

PML

Plymouth Marine
Laboratory

Marine Matters

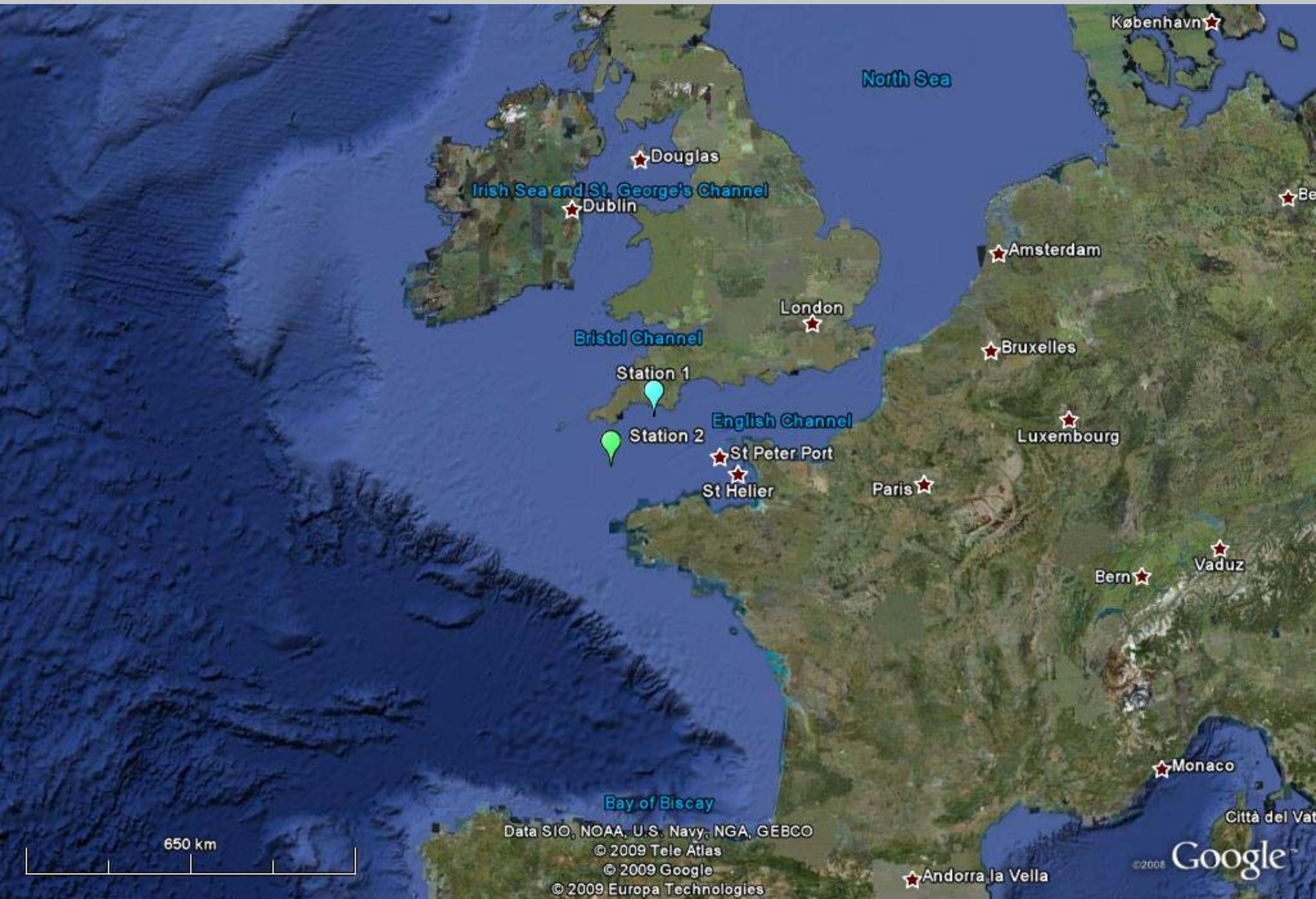
Nitrogen Fixation in the western English Channel

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Biological Nitrogen Fixation

- Vast global diversity of diazotrophic microorganisms.
- Limited information on extent of distribution
 - Plenty of detail on tropical and subtropical
 - Less focus on nutrient replete environments, e.g. coastal systems.
- Diazotrophy found in, e.g. brackish waters, Arctic tundra, Antarctic freshwater, deep sea hydrothermal vents, etc.
- So the Western English Channel is probably a good bet!



