Combined Field and Lab Study to Determine the Effects of Storm-Induced Mixing on Primary Production

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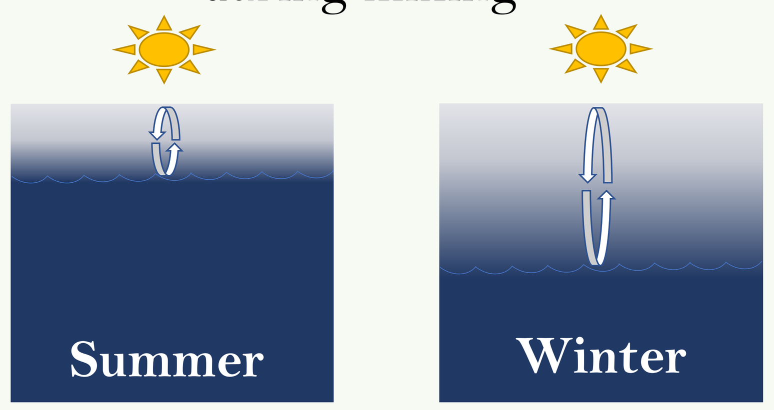
Introduction

- Phytoplankton are microscopic plants in the ocean that are the base of the food web
- The ocean mixes both seasonally and sporadically due to storm events
    - Light and nutrient availability changes during mixing

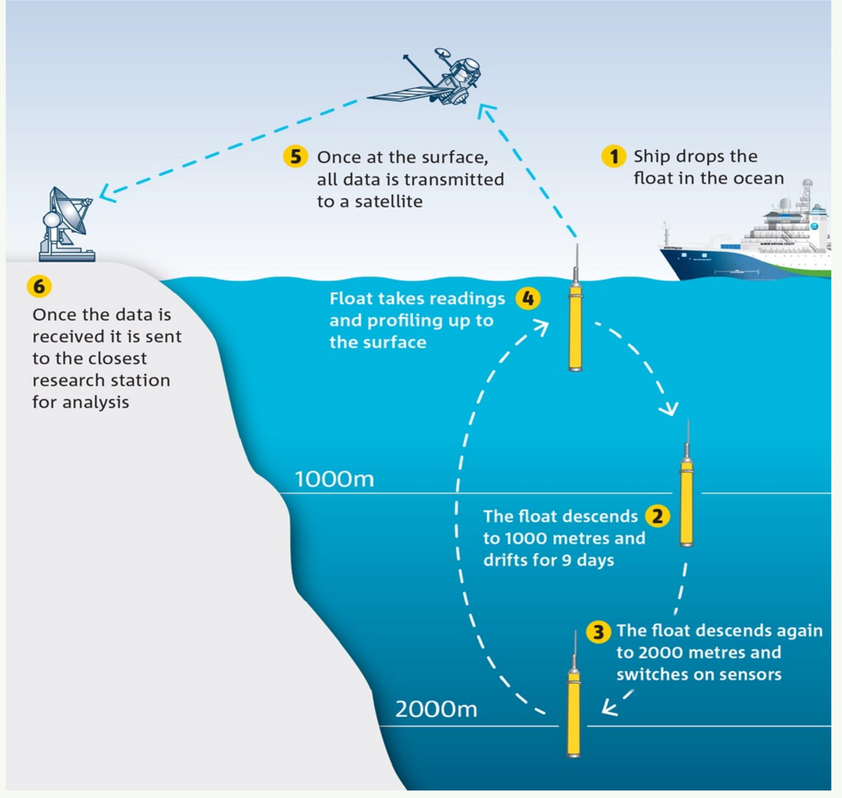


Arrows represents depth of uniform mixed layer

- Impacts on primary productivity (i.e., growth)
    - Require light and nutrients to grow
    - I hypothesize there to be species-specific responses
    - Do species respond on different timescales to this mixing?

