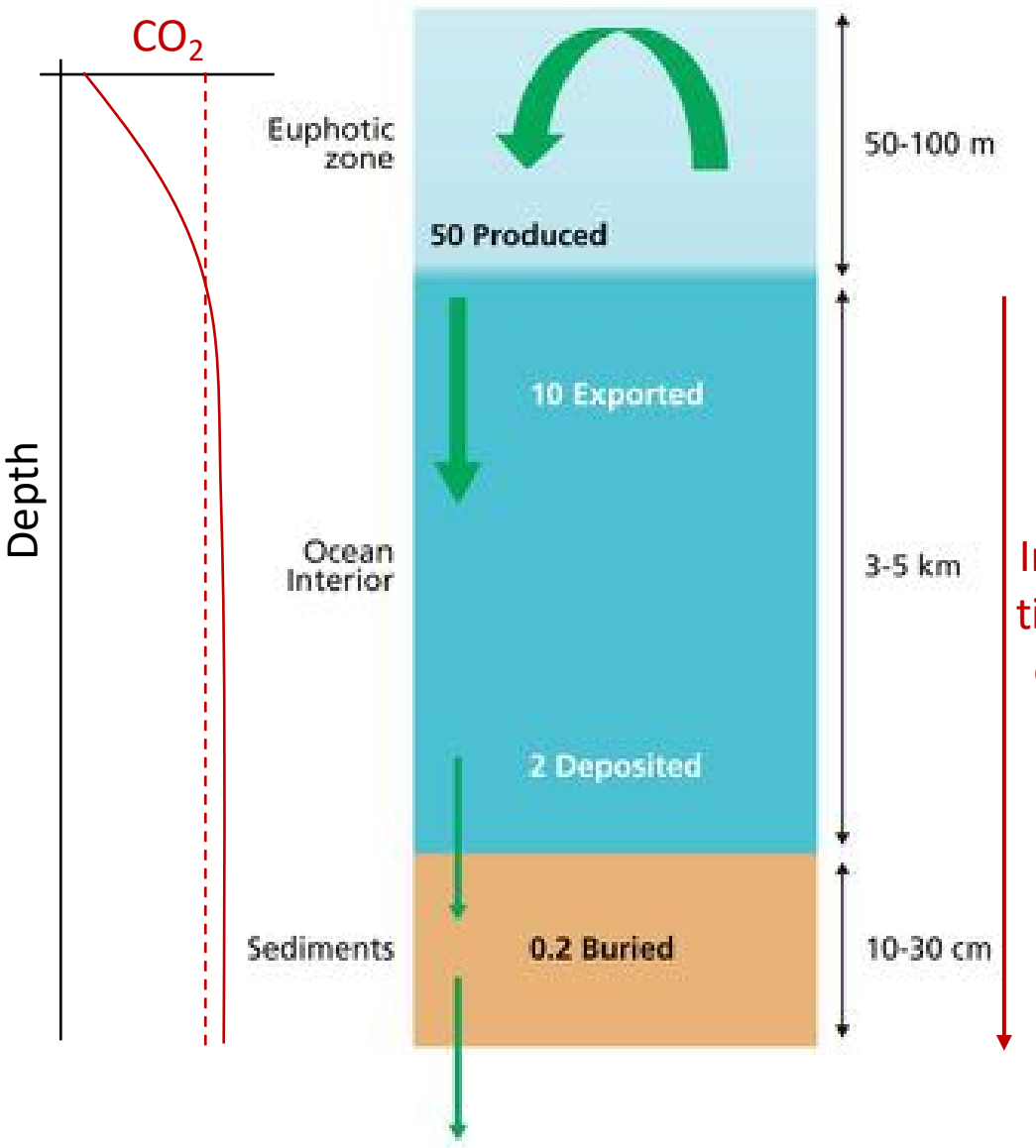
IOCCG Working Group on Ocean primary production from space

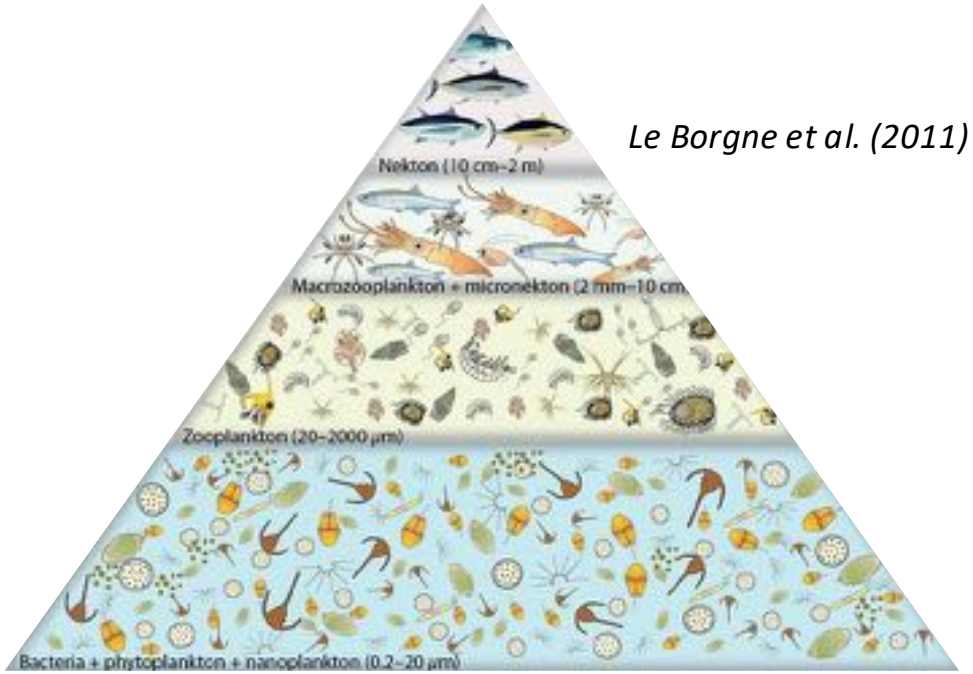
Bob Brewin, ZhongPing Lee, Joaquim Goes, David Antoine, Žarko Kovač, Frédéric Mélin, Ryan Vandermeulen, Qiang Hao, Gemma Kulk, Shubha Sathyendranath, Michael Behrenfeld, Toby Westberry, Xin Liu, Heather Bouman, Peng Chen, Chin-Chang Hung, Jinghui Wu, John Marra, Junwu Tang, Mini Raman, Tom Jackson, Joji Ishizaka

