

# Ocean Carbon From Space 2022 Workshop

## Investigating The Co-occurrence Of Chlorophyll-a And Primary Production Deep Maxima In The Oligotrophic Eastern Mediterranean

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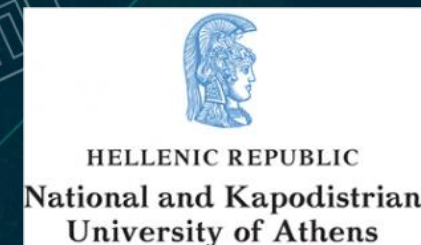
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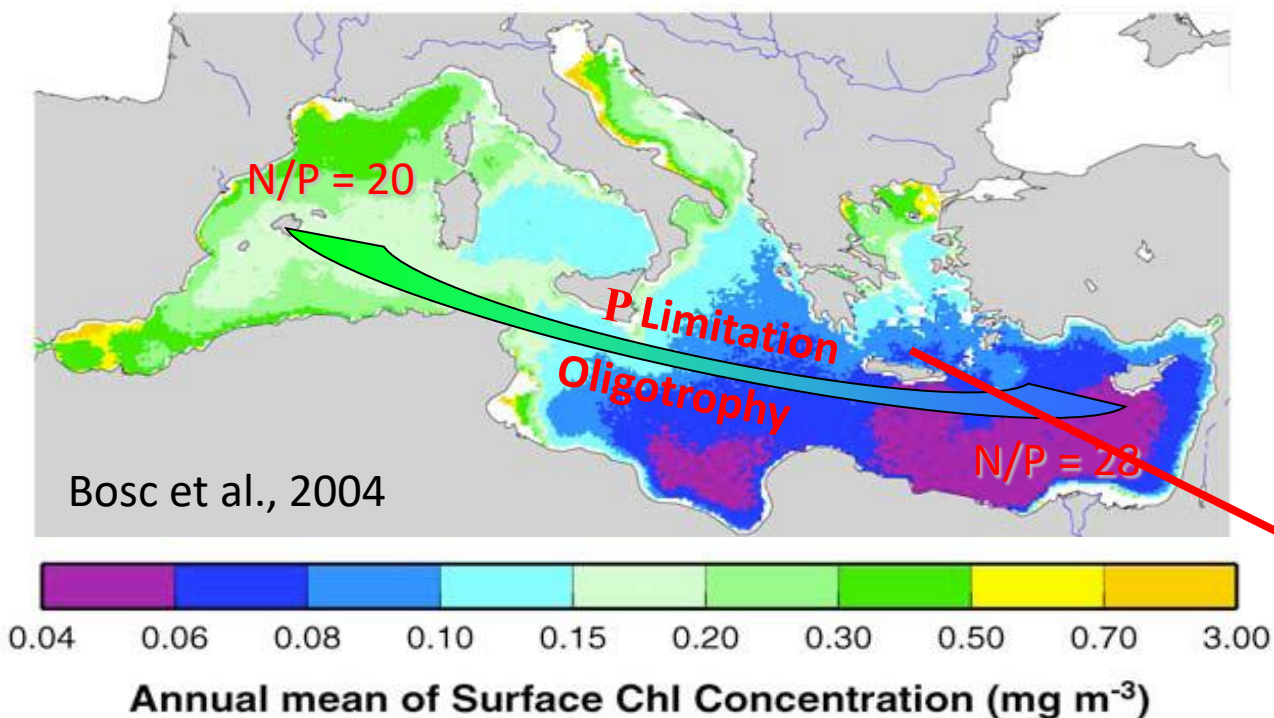
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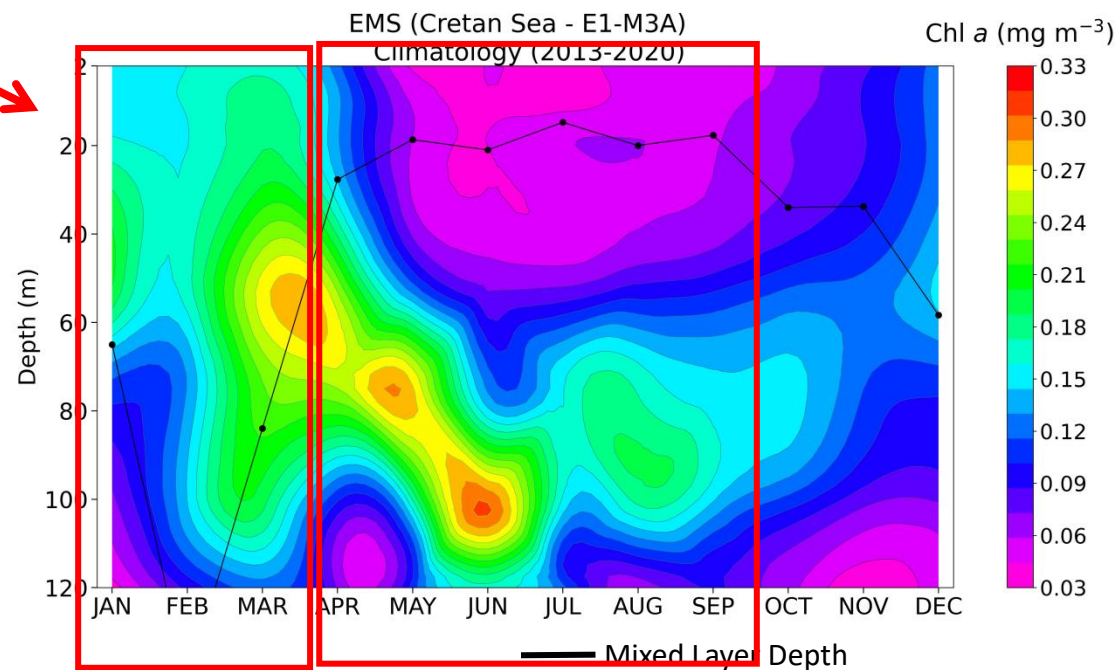
# The ultra-oligotrophic Eastern Mediterranean Sea (EMS)



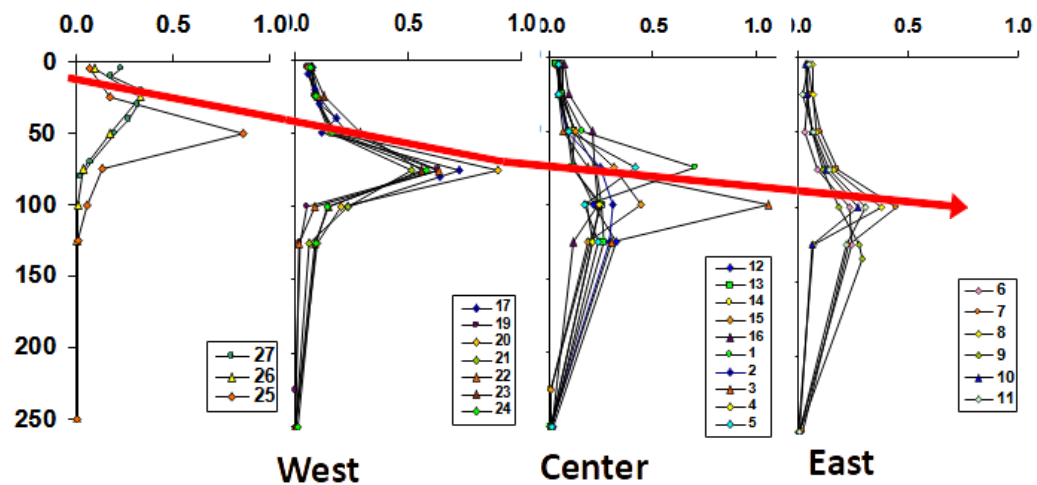
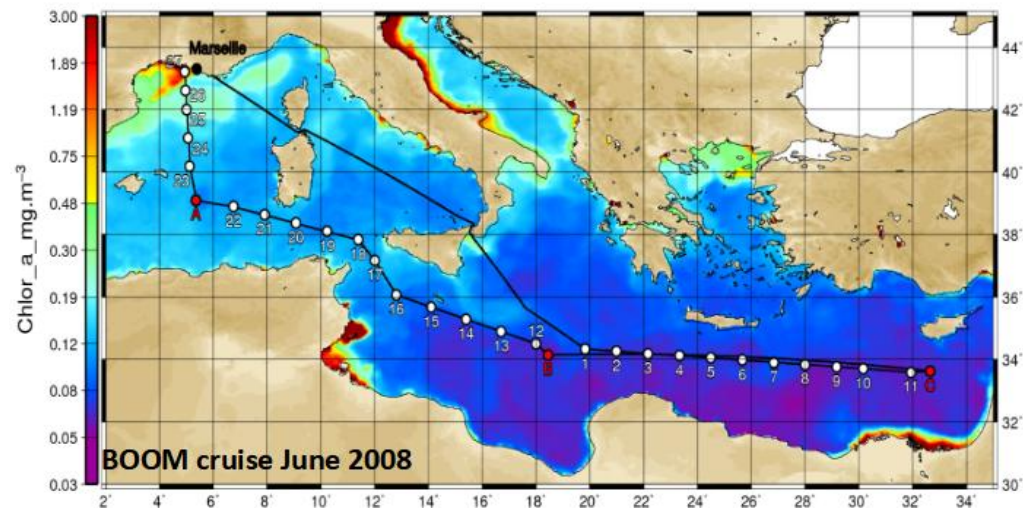
- Late autumn-early spring: Mixing period
- Late spring: Onset of thermal stratification, lasts until early autumn
- Quasi-permanent occurrence of the Deep Chlorophyll Maximum