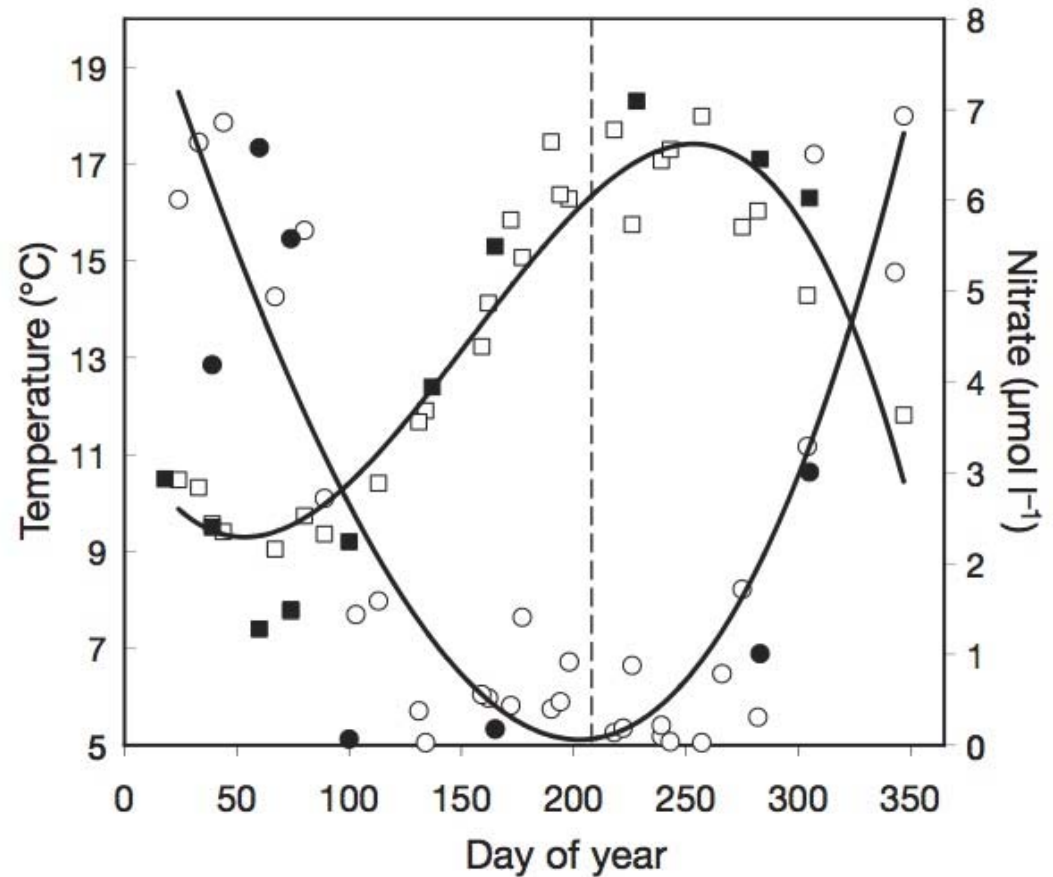
650 km

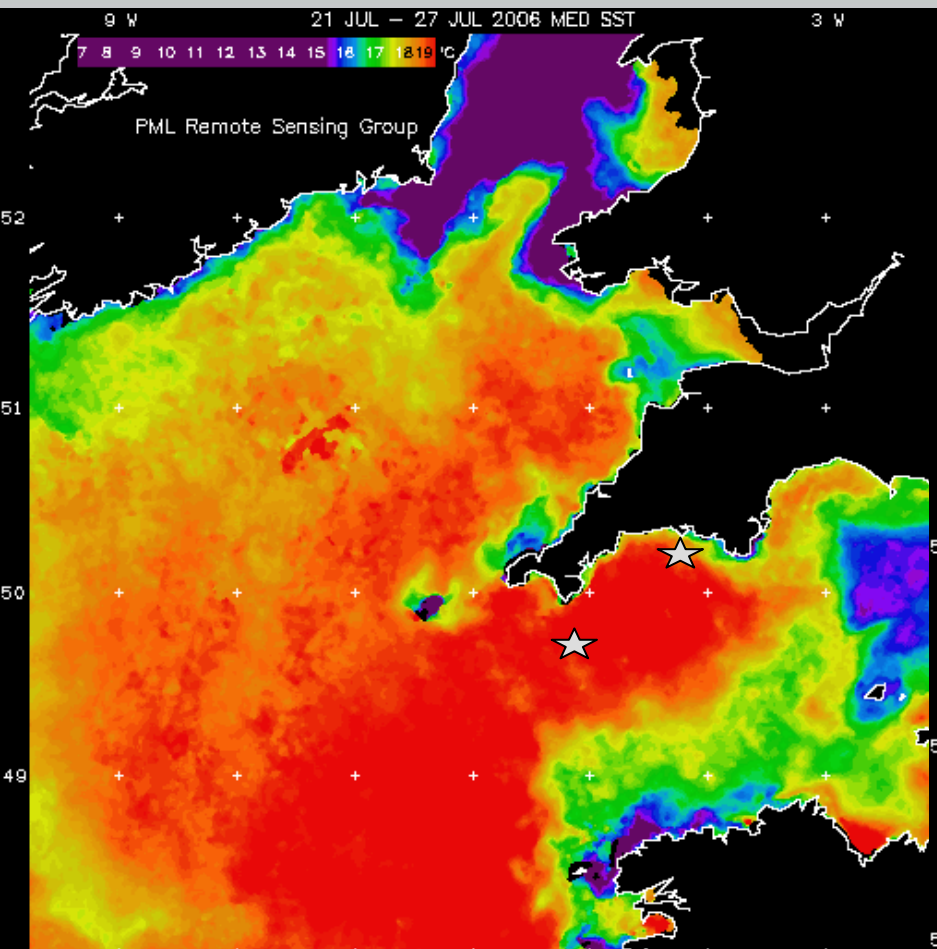
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
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Sampling

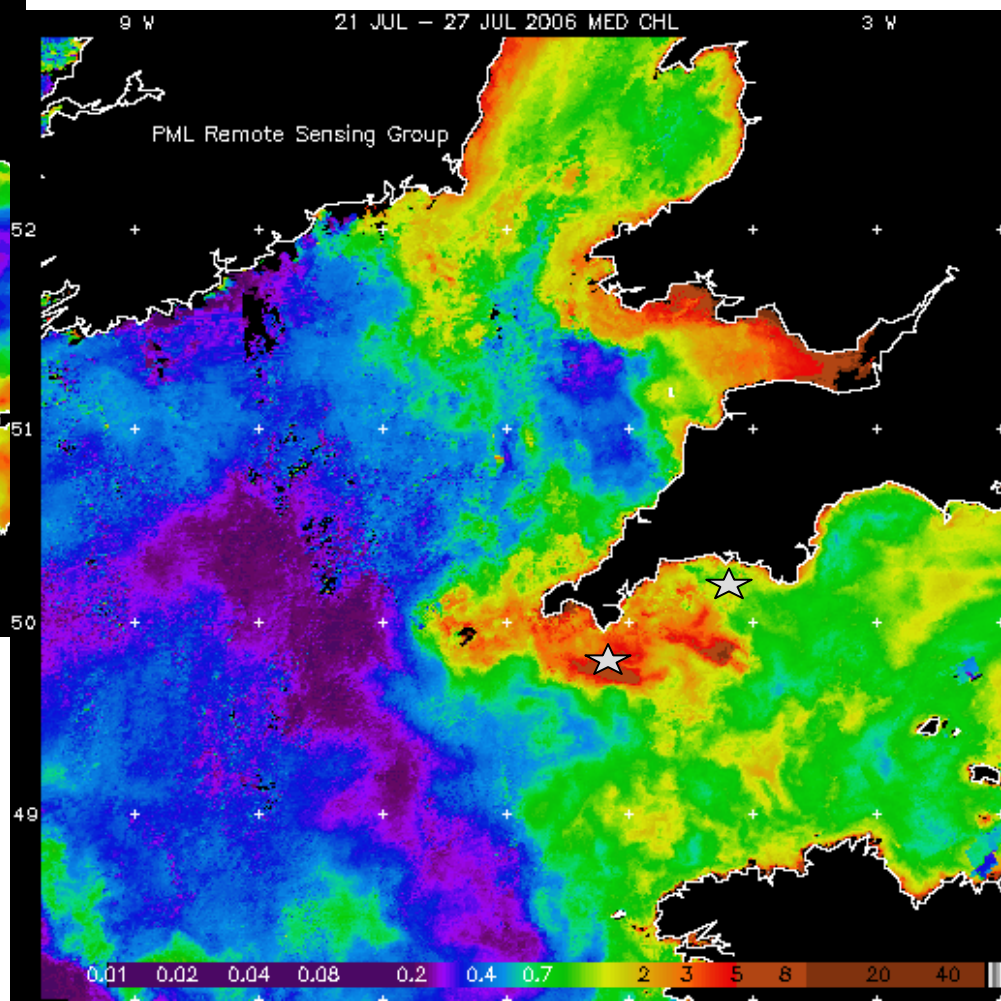
- Samples were collected on July 27th 2006
- Sampling inside and outside a mixed bloom of *Emiliana huxleyi* and *Karenia mikimotoi*.
- Sampling occurred at a time of relatively low nitrate concentration and high temperature.