Carbon Cycle

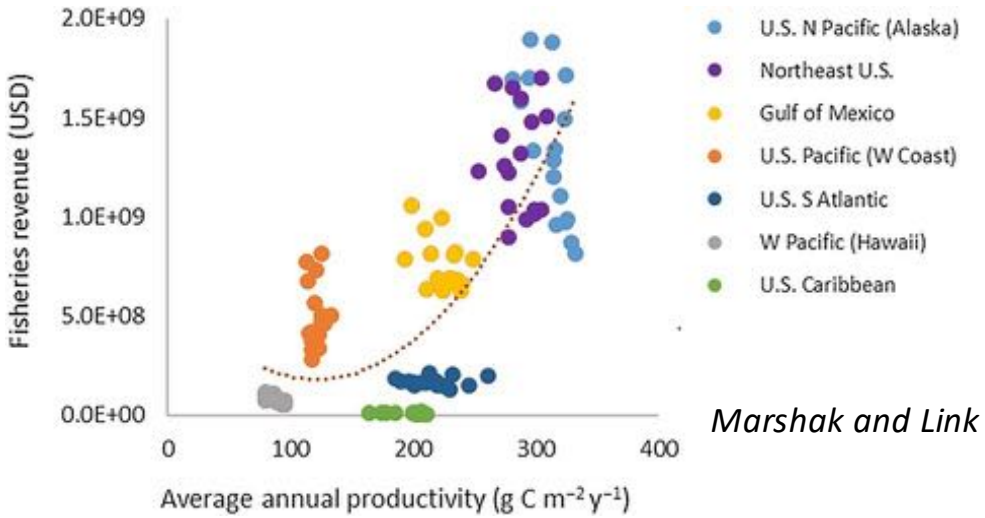


Middelburg (2019)

