Throughout $ is generic null/not given/not available placeholder
{curly brackets indicate clarifications added by author of *this* file}

Project Name:

SERIES

Subarctic Ecosystem Response to Iron Enrichment Study

Acronym: SERIES

Synonym: $

Program: SOLAS (Surface Ocean Lower Atmosphere Study).

Project url: http://www.uea.ac.uk/env/solas/

Related Program: C_SOLAS- (Canadian contribution to SOLAS).
http://csolas.dal.ca/solas_2618.html

Lead PI name and contact info:

J.P. Tully (ship): Marie Robert
robertm@pac.dfo-mpo.gc.ca

Philip Boyd
p.boyd@niwa.co.nz

El Puma (ship): Maurice Levasseur
maurice.levasseur@bio.ulaval.ca

co PI name(s) and contact info:

PI Paul Harrison
Hong Kong Univ. of Science and Technology (HKUST)
Harrison@ust.hk

PI Tom Pedersen
(Univ. of Victora)
tip@uvic.ca

PI Maurice Levasseur
Univ. Laval
maurice.levasseur@bio.ulaval.ca

PI William MillerUniv. of Georgia
bmiller@uga.edu

PI Robert Moore
Dalhousie Univ
robert.moore@dal.ca

PI Chi-Shing WongChi-Shing Wong
Institute of Ocean Sciences (IOS)
wongCS@pac.dfo-mpo.gc.ca

PI Ulrike Lohmann
Institut f. Atmosphäre und Klima (EC-MSC)
ulrike.lohmann@env.ethz.ch

PI Ann-Lise NormanAnn-Lise Norman
Univ. of Calgary
annlisen@phas.ucalgary.ca

PI Philip Boyd
National Institute of Water & Atmospheric Research Ltd (NIWA)
pboyd@chemistry.otago.ac.nz

PI Cliff Law (NIWA)
c.law@niwa.cri.nz

PI Frank Whitney
Institute of Ocean Sciences (IOS)
whitneyf@pac.dfo-mpo.gc.ca

Other responsible investigators and their contact information:
Taken from file: Data_Inventory_SERIES.xls

All abbreviations for measured parameters are explained below under the "metadata" section.

PI Paul Harrison
Hong Kong Univ. of Science and Technology (HKUST)
Harrison@ust.hk

co-PI Adrian Marchetti
Univ. of Washington
amarchetti@ocean.washington.edu

co-PI Jean-Éric Tremblay
Robert Strzepek

Nutrients (nitrate, nitrite, ammonium, silicate, phosphate)
Chlorophyll-a
15N uptake
Primary production
POC/PON
Chl(Fluorescence) mapping
Nitrate mapping
T/S mapping
Size fraction Chl a and C:N:P
TEP and deckboard discrete PAM

PI Tom Pedersen
(Univ. of Victora)
tip@uvic.ca

co-PI Joe Nedoba
needoba@mbari.org

δ15N of nitrate
δ15N of particulate nitrogen (PN) – GF/F filters
δ15N of particulate nitrogen (PN) – sediment traps

PI Maurice Levasseur
Univ. Laval
maurice.levasseur@bio.ulaval.ca

co-PI Sonia Michaud
IML
michauds@dfo-mpo.gc.ca

Concentrations of dissolved DMS
Concentrations of Total DMSP and Fractionated DMSP
DMS/P production

Grazing experiment: DMS/P production
Microcosm experiment: DMS/P production with iron
DMSPd consumption (S35)
DMS consumption (S35)

PI William MillerUniv. of Georgia
bmiller@uga.edu

co-PI Cedric Fichot
Univ. of Georgia
cfichot@uga.edu

Surface diffuse attenuation coefficients (Kd)
Surface downwelling irradiance (Ed)
PAR
Remote sensing reflectance (Rrs)
Apparent Quantum Yields (AQYs) for DMS photo-degradation
Absorption coefficients of CDOM (ag)

PI Robert Moore
Dalhousie Univ
robert.moore@dal.ca

Dissolved methyl chloride, methyl bromide, methyl iodide
Other dissolved halogenated trace gases
Dissolved isoprene

co-PI Richard Rivkin
Memorial Univ. of Newfoundland (MUN)
rrivkin@mun.ca

Bacterial abundance and biomass
Bacterial production and specific growth rate (TdR and Leucine)
Picophytoplankton cell counts (Synechococcus, Picoeukaryotes)
Nanophytoplankton cell counts
Pico- and nano-phytoplankton biomass
Community respiration
Abundance, carbon per cell, and biomass of flagellates
Abundance, carbon per cell, and biomass of dinoflagellates
Abundance, carbon per cell, and biomass of ciliates
Microzooplankton biomass
Bacterial community composition (FISH)
Bacterial cell volume (geometric mean from image analysis)
Microzooplankton grazing rates from dilution experiments (for bacteria, bacterial rods and cocci, picophytoplankton, nano-phytoplankton, total Chl a, Chl a < 5 um and Chl a > 5 um)
Bacterail growth rates from nutrient amendment experiments
Microcosm experiment data (abundance of heterotrophic bacteria, picophytoplankton, and nanophytoplankton, and bacterial production)

PI Chi-Shing WongChi-Shing Wong
Institute of Ocean Sciences (IOS)
wongCS@pac.dfo-mpo.gc.ca

co-PI Keith Johnson
IOS
JohnsonK@pac.dfo-mpo.gc.ca

Iron soluble (0.03u)
Iron dissolved (0.22u)
Iron reactive/labile (not filt.)
Iron total dissolved
Iron total unfiltered
Drifting trap Fe
DOC and TOC
pH
DIC
alkalinity
SF6
pCO2
Meteorological data from weather station
Meteorological data from bridge log
Iron speciation and ligands
DMS
Phytoplankton pigments (HPLC)
Nanoplankton (Flow cytometry)

PI Ulrike Lohmann
Institut f. Atmosphäre und Klima (EC-MSC)
ulrike.lohmann@env.ethz.ch

co-PI Richard Leaitch(ETHZ)
Meteorological Service of Canada
Richard.Leaitch@ec.gc.ca

Aerosol number concentration and size distribution
Total number concentration of particles with D>15nm
Aerosol mass concentration (S04,MSA,NO3,NH4,organic)
Aerosol mass spectrum (S04,MSA,NO3,NH4,organic)
Speciated mass distribution for particles with 60 nm < Dva < 1000 nm
Scattering and backscattering coefficients in blue, green, and red
Absorption coefficient for green light (PSAP)
Size-segregated mass concentration (MOUDI)
Concentrations of cloud condensation nuclei (CCNc)
SO2 mixing ratio
Ozone mixing ratio
Meteorological variables: Temperature (T), Relative humidity (RH),
Barometric Pressure (P), Relative wind speed,
Relative wind direction [onboard meteorological station]

PI Ann-Lise NormanAnn-Lise Norman
Univ. of Calgary
annlisen@phas.ucalgary.ca

DMS
Size segregated aerosol SO2, Sulphate, MSA (cascade impactors)
Isotope fractionation of sulphur in sulphate and SO2

PI Philip Boyd
National Institute of Water & Atmospheric Research Ltd (NIWA)
pboyd@chemistry.otago.ac.nz

co-PI Robert Strzepek

Underway FRRF mapping
Vertical FRRF profiling
Flavodoxin/ferredoxin
Particle size spectra
TEP and deckboard discrete PAM

PI Cliff Law (NIWA)
c.law@niwa.cri.nz

Nitrous oxide
Carbon monoxide
Tracer Layer Depth (TLD)

PI Frank Whitney
Institute of Ocean Sciences (IOS)
whitneyf@pac.dfo-mpo.gc.ca

Nutrients summary (nitrate, nitrite, ammonium, phosphate, silicate)
Chl a summary
SF6 summary
CTD (Temperature, salinity, pressure, Fluoroscence, transmittance
Sigma-T, Oxygen)

Start date:
27 June 2002

End date:
05 August 2002

Logo url:
$ not available

Geolocation:
NE Pacific, north of station P26 (Ocean Station Papa) on line P at 50°N 144°45E

Description:

from: http://csolas.dal.ca/solas_2618.html

In July, 2003 the SERIES was carried out in the NE Pacific near Ocean Station Papa (50N, 145W). Three ships, the CCGS John P. Tully, the M/V El Puma (Mexico) and M/V Kaiyo Maru from Japan, along with 45 researchers from 20 institutions across Canada as well as international collaborators participated in the experiment. The objectives were to study the response of phytoplankton, bacteria and zooplankton to the addition of Fe, the effect on carbon flux to the deep ocean, the influence of Fe on the production and cycling of climatically active trace gases and its influence on the atmospheric sulfur budget, sulfate aerosols and cloud microphysics. The decline and fate of the iron stimulated diatom bloom as been reported (Boyd et al. (2004) Nature, doi:10.1038).

Here we report on the decline and fate of an iron-stimulated diatom bloom in the Gulf of Alaska. The bloom terminated on day 18, following the depletion of iron and then silicic acid, after which mixed-layer particulate organic carbon (POC) concentrations declined over six days. Increased particulate silica export via sinking diatoms was recorded in sediment traps at depths between 50 and 125 m from day 21, yet increased POC export was not evident until day 24. Only a small proportion of the mixed-layer POC was intercepted by the traps, with more than half of the mixed-layer POC deficit attributable to bacterial remineralization and mesozooplankton grazing. The depletion of silicic acid and the inefficient transfer of iron-increased POC below the permanent thermocline have major implications both for the biogeochemical interpretation of times of greater iron supply in the geological past, and also for proposed geo-engineering schemes to increase oceanic carbon sequestration.

Prior to commencing the joint iron and SF6 addition, we conducted a 48-h oceanographic survey (7 and 8 July 2002) in the vicinity of Ocean Station Papa (OSP, 508N, 1458W; Fig. 1a) to identify an appropriate site with HNLC characteristics typical of this region (LaRoche et al. 1996; Nishioka et al. 2001). A suitable site (Table 1) was located 50 km northeast of OSP, and the surface waters were enriched on 10 July 2002 (denoted as day 0 of SERIES) with dissolved iron to .1 nmol L-1, along with the concurrent addition of the tracer SF6 (>400 fmol L-1) following procedures reported in Law et al. (1998). Throughout SERIES, mixed-layer SF6 concentrations were always significantly higher than background levels, and thus we did not add any more SF6 to the patch. However, on day 6, a second iron infusion was required that raised dissolved iron by around 0.6 nmol L-1.

Publications:

As at OCTOBER 2008: 31 publications (ABSTRACTS at END of this document)

Most publications in a special issue of Deep Sea Research II (vol 53 issue 20-22)

Metadata:

{Examination of files shows some data is not included. PIs have been asked several to provide data several times since July 2008, but as at time of writing, August 2009, have not supplied missing data.}

A DVD containing files was provided. The DVD is called:
"Canadian Surface Ocean-Lower Atmosphere Study Data and Document Collection (2001-2007)"

In addition to SERIES data, the DVD also contains data for C-SOLAS Pacific Mooring and SABINA projects. These non-SERIES data are NOT discussed in *this* current description of the SERIES project.

The directory structure of the DVD is given below. There are 2 top level directories and a file called "Readme First-Data Privacy and DVD Contents.pdf".

The full directory structure of the DVD is given here to facilitate navigation. Directory structure is default alphabetical listing produced using Windows XP Windows explorer. (Folders listed alphabetically then files listed alphabetically).

NOTE 1: File names are NOT unique. Therefore full pathways may need to be given.

NOTE 2: Following this directory listing, each SERIES file is described. Folders for other projects are listed but are not described fully. Folders for other projects with not-listed subdirectories and files are marked as "{more}".

NOTE 3: In addition to the files on the DVD, another file called "SERIES_KaiyoMaru_metadata.xls" was emailed to the author of *this* file (D Mackie). This file is discussed below along with files in the folder 1.1 C-SOLAS Data Inventory.

1 C-SOLAS Data

1.1 C-SOLAS Data Inventory
Data Inventory_Mooring.xls
Data Inventory_SABINA.xls
Data Inventory_SERIES.xls

1.2 C-SOLAS Pacific Mooring {more}

1.3 Metadata

1.3.1 MD Cruise
C-SOLAS_SABINA_cruise_track.pdf
C-SOLAS_SABINA_stations.xls
C-SOLAS_SERIES_Stations.xls
MD_SABINA_FALL.pdf
MD_SABINA_SPRING.pdf
MD_SABINA_SUMMER.pdf

1.3.2 MD Project
MD_Gosselin_SABINA.pdf
MD_Harrison_SERIES.pdf
MD_Levasseur.pdf
MD_Lohmann_SERIES.pdf
MD_Miller.pdf
MD_Moore.pdf
MD_Norman_SABINA.pdf
MD_Norman_SERIES.pdf
MD_Pedersen_SERIES.pdf
MD_Rivkin.pdf
MD_Sathyendranath_BGC_SABINA.pdf
MD_Sathyendranath_RS_SABINA.pdf
MD_Vagle_Mooring.pdf
MD_Wong_SERIES.pdf

1.4 SABINA {more}

1.5 SERIES
1.5.1 SERIES Atmosphere
Series_Lohmann_Leaitch_atmospheric.xls

1.5.2 SERIES CTD

1.5.2.1 CTD data El Puma
Bin Averaged CTD Profiles A inc sigmaT.xls
Bin Averaged CTD Profiles A.xls
Bin Averaged CTD Profiles B inc sigmaT.xls
Bin Averaged CTD Profiles B.xls
Bin Averaged CTD Profiles C inc sigmaT.xls
Bin Averaged CTD Profiles C.xls
Bin Averaged CTD Profiles D inc sigmaT.xls
Bin Averaged CTD Profiles D.xls

Bin Averaged CTD Profiles E inc sigmaT.xls
Bin Averaged CTD Profiles E.xls
CTD Bin_Ave_Summary_ElPuma.xls
CTD El Puma Readme.pdf
CTD note.txt
CTD profiles 21 to 30.xls
CTD profiles 31 to 40.xls
CTD profiles 41 to 50.xls
CTD profiles 5 to 20.xls
CTD profiles 51 to 57.xls
flatBin Averaged CTD Profiles A inc sigmaT.xls
flatBin Averaged CTD Profiles B inc sigmaT.xls
flatBin Averaged CTD Profiles C inc sigmaT.xls
flatBin Averaged CTD Profiles D inc sigmaT.xls
flatBin Averaged CTD Profiles E inc sigmaT.xls

1.5.2.2 CTD data Tully

2002-16-0033.CTD
2002-16-0034.CTD
2002-16-0036.CTD
2002-16-0037.CTD
2002-16-0038.CTD
2002-16-0039.CTD
2002-16-0040.CTD
2002-16-0041.CTD
2002-16-0042.CTD
2002-16-0043.CTD
2002-16-0044.CTD
2002-16-0045.CTD
2002-16-0046.CTD
2002-16-0047.CTD
2002-16-0048.CTD
2002-16-0049.CTD
2002-16-0050.CTD
2002-16-0051.CTD
2002-16-0052.CTD
2002-16-0053.CTD
2002-16-0054.CTD
2002-16-0055.CTD
2002-16-0056.CTD
2002-16-0057.CTD
2002-16-0058.CTD
2002-16-0059.CTD
2002-16-0060.CTD
2002-16-0061.CTD
2002-16-0062.CTD
2002-16-0063.CTD
2002-16-0064.CTD
2002-16-0065.CTD

2002-16-0066.CTD
2002-16-0067.CTD
2002-16-0068.CTD
2002-16-0069.CTD
2002-16-0070.CTD
2002-16-0071.CTD
2002-16-0072.CTD
2002-16-0073.CTD
2002-16-0074.CTD
2002-16-0075.CTD
2002-16-0076.CTD
2002-16-0077.CTD
2002-16-0078.CTD
2002-16-0079.CTD
2002-16-0080.CTD
2002-16-0081.CTD
2002-16-0082.CTD
2002-16-0083.CTD
2002-16-0084.CTD
2002-16-0085.CTD
2002-16-0086.CTD
2002-16-0087.CTD
2002-16-0088.CTD
2002-16-0089.CTD
2002-16-0090.CTD
2002-16-0091.CTD
2002-16-0092.CTD
2002-16-0093.CTD
2002-16-0094.CTD
2002-16-0095.CTD
2002-16-0096.CTD

1.5.3 SERIES Mapping

pCO2-licor-Tully_Wong.txt
SERIES EP_Harrison_Mapping.xls
SF6_drifter_Tully_Wong.txt

1.5.4 SERIES Miscellaneous

MET_BridgeLog_Tully_Wong.txt
MET_WeatherSt_Tully_Wong.txt
Nutrients Chla SF6_SERIES_Summary_Whitney.xls
TLDs_SERIES.xls

1.5.5 SERIES NiskinBottle

SERIES EP_Harrison_Nutr-Chl-PP-15N uptake-POC-PON.xls
SERIES EP_Levasseur_DMSP-DMS.xls
SERIES EP_Rivkin_Phytop-Microzoop-CommRespir.xls
SERIES JPT EP_Pedersen_d15N in NO3 PN.xls

SERIES JPT_Moore_Methylhalides.xls
SERIES JPT_Wong_DOC-TOC.xls
SERIES JPT_Wong_Hydro-pH -DIC-alk.xls
SERIES JPT_Wong_Iron.xls

1.5.6 SERIES Optics
SERIES_Miller_CDOM.xls
SERIES_Miller_Kd_Rrs_AQY DMS.xls
SERIES_Miller_PAR.xls
SERIES_Miller_Surface irradiances.xls

1.5.7 SERIES SedimentTrap
SERIES JPT KM_Pedersen_d15N_sediment trap.xls

2 Documentation

2.1 C-SOLAS data Management Documents

2.1.1 C-SOLAS Cruise Reports

2.1.1.1 SABINA reports {more}

2.1.1.2 SERIES reports
CruiseReport-SERIES-ElPuma.pdf
CruiseReport-SERIES-Tully.pdf

2.1.2 C-SOLAS Data Policy
C-SOLAS Data Policy.pdf
Data Management.pdf

2.1.3 C-SOLAS Data Templates
PIs_MD_SABINA.doc
PIs_MD_SERIES.doc
SABINA_Atmosphere.uw.xls
SABINA_Ocean.xls

2.2 C-SOLAS Documents
2.2.1 C-SOLAS Newsletter
C-SOLAS Newsletter Issue1-20034003.pdf
C-SOLAS Newsletter Issue2-20031009.pdf
C-SOLAS Newsletter Issue3-20040427.pdf
C-SOLAS Newsletter Issue4-20050408.pdf

2.2.2 C-SOLAS Posters
CSOLAS Poster 2004Sept24.pdf
CSOLAS Poster 2007Feb21.pdf

CSOLAS Final Report 2001-2007.pdf

CSOLAS Prospectus.pdf

{{description of files on DVD}}

Clarifications added by author of *this* document (D Mackie) are given {in curly brackets}

1.1 C-SOLAS Data Inventory
Data Inventory_SERIES.xls
This file is an excel spreadsheet .xls format. It contains 1 worksheet.

The worksheet describes extant data and gives the data location within the DVD directory structure.

The worksheet has 8 columns:

A) Responsible PI
B) Contact
C) Data description {what has been measured}
D) Ships {platform from which data were collected}
E) Data category {location of data folder}
{>1 C-SOLAS Data > 1.5 SERIES}
F) Metadata File Name {location of metadata file}
>1 C-SOLAS Data > 1.3 Metadata >1.3.2 MD Project}
G) Data File Name{datafile within folder given by Data category column}
H) Comments {field either empty or "*Data available upon request"}

1.3 Metadata
1.3.1 MD Cruise
C-SOLAS_SERIES_Stations.xls
{file may be partly corrupt and gives error message on opening}
This file is an excel spreadsheet .xls format. It contains 4 worksheets.

Sheet 1) Cruises_Timeline
A calendar from 5 July 2002 to 4 August 2002 showing active vessels.
Sheet 2) Tully
A list of stations occupied by the Tully (vessel).
Date, Time, In/Out, Cast, Long, Lat.
Also a plot of lat/long for stations.

Sheet 3) ElPuma
A list of stations occupied by the El Puma (vessel).
Date, Time, In/Out, Cast, Long, Lat.
Also a plot of lat/long for stations
.
Sheet 4) Kayo Maru
A list of stations occupied by the Kayo Maru (vessel).
Date, Time, In/Out, Cast, Long, Lat.
Also a plot of lat/long for stations.

1.3.2 MD Project

All files in this folder give metadata from each PI for their data. All files have been completed using the TEMPLATE in:

>Documentation
>>C-SOLAS Data Management Documents
>>>C-SOLAS Data Templates
>>>>PIs_MD_SERIES.doc

This template is reproduced below. Following the template is a list of the files and details of the parameters described by each file.

{TEMPLATE BEGINS}

C-SOLAS: SERIES METADATA
C.C.G.S. John Tully, Mexican ship El Puma, Japanese ship Kaiyo Maru

1. PROJECT TITLE:

2. PRIMARY INVESTOGATOR:

2.1 Address:

2.2 Telephone number:

2.3 Fax number:

2.4 Email address:

3. BRIEF PROJECT DESCRIPTION:

4. DATA ACQUISITION

4.1 What did you measure and how did you measure it (include references for analytical methods)?

(For instance: Nano-picophytoplankton dynamic (describe briefly how this was measured, the method used))

4.2 Sampling strategy

(For instance: Nano-picophytoplankton dynamic
At each station, a study of the variability over 24 h with a sampling frequency of 2 h in the surface layer (0-300 m) was done. Twelve depths were sampled on each profile. For each depth, two sub-samples, one of 2 and the other of 5 ml, were fixed with a solution of PFA 20% (final concentration of 2%) then froze and kept for later analyses.)

4.3 Analyses and treatments after the cruise, time scale needed for those analyses and treatments

Nano-picophytoplankton dynamic
The analyses will be performed after the cruise. The analyses and data analyses should be finished by “date”.

4.4 Error estimations, precision, sensitivity of the data

5. DATA DESCRIPTION

5.1 Filename of data file: please use a specific filename including your name and the parameter measured, not “NA-SOLAS”.

5.2 Explain the column titles, units et abbreviations used in the data file.

5.3 Describe what type of data would be necessary for you to complete your data set before submitting it to the database and estimate the delay before availability of your data for the database.

6. REFERENCES

{TEMPLATE ENDS}

List of files and parameters described by each file in the format of the above template:

MD_Harrison_SERIES.pdf
Nutrients, Chl, POC, PON, nitrate

MD_Levasseur.pdf
DMS, DMSP

MD_Lohmann_SERIES.pdf
Aerosols

MD_Moore.pdf
Algal pigments, methyl halides, light, temperature

MD_Norman_SERIES.pdf
Dimethyl Sulphide, Methanesulphonic Acid and Sulphate

MD_Pedersen_SERIES.pdf
Stable nitrogen isotopes

MD_Rivkin.pdf
Bacteria

MD_Wong_SERIES.pdf

Fe, SF6, pCO2, DIC, TA

1.5 SERIES
1.5.1 SERIES Atmosphere
SERIES_Lohmann_Leaitch_atmospheric.xls

{NOTE}
The time stamps and locations are anomalous.
PIs were notified in August 2008 and as at August 2009 they have yet to resolve the matter despite repeated requests.

This file has 16 worksheets.

Sheet 1) About the data
A well written metadata description.

