UK Ocean Acidification Research Programme
Benthic Acidification

Effect of elevated CO_2 and temperature on microphytobenthos - preliminary results from the benthic OA flume study

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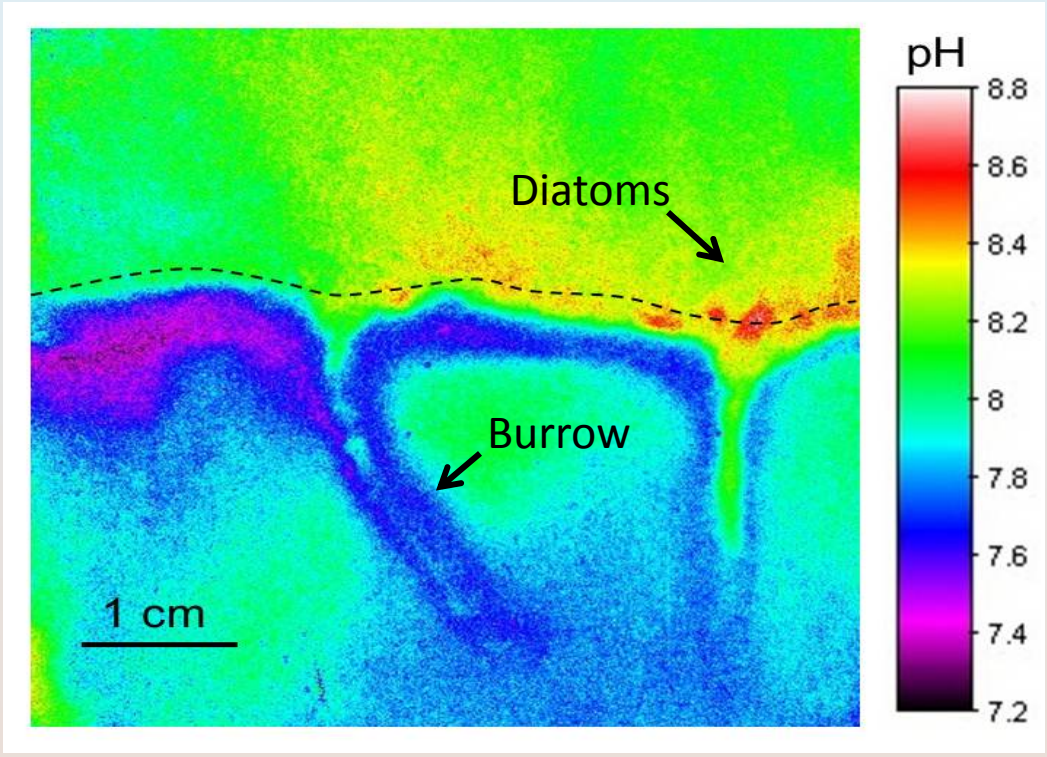
Aim 2: Quantify the impacts of ocean acidification on microbial communities and elemental cycling in coastal ecosystems



