A modeler's perspective: Validity and impact of carbon satellite products

Session 9: Carbon from ocean colour radiometry

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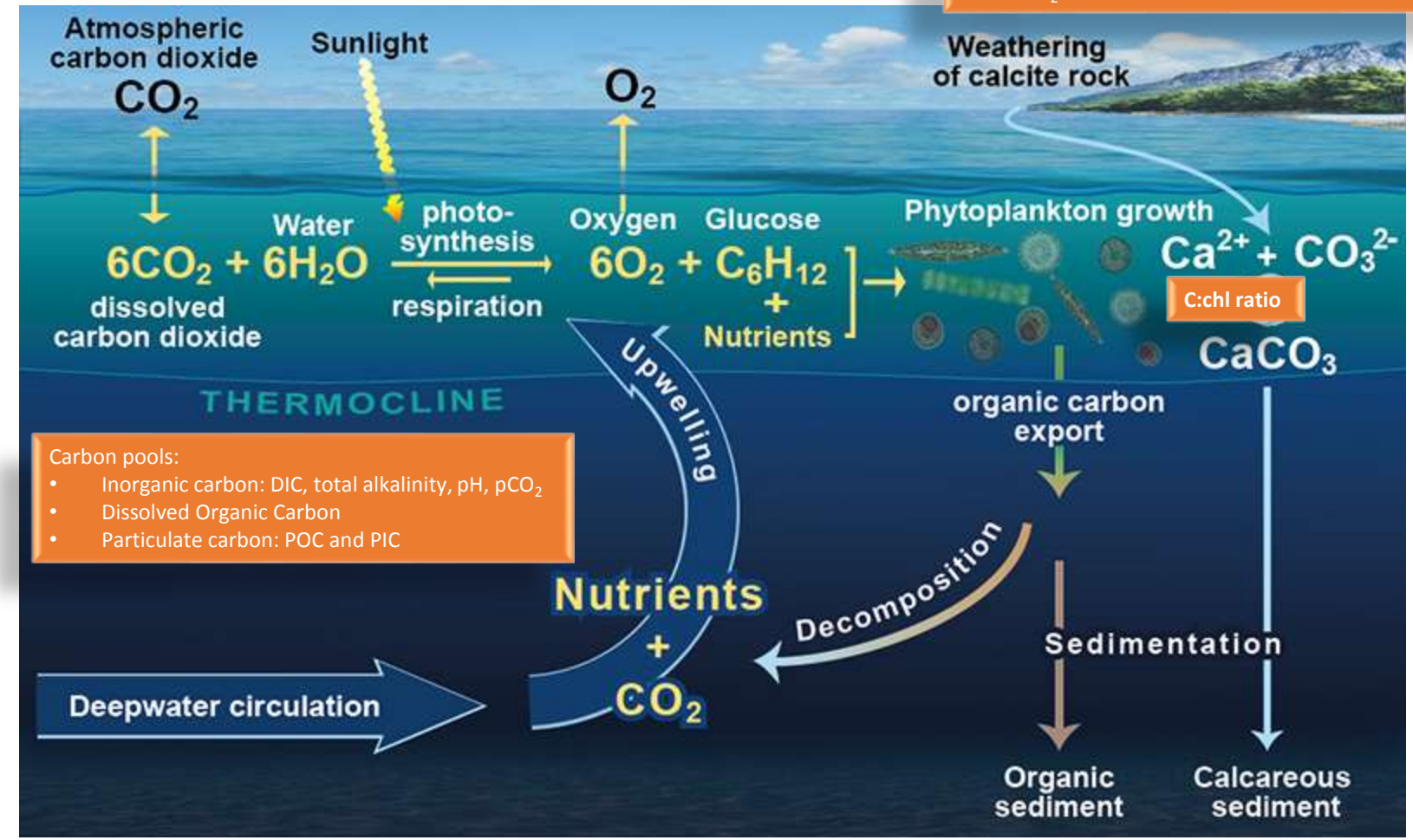
Carbon Pools and processes in the Oceans

Carbon fluxes:
- Particulate carbon export
- FCO_2



- Subject to anthropogenic activities
- Ocean=net carbon sink
- Ocean acidification
- Higher trophic levels