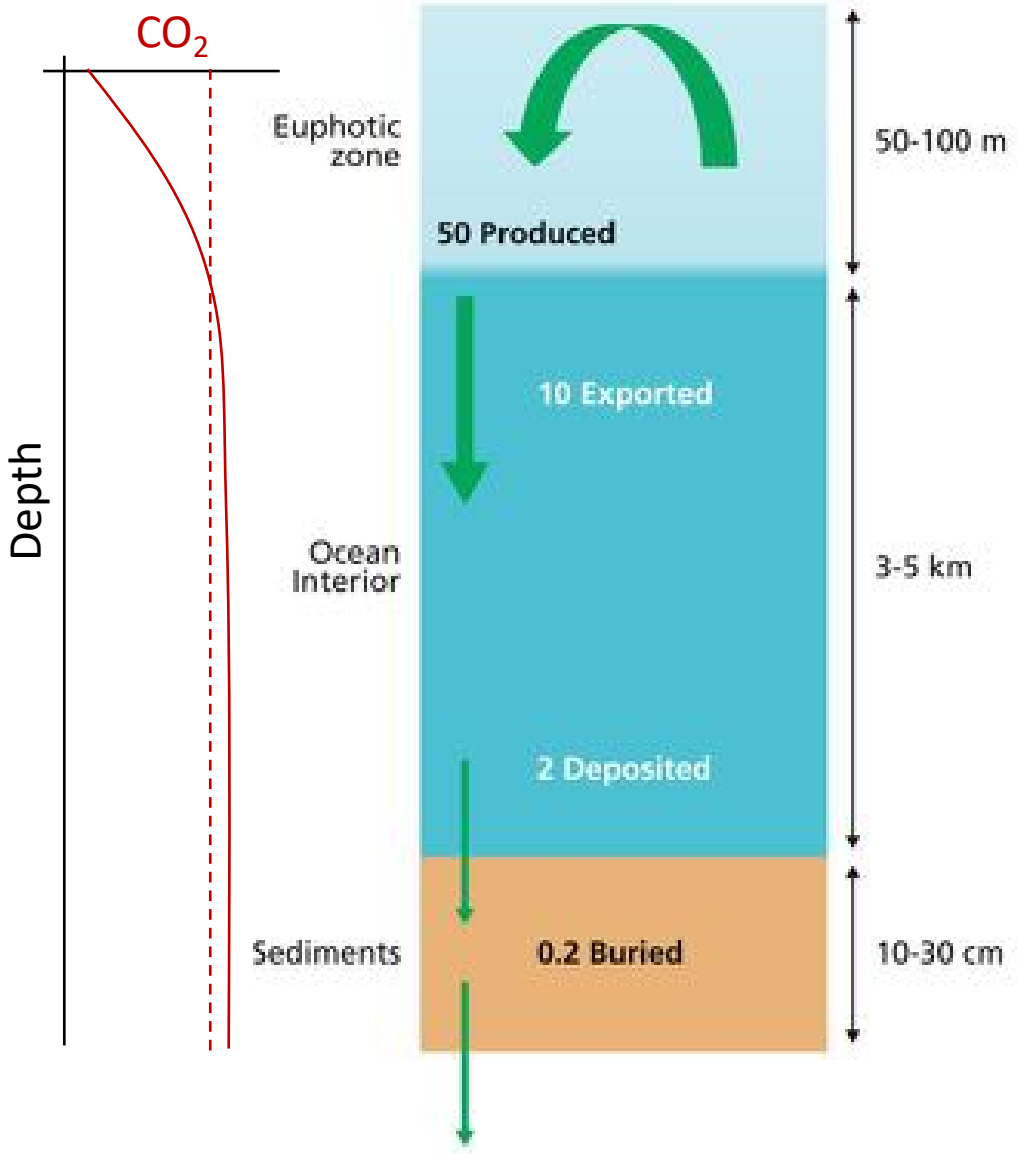
Fisheries



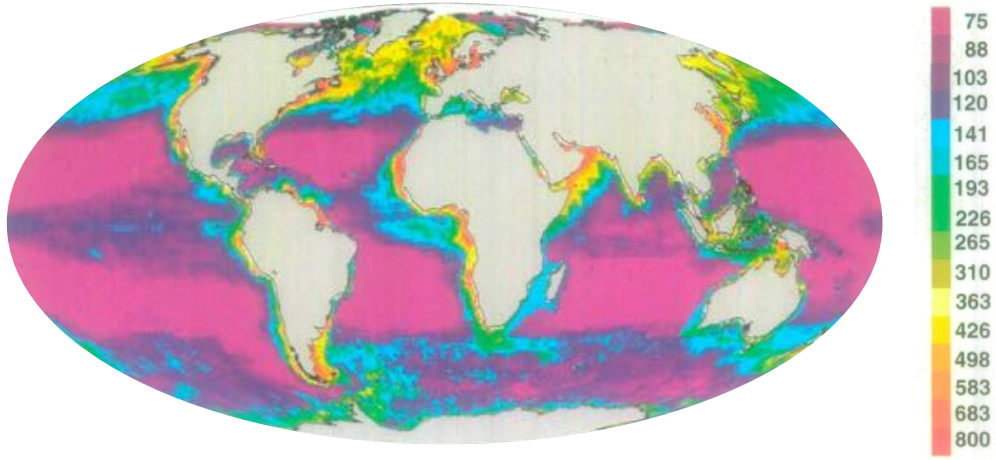
Le Borgne et al. (2011)



Marshak and Link (2021)



Middelburg (2019)



Longhurst et al. (1995)
(see also Antoine et al. 1996; Behrenfeld and Falkowski, 1997)

No IOCCG Report on Primary Production exists

Notwithstanding the effort and work that has gone on in the background since the mid-1990's

Primary Production Algorithm Round Robin (PPARR)

Campbell et al. (2002), Carr et al. (2006), Friedrichs et al. (2009), Saba et al. (2010), Saba et al. (2011) & Lee et al. (2015)

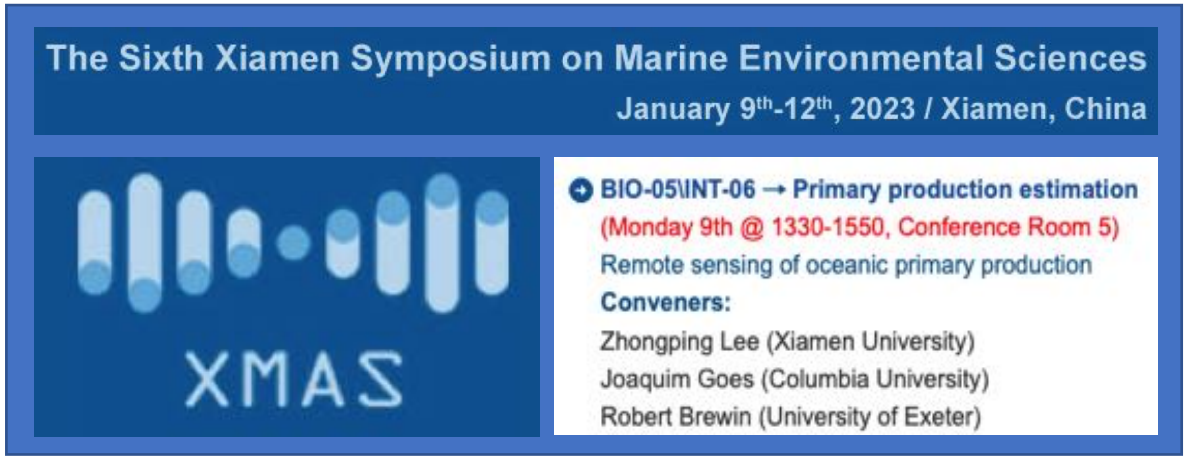
MAPPS

esa

BICEP
Biological Pump and Carbon Exchange Processes

Kulk et al. (2020)
Bouman et al. (2019)