Stahl et al 2007

Benthic PP – pH ↑

Aerobic respiration - pH ↓

Nitrification – pH ↓

Denitrification – pH ↑

Manganese reduction - pH ↑

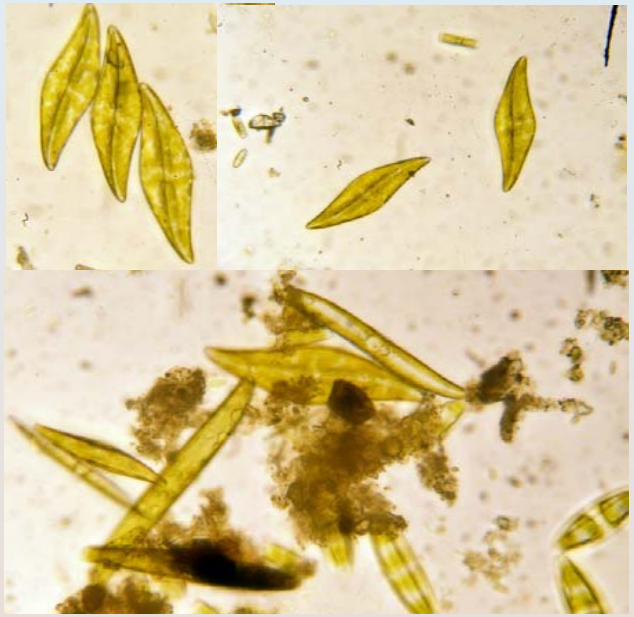
Iron reduction - pH ↑

Sulphate reduction – pH ↑

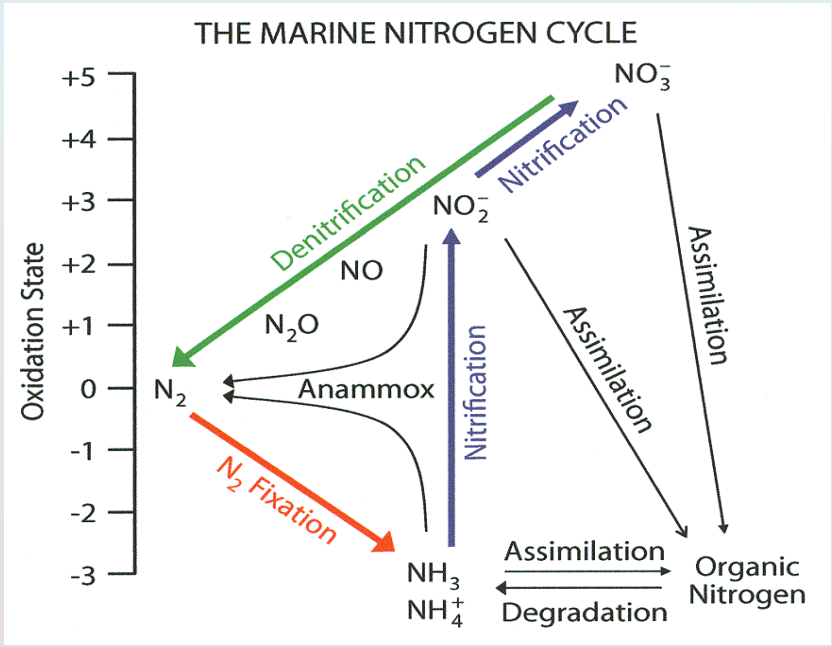
Reoxidation of Fe^{2+}, Mn^{2+}, H_2S – pH ↓

Effect of OA and temperature on MPB and nutrient cycling in sediment

Microphytobenthos (MPB)



Hicks et al 2011
Bulling et al 2009

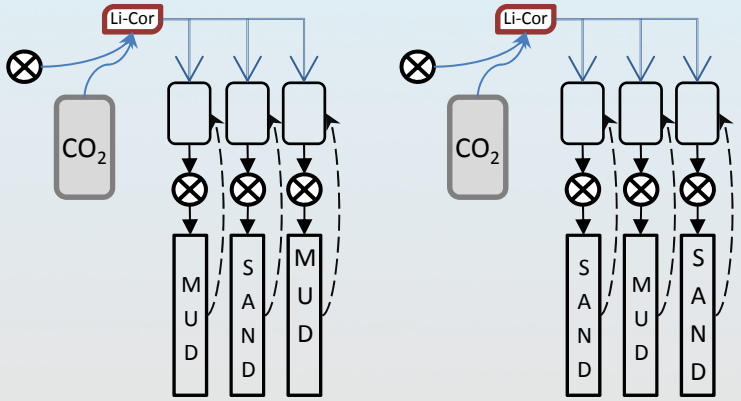


Hutchins *et al*. 2009
Widdicombe and Needham 2007
Widdicombe et al. 2009

Sediment collection

- Two types of sediment investigated
- Cohesive (muddy) sediment – Eden estuary (St Andrews)
- Permeable (sandy) sediment – Eden estuary (St Andrews)
- Rich in MPB assemblage
- Well studied sites
- Sediment collected 5 days before experiment
- Sieved (0.5mm) and left to settle