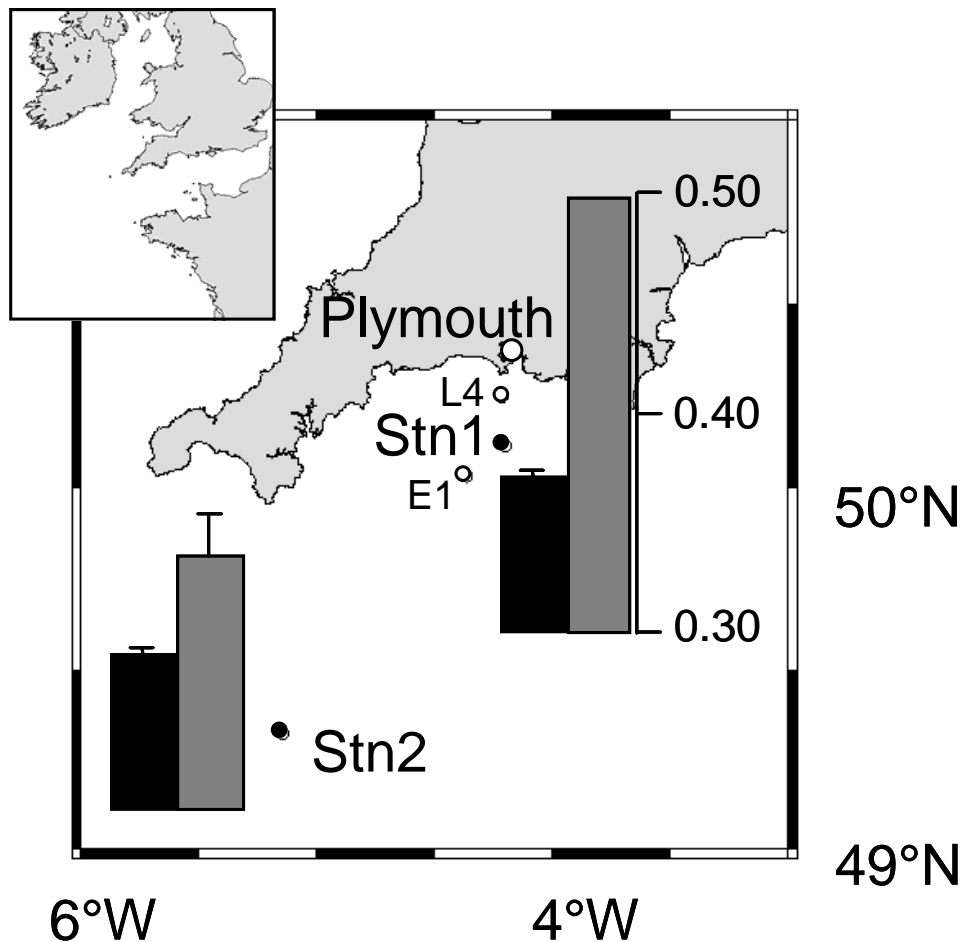


Temperature

Chlorophyll A



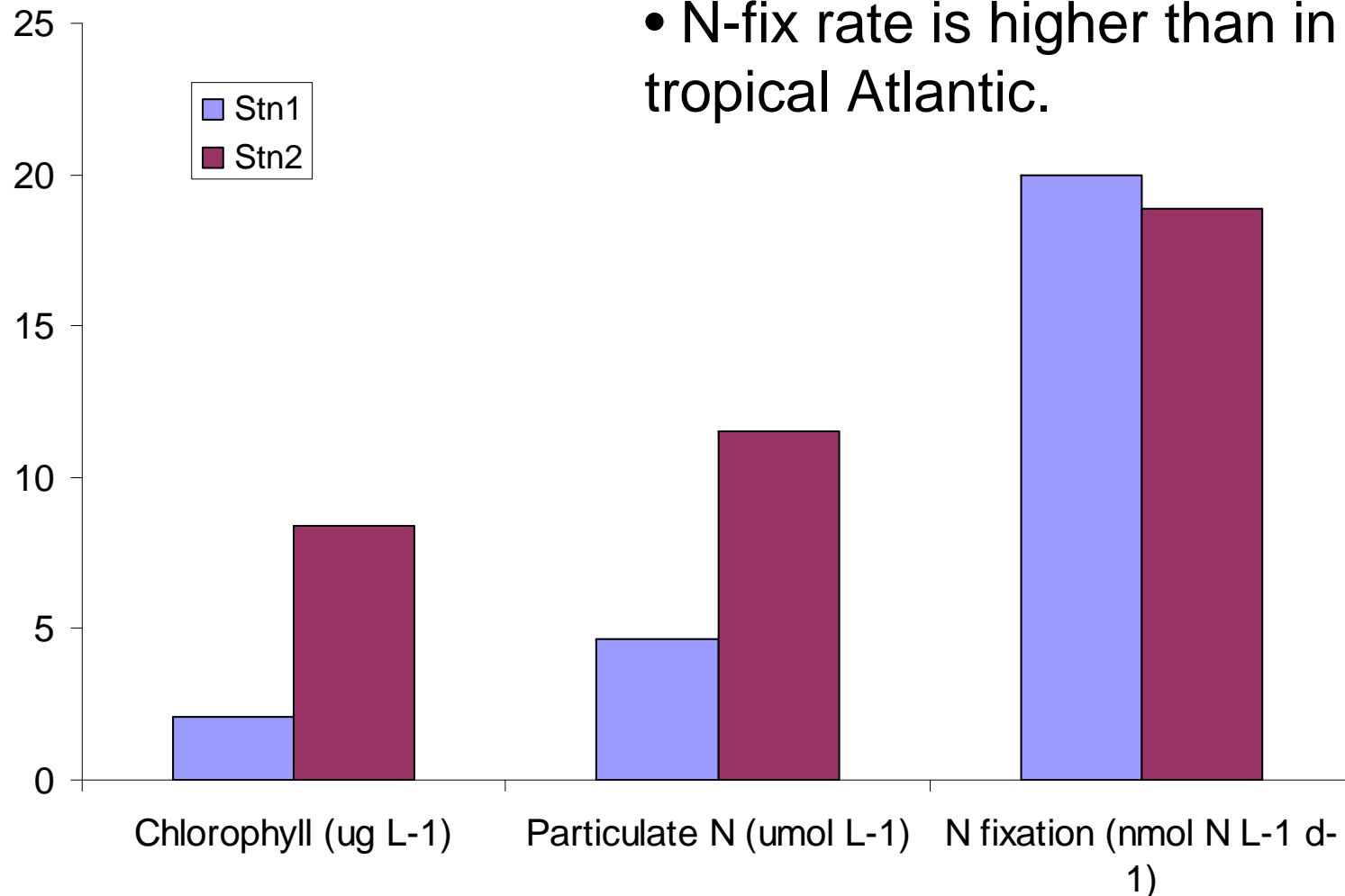
15N-atom% and 14N-atom %



- 15N-atom% was significant enriched over the background 14N-atom%.
- These values were used in conjunction with PN concentrations to determine N fixation rate

