QCL WATER SCIENCE

University of Bremen

Arctic Kelp

Effect of Rising Sea Surface Temperatures on Photosynthesis and Respiration

Kelps (large brown seaweed, Laminariales, Phaeophyceae) dominate many rocky shore coastlines in temperate and polar regions, forming submarine forests that are among the most productive ecosystems on our planet. Due to globally rising sea-surface temperatures, models predict a kelp biomass increase in the future Arctic.

However, rising temperatures also accelerate glacial run-off and the introduction of sediments to the fjords. The aim of this study was to gain a mechanistic understanding of the effect of rising temperatures on the photosynthetic and respiration rates of kelps and their light requirements to maintain a positive net photo synthesis.

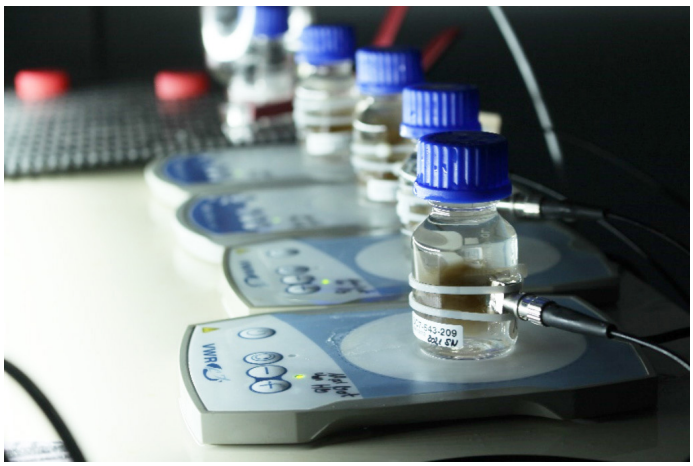
Further, we assessed whether these changes are met by the prevailing underwater light climate in Arctic Kongsfjorden, Svalbard to draw conclusions about the kelp forests future depth distribution.

Set-Up and Study Site

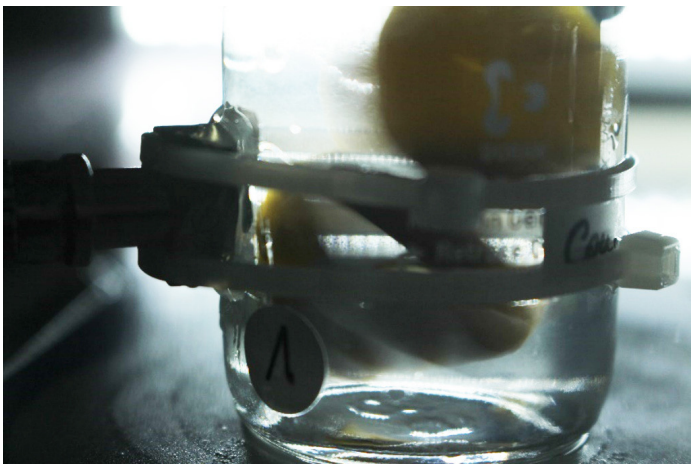
To determine kelp light requirements for a positive net photosynthesis, we measured oxygen concentration changes as response to different light intensities within closed incubation chambers, containing kelp meristematic discs.

We used contactless sensor spots OXSP5 and a four-channel FireSting-O2 with an integrated temperature sensor for the measurements. The system required several restarts at low temperatures (3 °C). We avoided this by isolating the FireSting connector box against cold surfaces (e.g. with styrofoam). Further, it was crucial for the measurements to ensure a homogenic water body within the incubation chamber by using magnetic stirrers.

A) Overview of the experimental set-up in a climate chamber with defined temperature and light conditions



B) Incubation chambers, containing meristematic discs of kelps



C) The magnetic stirrer inside the incubation chambers ensured a homogenic oxygen concentration and illumination of the discs

Results

The optodes were very responsive to oxygen concentration changes, and the method represented an easy way to measure kelp photo-respirometry.

At stable light intensities, we found the oxygen concentrations to change linearly over time, indicating that the incubation chambers were neither carbon-dioxide or nutrient limited, nor oxygen super-saturated during our measurements.