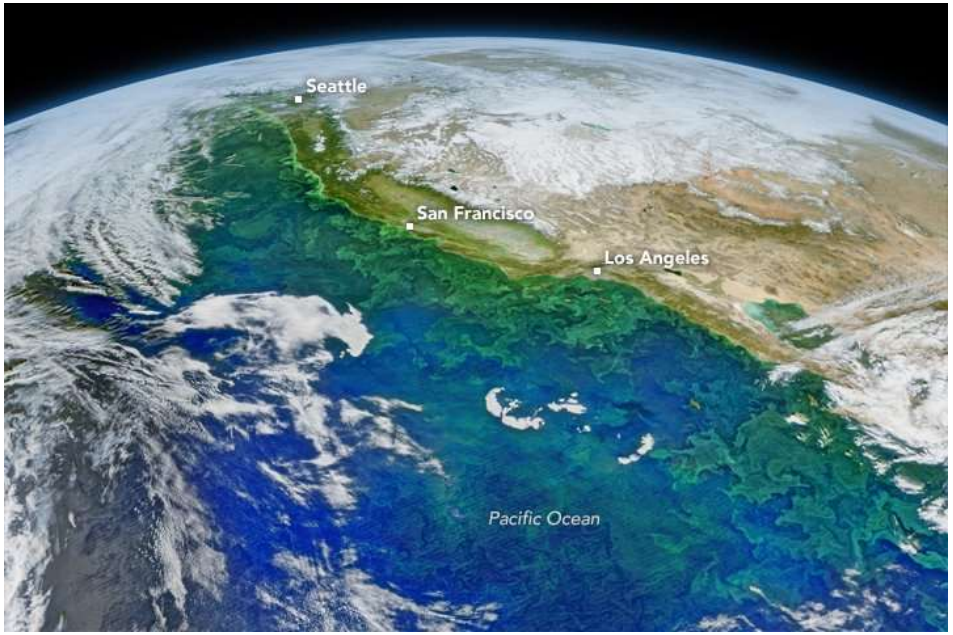
From Atlantic Biogeochemical Fluxes project
Credit: NOC/V.Byfield

Satellite ocean color and ocean biogeochemical models : Why?

- Global representation
- Variables not currently available from satellites
- Projections

Satellite ocean color and ocean biogeochemical models : How?

- Validation
- Parametrization
- Assimilation



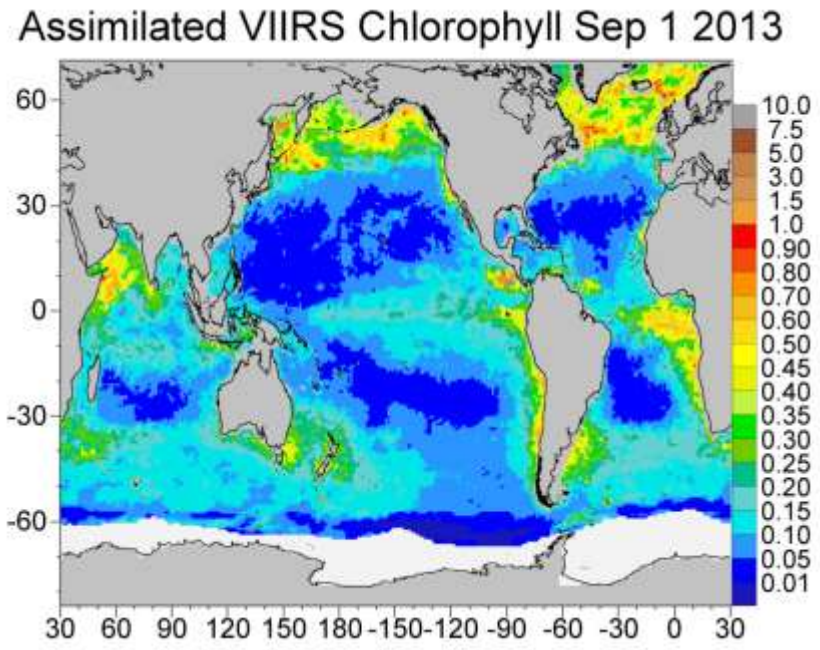
Using models to provide a global representation

Global mean chlorophyll representations are distorted by gaps in sampling. Ocean color missions typically observe only about **15%** of the ocean per day
Due to:

