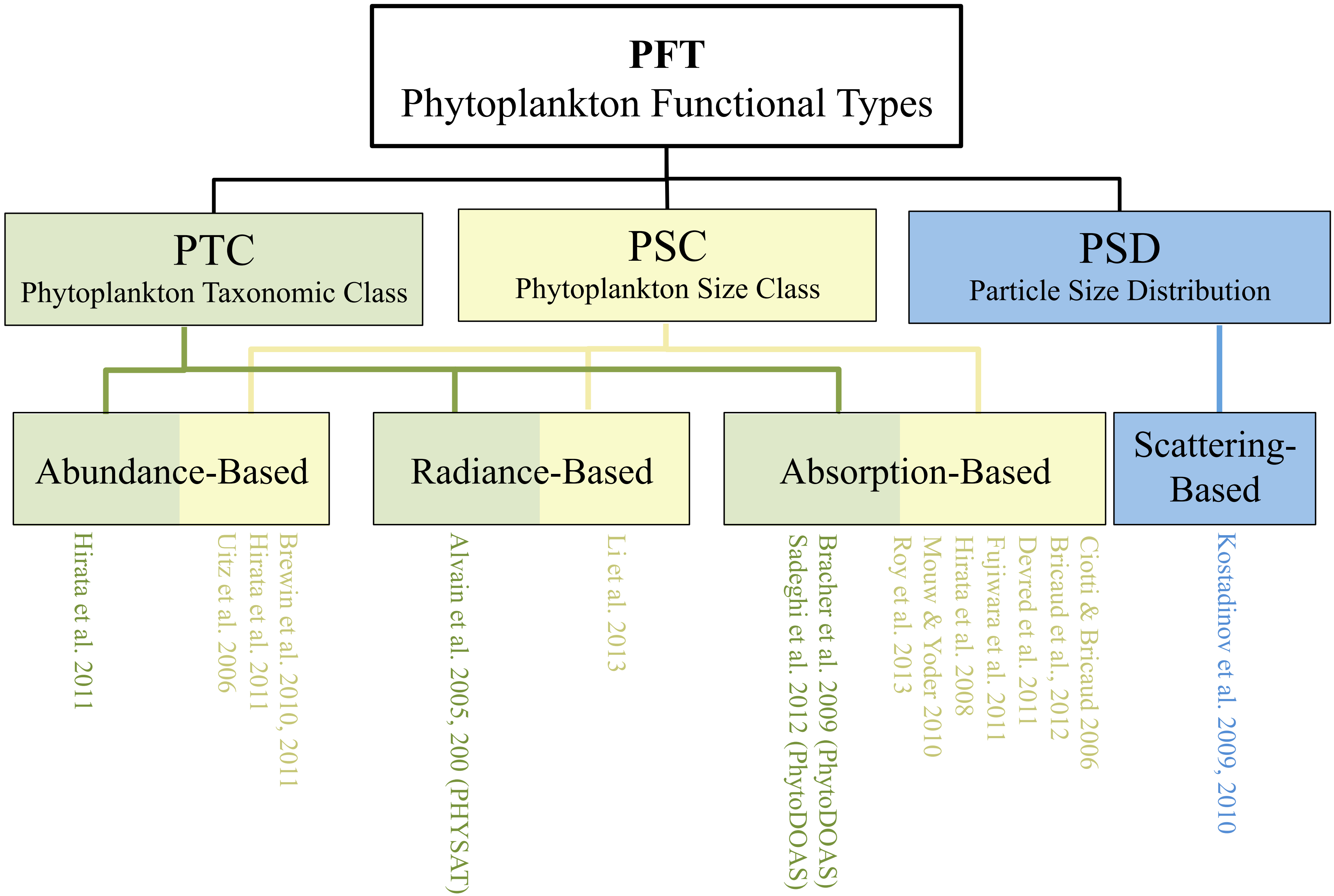
Remote Sensing of Phytoplankton Composition – Possibilities, Applications and Future Needs

Colleen Mouw[1], Astrid Bracher[2], Nick Hardman-Mountford[3]

[1]Michigan Technological University, USA
[2]Alfred Wegener Institute, Germany
[3]CSIRO, Australia



