Calibration and Validation for Ocean Color Remote Sensing
10 July – 4 August, 2017
Darling Marine Center, University of Maine, Walpole ME

Meals: breakfast – 0730; lunch – 1200; dinner – 1800; weekends will be posted
Class starts at 0800, except Saturday 15 July (start at 1000); also some days in weeks 3&4 (see below)
Most mornings will start with a student synthesis of data, findings, and questions from previous day’s lab (the schedule is flexible)
Class TA – Nils Haenjens. Alison Chase and Jordan Snyder will also be available.

Week 1: Introductions and inherent optical properties (IOPs)
Instructors: CM, CR, KV, EB, IC

Day 1 (Mon) – July 10

AM
Welcome to Maine and the Darling Center (EB)
Logistics and overview (Tim, Linda)
History of the Optics Class, logistics and overview of the course (CR & EB)
Introductions of faculty.
Lecture 1: What the Ocean Optics Class is All About (CM)
Lecture 2: Overview of Light in Water (CR) have a break between IOPs and AOPs

PM
Lecture 3: Absorption physics (CR)
Lab 1: Introductions of students. Emphasize what you hope to gain from the class.
Playing with Light (EB+All)

Day 2 (Tue) – July 11

AM
Lecture 4: Phytoplankton – Pigments, Photo-adaptation, and Taxonomy (IC) have a break in the middle
Lecture 5: Measuring Absorption (CR/EB) have a break in between A and B
A. Discrete Samples, Laboratory spectrophotometry
B. Flow through samples, In situ spectrophotometry

PM
Lab 2: Absorption by Dissolved Material, exploring the Lambert-Beer Law (CR, EB, IC) (spectrophotometry in homemade, benchtop and in situ (ac-meters) spectrophotometers); TA helps with homemade spectrophotometer
After dinner data lab: walk through ac-9/ac-S calculations (temperature/salinity corrections) (EB)
Day 3 (Wed) – July 12

AM
Lab report: CDOM lab synthesis and summary; let this discussion take 1.5 to 2 hours to dig deep
Lecture 6: Introduction to Scattering (CR); split in two with a break in between
A. Scattering theory
B. Scattering in the ocean and what Mie modeling tells us

PM
Lab 3A: Absorption by particulate material in environmental samples and phytoplankton cultures (ac-9 / ac-s and integrating sphere spectrophotometer) and discrete sample filtering techniques for QFT and chlorophyll analysis (CR, EB, IC).
After dinner data lab: walk through ac-9 calculations (scattering correction) (EB)

Day 4 (Thu) – July 13

AM
Lab report: Particulate absorption lab synthesis and summary, Part A
Lecture 7: The VSF and Models for Scattering (CM)
Lecture 8: Beam Attenuation (EB)

PM
Lab 3B: Absorption by particulate material in environmental samples and phytoplankton cultures (ac-9 / ac-s and integrating sphere spectrophotometer) and discrete sample filtering techniques for QFT and chlorophyll analysis (CR, EB, IC).

Day 5 (Fri) – July 14

AM
Lab report: Particulate absorption lab synthesis and summary, Part B, building on Part A, not a repeat, what new things did you learn, results from corrections of yesterday’s analysis
Lecture 9: Particulate organic carbon (POC) and other biogeochemical (BGC) parameters for which optics provide a proxy (IC)
Lecture X: Link between particle properties (size, packaging, composition, shape, internal structure) and IOPs (connection to Mie equations) (EB)
Lecture X: Size distributions, optics and ecosystem structure (IC, EB or CR)

PM
Lab 4: Scattering by particulate material (b and bₜ) (CR, EB, IC) + collecting & processing samples for SPM/POC (environmental + culture) LISST
Lab X: PSD lab (EB, CR, NH) – LISST, IFCB, Coulter counter, cₚ slope (EB, CR,
NH) – running environmental samples + culture.

**Day 6 (Sat) – July 15 (start at 10:00)**

**AM**  
Synthesis of first week: critique process of learning, Q&A on any topic; tie up loose ends.  
Finish environmental analyses from Friday lab  
*Lab report:* Attenuation and scattering synthesis and summary  
*Lab report:* PSD - synthesis and summary

**PM**  
Bar-B-Que at DMC (start at 17:30)

**Week 2: Radiometric Quantities, AOPs & Hydrolight**  
Instructors: CM, CR, KV, EB, JH

**Day 1 (Mon) – July 17**

**AM**  
*Lab report:* PSD lab synthesis and summary  
Lecture 10: Introduction to Light and Radiometry (CM)  
Lecture 11: Radiometric Quantities and Their Measurement (KV)