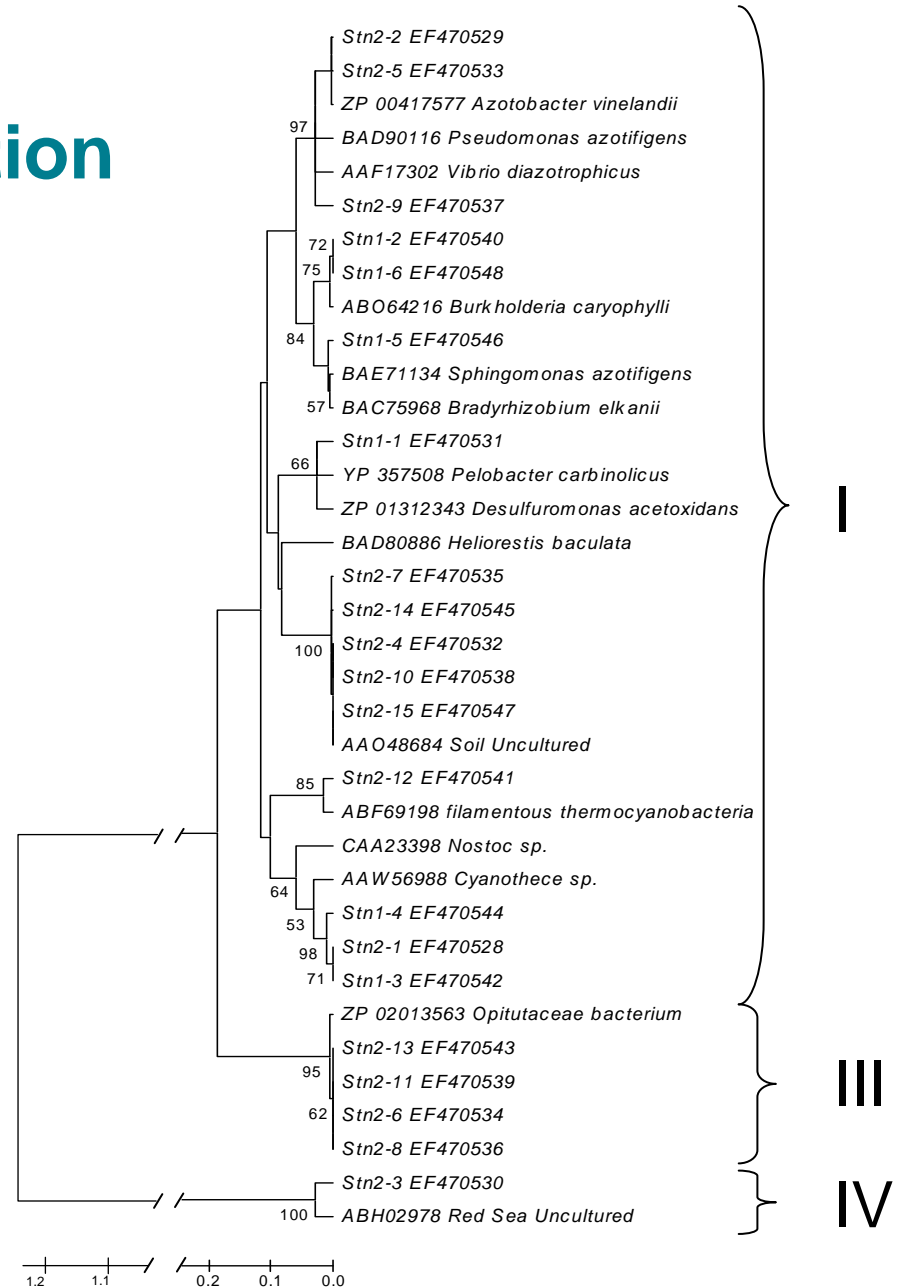
Chlorophyll, PN and N-fixation

- N-fix rate is higher than in the subtropical Atlantic.



Molecular Characterisation

- 13 different bacterial *nifH* transcripts were identified.
- 1 type from the anaerobic Cluster III group.
- 1 type formed a distant outlier named Cluster IV.
- Both were found at station 2 which had a higher transcriptional diversity than station 1.
- Alpha- and Betaproteobacteria mainly at station 1
- Gammaproteobacteria mainly at station 2



Why are there active diazotrophs in N-rich coastal waters

- The high energy requirement of diazotrophy would seem to make it unfeasible in high dissolved inorganic nitrogen concentrations.
- Yet N-fix has been observed with nitrate concentrations of $10 \text{ } \mu\text{mol L}^{-1}$.
- Summer in the WEC is probably a good bet.
- Ratio between DIN and DIP probably a driving force.
- Regularly less than redfield ratio of 16 – potential N-limitation.

What does this add to the N-budget

- Small number of samples – limited conclusions
- If N-fix rate of $20 \text{ nmol N l}^{-1} \text{ d}^{-1}$ is a maximum then it could provide between 42 % and 833 % of the NO_3^- requirement for a typical North Sea coccolithophore bloom.
- However, these blooms also use urea and proteins, so the NO_3^- component may only comprise 1.5% of the necessary N.
- N-fix rate is the same order as the denitrification rates from the North Sea.

