International Ocean Colour Science Meeting 2023

Advancing Global Ocean Colour Observations

Lidar applications for ocean color

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Breakout Workshop

IOCS

Friday 17 November 2023

Purpose of the Breakout Workshop

- To showcase what has been done so far with lidar through examples of successes in the field and from airborne, in-situ and satellite active sensors
- To discuss potential avenues for further advances for ocean applications
- To delve into the features that a future ocean-optimized Lidar
- Main focus will be in the instrumentation

Agenda

0:00-0:05	Introduction (Cédric Jamet)
0:05-0:20	Current international initiatives and collaborations (Cédric Jamet)
0:20-0:40	Ocean Color through Spaceborne lidar measurements: COLOR and CALIGOLA projects (Davide Dionisi)
0:40-1:00	Overview of the ocean capabilities of the space-borne lidars: CALIOP and ATLAS (Yongxiang Hu, NASA Langley)
1:00-1:20	Overview of the in-situ oceanic profiling lidar (Peng Chen/Dong Liu)
1:20-2:15	Discussions
2:15-2:30	Warm-up and Recommendations

Recommendations from previous IOCS

- 2015 - Increase the number of remote sensing observations over polar seas include: the use of geosynchronous satellites with inclined orbit (or other orbits permitting longer integration times in polar seas such as elliptical), Lidar technology and other means of measurements to complement ocean colour remote sensing (airborne radiometers, gliders, drones, unmanned autonomous vehicles).
- ~~2017 - Advocate for the enhanced version of MESCAL as the scenario that is the most interesting for doing new science (Lidar at 355 and 532 nm, fluorescence sensor, 3-m vertical resolution).~~
- 2019 - Encourage interdisciplinary collaboration between the modeling, atmospheric and the OC communities: numerical models, UV, LIDAR and multi-angle polarimetry to constrain the atmospheric correction
- 2019 - Develop capacities, such as numerical tools for Lidar simulation or "super sites", to obtain comprehensive and high-quality data to improve our understanding of "complex" waters

Recommendations on data and softwares

- Need to have **coupled atmosphere-ocean simulators** for lidar propagation (Hydrolight-like) freely available

- Need **open-source tools or codes** for processing L1 and L2 CALIOP and ATLAS data freely available (SeaDAS-like software)

- Need to make the **daily Ocean L1 and L2 CALIOP and ATLAS** archive available:
  - Need a portal to easily view and download the data (such as oceancolor.gsfc.nasa.gov)
  - **URGENT**

- Need to **share the current and past in-situ** (shipborne, airborne, fixed platforms) lidar measurements

Recommendations on in-situ lidar development

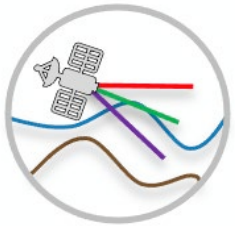
- Need to develop in-situ oceanic profiling lidar:
  - Collaborations with private companies
  - Need funding from space agencies to develop oceanic profiling lidar prototypes
  - Measurements up to the euphotic depth
  - Instruments to measure the back-scattering coefficient at 180°
  - Multi-wavelength : 355, 470, 532, 560 nm
  - Fluorescence profiles
  - Vertical resolution: ≤1 m
  - Temperature profiles
- Development of ground-based network of profiling sensors to validate future ocean spaceborne lidar and passive OC missions
- Better coordination with the atmospheric community for lidar development, scientific objectives and field campaigns

Recommendations on Training

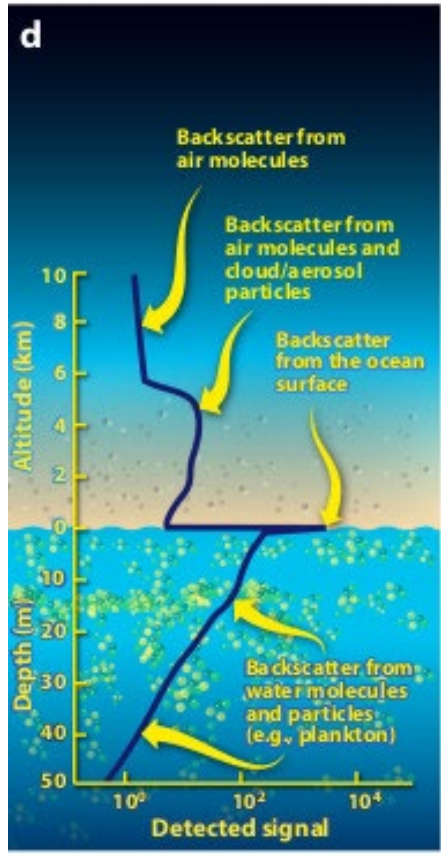
Strong interest to use lidar but lack of knowledge and training

- Session at conferences (Ocean Optics)
- Lectures at the IOCCG Lectures Series and Maine Summer School
- Fundamentals of lidar: principles, data processing
- Practical exercises to process the lidar data
- Courses on the components of a lidar: optics, electronics

❖ CALIGOLA



- CALIGOLA is a a **multi-purpose space LIDAR mission** developed by **ASI**. The goal is to launch the mission in the time window **2030-2031**
- **ASI-NASA** started an official **cooperation** with NASA Pre-Phase A study assigned to **LaRC**
- Development of a **state-of-the-art three-wavelength Raman LIDAR (355, 532, 1064)**, with ten or more acquiring channels, different vertical resolution for atmosphere and ocean echoes
- CALIGOLA will be the **first spaceborne lidar mission** designed to have **ocean observing capabilities**. This will represent a significant **advancement** for future ocean remote sensing satellite missions and the ocean science community



- oceanic particulate backscattering coefficient at 355 and 532 nm: $b_{bp\_355}(z)$, $b_{bp\_532}(z)$
- oceanic particulate depolarization ratio at 355, 532 nm: $\delta_{355\_OCE}(z)$, $\delta_{532\_OCE}(z)$
- oceanic diffuse attenuation coefficient for downwelling irradiance at 355 nm: $K_{d\_355}(z)$
- oceanic fluorescent coefficient (chlorophyll, plastic) at 450-460 nm: $\beta_{FL\_CHL}(z)$

Vertical resolution: 3-5 meters

Recommendations on space-borne oceanic profiling lidar

- Support of the participants of the BW for the ocean capabilities of CALIGOLA space mission

- Need for **endorsement of the OC community**

- **Need for endorsement of IOCCG and space agencies → URGENT**