Timeline



January 2023 idea of forming WG spun out of session on Primary Production Estimation at the 6th XMAS conference

IOCCG Working group proposal accepted

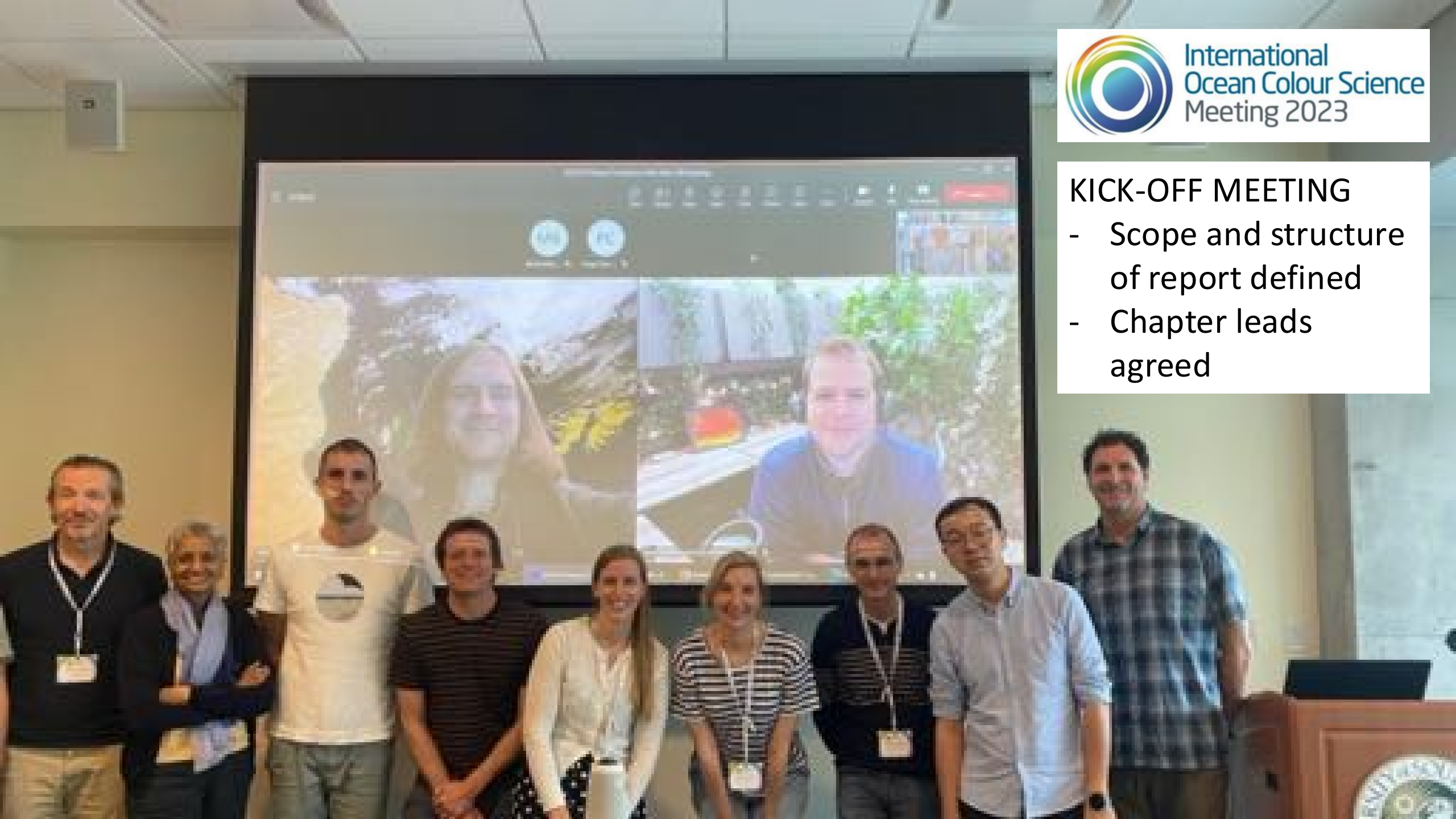
Bob Brewin, ZhongPing Lee & Joaquim Goes

Working group proposal submitted, Bob presented proposal at IOCCG Committee meeting and proposal was accepted April 2023