Experimental setup

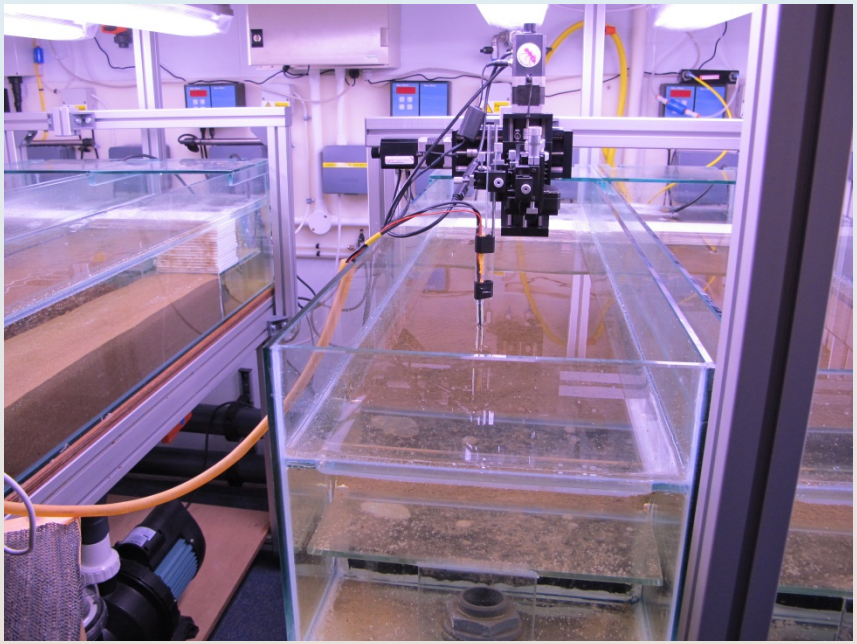


	380 ppmv	750 ppmv
Sept/Oct	12°C	16°C
Nov/Dec	16°C	12°C
Feb/March	12°C	16°C
April/May	16°C	12°C
June/July	12°C	16°C
July/Aug	16°C	12°C

- Medium term exposure (28 days) in CT room
- 12hr light : dark cycles
- Weekly water change

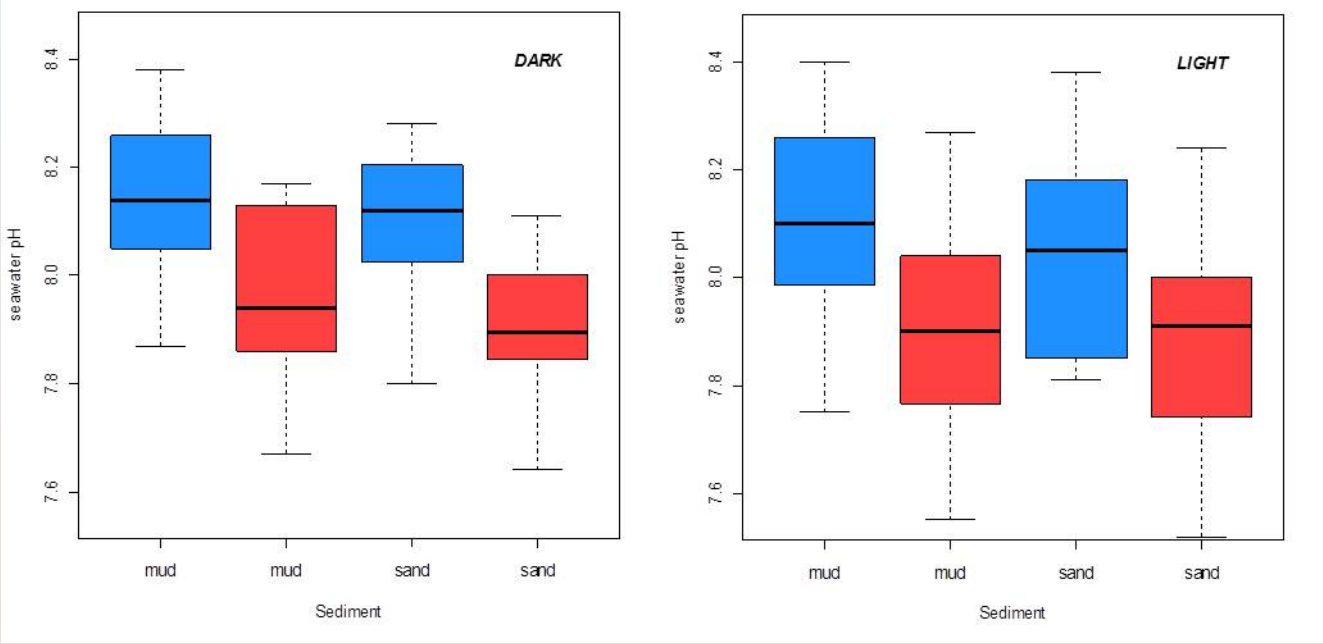
Response variables

- Primary productivity of MPB: PAM, Mag-Pi, CSM (St Andrews) – daily to weekly
- Microbial activity (Hull): weekly sediment cores
- Nutrient cycling: weekly fluxes (light & dark)
- Weekly whole flume respiration measurements (light & dark)
- Sediment oxygen distributions with microelectrodes (light & dark)
- Daily water pH and oxygen readings
- Weekly water carbonate parameters (DIC, TA)
- Highly resolved nutrient profiles (DET gels)



pH water column (C1 & C2)

