CLimate Impact on MARine ECOsystem State

CLIMARECOS

Marie-Fanny Racault
Institution Host: Shubha Sathyendranath
Research profile

Earth Observation Scientist

Biological Oceanography

MRes, University of Paris VI, France 2004-2005

Phylogenetic studies of small brown algae

MPhil, University of Portsmouth, UK 2005-2006

Phytoplankton Phenology in the Global Oceans

PhD, University of East-Anglia, UK 2006-2010

Ocean-Colour Remote Sensing Applications

Research Scientist, PML, UK 2010 - present
IPCC AR5: “medium evidence” for how the highly-productive regions are responding to recent warming (especially since the 1970s) and “low confidence” in the understanding of how equatorial upwelling systems will change in response to ENSO variability
(Hoegh-Guldberg et al., 2014; WG2, Chapter 30 – The Ocean)
Analysis of Contemporary Data Records

Pressure:
- El Niño variability
- Climate Index

Suite of Indicators from OC-CCI:
- Chlorophyll
- Primary Production
- Phenology (timing, duration)

Chlorophyll OC-CCI

Central Pacific
El Niño

Eastern Pacific
El Niño

Capotondi et al., JAS 2014

Racault et al., In prep.

Analysis of Past Data Records and Ecosystem Model Outputs

Pressure:
- Climate Change
- Warmer scenario

Phenology Indicators from CZCS

Suite of Indicators from Ecosystem Model
Phenology algorithm: Improvements with OC-CCI data
Phenology algorithm improvements with OC-CCI

a) Improved temporal resolution: from 8-day to 5-day

Algorithm based on Chlorophyll threshold: Racault et al., 2012

- Global oceans
- Interannual variability
- Phenological indices estimated for 1 growing period per year

Algorithm based on cumulative sum of Chl anomalies: Racault et al., 2015

OC-CCI Chl climatology (mg.m\(^{-3}\))

0.1

OND J F M A M J J A S

SeaWiFS 8-day

OC_CCI 5-day

Date

Nov Oct Jul May Mar Jan

year 2004
c) Further development

- Global oceans
- Interannual variability
- Improved resolution
- Improved algorithm
- Phenological indices estimated for up to 2 growing periods per year
Impact of El Niño variability

Capotondi et al., 2014
El Niño Impact on Temperature

Regression analysis

Impact on Air Temperature Anomalies - North America

Yu et al., GRL 2012
El Niño Impact on Temperature

Regression analysis

Impact on Sea Surface Temperature Anomalies

EP El Niño impact + CP El Niño impact

Index

Temp. anomalies

Slope

MEI impact

The 'classical' MEI impact view is a mixture of the impacts of the two types of El Niño.
El Niño Impact on Oceanic phytoplankton

Central Pacific El Niño Impact

Chlorophyll OC-CCI

Eastern Pacific El Niño Impact

Chlorophyll OC-CCI

Racault et al., In prep.
El Niño Impact on Sea Level and Wind

Central Pacific El Niño Impact

Geirach et al., 2012
CP event 2009-2010

Geirach et al., 2012


Eastern Pacific El Niño Impact

Geirach et al., 2012


Regression analysis 1997-2009
El Niño Impact on Sea Level and Wind

Central Pacific El Niño Impact

Sea Level-CCI data
ERA-I Wind data
Anomalies 1997-2009

Racault et al., In prep.

Eastern Pacific El Niño Impact
Mechanisms of El Niño Impact

- Interpretation of the dominant physical forcing mechanisms: horizontal and vertical advection, wind, riverine input, stratification.

Implications:

- Oceanic carbon cycle: variations in PP of -2.2 % during EP El Niño and +2.1 % during CP El Niño

- Fisheries: variations in phytoplankton biomass, PP, phenology, community structure (diatoms)

Racault et al., In prep.
Impact of El Niño Variability

Conclusions

• Regionally different patterns are observed in the response of phytoplankton and physical processes to the two types of El Niño.

• The ecosystem response presents a complex mosaic reflecting that different forcing mechanisms dominate in different regions.

• ENSO-type mode of variability contribute significantly to the regional trends in phytoplankton biomass estimated based on contemporary global ocean chlorophyll records, confounding attempts to isolate the changes due to climate change.

• The prevalence of one El Niño mode over another can have profound impacts on the marine ecosystem structure and functioning – affecting trophic interaction and carbon fluxes.

• The intensity and frequency of Central Pacific El Niño (Modoki) have increased significantly since the 1990s (Lee and McPhaden, 2010), and this trend is expected to continue under warming projection scenarios (Yeh et al., 2009).
Expectations on ESA and CCI Project Teams
Expectations on ESA and CCI Project Teams

Data and CCI Portal

• Importance of OLCI on Sentinel-3 cannot be underestimated. To have two identical sensors in orbit at the same time and in a sustained manner for decades is vital.

• As a user, I would appreciate the availability of all ECV’s from a common portal, mapped onto common grids and on common time scales would be appreciated.

• If the same portal could provide additional products (e.g. mixed-layer depth, wind) from ECMWF re-analysis, it would be extremely useful.

Scientific Support

• Being invited to CCI workshops and progress meetings is an excellent opportunity for networking and also for understanding the operational and research backgrounds of the CCI datasets.

• Learn more about ESA ITTs to help us continue our important science with ESA once our fellowship is completed.
Thank you for your attention

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