IOCCG WG Webpage set-up

https://ioccg.org/group/oceanpp/

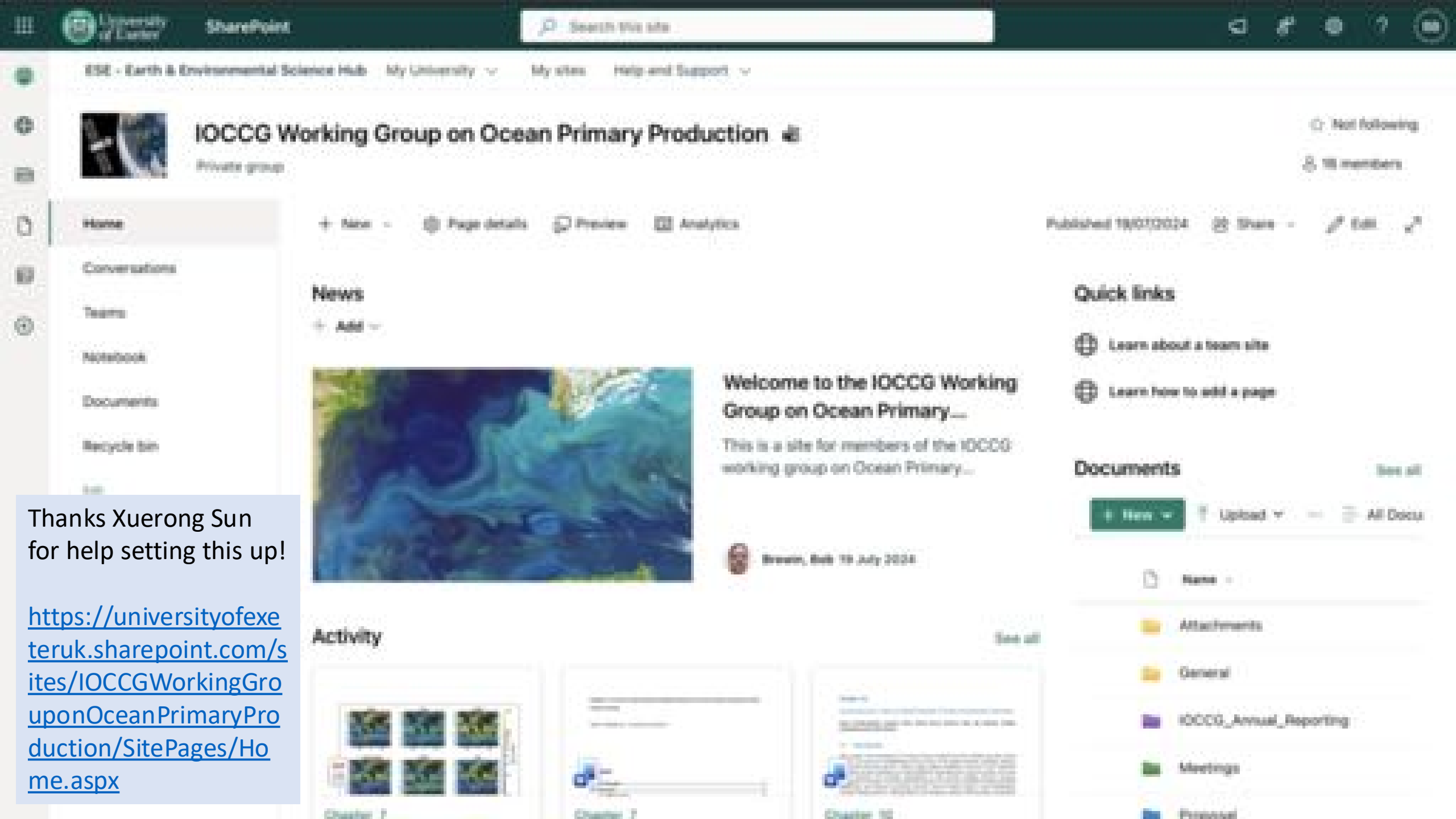
Formal webpage setup on the IOCCG website June 2023