Notes that: "The ship plume data is available on request."
{I recommend these be obtained before they are lost}
{I asked over a year ago, and was promised the data but…}
Notes that: AMS mass spectra are available on request
{I recommend these be obtained before they are lost}
{I asked over a year ago, and was promised the data but…}

Sheet 2) real_time_data
{start paste from sheet 1} {SEE sheet 1 for notes on these data}

This sheet contains original time series data for meteorological variables, ship log variables, AMS aerosol species mass concentration, gaseous sulphur dioxide (SO2) concentration, gaseous ozone concentration, SMPS, PCASP, and FSSP[?] number concentrations, CCN voltages, PSAP[?], Nephelometer[?].

Ship plume data has been removed where applicable (AMS, SO2, and SMPS measurements), but is present in the 7610 data, indicating periods of fumigation.

The ship plume data is available on request.
{end paste from sheet 1}

Sheet 3) MOUDI_flow_synopsis
{pasted from sheet 1} {SEE sheet 1 for notes on these data}

This sheet describes the samples collected on MOUDI filter apparatus.
Gives the average flow rate, the total sample time on, the total volume of air sampled, and the approximate midpoint of the time on (for plotting purposes) for each sample.

The following 12 sheets present the analysis for MOUDI samples.
Sheet 4) Cl-

Sheet 5) NO2-
Sheet 6) NO3-
Sheet 7) SO4=
Sheet 8) C2O4=
Sheet 9) Na+
Sheet 10) NH4+
Sheet 11) K+
Sheet 12) Mg++
Sheet 13) Ca++
Sheet 14) MSA
Sheet 15) TOTAL = sum of all above species

Sheet 16) AMS Spectrum
Contains a jpg of the average mass spectrum of the background aerosol. Obtaining mass spectra for specific periods of the data requires the use of analysis software; mass spectra are available by request.

1.5 SERIES
1.5.2 SERIES CTD
1.5.2.1 CTD data El Puma
These files contain PROCESSED CTD data from El Puma (vessel).
See C-SOLAS_SERIES_Stations.xls for details of when the El Puma was active

The files "CTD note.txt" and "CTD El Puma Readme.pdf" contain important information about data quality and data processing. READ these files before using any data.

{start pasted from CTD note.txt}
CTD files from El Puma July 2002 SOLAS/SERIES cruise to Station Papa.
Temp and Salinity data extracted from raw CTD files by Nelson Sherry UBC
Sigma-T calculation and data organization by Paul Matthews MUN
Station Log name- identifies CTD cast ref to daily log cast sheet
Secondary name- name commonly used to identify station
Event#- ref to cast sheet
YYYYMMDD HHMM(UTC)- self explanatory
Latitude (+)= North
Longitude (-) = West
Inpatch =1 out patch =0
Depth m
Temp (C) as obtained from CTD cast
Salinity as obtained from CTD cast
Sigma T calulated from T and S http://globec.whoi.edu/globec-dir/sigmat-calc-fortran.html
{end pasted from CTD note.txt}

{start pasted from file CTD El Puma Readme.pdf}
I was unable to get the CTD software to post-process the binary files into complete ASCII output files because of the software's inability to handle some sporadic pressure date associated with the beginning and the end of many files. The post-processing data truncated

the files instead of processing them with error flags included. As such, I managed only to get unprocessed ASCII data out from the binary files. Although the values reported in this CTD data set do include instrument calibration corrections and salinity calculations, they do not include spike correction for salinity over depths with rapid temperature change. Thus, there will be excessive salinity "noise" through the thermocline indicating poor data processing, not real salinity spiking.
{end pasted from file CTD El Puma Readme.pdf}

{NOTE:
Bin averaged files are distinguished as “A, B, C, D, E” and CTD profiles are distinguished with a numbered interval. These descriptors refer to the date of sampling.

“A” (bin averaged) and “5-20” (profiles) are for 10-15 July 2002
“B” (bin averaged) and “21-30” (profiles) are for 16-19 July 2002
“C” (bin averaged) and “31-40” (profiles) are for 20-23 July 2002
“D” (bin averaged) and “41-50” (profiles) are for 24-26 July 2002
“E” (bin averaged) and “51-57” (profiles) are for 27-28 July 2002

Bin Averaged CTD Profiles A inc sigmaT.xls
Bin Averaged CTD Profiles A.xls
Bin Averaged CTD Profiles B inc sigmaT.xls
Bin Averaged CTD Profiles B.xls
Bin Averaged CTD Profiles C inc sigmaT.xls
Bin Averaged CTD Profiles C.xls
Bin Averaged CTD Profiles D inc sigmaT.xls
Bin Averaged CTD Profiles D.xls
Bin Averaged CTD Profiles E inc sigmaT.xls
Bin Averaged CTD Profiles E.xls
CTD Bin_Ave_Summary_ElPuma.xls
CTD El Puma Readme.pdf
CTD note.txt
CTD profiles 5 to 20.xls
CTD profiles 21 to 30.xls
CTD profiles 31 to 40.xls
CTD profiles 41 to 50.xls
CTD profiles 51 to 57.xls
flatBin Averaged CTD Profiles A inc sigmaT.xls
flatBin Averaged CTD Profiles B inc sigmaT.xls
flatBin Averaged CTD Profiles C inc sigmaT.xls
flatBin Averaged CTD Profiles D inc sigmaT.xls
flatBin Averaged CTD Profiles E inc sigmaT.xls

1.5 SERIES
1.5.2 SERIES CTD
1.5.2.2 CTD data Tully
These files contain PROCESSED CTD data from the Tully (vessel).
{NOTE: See C-SOLAS_SERIES_Stations.xls for details of when the Tully was active}

No note about the data is included.
?? Presumably the notes about El Puma data (above} also apply??

These files are in "*.CTD" format.
The files are readable as with any ASCII text reader.
Headings and comments within each file give full details of sampling.

The file name ends with *-00XX.CTD where XX is the cast number.
See C-SOLAS_SERIES_Stations.xls for tables giving cast number, location and date/time.
(In Tully, El Puma and KayoMaru worksheets).

{Recommend that a copy of these tables be placed in the same directory}

2002-16-0033.CTD
2002-16-0034.CTD
2002-16-0036.CTD
2002-16-0037.CTD
2002-16-0038.CTD
2002-16-0039.CTD
2002-16-0040.CTD
2002-16-0041.CTD
2002-16-0042.CTD
2002-16-0043.CTD
2002-16-0044.CTD
2002-16-0045.CTD
2002-16-0046.CTD
2002-16-0047.CTD
2002-16-0048.CTD
2002-16-0049.CTD
2002-16-0050.CTD
2002-16-0051.CTD
2002-16-0052.CTD
2002-16-0053.CTD
2002-16-0054.CTD
2002-16-0055.CTD
2002-16-0056.CTD
2002-16-0057.CTD
2002-16-0058.CTD
2002-16-0059.CTD
2002-16-0060.CTD
2002-16-0061.CTD
2002-16-0062.CTD
2002-16-0063.CTD
2002-16-0064.CTD
2002-16-0065.CTD
2002-16-0066.CTD
2002-16-0067.CTD
2002-16-0068.CTD
2002-16-0069.CTD
2002-16-0070.CTD

2002-16-0071.CTD
2002-16-0072.CTD
2002-16-0073.CTD
2002-16-0074.CTD
2002-16-0075.CTD
2002-16-0076.CTD
2002-16-0077.CTD
2002-16-0078.CTD
2002-16-0079.CTD
2002-16-0080.CTD
2002-16-0081.CTD
2002-16-0082.CTD
2002-16-0083.CTD
2002-16-0084.CTD
2002-16-0085.CTD
2002-16-0086.CTD
2002-16-0087.CTD
2002-16-0088.CTD
2002-16-0089.CTD
2002-16-0090.CTD
2002-16-0091.CTD
2002-16-0092.CTD
2002-16-0093.CTD
2002-16-0094.CTD
2002-16-0095.CTD
2002-16-0096.CTD

1.5 SERIES
1.5.3 SERIES Mapping
pCO2-licor-Tully_Wong.txt

This file is in *.txt format and contains “Computed air/sea fCO2 data from Line P cruise 2002-16 (SERIES PATCH Only)”.

{start paste from the file}
Computed air/sea fCO2 data from Line P cruise 2002-16 (SERIES PATCH Only).
for Emmy Wong / OSAP / IOS
Input data file: pco2-licor-x85-27_2002-16_ico2-patch.chk06
[USES INTERPOLATED AIR XCO2 AND SEA XCO2]

fCO2 values are computed at insitu swt & sal (using Takahashi 1993 t-correction)

SST,SAL are merged from Thermosalinograph data
CO2 Flux (mMole.m^-2.d^-1) computed using DRY Delta fCO2
Equilibrator temp was computed from Surface Sea Temp (SST) using an assumed constant warming of 0.335 C
{end paste from the file}

The file has 5958 rows and 24 columns
Rows are for discrete samples.
Columns are:

1 YearMonthDayHourMin

2 atm UTC Date Latitude
3 dry UTC Time Longitude
4 wet baro sst (C)
5 wind bulb sal pss-78
6 instr bulb eqt (C)
7 instr rel press (kpa)
8 dry speed temp (C)
9 dry atmo temp (C)
10 dry equilib humid (%)
11 instr air @10m (m/s)
12 DRY sea pCO2 (ppm)
13 DRY delta pCO2 (ppm)
14 DRY LATY fCO2 (uatm)
15 LNGX fCO2 (uatm)
16 GYRD fCO2 (uatm)
17 GJUL scaled lat
18 STND2 scaled lng
19 CO2 scaled date
20 CO2 scaled day
21 CO2 pCO2 (ppm)
22 Flux mM.m2.d
23 Flux mM.m2.d
24 Flux mM.m2.d

{note: year prefixed with an extra "2".
{ Month, day, hour, minutes do not have leading zero.
{ THUS 22002 710 446 means 2002 July 10th 04.46 hours

1.5 SERIES
1.5.3 SERIES Mapping
SF6_drifter_Tully_Wong.txt

This file is in *.txt format and contains "Surface Drifter SF6 data for Cruise 2002-16 SERIES Experiment"

The file has 1579 rows and 14 columns
Rows are for discrete samples.
Columns are:

1 year
2 UTC Date Month
3 UTC Time Day
4 UTC HrMnSc
5 Latitude
6 Longitude
7 SF6 area
8 SF6 ppt
9 SF6 fmol/kg
10 SF6 fmol/L
11 Decimal Year
12 Julian Decimal Day
13 Decimal Lat
14 Decimnal Long

1.5 SERIES
1.5.3 SERIES Mapping
SERIES EP_Harrison_Mapping.xls
This file is in *.xls format
The file contains 4 worksheets.

Sheet 1) Chl TS SigmaT mapping July 24
Contains time, lat, long, Chl (ug/L), S, T, SigmaT for July 24

Sheet 2) Chl TS SigmaT mapping July 27-8
Contains time, lat, long, Chl, (ug/L), S, T, SigmaT for July 27-28

Sheet 3) NO3 mapping July 24
Contains time, lat, long, NO3 (uM) for July 24

Sheet 4) NO3 Chl TS SigmaT mapping Jul28
Contains time, lat, long, S, T, SigmaT, Chl fluor, NO3 (uM) for July28
This file is NOT the same data as 2) above
Sample frequency is greater in this sheet
(every minue cf every 10 minutes in 2) above
Chl HERE is as “Chl fluor”

1.5 SERIES
1.5.4 SERIES Miscellaneous
MET_BridgeLog_Tully_Wong.txt

This file is in *.txt format and contains “Met data extracted from Ship's Bridge Log (manual observations by ship's cruise from Ship's Anemometer... at 25m height)”

The file has 1047 rows and 15 columns
Rows are for discrete samples.
Columns are:

1	Bridge UTC GYRD years xxxx.xxxxxxx	
2	Bridge Log LATY degrees yyyy.yyyyy	
3	Log LNGY degrees zzzz.zzzzz	
4	Baro. Press. kPa aaa.aa	
5	DBT C bb.b	Dry Bulb Temperature
6	WBT C cc.c	Wet Bulb Temperature
7	SST C dd.d	Sea Surface Temperature
8	@25m TWD fromN deg eee.e	True Wind Directiom
9	@25m TWS Min knots fff.f	True Wind Speed
10	@25m TWS Max knots ggg.g	True Wind Speed
11	TWS Gust knots hhh.h	True Wind Speed
12	UTC YearMoDy yyyymmdd	
13	UTC HrMn hhmm	
14	Bridge Log Latitude dd:mm.mmmh	
15	Bridge Log Longitude ddd:mm.mmmh	

1.5 SERIES
1.5.4 SERIES Miscellaneous
MET_WeatherSt_Tully_Wong.txt

This file is in *.txt format and contains “Met data for Cruise 2002-16 (LineP & SERIES Experiment) (Wind corrected to TWD,TWS). From COCC portable Weather Station (@18m height) on "Monkey's Island" aboard Tully”

The file has 6362 rows and 11 columns
Rows are for discrete samples.
Columns are:

1	UTC YearMoDy aaaabbcc	
2	UTC HrMn ddee	
3	Latitude dd:mm.mmmh ff:gg.gggh	
4	Longitude ddd:mm.mmmh iii:jj.jjjk	
5	BaroP kPa ooo.oo	
6	TWS knots rrr.rRvvv.vVss.s	True Wind Speed
7	TWD degN AAA.A	True Wind Direction
8	DBT (C) B.BBB	Dry Bulb Temperature
9	RelH (%) CCCCCCC	Relative Humidity
10	SolRd kw/m2	Solar Irradiation
11	Cruise ID	

1.5 SERIES
1.5.4 SERIES Miscellaneous
Nutrients Chla SF6_SERIES_Summary_Whitney.xls
This file is in *.xls format
The file contains 4 worksheets.

Sheet 1) data
{sigh. this worksheet is a compilation of lots of things crammed on one sheet}

3 sets of data are presented:

Set ONE
There are 3 blocks with the same format giving Nitrate, Silicate and Phosphate data
Units are not given.

Each block has 7 rows: 6 rows for light depth% (100, 33, 10, 3, 1, 0.1% PAR) and one row for average 10-100%.

Each block has columns for 16 dates in July: 10, 11, 12, 13, 14, 15, (not 16), 17, 18, 19, (not 20), 21, 22, 23, 24, (not 25), 26, 27, 28.

Set TWO
There are 7 blocks with the same format giving Nitrate (uM), Silicate (uM), Phosphate (uM), Ammonium (uM), Nitrite (uM), Chlorophyll (ug/L), SF6 (fmol/kg) data.

Each block has 14 rows: 13 for nominal depth (m): 0, 5, 10, 15, 20, 30, 40, 50, 60, 80, 100, 150, 200 and one row for average 0-20. {this average row is not well headed}

Each block has columns for dates in July and August 2002:
7, 10-24 July complete (2 samples 20 July), 26, 28, 31, August 2, August 4.

1003 UTC	7-Jul
2204 UTC	7-Jul
2148 UTC	10-Jul
1812 UTC	11-Jul
1822 UTC	12-Jul
1838 UTC	13-Jul
1751 UTC	14-Jul
1726 UTC	15-Jul
1843 UTC	16-Jul
1815 UTC	17-Jul
1748 UTC	18-Jul
0051 UTC	20-Jul
1715 UTC	20-Jul
1815 UTC	21-Jul
2016 UTC	22-Jul
1913 UTC	23-Jul
D16	24-Jul
D18	26-Jul
D20	28-Jul
D23	31-Jul
D25	2-Aug
D27	4-Aug

Set THREE
Kaiyo Maru nutrients.
Essentially and extension of Set TWO above.

There are 5 blocks with the same format giving Nitrate (uM), Silicate (uM), Phosphate (uM), Ammonium (uM), Nitrite (uM) data. (NOT Chlorophyll, NOT SF6)

Each block has 14 rows: 13 for nominal depth (m): 0, 5, 10, 15, 20, 30, 40, 50, 60, 80, 100, 150, 200 and one row for average 0-20. {this average row is not well headed}

Each block has columns for dates in July and August 2002:
July 23 (D16), 24 (D18), 27 (D20), 30 (D23) and August 1 (D25), 3 (D27)

sheet 2) graphs

Plots some of the data above.

1.5 SERIES
1.5.4 SERIES Miscellaneous

TLDs_SERIES.xls
This file is in *.xls format
The file contains 1 worksheet.

There are two bocks of data having 10 columns.
Block 1 (rows 4-25) is data collected from Tully (vessel).
Data for casts:
60, 62, 64, 65, 68, 71, 73, 74, 76, 77, 78, 80, 81, 83, 85, 86, 88, 89, 91, 92, 94, 95
{IN patch casts only}
{UTC TIMES – column 3 – do NOT match those in C-SOLAS_SERIES_Stations.xls
{ TLD times range from 4-8 minutes later than Stations times

Block 2 (rows 27-38) is data collected from Kaiyo-Maru (vessel).
Data for 10 casts are given
{UTC TIMES – column 3 – do NOT contain TIME data}
It is not possible to know which stations were sampled}
?? Casts are labelled A-L but this is not used elsewhere?

The sheet has 10 columns:

1 Cast
2 UTC date
3 UTC time
4 SF6 Max
5 SF6 max depth
6 Depth of 50% SF6 average (m) = TLD (1)
7 Sigma-t /m
8 at sig-t
9 Depth of sigma-t increase > 0.02/m = TLD (2)
10 Notes

1.5.5 SERIES NiskinBottle
SERIES EP_Harrison_Nutr-Chl-PP-15N uptake-POC-PON.xls
Contains LINKED data.

This file is in *.xls format
The file contains 1 worksheet.
The file contains data for: Nutrients (Nitrate, Silicate, Phosphate), Chl a, NO3 Uptake, Primary Production, Inorganic PP, POC and PON, C:N

The sheet contains 116 rows, divided into 19 blocks. Each block corresponds to data at 6 different depths for a single cast on a single day. The depths are approximately 1, 10, 20, 40, 60 and 80 m. (Except the final cast is for 3 depths only)

1 10 July Out
2 11 July In
3 12 July In
4 12 July Out
5 13 July In

6	15 July In
7	15 July Out
8	17 July In
9	18 July In
10	19 July In
11	20 July In
12	21 July In
13	21 July Out
14	22 July In
15	23 July In
16	24 July In
17	26 July In
18	28 July Out
19	28 July In

The sheet has 45 columns:

1	Date
2	Day
3	Station
4	Lat.
5	Long.
6	Bottle #
7	Depth (m)
8	Mixed Layer (m)
9	% PAR
10	Nutrients: NO3 (uM)
11	Nutrients: Stand. Dev.
12	Nutrients: SiO3 (uM)
13	Nutrients: Stand Dev.
14	Nutrients: PO4 (uM)
15	Nutrients: Stand. Dev.
16	Chl a: >20 mm ug/L
17	Chl a: Stand. Dev.
18	Chl a: 20-5 mm ug/L
19	Chl a: Stand. Dev.
20	Chl a: 5-2 mm ug/L
21	Chl a: Stand. Dev.
22	Chl a: 2-0.2 mm ug/L
23	Chl a: Stand. Dev.
24	NO3 Uptake: > 5 um SF (ugN/L/day)
25	NO3 Uptake: Stand. Dev.
26	NO3 Uptake: 5 um - GFF SF (ugN/L/day)
27	NO3 Uptake: Stand. Dev.
28	Organic Primary Production (ug C/L/day) 0.2 umAverage
29	Organic Primary Production (ug C/L/day) 0.2 um n
30	Organic Primary Production (ug C/L/day) 0.2 um SE
31	Organic Primary Production (ug C/L/day) 2 um Average
32	Organic Primary Production (ug C/L/day) 2 um n

33	Organic Primary Production (ug C/L/day)	2 um	SE
34	Organic Primary Production (ug C/L/day)	5 um	Average
35	Organic Primary Production (ug C/L/day)	5 um	n
36	Organic Primary Production (ug C/L/day)	5 um	SE
37	Organic Primary Production (ug C/L/day)	20 um	Average
38	Organic Primary Production (ug C/L/day)	20 um	n
39	Organic Primary Production (ug C/L/day)	20 um	SE
40	Inorganic PP (ug C.L.day)	Average	
41	Inorganic PP (ug C.L.day)	St. Dev.	
42	Particulate Organic Matter	PON (ug/L)	
43	Particulate Organic Matter	PON (uM)	
44	Particulate Organic Matter	POC (ug/L)	
45	Particulate Organic Matter	C:N	

1.5.5 SERIES NiskinBottle

SERIES EP_Levasseur_DMSP-DMS.xls

This file is in *.xls format
The file contains 1 worksheet.
The file contains data for Dimethylsulfoniopropionate (DMSP) and Dimethylsulfide (DMS)

The sheet contains 480 rows and 11 columns.
The rows correspond to Niskin bottle samples. Only 132 rows contain DMSP and DMS data.

The columns record:
Station IN or OUT
Start Latitude according to El Puma log {?decimal}
Start Longitude according to El Puma log {?decimal}
Date in July 2002
Unique Niskin Bottle number
Depth (m) as in log book
Light level % low.
Total particulate DMSP (>0.7 um)
Dissolved DMSP (<0.7 um)
Dissolved DMS (<0.7 um)
Depth (m) used in publication {not clear why the two sets of depth had differences}

The rows record data in batches of 6 rows, each batch of 6 rows corresponds to a cast at different depths; ~80, 60, 40, 20, 10, 1 m.

There are thus data for 22 casts:

Date in July 2002	in/out
10	OUT
11	IN
12	IN
13	IN

14	IN
15	OUT
15	IN
16	IN
17	IN
18	IN
19	IN
20	OUT
20	IN
21	IN
22	IN
23	IN
24	IN
25	OUT
26	IN
27	IN
28	IN
28	OUT

1.5.5 SERIES NiskinBottle

SERIES EP_Rivkin_Phytop-Microzoop-CommRespir.xls

{This is a well structured spreadsheet, thank you}
{If all the spreadsheets were as good as this we could post this as is}

This file is in *.xls format
The file contains 1 worksheet.
The file contains data for phytoplankton and microzooplankton abundance, biomass and production.

The sheet contains data for 133 samples (S1-S133), one to a row.
The sheet has data in 62 columns:

1	File ID	
2	Sample	
3	Date	
4	Day	
5	Station/Cast	
6	Patch	1= in, 0=out
7	Latitude	
8	Latitude	deg
9	Latitude	min
10	Longitude	
11	Longitude	deg
12	Longitude	min
13	Depth	(m)
14	Temp	(deg C)
15	Salinity	(ppt)
16	Bacterial Abundance	(cells L-1)
17	Bacterial Biomass	(ug C L-1)
18	Abundance of cells with LDNA content	(cells L-1)
19	Abundance of cells with HDNA content	(cells L-1)
20	%HDNA	(%)
21	TdR Bacterial Production	(ug C L-1 d-1)
22	TdR Bacterial Specific Growth Rate	(d-1)

23	Leu Bacterial Production		(ug C L-1 d-1)
24	Leu Bacterial Specific Growth Rate		(d-1)
25	Ave Bacterial Production		(ug C L-1 d-1)
26	Ave Bacterial Specific Growth Rate		(d-1)
27	Synechococcus		(cells mL-1)
28	Picoeukaryotes		(cells mL-1)
29	Total Picophytoplankton		(cells mL-1)
30	Small Nanophytoplankton (2-10 um)		(cells mL-1)
31	Large Nanophytoplankton (>10 um)		(cells mL-1)
32	Total Nanophytoplankton		(cells mL-1)
33	Total Phytoplankton (<20 um)		(cells mL-1)
34	Total Picophytoplankton Biomass (<2 um)		(pg C mL-1)
35	Small Nanophytoplankton Biomass (2-10 um)		(pg C mL-1)
36	Large Nanophytoplankton Biomass (>10 um)		(pg C mL-1)
37	Total Nanophytoplankton Biomass		(pg C mL-1)
38	Total Phytoplankton Biomass (<20 um)		(pg C mL-1)
39	Community Respiration	Mean	(ug C L-1 d-1)
40	Community Respiration	SE	(ug C L-1 d-1)
41	<10 um Flagellates	Abundance	(cells L-1)
42	<10 um Flagellates	Carbon per cell	(pg C cell-1)
43	<10 um Flagellates	Biomass	(ug C L-1)
44	>10 um Flagellates	Abundance	(cells L-1)
45	>10 um Flagellates	Carbon per cell	(pg C cell-1)
46	>10 um Flagellates	Biomass	(ug C L-1)
47	<10 um Dinoflagellates	Abundance	(cells L-1)
48	<10 um Dinoflagellates	Carbon per cell	(pg C cell-1)
49	<10 um Dinoflagellates	Biomass	(ug C L-1)
50	>10 um Dinoflagellates	Abundance	(cells L-1)
51	>10 um Dinoflagellates	Carbon per cell	(pg C cell-1)
52	>10 um Dinoflagellates	Biomass	(ug C L-1)
53	<20 um Ciliates	Abundance	(cells L-1)
54	<20 um Ciliates	Carbon per cell	(pg C cell-1)
55	<20 um Ciliates	Biomass	(ug C L-1)
56	>20 um Ciliates	Abundance	(cells L-1)
57	>20 um Ciliates	Carbon per cell	(pg C cell-1)
58	>20 um Ciliates	Biomass	(ug C L-1)
59	Total Flagellate	Biomass	(ug C L-1)
60	Total Dinoflagellate	Biomass	(ug C L-1)
61	Total Ciliate	Biomass	(ug C L-1)
62	Total Microzooplankton Biomass		(ug C L-1)

1.5.5 SERIES NiskinBottle
SERIES JPT EP_Pedersen_d15N in NO3 PN.xls

This file is in *.xls format
The file contains 1 worksheet called “SERIES d15N in NO3 PN”.

