IOCCG Optical Water Type Working Group: May 2026 Update

Team Members

Co-chairs: Dr. Thomas Jackson (EUMETSAT)
Dr. Tim Moore (Florida Atlantic University)

Liz Atwood PML (UK)
Shun Bi Hereon (Germany)
Jacob Bien USC (USA)
Hannelie Botha CSIRO (Australia)
Carsten Brockmann (Brockmann Consult)
Martin Hieronymi Hereon (Germany)
Bror Jönsson UNH (USA)
Maria Kavanaugh OSU (USA)
Frederic Melin JRC (Italy)
Marie Smith CSIR (South Africa)
Evangelos Spyrakos Stirling (UK)
Vincent Vantrepotte LOG (France)
Mortimer Werther Eawag (Switzerland)
Jianwie Wie NOAA (USA)

Overall Goal: To provide a unifying foundation as an aid for development and uses of Optical Water Types with Ocean Color data

OWT Historical Development

Forel-Ule
1890's

Jerlov
1950s

Morel & Prieur
1977
Case 1/Case 2

Early Period: Conceptual OWTs

Modern OWTs
(ocean color)

Marine OWTs
(2001 -)

AI & OWTs
(2017 -)

- Hieronymi et al (2017)
- Bi et al (2024)
- Ma et al (2025)
- Tran et al (2025)
- Xiong et al (2025)
- Yang et al (2025)

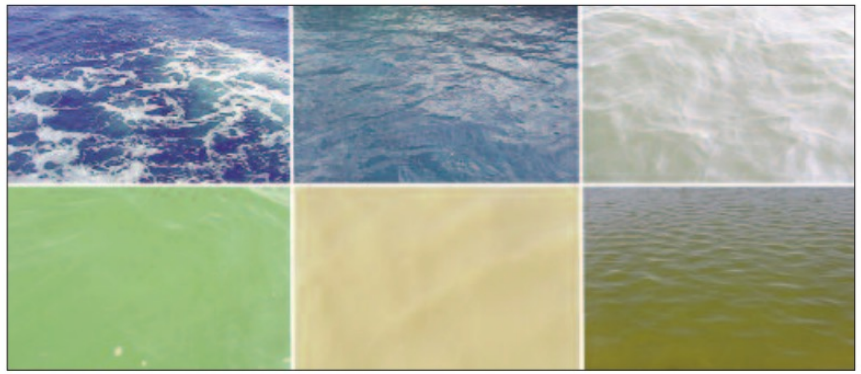
Lake OWTs
(2014 -)

- Reinart et al (2003)
- Le et al (2011)
- Moore et al (2014)
- Shi et al (2014)
- Trochta et al (2015)
- Zhang et al (2015)
- Toming et al (2016)
- Eleveld et al (2017)
- Spyrakos et al (2018)
- Soomets et al (2019)
- Uudeberg et al (2019)
- Xue et al (2019)
- Botha et al (2020)
- da Silva et al (2020)
- Matsushita et al (2020)
- Valerio et al (2021)

- Moore et al (2001)
- Traykovski et al (2003)
- Feng et al (2005)
- Lubac et al (2007)
- Moore et al (2009)
- Hommersom et al (2011)
- Melin and Vantrepotte (2011)
- Moore et al (2011)
- Vantrepotte et al (2012)
- Wernand et al (2013)
- Moore et al (2015)
- Ye et al (2016)
- Jackson et al (2017)
- Monolisha et al (2018)
- Jia et al (2021)
- Atwood et al (2024)

While the common thread is the use of *remote sensing reflectance (with ocean color applications in mind)* as the basis of **optical water types**, these studies use a diversity of:

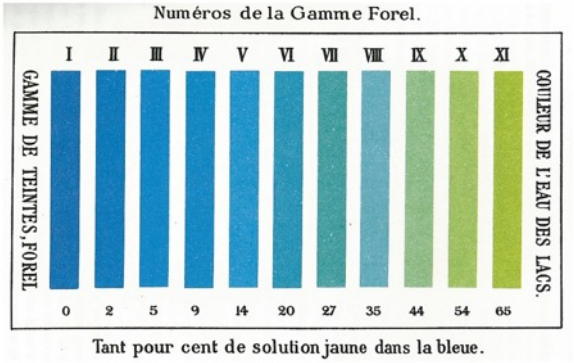
- Distance metrics
- Data transformations
- Cluster optimization schemes
- Spectral choices
- Local vs. global scales
- Data representation: insufficient or biased training data, overtraining, missing 'types'.
- Classifier design