International Ocean Colour Science Meeting 2023

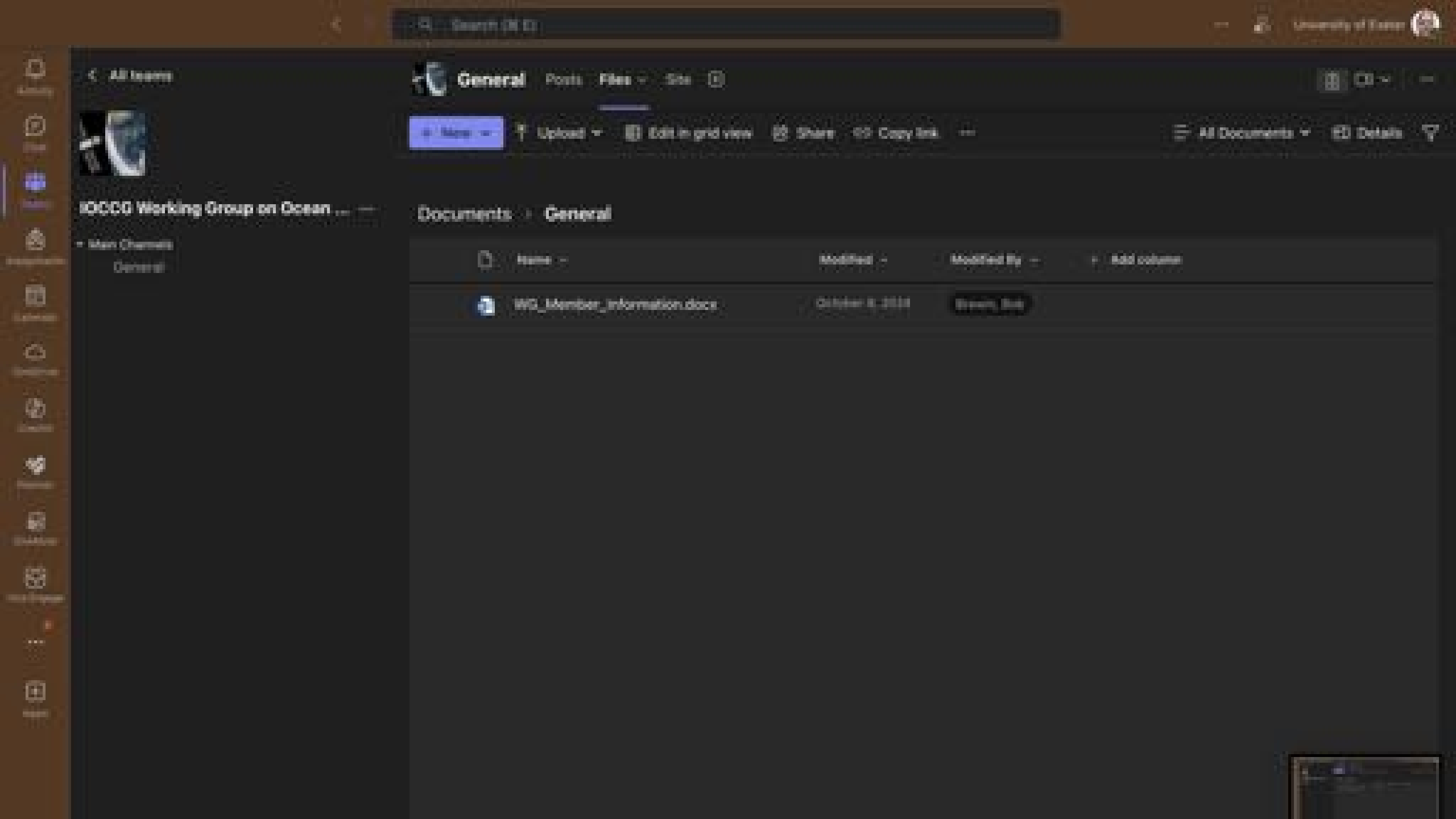
KICK-OFF MEETING

- Scope and structure of report defined
- Chapter leads agreed



Thanks Xuerong Sun for help setting this up!

https://universityofexeteruk.sharepoint.com/sites/IOCCGWorkingGrouponOceanPrimaryProduction/SitePages/Home.aspx


All teams
General
Posts
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New
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IOCCG Working Group on Ocean ...
Main Channels
General
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Name
Modified
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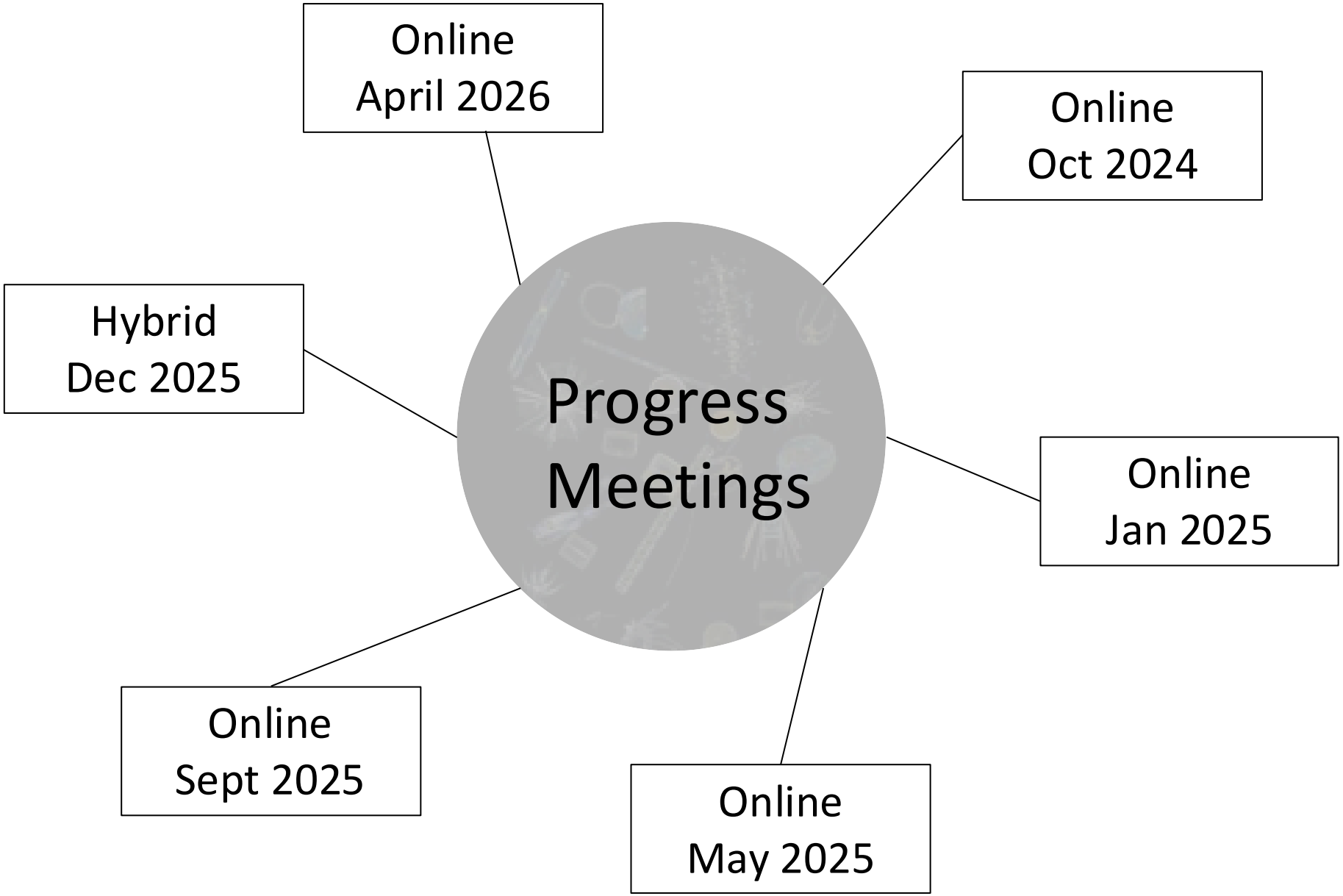
WG_Member_Information.docx