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- West - East gradient of oligotrophy and N/P ratio



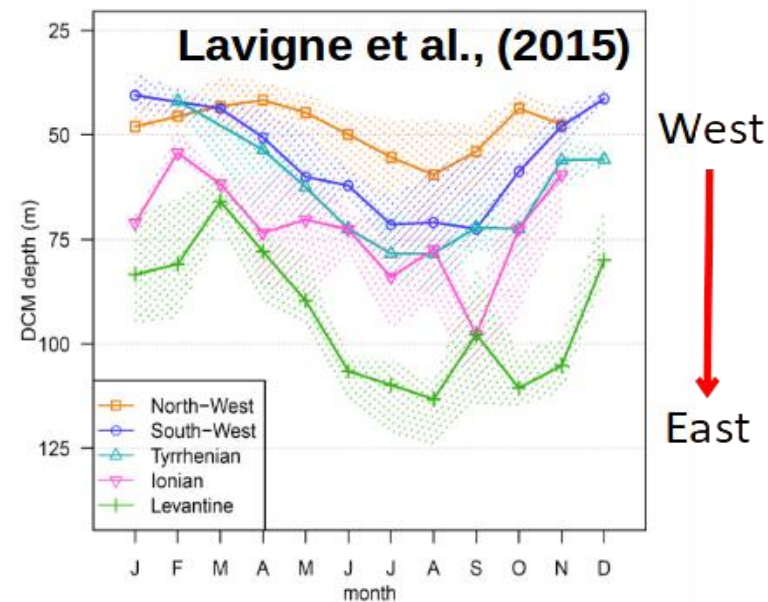
# Deep Chlorophyll Maximum (DCM) in the EMS



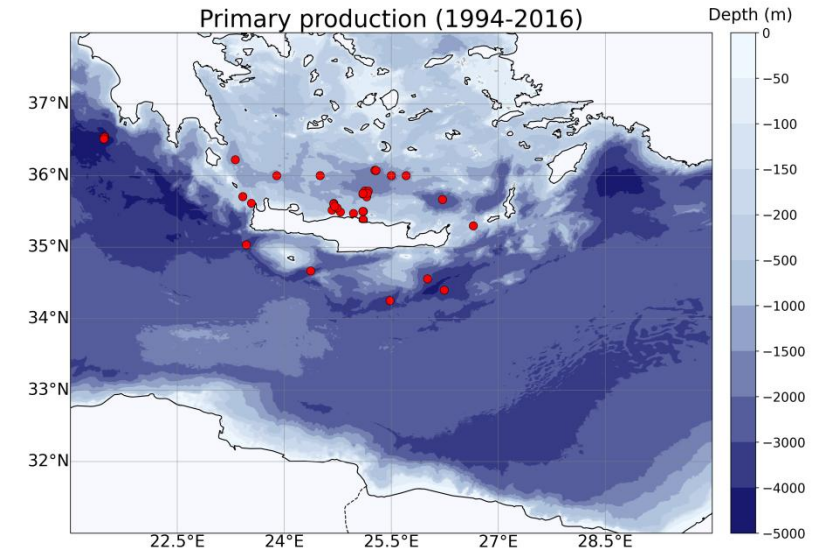
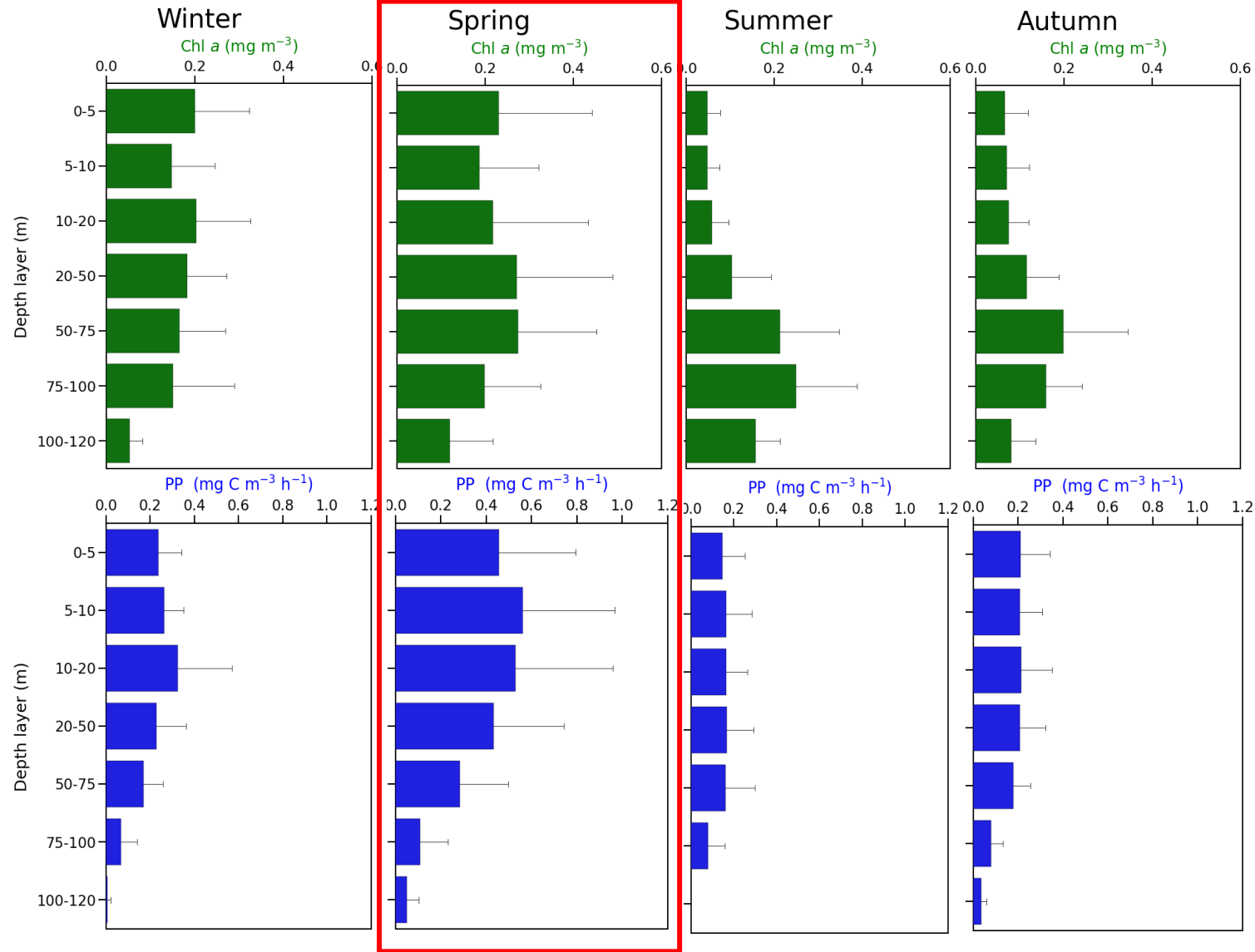
BOOM Transmediterranean cruise (June 2008) (Christaki et al., 2011)