Wernand, 2011

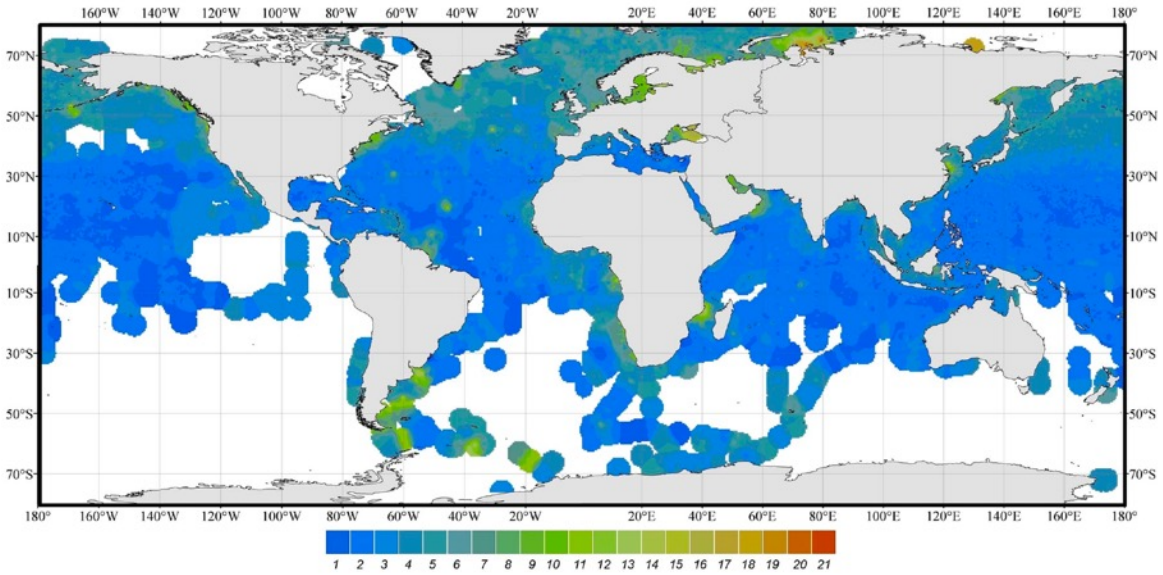
Report Main Purpose: *To reconcile issues under a common framework to unify and standardize definitions, interpretations, and uses to establish guidelines for a growing body of developers and users, as well as to close methodological gaps*

Forel-Ule: The Primordial Ocean Color Map

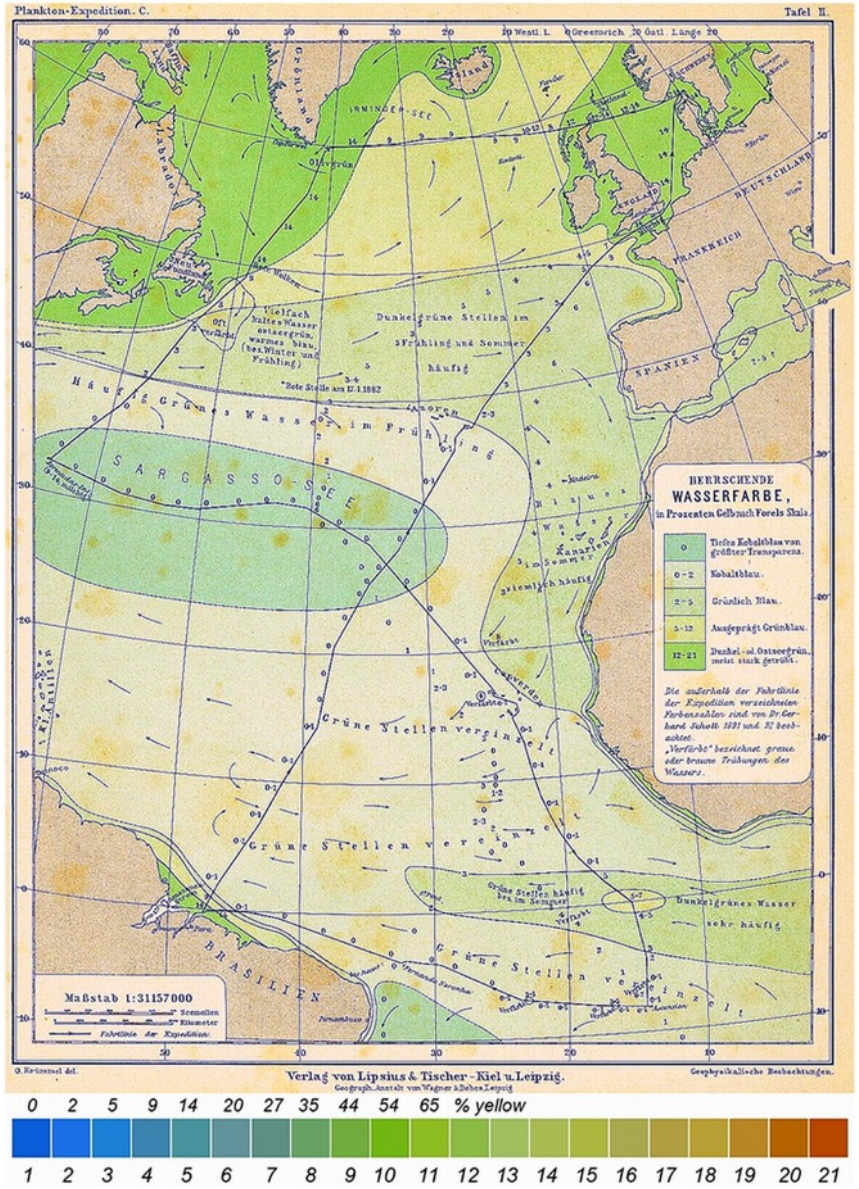


Optical Water Types are an abstract representation of the aquatic environment through *color*