The spreadsheet mentions that the metadata are in
MD_SERIES_Needoba_d15N.pdf

This file is not on the DVD and is probably not important since nobody bothered to give it to me.

The spreadsheet file contains IN patch data for d15N in nitrate and d15N in several classes of size fractionated particulate matter.

There are 5 blocks of data.

Block 1: d15 N in NO3 (IN patch)
13 rows with daily value for 10 July-23 July (NOT 16 July).
7 columns:
Date
Time
Lat. (N)
Long (W)
d15N in NO3 at 5 m depth
d15N in NO3 at 5 m depth
d15N in NO3 at 5 m depth

Block 2: d15 N in particulate material (IN patch) from Tully (vessel)
13 rows with daily value for 10 July-23 July (NOT 16 July).
10 columns:

	Date
	Time
	Lat. (N)
	Long (W)
5m	PN of sample (micrograms N)
5m	d15N
10 m	PN of sample (micrograms N)
10 m	d15N
20 m	PN of sample (micrograms N)
20 m	d15N

Block 3: d15 N in particulate material (IN patch) from El Puma (vessel)
d15N PN - Not size fractionated - everything larger than GF/F pore size
6 rows with daily value for 13, 16, 18, 21 23, 27 July.
8 columns:

	Date
	Time
	Lat. (N)
	Long (W)
100% light depth	PN on filter {? ug N ?}
	d15N
33% light depth	PN on filter {? ug N ?}
	d15N

Block 4: d15 N in particulate material (IN patch) from El Puma (vessel)
d15N PN - GF/F - 5 micrometer size fraction
9 rows with daily value for 11, 12, 14, 17, 20, 22, 24, 26, 28 July.

8 columns:

	Date
	Time
	Lat. (N)
	Long (W)
100% light depth	PN on filter {? ug N ?}
	d15N
33% light depth	PN on filter {? ug N ?}
	d15N

Block 5: d15 N in particulate material (IN patch) from El Puma (vessel)
d15N PN - GF/F >=5 micrometer size fraction
9 rows with daily value for 11, 12, 14, 17, 20, 22, 24, 26, 28 July.
8 columns:

	Date
	Time
	Lat. (N)
	Long (W)
100% light depth	PN on filter {? ug N ?}
	d15N
33% light depth	PN on filter {? ug N ?}
	d15N

1.5.5 SERIES NiskinBottle
SERIES JPT_Moore_Methylhalides.xls
This file is in *.xls format
The file presents data for methylhalides
The file was 1 worksheet

The data are presented in 22 blocks, each block corresponding to a single cast.
Each block contains a varying number of rows.
Each row corresponds to an individual Niskin bottle.
There are many replicate samples.

There are 28 rows:

Lat.	(N)
Long.	(W)
Date	(UTC)
Time	(UTC)
Cast No.	
Station In/Out	
Sample number	
Nominal Depth	(m)
CTD Depth	(dbar)
CTD Temp.	(C)
CTD Sal	
CTD Transmission	%/m
Sig-t	
CTD O2	umol/kg

Bottle Sal	
O2	mL/L
O2	uM/kg
NO3	uM/L
PO4	uM/L
SiO4	uM/L
NH4	uM/L
NO2	uM/L
Chl a	ug/L
SF6	fmol/kg
CH3Cl	pmol/L
CH3Br	pmol/L
CH3I	pmol/L
wind speed	m/s

Data do not exist for all parameters at all stations.

1.5.5 SERIES NiskinBottle

SERIES JPT_Wong_DOC-TOC.xls

This file is in *.xls format
The file presents data for DOC and TOC
The file was 7 worksheets

Sheet 1) Data Sum
Sheet is divided into 2 main parts:

a) SERIES DOC and TOC Summary Table
This section has 3 sub-sections that all follow the same format.
There are 12 columns
Station In/Out/Vfin
Date in July 2002
Sampling time
Depth (m)
Replicate A/B
DOC value (uM)
DOC error code
DOC notes
{empty column}
TOC value (uM)
TOC error code
TOC notes

subsection i) Outside stations
ii) V fin
iii) Patch stations

b) Summary Table of DOC and TOC integrated to 40m

This section has 2 sub-sections that all follow the same format.
There are 7 columns
Station Out/In
Date in July 2002
Sampling time
{empty column}
DOC
TOC

subsection i) Outside stations
ii) Patch stations

Sheet 2) Metadata
Describes methods, reference materials and replicate statistics.
A really fiddly sheet that was hard to follow.

Sheet 3) 10mTime
A plot of time series data for DOC and TOC collected at 10m

Sheet 4) 40mIntegTime
A plot of time series data for DOC and TOC integrated over the top 40m.

Sheet 5) V 22J
A plot of V Fin DOC collected on 22 July. No legend but appears to include pCO2 data.

Sheet 6) DOC profile
A plot of DOC with depth for 7, 10, 13, 14, 15, 17, 18, 20 and 22 July.

Sheet 7) TOC profile
A plot of TOC with depth for 7, 10, 13, 14, 15, 17, 18, 20 and 22 July.

1.5.5 SERIES NiskinBottle
SERIES JPT_Wong_Hydro-pH -DIC-alk.xls
This file is in *.xls format
The file presents water physical and chemical properties:
Depth, Temp, Sal, Fluo, Trans, sigma-t
O2, O2, NO3, PO4, SiO4, NH4, Chla, alk, DIC

The file contains 1 worksheet called “series”.
There are 41 blocks of data, each presenting data for a single cast.

Block 1 is pre-SERIES (2 July)
Blocks 2-41 are SERIES

Each block has a varying number (up to 24) or rows corresponding to samples from individual Niskin bottles fired at different depths in a single cast.

Data are presented in 24 columns:
(Except Block 1 which lacks column 11. Column 11 onwards in block 1 are same as column 12 onwards in other blocks):

1 Nisk. Bottle
2 Nom. Depth (m)
3 CTD Depth (dbar)
4 CTD Temp. (C)
5 CTD Sal
6 CTD Fluo
7 CTD Trans %/25 cm
8 Sig-t
9 raw CTD O2 ml/l
10 raw CTD O2 umol/kg
11 corr CTD O2 umol/kg
12 Bottle Sal.
13 O2 mL/L
14 O2 uM/kg
15 NO3 uM/L
16 PO4 uM/L
17 SiO4 uM/L
18 NH4 uM/L
19 NO2 uM/L
20 Chl a ug/L
21 DIC uMol/kg
22 ALK uMol/kg
23 pH 20 C
24 Comments

Each block has a varying number (up to 24) or rows corresponding to samples from individual Niskin bottles fired at different depths in a single cast.

Details of casts:

data block	details
1	Cruise: 2002-16 Station: P26 UTC Date: 02 07 07 UTC Time: 0241
1	Lat: 49:59.95N Long: 144:59.90W Cast No: 34
2	Cruise: 2002-16 Station: P26 UTC Date: 02 07 07 UTC Time: 1003
2	Lat: 49:59.97N Long: 144:59.93W Cast No: 37
3	Cruise: 2002-16 Station: P26 UTC Date: 02 07 07 UTC Time: 1544
3	Lat: 49:59.99N Long: 145:00.12W Cast No: 38
4	Cruise: 2002-16 Station: P26 UTC Date: 02 07 07 UTC Time: 2204
4	Lat: 50:00.14N Long: 145:00.01W Cast No: 42
5	Cruise: 2002-16 Station: IN UTC Date: 02 07 10 UTC Time: 2148
5	Lat: 50:11.64N Long: 144:44.09W Cast No: 60

```
 6 Cruise: 2002-16  Station:  OUT   UTC Date: 02 07 11  UTC Time: 0257
 6 Lat: 50:20.62N   Long: 144:45.83W   Cast No: 61

 7 Cruise: 2002-16  Station:  IN2   UTC Date: 02 07 11  UTC Time: 1812
 7 Lat: 50:12.79N   Long: 144:45.67W   Cast No: 62

 8 Cruise: 2002-16  Station:  OUT2   UTC Date: 02 07 11  UTC Time: 2213
 8 Lat: 50:20.42N   Long: 144:56.52W   Cast No: 63

 9 Cruise: 2002-16  Station:  IN3   UTC Date: 02 07 12  UTC Time: 0109
 9 Lat: 50:16.11N   Long: 144:45.55W   Cast No: 64

10 Cruise: 2002-16  Station:  IN4   UTC Date: 02 07 12  UTC Time: 1822
10 Lat: 50:16.52N   Long: 144:47.34W   Cast No: 65

11 Cruise: 2002-16  Station:  OUT3   UTC Date: 02 07 12  UTC Time: 2228
11 Lat: 50:18.66N   Long: 144:58.96W   Cast No: 66

12 Cruise: 2002-16  Station:  IN5   UTC Date: 02 07 13  UTC Time: 0201
12 Lat: 50:17.63N   Long: 144:46.83W   Cast No: 67

13 Cruise: 2002-16  Station:  IN6   UTC Date: 02 07 13  UTC Time: 1838
13 Lat: 50:20.38N   Long: 144:48.92W   Cast No: 68

14 Cruise: 2002-16  Station:  OUT4 UTC Date: 02 07 13  UTC Time: 2116
14 Lat: 50:19.92N   Long: 144:54.58W   Cast No: 69

15 Cruise: 2002-16  Station:  IN7 UTC Date: 02 07 14  UTC Time: 0326
15 Lat: 50:22.13N   Long: 144:45.99W   Cast No: 70

16 Cruise: 2002-16  Station:  IN8 UTC Date: 02 07 14  UTC Time: 1751
16 Lat: 50:23.20N   Long: 144:46.18W   Cast No: 71

17 Cruise: 2002-16  Station:  OUT5 UTC Date: 02 07 14  UTC Time: 2208
17 Lat: 50:22.86N   Long: 144:30.06W   Cast No: 72

18 Cruise: 2002-16  Station:  IN9 UTC Date: 02 07 15  UTC Time: 0253
18 Lat: 50:23.18N   Long: 144:46.08W   Cast No: 73

19 Cruise: 2002-16  Station:  IN10 UTC Date: 02 07 15  UTC Time: 1726
19 Lat: 50:25.14N   Long: 144:44.98W   Cast No: 74

20 Cruise: 2002-16  Station:  OUT6 UTC Date: 02 07 15  UTC Time: 2056
20 Lat: 50:37.17N   Long: 144:44.92W   Cast No: 75

21 Cruise: 2002-16  Station:  IN11 UTC Date: 02 07 16  UTC Time: 0242
21 Lat: 50:25.23N   Long: 144:44.95W   Cast No: 76

22 Cruise: 2002-16  Station:  IN12 UTC Date: 02 07 16  UTC Time: 1843
22 Lat: 50:28.06N   Long: 144:46.50W   Cast No: 77

23 Cruise: 2002-16  Station:  IN13 UTC Date: 02 07 17  UTC Time: 1815
23 Lat: 50:30.18N   Long: 144:45.28W   Cast No: 78
```

```
24 Cruise: 2002-16  Station:  OUT7 UTC Date: 02 07 17  UTC Time: 2302
24 Lat: 50:33.25N   Long: 144:36.76W   Cast No: 79

25 Cruise: 2002-16  Station:  IN14 UTC Date: 02 07 18  UTC Time: 0211
25 Lat: 50:30.12N   Long: 144:45.32W   Cast No: 80

26 Cruise: 2002-16  Station:  IN15 UTC Date: 02 07 18  UTC Time: 1748
26 Lat: 50:34.78N   Long: 144:48.07W   Cast No: 81

27 Cruise: 2002-16  Station:  OUT8 UTC Date: 02 07 18  UTC Time: 2107
27 Lat: 50:41.14N   Long: 144:38.01W   Cast No: 82

28 Cruise: 2002-16  Station:  IN16 UTC Date: 02 07 19  UTC Time: 0257
28 Lat: 50:35.17N   Long: 144:48.90W   Cast No: 83

29 Cruise: 2002-16  Station:  OUT9 UTC Date: 02 07 19  UTC Time: 2036
29 Lat: 50:39.87N   Long: 144:35.48W   Cast No: 84

30 Cruise: 2002-16  Station:  IN17 UTC Date: 02 07 20  UTC Time: 0051
30 Lat: 50:37.46N   Long: 144:47.17W   Cast No: 85

31 Cruise: 2002-16  Station:  IN18 UTC Date: 02 07 20  UTC Time: 1715
31 Lat: 50:41.77N   Long: 144:43.07W   Cast No: 86

32 Cruise: 2002-16  Station:  OUT10 UTC Date: 02 07 20  UTC Time: 1957
32 Lat: 50:46.95N   Long: 144:34.15W   Cast No: 87

33 Cruise: 2002-16  Station:  IN19 UTC Date: 02 07 20  UTC Time: 2352
33 Lat: 50:41.35N   Long: 144:43.51W   Cast No: 88

34 Cruise: 2002-16  Station:  IN20 UTC Date: 02 07 21  UTC Time: 1815
34 Lat: 50:50.99N   Long: 144:40.87W   Cast No: 89

35 Cruise: 2002-16  Station:  OUT11 UTC Date: 02 07 22  UTC Time: 0046
35 Lat: 50:55.75N   Long: 144:31.20W   Cast No: 90

36 Cruise: 2002-16  Station:  IN21 UTC Date: 02 07 22  UTC Time: 0239
36 Lat: 50:52.28N   Long: 144:37.68W   Cast No: 91

37 Cruise: 2002-16  Station:  IN22 UTC Date: 02 07 22  UTC Time: 2016
37 Lat: 50:53.82N   Long: 144:36.69W   Cast No: 92

38 Cruise: 2002-16  Station:  OUT12 UTC Date: 02 07 22  UTC Time: 2322
38 Lat: 51:02.09N   Long: 144:23.38W   Cast No: 93

39 Cruise: 2002-16  Station:  IN23 UTC Date: 02 07 23  UTC Time: 0256
39 Lat: 50:54.89N   Long: 144:36.01W   Cast No: 94

40 Cruise: 2002-16  Station:  IN24 UTC Date: 02 07 23  UTC Time: 1932
40 Lat: 50:57.24N   Long: 144:21.25W   Cast No: 95

41 Cruise: 2002-16  Station:  OUT13 UTC Date: 02 07 24  UTC Time: 0142
41 Lat: 50:53.95N   Long: 143:58.59W   Cast No: 96
```

1.5.5 SERIES NiskinBottle
SERIES JPT_Wong_Iron.xls

This file is in *.xls format
The file contains data for iron (soluble, dissolved, labile, total dissolved, total).

The file contains 2 worksheets:

Sheet 1) Tully Fe
Has results for more or less daily samples from 10 to 23 July.
Also (at the bottom) data for pre-SERIES on 7 July,

Data in 14 columns:

1 Date ID July
2 Site (P = in patch or OUT)
3 Latitude (N)
4 Longitude (W)
5 Depth
6 Time PDT
7 Pump or Go-Flo
8 0.03u B Soluble
9 At Sea Analysis 0.22u B Dissolved
10 UF B Labile
11 {? UFB + X hours?} {no idea what this is}
12 Acified & Microwaved F M Tot. Diss.
13 UF M Total
14 Notes

Sheet 2) Towed Fish

Very sketchy data.
Not easy to work out what this is supposed to be.
e.g. If these are towed fish transects I should expect start/finish times or locations.

1.5.6 SERIES Optics
SERIES_Miller_CDOM.xls
This file is in *.xls format
The file contains data for “ag = CDOM”
The file contains 2 worksheets:

{begin paste from worksheet 1}
ag is the absorption coefficient of CDOM (=Gelbstoff, Gilvin,…).
ag has units of (m-1)
Samples were taken at the surface at a depth of 1m.
ag spectra were measured over the 280-700nm range in a spectrophotometer using 10cm pathlength quartz cells filled with 0.2um filtered seawater
{end paste from worksheet 1}

sheet 1) description for ag (=CDOM)
notes

sheet 2) SERIES.txt
The sheet contains 420 rows, 1 per nm for a spectrum from 280 to 700 nm.
The sheet contains 11 columns, each corresponding to a daily sample.
Each sample is identified as
IN/OUT of patch, Lat, Long, Date, Time.

1.5.6 SERIES Optics
SERIES_Miller_Kd_Rrs_AQY DMS.xls
This file is in *.xls format
The file contains data for "Kd, Rrs and AQY_{DMS}"
The file contains 4 worksheets:

Sheet 1) Description for Kd.
Describes calculation

Sheet 2) Description for Rrs
Describes calculation for Remote sensing reflectance
{is rrs a typo for rsr?}

Sheet 3) Description for AQY(DMS)
Describes calculation for apparent quantum yields of DMS

Sheet 4) SERIES.dat

Sheet has 19 rows corresponding to different IN and OUT of patch stations.

1	10 July Out
2	11 July In
3	12 July In
4	12 July Out
5	13 July In
6	15 July In
7	15 July Out
8	17 July In
9	18 July In
10	19 July In
11	20 July In
12	21 July In
13	21 July Out
14	22 July In
15	23 July In
16	24 July In
17	26 July In

18 28 July Out
19 28 July In

Sheet has 36 columns:

1 In/Out patch
2 Latitude (N)
3 Longitude (W)
4 Day
5 Time (UTC)
6 Kd(305)
7 Kd(325)
8 Kd(340)
9 Kd(380)
10 Kd(412)
11 Kd(443)
12 Kd(490)
13 Kd(510)
14 Kd(532)
15 Kd(555)
16 Kd(670)
17 Kd(683)
18 Kd(700)
19 Rrs(305)
20 Rrs(325)
21 Rrs(340)
22 Rrs(380)
23 Rrs(412)
24 Rrs(443)
25 Rrs(490)
26 Rrs(510)
27 Rrs(532)
28 Rrs(555)
29 Rrs(590)
30 Rrs(670)
31 Rrs(683)
32 Rrs(700)
33 AQY*DMS(290)
34 SAQY* (nm-1)
35 r2
36 n

1.5.6 SERIES Optics
SERIES_Miller_PAR.xls
This file is in *.xls format
The file contains data for PAR
The file contains 21 worksheets:

Sheet 1)
Is a summary of the other 20 sheets.
The sheet has 20 rows, each corresponding at a single cast at a single station per on a given day.
The sheet has 12 columns:

1 station
2 time (PDT)
3 PAR (quanta/cm2/s)
4 PAR (uE/m2/s)
5 K (m-1) low
6 K (m-1) high
7 100% light depth (m)
8 33% light depth (m)
9 10% light depth (m)
10 3% light depth (m)
11 1% light depth (m)
12 0.1% light depth (m)

Sheets 2-20)
"each sheet is the summary data from a set of profiles.
"some sheets are the average of three casts, some will be only one or two casts.

Each sheet reproduces the %lighgt at depth information given in sheet 1.
Then each sheet has 3 columns and a varying number of rows; each row corresponds to a reading at 1m intervals down to ~0.3% light level.

1 depth (m)
2 pPAR
3 % light

sheet	*station*
sheet 2	july10out
sheet 3	july11in
sheet 4	july12in
sheet 5	july12out
sheet 6	july13in
sheet 7	july15in
sheet 8	july15out
sheet 9	july17in
sheet 10	july17out
sheet 11	july18in
sheet 12	july19in
sheet 13	july20in
sheet 14	july21in
sheet 15	july21out
sheet 16	july22inA
sheet 17	july22inB
sheet 18	july23in
sheet 19	july24in

sheet 20	july26in
sheet 21	july27in

1.5.6 SERIES Optics

SERIES_Miller_Surface irradiances.xls

This file is in *.xls format

The file contains data for Surface Irradiance collected by a Multichannel Visible Detector System (MVDS)

The file contains 21 worksheets:

Sheet 1) Description of how data were collected.

Sheets 2-21) P

sheet	*station*
sheet 2	july10out
sheet 3	july11in
sheet 4	july12in
sheet 5	july12out
sheet 6	july13in
sheet 7	july15in
sheet 8	july15out
sheet 9	july17in
sheet 10	july17out
sheet 11	july18in
sheet 12	july19in
sheet 13	july20in
sheet 14	july21in
sheet 15	july21out
sheet 16	july22inA
sheet 17	july22inB
sheet 18	july23in
sheet 19	july24in
sheet 20	july26in
sheet 21	july27in

Each sheet has 386 rows. Corresponding to a irradiance measurement at 1 nm intervals from 280-400 nm then at 1 nm intervals from 401.5-629.5 nm and then at 2 nm intervals from 631-699 nm and a final value for 700 nm.

Each sheet has a varying number of columns. Each column corresponds to hourly averaged measurements made during daylight (usually 0800-2000 hours).

1.5.7 SERIES SedimentTrap

SERIES JPT KM_Pedersen_d15N_sediment trap.xls

This file is in *.xls format

The file contains data for d15N in particulate material recovered from sediment trap deployments.
The file contains 1 worksheet: SERIES d15N Sediment Trap.