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- DCMs: 30-120 m
- West - East gradient: Deepening of the DCM depth, decreasing absolute DCM Chl  $a$  values
- Seasonal variability: Deepening of DCM from March to summer and shallowing from late summer to November



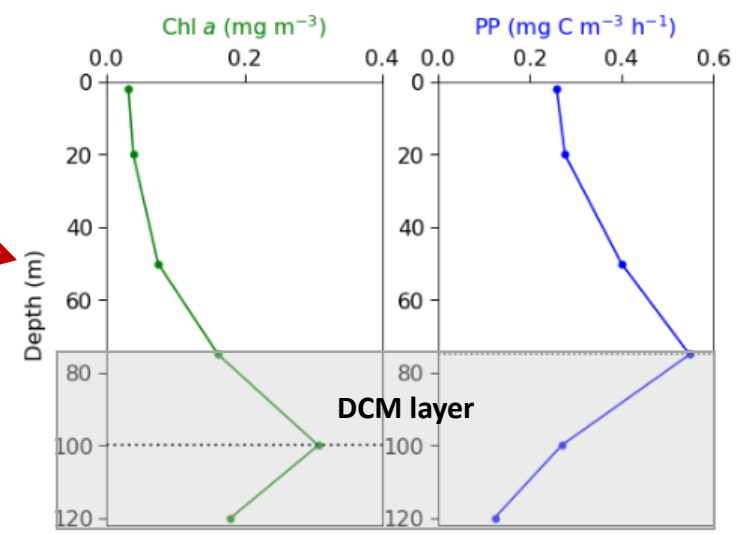
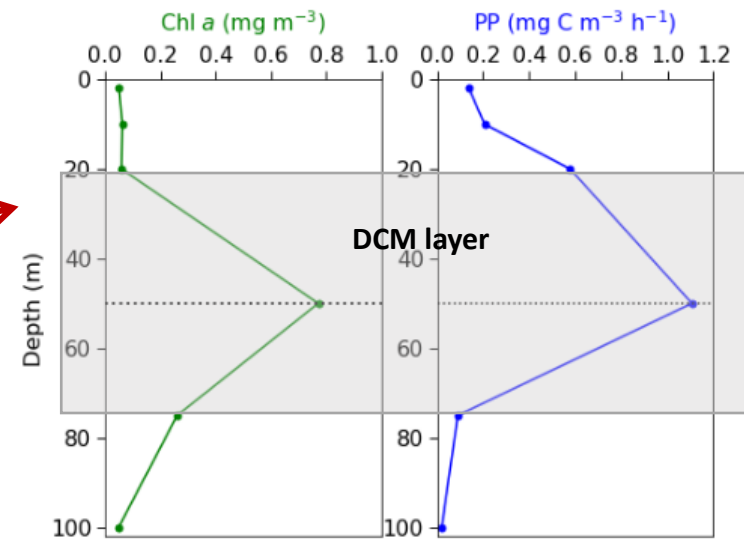
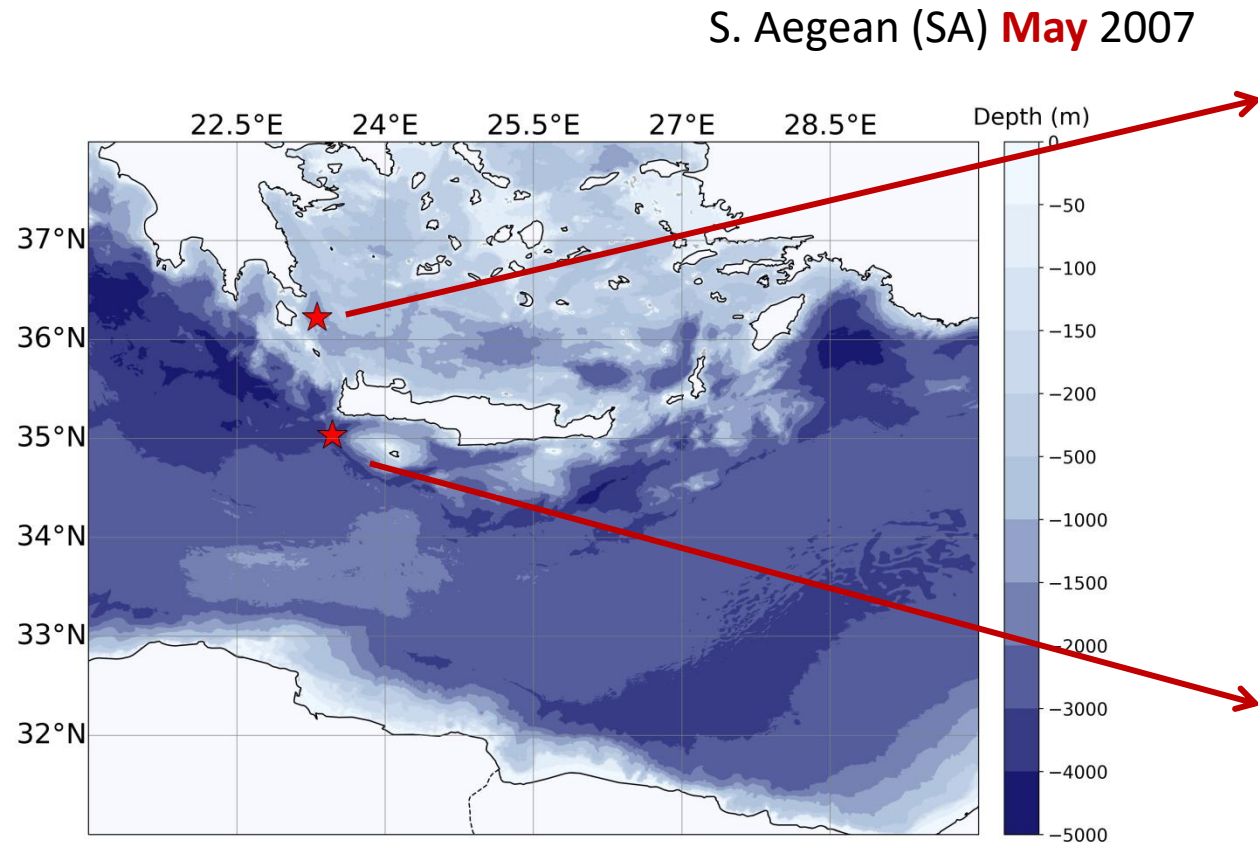
# Mechanisms of DCM formation in the EMS (1)