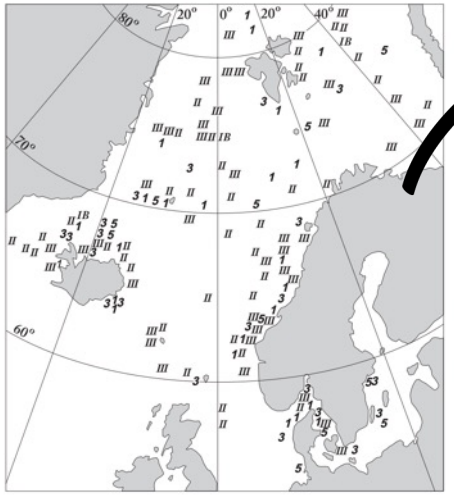
Wernand et al 2013



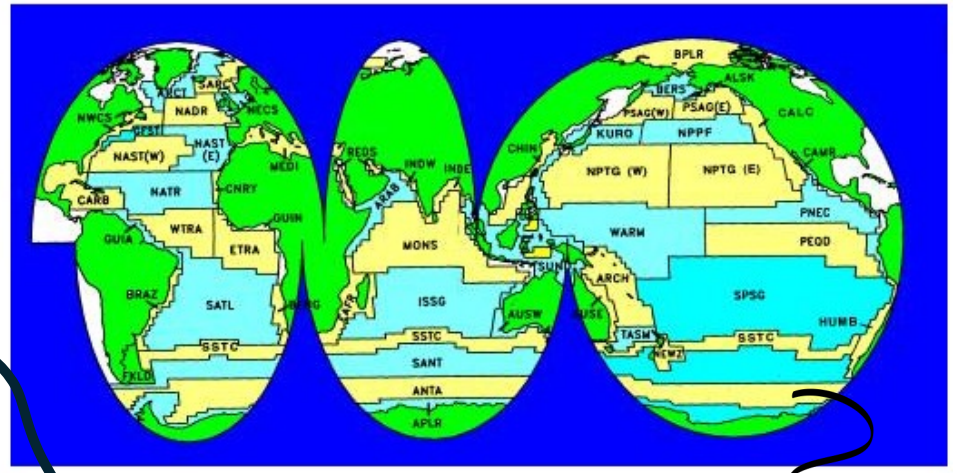
Krummel 1889



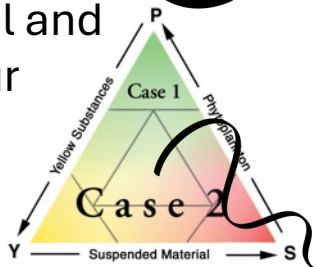
Jerlov 1950-60s



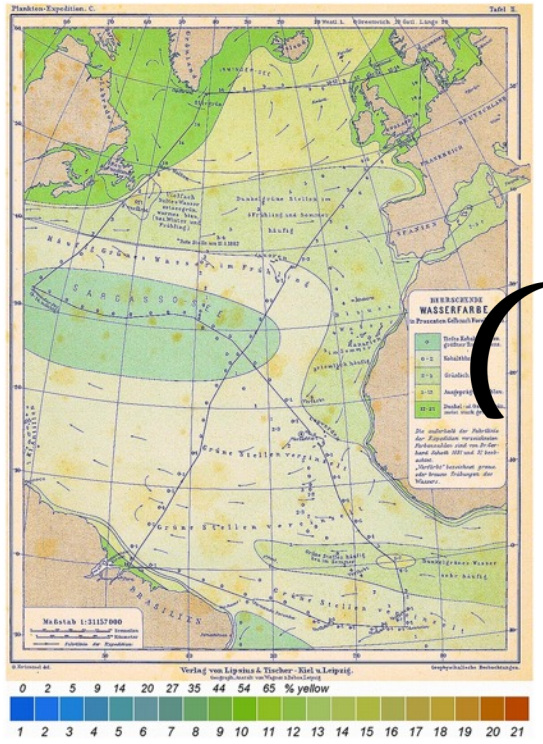
Longhurst 1990s



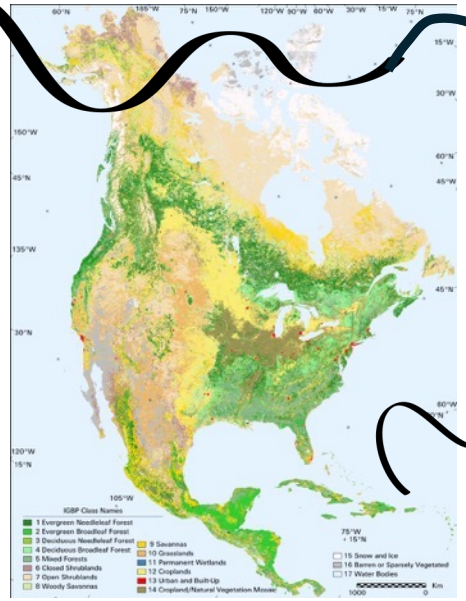
Morel and Prieur 1977



Ocean Color Era

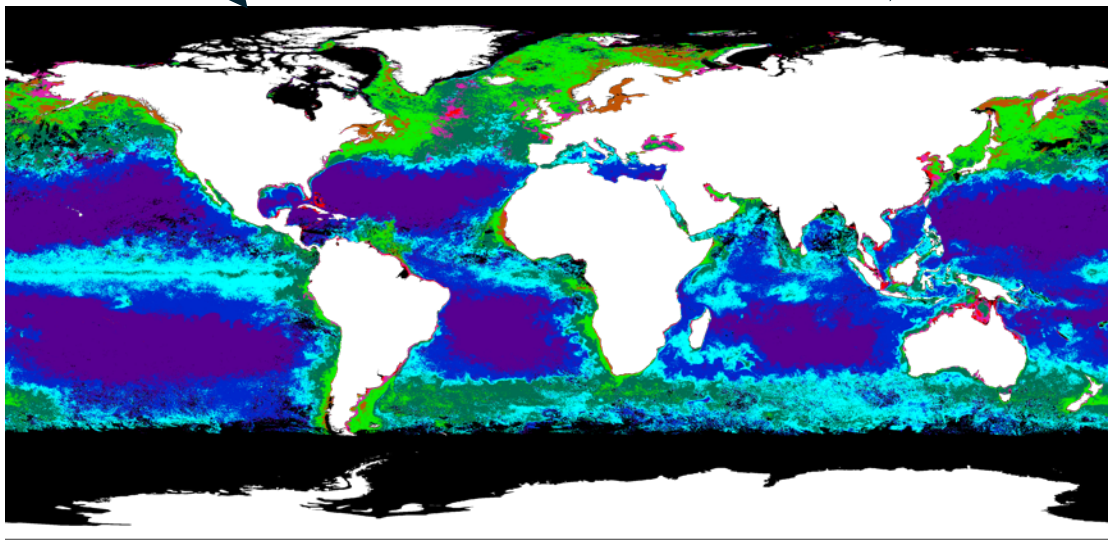


Forel-Ule

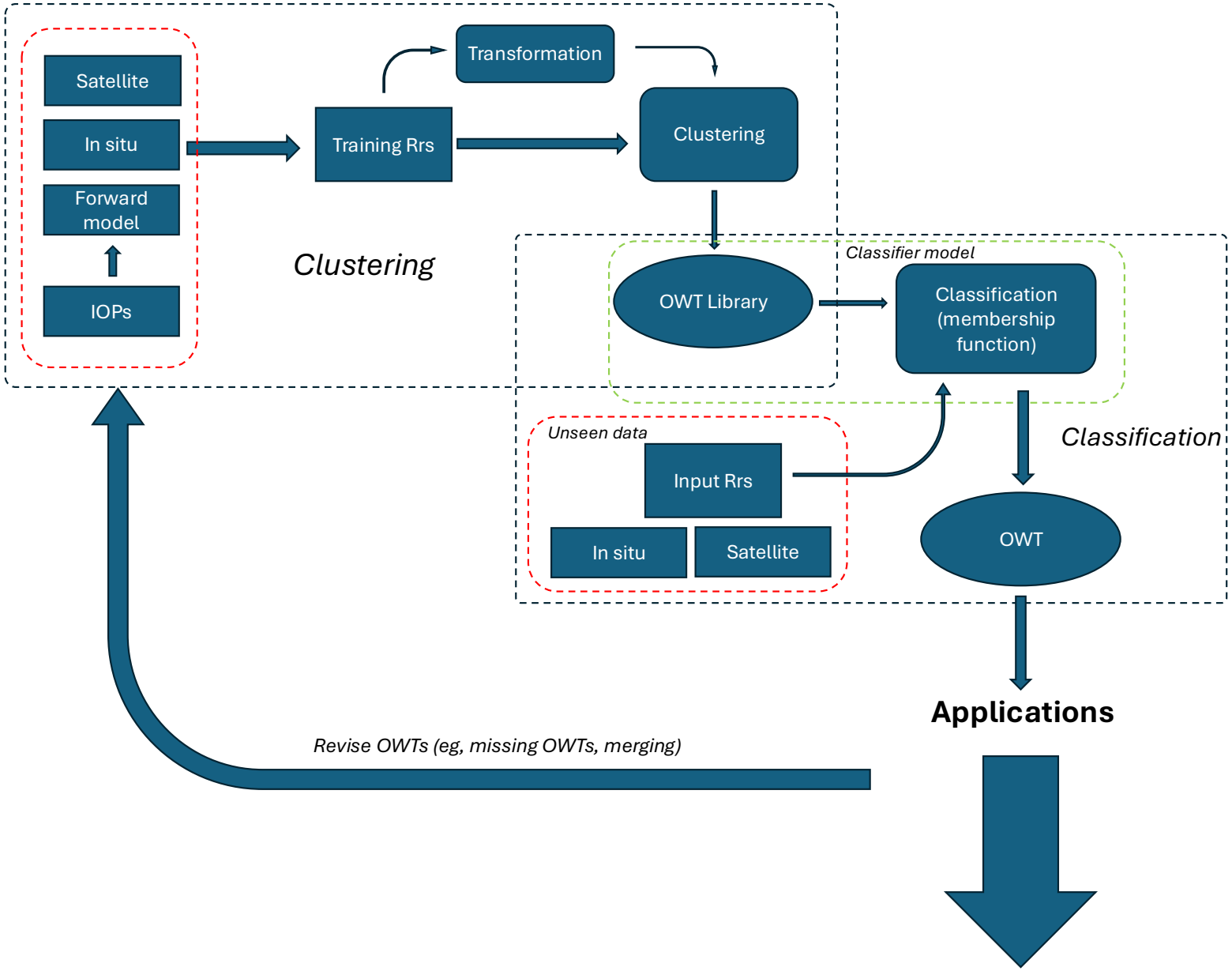


Landsat1970s