Methods

Remote observation



CSIRO

Autonomous profiling floats were used to determine storm frequency and storm impacts on the mixed layer

This information was used to simulate a storm induced mixing event in the lab

Laboratory Study

Simulated Mixing Event | Measuring a broad suite of cell physiology collected over seven days

Dunaliella tertiolecta, green alga
UTEX Culture Collection of Algae

Thalassiosira pseudonana, diatom
Algae Research Supply

Results

Storm-Induced Mixing Events in the North Atlantic Ocean

Mixing Event Case Study		
Example float: 573		Duration: 31 days
Date	**Mixing Depth**	**Median Mixed Layer PAR**
4/17	12m	198.5 µE
4/17-5/18	107m	5.7 µE
5/18	16m	100 µE
Number of Floats	Total mixing events longer than 3 days	
11	101	

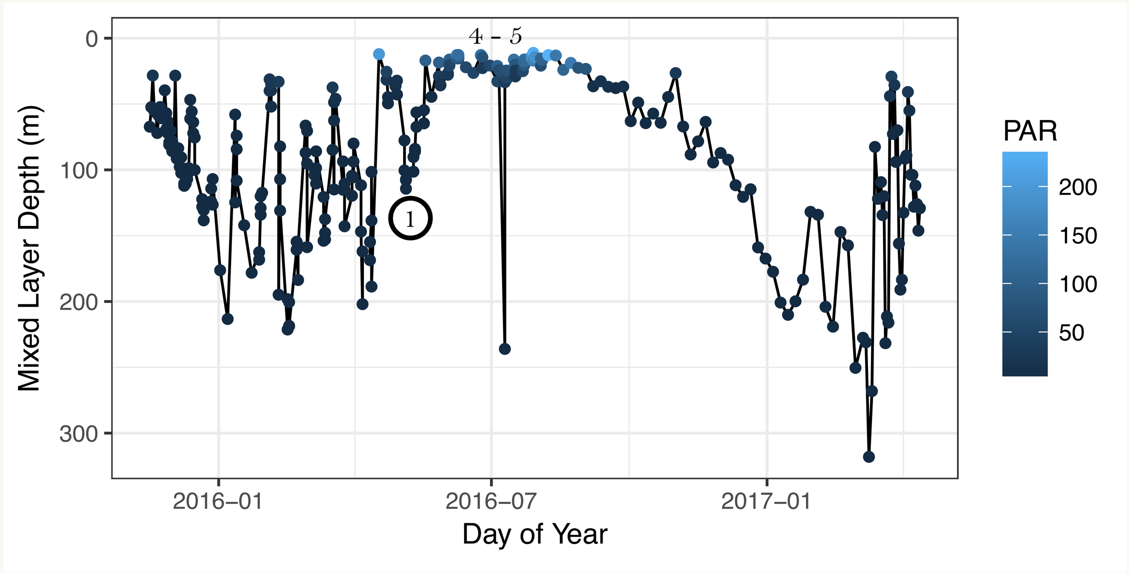


Figure 1 | Yearly profile by float number 573. Points are colored according to the median value of photosynthetically available radiation (PAR, i.e. light).