- **Photoacclimation**

# Mechanisms of DCM formation in the EMS (2)

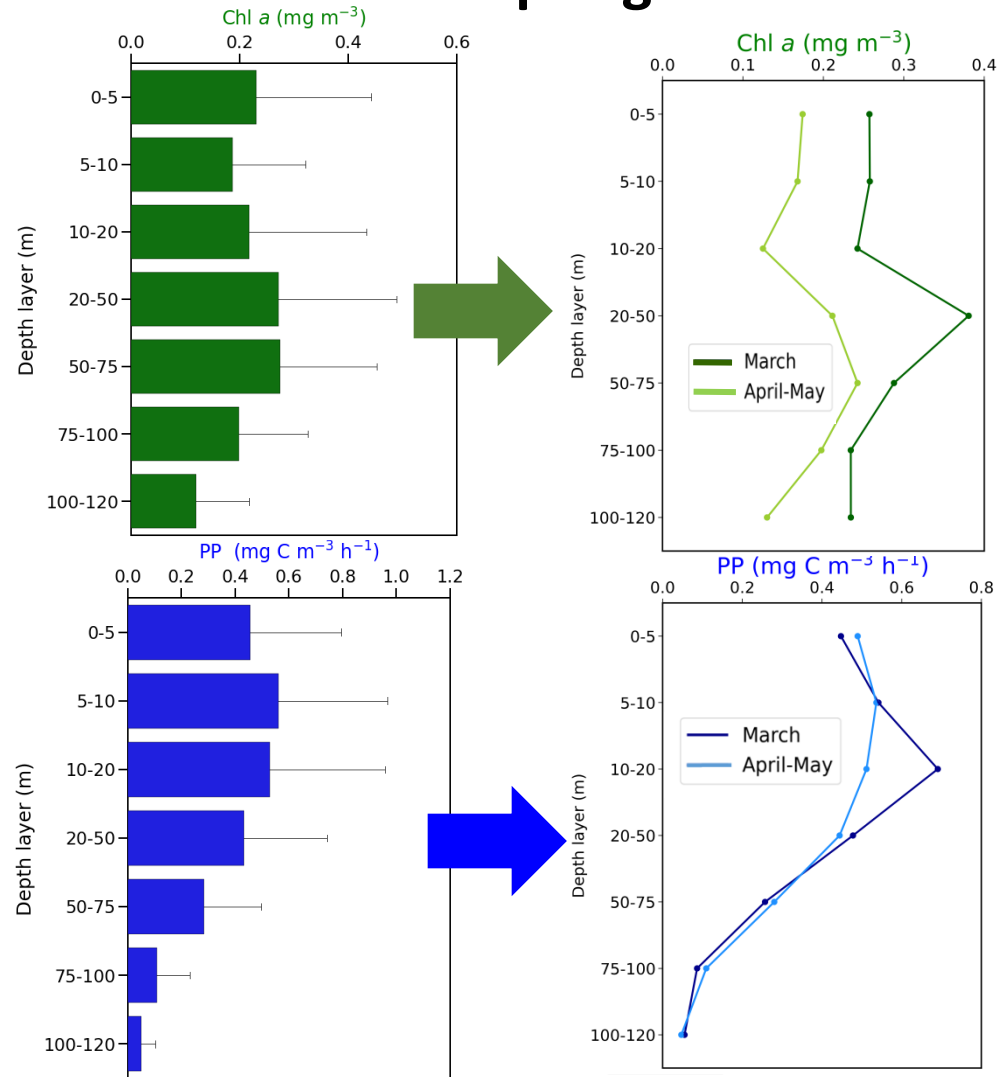
- In situ growth in the DCM layer**



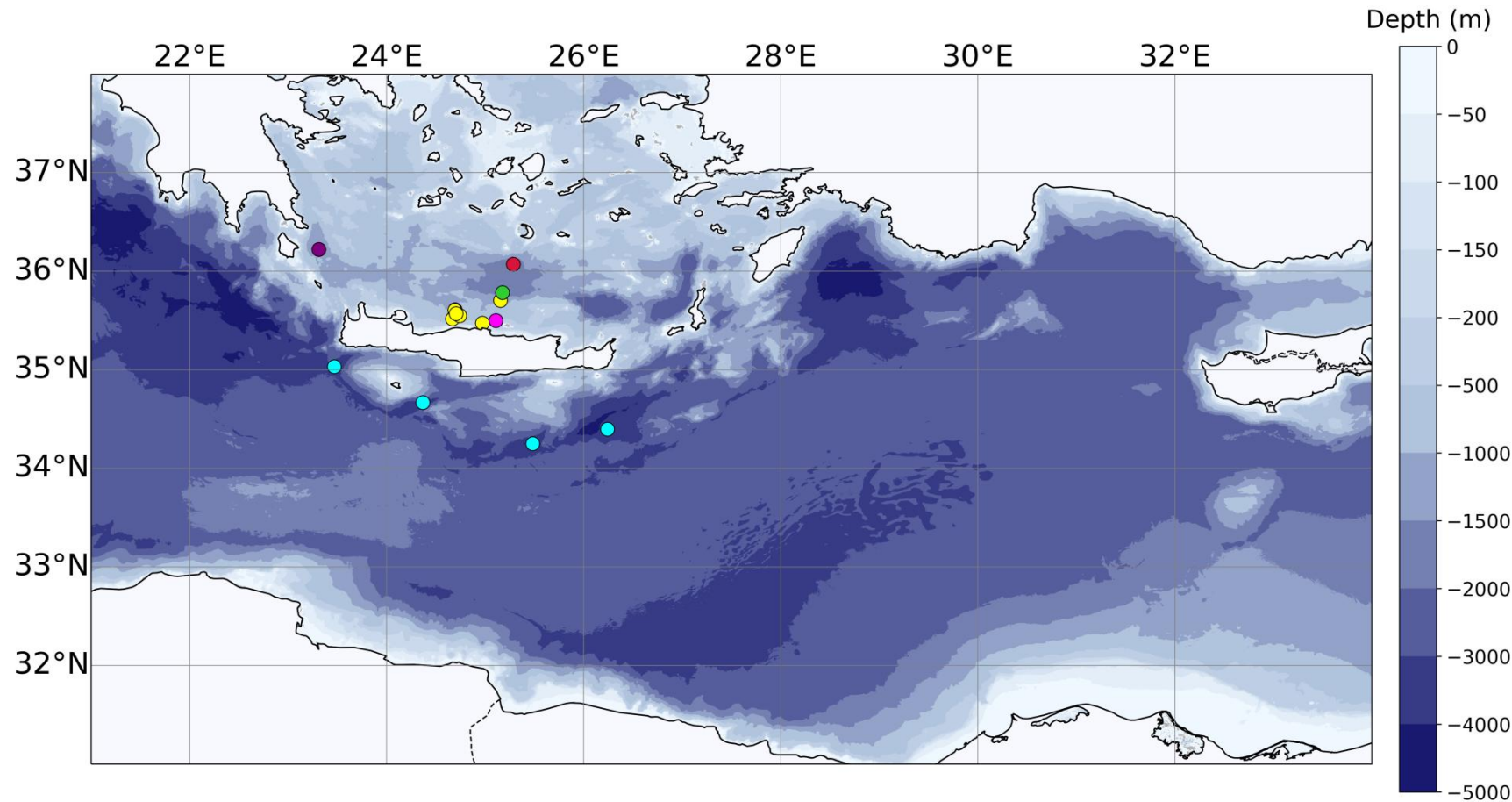
NW Levantine (L) **April 2016**

# From Early to Late Spring - From mixing to stratification

## Spring



# Case studies in the EMS – Late Spring (2002-2016)

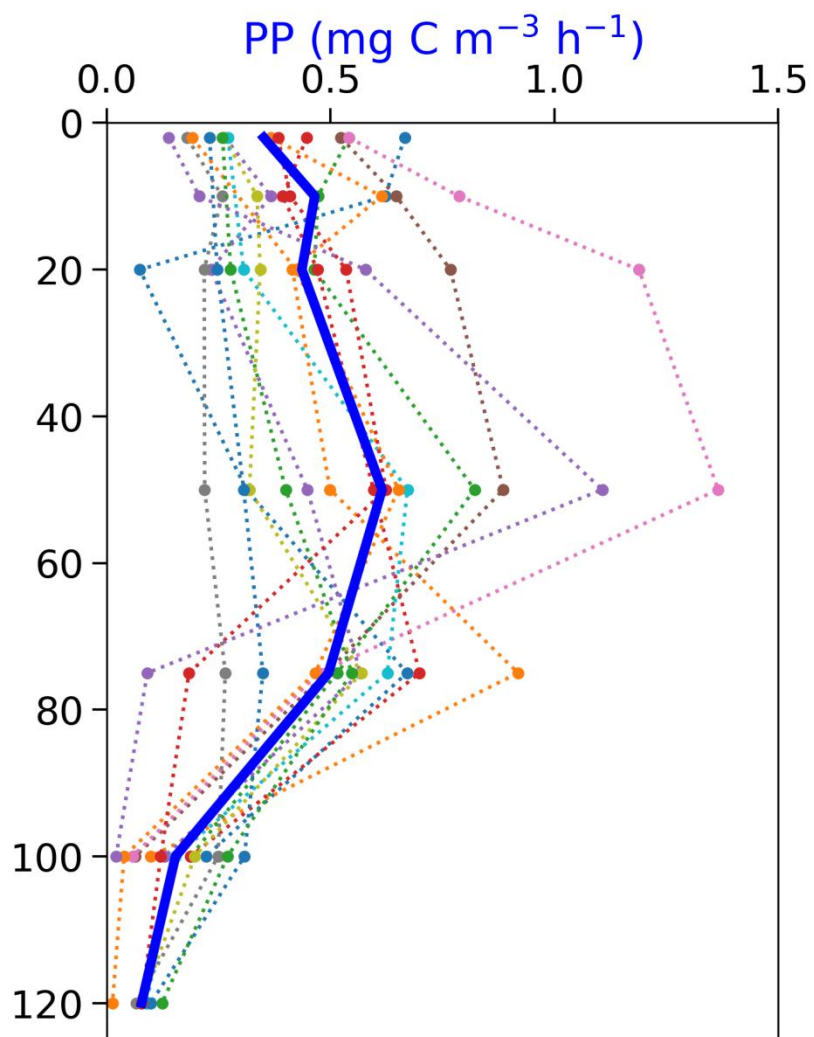
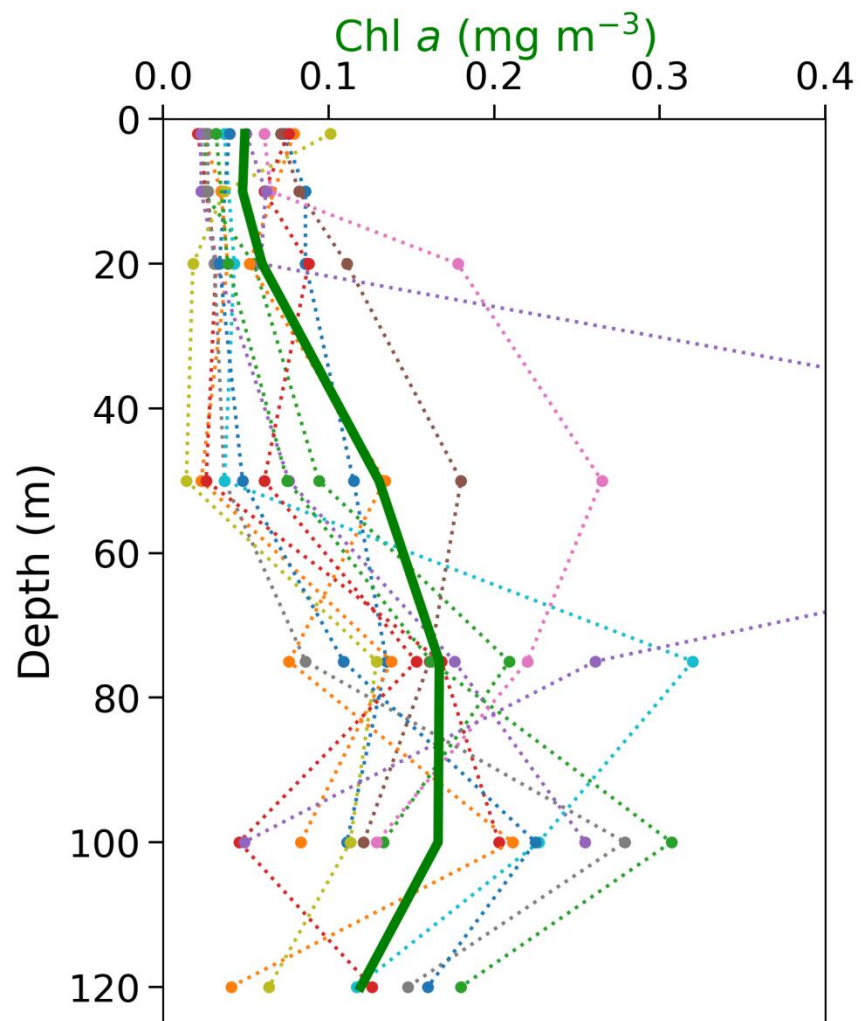


- 15 case studies in the South Aegean and Northwestern Levantine Seas