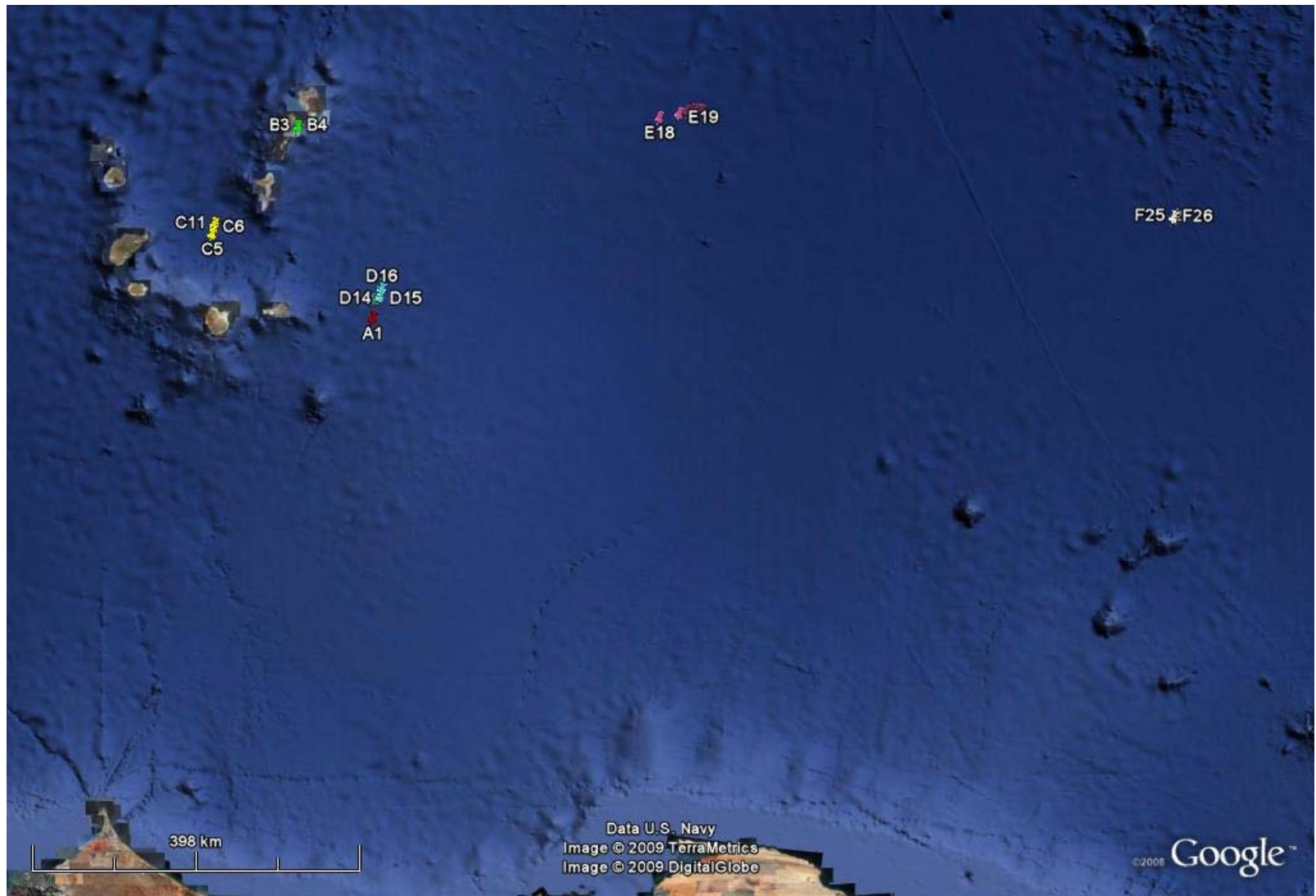
Conclusions from this study

- Clear evidence of nitrogen fixation in mesotrophic waters of the WEC during the thermally stratified summer.
- Calculated rate is greater than observed in the sub-tropical Atlantic.
- Diverse nifH transcripts.
- N-fix in this environment may counter losses due to denitrification.
- N-budgets may have to be adjusted to reflect this.