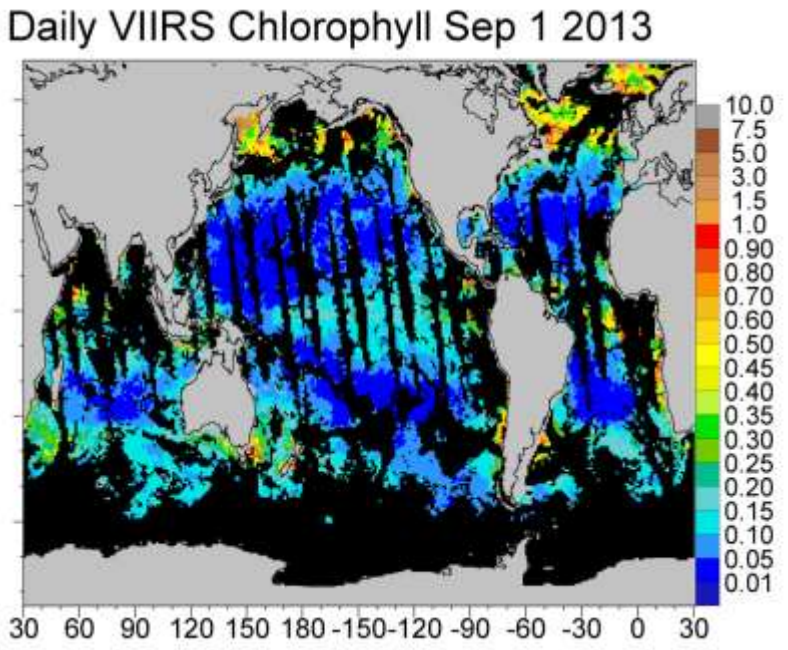
- inter-orbit gaps
- insufficient light for detection at high latitudes
- sun glint
- clouds
- aerosols

Gregg, 2008

	Bias	Uncertainty	N
SeaWiFS	-1.3%	32.7%	2086
Free-run Model	-1.4%	61.8%	4465
Assimilation	0.1%	33.4%	4465