- Onset of thermal stratification (MLD = 26 m)
- PP rate: Steemann-Nielsen's protocol 2 hours in situ incubations at midday
- Chl  $a$ , CTD, PAR measurements
- Size-fractionation

Projects		
● ADIOS - April 2002	● POSEIDON - May 2007	● KRIPIS - May 2015
● PELAGIAL - April 2006	● PERSEUS - May 2013	● LEVECO - April 2016

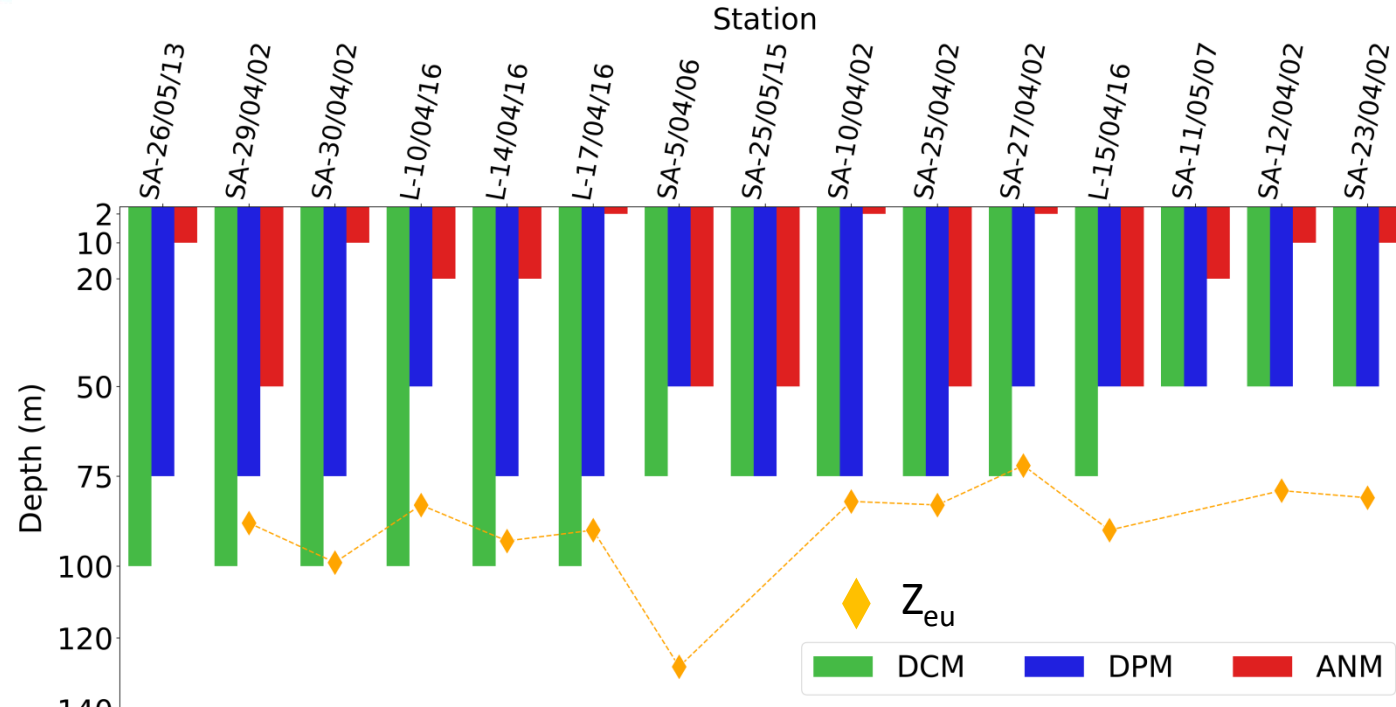
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# Vertical profiles of Primary production and Chl *a*