The worksheet has 9 columns and 10 rows.
Column 1: Ship name
Column 2: Sediment trap deployment name
Column 3: Date dd/mm/yy
Column 4: Lat (see NOTE)
Column 5: Long (see NOTE)
Column 6: d15N of particulate material at 50m depth
Column 7: d15N of particulate material at 75m depth
Column 8: d15N of particulate material at 100m depth
Column 9: d15N of particulate material at 125m depth

Platform notes: **Three vessels were used.**

see
1.3 Metadata
1.3.1 MD Cruise
C-SOLAS_SERIES_Stations.xls

PUBLICATIONS
{abstracts follow this list}

Agawin, N. S. R., Hale, M. S., Rivkin, R. B., Matthews, P. & Li, W. K. W. (2006): Microbial response to a mesoscale iron enrichment in the NE Subarctic Pacific: Bacterial community composition. *Deep-Sea Res. Part II-Top. Stud. Oceanogr.* 53(20-22), 2248-2267,

Bouillon, R.-C., Miller, W. L., Levasseur, M., Scarratt, M., Merzouk, A., Michaud, S. & Ziolkowski, L. (2006): The effect of mesoscale iron enrichment on the marine photochemistry of dimethylsulfide in the NE subarctic Pacific. *Deep Sea Research Part II: Topical Studies in Oceanography* 53(20-22), 2384-2397,

Boyd, P. W., et al. (2004): The decline and fate of an iron-induced subarctic phytoplankton bloom. *Nature* 428(6982), 549-553,

Boyd, P. W., et al. (2005): The evolution and termination of an iron-induced mesoscale bloom in the northeast subarctic Pacific. *Limnol. Oceanogr.* 50(6), 1872-1886,

Denman, K. L., Voelker, C., Angelica Peña, M. & Rivkin, R. B. (2006a): Modelling the ecosystem response to iron fertilization in the subarctic NE Pacific: The influence of grazing, and Si and N cycling on CO2 drawdown. *Deep Sea Research Part II: Topical Studies in Oceanography* 53(20-22), 2327-2352,

Denman, K. L., Voelker, C., Pena, M. A. & Rivkin, R. B. (2006b): Modelling the ecosystem response to iron fertilization in the subarctic NE Pacific: The influence of grazing, and

Si and N cycling on CO2 drawdown. *Deep-Sea Res. Part II-Top. Stud. Oceanogr.* 53(20-22), 2327-2352,

Hale, M. S., Rivkin, R. B., Matthews, P., Agawin, N. S. R. & Li, W. K. W. (2006): Microbial response to a mesoscale iron enrichment in the NE subarctic Pacific: Heterotrophic bacterial processes. *Deep Sea Research Part II: Topical Studies in Oceanography* 53(20-22), 2231-2247,

Harrison, P. J. (2006a): SERIES (subarctic ecosystem response to iron enrichment study): A Canadian-Japanese contribution to our understanding of the iron-ocean-climate connection. *Deep Sea Research Part II: Topical Studies in Oceanography* 53(20-22), 2006-2011,

Harrison, P. J. (2006b): SERIES (subarctic ecosystem response to iron enrichment study): A Canadian-Japanese contribution to our understanding of the iron-ocean-climate connection - Preface. *Deep-Sea Res. Part II-Top. Stud. Oceanogr.* 53(20-22), 2006-2011,

Law, C. S., et al. (2006): Patch evolution and the biogeochemical impact of entrainment during an iron fertilisation experiment in the sub-Arctic Pacific. *Deep-Sea Res. Part II-Top. Stud. Oceanogr.* 53(20-22), 2012-2033,

Le Clainche, Y., et al. (2006): Modeling analysis of the effect of iron enrichment on dimethyl sulfide dynamics in the NE Pacific (SERIES experiment). *J. Geophys. Res.-Oceans* 111(C1),

Levasseur, M., et al. (2006): DMSP and DMS dynamics during a mesoscale iron fertilization experiment in the Northeast Pacific--Part I: Temporal and vertical distributions. *Deep Sea Research Part II: Topical Studies in Oceanography* 53(20-22), 2353-2369,

Marchetti, A., Juneau, P., Whitney, F. A., Wong, C.-S. & Harrison, P. J. (2006a): Phytoplankton processes during a mesoscale iron enrichment in the NE subarctic Pacific: Part II--Nutrient utilization. *Deep Sea Research Part II: Topical Studies in Oceanography* 53(20-22), 2114-2130,

Marchetti, A., Sherry, N. D., Juneau, P., Strzepek, R. F. & Harrison, P. J. (2006b): Phytoplankton processes during a mesoscale iron enrichment in the NE subarctic Pacific: Part III--Primary productivity. *Deep Sea Research Part II: Topical Studies in Oceanography* 53(20-22), 2131-2151,

Marchetti, A., Sherry, N. D., Kiyosawa, H., Tsuda, A. & Harrison, P. J. (2006c): Phytoplankton processes during a mesoscale iron enrichment in the NE subarctic Pacific: Part I--Biomass and assemblage. *Deep Sea Research Part II: Topical Studies in Oceanography* 53(20-22), 2095-2113,

Merzouk, A., Levasseur, M., Scarratt, M. G., Michaud, S., Rivkin, R. B., Hale, M. S., Kiene, R. P., Price, N. M. & Li, W. K. W. (2006): DMSP and DMS dynamics during a mesoscale iron fertilization experiment in the Northeast Pacific-Part II: Biological cycling. *Deep Sea Research Part II: Topical Studies in Oceanography* 53(20-22), 2370-2383,

Moore, R. M. & Wang, L. (2006): The influence of iron fertilization on the fluxes of methyl halides and isoprene from ocean to atmosphere in the SERIES experiment. *Deep Sea Research Part II: Topical Studies in Oceanography* 53(20-22), 2398-2409,

Needoba, J. A., Marchetti, A., Henry, M. F., Harrison, P. J., Wong, C.-S., Keith Johnson, W. & Pedersen, T. F. (2006): Stable nitrogen isotope dynamics of a mesoscale iron enrichment experiment in the NE Subarctic Pacific. *Deep Sea Research Part II: Topical Studies in Oceanography* 53(20-22), 2214-2230,

Phinney, L., et al. (2006): Characterization of the aerosol over the sub-arctic north east Pacific Ocean. *Deep Sea Research Part II: Topical Studies in Oceanography* 53(20-22), 2410-2433,

Saito, H., et al. (2006): Nutrient and phytoplankton dynamics during the stationary and declining phases of a phytoplankton bloom induced by iron-enrichment in the eastern subarctic Pacific. *Deep-Sea Res. Part II-Top. Stud. Oceanogr.* 53(20-22), 2168-2181,

Sastri, A. R. & Dower, J. F. (2006): Mesozooplankton community response during the SERIES iron enrichment experiment in the subarctic NE Pacific. *Deep Sea Research Part II: Topical Studies in Oceanography* 53(20-22), 2268-2280,

Scarratt, M. G., et al. (2006): Assessing microbial responses to iron enrichment in the Subarctic Northeast Pacific: Do microcosms reproduce the in situ condition? *Deep Sea Research Part II: Topical Studies in Oceanography* 53(20-22), 2182-2200,

Steiner, N., Denman, K., Mcfarlane, N. & Solheim, L. (2006): Simulating the coupling between atmosphere-ocean processes and the planktonic ecosystem during SERIES. *Deep Sea Research Part II: Topical Studies in Oceanography* 53(20-22), 2434-2454,

Takeda, S., Yoshie, N., Boyd, P. W. & Yamanaka, Y. (2006): Modeling studies investigating the causes of preferential depletion of silicic acid relative to nitrate during SERIES, a mesoscale iron enrichment in the NE subarctic Pacific. *Deep-Sea Res. Part II-Top. Stud. Oceanogr.* 53(20-22), 2297-2326,

Timothy, D. A., Wong, C. S., Nojiri, Y., Ianson, D. C. & Whitney, F. A. (2006): The effects of patch expansion on budgets of C, N and Si for the Subarctic Ecosystem Response to Iron Enrichment Study (SERIES). *Deep Sea Research Part II: Topical Studies in Oceanography* 53(20-22), 2034-2052,

Tsuda, A., Saito, H., Nishioka, J., Ono, T., Noiri, Y. & Kudo, I. (2006): Mesozooplankton response to iron enrichment during the diatom bloom and bloom decline in SERIES (NE Pacific). *Deep Sea Research Part II: Topical Studies in Oceanography* 53(20-22), 2281-2296,

Wong, C. S. & Crawford, D. W. (2006): Evolution of phytoplankton pigments in an in-situ iron enrichment experiment in the subarctic NE Pacific. *Deep Sea Research Part II: Topical Studies in Oceanography* 53(20-22), 2152-2167,

Wong, C. S., Johnson, W. K., Sutherland, N., Nishioka, J., Timothy, D. A., Robert, M. & Takeda, S. (2006a): Iron speciation and dynamics during SERIES, a mesoscale iron enrichment experiment in the NE Pacific. *Deep Sea Research Part II: Topical Studies in Oceanography* 53(20-22), 2075-2094,

Wong, C. S., Timothy, D. A., Law, C. S., Nojiri, Y., Xie, L., Wong, S.-K. E. & Page, J. S. (2006b): Carbon distribution and fluxes during the SERIES iron fertilization experiment with special reference to the fugacity of carbon dioxide (fCO2). *Deep Sea Research Part II: Topical Studies in Oceanography* 53(20-22), 2053-2074,

Wong, C. S., Timothy, D. A., Law, C. S., Nojiri, Y., Xie, L. S., Wong, S. K. E. & Page, J. S. (2006c): Carbon distribution and fluxes during the SERIES iron fertilization experiment with special reference to the fugacity of carbon dioxide (fCO(2)). *Deep-Sea Res. Part II-Top. Stud. Oceanogr.* 53(20-22), 2053-2074,

PUBLICATION ABSTRACTS:

P. W. Boyd, C. S. Law, C. S. Wong, Y. Nojiri, A. Tsuda, M. Levasseur, S. Takeda, R. Rivkin, P. J. Harrison, R. Strzepek, J. Gower, R. M. McKay, E. Abraham, M. Arychuk, J. Barwell-Clarke, W. Crawford, D. Crawford, M. Hale, K. Harada, K. Johnson, H. Kiyosawa, I. Kudo, A. Marchetti, W. Miller, J. Needoba, J. Nishioka, H. Ogawa, J. Page, M. Robert, H. Saito, A. Sastri, N. Sherry, T. Soutar, N. Sutherland, Y. Taira, F. Whitney, S. K. E. Wong and T.

Yoshimura, 2004, The decline and fate of an iron-induced subarctic phytoplankton bloom, Nature, 428 (6982), 549-553.

"Iron supply has a key role in stimulating phytoplankton blooms in high-nitrate low-chlorophyll oceanic waters(1-5). However, the fate of the carbon fixed by these blooms, and how efficiently it is exported into the ocean's interior, remains largely unknown(1-5). Here we report on the decline and fate of an iron-stimulated diatom bloom in the Gulf of Alaska. The bloom terminated on day 18, following the depletion of iron and then silicic acid, after which mixed-layer particulate organic carbon (POC) concentrations declined over six days. Increased particulate silica export via sinking diatoms was recorded in sediment traps at depths between 50 and 125 m from day 21, yet increased POC export was not evident until day 24. Only a small proportion of the mixed-layer POC was intercepted by the traps, with more than half of the mixed-layer POC deficit attributable to bacterial remineralization and mesozooplankton grazing. The depletion of silicic acid and the inefficient transfer of iron-increased POC below the permanent thermocline have major implications both for the biogeochemical interpretation of times of greater iron supply in the geological past(6,7), and also for proposed geo-engineering schemes to increase oceanic carbon sequestration(3,8)." Iron supply has a key role in stimulating phytoplankton blooms in high-nitrate low-chlorophyll oceanic waters(1-5). However, the fate of the carbon fixed by these blooms, and how efficiently it is exported into the ocean's interior, remains largely unknown(1-5). Here we report on the decline and fate of an iron-stimulated diatom bloom in the Gulf of Alaska. The bloom terminated on day 18, following the depletion of iron and then silicic acid, after which mixed-layer particulate organic carbon (POC) concentrations declined over six days. Increased particulate silica export via sinking diatoms was recorded in sediment traps at depths between 50 and 125 m from day 21, yet increased POC export was not evident until day 24. Only a small proportion of the mixed-layer POC was intercepted by the traps, with more than half of the mixed-layer POC deficit attributable to bacterial remineralization and mesozooplankton grazing. The depletion of silicic acid and the inefficient transfer of iron-increased POC below the permanent thermocline have major implications both for the biogeochemical interpretation of times of greater iron supply in the geological past(6,7), and also for proposed geo-engineering schemes to increase oceanic carbon sequestration(3,8).

P. W. Boyd, R. Strzepek, S. Takeda, G. Jackson, C. S. Wong, R. M. McKay, C. Law, H. Kiyosawa, H. Saito, N. Sherry, K. Johnson, J. Gower and N. Ramaiah, 2005, The evolution and termination of an iron-induced mesoscale bloom in the northeast subarctic Pacific, Limnology And Oceanography, 50 (6), 1872-1886.

"We initiated and mapped a diatom bloom in the northeast subarctic Pacific by concurrently adding dissolved iron and the tracer sulfur hexafluoride to a mesoscale patch of high-nitrate, low-chlorophyll waters. The bloom was dominated by pennate diatoms and was monitored for 25 d, which was sufficiently long to observe the evolution and termination of the bloom and most of the decline phase. Fast repetition-rate fluorometry indicated that the diatoms were iron-replete until day 12, followed by a 4-5-d transition to iron limitation. This transition period was characterized by relatively high rates of algal growth and nutrient uptake, which pointed to diatoms using intracellularly stored iron. By days 16-17, the bloom was probably limited simultaneously by both iron and silicic acid Supply, because low silicic acid concentrations were evident. Modeling Simulations, using data from our study, provided an estimate of the critical threshold for algal aggregation. Observed diatom abundances during the bloom exceeded this threshold between days 13 and 17. Mass sedimentation of diatorns

and diatom aggregates was recorded in surface-tethered free-drifting sediment traps at 50 in in depth on day 21. Although the termination of the bloom was probably controlled by the availability of both iron and silicic acid, we cannot rule out the role of algal aggregation. The bloom decline was likely triggered by the onset of mass sedimentation. During our study, evidence of both diatom species succession and species-specific aggregation point to important links between algal nutrient stress and the initiation of algal aggregation." We initiated and mapped a diatom bloom in the northeast subarctic Pacific by concurrently adding dissolved iron and the tracer sulfur hexafluoride to a mesoscale patch of high-nitrate, low-chlorophyll waters. The bloom was dominated by pennate diatoms and was monitored for 25 d, which was sufficiently long to observe the evolution and termination of the bloom and most of the decline phase. Fast repetition-rate fluorometry indicated that the diatoms were iron-replete until day 12, followed by a 4-5-d transition to iron limitation. This transition period was characterized by relatively high rates of algal growth and nutrient uptake, which pointed to diatoms using intracellularly stored iron. By days 16-17, the bloom was probably limited simultaneously by both iron and silicic acid Supply, because low silicic acid concentrations were evident. Modeling Simulations, using data from our study, provided an estimate of the critical threshold for algal aggregation. Observed diatom abundances during the bloom exceeded this threshold between days 13 and 17. Mass sedimentation of diatorns and diatom aggregates was recorded in surface-tethered free-drifting sediment traps at 50 in in depth on day 21. Although the termination of the bloom was probably controlled by the availability of both iron and silicic acid, we cannot rule out the role of algal aggregation. The bloom decline was likely triggered by the onset of mass sedimentation. During our study, evidence of both diatom species succession and species-specific aggregation point to important links between algal nutrient stress and the initiation of algal aggregation.
P. J. Harrison, 2006, SERIES (subarctic ecosystem response to iron enrichment study): A Canadian-Japanese contribution to our understanding of the iron-ocean-climate connection - Preface, Deep-Sea Research Part Ii-Topical Studies in Oceanography, 53 (20-22), 2006-2011.

C. S. Law, W. R. Crawford, M. J. Smith, P. W. Boyd, C. S. Wong, Y. Nojiri, M. Robert, E. R. Abraham, W. K. Johnson, V. Forsland and M. Arychuk, 2006, Patch evolution and the biogeochemical impact of entrainment during an iron fertilisation experiment in the sub-Arctic Pacific, Deep-Sea Research Part Ii-Topical Studies in Oceanography, 53 (20-22), 2012-2033.

"An in situ mesoscale iron-fertilisation experiment in the eastern sub-Arctic Pacific (SERIES) was undertaken to test the Iron Hypothesis, that increasing iron supply would stimulate phytoplankton production and particulate organic carbon (POC) export to deep water. Patch dispersion was monitored for 26 days, using an inert tracer (SF6) and biological tracers (chlorophyll-a and fCO(2)), and we examine the vertical and lateral evolution of the patch, and the influence of dilution on the biological and biogeochernical response to iron addition. Vertical dispersion of the added iron was initially restricted to the upper 12 m by near-surface stratification, although the vertical flux to the lower mixed layer at this time significantly exceeded the unperturbed rate of iron supply. Calculation of vertical diffusion rates (K) provided an estimate of the unperturbed Fe flux across the seasonal pycnocline of 0.3-1.5 nmol/m(2)/d. The iron/tracer patch partially advected around an anticyclonic Haida Eddy that originated off the west coast of Canada in 1999-2000. Lateral patch evolution was initially dominated by current strain, stretching it into a filament of similar to 300 km(2) by day 11 and reaching a maximum area of 1300 km(2) by day 23. Sustained high winds and intrusion of external waters between days 11 and 18 altered patch geometry and advection. Two

scenarios for patch evolution are presented of a single exponential dilution at 0.1/d, and a variable dilution in which dilution increased from 0.078/d to 0.16/d (days 11-18) before decreasing to 0.05/d. Dilution rates were used to constrain dissolved iron dynamics, with iron regeneration rates indirectly estimated from biological iron uptake and lateral dilution losses. Lateral entrainment supplied similar to 6-7 mu mol/L silicic acid and 4.6 mu mol/L nitrate to the patch centre by day 20, equivalent to 37% and 45%, respectively, of total biological uptake. Indirect estimates of phytoplankton nitrate uptake from patch dilution indicated a maximum rate of 1.4 mu mol/L/d, in agreement with measured rates. The cumulative entrainment of 392-500 mmol dissolved inorganic carbon (DIC)/m(2) at the patch centre by day 20 was of the same order as the total biological DIC uptake and POC accumulation. The potential impacts of a mid-experiment increase in dilution were explored; these included elevated entrainment of silicic acid when concentrations in the patch were growth limiting for phytoplankton, and decreased cell aggregation. Both factors could potentially have delayed the onset of bloom termination and export, and increased the longevity of the SERIES phytoplankton bloom. (c) 2006 Elsevier Ltd. All rights reserved." An in situ mesoscale iron-fertilisation experiment in the eastern sub-Arctic Pacific (SERIES) was undertaken to test the Iron Hypothesis, that increasing iron supply would stimulate phytoplankton production and particulate organic carbon (POC) export to deep water. Patch dispersion was monitored for 26 days, using an inert tracer (SF6) and biological tracers (chlorophyll-a and fCO(2)), and we examine the vertical and lateral evolution of the patch, and the influence of dilution on the biological and biogeochernical response to iron addition. Vertical dispersion of the added iron was initially restricted to the upper 12 m by near-surface stratification, although the vertical flux to the lower mixed layer at this time significantly exceeded the unperturbed rate of iron supply. Calculation of vertical diffusion rates (K) provided an estimate of the unperturbed Fe flux across the seasonal pycnocline of 0.3-1.5 nmol/m(2)/d. The iron/tracer patch partially advected around an anticyclonic Haida Eddy that originated off the west coast of Canada in 1999-2000. Lateral patch evolution was initially dominated by current strain, stretching it into a filament of similar to 300 km(2) by day 11 and reaching a maximum area of 1300 km(2) by day 23. Sustained high winds and intrusion of external waters between days 11 and 18 altered patch geometry and advection. Two scenarios for patch evolution are presented of a single exponential dilution at 0.1/d, and a variable dilution in which dilution increased from 0.078/d to 0.16/d (days 11-18) before decreasing to 0.05/d. Dilution rates were used to constrain dissolved iron dynamics, with iron regeneration rates indirectly estimated from biological iron uptake and lateral dilution losses. Lateral entrainment supplied similar to 6-7 mu mol/L silicic acid and 4.6 mu mol/L nitrate to the patch centre by day 20, equivalent to 37% and 45%, respectively, of total biological uptake. Indirect estimates of phytoplankton nitrate uptake from patch dilution indicated a maximum rate of 1.4 mu mol/L/d, in agreement with measured rates. The cumulative entrainment of 392-500 mmol dissolved inorganic carbon (DIC)/m(2) at the patch centre by day 20 was of the same order as the total biological DIC uptake and POC accumulation. The potential impacts of a mid-experiment increase in dilution were explored; these included elevated entrainment of silicic acid when concentrations in the patch were growth limiting for phytoplankton, and decreased cell aggregation. Both factors could potentially have delayed the onset of bloom termination and export, and increased the longevity of the SERIES phytoplankton bloom.

C. S. Wong, D. A. Timothy, C. S. Law, Y. Nojiri, L. S. Xie, S. K. E. Wong and J. S. Page, 2006, Carbon distribution and fluxes during the SERIES iron fertilization experiment with special reference to the fugacity of carbon dioxide (fCO(2)), Deep-Sea Research Part Ii-Topical Studies in Oceanography, 53 (20-22), 2053-2074.

"Surface seawater fugacity of carbon dioxide (fCO(2)) was measured during the Subarctic Ecosystem Response to Iron Enrichment Study (SERIES), July 9-August 5, 2002. Three ships sampled the iron-fertilized waters near Ocean Station P (50 degrees N, 145 degrees W): the Canadian CCGS J. P. Tully (July 9-23, 2002), the chartered Mexican M/V El Puma (July 9-28, 2002), and the Japanese fisheries research ship M/V Kaiyo Maru (July 24-August 5, 2002). Data used here are from the CCGS J. P. Tully and the M/V Kaiyo Marti. From the onset of the experiment to the peak of the iron-induced diatom bloom on day 19, sea-surface fCO(2) decreased from 350 to 265 paint and average DIC concentration in the upper 30 m decreased from 2030 to 1990 mu mol kg(-1). Changes in tCO(2) in and near the iron patch as observed from the CCGS J P. Tully and later from the M/V.Kaiyo Maru were used to estimate CO2 drawdown and air-sea fluxes, and in generating a carbon budget during the growth phase (days 3-19) of the experiment. Without considering patch dilution, sources of dissolved inorganic carbon to the patch (1.6 + 0.25 mol m(-2)) were nearly double the sum (0.87 + 0.34 mol m(-2)) of the sinks: accumulations of dissolved organic and particulate carbon, and the flux of particulate carbon to sediment traps below the patch. However, the budget is balanced after considerations of the effects of patch expansion on property concentrations within the patch. A comparison with other iron fertilization experiments from 1995 to present was made to assess the CO2 drawdown values. (c) 2006 Published by Elsevier Ltd." Surface seawater fugacity of carbon dioxide (fCO(2)) was measured during the Subarctic Ecosystem Response to Iron Enrichment Study (SERIES), July 9-August 5, 2002. Three ships sampled the iron-fertilized waters near Ocean Station P (50 degrees N, 145 degrees W): the Canadian CCGS J. P. Tully (July 9-23, 2002), the chartered Mexican M/V El Puma (July 9-28, 2002), and the Japanese fisheries research ship M/V Kaiyo Maru (July 24-August 5, 2002). Data used here are from the CCGS J. P. Tully and the M/V Kaiyo Marti. From the onset of the experiment to the peak of the iron-induced diatom bloom on day 19, sea-surface fCO(2) decreased from 350 to 265 paint and average DIC concentration in the upper 30 m decreased from 2030 to 1990 mu mol kg(-1). Changes in tCO(2) in and near the iron patch as observed from the CCGS J P. Tully and later from the M/V.Kaiyo Maru were used to estimate CO2 drawdown and air-sea fluxes, and in generating a carbon budget during the growth phase (days 3-19) of the experiment. Without considering patch dilution, sources of dissolved inorganic carbon to the patch (1.6 + 0.25 mol m(-2)) were nearly double the sum (0.87 + 0.34 mol m(-2)) of the sinks: accumulations of dissolved organic and particulate carbon, and the flux of particulate carbon to sediment traps below the patch. However, the budget is balanced after considerations of the effects of patch expansion on property concentrations within the patch. A comparison with other iron fertilization experiments from 1995 to present was made to assess the CO2 drawdown values. (c) 2006 Published by Elsevier Ltd.