See minutes on SharePoint site under folder meetings

Chapter 1: Introduction and Overview (Lead Bob)

Chapter 2: Mechanisms of photosynthesis and photoacclimation (Lead Mike)

Chapter 3: In situ methods for measuring primary production and relevance of scales (Heather)

Chapter 4: Fundamentals of modelling primary production (Shubha)

Chapter 5: Strategies to estimating primary production from remote sensing: 1 Input variables (ZhongPing)

Chapter 6: Strategies to estimating primary production from remote sensing: 2 Model parameters (Gemma)

Chapter 7: Current understanding of global estimates of ocean primary production from remote sensing (Toby)

Chapter 8: Uncertainties in primary production modelling (Frederic)

Chapter 9: Future perspectives (David)

Chapter 10: Socio-economic Value of Satellite-based Primary Productivity Estimates (Ryan)

Chapter 11: Summary and Recommendations (Joaquim)

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Deadline 31st May 2026

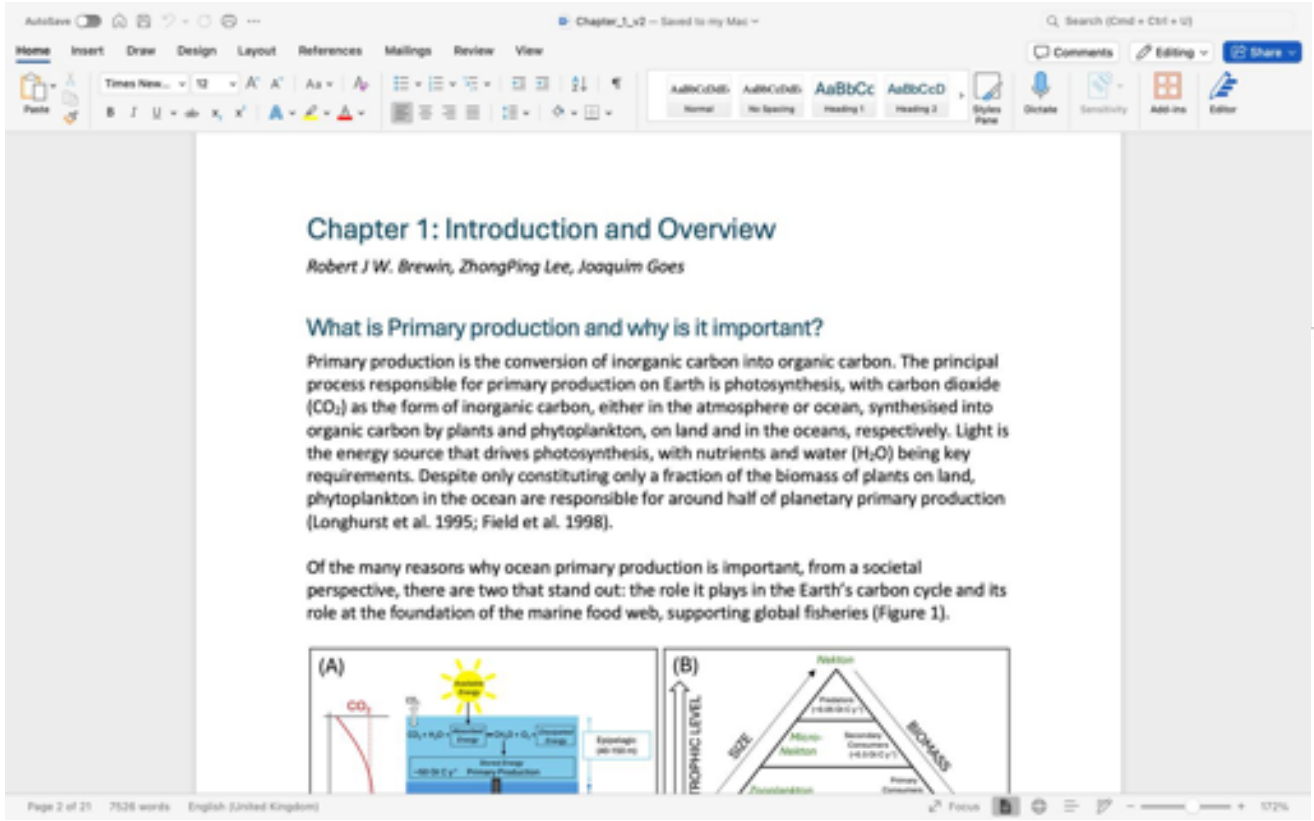
Hard deadline 30th June 2026

Draft completed
Draft started
Draft not started

List of symbols, notations, acronyms currently circulated for comment with the aim to be consistent across chapters