# Depths of biological interest

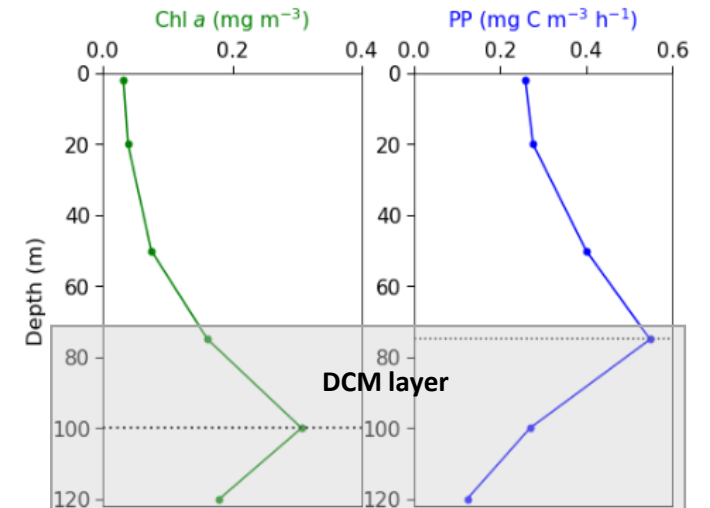
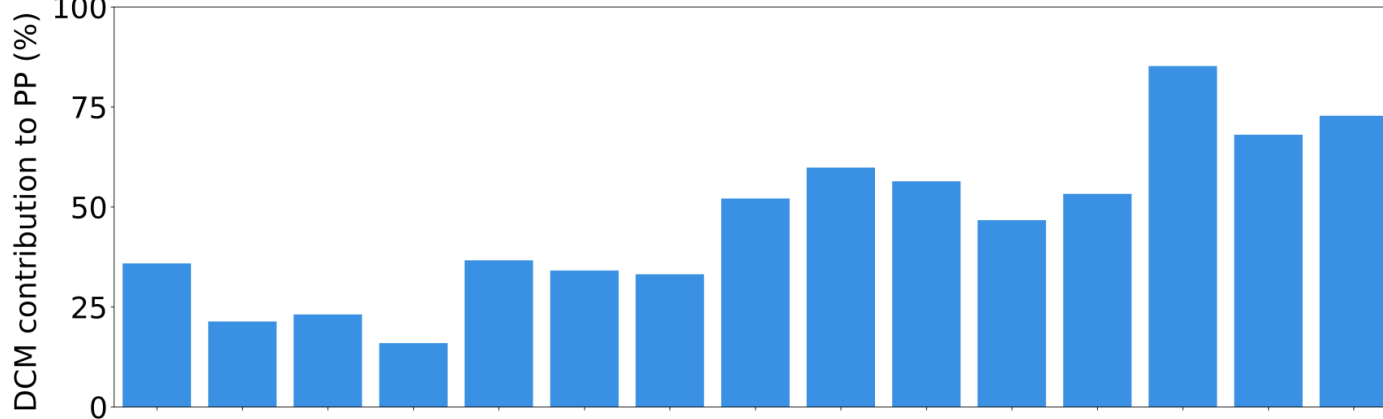


**DCM:** Deep Chlorophyll Maximum

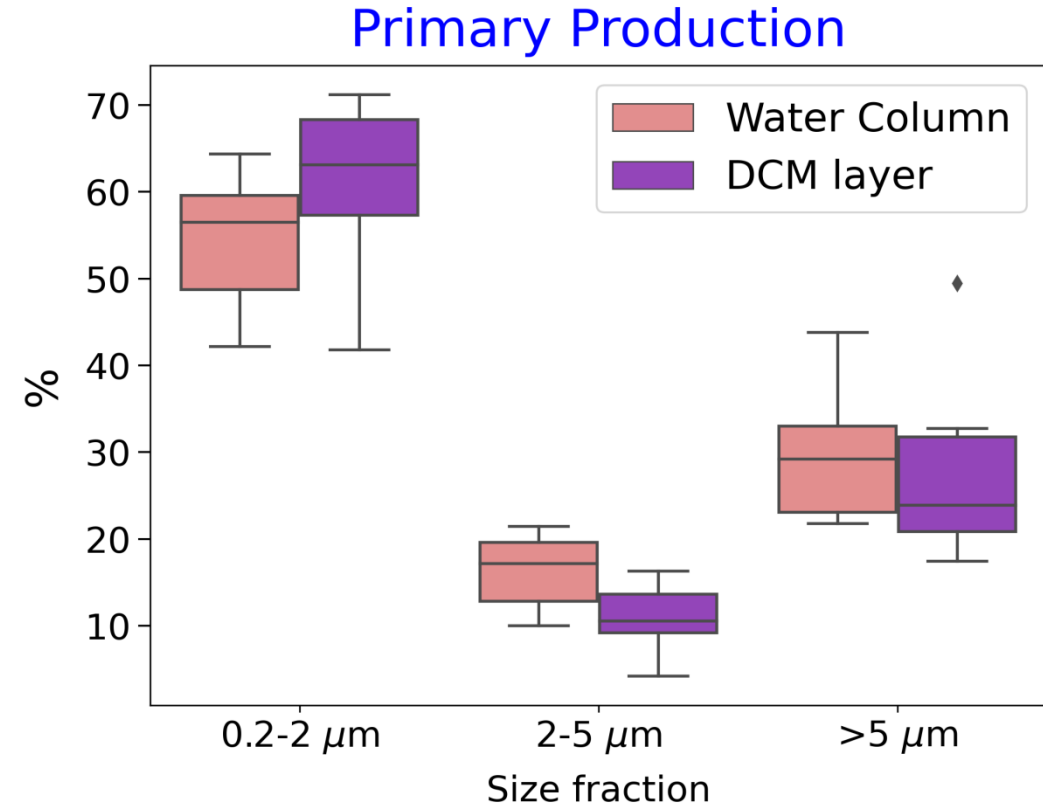
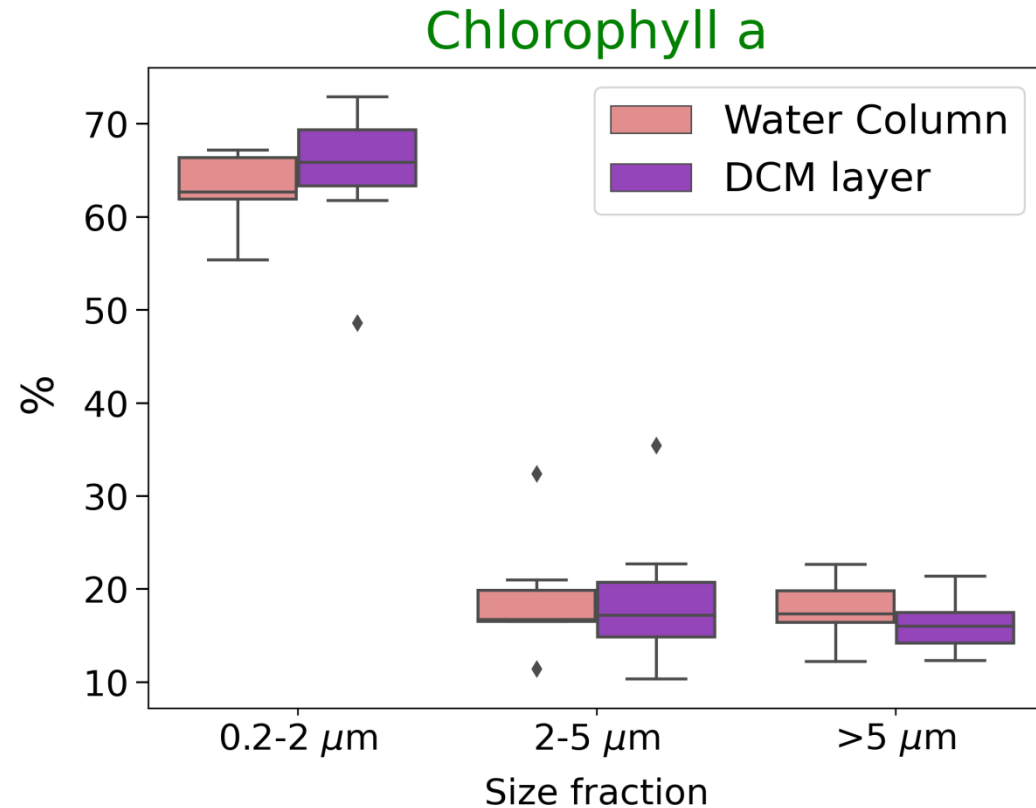
**DPM:** Deep Productivity Maximum