H. Saito, A. Tsuda, Y. Nojiri, J. Nishioka, S. Takeda, H. Kiyosawa, I. Kudo, Y. Noiri, T. Ono, Y. Taira, K. Suzuki, T. Yoshimura and P. W. Boyd, 2006, Nutrient and phytoplankton dynamics during the stationary and declining phases of a phytoplankton bloom induced by iron-enrichment in the eastern subarctic Pacific, Deep-Sea Research Part Ii-Topical Studies in Oceanography, 53 (20-22), 2168-2181.

"This paper reports on the variations in nutrient concentrations and phytoplankton dynamics during the stationary and declining phases of a phytoplankton bloom induced by a mesoscale iron-enrichment conducted in the high-nutrient low-chlorophyll (HNLC) eastern subarctic Pacific. During the 26-d sampling period, the main pycnocline was located between 30 and 45 m with a shallow pycnocline developing at 10 m, 19 d after the first iron-enrichment. The

iron-induced bloom dominated by diatoms peaked during days 15 and 18, a period of high chlorophyll a concentrations (ca. 5 mg m(-3)), and declined thereafter. Nitrogenous nutrients and phosphate were not depleted during the whole experiment. In contrast, silicic acid and iron concentrations became very low during the stationary phase of the diatom bloom (days 15-18) and F-v/F-m declined. These observations suggest that silicic acid and iron limitation probably prevented further development of the diatom bloom. The decline in chlorophyll a concentrations during days 19-24 was mostly due to the decrease in diatom abundance. On the other hand, cell abundances of pico- and nanophytoplankton exhibited little change until day 24. In the layer located between the main and the shallow pycnocline (10-30 m), ammonium and silicic acid concentration increased during days 19-26, suggesting recycling of these nutrients. The amount of silicic acid recycled during that period was estimated at 71.3-99.2 mmol m(-2), while the dissolution rate of biogenic silica (BSi) was estimated to be 5.9-9.2% d(-1) in the upper 50 m of the water column. These results show that the development of a shallow pycnocline during the experiment accelerated the iron and silicic acid depletion in the upper mixed layer and influenced the recycling of the organic matter assimilated during the iron-induced bloom in the ocean surface. (c) 2006 Elsevier Ltd. All rights reserved." This paper reports on the variations in nutrient concentrations and phytoplankton dynamics during the stationary and declining phases of a phytoplankton bloom induced by a mesoscale iron-enrichment conducted in the high-nutrient low-chlorophyll (HNLC) eastern subarctic Pacific. During the 26-d sampling period, the main pycnocline was located between 30 and 45 m with a shallow pycnocline developing at 10 m, 19 d after the first iron-enrichment. The iron-induced bloom dominated by diatoms peaked during days 15 and 18, a period of high chlorophyll a concentrations (ca. 5 mg m(-3)), and declined thereafter. Nitrogenous nutrients and phosphate were not depleted during the whole experiment. In contrast, silicic acid and iron concentrations became very low during the stationary phase of the diatom bloom (days 15-18) and F-v/F-m declined. These observations suggest that silicic acid and iron limitation probably prevented further development of the diatom bloom. The decline in chlorophyll a concentrations during days 19-24 was mostly due to the decrease in diatom abundance. On the other hand, cell abundances of pico- and nanophytoplankton exhibited little change until day 24. In the layer located between the main and the shallow pycnocline (10-30 m), ammonium and silicic acid concentration increased during days 19-26, suggesting recycling of these nutrients. The amount of silicic acid recycled during that period was estimated at 71.3-99.2 mmol m(-2), while the dissolution rate of biogenic silica (BSi) was estimated to be 5.9-9.2% d(-1) in the upper 50 m of the water column. These results show that the development of a shallow pycnocline during the experiment accelerated the iron and silicic acid depletion in the upper mixed layer and influenced the recycling of the organic matter assimilated during the iron-induced bloom in the ocean surface. (c) 2006 Elsevier Ltd. All rights reserved.

N. S. R. Agawin, M. S. Hale, R. B. Rivkin, P. Matthews and W. K. W. Li, 2006, Microbial response to a mesoscale iron enrichment in the NE Subarctic Pacific: Bacterial community composition, Deep-Sea Research Part Ii-Topical Studies in Oceanography, 53 (20-22), 2248-2267.

"Changes in microbial community composition were determined during the subarctic ecosystem response to iron enrichment study (SERIES), a mesoscale Fe enrichment conducted in a high-nutrient low-chlorophyll (HNLC) region of the Northeast Subarctic Pacific, in July 2002. Phylogenetic composition using fluorescence in situ hybridization (FISH), relative DNA content using flow cytometry (FCM), and cellular morphometrics

(shape and volume) of heterotrophic bacteria were used to characterize community composition from samples collected within and below the mixed layer, inside and outside the Fe-patch. The proportion of total cells detected as members of the Cytophaga-Flavobacterium cluster increased in a log-linear manner from 16 (+/- 1.0)% to 47 (+/- 1.9)% in samples within the mixed layer, inside the Fe-enriched patch, while outside the patch, the proportion remained <= 21 (+/- 2.2)%. Temporal changes in the proportion of cells in the mixed layer with high DNA content (% HDNA) were significantly different inside and outside the Fe-enriched patch, where inside the patch % HDNA increased 2-fold after a week, reaching 93% towards the end of the observation period. Coupling in situ observations with the results of manipulation experiments allowed us to determine the relative contributions of bottom-up (nutrient limitation) and top-down (grazing) processes on heterotrophic bacterial abundance and community composition. Shifts in heterotrophic bacterial community composition inside the Fe-enriched patch were mainly controlled by top-down processes and moderately controlled by bottom-up controls (organic substrate limitation). (c) 2006 Elsevier Ltd. All rights reserved." Changes in microbial community composition were determined during the subarctic ecosystem response to iron enrichment study (SERIES), a mesoscale Fe enrichment conducted in a high-nutrient low-chlorophyll (HNLC) region of the Northeast Subarctic Pacific, in July 2002. Phylogenetic composition using fluorescence in situ hybridization (FISH), relative DNA content using flow cytometry (FCM), and cellular morphometrics (shape and volume) of heterotrophic bacteria were used to characterize community composition from samples collected within and below the mixed layer, inside and outside the Fe-patch. The proportion of total cells detected as members of the Cytophaga-Flavobacterium cluster increased in a log-linear manner from 16 (+/- 1.0)% to 47 (+/- 1.9)% in samples within the mixed layer, inside the Fe-enriched patch, while outside the patch, the proportion remained <= 21 (+/- 2.2)%. Temporal changes in the proportion of cells in the mixed layer with high DNA content (% HDNA) were significantly different inside and outside the Fe-enriched patch, where inside the patch % HDNA increased 2-fold after a week, reaching 93% towards the end of the observation period. Coupling in situ observations with the results of manipulation experiments allowed us to determine the relative contributions of bottom-up (nutrient limitation) and top-down (grazing) processes on heterotrophic bacterial abundance and community composition. Shifts in heterotrophic bacterial community composition inside the Fe-enriched patch were mainly controlled by top-down processes and moderately controlled by bottom-up controls (organic substrate limitation). (c) 2006 Elsevier Ltd. All rights reserved.

S. Takeda, N. Yoshie, P. W. Boyd and Y. Yamanaka, 2006, Modeling studies investigating the causes of preferential depletion of silicic acid relative to nitrate during SERIES, a mesoscale iron enrichment in the NE subarctic Pacific, Deep-Sea Research Part Ii-Topical Studies in Oceanography, 53 (20-22), 2297-2326.

"Numerical modeling experiments were conducted to examine the reasons for observed changes in the silicic acid ([Si(OH)(4)]) to nitrate ([NO3-]) drawdown ratio after the onset of algal iron stress during SERIES. During phytoplankton blooms and immediately after them, cells encounter a range of iron stress (between iron-replete and iron-deplete) and therefore show a range of growth rates. For these reasons, the potential influence of phytoplankton growth rate, under conditions of algal iron stress, on silicic acid and nitrate depletion were investigated in numerical experiments by altering the timing of a shift in the [Si(OH)(4)]: [NO3-] uptake ratio. These simulations suggested that the continued growth of iron-stressed phytoplankton at sub-maximum rates, with an elevated [Si(OH)]:[NO3-] uptake ratio, induced

depletion of silicic acid in the surface water and resulted in simultaneous limitation of growth by both iron and silicic-acid supply. Therefore, bottom-up control played an important role in terminating the phytoplankton bloom in SERIES. In the model simulations, the enhancement of diatom silicification due to increased rates of biomass-normalized silicic-acid uptake, led to increases in the export flux of opal after the onset of algal iron-stress and, consequently, it stimulated the silica pump. The regulation of both the [Si(OH)(4)]:[NO3-] uptake ratio and the growth rate of phytoplankton by iron supply are important factors that determine the relative consumption of silicic acid and nitrate upon iron stress, although the potential influence of a floristic shift in the diatom assemblage cannot be ruled out. These findings offer insights into the impact of iron fertilization, both artificial and natural, on the biogeochemical cycling of nutrients in high-nitrate, low-chlorophyll waters. (c) 2006 Elsevier Ltd. All rights reserved." Numerical modeling experiments were conducted to examine the reasons for observed changes in the silicic acid ([Si(OH)(4)]) to nitrate ([NO3-]) drawdown ratio after the onset of algal iron stress during SERIES. During phytoplankton blooms and immediately after them, cells encounter a range of iron stress (between iron-replete and iron-deplete) and therefore show a range of growth rates. For these reasons, the potential influence of phytoplankton growth rate, under conditions of algal iron stress, on silicic acid and nitrate depletion were investigated in numerical experiments by altering the timing of a shift in the [Si(OH)(4)]:[NO3-] uptake ratio. These simulations suggested that the continued growth of iron-stressed phytoplankton at sub-maximum rates, with an elevated [Si(OH)]:[NO3-] uptake ratio, induced depletion of silicic acid in the surface water and resulted in simultaneous limitation of growth by both iron and silicic-acid supply. Therefore, bottom-up control played an important role in terminating the phytoplankton bloom in SERIES. In the model simulations, the enhancement of diatom silicification due to increased rates of biomass-normalized silicic-acid uptake, led to increases in the export flux of opal after the onset of algal iron-stress and, consequently, it stimulated the silica pump. The regulation of both the [Si(OH)(4)]:[NO3-] uptake ratio and the growth rate of phytoplankton by iron supply are important factors that determine the relative consumption of silicic acid and nitrate upon iron stress, although the potential influence of a floristic shift in the diatom assemblage cannot be ruled out. These findings offer insights into the impact of iron fertilization, both artificial and natural, on the biogeochemical cycling of nutrients in high-nitrate, low-chlorophyll waters. (c) 2006 Elsevier Ltd. All rights reserved.

K. L. Denman, C. Voelker, M. A. Pena and R. B. Rivkin, 2006, Modelling the ecosystem response to iron fertilization in the subarctic NE Pacific: The influence of grazing, and Si and N cycling on CO2 drawdown, Deep-Sea Research Part Ii-Topical Studies in Oceanography, 53 (20-22), 2327-2352.

"We have employed a coupled one-dimensional mixed layer /ecosystem /carbon cycle model to simulate both the normal annual cycle and the iron-fertilization experiment in the subarctic NE Pacific Ocean near Ocean Station P (50 degrees N, 145 degrees W) during summer 2002. We considered two size classes of phytoplankton, the larger representing diatoms, where each size class has a different degree of iron limitation, and compartments for nitrate, ammonium, microzooplankton, sinking detritus, and a prescribed annual cycle in mesozooplankton. The base ecosystem model is formulated in terms of nitrogen, but is coupled to sub-models of silicon and carbon. Diatoms formed aggregates during blooms that sink rapidly from the surface ocean, and diatoms also can be grazed by microzooplankton, consistent with observations. Using the same parameter set as for the base ecosystem model, we reproduce the basic responses to fertilization: an initial bloom of small phytoplankton (including

calcifying coccolithophorids), followed rapidly by an increase of microzooplankton biomass; a continuing increase in diatoms that peak as silicate becomes limiting; and a later rapid sinking event of both carbon and silica particulates. Generally this sequence proceeds more rapidly in simulations than in situ. Simulations of the fertilization response show little sensitivity to the assumed fraction of small phytoplankton that are calcifiers, but a strong sensitivity to the assumed diatom uptake ratio Si:N. With an uptake ratio of 2.5, silicate is rapidly exhausted after fertilization, and 8 months later the regional PCO2 was 14 mu atm higher than in the case with no fertilization (assuming no exchange with surrounding waters): for all other simulations the pCO(2) anomaly is negative (indicating increased CO2 exchange from the atmosphere) but small, 2-5 mu atm, suggesting a persistence for a single large-scale fertilization of less than 1year. Simulated mixed layer Si:N drawdown ratios for different fixed diatom uptake ratios of Si:N illustrate the dangers of interpreting uptake ratios from drawdown ratios: (i) for a fixed uptake ratio the drawdown ratio varies with time as the ratio of small to large phytoplankton changes, and (ii) simulated drawdown ratios are always higher than uptake ratios because of the more rapid recycling (according to the model structure) of N relative to Si in the surface layer. Sensitivity simulations, with the diatom uptake ratio for Si:N varying as an inverse function of iron limitation and with a higher remineralization rate for detrital Si, delayed the onset of silica limitation after fertilization by several days. The magnitude and timing of the diatom peak was unchanged, indicating that in the model the (early) termination of the diatom bloom following fertilization resulted from formation and sinking of aggregates, and not Si limitation. Crown Copyright (c) 2006 Published by Elsevier Ltd. All rights reserved." We have employed a coupled one-dimensional mixed layer /ecosystem /carbon cycle model to simulate both the normal annual cycle and the iron-fertilization experiment in the subarctic NE Pacific Ocean near Ocean Station P (50 degrees N, 145 degrees W) during summer 2002. We considered two size classes of phytoplankton, the larger representing diatoms, where each size class has a different degree of iron limitation, and compartments for nitrate, ammonium, microzooplankton, sinking detritus, and a prescribed annual cycle in mesozooplankton. The base ecosystem model is formulated in terms of nitrogen, but is coupled to sub-models of silicon and carbon. Diatoms formed aggregates during blooms that sink rapidly from the surface ocean, and diatoms also can be grazed by microzooplankton, consistent with observations. Using the same parameter set as for the base ecosystem model, we reproduce the basic responses to fertilization: an initial bloom of small phytoplankton (including calcifying coccolithophorids), followed rapidly by an increase of microzooplankton biomass; a continuing increase in diatoms that peak as silicate becomes limiting; and a later rapid sinking event of both carbon and silica particulates. Generally this sequence proceeds more rapidly in simulations than in situ. Simulations of the fertilization response show little sensitivity to the assumed fraction of small phytoplankton that are calcifiers, but a strong sensitivity to the assumed diatom uptake ratio Si:N. With an uptake ratio of 2.5, silicate is rapidly exhausted after fertilization, and 8 months later the regional PCO2 was 14 mu atm higher than in the case with no fertilization (assuming no exchange with surrounding waters): for all other simulations the pCO(2) anomaly is negative (indicating increased CO2 exchange from the atmosphere) but small, 2-5 mu atm, suggesting a persistence for a single large-scale fertilization of less than 1year. Simulated mixed layer Si:N drawdown ratios for different fixed diatom uptake ratios of Si:N illustrate the dangers of interpreting uptake ratios from drawdown ratios: (i) for a fixed uptake ratio the drawdown ratio varies with time as the ratio of small to large phytoplankton changes, and (ii) simulated drawdown ratios are always higher than uptake ratios because of the more rapid recycling (according to the model structure) of N relative to Si in the surface layer. Sensitivity simulations, with the diatom uptake ratio for Si:N varying as an inverse function of iron limitation and with a higher

remineralization rate for detrital Si, delayed the onset of silica limitation after fertilization by several days. The magnitude and timing of the diatom peak was unchanged, indicating that in the model the (early) termination of the diatom bloom following fertilization resulted from formation and sinking of aggregates, and not Si limitation.

Y. Le Clainche, M. Levasseur, A. Vezina, R. C. Bouillon, A. Merzouk, S. Michaud, M. Scarratt, C. S. Wong, R. B. Rivkin, P. W. Boyd, P. J. Harrison, W. L. Miller, C. S. Law and F. J. Saucier, 2006, Modeling analysis of the effect of iron enrichment on dimethyl sulfide dynamics in the NE Pacific (SERIES experiment), Journal of Geophysical Research-Oceans, 111 (C1)

"The large-scale iron enrichment conducted in the NE Pacific during the Subarctic Ecosystem Response to Iron Enrichment Study (SERIES) triggered a phytoplankton bloom dominated successively by nanophytoplankton and large diatoms. During the first 14 days, surface dimethyl sulfide (DMS) levels increased both inside (up to 22 nmol L-1) and outside (up to 19 nmol L-1) the patch, with no consistent Fe effect. Later, DMS concentrations became sixfold lower inside the patch than outside. In this study, we used a DMS budget module embedded in a one-dimensional ocean turbulence model to investigate the contribution of the interacting physical, photochemical, and biological processes to this particular DMS response. Temporal variations in biological net DMS production were reconstructed using an inverse modeling approach. Our results show that short-term (days) variations in both the physical processes (i.e., turbulent mixing and ventilation) and the biological cycling of DMS are needed to explain the time evolution of DMS concentrations both outside and inside the Fe-enriched patch. The biological net DMS production was generally high (up to 0.35 nmol L-1 h(-1)) and comparable outside and inside the patch during the first 10 days, corresponding to the observed accumulation of DMS inside and outside the patch. Later, it became negative (net DMS biological consumption) inside the patch, suggesting a change in dimethylsulfoniopropionate bacterial metabolism. This study stresses the importance of short-term variations in biological processes and their sensitivity to the physical environment in shaping the DMS response to iron enrichment." The large-scale iron enrichment conducted in the NE Pacific during the Subarctic Ecosystem Response to Iron Enrichment Study (SERIES) triggered a phytoplankton bloom dominated successively by nanophytoplankton and large diatoms. During the first 14 days, surface dimethyl sulfide (DMS) levels increased both inside (up to 22 nmol L-1) and outside (up to 19 nmol L-1) the patch, with no consistent Fe effect. Later, DMS concentrations became sixfold lower inside the patch than outside. In this study, we used a DMS budget module embedded in a one-dimensional ocean turbulence model to investigate the contribution of the interacting physical, photochemical, and biological processes to this particular DMS response. Temporal variations in biological net DMS production were reconstructed using an inverse modeling approach. Our results show that short-term (days) variations in both the physical processes (i.e., turbulent mixing and ventilation) and the biological cycling of DMS are needed to explain the time evolution of DMS concentrations both outside and inside the Fe-enriched patch. The biological net DMS production was generally high (up to 0.35 nmol L-1 h(-1)) and comparable outside and inside the patch during the first 10 days, corresponding to the observed accumulation of DMS inside and outside the patch. Later, it became negative (net DMS biological consumption) inside the patch, suggesting a change in dimethylsulfoniopropionate bacterial metabolism. This study stresses the importance of short-

term variations in biological processes and their sensitivity to the physical environment in shaping the DMS response to iron enrichment.

P. J. Harrison, 2006, SERIES (subarctic ecosystem response to iron enrichment study): A Canadian-Japanese contribution to our understanding of the iron-ocean-climate connection, Deep Sea Research Part II: Topical Studies in Oceanography, 53 (20-22), 2006-2011.

D. A. Timothy, C. S. Wong, Y. Nojiri, D. C. Ianson and F. A. Whitney, 2006, The effects of patch expansion on budgets of C, N and Si for the Subarctic Ecosystem Response to Iron Enrichment Study (SERIES), Deep Sea Research Part II: Topical Studies in Oceanography, 53 (20-22), 2034-2052.

"Iron enrichment was carried out near Ocean Station Papa (OSP; 50°N, 145°W) in the subarctic northeast Pacific Ocean in July 2002, to assess the biogeochemical response to iron availability in these high-nitrate, low-chlorophyll (HNLC) waters. The phytoplankton responded immediately to iron addition. At day 0, flagellates were predominant and reached maximum abundance (days 6-9) before diatoms (days 16-19). At days 15-16, the iron-enriched patch shifted from a northward to an eastward direction and, from day 19.5 onward, mixing increased salinity and nutrient concentrations within the patch. Also at day 19.5, the iron-induced diatom bloom began to decline. We present budgets of C, N and Si for the periods of bloom development (days 3.5-19.5) and decline (days 19.5-26.5). A model that corrects for the dilution caused by patch expansion improves budgets for bloom development, but it does not account for the mixing that occurred during bloom decline. However, the model generates realistic rates of nutrient uptake during bloom decline if waters at the pycnocline were the source of salt and nutrients into the patch and if estimates of patch expansion were artificially low towards the end of the experiment, a possibility due to weakened tracer signals at patch boundaries." Iron enrichment was carried out near Ocean Station Papa (OSP; 50°N, 145°W) in the subarctic northeast Pacific Ocean in July 2002, to assess the biogeochemical response to iron availability in these high-nitrate, low-chlorophyll (HNLC) waters. The phytoplankton responded immediately to iron addition. At day 0, flagellates were predominant and reached maximum abundance (days 6-9) before diatoms (days 16-19). At days 15-16, the iron-enriched patch shifted from a northward to an eastward direction and, from day 19.5 onward, mixing increased salinity and nutrient concentrations within the patch. Also at day 19.5, the iron-induced diatom bloom began to decline. We present budgets of C, N and Si for the periods of bloom development (days 3.5-19.5) and decline (days 19.5-26.5). A model that corrects for the dilution caused by patch expansion improves budgets for bloom development, but it does not account for the mixing that occurred during bloom decline. However, the model generates realistic rates of nutrient uptake during bloom decline if waters at the pycnocline were the source of salt and nutrients into the patch and if estimates of patch expansion were artificially low towards the end of the experiment, a possibility due to weakened tracer signals at patch boundaries.

C. S. Wong, D. A. Timothy, C. S. Law, Y. Nojiri, L. Xie, S.-K. E. Wong and J. S. Page, 2006, Carbon distribution and fluxes during the SERIES iron fertilization experiment with special reference to the fugacity of carbon dioxide (fCO2), Deep Sea Research Part II: Topical Studies in Oceanography, 53 (20-22), 2053-2074.