Blue = 380 ppmv
Red = 750 ppmv



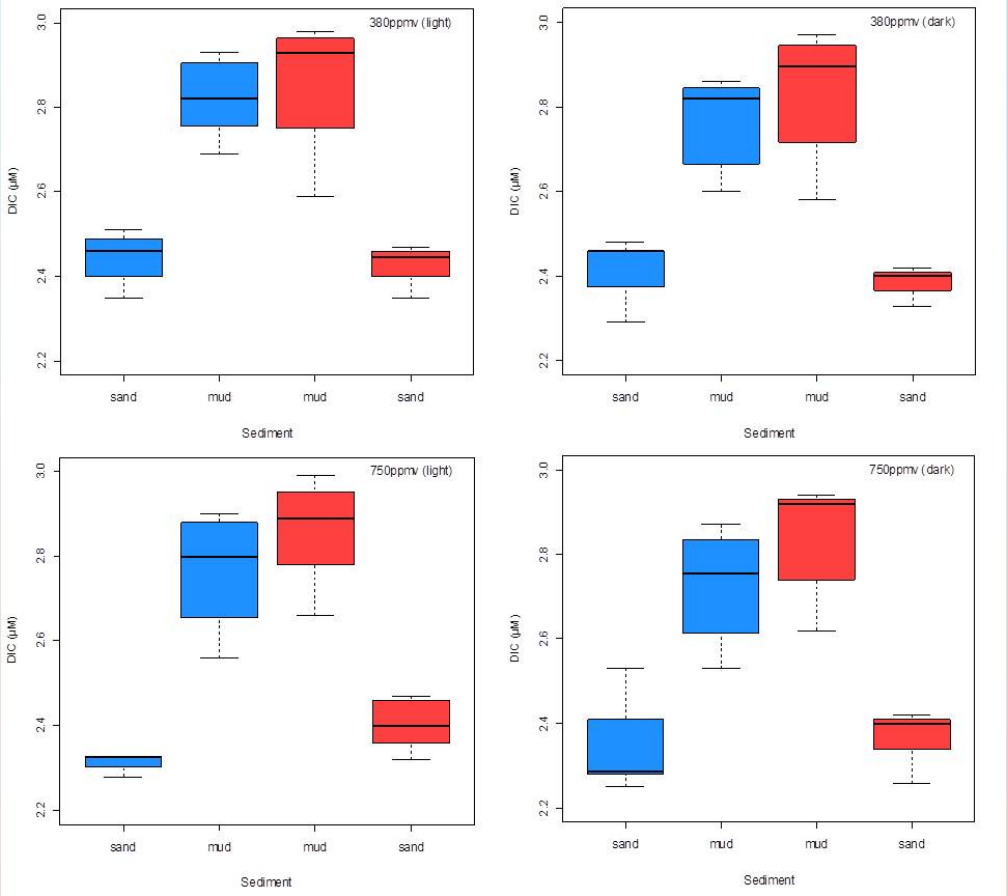
DIC water column (C1 & C2)

Blue = 12°C
Red = 16°C

- High DIC values
- Significantly higher DIC in cohesive/muddy sediments compared to sandy sed.
- No clear trends w.r.t treatments
- Large variability within each treatment (average over 8 weeks)