Physiological Results of Phytoplankton Species in the Lab Simulated Mixing

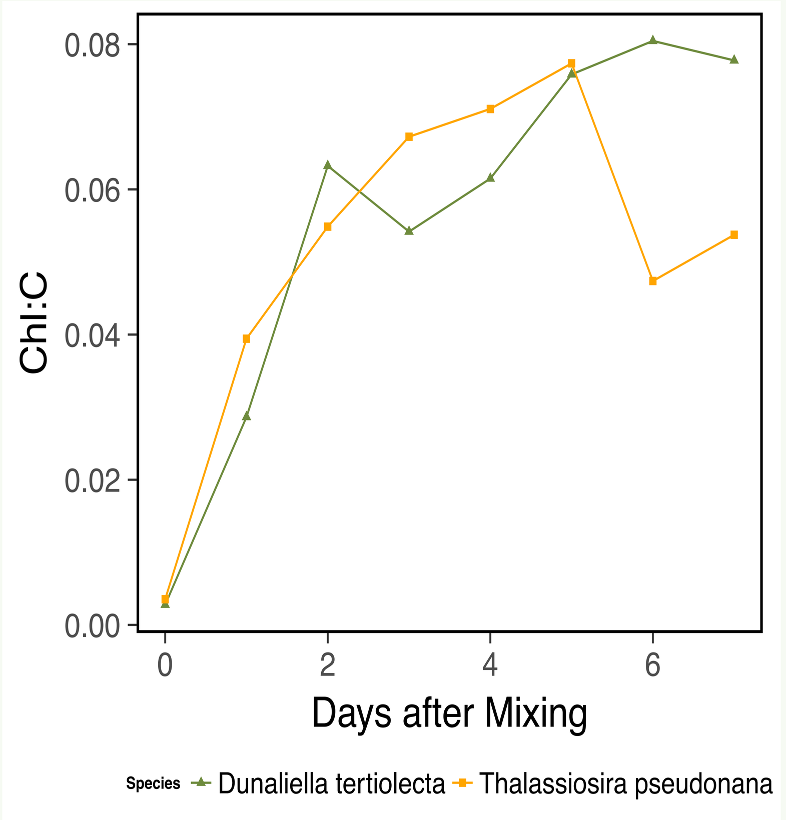


Figure 2 | Chlorophyll to carbon ratios (Chl:C) for both species show striking similarity during the study.

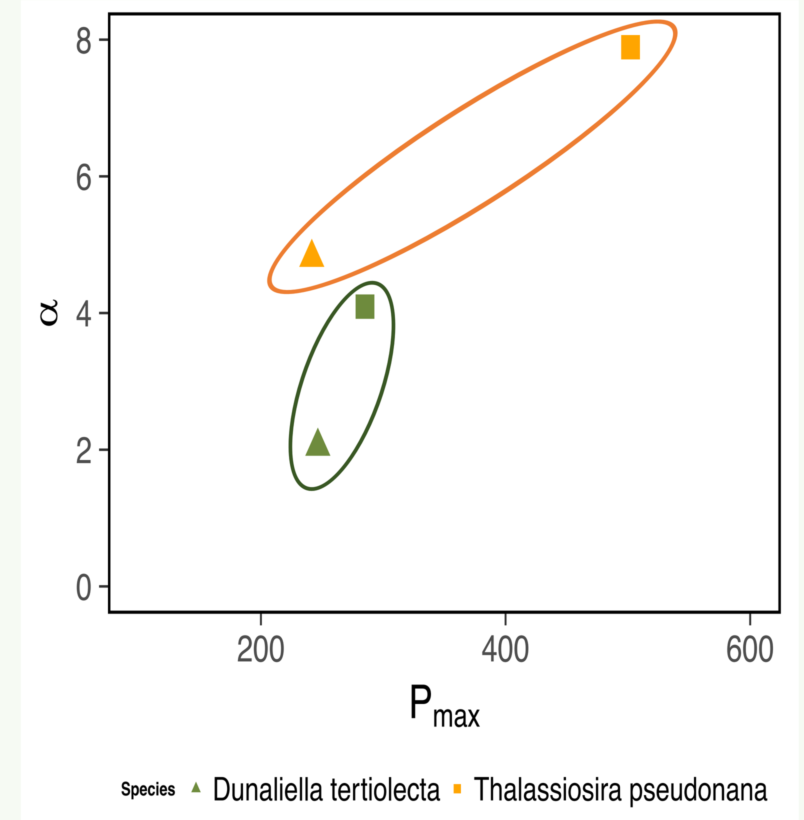


Figure 3 | Carbon fixation attributes. α is the light dependent rate of carbon fixation and P_{max} is the maximum rate of carbon fixation. Initial time point denote by triangle and final time point by square.