"Surface seawater fugacity of carbon dioxide (fCO2) was measured during the Subarctic Ecosystem Response to Iron Enrichment Study (SERIES), July 9-August 5, 2002. Three ships sampled the iron-fertilized waters near Ocean Station P (50°N, 145°W): the Canadian CCGS J.P. Tully (July 9-23, 2002), the chartered Mexican M/V El Puma (July 9-28, 2002), and the Japanese fisheries research ship M/V Kaiyo Maru (July 24-August 5, 2002). Data used here are from the CCGS J.P. Tully and the M/V Kaiyo Maru. From the onset of the experiment to the peak of the iron-induced diatom bloom on day 19, sea-surface fCO2 decreased from 350 to 265 [mu]atm and average DIC concentration in the upper 30 m decreased from 2030 to 1990 [mu]mol kg-1. Changes in fCO2 in and near the iron patch as observed from the CCGS J.P. Tully and later from the M/V Kaiyo Maru were used to estimate CO2 drawdown and air-sea fluxes, and in generating a carbon budget during the growth phase (days 3-19) of the experiment. Without considering patch dilution, sources of dissolved inorganic carbon to the patch (1.6±0.25 mol m-2) were nearly double the sum (0.87±0.34 mol m-2) of the sinks: accumulations of dissolved organic and particulate carbon, and the flux of particulate carbon to sediment traps below the patch. However, the budget is balanced after considerations of the effects of patch expansion on property concentrations within the patch. A comparison with other iron fertilization experiments from 1995 to present was made to assess the CO2 drawdown values." Surface seawater fugacity of carbon dioxide (fCO2) was measured during the Subarctic Ecosystem Response to Iron Enrichment Study (SERIES), July 9-August 5, 2002. Three ships sampled the iron-fertilized waters near Ocean Station P (50°N, 145°W): the Canadian CCGS J.P. Tully (July 9-23, 2002), the chartered Mexican M/V El Puma (July 9-28, 2002), and the Japanese fisheries research ship M/V Kaiyo Maru (July 24-August 5, 2002). Data used here are from the CCGS J.P. Tully and the M/V Kaiyo Maru. From the onset of the experiment to the peak of the iron-induced diatom bloom on day 19, sea-surface fCO2 decreased from 350 to 265 [mu]atm and average DIC concentration in the upper 30 m decreased from 2030 to 1990 [mu]mol kg-1. Changes in fCO2 in and near the iron patch as observed from the CCGS J.P. Tully and later from the M/V Kaiyo Maru were used to estimate CO2 drawdown and air-sea fluxes, and in generating a carbon budget during the growth phase (days 3-19) of the experiment. Without considering patch dilution, sources of dissolved inorganic carbon to the patch (1.6±0.25 mol m-2) were nearly double the sum (0.87±0.34 mol m-2) of the sinks: accumulations of dissolved organic and particulate carbon, and the flux of particulate carbon to sediment traps below the patch. However, the budget is balanced after considerations of the effects of patch expansion on property concentrations within the patch. A comparison with other iron fertilization experiments from 1995 to present was made to assess the CO2 drawdown values.

C. S. Wong, W. K. Johnson, N. Sutherland, J. Nishioka, D. A. Timothy, M. Robert and S. Takeda, 2006, Iron speciation and dynamics during SERIES, a mesoscale iron enrichment experiment in the NE Pacific, Deep Sea Research Part II: Topical Studies in Oceanography, 53 (20-22), 2075-2094.

"During the Sub-arctic Ecosystem Response to Iron Enrichment Study (SERIES), the addition of ferrous iron to high-nitrate low-chlorophyll (HNLC) waters near Ocean Station PAPA (OSP: 50°N, 145°W) produced a phytoplankton bloom and CO2 drawdown, as evidenced by decreasing CO2 fugacity (fCO2). We analyzed five fractions or phases of iron: soluble (<0.03 [mu]m), dissolved (<0.22 [mu]m), total dissolved (acidified dissolved, <0.22 [mu]m), labile (unfiltered), and total (acidified, unfiltered). From these, we also calculated non-labile iron, colloidal iron (0.03-0.22 [mu]m), and both labile and non-labile particulate iron (>0.22 [mu]m). Here, we describe iron distributions and the evolution of iron phases in the

upper ocean during the experiment. We also present an iron budget accounting for horizontal and vertical dilution. At the time of our first sampling eight hours after fertilization was completed, total iron reached 8.6 nmol L-1 and dissolved iron was approximately 3 nmol L-1. Early in the experiment the dissolved iron phase decreased the most rapidly and by late day 6 the integrated dissolved iron (8.6 [mu]mol m-2) represented less than 10% of the initial addition (90-95 [mu]mol m-2). However at this same time the total integrated iron at the centre of the patch was still 52 [mu]mol m-2 or almost 60% of the calculated initial addition. By day 12,45% of the added iron (from both injections) could be accounted for in the patch. The half-life of total iron in the patch for the first injection was estimated to be less than 5 days if dilution is not considered, but more than 13 days if dilution is taken into account. The most notable change in iron percentages from one form to another occurred early in the first week of the experiment where the predominant phase shift was from the colloidal portion of dissolved iron to labile particulate iron that could have been biologically induced or simply aggregation of oxyhydroxides. This was immediately followed by a physical event resulting in a reduction in the non-labile particulate iron due to sinking out of the patch. The second infusion did not change the relative concentration of the various pools of iron as might be expected, but this was likely due to the fact that it was a much smaller injection than the first. The most pronounced change after the second infusion was the reduction in the labile particulate pool which coincided with one of the largest decreases in silicate observed during the entire experiment. In general the gradual decrease in the fraction of the 10 m colloidal iron as well as episodic losses of, or shifts in, integrated colloidal iron are thought to be the result of adsorption of colloidal iron to the plankton cell surfaces as well as aggregation of oxyhydroxides but could also be the result of utilization of colloidal iron by mixotrophic phytoplankton." During the Sub-arctic Ecosystem Response to Iron Enrichment Study (SERIES), the addition of ferrous iron to high-nitrate low-chlorophyll (HNLC) waters near Ocean Station PAPA (OSP: 50°N, 145°W) produced a phytoplankton bloom and CO2 drawdown, as evidenced by decreasing CO2 fugacity (fCO2). We analyzed five fractions or phases of iron: soluble (<0.03 [mu]m), dissolved (<0.22 [mu]m), total dissolved (acidified dissolved, <0.22 [mu]m), labile (unfiltered), and total (acidified, unfiltered). From these, we also calculated non-labile iron, colloidal iron (0.03-0.22 [mu]m), and both labile and non-labile particulate iron (>0.22 [mu]m). Here, we describe iron distributions and the evolution of iron phases in the upper ocean during the experiment. We also present an iron budget accounting for horizontal and vertical dilution. At the time of our first sampling eight hours after fertilization was completed, total iron reached 8.6 nmol L-1 and dissolved iron was approximately 3 nmol L-1. Early in the experiment the dissolved iron phase decreased the most rapidly and by late day 6 the integrated dissolved iron (8.6 [mu]mol m-2) represented less than 10% of the initial addition (90-95 [mu]mol m-2). However at this same time the total integrated iron at the centre of the patch was still 52 [mu]mol m-2 or almost 60% of the calculated initial addition. By day 12,45% of the added iron (from both injections) could be accounted for in the patch. The half-life of total iron in the patch for the first injection was estimated to be less than 5 days if dilution is not considered, but more than 13 days if dilution is taken into account. The most notable change in iron percentages from one form to another occurred early in the first week of the experiment where the predominant phase shift was from the colloidal portion of dissolved iron to labile particulate iron that could have been biologically induced or simply aggregation of oxyhydroxides. This was immediately followed by a physical event resulting in a reduction in the non-labile particulate iron due to sinking out of the patch. The second infusion did not change the relative concentration of the various pools of iron as might be expected, but this was likely due to the fact that it was a much smaller injection than the first. The most pronounced change after the second infusion was the reduction in the labile particulate pool which coincided with one of the largest decreases in

silicate observed during the entire experiment. In general the gradual decrease in the fraction of the 10 m colloidal iron as well as episodic losses of, or shifts in, integrated colloidal iron are thought to be the result of adsorption of colloidal iron to the plankton cell surfaces as well as aggregation of oxyhydroxides but could also be the result of utilization of colloidal iron by mixotrophic phytoplankton.

A. Marchetti, N. D. Sherry, H. Kiyosawa, A. Tsuda and P. J. Harrison, 2006, Phytoplankton processes during a mesoscale iron enrichment in the NE subarctic Pacific: Part I--Biomass and assemblage, Deep Sea Research Part II: Topical Studies in Oceanography, 53 (20-22), 2095-2113.

"We report results from the Subarctic Ecosystem Response to Iron Enrichment Study (SERIES) experiment in waters of the NE subarctic Pacific in which a large scale iron (Fe) enrichment lead to a shift in the phytoplankton assemblage from pico- and nanophytoplankton to one dominated by large diatoms. The phytoplankton response to the added Fe was monitored for 26 days following two infusions into a 77 km2 patch of seawater. During the course of the experiment, the resulting algal bloom was constrained within the upper 30 m and spread to a region measuring over 1000 km2. Phytoplankton chlorophyll a (chl a) increased from 0.3 mg m-3 to a peak of 6.3 mg m-3 18 days after the initial addition of Fe. Water-column integrated chl a was enhanced 8-fold, reaching a maximum of 114 mg m-2 on day 17. The resulting bloom is described in two ecological phases based on dominant phytoplankton groups. In Phase I, which encompassed the initial infusion up to day 10, all size-fractions (0.2-2, 2-20 and >20 [mu]m) increased in biomass as indicated by chl a, contributing to a surface standing stock of 2 mg m-3. In Phase II, from days 10 to 18, the bloom was dominated by microphytoplankton (>20 [mu]m), with a concomitant decrease in phytoplankton <20 [mu]m. Microphytoplankton, which initially accounted for 25% of the phytoplankton biomass and increased by a factor of 50, consisted primarily of the pennate diatom genera, Pseudo-nitzschia, Neodenticula and Thalassiothrix and the centric diatom genera, Chaetoceros, Rhizosolenia, and Proboscia. Particulate carbon-to-chl a (PC: chl a) ratios for large cells ([greater-or-equal, slanted]5 [mu]m) decreased 5-fold by day 18, indicative of enhanced cellular chl a content and increased phytoplankton contributions to PC. Pennate diatoms were most abundant in the patch, although when converted to biovolume, centric diatoms contributed larger amounts of algal carbon (C) to the bloom. A rapid decline in chl a on day 19 marked the onset of bloom decline. The magnitude, duration and composition of the phytoplankton response to the Fe enrichment clearly depicted a major shift in the structure of the algal assemblage and increased C export potential." We report results from the Subarctic Ecosystem Response to Iron Enrichment Study (SERIES) experiment in waters of the NE subarctic Pacific in which a large scale iron (Fe) enrichment lead to a shift in the phytoplankton assemblage from pico- and nanophytoplankton to one dominated by large diatoms. The phytoplankton response to the added Fe was monitored for 26 days following two infusions into a 77 km2 patch of seawater. During the course of the experiment, the resulting algal bloom was constrained within the upper 30 m and spread to a region measuring over 1000 km2. Phytoplankton chlorophyll a (chl a) increased from 0.3 mg m-3 to a peak of 6.3 mg m-3 18 days after the initial addition of Fe. Water-column integrated chl a was enhanced 8-fold, reaching a maximum of 114 mg m-2 on day 17. The resulting bloom is described in two ecological phases based on dominant phytoplankton groups. In Phase I, which encompassed the initial infusion up to day 10, all size-fractions (0.2-2, 2-20 and >20 [mu]m) increased in biomass as indicated by chl a, contributing to a surface standing stock of 2 mg m-3. In Phase II, from days 10 to 18, the bloom was dominated by

microphytoplankton (>20 [mu]m), with a concomitant decrease in phytoplankton <20 [mu]m. Microphytoplankton, which initially accounted for 25% of the phytoplankton biomass and increased by a factor of 50, consisted primarily of the pennate diatom genera, Pseudo-nitzschia, Neodenticula and Thalassiothrix and the centric diatom genera, Chaetoceros, Rhizosolenia, and Proboscia. Particulate carbon-to-chl a (PC: chl a) ratios for large cells ([greater-or-equal, slanted]5 [mu]m) decreased 5-fold by day 18, indicative of enhanced cellular chl a content and increased phytoplankton contributions to PC. Pennate diatoms were most abundant in the patch, although when converted to biovolume, centric diatoms contributed larger amounts of algal carbon (C) to the bloom. A rapid decline in chl a on day 19 marked the onset of bloom decline. The magnitude, duration and composition of the phytoplankton response to the Fe enrichment clearly depicted a major shift in the structure of the algal assemblage and increased C export potential.

A. Marchetti, P. Juneau, F. A. Whitney, C.-S. Wong and P. J. Harrison, 2006, Phytoplankton processes during a mesoscale iron enrichment in the NE subarctic Pacific: Part II--Nutrient utilization, Deep Sea Research Part II: Topical Studies in Oceanography, 53 (20-22), 2114-2130.

"The subarctic Pacific is one of the three main regions in which phytoplankton productivity is limited by the availability of iron (Fe). During the Subarctic Ecosystem Response to Iron Enrichment (SERIES) experiment, the response of phytoplankton to the addition of Fe and the consequential effects on chemical and physical water properties were monitored. Over the duration of the Fe-induced phytoplankton bloom, macronutrient concentrations (nitrate (NO3), silicic acid (Si(OH)4) and phosphate (PO4)) were drawn down with Si(OH)4 being depleted to low concentrations (<1 [mu]M) after 18 days. The dissolved Si(OH)4: NO3 ratio varied between two phases of the bloom. From days 0 to 10 (phase I), when all phytoplankton size classes increased in biomass, the dissolved Si(OH)4: NO3 ratio of the seawater in the patch increased as a result of the greater drawdown of NO3. After day 10 (phase II), when diatoms dominated the patch, a rapid decline in Si(OH)4 concentrations resulted in a sharp decrease in the Si(OH)4: NO3 ratio of the seawater. Increases in the suspended particulate biogenic silica (BSi) and particulate nitrogen (PN) resulted in a BSi: PN ratio of ca. 2 in the later stages of the Fe-induced bloom. The uptake of NO3 was enhanced due to the Fe enrichment. In the patch, absolute NO3 uptake rates increased in both large ([greater-or-equal, slanted]5 [mu]m) and small (<5 [mu]m) cells with the large cells accounting for 84% of total measured NO3 uptake over the duration of the experiment. Biomass-specific NO3 uptake rates also increased, but, in the small cells, the extent of the increase was largely dependent on the proxy for biomass used (PN or chlorophyll a). The photosynthetic efficiency of the phytoplankton assemblage was assessed at various stages of the bloom through the use of pulse amplitude-modulated (PAM) fluorometry. The trends in maximal and operational photochemical yields measured in the patch suggest that bloom termination resulted from a combination of Fe-stress and Si-stress. The observed changes in nutrient utilization during SERIES demonstrate the crucial role of Fe in regulating macronutrient inventories and NO3 uptake rates by phytoplankton in Fe-limited regions such as the NE subarctic Pacific." The subarctic Pacific is one of the three main regions in which phytoplankton productivity is limited by the availability of iron (Fe). During the Subarctic Ecosystem Response to Iron Enrichment (SERIES) experiment, the response of phytoplankton to the addition of Fe and the consequential effects on chemical and physical water properties were monitored. Over the duration of the Fe-induced phytoplankton bloom, macronutrient concentrations (nitrate (NO3), silicic acid (Si(OH)4) and phosphate (PO4)) were drawn down with Si(OH)4 being

depleted to low concentrations (<1 [mu]M) after 18 days. The dissolved Si(OH)4: NO3 ratio varied between two phases of the bloom. From days 0 to 10 (phase I), when all phytoplankton size classes increased in biomass, the dissolved Si(OH)4: NO3 ratio of the seawater in the patch increased as a result of the greater drawdown of NO3. After day 10 (phase II), when diatoms dominated the patch, a rapid decline in Si(OH)4 concentrations resulted in a sharp decrease in the Si(OH)4: NO3 ratio of the seawater. Increases in the suspended particulate biogenic silica (BSi) and particulate nitrogen (PN) resulted in a BSi: PN ratio of ca. 2 in the later stages of the Fe-induced bloom. The uptake of NO3 was enhanced due to the Fe enrichment. In the patch, absolute NO3 uptake rates increased in both large ([greater-or-equal, slanted]5 [mu]m) and small (<5 [mu]m) cells with the large cells accounting for 84% of total measured NO3 uptake over the duration of the experiment. Biomass-specific NO3 uptake rates also increased, but, in the small cells, the extent of the increase was largely dependent on the proxy for biomass used (PN or chlorophyll a). The photosynthetic efficiency of the phytoplankton assemblage was assessed at various stages of the bloom through the use of pulse amplitude-modulated (PAM) fluorometry. The trends in maximal and operational photochemical yields measured in the patch suggest that bloom termination resulted from a combination of Fe-stress and Si-stress. The observed changes in nutrient utilization during SERIES demonstrate the crucial role of Fe in regulating macronutrient inventories and NO3 uptake rates by phytoplankton in Fe-limited regions such as the NE subarctic Pacific.

A. Marchetti, N. D. Sherry, P. Juneau, R. F. Strzepek and P. J. Harrison, 2006, Phytoplankton processes during a mesoscale iron enrichment in the NE subarctic Pacific: Part III--Primary productivity, Deep Sea Research Part II: Topical Studies in Oceanography, 53 (20-22), 2131-2151.

"As part of the Canadian SOLAS program, a large scale iron (Fe) enrichment experiment (Subarctic Ecosystem Response to Iron Enrichment Study; SERIES) was performed in the NE subarctic Pacific in July of 2002. Dissolved Fe was added to a 77 km2 patch of seawater and the evolution of the subsequent phytoplankton bloom was monitored for 26 days. Particulate organic primary productivity (OPP) inside the patch began to increase in all phytoplankton size-fractions (picophytoplankton, nanophytoplankton and microphytoplankton) relative to outside the patch within 48 h. After day 10, microphytoplankton (>20 [mu]m) were responsible for the vast majority of both OPP and phytoplankton biomass. Maximum OPP of ca. 15 mmol C m-3 d-1 was achieved on day 15, representing a 20-fold increase from average OPP measured outside the patch. Water-column integrated, biomass (chl a)-specific OPP (Pbint) of the total phytoplankton assemblage peaked twice, once following the first Fe infusion on day 4 (2.9 mmol C mg chl a-1 d-1) and then coinciding with maximum OPP on day 15 (2.6 mmol C mg chl a-1 d-1). Maximum Pbint achieved on day 4 represented a 5-fold increase relative to Pbint measured outside the patch. Water-column integrated OPP also peaked on day 15 at ca. 251 mmol C m-2 d-1, and coincided with a rapid decline in silicic acid (Si(OH4)) concentrations. At this time, microphytoplankton accounted for ca. 90% of total OPP. Patch-averaged chlorophyll a (chl a) concentrations were maximal (~5 mg m-3, >16 times the outside patch) on day 18, during which time microphytoplankton OPP had begun to decline. In addition to OPP, particulate inorganic primary productivity (IPP) also increased due to an elevated coccolithophore abundance, reaching a maximum of 0.25 mmol C m-3 d-1 achieved 9 days after the initial Fe enrichment, which then decreased back to rates similar to those measured outside of the patch. Changes in primary productivity were also assessed using pulse amplitude-modulated (PAM) fluorometry. Relative electron transport rates (ETR) obtained by PAM fluorometry were significantly correlated ($p<0.001$,

r2=0.82) with the 14C-based primary production rates during the Fe enrichment experiment. The increase in all measured photosynthetic parameters with Fe enrichment provides compelling evidence that primary productivity in the NE subarctic Pacific is regulated by Fe availability during the summer." As part of the Canadian SOLAS program, a large scale iron (Fe) enrichment experiment (Subarctic Ecosystem Response to Iron Enrichment Study; SERIES) was performed in the NE subarctic Pacific in July of 2002. Dissolved Fe was added to a 77 km2 patch of seawater and the evolution of the subsequent phytoplankton bloom was monitored for 26 days. Particulate organic primary productivity (OPP) inside the patch began to increase in all phytoplankton size-fractions (picophytoplankton, nanophytoplankton and microphytoplankton) relative to outside the patch within 48 h. After day 10, microphytoplankton (>20 [mu]m) were responsible for the vast majority of both OPP and phytoplankton biomass. Maximum OPP of ca. 15 mmol C m-3 d-1 was achieved on day 15, representing a 20-fold increase from average OPP measured outside the patch. Water-column integrated, biomass (chl a)-specific OPP (Pbint) of the total phytoplankton assemblage peaked twice, once following the first Fe infusion on day 4 (2.9 mmol C mg chl a-1 d-1) and then coinciding with maximum OPP on day 15 (2.6 mmol C mg chl a-1 d-1). Maximum Pbint achieved on day 4 represented a 5-fold increase relative to Pbint measured outside the patch. Water-column integrated OPP also peaked on day 15 at ca. 251 mmol C m-2 d-1, and coincided with a rapid decline in silicic acid (Si(OH4)) concentrations. At this time, microphytoplankton accounted for ca. 90% of total OPP. Patch-averaged chlorophyll a (chl a) concentrations were maximal (~5 mg m-3, >16 times the outside patch) on day 18, during which time microphytoplankton OPP had begun to decline. In addition to OPP, particulate inorganic primary productivity (IPP) also increased due to an elevated coccolithophore abundance, reaching a maximum of 0.25 mmol C m-3 d-1 achieved 9 days after the initial Fe enrichment, which then decreased back to rates similar to those measured outside of the patch. Changes in primary productivity were also assessed using pulse amplitude-modulated (PAM) fluorometry. Relative electron transport rates (ETR) obtained by PAM fluorometry were significantly correlated ($p<0.001$, r2=0.82) with the 14C-based primary production rates during the Fe enrichment experiment. The increase in all measured photosynthetic parameters with Fe enrichment provides compelling evidence that primary productivity in the NE subarctic Pacific is regulated by Fe availability during the summer.

C. S. Wong and D. W. Crawford, 2006, Evolution of phytoplankton pigments in an in-situ iron enrichment experiment in the subarctic NE Pacific, Deep Sea Research Part II: Topical Studies in Oceanography, 53 (20-22), 2152-2167.

"Phytoplankton pigments were analysed using high performance liquid chromatography (HPLC) analysis following an in-situ iron (Fe) enrichment in the subarctic NE Pacific. Profiles of pigment concentrations in the upper 100 m were measured both inside and outside the Fe-enriched patch over the first 14 days of the experiment. In the upper 50 m, all phytoplankton pigments measured, with the exception of zeaxanthin, were significantly higher inside the Fe-enriched patch than in surrounding waters. Chlorophyll a increased strongly in the Fe patch, with concentration in the upper 20 m reaching 1-1.3 mg m-3 between 7 and 14 days after enrichment, an order of magnitude higher than outside (0.1-0.15 mg m-3). Depth integrated chlorophyll a (mg m-2) in the upper 50 m inside the patch revealed two major peaks at around 7-9 and 12-14 days. During the first peak, 19'-hexanoyloxyfucoxanthin was the other major pigment, suggesting that prymnesiophytes were abundant at this time, and diagnostic pigment indices confirmed that nanoplankton dominated the phytoplankton community. Degradation pigments phaeophytin a1 and a2, and phaeophorbide a2 also peaked

during this nanoplankton bloom. During the second peak in chlorophyll a (12-14 days), the other major pigment was fucoxanthin suggesting that diatoms were abundant, and diagnostic pigment indices confirmed that this later bloom was dominated by microplankton. Phaeophytin a1 and a2 and phaeophorbide a1 also strongly increased in the Fe patch during this second peak. The only phytoplankton pigment not significantly higher in the upper 50 m of the Fe-enriched patch was zeaxanthin, and diagnostic pigment indices confirmed that picoplankton were relatively insensitive to Fe enrichment. The potential for pigments as markers for other biogeochemical consequences of the Fe fertilisation is briefly discussed." Phytoplankton pigments were analysed using high performance liquid chromatography (HPLC) analysis following an in-situ iron (Fe) enrichment in the subarctic NE Pacific. Profiles of pigment concentrations in the upper 100 m were measured both inside and outside the Fe-enriched patch over the first 14 days of the experiment. In the upper 50 m, all phytoplankton pigments measured, with the exception of zeaxanthin, were significantly higher inside the Fe-enriched patch than in surrounding waters. Chlorophyll a increased strongly in the Fe patch, with concentration in the upper 20 m reaching 1-1.3 mg m-3 between 7 and 14 days after enrichment, an order of magnitude higher than outside (0.1-0.15 mg m-3). Depth integrated chlorophyll a (mg m-2) in the upper 50 m inside the patch revealed two major peaks at around 7-9 and 12-14 days. During the first peak, 19'-hexanoyloxyfucoxanthin was the other major pigment, suggesting that prymnesiophytes were abundant at this time, and diagnostic pigment indices confirmed that nanoplankton dominated the phytoplankton community. Degradation pigments phaeophytin a1 and a2, and phaeophorbide a2 also peaked during this nanoplankton bloom. During the second peak in chlorophyll a (12-14 days), the other major pigment was fucoxanthin suggesting that diatoms were abundant, and diagnostic pigment indices confirmed that this later bloom was dominated by microplankton. Phaeophytin a1 and a2 and phaeophorbide a1 also strongly increased in the Fe patch during this second peak. The only phytoplankton pigment not significantly higher in the upper 50 m of the Fe-enriched patch was zeaxanthin, and diagnostic pigment indices confirmed that picoplankton were relatively insensitive to Fe enrichment. The potential for pigments as markers for other biogeochemical consequences of the Fe fertilisation is briefly discussed.

