

The impact of coastal upwellings on the air-sea exchange of climatically important gases (ICON)

RRS Discovery 330 8th May 2008 – 19th June 2008 Tenerife – Tenerife

Scientific Planning meeting 16th - 17th January 2008

Plankton biomass and Diversity

Glen Tarran

- a.. What is being measured and how does this fit into at least one of the cruise objectives,
- b.. what do we know already (especially in light of previous SOLAS cruises) about the parameters you're measuring,
- c.. what are your hypotheses/ or what do you expect to find,
- d.. what type of facilities do you need from the ship e.g. incubator space, access to sink / gas lines, and
- e.. what other measurements will you need to interpret your data

a.. What is being measured and how does this fit into at least one of the cruise objectives ?

I will be.....

using flow cytometry to quantify: Heterotrophic bacteria

Picophytoplankton - Cyanobacteria

Picoeukaryotes

Nanophytoplankton – Coccolithophores

Cryptophytes

Others

I think I will be doing the following:

Pico and nanophytoplankton – Pre-patch surveys (with others, in shifts)

Patch study CTDs (Obj 1, Obj 3)

Post-patch filament X section CTDs

Heterotrophic bacteria -

Patch study CTDs (Obj 1, Obj 3)

Post-patch filament X section CTDs

Filtrate monitoring: photochem expts (Obj 2)

I will also be....

a) working with Susan Kimmance,

- using the flow cytometers to sort specific phytoplankton groups for viral production experiments (Obj 3)
- conducting grazing experiments to determine phytoplankton mortality and DMSP production (Obj 3)

b) filling bottles containing Lugol's iodine for post-cruise analysis by Claire Widdicombe and Elaine Fileman (Obj 3)

c) involved with the HPLC pigment analysis after the cruise

I suspect I might also end up getting involved with....

- “.... determining turnover rates of labile organic molecules and their consumption by dominant microbial groups using a tracer dilution technique and flow cytometric sorting” (Obj 2)
- “.... estimate....the relative contribution of dominant bacterial groups using amino acid tracers and flow cytometric sorting” (Obj 3)

I don't think I will be doing....

much sunbathing (not the right skin type)

much exercise in the gym

Consequently, I don't think I will be....

losing any weight

b.. what do we know already (especially in light of previous SOLAS cruises) about the parameters you're measuring ?

See next slide - expectations

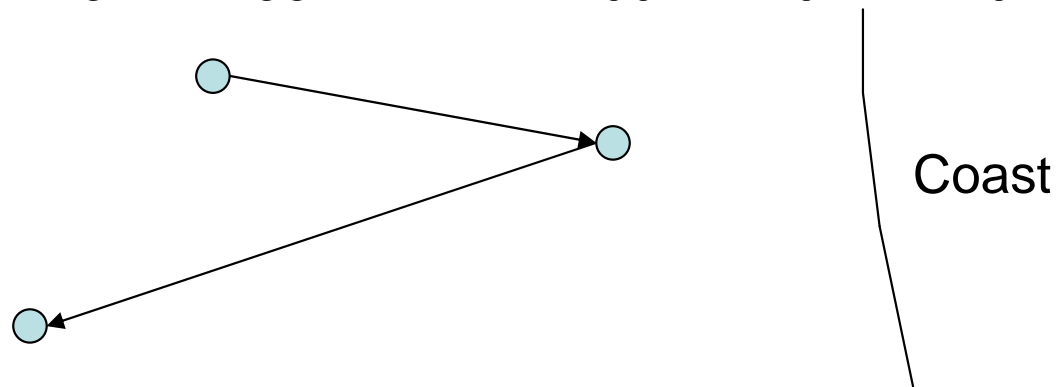
c.. what are your hypotheses/ or what do you expect to find ?

Most of the work supports other areas of the cruise, so no hypotheses

Expectations: Flow cytometric analysis –

From AMT 13 September 2003 – Cells per mL

| Date | Time | Lat N | Long W | Syn | Pro | Peuk | Neuk | Cocco | Cryp | HBac |
|------|------|----------|-----------|-----|------|------|------|-------|------|-------------------|
| 23/9 | 0448 | 20.6 | 18.2 | 80k | 240k | 5k | 1k | 20 | 100 | 700k |
| 23/9 | 1233 | 20.3 | 17.8 | 5k | 0 | 4k | 1k | 150 | 450 | 3x10 ⁶ |
| 24/9 | 0434 | 18 | 18.3 | 57k | 156k | 4k | 400 | <20 | <20 | 680k |



**d.. what type of facilities do you need from the ship
e.g. incubator space, access to sink / gas lines ?**

Questionnaire passed to Malcolm

e.. what other measurements will you need to interpret your data ?