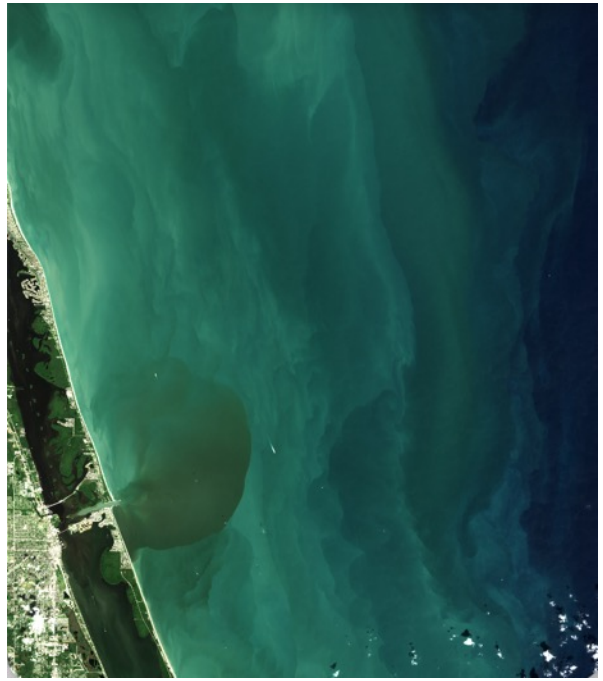
OWTs 2000s



OWT Generalized Conceptual Framework



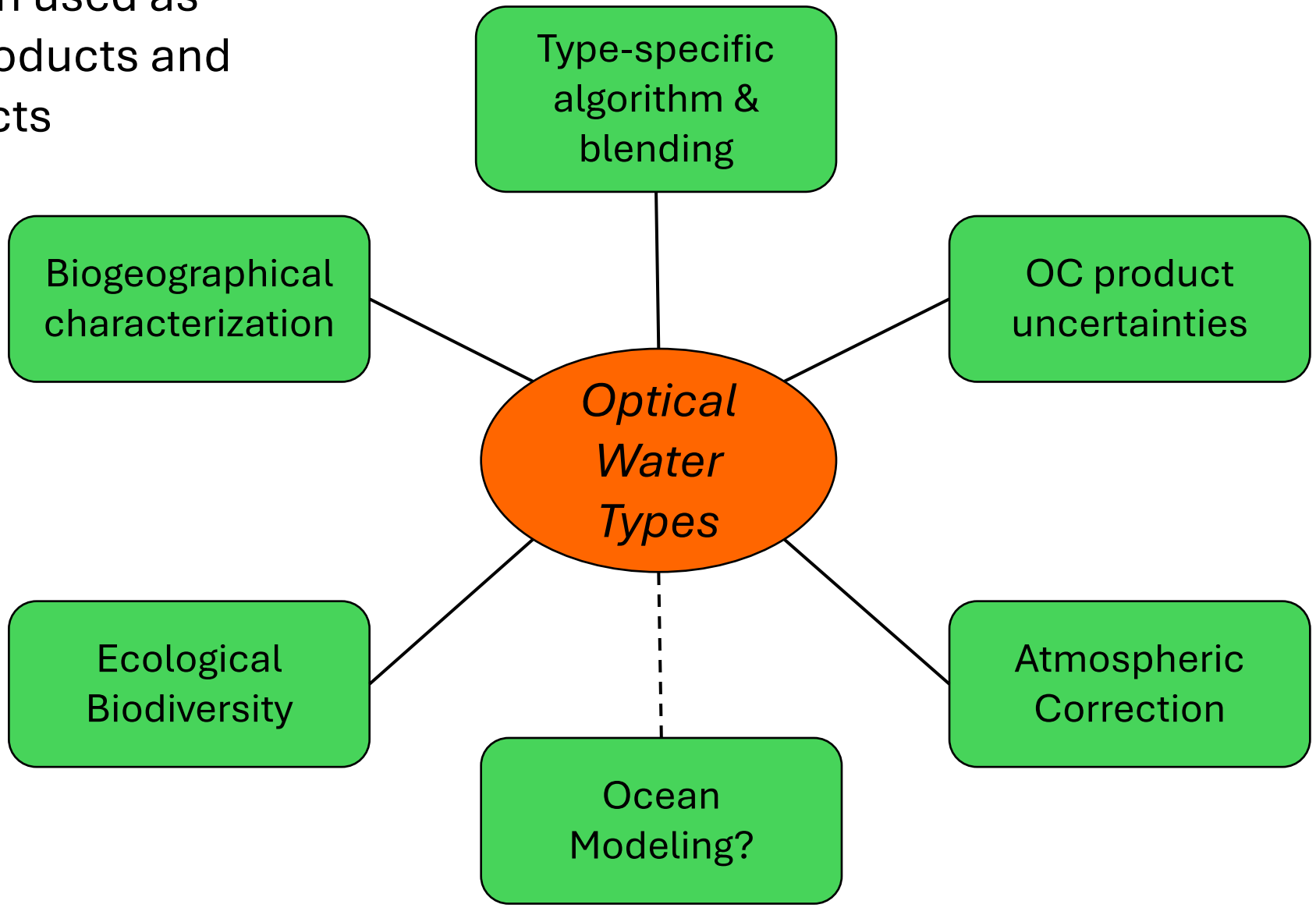
Sentinel-2



Indian River Lagoon, FL

OWT Applications (ocean color)

OWTs have been used as *intermediary* products and as *direct* products themselves



Objectives

- To unify and standardize definitions for the growing body of developers and users of optical classification schemes.