The change in oxygen concentration of all four channels (used as biological replicates) were within the same range. Responding to increasing temperatures, we detected significant differences in kelp respiration rates and light requirements in order to maintain a positive net photosynthesis.

Conclusion from Data and Application

We related this dataset to the prevailing underwater light climate in Kongsfjorden. Thereby, we showed distinct spatial

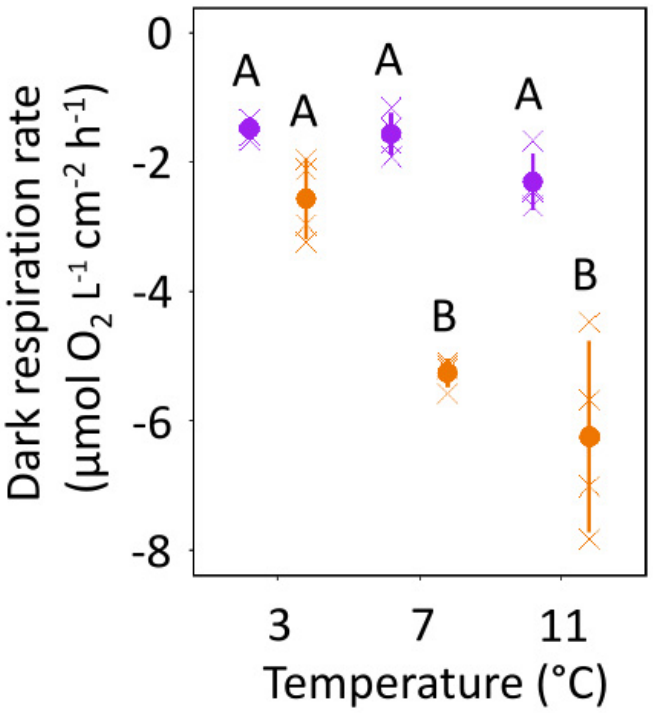


Fig. 2 Dark respiration rate of two kelp species, Alaria esculenta (purple) and Saccharina latissima (orange), in response to temperature changes. Treatment mean (dots) ± SD and average replicate response (cross) (n=4). Different capital letters indicate significant (p<0.05) differences between the temperature treatments and species.

differences in the underwater light climate and potential kelp habitat. We found that the kelp depth distribution is likely to be reduced with increasing water temperature, due to changes in their photosynthetic and respiration rates.

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Kelp forests are among the most productive ecosystems on our planet. They function as ecosystem engineers and foundation species and provide a wide range of ecosystem services that are of ecological and socioeconomic importance.

The Arctic is warming at a rate far beyond the global average.

Rising temperatures lead to to increasing ezyme activities.

Alaria esculenta & *Saccharina latissima*

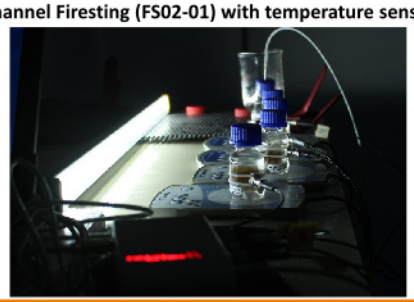
Does kelp light requirement for a positive net photosynthesis increase?

Universität Bremen

FACE-IT

We measured kelp photosynthesis and respiration after exposure to 3°C, 7°C and 11°C, to assess their light requirement for a positive net photosynthesis

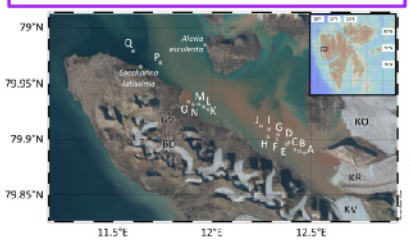
4-channel Firesting (FS02-01) with temperature sensor



We detected temperature induced changes in kelp photo-respirometry and light requirement for a positive net photosynthesis.

We related the temperature induced differences in kelp photo-respirometry to the prevailing underwater light climate in Kongsfjorden, Svalbard.

Rising temperatures lead to increased terrestrial run-off and a deteriorating under water light climate.



We were able to show distinct spatial differences in the underwater light climate in Kongsfjorden and potential kelp depth distribution, which is likely to be reduced with increasing water temperature, due to changes in their photo-respirometry.

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