380 ppmv

750 ppmv



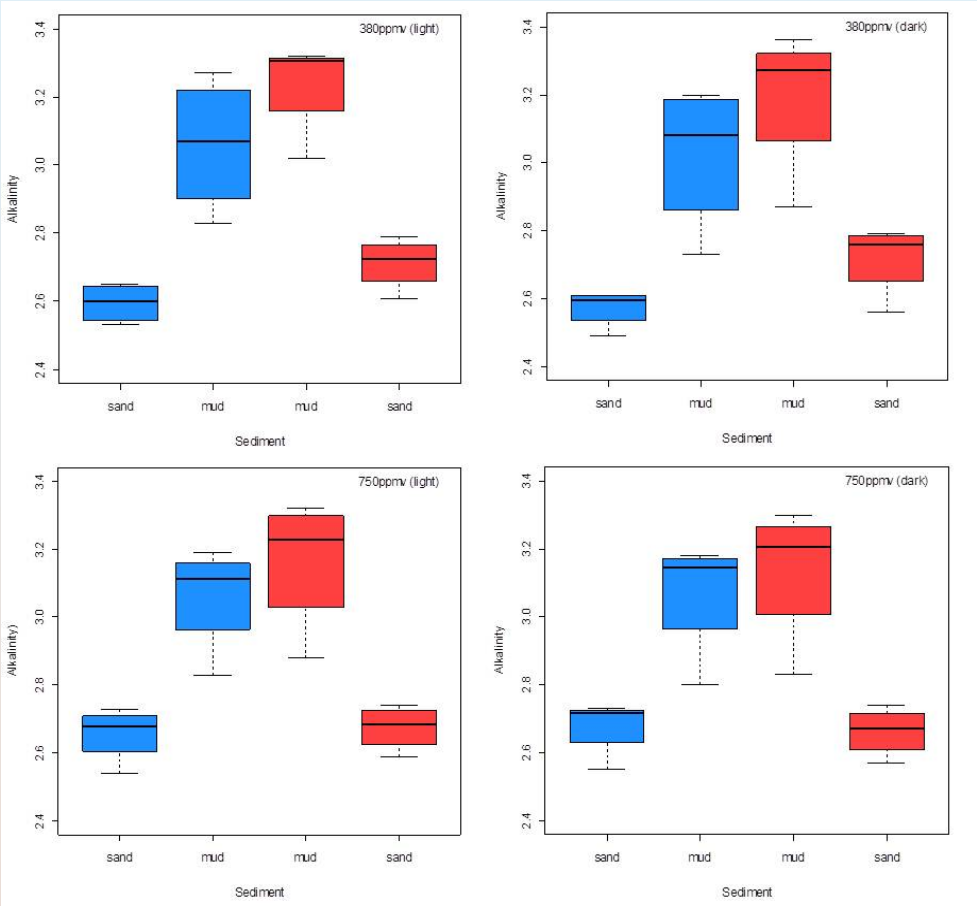
TA water column (C1 & C2)

Blue = 12°C
Red = 16°C

- High TA values
- Significantly higher TA in cohesive/muddy sediments compared to sandy sed.
- No clear trends w.r.t treatments
- Large variability within each treatment (average over 8 weeks)

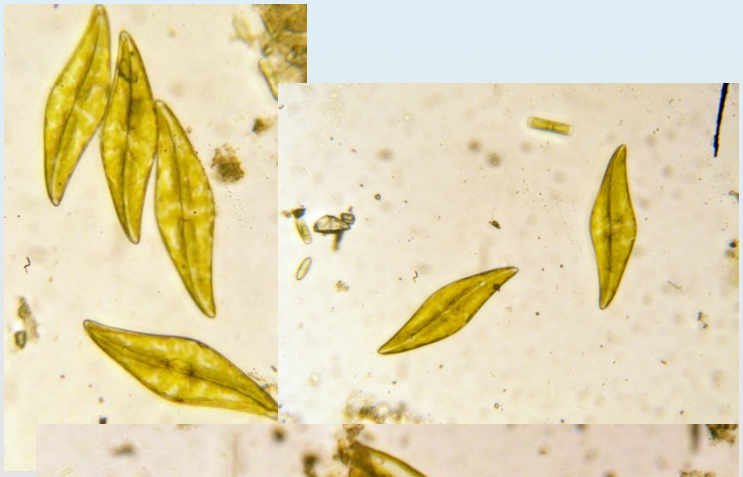
380 ppmv

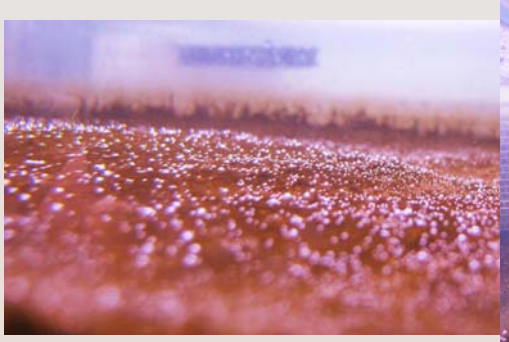
750 ppmv

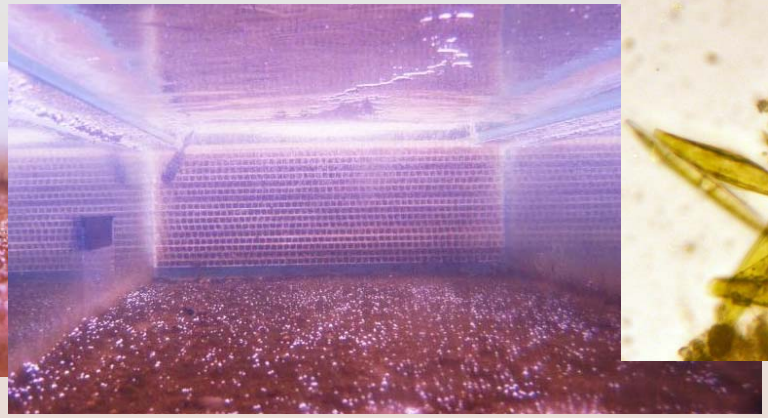


MPB assemblage (cohesive)