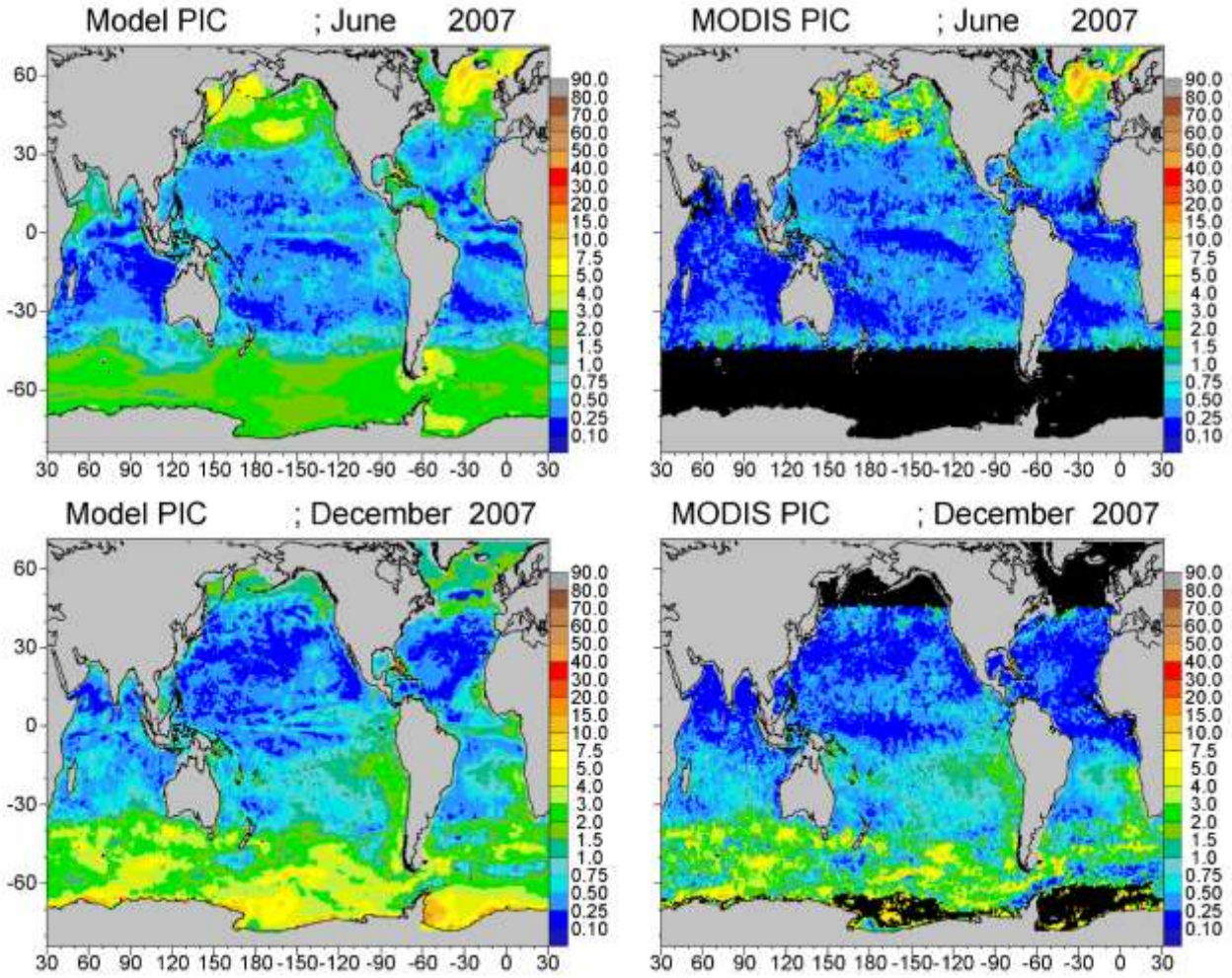


Ice fields are shown in white.



Missing data is shown in black.

Particulate Inorganic Carbon (µg C L^{-1})



Gregg and Rousseaux, 2017

- Concentration within -28.5% of satellite PIC ($P<0.05$, $R = 0.868$)
- Higher PIC in Southern Ocean in December
- Unable to capture high concentration in June in high northern latitudes

→ Need to know the uncertainties of the carbon satellite products

→ Increasing satellite products available can/should be used in models

Assimilation not only improves surface chlorophyll representation…
(Slide courtesy of David Ford - Ford and Barciela 2016)

Using:

- **HadOCC (Had**ley Centre **O**cean **C**arbon **C**ycle Model)
- Ocean colour data assimilation

Assimilation of ocean color can also improve the model's representation of:

- Chlorophyll concentration throughout the water column (including the frequency and positioning of DCM)
- Slight improvement in nutrient concentrations and
- Improvement of surface fugacity of carbon dioxide compared with in situ observations, although the overall impact on mean fields was small

	Free run			Assimilation run	
DCM?	Yes in model	No in model		Yes in model	No in model
Yes in obs	**984**	**604**		**1107**	**481**
No in obs	**206**	**1403**		**223**	**1386**
Correct	**74.7 %**			**78.0 %**	

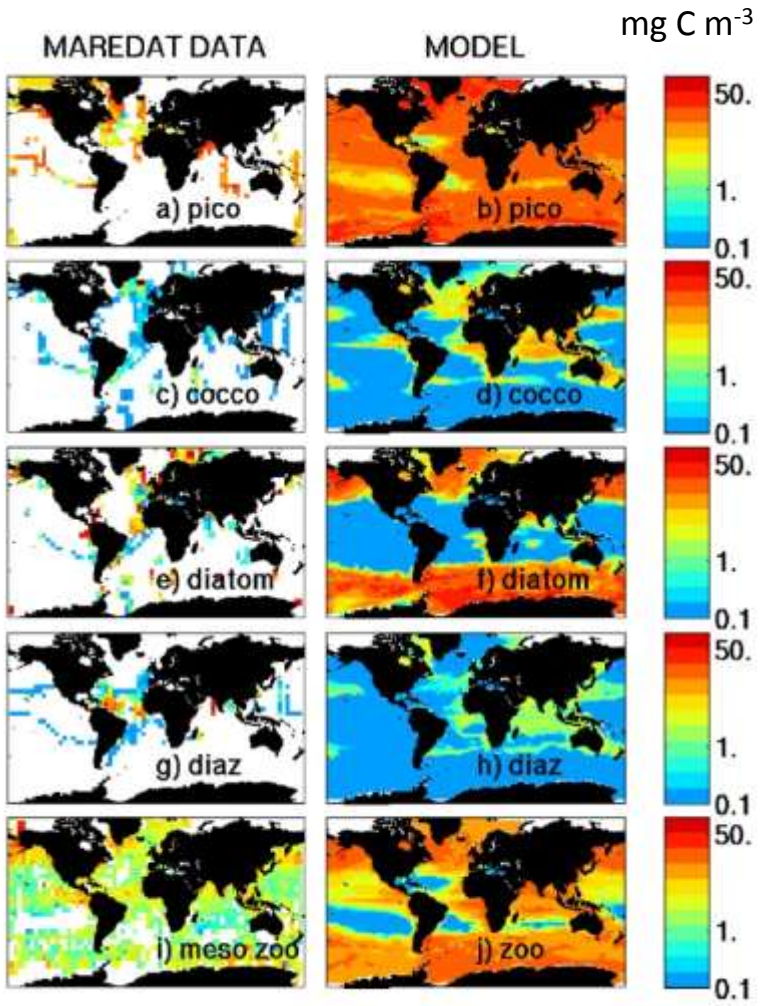
Additional variables that models can provide : Phytoplankton carbon