Mouw et al., in prep

Former and on-going Activity

2006-2014 IOCCG PFT working group

IOCCG report 15

2008-2010: 1st PFT algorithm intercomparison (focus on global dominance)

Brewin et al. (2011) RSE 115: 325-339

2011- : 2nd intercomparison round on global PFT algorithms

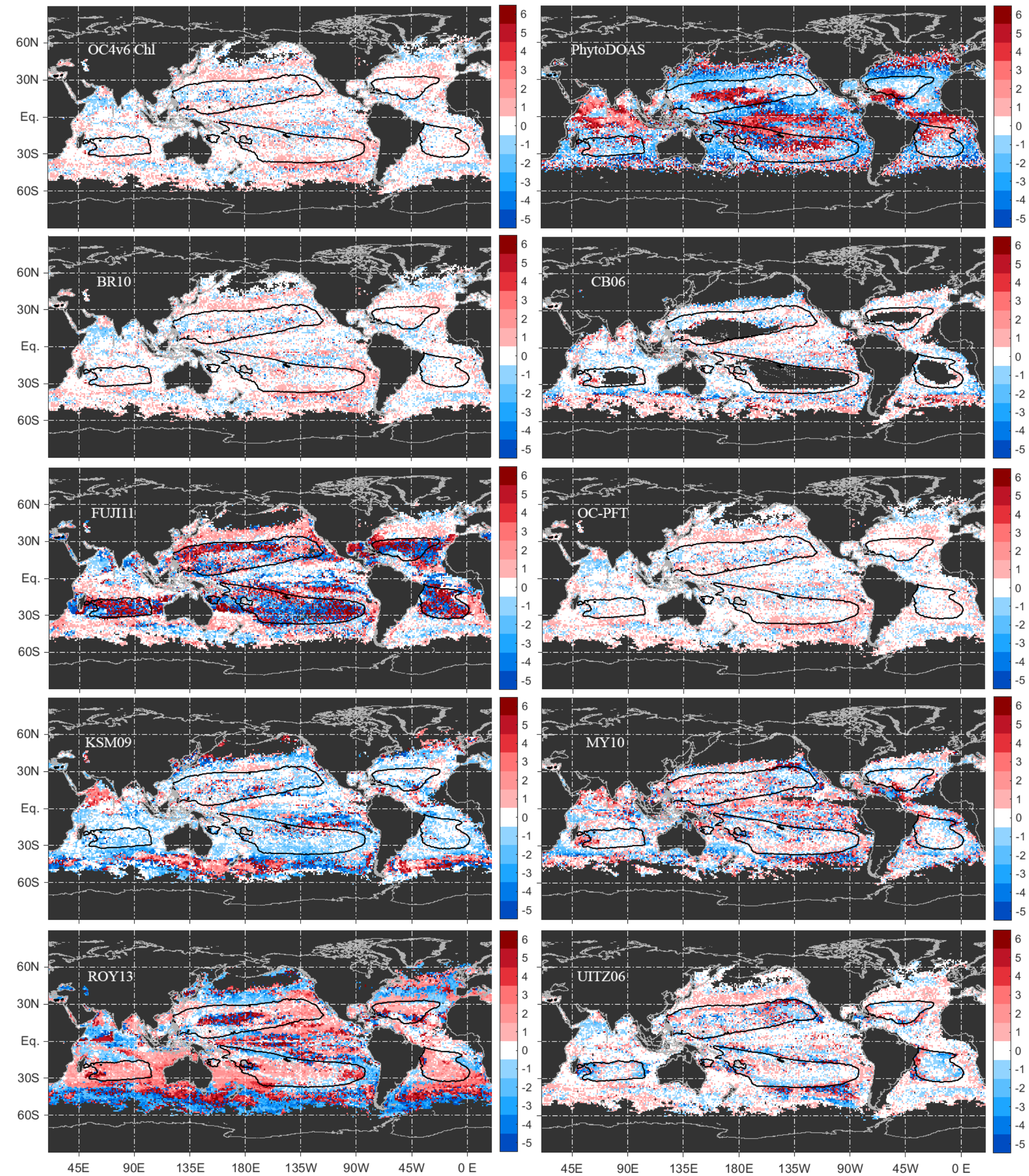
May 2013: IOCS Splinter Meeting on “PFTs from space” with recommendations to agencies

Oct 2014: IOCCG WS on “Phytoplankton Composition from Space: towards a validation strategy for satellite algorithms”

NASA TM #217528_01-22-15 - action items & recommendations

http://www.ioccg.org/groups/PFT-TM_2015-217528_01-22-15.pdf

Month of Maximum Differences



Phenology of microplankton through Fourier analysis

Kostadinov et al. (in prep.)