- To provide an overview of the current maturity of the techniques developed and their limitations.
- To establish guidelines for both the creation and application of such statistical techniques.
- To bring all readers to a common level of understanding such that the discussion, use and development of optical water type classification schemes is enhanced.
- To propose key areas for development and investigation for the next phase of aquatic remote sensing.

Existential questions for optical water types

Consideration 1*: Do Optical Water Types exist? If they do, how many?*

Problem: Many properties are continuous in the ocean. How (and why) do you discretize (or partition) a continuum?

Consideration 2*: How can Optical Water Types be distinguished?*

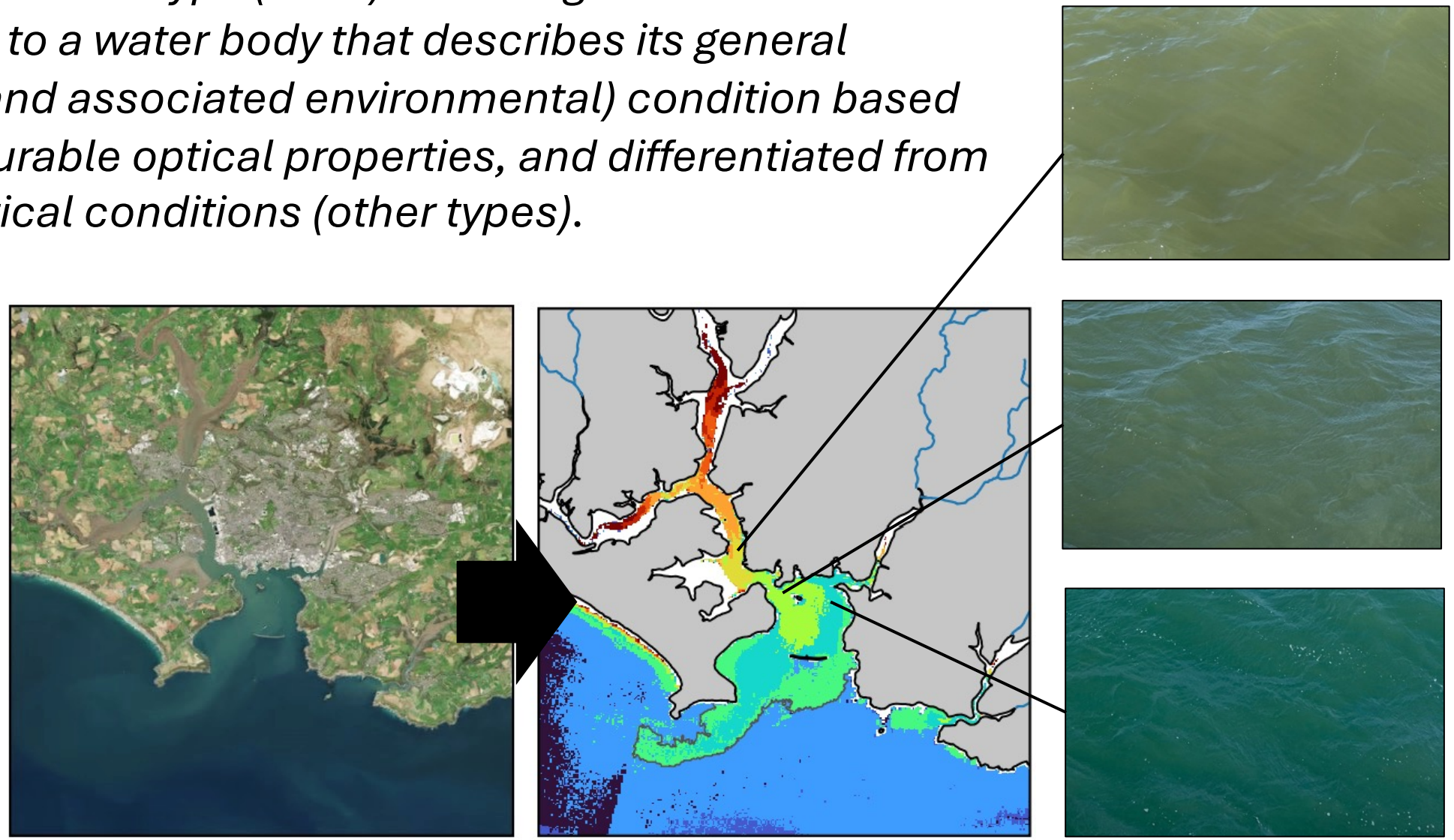
Problem: The ocean has dynamic and ever-changing waters and boundaries – the ocean is not static.

