Proposition for a new IOCCG WG on lidar for ocean applications

Proposed by

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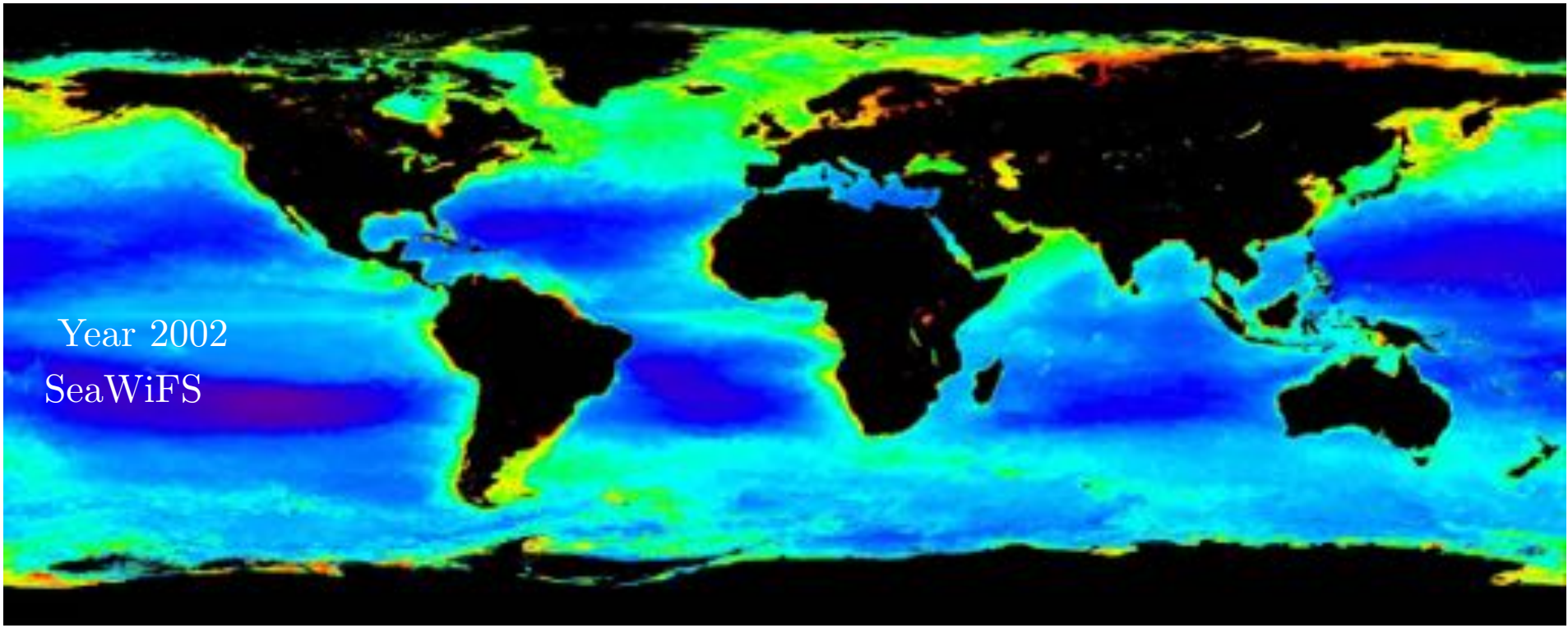
Remote Sensing of Ocean Color

