020.

[3] Chen C, Dubovik O, Litvinov P, Fuertes D, Lopatin A, Lapyonok T, et al. Properties of aerosol and surface derived from OLCI/Sentinel-3A using GRASP approach: Retrieval development and preliminary validation. Remote Sensing of Environment 2022;280:113142. https://doi.org/10.1016/J.RSE.2022.113142.

[4] Werdell PJ, McKinna LIW, Boss E, Ackleson SG, Craig SE, Gregg WW, et al. An overview of approaches and challenges for retrieving marine inherent optical properties from ocean color remote sensing. Progress in Oceanography 2018;160:186–212. https://doi.org/10.1016/j.pocean.2018.01.001.

[5] Matthews MW. Eutrophication and cyanobacterial blooms in South African inland waters: 10years of MERIS observations. Remote Sensing of Environment 2014. https://doi.org/10.1016/j.rse.2014.08.010.

[6] Cavicchioli R, Ripple WJ, Timmis KN, Azam F, Bakken LR, Baylis M, et al. Scientists' warning to

humanity: microorganisms and climate change. Nature Reviews Microbiology 2019. https://doi.org/10.1038/s41579-019-0222-5.
[7] Behrenfeld MJ, Boss E, Siegel DA, Shea DM. Carbon-based ocean productivity and phytoplankton physiology from space. Global Biogeochemical Cycles 2005;19:1–14. https://doi.org/10.1029/2004GB002299.
[8] Chowdhary J, Zhai PW, Boss E, Dierssen H, Frouin R, Ibrahim A, et al. Modeling atmosphere-ocean radiative transfer: A PACE mission perspective. Frontiers in Earth Science 2019;7:100. https://doi.org/10.3389/feart.2019.00100.
[9] Frouin RJ, Franz BA, Ibrahim A, Knobelspiesse K, Ahmad Z, Cairns B, et al. Atmospheric Correction of Satellite Ocean-Color Imagery During the PACE Era. Frontiers in Earth Science 2019. https://doi.org/10.3389/feart.2019.00145.
[10] Dubovik O, Fuertes D, Litvinov P, Lopatin A, Lapyonok T, Doubovik I, et al. A Comprehensive Description of Multi-Term LSM for Applying Multiple a Priori Constraints in Problems of Atmospheric Remote Sensing: GRASP Algorithm, Concept, and Applications. Frontiers in Remote Sensing 2021;0:23. https://doi.org/10.3389/FRSEN.2021.706851.

Preferred mode of presentation
☐ Oral
☒ Poster
☐ Either

Topic (check all that apply)
☒ Inversion algorithms - achievements and new ideas to derive aerosol, clouds and surface properties
☒ Characterization of aerosol, clouds and surface
☐ Modeling and inverse modeling of aerosol and clouds climatic effects
☒ Measurement synergy approaches
☐ *In situ* observations and field campaigns
☒ Upcoming and current satellite missions
☐ Other: if checked, enter description here