Objectives

1) How current satellite phytoplankton composition products are and could be used in modeling (climate, ecosystem, optical) activities and ecosystem and fisheries management.

   - Global models
   - Fisheries management
   - Aquaculture management
   - HABs and water quality

Objectives

2) *In situ* observational needs and opportunities to support forthcoming satellite capabilities leading to expanded satellite phytoplankton composition algorithm approaches and products.

- Overview of observational capability
  - HPLC pigments
  - microscopy
  - Particle imaging
  - genomics

Guiding Questions

- Many of the approaches are globally focused; where as users often have a local interest. With the current validation and detection capabilities, how do we best serve interested users? How best can we communicate strengths and limitations so the appropriate products are matched with a given use?

- What is most valuable for users?
  - Clear communication of algorithm uncertainty, strengths & limitations with each end use in mind

- What coordinated efforts in future satellite PFT algorithm development would have the most impact?
  - Selecting specific unified datasets to work with coincident AOPs, IOPs, and phytoplankton composition (from pigments at minimum)
    - Utilizing existing time series sites rich in phytoplankton composition information
    - Adding additional phytoplankton composition observational capability
    - Ensuring inter-calibration and standardization of measurements advancing the knowledge of phytoplankton composition *in situ*

Initial User Product Scoping from OOXXII

Product type	Application	Product specification	Units	Uncertainty (user requirement)
Phytoplankton size structure	Open ocean: productivity assessments, trophic energy flows, fisheries, climate and ocean acidification assessments	• large (micro), medium (nano) and small (pico) phytoplankton • continuous phytoplankton size spectrum	• Dominant size class • Proportion of total population (% Chl or carbon) • Concentration (mg m^{-3} Chl or C)	
	Coastal: as above	• As above	• As above	
Biogeochemical functional types	Earth system, climate and ocean acidification assessments	• Multiple-functional types to characterise whole phytoplankton community • Coccolithophores (calcifiers) • Trichodesmium (N2 fixers) • Diatoms (carbon export) • Haptophytes (DMS producers) • Cyanobacteria	• Presence • Dominant type • Proportion of total population (% Chl or carbon) • Concentration (mg m^{-3} Chl or C) • Liths per m^{-3} (coccolithophores only) • Trichomes per m^{-3} (Trichodesmium only)	
HABs	Water quality	• High intensity blooms • Specific spectral signatures of known HAB types	• Presence/absence • Concentration (mg m^{-3} Chl or toxin, cells m^{-3})	

Courtesy of Nick Hardman-Mountford

Gap Analysis

	Existing	Desired (10-15 years)	Needed
In situ Observations	• Reasonable global distribution of HPLC pigments. Some pigment time series. • Few time series of particle imaging • Rapidly growing genomic capabilities • Little synergy between observational types	• Broad global distribution and many time series sites of coordinated pigment, particle imaging and genomic observations. • Expanding platforms for phytoplankton observing	• Coordination of existing time series sites with AOPs, IOPs, and phytoplankton composition. • Investment in additional phytoplankton composition observations • Development of unified protocols and data repository for various types of phytoplankton composition observations.
Algorithm Strengths/ Limitations	• Primarily global • Rooted mostly in multispectral resolution • Broad similarities but many divergent details	• Hyperspectal exploitation resulting in greater discrimination of functional types • Reduced uncertainty due to improved sensor capability and reduced input product uncertainty. • Identification of 'standard' PFT products for various applications.	• Coordinated use of identical independent datasets in development and validation across all algorithms. • Exploitation of current hyperspectral as synergistic use to multispectral satellite data
Meeting Users Needs	• Some comparisons to global models • Limited regional implementation for fisheries management	• Clear communication limitations and uncertainty. • Condensing range of algorithm options based on intended use and uncertainty requirements.	• Greater regional scale algorithm development surrounding prioritized user needs