A lot of the data will be used by others to interpret their own work

Nutrients

Maybe HPLC

Physics

Hydrography

NOTES

Objective 1: To determine the role of upwelling on the supply, loss and air-sea exchange of trace and biogenic gases

Concurrent **determination of** physics (ADCP, temperature, buoy drift, SF6) and **biogeochemistry** (nutrients, Chl a, **AFC**) will enable quantification of upwelling and filament dispersion, and determination of horizontal and vertical diffusivity, shear and volume transport. Co-ordinated measurements of N₂O, pCO₂, CH₄, DMS, O₂, CO and iodocarbons with transfer velocity measurements (3He) will constrain regional air-sea fluxes and offshore transport. Filament strength and periodicity will be determined using MODIS remote sensing. Stable isotopic characterisation of N₂O and CH₄ will quantify the upwelling source of these gases.

Objective 2: To determine the photochemical and biological fate of upwelled and recently produced dissolved organic matter and its role in air-sea exchange of climatically important trace gases.

In order to elucidate the importance of photochemistry in the production and loss of trace gases we will undertake a number of incubation experiments using natural light +/- UVA and UVB exclusion filters linking CDOM photobleaching with the photochemical transformation of NH₄, O₂, iodocarbons, oVOCs and DMS [these latter pending additional SOLAS funding to Nightingale and Uher]. A recent open ocean diel study, with iodocarbon surface seawater concentrations measured every 2 hours, showed a 50 and 200% increase for iodomethane and chloriodomethane, respectively.

These patterns are significant in terms of net daily fluxes and warrant further investigation. Photochemical transformations will be separated from microbial transformation in these experiments by ultrafiltration and **monitoring of the filtrate using flow cytometry**. We will assess the cumulative effect of photo- and **microbial oxidation of DOM by determining turnover rates of labile organic molecules and their consumption by dominant microbial groups using a tracer dilution technique and flow cytometric sorting**. We will also compare rates of sugar and amino acid turnover in light /dark and UV irradiated / screened bottles. CDOM also plays an important role in seawater spectral quality and hence the efficiency of nitrogen and carbon uptake during photosynthesis. The absorption coefficient of CDOM will be determined at discrete depths in the photic zone by both spectrophotometry and fluorometry following published methods. These will be coupled with vertical profiles of the apparent optical properties of the water column using both free fall PAR and UV optical profilers and the inherent optical properties of the water column using ac-9, ECO-VSF and Hobilabs Bb6. We will assess the magnitude of photoinhibition of photosynthesis and CDOM absorption using short term ¹⁴C irradiance and benchtop FRRF experiments.

Objective 3: To determine the impact of nutrient enriched upwelled water on the spatial and temporal variability of plankton community structure and activity and resultant influence on biogenic gas flux.

The upwelled and surrounding waters will be sampled for viral, algal, bacterial and microzooplankton biomass, taxonomic composition and activity (production and respiration) linked to concurrent measurements of *in vitro* and *in situ* changes in trace and biogenic gas concentrations, in order to identify the important trace gas production and loss processes mediated by the plankton community. **We will estimate** bacterioplankton production as well as **the relative contribution of dominant bacterial groups using amino acid radiotracers and flow cytometric sorting.**

These bacterial groups will then be phylogenetically characterised and quantified by fluorescent *in situ* hybridisation (FISH) with rRNA oligonucleotide probes, or if necessary the complete rRNA cycle. We aim to quantify the number of bacteriochlorophyll containing cells and estimate their contribution to total bacterioplankton production. We will bioassay concentrations and turnover rates of organic (amino acids, sugars etc.) and inorganic nutrients (phosphate, iron etc.) to assess the role of nutrient limitation. **We will also estimate protist grazing using prey pulse-chase isotopic labelling and size fractionation techniques.** In order to determine the impact of upwelled water on DMSP production, and the fate of the DMSP production through viral lysis and grazing, we will determine the temporal change in DMSP_p, DMSP_d and DMS within the upwelled water compared to adjacent waters, the taxa responsible for DMSP production, viral abundance and genetic diversity, µzooplankton grazing impact on DMSP-specific phytoplankton, viral impact on DMSP-specific phytoplankton, and grazer and viral production of dissolved DMSP and DMS. We aim to develop a comprehensive model of the role that upwelling water plays in DMS sea to air flux, linking to the proposed work by SOLAS collaborators on photochemical transformations (Uher), sea to air flux estimates (Fowler) and modelling (Allen). Nitrification is a major source of N₂O to the atmosphere, and so we will examine the influence of enhanced nutrient availability on the rates of ammonium regeneration and nitrification. Previous unpublished data demonstrated elevated rates of ammonium regeneration associated with upwelling and *in situ* nutrient addition experiments. Preliminary results suggest a similar enhancement of nitrification under these conditions. Pending additional funding (Nightingale) we will also investigate the flux of OVOCs in relation to bacterial activity.