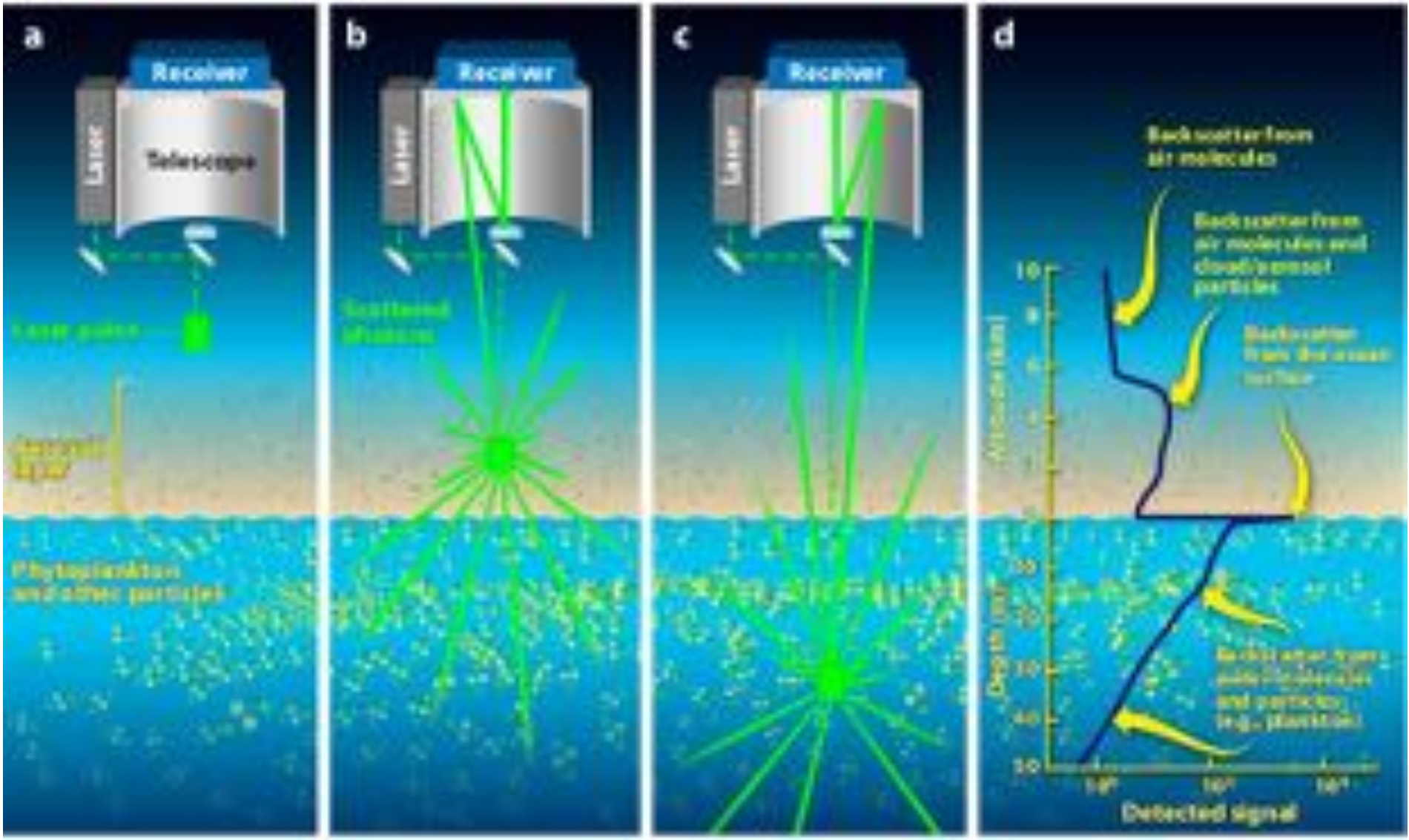
Space-borne observations of ocean color are the only tools to monitor at high spatial and temporal resolutions the bio-optical and biogeochemical parameters of the ocean



Limitations of ocean color images

- No night-time observations
- No observations over clouds and absorbing aerosols
- No observations for high solar angles$>$ 70° (high latitudes)
- Vertically-weigthed values over the water column
- No polarization

→ LIDAR



Hostetler et al. (2018)

Scientific applications

- Fisheries
- Scattering layer
- Bio-optical properties of the upper ocean
- Vertical structure of the upper ocean
- Air bubbles
- SST
- Bathymetry
- Internal waves

How to observe with lidar?