**PM**  
Lab 5: Radiometric measurements: in-water and above-water (KV, EB)  
Lecture 12: Introduction to AOPs (CM)

**Day 2 (Tue) – July 18**

**AM**  
*Lab report:* Radiometry lab synthesis and summary  
Lecture 13: Inelastic scattering – Raman, CDOM (KV)  
Lecture 14: Fluorescence by phytoplankton pigments (CR)

**PM**  
Lab 6a: Fluorescence of CDOM and chlorophyll (CR)  
Lab 6b: Raman Scattering  
Lab 6c: NPQ experiment – how Fchl changes with exposure of cells to light.  
Lecture 15: Basics of polarization (KV)

**Day 3 (Wed) – July 19**

**AM**  
*Lab report:* Fluorescence lab synthesis and summary  
Lecture 16: The Radiative Transfer Equation (CM)  
Lecture 17: Cal/Val and MOBY (KV)
PM
Lab 7: HydroLight Lab 1: Introduction to HydroLight and Guided Simulations (simple simulations) (CM, JH)

Day 4 (Thu) – July 20

AM
Lab report: Report from HydroLight Lab 1
Brief report on topics selected for Student Projects – individual or small group project
Lecture 18: Introduction to Remote Sensing (CM)
Lecture 19: Closure (CM)

PM
Lab 8: HydroLight Lab 2: Guided Simulations (advanced simulations) (CM, JH)

Day 5 (Fri) – Jul 21

AM
Lab report: Report from HydroLight Lab II
Lecture 20: Rrs inversion methods A: Statistical Methods (band ratios, Neural Networks; CM)
Lecture 21: Rrs inversion methods B: Semi-analytical Models to obtain IOPs (CR)

PM
Lab 9: Semi-analytical Rrs inversion lab (CR)

Week 3: Field Measurements, SeaDAS and Models
Instructors: CM, CR, KV, EB, JW, SB

Day 1 (Mon) – July 24

AM
Lecture 22: Ocean color satellite remote sensing; basic atmospheric corrections (JW)
Lecture 23: Guest Lecture by H. Dierssen: shallow water optics and other complex issues associated with Ocean Color.

PM Prep for cruise

Day 2 (Tues) – July 25
Group A – Field sampling on the R/V Ira C (EB, KV, CR)
Group B – SeaDAS in the lab (JW and/or SB)

PM
Lab 10: Analysis of Tuesday cruise data/ Work on student projects
Day 3 (Wed) – July 26

Group B – Field sampling on the R/V Ira C (EB, KV, CR)
Group A – SeaDAS in lab (JW and/or SB)

PM
Lab 10: Analysis of Wednesday cruise data/ Work on student projects

Day 4 (Thur) – July 27

AM
Lab reports: Preliminary reports on analysis of radiometry and IOPs from cruise
Lecture 24: In situ data for satellite QA/QC, Cal/Val (JW)
Lecture 25: Guest Lecture by Barney Balch: Optical properties of PIC and their impact on ocean color.

PM
Lab 11a: Group B – Analysis of cruise radiometry (KV, JW)
Lab 11b: Group A – Analysis of cruise IOPs (EB, CR)

Day 5 (Fri) – July 28

AM
Lecture 26: PSD calculus (EB)
Lecture 27: PFT and PSD measurements (CR)
Lecture 28: PFT and PSD inversions from Rrs (JW)

PM
Lab 12: Arduino board lab (EB)
Lab 13: Continued data analysis of cruise radiometry and IOPs
      Exploration of optical phenomena (instructors)

Lobster dinner – leave at 4:40 PM and carpool and caravan to lobster wharf

Week 4: Synthesis
Instructors: CM, CR, KV, EB

Day 1 (Mon) – July 31

AM
Lab reports: Updates on analysis of cruise radiometry and IOPs
Lecture 29: Uncertainty analysis and propagation of errors (EB)
Lecture 30: Optical properties of individual particles. Mie theory and its limitations. (EB)

PM
Lab 14: Mie theory calculations (EB).
Lab 15: Instrumental closure using cruise data (working in small groups with instructors)

Day 2 (Tues) – August 1

AM
Lab report: Field data and closure
Lecture 31: Introduction to Monte Carlo Simulation (CM)

PM
Labs: Monte Carlo lab (NH)
Lab 16: Continuing to work on data/projects

Day 3 (Wed) – August 2

AM
Lab 17: Data processing, projects, submission to SeaBASS, portfolios (videos, etc.), etc.

Day 4 (Thur) – August 3

Lecture 33: Basic Concepts of Visibility and Lidar Remote Sensing (CM)
Lab 18: Data processing, projects, submission to SeaBASS, portfolios (videos, etc.), etc.

PM: Guest Lecture by Paul Hill: Using optics to study sediment dynamics.

Day 5 (Fri) – August 4

Student Presentations of Projects. Review of Class

Day 6 (Sat) – August 5

Clean and vacate room by 10:00am; other directions from Nils