- MIT 'Darwin' Ecosystem Model
- 9 phytoplankton, 2 zooplankton
- Radiation Transfer model (OASIM)
- Intercomparison model versus in situ carbon products

POCO: comparison of MIT carbon pools with satellite-derived carbon products (Anna Hickman)

Assess reasons for disparities between satellite carbon products (POC and phytoplankton C) and biogeochemical model output

- what extent are we comparing 'apples' to 'oranges'?
- do underlying assumptions in model and satellite products differ?
- what can we learn from models to help inform use of existing (or new) products?



Dutkiewicz et al. 2015

PML Plymouth Marine Laboratory

esa

Role of Ocean Colour in Biogeochemical, Ecosystem and Climate Modelling

Chair:

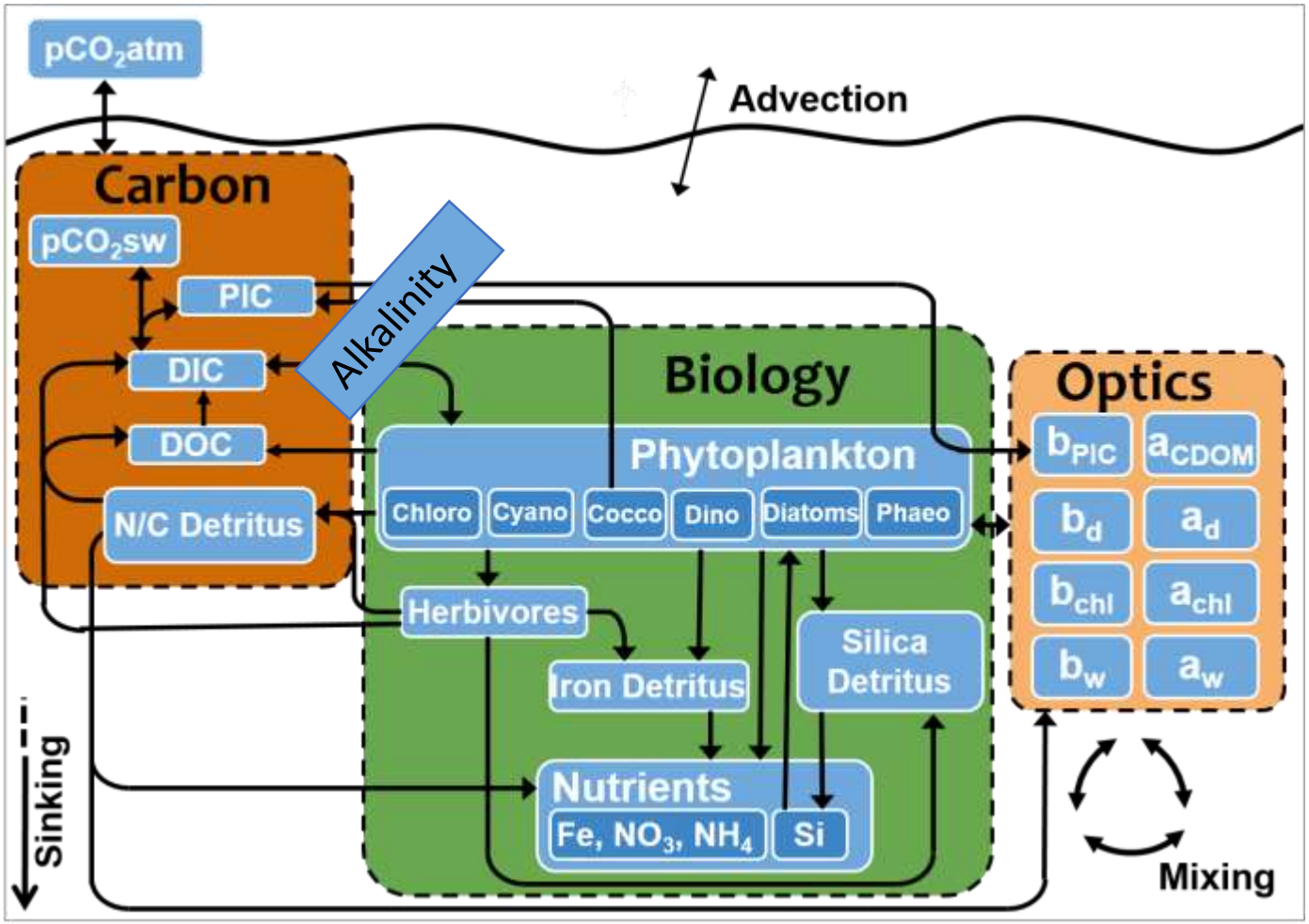
Stephanie Dutkiewicz
Massachusetts Institute of Technology (MIT)
Cambridge MA 02139, USA
Email: stephd@ocean.mit.edu