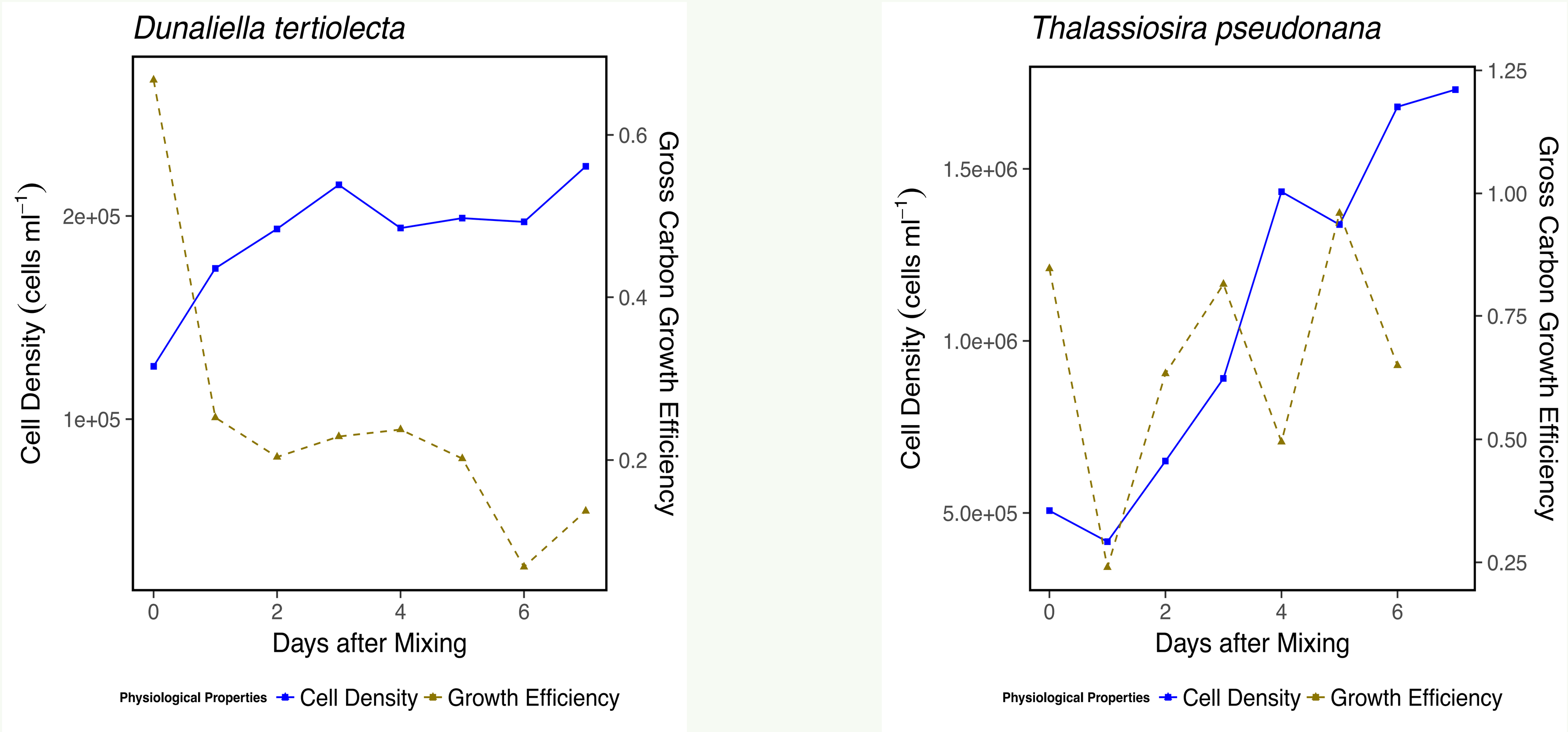


Figure 4 | Species specific responses to the simulated mixing event. *Dunaliella tertiolecta* (left) showed little growth following mixing. *Thalassiosira pseudonana* (right) began growing by day two by recovering to a high carbon growth efficiency.