Problem: Boundaries in the ocean are hard to discern, not only do they move but often times they are not abrupt, but graduated

What is an Optical Water Type?

One definition:

An optical water type (OWT) is a categorical label assigned to a water body that describes its general optical (and associated environmental) condition based on measurable optical properties, and differentiated from other optical conditions (other types).



Courtesy of L. Atwood

Sentinel-2

OWT Report Organization

(established in late 2023 at IOCS, St. Pete)

- Chapter 1: *Introduction* (Jackson & Moore)
- Chapter 2: *Statistics* (Bien & Melin)
- Chapter 3: *Requirements* (Brockmann & Hieronymi)
- Chapter 4: *Merging Cluster Sets (*Atwood & Botha)
- Chapter 5: *Data Sets* (Spyrakos & Vantrepotte)
- Chapter 6: *Applications* (Wei & Bi)
- Chapter 7: *Recommendations* (Jackson & Moore)
- Appendices: Glossary, Reference Data Sets, Codes

Chapter Concepts

Ch 2: Statistics — 60%

- Distances and similarity metrics
- Clustering approaches
- Supervised vs Unsupervised
- Reproducible and invertible transformations
- Cluster performance metrics

Ch. 3: Requirements — 70%

- Application Requirements
- Requirements of input data
- Information reduction techniques
- Atmospheric correction impacts
- TOA considerations
- Data volumes and processing
- Limitations of OWTs

Ch. 4: Merging — 60%

- Problems with cluster comparisons (e.g., regional vs. global, different data types)
- Cluster merging approaches
- Comparison approaches and merging cluster sets
- Recommendations

Ch. 5: Data Sets

- In-situ data sets
- Remote sensing data
- Spectral Considerations
- Normalization transformations vs. non-normalized