**ANM:** Assimilation Number (PP/Chl a) maximum

$Z_{eu}$ : Euphotic Depth

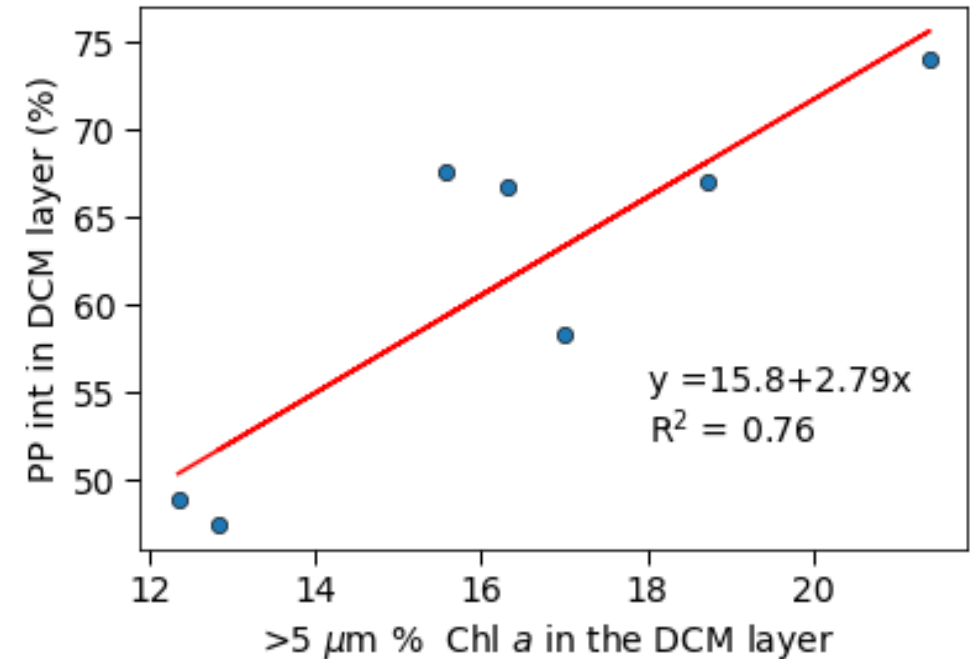
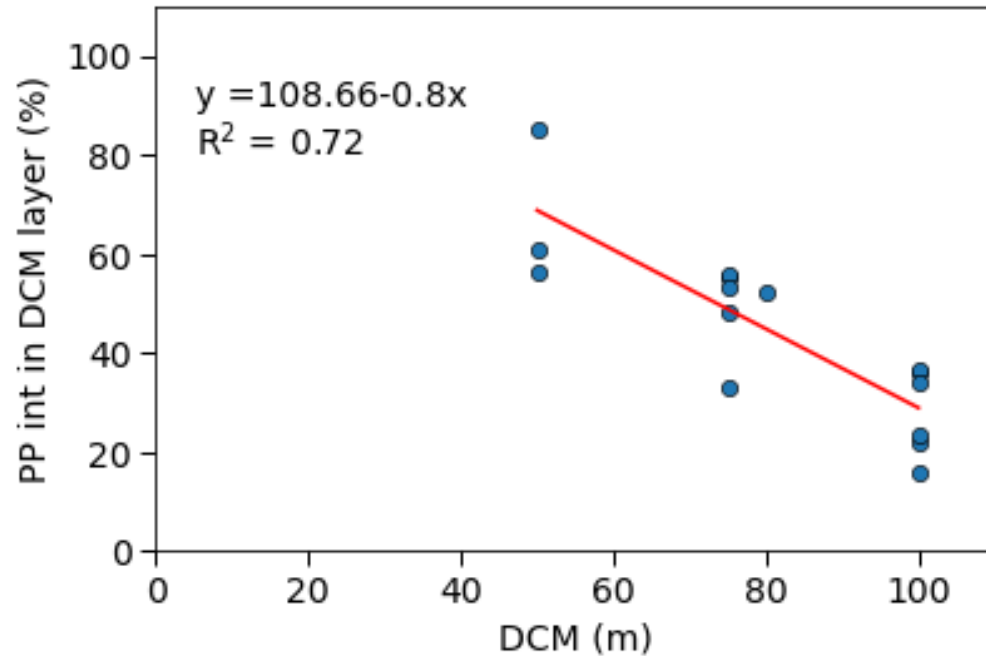


# Chlorophyll a and Primary Production by size fractions



- 0.2-2 μm dominate Chla and PP rates in the water column and in the DCM layer
- >5 μm the next most important group in terms of primary production

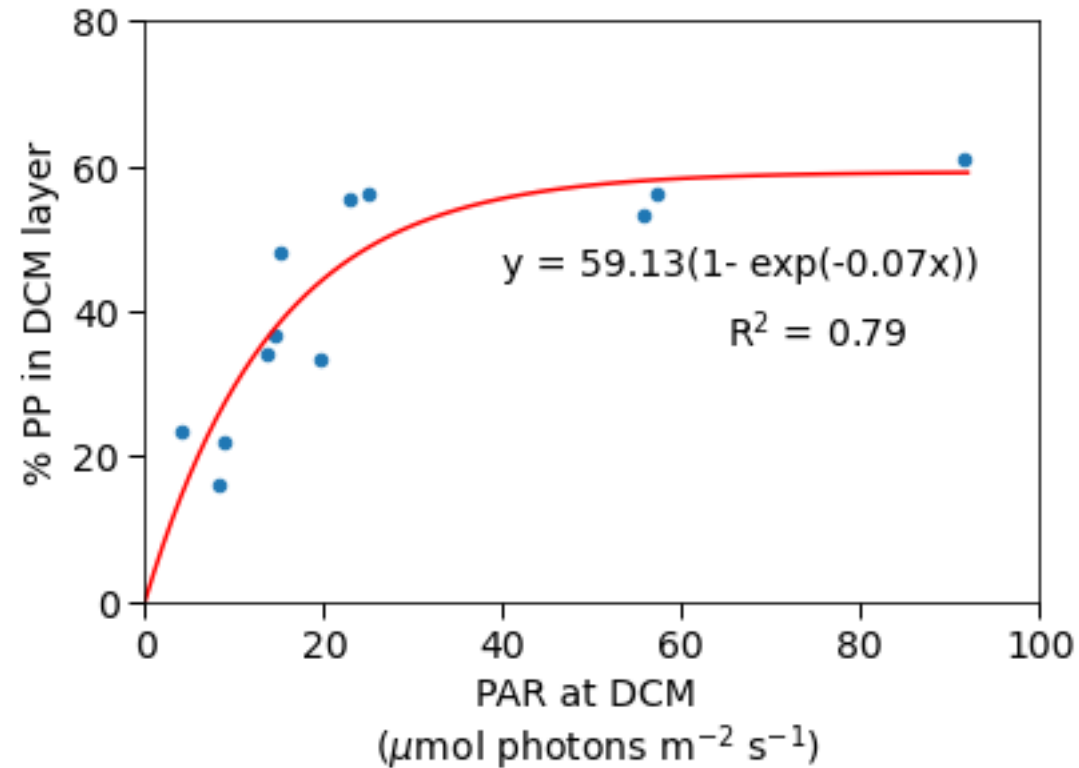
# Controlling factors of the DCM layer contribution to PP