Conclusions

- Diatom responded more rapidly than the green algae through an increased carbon growth efficiency and increased maximum Chl-specific carbon fixation
- Potential overestimation of primary production because of the matching Chl:C
- Diatoms continued to grow at depth in extremely low light, which has important impacts on global carbon cycling

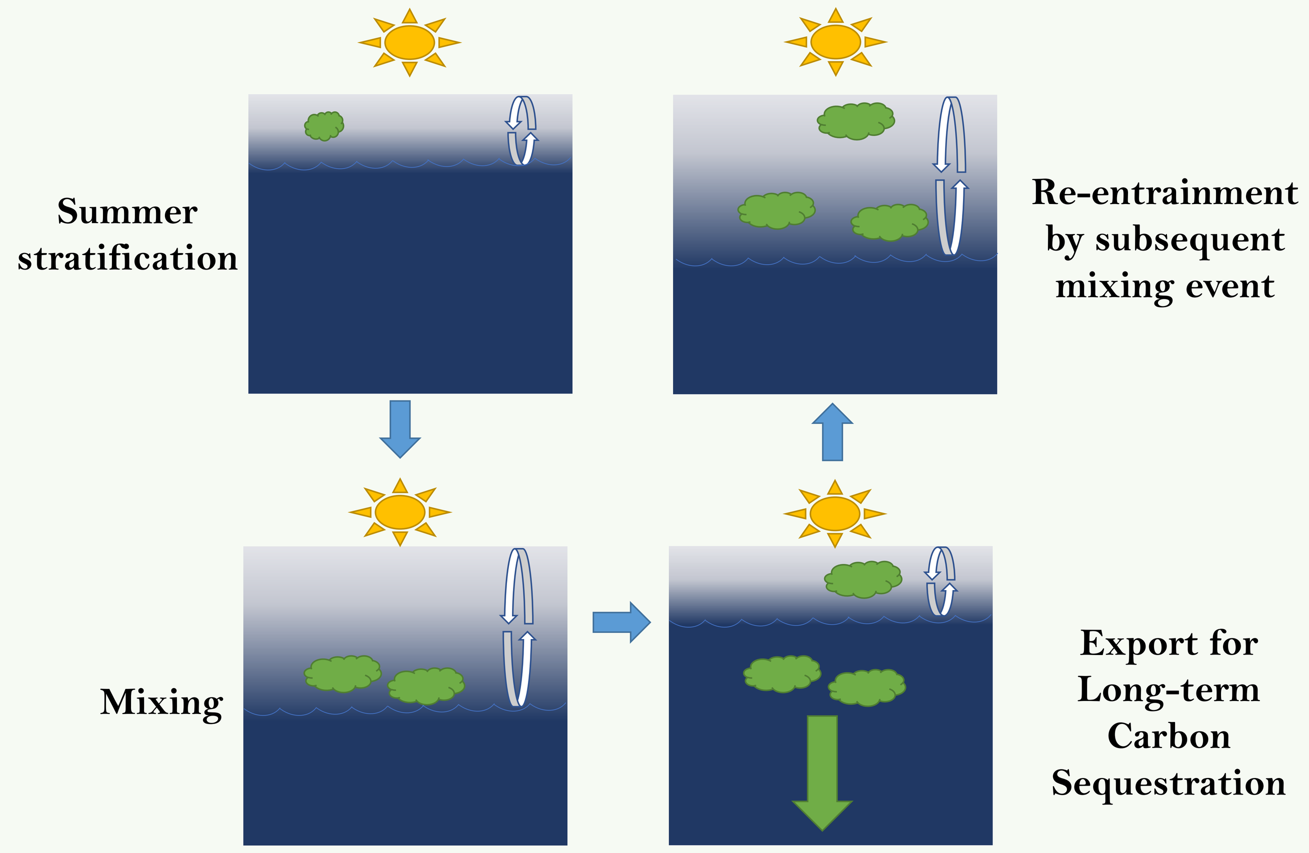


Figure 5 | Potential fates of diatom growth at depth: Export to depth or re-entrainment into the mixed layer depth. Export to depth represents a loss of productivity in the mixed layer.

Future Directions

- Global estimates of primary production use satellite measurements of the Chl:C physiological property
- The next generation of satellite ocean color detectors will allow us to discriminate between phytoplankton groups such as diatoms and green algae
- This new detector is important because it will be able to resolve species-specific differences in physiological responses, as shown in this study
- Quantifying production either lost or increased as a result of storm induced mixing

Acknowledgements

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