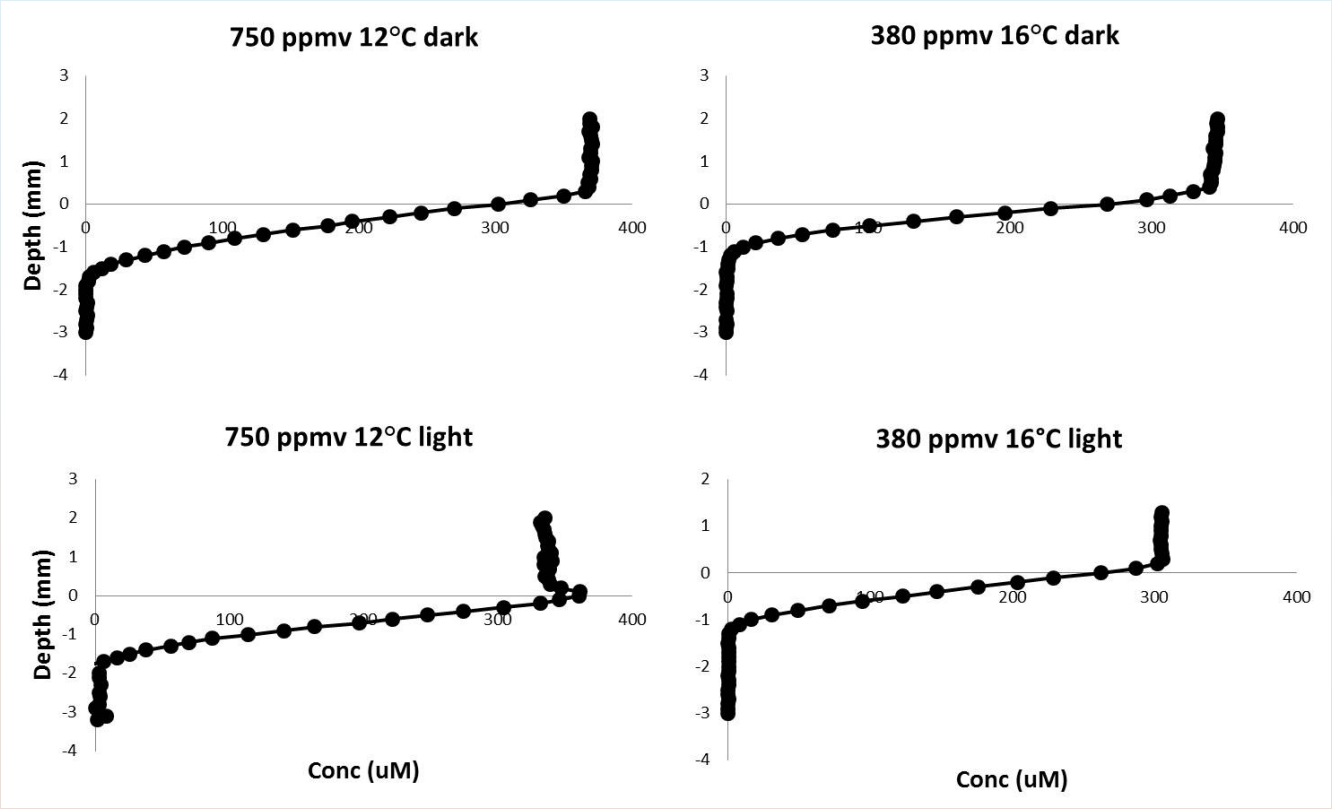
- Diverse species assemblage
- Main diatom species present:
    - *Gyrosigma sp*
    - *Pleurosigma sp*
- Cyanobacteria also found in biofilm







Average (n=5) O_2 profiles cohesive sediment



Water column nutrients

- Low levels of PO_4 and Silica in mud and sand
- Clear trends in NH_4 and NO_3 across all treatments
- Sediment types analysed separately for NH_4 and NO_3
- Influential variables in models include:
  - *Temperature*
  - *pCO_2*
  - *Light*
  - *Time (week)*
- Statistical model show interaction of environmental variables
  - *NH_4 – four-way interaction for mud and sand*
  - *NO_3 – three-way interaction (2 for mud, 3 for sand)*