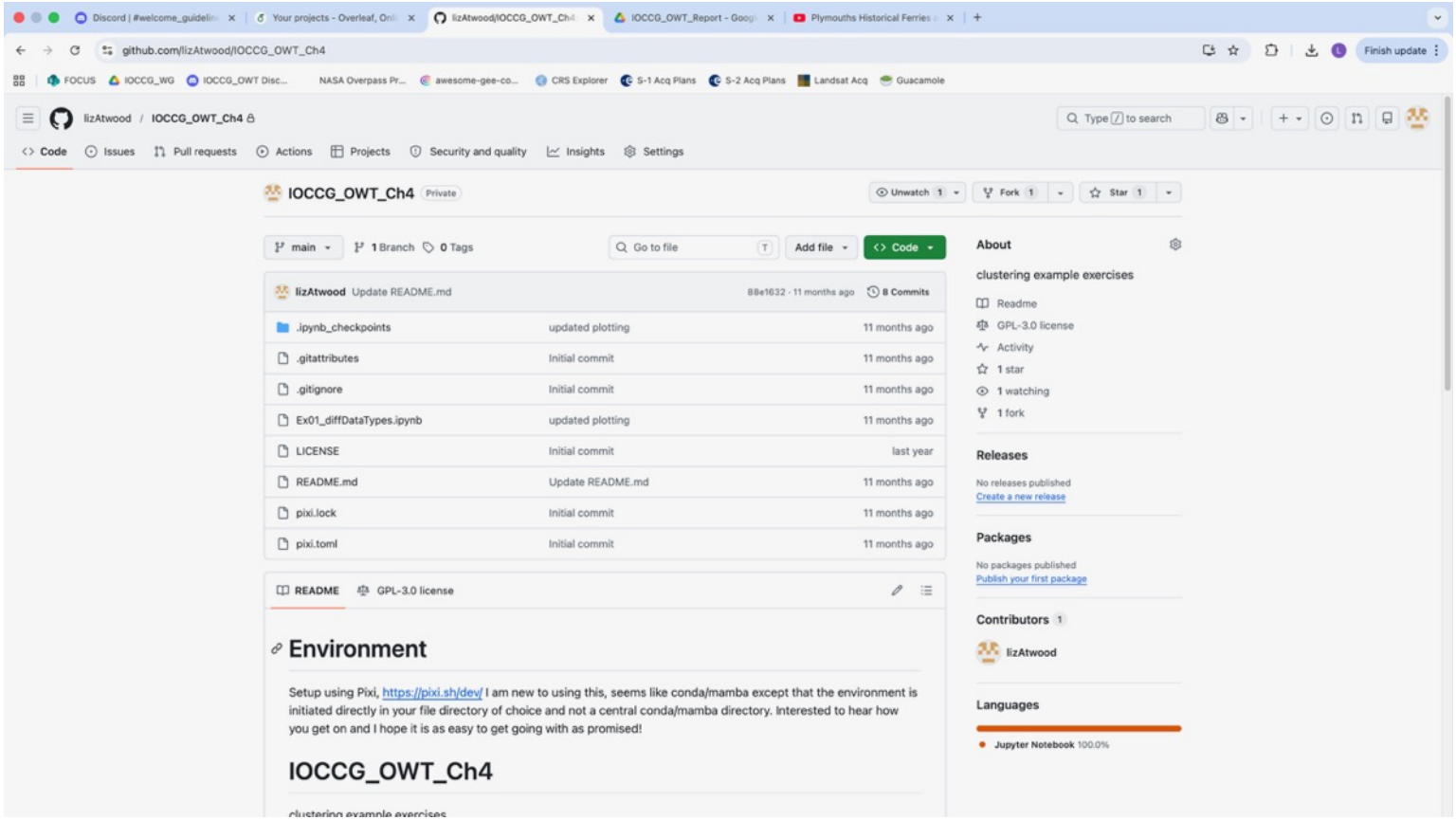
Ch. 6: Applications — 60%

- Atmospheric correction
- Bio-optical inversion
- Data quality assessment
- Satellite data uncertainty
- Fish tracking
- Ocean modeling

Ch 1: Introduction — 70%

Ch 7: Recommendations — 5%

GitHub repo - Provide open code tools for users alongside reference datasets for algorithm testing and comparison.



Developed by Bror Jönsson

- Python Notebooks
- Codes
- Data Sets
- Living Documents
- Links to GitHub OWT page of Shun Bi (Python library for Optical Water Type framework)

- Creation of a Discord Channel for Discussion

Essentially completed but can always add more content!

Reference Data Sets

- Satellite Data Sets (from CCI)
  I. Open Ocean - data from OC-CCI over the global ocean. One randomly selected day each month from 2003 to 2023. Spatially stratified so that every Longhurst region has at least 5 samples and each number is weighted to the areas of the regions.
  II. Coastal Ocean – Data from MSI over the Tagus Estuary in Portugal. One randomly selected day each month from 2017 to 2023. Spatially stratified so with more data points closer to shore.

- In situ Data Sets
  I. Global coverage from https://doi.org/10.5194/essd-11-1037-2019 and https://doi.org/10.1594/PANGAEA.898188
  II. https://doi.org/10.1002/lno.12606 and https://github.com/bishun945/pyOWT
  III. Pitarch-Brando Hydrolight data set (N=5,000)

OWT Report Achievement Timeline

- Dec 2025 - IOCS Meeting (meetings with Chapter leads)
- Jan 2026 – 2026 Report Status Summary & Planning Letter (instructions to Chapter Leads)
- May 2026 – IOOCG Update
- June 2026 – Co-chairs meet (zoom) with each chapter group
- June/July 2026 – Chapter integration into full report
- July 2026 – Report Review - Zoom meeting #1
- Aug 2026 – Report Review - Zoom meeting #2
- Sep 2026 – Ocean Optics Follow Up meeting
- Spring 2027– Aim for Draft Report (Full)
- Summer/Fall 2027 – Finalize and Publish

Bottlenecks

- Time!
- Chapter Coordination (writing gaps and overlaps)
- Group Coordination (meeting directly or indirectly across time zones)

Solutions

- Merge Chapters into full report
- Commit to meet more regularly

The report is coming into view!