- Air-borne
- Ship-borne
- Space-borne

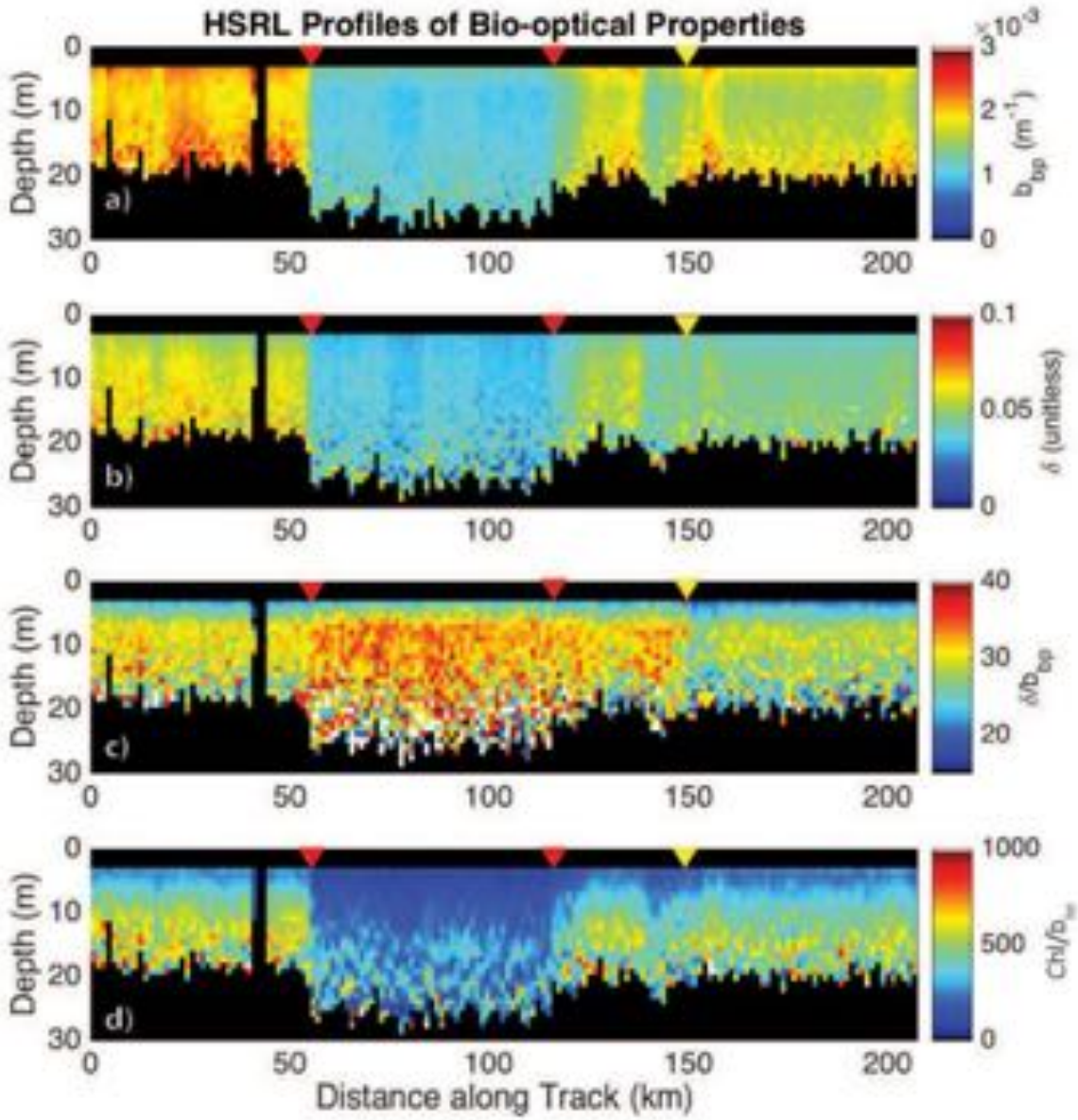