M. G. Scarratt, A. Marchetti, M. S. Hale, R. B. Rivkin, S. Michaud, P. Matthews, M. Levasseur, N. Sherry, A. Merzouk, W. K. W. Li and H. Kiyosawa, 2006, Assessing microbial responses to iron enrichment in the Subarctic Northeast Pacific: Do microcosms reproduce the in situ condition?, Deep Sea Research Part II: Topical Studies in Oceanography, 53 (20-22), 2182-2200.

"A microcosm experiment was conducted in the NE Pacific in July 2002 to compare the microbial response between microcosms and the Subarctic Ecosystem Response to Iron-Enrichment Study (SERIES) in situ iron-enrichment experiment. Seawater microcosms (20 L) were incubated aboard ship under natural light using three treatments: (1) low-iron seawater amended with 4 nmol l-1 FeSO4 (+Fe); (2) low-iron seawater amended with 4 nmol l-1 FeSO4 and 86 nmol l-1 GeO2 (+Fe+Ge); (3) seawater collected from the in situ Fe-enriched patch (PW). The +Fe+Ge treatment used germanium to control diatom growth to assess the role of diatoms in dimethylsulfoniopropionate (DMSP) production. The following variables were measured in the microcosms and in situ: chlorophyll a (chl a), nitrate (), silicic acid (Si(OH)4), phytoplankton abundance and species identification, bacterial abundance (including estimates of low- and high-DNA bacteria), bacterial production, bacterial specific growth rate, particulate and dissolved DMSP and dimethylsulfide (DMS) concentrations. There was little or no significant difference (ANCOVA) in the response of most variables

between the +Fe and PW microcosms, but large differences were observed between both these treatments and the in situ data from the enriched patch. Chl a in all microcosms increased from ambient levels (approx. 0.5-1 [mu]g l-1) to approx. 4.5-6.2 [mu]g l-1 after 11 d incubation, when was fully depleted from all microcosms. During this same period, in situ chl a increased more slowly to a maximum of 2.9 [mu]g l-1 on day 11. Nanophytoplankton and picophytoplankton were more abundant in the microcosms relative to the in situ community, which became dominated by large diatoms. Bacterial abundance was similar in the microcosms and in situ, but bacterial production was significantly higher in the microcosms. While neither DMSPd nor DMS accumulation showed significant differences between the microcosms and in situ, particulate DMSP concentrations increased significantly faster in the +Fe and PW treatments. These differences represent bottle effects resulting from the containment of the microcosms, which suppresses grazing, alters community and food web structure, enhances iron and nutrient regeneration, and isolates the community from physical transport and export processes including sinking. Thus during this experiment, the microcosms were not a good model for the in situ system in terms of the effects of iron on the phytoplankton biomass, nutrient uptake, bacterial dynamics and DMSPp production. In the germanium-amended treatment, the inhibition of diatom growth resulted in enhanced growth of other taxa and a suppression of bacterial production, leading to increased production of DMSP and DMS and strong correlations between DMSP, DMS and non-diatom phytoplankton taxa. Diatoms did not contribute significantly to particulate DMSP concentrations." A microcosm experiment was conducted in the NE Pacific in July 2002 to compare the microbial response between microcosms and the Subarctic Ecosystem Response to Iron-Enrichment Study (SERIES) in situ iron-enrichment experiment. Seawater microcosms (20 L) were incubated aboard ship under natural light using three treatments: (1) low-iron seawater amended with 4 nmol l-1 FeSO4 (+Fe); (2) low-iron seawater amended with 4 nmol l-1 FeSO4 and 86 nmol l-1 GeO2 (+Fe+Ge); (3) seawater collected from the in situ Fe-enriched patch (PW). The +Fe+Ge treatment used germanium to control diatom growth to assess the role of diatoms in dimethylsulfoniopropionate (DMSP) production. The following variables were measured in the microcosms and in situ: chlorophyll a (chl a), nitrate (), silicic acid (Si(OH)4), phytoplankton abundance and species identification, bacterial abundance (including estimates of low- and high-DNA bacteria), bacterial production, bacterial specific growth rate, particulate and dissolved DMSP and dimethylsulfide (DMS) concentrations. There was little or no significant difference (ANCOVA) in the response of most variables between the +Fe and PW microcosms, but large differences were observed between both these treatments and the in situ data from the enriched patch. Chl a in all microcosms increased from ambient levels (approx. 0.5-1 [mu]g l-1) to approx. 4.5-6.2 [mu]g l-1 after 11 d incubation, when was fully depleted from all microcosms. During this same period, in situ chl a increased more slowly to a maximum of 2.9 [mu]g l-1 on day 11. Nanophytoplankton and picophytoplankton were more abundant in the microcosms relative to the in situ community, which became dominated by large diatoms. Bacterial abundance was similar in the microcosms and in situ, but bacterial production was significantly higher in the microcosms. While neither DMSPd nor DMS accumulation showed significant differences between the microcosms and in situ, particulate DMSP concentrations increased significantly faster in the +Fe and PW treatments. These differences represent bottle effects resulting from the containment of the microcosms, which suppresses grazing, alters community and food web structure, enhances iron and nutrient regeneration, and isolates the community from physical transport and export processes including sinking. Thus during this experiment, the microcosms were not a good model for the in situ system in terms of the effects of iron on the phytoplankton biomass, nutrient uptake, bacterial dynamics and DMSPp production. In the germanium-amended treatment, the inhibition of diatom growth resulted in

enhanced growth of other taxa and a suppression of bacterial production, leading to increased production of DMSP and DMS and strong correlations between DMSP, DMS and non-diatom phytoplankton taxa. Diatoms did not contribute significantly to particulate DMSP concentrations.

J. A. Needoba, A. Marchetti, M. F. Henry, P. J. Harrison, C.-S. Wong, W. Keith Johnson and T. F. Pedersen, 2006, Stable nitrogen isotope dynamics of a mesoscale iron enrichment experiment in the NE Subarctic Pacific, Deep Sea Research Part II: Topical Studies in Oceanography, 53 (20-22), 2214-2230.

"We report the response in the natural abundance of the stable isotopes of nitrogen ([delta]15N) during the Fe-enrichment experiment SERIES (Subarctic Ecosystem Response to Iron Enrichment Study) in the NE Pacific. Samples were collected for isotope analysis of nitrate, particulate material (including size fractionated samples), and particles trapped in the water column from beneath the Fe-enriched patch. In all sample types, [delta]15N changed in response to increased phytoplankton productivity after the Fe enrichment. The nitrate concentration and [delta]15N of nitrate were inversely related, the result of the opposing effects of isotope fractionation during nitrate assimilation and the addition of new nitrate by periodic mixing of water from outside the Fe patch. During the growth period a decrease in the difference of the [delta]15N of particulate nitrogen and nitrate occurred that was attributed to physical mixing, shifts in growth from regenerated nitrogen sources to nitrate, and the change in the community assemblage from<5-[mu]m phytoplankton cells to a larger assemblage dominated by diatoms. The surface-tethered sediment trap [delta]15N samples indicate that the nitrate isotope fractionation signal in surface waters was not transported below the permanent mixed layer until the end of the phytoplankton growth period, and therefore only the highest values associated with the isotope fractionation process were recorded in the sinking material from the patch. An important conclusion from this study is that mesoscale physical mixing effects and nitrogen remineralization can reduce the expression of isotope fractionation during phytoplankton growth, explaining why the high fractionation values measured in laboratory studies are not commonly observed in the natural environment." We report the response in the natural abundance of the stable isotopes of nitrogen ([delta]15N) during the Fe-enrichment experiment SERIES (Subarctic Ecosystem Response to Iron Enrichment Study) in the NE Pacific. Samples were collected for isotope analysis of nitrate, particulate material (including size fractionated samples), and particles trapped in the water column from beneath the Fe-enriched patch. In all sample types, [delta]15N changed in response to increased phytoplankton productivity after the Fe enrichment. The nitrate concentration and [delta]15N of nitrate were inversely related, the result of the opposing effects of isotope fractionation during nitrate assimilation and the addition of new nitrate by periodic mixing of water from outside the Fe patch. During the growth period a decrease in the difference of the [delta]15N of particulate nitrogen and nitrate occurred that was attributed to physical mixing, shifts in growth from regenerated nitrogen sources to nitrate, and the change in the community assemblage from<5-[mu]m phytoplankton cells to a larger assemblage dominated by diatoms. The surface-tethered sediment trap [delta]15N samples indicate that the nitrate isotope fractionation signal in surface waters was not transported below the permanent mixed layer until the end of the phytoplankton growth period, and therefore only the highest values associated with the isotope fractionation process were recorded in the sinking material from the patch. An important conclusion from this study is that mesoscale physical mixing effects and nitrogen remineralization can reduce the expression of isotope fractionation during phytoplankton

growth, explaining why the high fractionation values measured in laboratory studies are not commonly observed in the natural environment.

M. S. Hale, R. B. Rivkin, P. Matthews, N. S. R. Agawin and W. K. W. Li, 2006, Microbial response to a mesoscale iron enrichment in the NE subarctic Pacific: Heterotrophic bacterial processes, Deep Sea Research Part II: Topical Studies in Oceanography, 53 (20-22), 2231-2247.

"The response of heterotrophic bacteria to an in situ mesoscale Fe-addition was characterized during the Subarctic Ecosystem Response to Iron Enrichment Study (SERIES), in the high nutrient low chlorophyll region of the Northeast subarctic Pacific, during July 2002. Samples were collected from inside and outside the Fe-enriched patch for the determination of bacterial biomass, and rates of production and growth, and community respiration. The addition of Fe significantly changed the dynamics of the mixed layer heterotrophic bacterial community compared to unfertilized waters. Outside the patch, bacterial dynamics remained relatively constant. Inside the Fe-enriched patch, depth-integrated bacterial biomass decreased 5-fold during the first 12 days after fertilization, after which biomass increased more than 10-fold, to a maximum of 23.3 mg C m-3. Similarly, bacterial production decreased 3-fold over the first 8 days, followed by a 15-fold increase to 5.7 mg C m-3 d-1. Bacterial specific growth rates remained constant for 8 days after the initial Fe-addition and close to values initially observed outside the patch. After day 8, mixed layer specific growth rates inside the patch increased more than 10-fold to a maximum of 1.24 d-1 by day 12, then steadily decreased to 0.22 d-1 by day 16 and remained relatively constant thereafter. Temporal changes in growth were not significantly different inside and outside the patch, suggesting that bacterial growth was not directly limited by Fe availability. The temporal uncoupling of bacterial biomass and production inside the patch, combined with the lack of evidence for direct iron limitation, suggest that inside the patch, bacteria were initially controlled by a combination of moderate bottom-up control, due to the effects of organic substrate limitation of bacterial growth, and strong top-down control, by processes such as microzooplankton bacterivory or viral lysis. Release of bacteria from grazing pressure (around day 12), coupled with an increase in specific growth rate (day 8), resulted in the rapid increase in bacterial biomass observed towards the end of the observation period. Mixed layer bacterial carbon demand ranged from 1.5 to 22.9 mg C m-3 inside the patch and accounted for an average (±st dev) of 25% (±11%) of primary production. Consequently, a high proportion of the Fe-enhanced primary production in the mixed layer during SERIES was channelled through the microbial food web, thus reducing the amount of organic carbon available for export." The response of heterotrophic bacteria to an in situ mesoscale Fe-addition was characterized during the Subarctic Ecosystem Response to Iron Enrichment Study (SERIES), in the high nutrient low chlorophyll region of the Northeast subarctic Pacific, during July 2002. Samples were collected from inside and outside the Fe-enriched patch for the determination of bacterial biomass, and rates of production and growth, and community respiration. The addition of Fe significantly changed the dynamics of the mixed layer heterotrophic bacterial community compared to unfertilized waters. Outside the patch, bacterial dynamics remained relatively constant. Inside the Fe-enriched patch, depth-integrated bacterial biomass decreased 5-fold during the first 12 days after fertilization, after which biomass increased more than 10-fold, to a maximum of 23.3 mg C m-3. Similarly, bacterial production decreased 3-fold over the first 8 days, followed by a 15-fold increase to 5.7 mg C m-3 d-1. Bacterial specific growth rates remained constant for 8 days after the initial Fe-addition and close to values initially observed outside the patch. After day 8, mixed layer specific growth rates inside the patch increased

more than 10-fold to a maximum of 1.24 d-1 by day 12, then steadily decreased to 0.22 d-1 by day 16 and remained relatively constant thereafter. Temporal changes in growth were not significantly different inside and outside the patch, suggesting that bacterial growth was not directly limited by Fe availability. The temporal uncoupling of bacterial biomass and production inside the patch, combined with the lack of evidence for direct iron limitation, suggest that inside the patch, bacteria were initially controlled by a combination of moderate bottom-up control, due to the effects of organic substrate limitation of bacterial growth, and strong top-down control, by processes such as microzooplankton bacterivory or viral lysis. Release of bacteria from grazing pressure (around day 12), coupled with an increase in specific growth rate (day 8), resulted in the rapid increase in bacterial biomass observed towards the end of the observation period. Mixed layer bacterial carbon demand ranged from 1.5 to 22.9 mg C m-3 inside the patch and accounted for an average (±st dev) of 25% (±11%) of primary production. Consequently, a high proportion of the Fe-enhanced primary production in the mixed layer during SERIES was channelled through the microbial food web, thus reducing the amount of organic carbon available for export.

A. R. Sastri and J. F. Dower, 2006, Mesozooplankton community response during the SERIES iron enrichment experiment in the subarctic NE Pacific, Deep Sea Research Part II: Topical Studies in Oceanography, 53 (20-22), 2268-2280.

"The response of the mesozooplankton community was examined during the development and early decline of the Subarctic Ecosystem Response to Iron Enrichment Study diatom bloom in July 2002. No significant changes in species composition were observed during this period. In terms of abundance, the community was dominated by small copepods (Oithona spp. and Pseudocalanus spp.). The abundance of large herbivorous calanoids of the genus Neocalanus (N. plumchrus, N. cristatus and N. flemingeri) was already low at the start of the experiment as most of these animals had already descended to their overwintering depth. Mesozooplankton biomass was dominated by the calanoids Eucalanus bungii, Calanus pacificus, Metridia pacifica and, to a lesser extent, late stage copepodites (CIV, CV) of Neocalanus spp. In general, the abundance of all copepod species tended to increase inside the patch (relative to conditions outside the patch) during the experiment. However, mean species-specific abundances were not significantly different inside and outside of the patch, except for a significant increase of E. bungii ($p<0.05$) that occurred between Days 10 and 13 inside the iron-fertilized patch. By Day 8, most of the E. bungii population had shifted its vertical distribution into the surface mixed layer. We hypothesize that a wind event displacing the surface mixed layer coincident with continued immigration from below the thermocline facilitated this increase in abundance. Here we address this higher trophic level response to pulsed primary production in terms of potential mechanisms and their potential impact on the diatom bloom." The response of the mesozooplankton community was examined during the development and early decline of the Subarctic Ecosystem Response to Iron Enrichment Study diatom bloom in July 2002. No significant changes in species composition were observed during this period. In terms of abundance, the community was dominated by small copepods (Oithona spp. and Pseudocalanus spp.). The abundance of large herbivorous calanoids of the genus Neocalanus (N. plumchrus, N. cristatus and N. flemingeri) was already low at the start of the experiment as most of these animals had already descended to their overwintering depth. Mesozooplankton biomass was dominated by the calanoids Eucalanus bungii, Calanus pacificus, Metridia pacifica and, to a lesser extent, late stage copepodites (CIV, CV) of Neocalanus spp. In general, the abundance of all copepod species tended to increase inside the patch (relative to conditions outside the patch) during the experiment.

However, mean species-specific abundances were not significantly different inside and outside of the patch, except for a significant increase of E. bungii ($p<0.05$) that occurred between Days 10 and 13 inside the iron-fertilized patch. By Day 8, most of the E. bungii population had shifted its vertical distribution into the surface mixed layer. We hypothesize that a wind event displacing the surface mixed layer coincident with continued immigration from below the thermocline facilitated this increase in abundance. Here we address this higher trophic level response to pulsed primary production in terms of potential mechanisms and their potential impact on the diatom bloom.

A. Tsuda, H. Saito, J. Nishioka, T. Ono, Y. Noiri and I. Kudo, 2006, Mesozooplankton response to iron enrichment during the diatom bloom and bloom decline in SERIES (NE Pacific), Deep Sea Research Part II: Topical Studies in Oceanography, 53 (20-22), 2281-2296.

"A mesoscale iron-fertilization experiment was carried out in the eastern subarctic Pacific during summer 2002. The iron patch was traced for 26 days after the enrichment, and the abundance and behavior of mesozooplankton was compared with those outside of the patch during the first half of the experiment (days 2-18) by Sastri and Dower [2006. Mesozooplankton community response during the SERIES iron enrichment experiment in the subarctic NE Pacific. Deep-Sea Research Part II.) and during the post-enrichment diatom bloom and its period of decline (days 15-26; this paper). The surface chlorophyll-a concentration in the patch was high between days 15 and 17 (6 mg m-3) and decreased to 1.4 mg m-3 at the end of the observation. Dominant zooplankton species in the upper 200 m were copepods: Eucalanus bungii, Pseudocalanus spp., Neocalanus plumchrus, N. cristatus, and Metridia pacifica. Species composition did not change significantly in the patch over the observation period. However, shallower distribution depths of E. bungii, N. cristatus and M. pacifica were observed in the patch during and after the diatom bloom. Especially, E. bungii was mainly distributed in the subsurface layer outside of the patch, but it was mainly in the surface mixed layer inside the patch, where it also had an enhanced development rate and increased biomass. We also propose the accumulation mechanism of zooplankton in the patch due to the upward immigration. Moreover, the abundance of the first copepodite stage of E. bungii and calyptopis larvae of euphausiids increased several fold in the patch compared to the densities outside the patch. The increases in both species are considered to be due to lowered mortality during the egg and naupliar stages, which was caused by lowered relative importance of eggs and nauplii in the diets of the suspension-feeding omnivores in the patch due to increased diatom abundance during the diatom bloom. Gut-pigment contents of dominant copepods in the patch increased 6-8 times, and the maximum values were observed during the bloom peak. The grazing impact on phytoplankton was low during the bloom period, but increased in the declining period of the diatom bloom." A mesoscale iron-fertilization experiment was carried out in the eastern subarctic Pacific during summer 2002. The iron patch was traced for 26 days after the enrichment, and the abundance and behavior of mesozooplankton was compared with those outside of the patch during the first half of the experiment (days 2-18) by Sastri and Dower [2006. Mesozooplankton community response during the SERIES iron enrichment experiment in the subarctic NE Pacific. Deep-Sea Research Part II.) and during the post-enrichment diatom bloom and its period of decline (days 15-26; this paper). The surface chlorophyll-a concentration in the patch was high between days 15 and 17 (6 mg m-3) and decreased to 1.4 mg m-3 at the end of the observation. Dominant zooplankton species in the upper 200 m were copepods: Eucalanus bungii, Pseudocalanus spp., Neocalanus plumchrus, N. cristatus, and Metridia pacifica.

Species composition did not change significantly in the patch over the observation period. However, shallower distribution depths of E. bungii, N. cristatus and M. pacifica were observed in the patch during and after the diatom bloom. Especially, E. bungii was mainly distributed in the subsurface layer outside of the patch, but it was mainly in the surface mixed layer inside the patch, where it also had an enhanced development rate and increased biomass. We also propose the accumulation mechanism of zooplankton in the patch due to the upward immigration. Moreover, the abundance of the first copepodite stage of E. bungii and calyptopis larvae of euphausiids increased several fold in the patch compared to the densities outside the patch. The increases in both species are considered to be due to lowered mortality during the egg and naupliar stages, which was caused by lowered relative importance of eggs and nauplii in the diets of the suspension-feeding omnivores in the patch due to increased diatom abundance during the diatom bloom. Gut-pigment contents of dominant copepods in the patch increased 6-8 times, and the maximum values were observed during the bloom peak. The grazing impact on phytoplankton was low during the bloom period, but increased in the declining period of the diatom bloom.

K. L. Denman, C. Voelker, M. Angelica Peña and R. B. Rivkin, 2006, Modelling the ecosystem response to iron fertilization in the subarctic NE Pacific: The influence of grazing, and Si and N cycling on CO2 drawdown, Deep Sea Research Part II: Topical Studies in Oceanography, 53 (20-22), 2327-2352.