NH_4 results from first 2 campaigns

Final models for both sand and mud showed a four-way interaction for:

- Temperature
- CO_2
- Light
- Time (week)

NB models based on only TWO runs, by end of study there will be SIX runs to give four replicates of each treatment

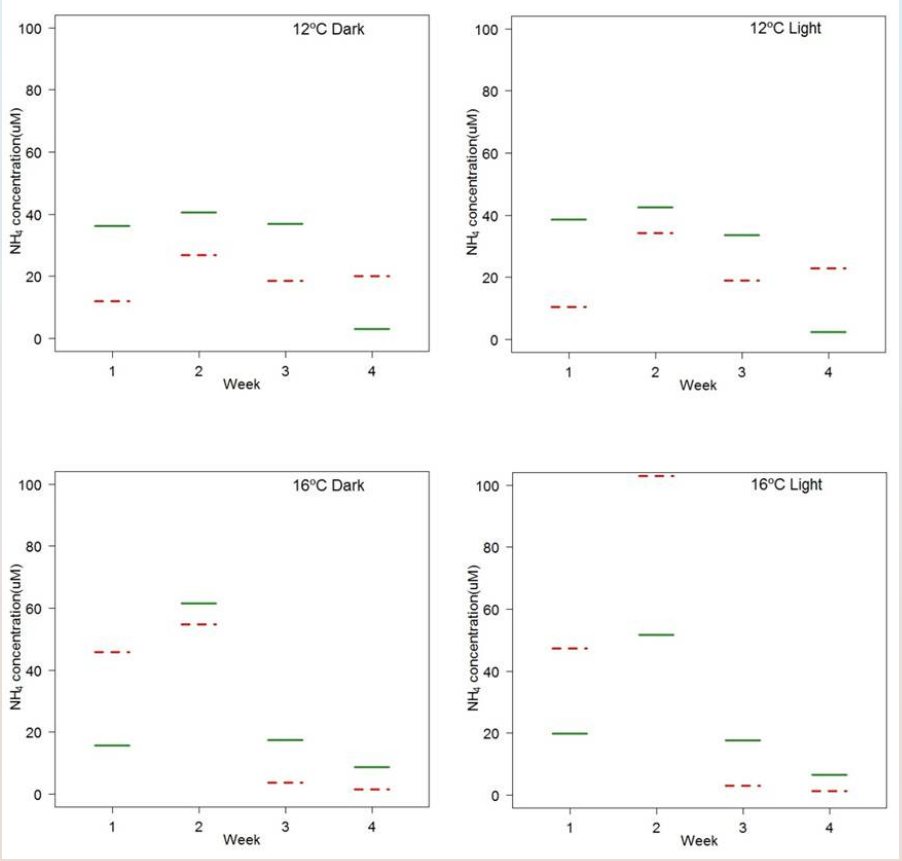
Boxplots of raw data support model visualisations

NH_4 results – cohesive (mud)

Green = 380 ppmv
Red = 750 ppmv

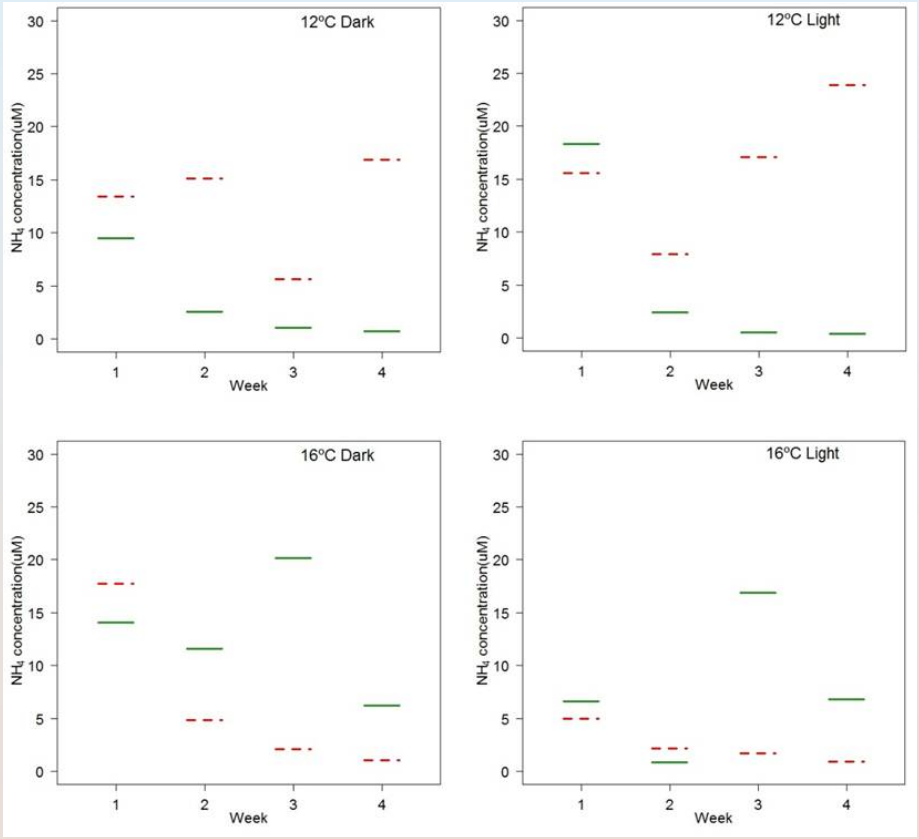
In order of importance to the model:

- Week
- CO_2
- Temperature
- Light



NH_4 results – permeable (sand)

Green = 380 ppmv
Red = 750 ppmv



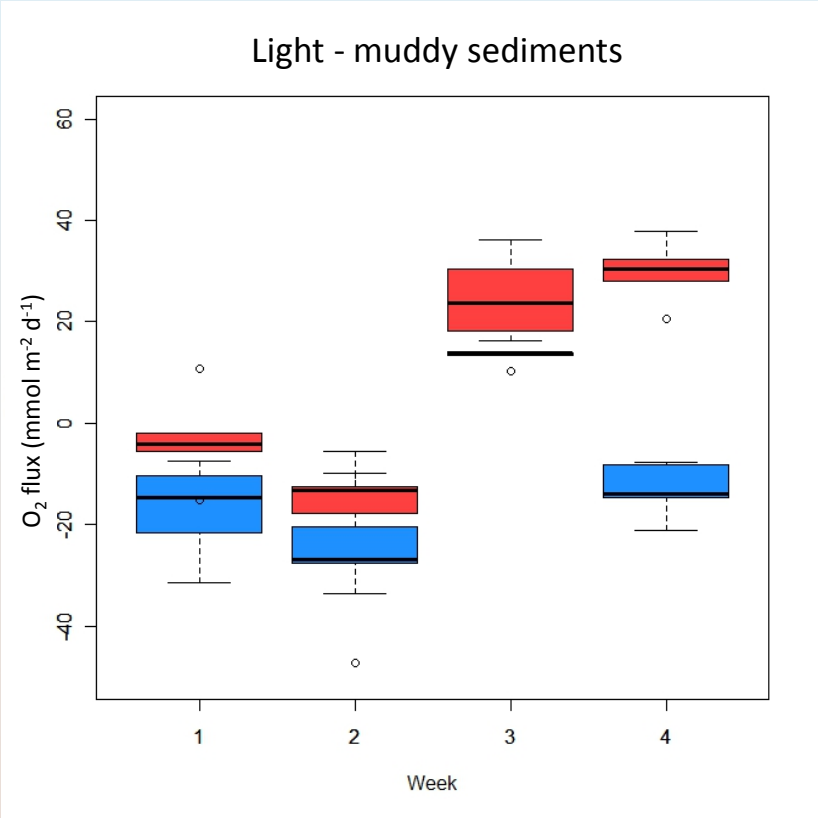
In order of importance to the model:

- Week
- CO_2
- Temperature
- Light

O_2 flux data supports MPB dynamics

Blue = 12°C
Red = 16°C

- Shifts from net phototrophic to net heterotrophic after week two (NB: negative flux = efflux)



Preliminary 'observations':

- Significant difference between muddy and sandy sediments for most variables.
- Quick development of MPB in flumes
- Possible interaction between nutrient fluxes and MPB dynamics
- MPB typically 'crashes' week 2 – very dynamic system
- Temporal variability within one treatments possibly larger than variability between treatmetns.
- We need to analyse data on weekly basis rather than monthly in order to compare between treatments
- Further replication, complimentary parameters and statistical analysis are need to draw any firm conclusions

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Acknowledgements

Thanks to:
Irvine Davidson (Univ. St Andrews)
John Montgomery (SAMS)
Andy Reynolds (SAMS)
Pete Taylor (SAMS)
John Kershaw (SAMS)
Tamara Green (SAMS)
Beatrice de Francisco (SAMS)
Nick Kamenos (Glasgow Univ.)
Heidi Burdett (Glasgow Univ.)

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