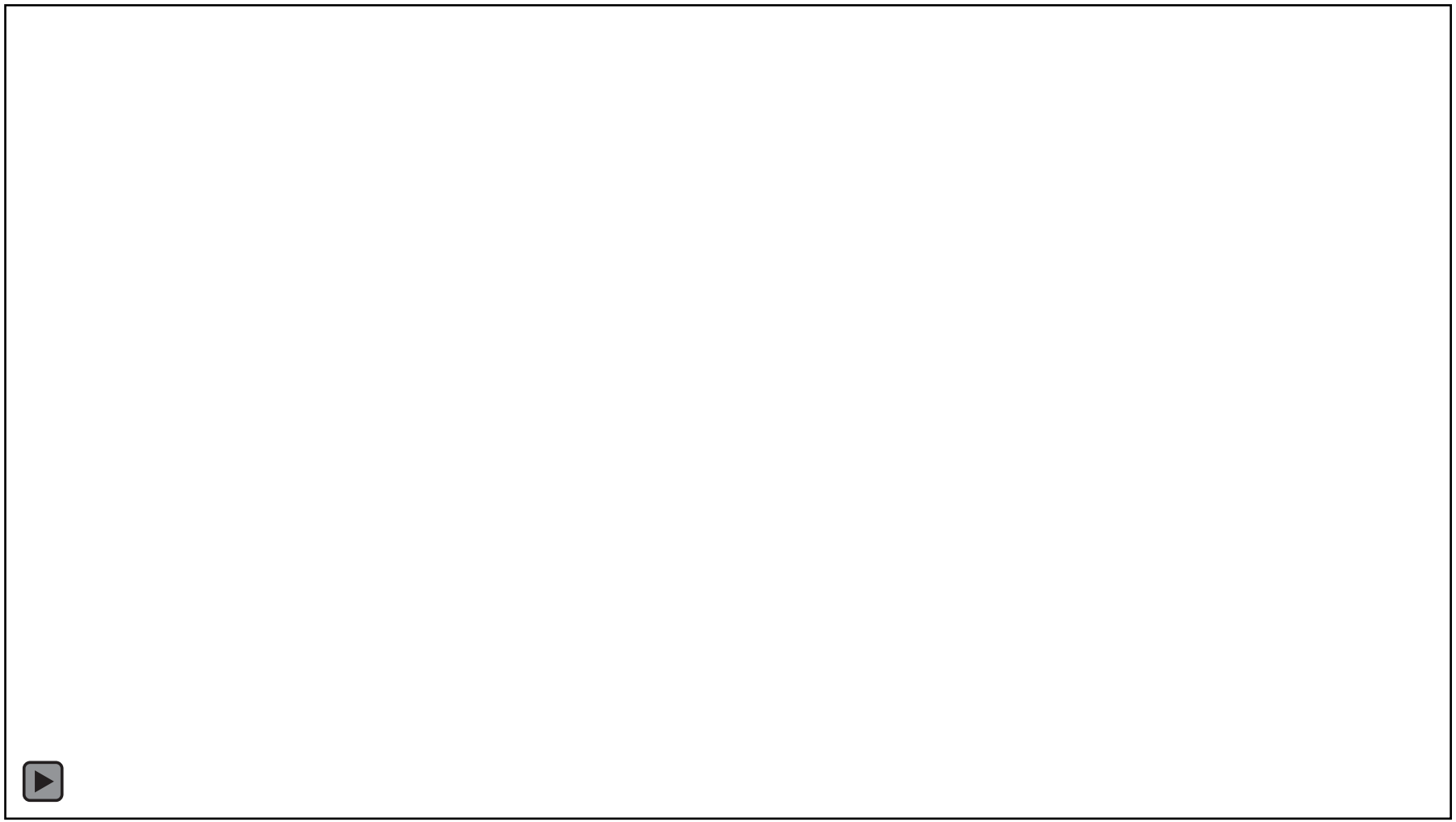