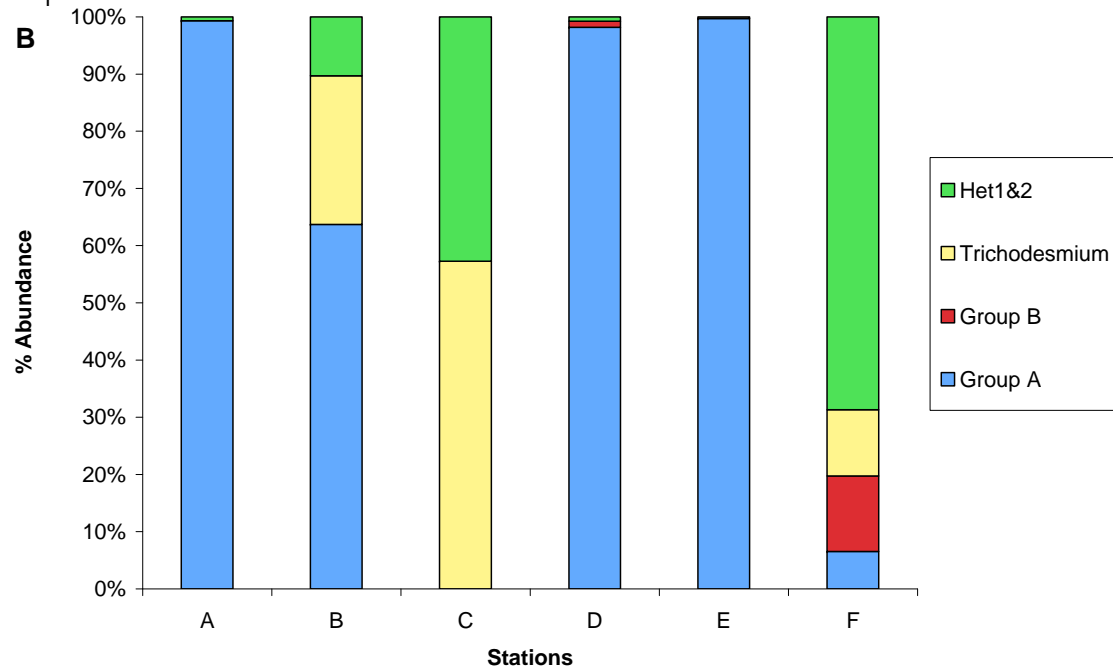
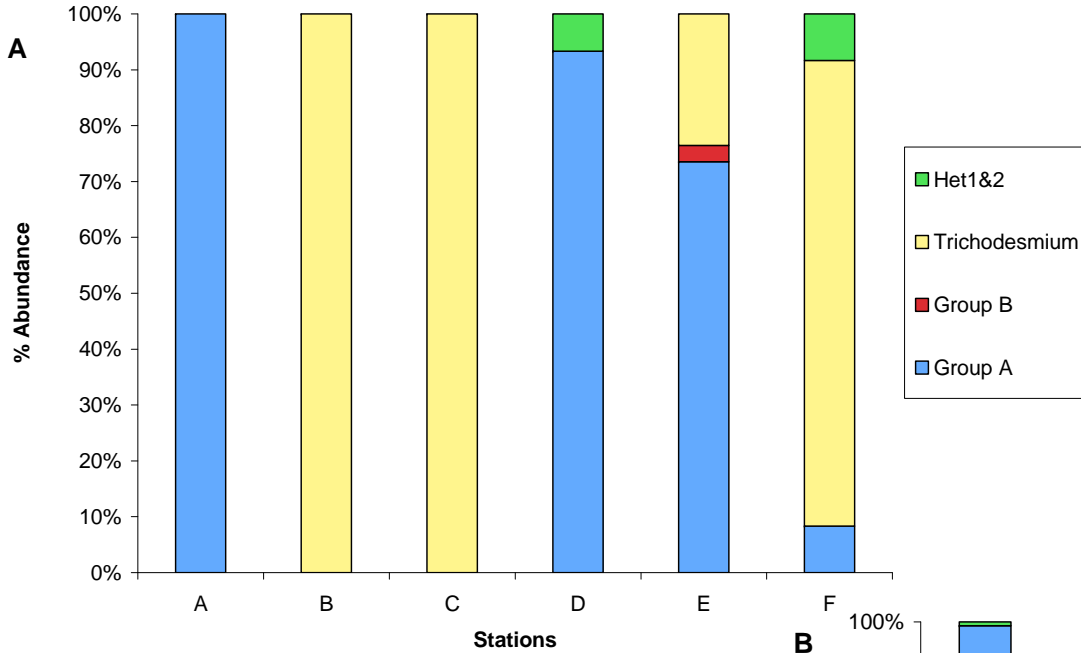
Hot off the Press!!!

- Currently working with Jon Zehr from UCSD, USA.
- Transcriptional study on 6 diverse oceanographic sites around the Cape Verde Islands.
- 660 sequences, comprising 220 unique proteins. 87 % are singletons.
- Oligotrophic open ocean sites were the most diverse and had least dominance in the population.

Study sites



RT-PCR diversity and relative abundance.



RT-qPCR diversity and relative abundance.

Acknowledgements

- NERC for funding
- PML research group for assistance
 - Simon Thomas

Questions?