"We have employed a coupled one-dimensional mixed layer /ecosystem /carbon cycle model to simulate both the normal annual cycle and the iron-fertilization experiment in the subarctic NE Pacific Ocean near Ocean Station P (50°N, 145°W) during summer 2002. We considered two size classes of phytoplankton, the larger representing diatoms, where each size class has a different degree of iron limitation, and compartments for nitrate, ammonium, microzooplankton, sinking detritus, and a prescribed annual cycle in mesozooplankton. The base ecosystem model is formulated in terms of nitrogen, but is coupled to sub-models of silicon and carbon. Diatoms formed aggregates during blooms that sink rapidly from the surface ocean, and diatoms also can be grazed by microzooplankton, consistent with observations. Using the same parameter set as for the base ecosystem model, we reproduce the basic responses to fertilization: an initial bloom of small phytoplankton (including calcifying coccolithophorids), followed rapidly by an increase of microzooplankton biomass; a continuing increase in diatoms that peak as silicate becomes limiting; and a later rapid sinking event of both carbon and silica particulates. Generally this sequence proceeds more rapidly in simulations than in situ. Simulations of the fertilization response show little sensitivity to the assumed fraction of small phytoplankton that are calcifiers, but a strong sensitivity to the assumed diatom uptake ratio Si:N. With an uptake ratio of 2.5, silicate is rapidly exhausted after fertilization, and 8 months later the regional pCO2 was 14 [mu]atm higher than in the case with no fertilization (assuming no exchange with surrounding waters): for all other simulations the pCO2 anomaly is negative (indicating increased CO2 exchange from the atmosphere) but small, 2-5 [mu]atm, suggesting a persistence for a single large-scale fertilization of less than 1 year. Simulated mixed layer Si:N drawdown ratios for different fixed diatom uptake ratios of Si:N illustrate the dangers of interpreting uptake ratios from drawdown ratios: (i) for a fixed uptake ratio the drawdown ratio varies with time as the ratio of small to large phytoplankton changes, and (ii) simulated drawdown ratios are always higher than uptake ratios because of the more rapid recycling (according to the model structure) of N relative to Si in the surface layer. Sensitivity simulations, with the diatom uptake ratio for Si:N varying as an inverse function of iron limitation and with a higher

remineralization rate for detrital Si, delayed the onset of silica limitation after fertilization by several days. The magnitude and timing of the diatom peak was unchanged, indicating that in the model the (early) termination of the diatom bloom following fertilization resulted from formation and sinking of aggregates, and not Si limitation." We have employed a coupled one-dimensional mixed layer /ecosystem /carbon cycle model to simulate both the normal annual cycle and the iron-fertilization experiment in the subarctic NE Pacific Ocean near Ocean Station P (50°N, 145°W) during summer 2002. We considered two size classes of phytoplankton, the larger representing diatoms, where each size class has a different degree of iron limitation, and compartments for nitrate, ammonium, microzooplankton, sinking detritus, and a prescribed annual cycle in mesozooplankton. The base ecosystem model is formulated in terms of nitrogen, but is coupled to sub-models of silicon and carbon. Diatoms formed aggregates during blooms that sink rapidly from the surface ocean, and diatoms also can be grazed by microzooplankton, consistent with observations. Using the same parameter set as for the base ecosystem model, we reproduce the basic responses to fertilization: an initial bloom of small phytoplankton (including calcifying coccolithophorids), followed rapidly by an increase of microzooplankton biomass; a continuing increase in diatoms that peak as silicate becomes limiting; and a later rapid sinking event of both carbon and silica particulates. Generally this sequence proceeds more rapidly in simulations than in situ. Simulations of the fertilization response show little sensitivity to the assumed fraction of small phytoplankton that are calcifiers, but a strong sensitivity to the assumed diatom uptake ratio Si:N. With an uptake ratio of 2.5, silicate is rapidly exhausted after fertilization, and 8 months later the regional pCO2 was 14 [mu]atm higher than in the case with no fertilization (assuming no exchange with surrounding waters): for all other simulations the pCO2 anomaly is negative (indicating increased CO2 exchange from the atmosphere) but small, 2-5 [mu]atm, suggesting a persistence for a single large-scale fertilization of less than 1 year. Simulated mixed layer Si:N drawdown ratios for different fixed diatom uptake ratios of Si:N illustrate the dangers of interpreting uptake ratios from drawdown ratios: (i) for a fixed uptake ratio the drawdown ratio varies with time as the ratio of small to large phytoplankton changes, and (ii) simulated drawdown ratios are always higher than uptake ratios because of the more rapid recycling (according to the model structure) of N relative to Si in the surface layer. Sensitivity simulations, with the diatom uptake ratio for Si:N varying as an inverse function of iron limitation and with a higher remineralization rate for detrital Si, delayed the onset of silica limitation after fertilization by several days. The magnitude and timing of the diatom peak was unchanged, indicating that in the model the (early) termination of the diatom bloom following fertilization resulted from formation and sinking of aggregates, and not Si limitation.

M. Levasseur, M. G. Scarratt, S. Michaud, A. Merzouk, C. S. Wong, M. Arychuk, W. Richardson, R. B. Rivkin, M. Hale, E. Wong, A. Marchetti and H. Kiyosawa, 2006, DMSP and DMS dynamics during a mesoscale iron fertilization experiment in the Northeast Pacific--Part I: Temporal and vertical distributions, Deep Sea Research Part II: Topical Studies in Oceanography, 53 (20-22), 2353-2369.

"This paper reports on the influence of the Fe fertilization conducted during the subarctic ecosystem response to iron enrichment study (SERIES) on the distribution of the biogenic sulfur compounds dimethylsulfoniopropionate (DMSP) and dimethylsulfide (DMS) in the context of changes in plankton composition. The Fe enrichment resulted in a rapid increase in the abundance of a nanoplankton assemblage dominated by Prymnesiophyceae, Prasinophyceae, small diatoms (<5 [mu]m), heterotrophic dinoflagellates, and zooflagellates.

This first assemblage persisted for 8 days before collapsing abruptly due to an increase in microzooplankton herbivory. The abundance of large diatoms started to increase shortly after the initial Fe fertilization but peaked 1-2 days after the crash of the nanoplankton bloom. Inside the Fe patch, particulate DMSP (DMSPp) increased from 100 to 285 nmol L-1 during the nanoplankton bloom, decreased rapidly back to initial level as this bloom collapsed, and remained low during the bloom of large diatoms. Outside the patch, phytoplankton and protists abundance and DMSPp concentrations remained low and relatively stable throughout the experiment. DMS concentrations were elevated at the onset of the experiment outside the patch (maximum of 15.7 nmol L-1 on day 1), increased up to 26.5 nmol L-1 10 days after the enrichment, and decreased to ca. 6 nmol L-1 by the end of the experiment. This large natural pulse in DMS coincided with conditions of high irradiance and decreasing wind speed. Inside the Fe patch, DMS concentrations exhibited the same general pattern, but with distinctive features related to the Fe fertilization. First, DMS concentrations tended to increase more rapidly inside the patch during the initial nanoplankton bloom, leading to DMS concentrations ca. 2 times higher inside the patch than outside on day 6. Second, DMS concentrations became consistently lower inside the patch (often below our limit of quantification of 0.03 nmol L-1) than outside (ca. 6 nmol L-1) during the peak of the diatom bloom. Our results thus confirm the rapid increase in nanoplankton and DMSPp reported during all previous Fe-fertilization experiments. On the other hand, the decrease in DMS concentrations measured inside the Fe patch during SERIES is unique and shows that adding Fe to HNLC waters may not always lead to conditions that could mitigate climate warming." This paper reports on the influence of the Fe fertilization conducted during the subarctic ecosystem response to iron enrichment study (SERIES) on the distribution of the biogenic sulfur compounds dimethylsulfoniopropionate (DMSP) and dimethylsulfide (DMS) in the context of changes in plankton composition. The Fe enrichment resulted in a rapid increase in the abundance of a nanoplankton assemblage dominated by Prymnesiophyceae, Prasinophyceae, small diatoms (<5 [mu]m), heterotrophic dinoflagellates, and zooflagellates. This first assemblage persisted for 8 days before collapsing abruptly due to an increase in microzooplankton herbivory. The abundance of large diatoms started to increase shortly after the initial Fe fertilization but peaked 1-2 days after the crash of the nanoplankton bloom. Inside the Fe patch, particulate DMSP (DMSPp) increased from 100 to 285 nmol L-1 during the nanoplankton bloom, decreased rapidly back to initial level as this bloom collapsed, and remained low during the bloom of large diatoms. Outside the patch, phytoplankton and protists abundance and DMSPp concentrations remained low and relatively stable throughout the experiment. DMS concentrations were elevated at the onset of the experiment outside the patch (maximum of 15.7 nmol L-1 on day 1), increased up to 26.5 nmol L-1 10 days after the enrichment, and decreased to ca. 6 nmol L-1 by the end of the experiment. This large natural pulse in DMS coincided with conditions of high irradiance and decreasing wind speed. Inside the Fe patch, DMS concentrations exhibited the same general pattern, but with distinctive features related to the Fe fertilization. First, DMS concentrations tended to increase more rapidly inside the patch during the initial nanoplankton bloom, leading to DMS concentrations ca. 2 times higher inside the patch than outside on day 6. Second, DMS concentrations became consistently lower inside the patch (often below our limit of quantification of 0.03 nmol L-1) than outside (ca. 6 nmol L-1) during the peak of the diatom bloom. Our results thus confirm the rapid increase in nanoplankton and DMSPp reported during all previous Fe-fertilization experiments. On the other hand, the decrease in DMS concentrations measured inside the Fe patch during SERIES is unique and shows that adding Fe to HNLC waters may not always lead to conditions that could mitigate climate warming.

A. Merzouk, M. Levasseur, M. G. Scarratt, S. Michaud, R. B. Rivkin, M. S. Hale, R. P. Kiene, N. M. Price and W. K. W. Li, 2006, DMSP and DMS dynamics during a mesoscale iron fertilization experiment in the Northeast Pacific-Part II: Biological cycling, Deep Sea Research Part II: Topical Studies in Oceanography, 53 (20-22), 2370-2383.

"Dimethylsulfoniopropionate (DMSP) and dimethylsulfide (DMS) biological cycling rates were determined during SERIES, a mesoscale iron-fertilization experiment conducted in the high-nutrient low-chlorophyll (HNLC) waters of the northeast subarctic Pacific. The iron fertilization resulted in the rapid development of a nanoplankton assemblage that persisted for 11 days before abruptly crashing. The nanoplankton bloom was followed by a diatom bloom, accompanied by an important increase in bacterial abundance and production. These iron-induced alterations of the plankton assemblage coincided with changes in the size and biological cycling of the DMSP and DMS pools. The initial nanoplankton bloom resulted in increases in particulate DMSP (DMSPp; 77-180 nmol L-1), dissolved DMSP (DMSPd; 1-24 nmol L-1), and biological gross (0.11-0.78 nmol L-1 h-1) and net (0.04-0.74 nmol L-1 h-1) DMS production rates. During the nanoplankton bloom, DMSPd consumption by bacteria exceeded their sulfur demand and the excess sulfur was probably released as DMS, consistent with the high gross DMS production rates observed during that period. The crash of the nanoplankton bloom was marked by the rapid decline of DMSPp, DMSPd, and gross DMS production to their initial values. Following the crash of the nanoplankton bloom, bacterial production and estimated sulfur demand reached transient maxima of 9.3 [mu]g C L-1 d-1 and 14.2 nmol S L-1 d-1, respectively. During this period of high bacterial production, bacterial DMSPd consumption was also very high (6 nmol L-1 h-1), but none of the consumed DMSPd was converted into DMS and a net biological DMS consumption was measured. This transient period initiated a rapid decrease in DMS concentrations inside the iron-enriched patch, which persisted during the following diatom bloom due to low biological gross and net DMS production that prevented the replenishment of DMS. Our results show that the impact of Fe fertilization on DMS production in HNLC waters result from a complex interplay between the dynamics of the algal blooms and their influence on bacterial DMSP and DMS metabolism."
Dimethylsulfoniopropionate (DMSP) and dimethylsulfide (DMS) biological cycling rates were determined during SERIES, a mesoscale iron-fertilization experiment conducted in the high-nutrient low-chlorophyll (HNLC) waters of the northeast subarctic Pacific. The iron fertilization resulted in the rapid development of a nanoplankton assemblage that persisted for 11 days before abruptly crashing. The nanoplankton bloom was followed by a diatom bloom, accompanied by an important increase in bacterial abundance and production. These iron-induced alterations of the plankton assemblage coincided with changes in the size and biological cycling of the DMSP and DMS pools. The initial nanoplankton bloom resulted in increases in particulate DMSP (DMSPp; 77-180 nmol L-1), dissolved DMSP (DMSPd; 1-24 nmol L-1), and biological gross (0.11-0.78 nmol L-1 h-1) and net (0.04-0.74 nmol L-1 h-1) DMS production rates. During the nanoplankton bloom, DMSPd consumption by bacteria exceeded their sulfur demand and the excess sulfur was probably released as DMS, consistent with the high gross DMS production rates observed during that period. The crash of the nanoplankton bloom was marked by the rapid decline of DMSPp, DMSPd, and gross DMS production to their initial values. Following the crash of the nanoplankton bloom, bacterial production and estimated sulfur demand reached transient maxima of 9.3 [mu]g C L-1 d-1 and 14.2 nmol S L-1 d-1, respectively. During this period of high bacterial production, bacterial DMSPd consumption was also very high (6 nmol L-1 h-1), but none of the consumed DMSPd was converted into DMS and a net

biological DMS consumption was measured. This transient period initiated a rapid decrease in DMS concentrations inside the iron-enriched patch, which persisted during the following diatom bloom due to low biological gross and net DMS production that prevented the replenishment of DMS. Our results show that the impact of Fe fertilization on DMS production in HNLC waters result from a complex interplay between the dynamics of the algal blooms and their influence on bacterial DMSP and DMS metabolism.

R.-C. Bouillon, W. L. Miller, M. Levasseur, M. Scarratt, A. Merzouk, S. Michaud and L. Ziolkowski, 2006, The effect of mesoscale iron enrichment on the marine photochemistry of dimethylsulfide in the NE subarctic Pacific, Deep Sea Research Part II: Topical Studies in Oceanography, 53 (20-22), 2384-2397.

"Measurements of underwater light fields and available quantum yield spectra were used to calculate photochemical removal rates of DMS for surface waters of the northeast subarctic Pacific during the SERIES mesoscale iron-fertilization experiment in July 2002. We observed that the UV portion of the solar spectrum was most important in inducing DMS photo-oxidation, and calculated that UV-B accounted for more than 20% and UV-A for more than 68% of the total DMS photo-oxidation near the sea surface. Vertically resolved rates showed that most (>90%) of the DMS photo-oxidation occurs in the upper 15 m of the water column. During the study, calculated rates of DMS photo-oxidation, just below the ocean's surface ranged from 0.34 to 5.9 [mu]mol m-3 d-1. As the study progressed, an initial increase in photo-oxidation rates occurred within the iron-enriched patch and this was followed by a dramatic decrease in rates, whereas little change was observed outside the patch. Changes in DMS concentrations and decreases in the photochemical removal efficiency for DMS were the dominant factors explaining the variation in the DMS photo-oxidation rates. The turnover rate constants for DMS photo-oxidation, calculated for the upper mixed layer (UML) of the water column, (0.03-0.25 d-1) were in the range of those previously published and were at times higher than those calculated for biological consumption of DMS during SERIES. Our results suggest that iron fertilization of an oceanic patch in the northeast Pacific Ocean considerably altered the photochemical removal rates and turnover rate constants of DMS." Measurements of underwater light fields and available quantum yield spectra were used to calculate photochemical removal rates of DMS for surface waters of the northeast subarctic Pacific during the SERIES mesoscale iron-fertilization experiment in July 2002. We observed that the UV portion of the solar spectrum was most important in inducing DMS photo-oxidation, and calculated that UV-B accounted for more than 20% and UV-A for more than 68% of the total DMS photo-oxidation near the sea surface. Vertically resolved rates showed that most (>90%) of the DMS photo-oxidation occurs in the upper 15 m of the water column. During the study, calculated rates of DMS photo-oxidation, just below the ocean's surface ranged from 0.34 to 5.9 [mu]mol m-3 d-1. As the study progressed, an initial increase in photo-oxidation rates occurred within the iron-enriched patch and this was followed by a dramatic decrease in rates, whereas little change was observed outside the patch. Changes in DMS concentrations and decreases in the photochemical removal efficiency for DMS were the dominant factors explaining the variation in the DMS photo-oxidation rates. The turnover rate constants for DMS photo-oxidation, calculated for the upper mixed layer (UML) of the water column, (0.03-0.25 d-1) were in the range of those previously published and were at times higher than those calculated for biological consumption of DMS during SERIES. Our results suggest that iron fertilization of an oceanic patch in the northeast Pacific Ocean considerably altered the photochemical removal rates and turnover rate constants of DMS.

R. M. Moore and L. Wang, 2006, The influence of iron fertilization on the fluxes of methyl halides and isoprene from ocean to atmosphere in the SERIES experiment, Deep Sea Research Part II: Topical Studies in Oceanography, 53 (20-22), 2398-2409.
"As a part of an iron-fertilization experiment in the NE Pacific in July 2002 measurements were made of isoprene and methyl halides both within the fertilized patch and outside. Isoprene showed the response that would be expected of a gas having a source in phytoplankton: its concentration within the patch increased relative to outside, and after 10-14 days its calculated net production rate was about 6-fold higher within the patch. In contrast, the methyl halides showed no clear effect of fertilization, though the production rates of methyl iodide were appreciable. Hence there is no evidence that any of the algal groups present, such as diatoms that were stimulated by the fertilization played a significant role in the net production of methyl halides. The results are not inconsistent with a photochemical source of the gases, though light levels were attenuated by persistent cloud cover." As a part of an iron-fertilization experiment in the NE Pacific in July 2002 measurements were made of isoprene and methyl halides both within the fertilized patch and outside. Isoprene showed the response that would be expected of a gas having a source in phytoplankton: its concentration within the patch increased relative to outside, and after 10-14 days its calculated net production rate was about 6-fold higher within the patch. In contrast, the methyl halides showed no clear effect of fertilization, though the production rates of methyl iodide were appreciable. Hence there is no evidence that any of the algal groups present, such as diatoms that were stimulated by the fertilization played a significant role in the net production of methyl halides. The results are not inconsistent with a photochemical source of the gases, though light levels were attenuated by persistent cloud cover.

L. Phinney, W. Richard Leaitch, U. Lohmann, H. Boudries, D. R. Worsnop, J. T. Jayne, D. Toom-Sauntry, M. Wadleigh, S. Sharma and N. Shantz, 2006, Characterization of the aerosol over the sub-arctic north east Pacific Ocean, Deep Sea Research Part II: Topical Studies in Oceanography, 53 (20-22), 2410-2433.

"Time series measurements of the size and composition of aerosol particles made near Ocean Station Papa during the Canadian SOLAS SERIES experiment in July 2002 indicate major contributions to the aerosol mass from the oxidation of dimethyl sulphide, from primary emissions of sea salt, and from ship emissions. The high temporal resolution of the AMS revealed significant variability in the fine mode species mass concentrations in this area. The background fine mode composition was dominated by non-sea-salt-sulphate (nss-SO4), sea salt, organics, and methanesulphonic acid (MSA), with average mass concentrations of 0.74±0.04, 0.6±0.1, 0.3±0.1, and 0.16±0.05 [mu]g m-3, respectively. The fine mode MSA:nss-SO4 ratio varied from 0.01 to 3.19±0.2, with a mean of 0.23. The average fine mode mass distribution was internally mixed with a mode vacuum aerodynamic diameter of 475 nm. The concentration of MSA was an order of magnitude higher than previously reported values in the North Pacific, indicating significant oxidation of DMS. A diurnal signal in particulate products of DMS oxidation (i.e. MSA and sulphate) and in gaseous DMS and SO2 indicates daytime photochemistry and in-cloud oxidation. A simple examination of chemical reaction pathways is used to help elucidate the relationships among the sulphur species and oxidants. The relationship between sea salt mass and wind speed is examined. This study marks the first time atmospheric measurements have been included in an iron enrichment experiment, and the first time an Aerodyne Aerosol Mass Spectrometer (AMS) has been deployed in a remote marine setting. Due to the proximity of the ship to the fertilized patch and the relatively high wind speeds, no impact of the SERIES iron fertilization on the

local aerosol was observed." Time series measurements of the size and composition of aerosol particles made near Ocean Station Papa during the Canadian SOLAS SERIES experiment in July 2002 indicate major contributions to the aerosol mass from the oxidation of dimethyl sulphide, from primary emissions of sea salt, and from ship emissions. The high temporal resolution of the AMS revealed significant variability in the fine mode species mass concentrations in this area. The background fine mode composition was dominated by non-sea-salt-sulphate (nss-SO4), sea salt, organics, and methanesulphonic acid (MSA), with average mass concentrations of 0.74±0.04, 0.6±0.1, 0.3±0.1, and 0.16±0.05 [mu]g m-3, respectively. The fine mode MSA:nss-SO4 ratio varied from 0.01 to 3.19±0.2, with a mean of 0.23. The average fine mode mass distribution was internally mixed with a mode vacuum aerodynamic diameter of 475 nm. The concentration of MSA was an order of magnitude higher than previously reported values in the North Pacific, indicating significant oxidation of DMS. A diurnal signal in particulate products of DMS oxidation (i.e. MSA and sulphate) and in gaseous DMS and SO2 indicates daytime photochemistry and in-cloud oxidation. A simple examination of chemical reaction pathways is used to help elucidate the relationships among the sulphur species and oxidants. The relationship between sea salt mass and wind speed is examined. This study marks the first time atmospheric measurements have been included in an iron enrichment experiment, and the first time an Aerodyne Aerosol Mass Spectrometer (AMS) has been deployed in a remote marine setting. Due to the proximity of the ship to the fertilized patch and the relatively high wind speeds, no impact of the SERIES iron fertilization on the local aerosol was observed.

N. Steiner, K. Denman, N. McFarlane and L. Solheim, 2006, Simulating the coupling between atmosphere-ocean processes and the planktonic ecosystem during SERIES, Deep Sea Research Part II: Topical Studies in Oceanography, 53 (20-22), 2434-2454.

"We have developed a 1-D atmosphere-ocean-biogeochemical model to investigate the coupling between atmosphere-ocean exchanges and the planktonic ecosystem during the Subarctic Ecosystem Response to Iron Enrichment Study (SERIES) in 2002. The atmospheric Single Column Model (SCM) is based on the Canadian Centre for Climate Modelling and Analysis (CCCma) Atmospheric General Circulation Model (AGCM). The ocean component employs the General Ocean Turbulence Model (GOTM). A seven-component ecosystem model is embedded in GOTM, which includes nitrogen, organic and inorganic carbon, silica and oxygen cycling. We use observations from SERIES combined with atmospheric reanalysis data to initiate and force the coupled physical model. We found that atmospheric temperatures and humidities are higher and the stratification more stable if nudged to National Centre of Environmental Prediction (NCEP) rather than to European Centre for Medium-Range Weather Forecasts (ECMWF) 40-yr reanalysis data. Doubling the vertical resolution in the atmosphere improved the representation of mixing and the thermal structure, affecting cloudiness and radiative fluxes at the ocean surface as well as planetary boundary layer heights and gas dispersion in the lower atmosphere. From observed ocean-surface dimethyl sulphide (DMS) concentrations (outside the patch) we simulated DMS dispersion in the atmospheric boundary layer by applying a first-order loss term, with turnover times ranging from 1 to 4 days. During SERIES, shallow boundary-layer heights that occurred when DMS production was highest prevented dispersion into the atmosphere beyond several 100 m. Finally, successive model runs with iron fertilization starting on June 25, July 10 and 25 showed that the general nature of the response to iron enrichment at OSP (SERIES) is robust, but the strength as well as length of the response depend strongly on short-term atmospheric conditions (wind and radiative fluxes)." We have developed a 1-D atmosphere-ocean-

biogeochemical model to investigate the coupling between atmosphere-ocean exchanges and the planktonic ecosystem during the Subarctic Ecosystem Response to Iron Enrichment Study (SERIES) in 2002. The atmospheric Single Column Model (SCM) is based on the Canadian Centre for Climate Modelling and Analysis (CCCma) Atmospheric General Circulation Model (AGCM). The ocean component employs the General Ocean Turbulence Model (GOTM). A seven-component ecosystem model is embedded in GOTM, which includes nitrogen, organic and inorganic carbon, silica and oxygen cycling. We use observations from SERIES combined with atmospheric reanalysis data to initiate and force the coupled physical model. We found that atmospheric temperatures and humidities are higher and the stratification more stable if nudged to National Centre of Environmental Prediction (NCEP) rather than to European Centre for Medium-Range Weather Forecasts (ECMWF) 40-yr reanalysis data. Doubling the vertical resolution in the atmosphere improved the representation of mixing and the thermal structure, affecting cloudiness and radiative fluxes at the ocean surface as well as planetary boundary layer heights and gas dispersion in the lower atmosphere. From observed ocean-surface dimethyl sulphide (DMS) concentrations (outside the patch) we simulated DMS dispersion in the atmospheric boundary layer by applying a first-order loss term, with turnover times ranging from 1 to 4 days. During SERIES, shallow boundary-layer heights that occurred when DMS production was highest prevented dispersion into the atmosphere beyond several 100 m. Finally, successive model runs with iron fertilization starting on June 25, July 10 and 25 showed that the general nature of the response to iron enrichment at OSP (SERIES) is robust, but the strength as well as length of the response depend strongly on short-term atmospheric conditions (wind and radiative fluxes).

this file prepared in MS Word (Office 2003)
by Doug Mackie (U. Otago) September 2009.