FIGURE 6 | HSRL measurements of **(a)** b_{bp}, m^{-1}; **(b)** the depolarization ratio, δ (unitless); **(c)** the ratio λ/b_{bp}; and **(d)** the *Chl*:b_{bp} ratio across the eddy. The red triangles mark the eddy core boundaries. The yellow triangle marks the boundary in the ratio, b_{bp}/λ. *Chl* was calculated as a function of K_d following Morel et al. (2007).

Schulien et al., 2020

LiDAR Remote Sensing for Vertical Distribution of Seawater Optical Properties and Chlorophyll-a From the East China Sea to the South China Sea

$b_{bp}(532)$



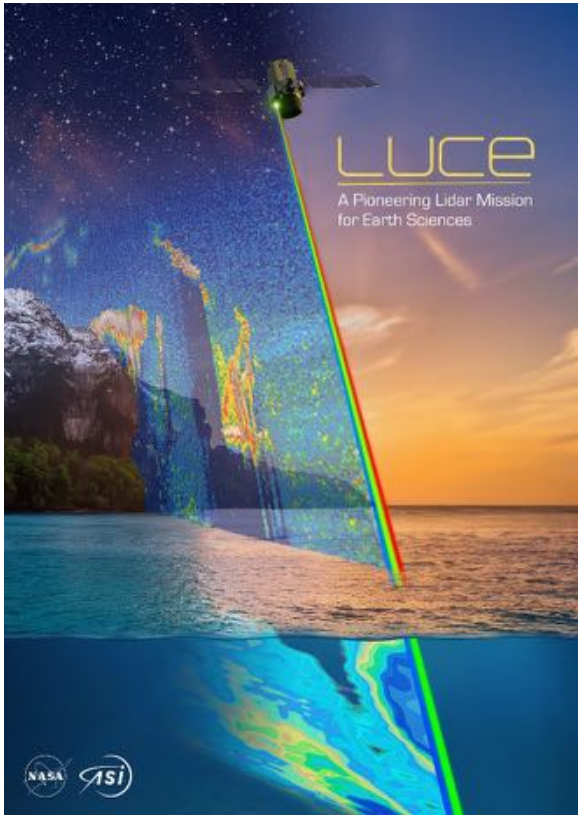
Chen, Jamet et al., 2022

Space-borne LUCE lidar mission

LUCE is an **interdisciplinary Earth Sciences mission** significantly advancing global knowledge on the coupled atmosphere-ocean-land system. The launch date is foreseen in the 2032 timeframe.

- **First spaceborne Raman-elastic-fluorescence lidar** enabled through a partnership between ASI and NASA.
- Provides **multi-wavelength vertical profile measurements** of atmospheric particles (aerosols) and clouds to better understand their roles in air quality, weather, and climate.
- Provides the **depth-resolved near-surface observations of the world's oceans** revealing unprecedented insights on the health and productivity of phytoplankton and zooplankton, their impact on fisheries, and role in Earth's carbon cycle.
- Offers **new land measurement capabilities** on natural and agricultural plant health and refined estimates of snow depth and snow water content.

LUCE 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



Vertical resolution: 1.25 meters

- 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: $d_{355\_OCE}(z)$, $d_{532\_OCE}(z)$
- oceanic diffuse attenuation coefficient for downwelling irradiance at 355, 532 nm: $K_{d\_355}(z)$, $K_{d\_405}(z)$, $K_{d\_532}(z)$
- oceanic fluorescent coefficient (chlorophyll) at 685 nm: $b_{FL\_CHL}(z)$

Term of references

- To showcase the use of active remote sensing technique, Lidar, for studying the ocean
- To explain and to train ocean color community to the basics of lidar instrumentation and data processing
- To provide sample data and codes for visualizing and processing lidar data
- To provide examples of applications of lidar for oceanic studies
- To discuss the advantages and limitations of lidar to monitor the upper ocean layer
- To provide recommendations and actions for increasing the use of lidar in the ocean color community in term of training, instrumentation, algorithms and good practices
- To prepare a report on lidar for ocean applications with the IOCCG series

Proposed membership

- Kelsey Bisson, NASA HQ, USA
- Peng Chen, SEOD/SIO, China
- Brain Collister, NASA Langley, USA
- Davide Dionisi, CNR, Italy,
- Paolo Di Girolamo, Universita di Basilitaca, Italy
- Cédric Jamet, LOG, France
- Xiaomei Lu, NASA Langley, USA
- Iwona Stachlewska, Warsaw University, Poland
- Siqi Zhang, SEOD/SIO, China
- Yudi Zhou, Zhejiang University, China

Schedule

ACTIVITY	0-3m	3m-6m	6m-9m	9m-12m	12m-15m	15m-18m	18m-21m	21m-24m
Refinement of the term of references								
Literature review on lidar applications for the ocean								
Evaluation of the advantages and limitations of lidar								
State-of-the-art of the algorithms for resolving the lidar multiple scattering effects								
State-of-the-art of the algorithms for processing lidar techniques								
Roadmap for training courses on lidar								
Future recommendations and actions								
Prepare-publish a report								

Table of contents of the report

- **Chapter 1:** Fundamentals of lidar
- **Chapter 2:** Glossary
- **Chapter 3:** Instrumentation appendix linked to fourth paper
- **Chapter 4:** Lidar multiple scattering and RTE
- **Chapter 5:** Lidar data processing (how it links, how to find the data, how to process, XXXX)
- **Chapter 6:** Lidar Applications (optical profiling; phytoplankton profiling; bathymetry; fishes; Internal waves; diel observation; polar observation)
- **Chapter 7:** Lidar and ocean color fusion remote sensing (spatial fusion method; spectral fusion method: lidar-based QAA and so on; AI-based fusion method)
- **Chapter 8:** Recommendations


THANK YOU