Symbol	Definition	Typical units *NB: these are provided for guidance. Actual units may vary depending on model formulation, scaling, and the basis of normalisation.*
a	Absorption coefficient	m^{-1}
$a^*_{[chl]}$	Chlorophyll-*a* specific phytoplankton absorption coefficient	m^2 (mg [chl])$^{-1}$
a_d	Absorption coefficient of NAP	m^{-1}
a_g	Absorption coefficient of CDOM	m^{-1}
a_p	Particulate absorption coefficient	m^{-1}
$\overline{a_{phy}}$	Spectrally averaged phytoplankton absorption coefficient	m^{-1}
a_{phy}	Phytoplankton absorption coefficient	m^{-1}
a_w	Pure seawater absorption coefficient	m^{-1}
b	Scattering coefficient	m^{-1}
b_b	Backscattering coefficient	m^{-1}
b_{bp}	Particulate backscattering coefficient	m^{-1}
$b_{b,phy}$	Phytoplankton backscattering coefficient	m^{-1}
b_{bw}	backscattering coefficient	m^{-1}
C	Carbon	mg C
C_{cell}	Phytoplankton carbon per cell	mg C
C_{phy}	Phytoplankton carbon	mg C m^{-3}
C_{POC}	Particulate Organic Carbon	mg C m^{-3}
[chl]	Chlorophyll-*a* concentration	mg [chl] m^{-3}

Acronyms and Abbreviations	Definition
AbPM	Absorption-based Production Model
AOP	Apparent Optical Property
ATP	Adenosine triphosphate
BGC-Argo	Biogeochemical Argo float
CAFE	Carbon, Absorption, Fluorescence, Euphotic-resolving NP
CALIOP	Cloud-Aerosol Lidar with Orthogonal Polarization
CbPM	Carbon-based Production Model
CCI	Climate Change Initiative
CDOM	Chromophoric Dissolved Organic Matter
CDM	Coloured Detrital Material
CDR	Climate Data Record
Chl	Chlorophyll-*a* concentration
ΣChl	Depth integrated chlorophyll concentration
CMEMS	Copernicus Marine Environment Monitoring Service
CMIP	Coupled Model Intercomparison Project
CZCS	Coastal Zone Color Scanner
DIC	Dissolved Inorganic Carbon
DOC	Dissolved Organic Carbon
ECV	Essential Climate Variable
EO	Earth Observation
EP	Export Production
E-VGPM	Eppley- Vertically Generalized Production Model
ESA	European Space Agency
ESM	Earth System Model
ESV	Ecosystem Service Valuation



Chapter 1: Introduction and Overview

Robert J W. Brewin, ZhongPing Lee, Joaquim Goes

What is Primary production and why is it important?

Primary production is the conversion of inorganic carbon into organic carbon. The principal process responsible for primary production on Earth is photosynthesis, with carbon dioxide (CO_2) as the form of inorganic carbon, either in the atmosphere or ocean, synthesised into organic carbon by plants and phytoplankton, on land and in the oceans, respectively. Light is the energy source that drives photosynthesis, with nutrients and water (H_2O) being key requirements. Despite only constituting only a fraction of the biomass of plants on land, phytoplankton in the ocean are responsible for around half of planetary primary production (Longhurst et al. 1995; Field et al. 1998).

Of the many reasons why ocean primary production is important, from a societal perspective, there are two that stand out: the role it plays in the Earth's carbon cycle and its role at the foundation of the marine food web, supporting global fisheries (Figure 1).

(A) (B) TROPHIC LEVEL SIZE BIOMASS

Converting Word Chapters into LaTeX format

Chapter 1

Introduction and Overview

Robert J W. Brewin, Zhongping Lee and Joaquim Goes

1.1 What is Primary production and why is it important?

Primary production is the conversion of inorganic carbon into organic carbon. The principal process responsible for primary production on Earth is photosynthesis, with carbon dioxide (CO_2) as the form of inorganic carbon, either in the atmosphere or ocean, synthesised into organic carbon by plants and phytoplankton, on land and in the oceans, respectively. Light is the energy source that drives photosynthesis, with nutrients and water (H_2O) being key requirements. Despite only constituting only a fraction of the biomass of plants on land, phytoplankton in the ocean are responsible for around half of planetary primary production (Longhurst et al. 1995; Field et al. 1998).

Of the many reasons why ocean primary production is important, from a societal perspective, there are two that stand out: the role it plays in the Earth's carbon cycle and its role at the foundation of the marine food web, supporting global fisheries (Figure 1.1).

1.1.1 Role of primary production in the Earth's carbon cycle

It is estimated that ocean primary production in the epipelagic zone constitutes around $50\,Gt\,C\,yr^{-1}$ (Carr et al. 2006; Kulk et al. 2020). It is currently assumed that around 20% of this primary production ($10\,Gt\,C\,yr^{-1}$) get exported out of the epipelagic into the ocean interior (Figure 1.1A), with the remaining 80% remineralised in the epipelagic. Of the $10\,Gt\,C\,yr^{-1}$ of export production, it is thought around $2\,Gt\,C\,yr^{-1}$ is deposited at the seafloor ($8\,Gt\,C\,yr^{-1}$ remineralised in the ocean interior, see key processes attenuating flux in Figure 1.1A) and $0.2\,Gt\,C\,yr^{-1}$ buried

Currently using the LaTeX file from Report 18 (thanks Frédéric for supplying this)

Tentative deadlines

Draft chapter hard deadline	30th June 2026
Compile full report and complete recommendations	30th Sept 2026
Deadline for comments on full report by WG members	30th Nov 2026
Provide final to IOCCG committee for external review	31th Jan 2027
Report completed	31th Apr 2027