Working Group Documents

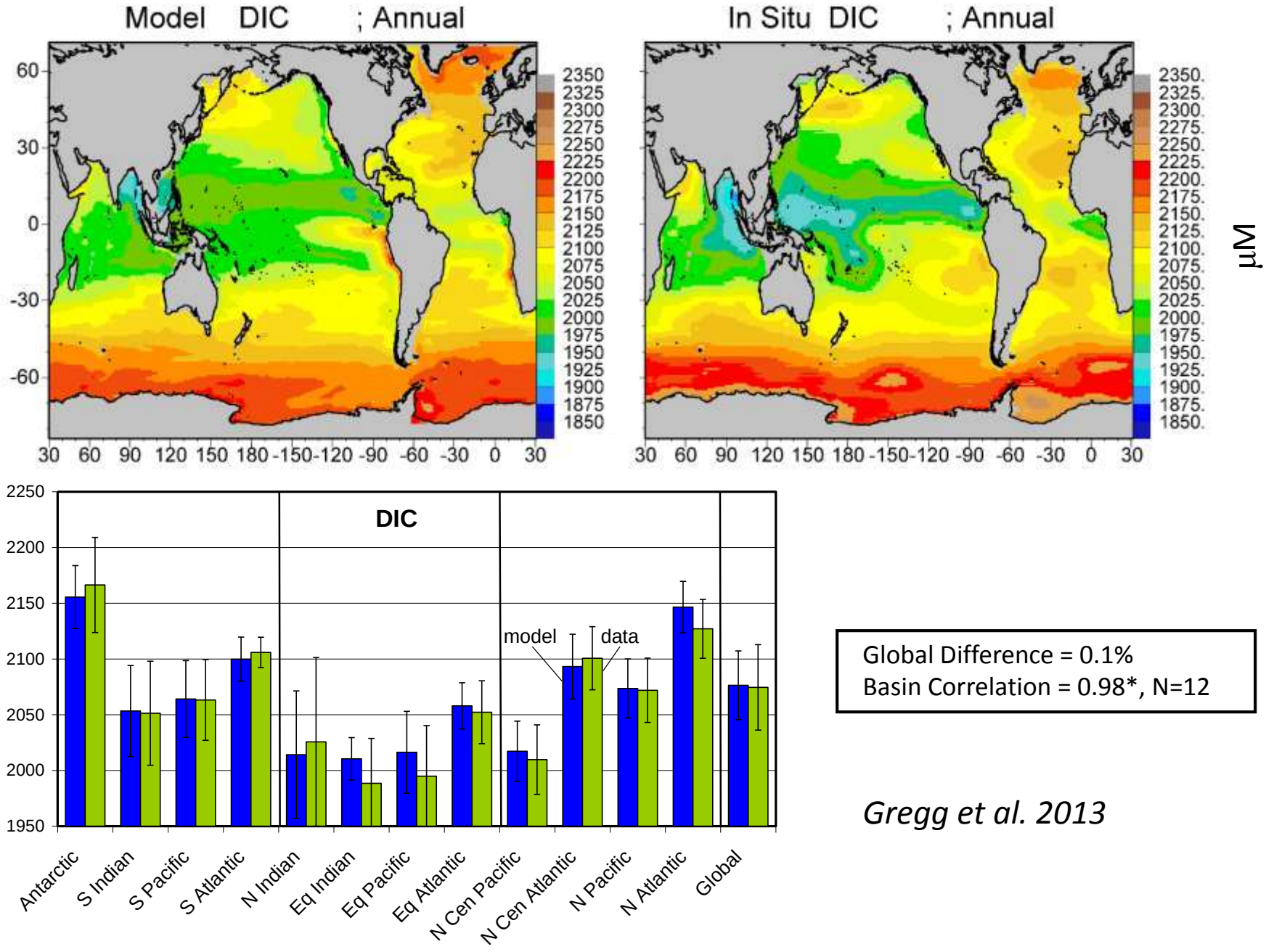
Working group proposal (August 2015)

