# SIO237B: Ocean Color Remote Sensing (Winter 2025)

## INSTRUCTOR:

Dariusz Stramski
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Wednesday and Friday 12:00 – 1:20 pm; Nierenberg Hall 101 & On-line Zoom
Office hours: Meetings after the class or scheduled via email

## PREREQUISITES:

Students admitted to the SIO & UCSD graduate programs or permission of instructor.

## COURSE DESCRIPTION:

Units: 4; Grade: Letter grade only; Required a passing score on homework assignments, participation in lectures, hands-on lab, and discussion sessions.

This course provides an overview of science and applications of aerospace optical remote sensing in the study of the Earth's oceans. The course is directed to graduate students pursuing research in different disciplines of oceanography, including ocean biology, biogeochemistry, physics, as well as the Earth's climate. The level of discussion is suitable for students who have had introductory courses in physics, as can be assumed for beginning graduate students in oceanography and climate sciences. The course is presented from the perspective that the underlying principles of optical remote sensing of ocean color can be viewed as a multidisciplinary venture with applications to a broad range of problems of the Earth system science from optics itself to ocean biology, biogeochemistry, and climate-related studies. The course is designed to provide the students with a basic understanding of ocean color remote sensing and an opportunity to gain or enhance knowledge necessary to explore and apply the ocean color data to various questions in oceanography and Earth system science. The layout of the course is intended to carry the students through a logical progression of discussions which begin with fundamentals of optical remote sensing (historical background, remote sensing principles, platforms, sensors, satellite missions), followed by a survey of foundations of radiometry, inherent and apparent optical properties of the ocean, radiative transfer, solar radiation in the atmosphere, light at the sea surface, light absorption and scattering by seawater, and light fields within and leaving the ocean. The next portion of the course covers the topics of basic remote sensing equation, atmospheric correction, relationships between ocean color and seawater constituents, ocean color algorithms and frontier research directions. The strong flavor of diversity of applications of ocean color remote sensing are covered through discussions of selected papers from the ocean color-related literature with emphasis on applications of particular interest to students. The course consists of approximately 60% lectures (Lec on Schedule), 25% hands-on science lab (Lab on Schedule), and 15% student presentations & discussions (Dis on Schedule) of selected papers. Final evaluation is based on homework problems, lab assignment, and presentation of a selected paper.

**COURSE GOALS:**

(1) To lay physical and conceptual foundations of ocean color remote sensing.
(2) To review concepts, terminology, and measurement techniques underlying the application of the technology of aerospace optical remote sensing in the study of the oceans.
(3) To present an integrated and cohesive treatment of the links and interactions between various constituents of seawater, inherent optical properties of seawater, and ocean color.
(4) To review algorithms for retrieving useful information about various ocean parameters from ocean color remote sensing.
(5) To discuss example applications of ocean color remote sensing in oceanography and Earth system science.
(6) To provide hands-on science experience in using satellite ocean color software tools

**READING:**

Robinson, I. A. "Measuring the Oceans from Space. The Principles and Methods of Satellite Oceanography", Springer, 2004.
A comprehensive text on satellite oceanography. Part I reviews the fundamentals of satellite oceanography. Part II section 6 provides an overview of ocean color remote sensing. Recommended reading: Part I and Part II section 6.

Ocean Optics Web Book (http://www.oceanopticsbook.info/).
A collaborative web-based, dynamically growing, community resource that addresses both the education and reference needs of the broad optical oceanography and ocean color remote sensing communities, which is freely accessible to all. Recommended as an excellent resource on fundamentals of ocean optics and various topics in optical oceanography and ocean color remote sensing.

Additional relevant textbooks:

Martin, S. "An Introduction to Remote Sensing", Cambridge University Press, 2004.
This textbook is designed for use in graduate and senior undergraduate courses in satellite oceanography. Recommended reading: Chapters 1 - 6.

Kirk, J. T. O. "Light and Photosynthesis in Aquatic Ecosystems", Cambridge Univ. Press, 1994.
The first part of the book is an introductory text on ocean optics including chapter 7 on remote sensing. Recommended reading: Part I which includes Chapter 7 on remote sensing of aquatic environments.

Mobley, C. "Light and Water. Radiative Transfer in Natural Waters", Academic Press, 1994.
A comprehensive text on radiative transfer in aquatic environments. Part I can serve as a standard reference work on introduction to ocean optics. Recommended reading: Chapters 1 and 3.

Example textbooks covering basic topics of electromagnetic theory and light:
Hecht, E., Physics, Brooks/Cole Publishing Co, 1994.
Hecht, E., Optics, Addison-Wesley, 1998.

**GRADING:**

Homework problems: 50%
Hand-on lab assignments: 25%
Paper presentation: 25%

**ASSIGNMENTS:**

Students will receive the mid-term and final take-home problem sets as well as the hands-on lab assignment during the course. Students are expected to return the problem sets with answers by the deadline. In consultation with instructor each student will also select a paper for the presentation & discussion sessions. The papers selected by students can address the topical areas presented in lectures or other areas of interest to the student and relevance to the general theme of the course. A student is expected to be involved in debating scientific issues of the presented paper as well as discussions of papers presented by other students.

**SCHEDULE:**

Course meetings will take place twice a week of 1 hr 20 min duration each. Days/time will be determined in consultation with students at the beginning of the quarter. There will be three types of activities: lectures (Lec, approx. 60% of the course), hand-on science lab to learn ocean color-related software tools and their applications (Lab, approx. 25% of the course) and presentations & discussion of selected literature by students (Dis, approx. 15% of the course).

| Week | Type of Activity | Topic |
|---|---|---|
| 1 | Lec | Fundamentals of ocean color remote sensing |
| 1 | Lec | Fundamentals of ocean color remote sensing (contd) |
| 2 | Lab | Hands-on lab on ocean color software tools |
| 2 | Lec | Radiometry: Concepts, terminology, measurement techniques |
| 3 | Lec | Inherent and apparent optical properties: Concepts, terminology, measurement techniques |
| 3 | Lab | Hands-on lab on ocean color software tools |
| 4 | Lec | Inherent and apparent optical properties (contd) |
| 4 | Lec | Optical pathways and basic equations of ocean color remote sensing |
| 5 | Lab | Hands-on lab on ocean color software tools and applications |
| 5 | Lec | Relationships between ocean color and seawater constituents |

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|---|---|---|
| 6 | Lec | Ocean color algorithms and applications |
| 6 | Lab | Hands-on lab on applications of ocean color algorithms |
| 7 | Lec | Solar radiation and optical properties of the atmosphere |
| 7 | Lec | Light reflection and transmission at the air-water interface |
| 8 | Lab | Hands-on lab on applications of ocean color algorithms |
| 8 | Lec | Atmospheric correction |
| 9 | Lec | Light fields within the ocean and leaving the ocean |
| 9 | Dis | Ocean color applications |
| 10 | Dis | Ocean color applications |
| 10 | Dis | Ocean color applications |