## Contribution of the DCM layer to water column integrated PP:

- Decreasing function of the DCM depth
- Increasing function of % contribution of large nano- and microphytoplankton (>5  $\mu\text{m}$ ) to total chlorophyll a

# Photosynthetic Available Radiation (PAR) effect on the DCM contribution to PP

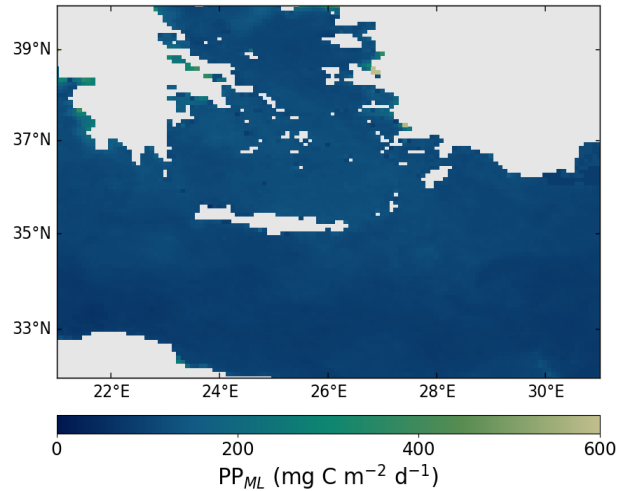


- The contribution of the DCM layer to water column integrated PP is a saturating function of PAR

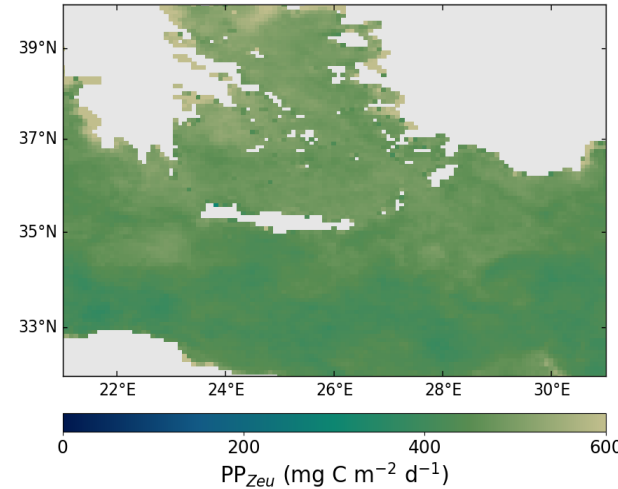
# Modeling PP in the EMS - The importance of deep production

April 2016

primary production in the mixed layer



primary production in the euphotic layer



Based on the model of Kulk et al., 2021

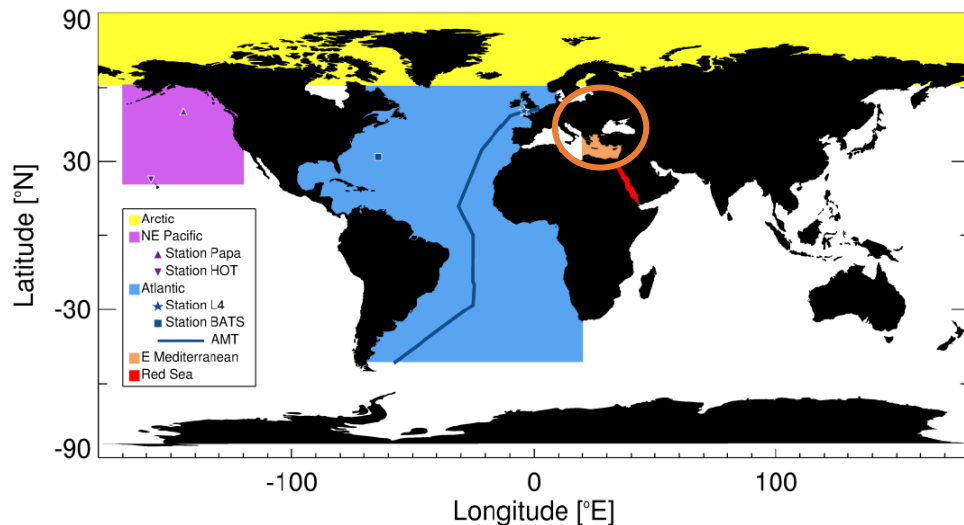
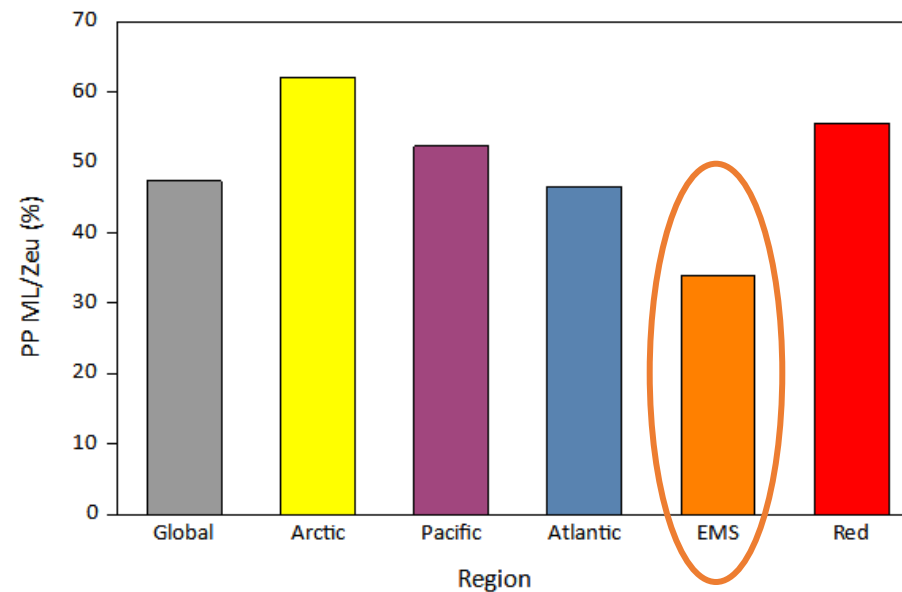


Figure 3.3. Sites of specific interest in BICEP



# Conclusions and Perspectives

- Significant contribution of the DCM layer to the biological productivity of the Eastern Mediterranean during late spring
- Deep productivity is a consistent feature in the EMS: the selected case studies represent 62 % of all the available PP profiles from late Spring collected over the past 20 years
- Biogeochemical and bio-optical data from autonomous platforms with higher spatial and temporal resolution will allow to establish the existence and significant contribution of deep PP maxima in association with the DCM layer and to quantify their role in carbon sequestration and carbon budgets in the EMS during the onset of stratification, especially in view of an increasingly stratified ocean in the near future.
- Future efforts should focus on detailed assessments of the low-light adapted phytoplankton photophysiology, also employing novel methods such as new generation active fluorometers in order to further improve the estimates of water column production in the EMS by satellite-based models



Thank you!

Questions?

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