Additional variables that models can provide : Dissolved Inorganic Carbon

The NASA Ocean Biogeochemical Model (NOBM)



- Interactions among the carbon, biological and optical components
- Assimilation of satellite products (e.g. chlorophyll, PIC and aCDOM)



Global Difference = 0.1%
Basin Correlation = 0.98*, N=12

Gregg et al. 2013

Dissolved Inorganic Carbon: Model represents DIC quite well

Where are the critical shortcomings and needs in modeling of carbon pools?

(1) Appropriate temporal and spatial scale of satellite-derived fields

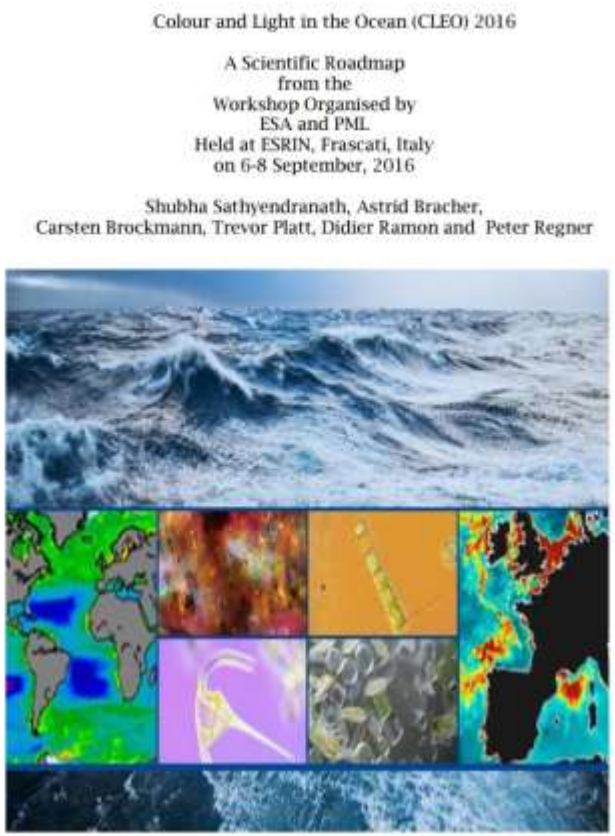
(2) Additional variables (PP, phytoplankton carbon, particulate and dissolved carbon)

(3) Priority to surface fields

(4) Info at high latitudes

(5) Communication between in situ/satellite and modelling community

http://esaconferencebureau.com/2016-events/Cleo/workshop-report



Where are the critical shortcomings and needs?
What is ready for operational agencies to pick up?
Algorithms development and validation: what actions are needed?
What is needed from in situ observations?
What are the priority directions, evolution of needs?

Where to from here? What are the priority needs/directions for the modeling community?

- Assimilation of biogeochemical variables from satellites in models
- Assess long-term trends in carbon pools

What is needed from in situ observations?

- Maintain in situ data for validation/parametrization

Algorithms development and validation: what actions are needed?

- Uncertainties of satellite product for model evaluation
- Right currency between satellite products and models-needed for intercomparison efforts
- Need for additional satellite derived carbon products

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What are the priority directions, evolution of needs?

Thank you,
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