National Facility Research Vessel

RV FRANKLIN

VOYAGE DOCUMENTS

RV SOUTHERN SURVEYOR

CSIRO AUSTRALIA

CSIRO MARINE AND ATMOSPHERIC RESEARCH

Voyage Plans and Summaries

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Franklin Voyage Plan No. FR01/00

TROPICS 2000: A continuing investigation on the supply of nutrients, organics and trace metals to the equatorial region from the Sepik River and their influence on coastal and oceanic primary production.

Itinerary
Depart Cairns 1000 hrs, Friday 14 January 2000
Arrive Rabaul 1000 hrs, Thursday 3 February 2000

Principal Investigator

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Scientific Objectives

1. To investigate the supply of nutrients, organics and trace metals to the equatorial region from the Sepik River and their influence on coastal and oceanic primary production during the wet season and to contrast these results with those obtained on FR06/97 and FR07/97 (Mackey, Burns, Szymczak).

2. To identify organic biomarkers, isotopic and geochemical signatures that can be used to trace sediments, dissolved, and suspended materials from riverine to oceanic regimes (Mackey, Burns, Szymczak, Higgins).

3. To determine radiochemical and geochemical signatures for the New Guinea Coastal Undercurrent and the Equatorial Undercurrent, and use these signatures to differentiate between potential riverine and hydrothermal sources of iron and other trace elements that may be

assisting primary production in the western and eastern Equatorial Pacific ocean (Mackey, Burns, Szymczak, Griffiths).

4. To assess the relative importance of nutrients (including micronutrients such as iron), and light to the biological productivity and phytoplankton biomass of the region (Griffiths, Mackey, Higgins, Parslow).

Cruise Objectives

This cruise is similar in scope to FR07/97, which was undertaken during the time of the southeast tradewinds, and at the beginning of an El Niño event. In contrast, this cruise in 2000 will be undertaken during the period of the northwest monsoons when the rainfall, and river flow, should be much greater than occurred during FR07/97. We will assess the terrestrial inputs of organic matter, macronutrients and trace elements under these two extremes of precipitation. This should help us to complete the quantitative assessment of the relative contributions of terrestrial versus marine inputs of organic matter in these coastal environments.

Comparison of data from FR07/97 and this cruise will help us to determine whether changes in precipitation over New Guinea could affect the supply of trace elements, nutrients and organic matter to the Bismarck Sea and to the Equatorial Pacific via the New Guinea Coastal Undercurrent (NGCU) and the Equatorial Undercurrent (EUC) (Lindstrom et al., Nature, 330, 533-537, 1987). Of particular importance is the supply of iron since it has recently been proposed that the productivity of the whole equatorial Pacific is ultimately driven by the supply of iron from the EUC into the overlying euphotic zone. While new production in the Equatorial Pacific is low in relation to other regions subject to upwelling, the total production is globally important since the equatorial Pacific covers such a large area (Murray et al., Science, 266, 58-65, 1994). Changes in new production in the equatorial Pacific would significantly alter the exchange of carbon dioxide between the atmosphere and the equatorial Pacific and play an important role in feedback mechanisms in the global carbon cycle.

The research plan provided here is based on the expertise and resources used during FR07/97. Two transects will be occupied: one will be out from the Sepik River across to Manus Island, and the second will be along the NGCU from about 147ºE to 143ºE. Stations will also be occupied on the Equator at about 143ºE and 150ºE in order to measure marker compounds in the Equatorial Undercurrent, and to carry out optics and primary production measurements. Sampling will be carried out over hydrothermal vents in the Bismarck Sea to allow differentiation to be made between riverine and hydrothermal sources of the radiochemical and geochemical signatures in the Equatorial Undercurrent.

Organic geochemical studies involving the use of specific organic markers and their isotopic composition have been used in the past to investigate a variety of sedimentary environments. A second issue is that organic geochemists

frequently look at surface sedimentary material and make assumptions about the overlying water column. These assumptions may then be transferred to studies of ancient sediments and environments. However, it has never been fully established exactly what the sedimentary material represents as a representation of the total organic carbon input to the water column. If time permits, Kasten coring in deep water (1000-2000m) will provide additional material for these studies Again, this study in conjunction with previous data, will provide a perfect opportunity to assess this in a quantitative way.

Measurements of biological productivity and phytoplankton biomass will enable us to assess the relative importance of nutrients (including micronutrients such as iron), light and grazing in this region. Comparisons of primary production measurements made by traditional ^{14}C methods, and with two new instruments, a fast repetition-rate fluorometer and a passive solar fluorescence instrument. If a good correlation is obtained between instrument-produced primary production measurements and the ^{14}C method it may allow us to reduce the use of radioactive carbon to obtain primary production measurements. In addition, data will be collected to provide ground truth calibration/validation for SeaWIFS and MODIS ocean colour algorithms in Case 1 and Case 2 waters, and to provide support and validation of primary production algorithms. Sediment traps and *in-situ* pumps will be deployed both on the continental shelf and in the open ocean to determine the vertical fluxes of carbon and related elements. We will also measure the disequilibrium between naturally occurring actinides to provide an independent estimate of particle fluxes and to calibrate the collection efficiency of the sediment traps. Underway measurements of iron along the cruise track and vertical profiles of iron, copper and cadmium will be made and related to variations in phytoplankton biomass and productivity.

Estimates of phytoplankton class abundances will be made both by direct counts and estimates of class abundances from HPLC measurements of photosynthetic pigments using the program Chemtax (Mackey et al 1996; Mackey et al., Deep-Sea Research, - in press). While the biological pump depends on the total amount of new production in the euphotic zone, the magnitude of the pump is strongly dependent on the types and sizes of organism present for two reasons. Firstly, the rate of removal of carbon depends on the size of the organism (large, dense phytoplankton sink faster than small ones) and on how readily they are incorporated into larger particles via processes such as aggregation or incorporation into faecal pellets. Secondly, changes in the abundance of calcareous organisms will alter the alkalinity of surface waters, which alters the solubility of carbon dioxide and hence directly affects the exchange of carbon dioxide between the atmosphere and the surface waters.

Particles in the upper layer of the ocean sink to the deep ocean carrying associated organic carbon. This organic carbon may originate in surface waters of the ocean via primary production by phytoplankton, or it may originate in terrestrial plants and their decomposition products in soil and enter the ocean via rivers such as the Sepik River. The relative importance of these two

sources and the rates at which the organic matter enters the deep ocean are important components of the global carbon cycle that need closer attention. Isotopic signatures of this material will be determined from in-situ pumped samples and from cores.

We will measure a suite of naturally occurring radionuclides that are attached to particles and dissolved in seawater. Calculations using the results will yield data on particle fluxes. Combined with measurement of the organic carbon content of the particles this will allow estimation of vertical organic carbon flux to the deep ocean in the region studied. The radionuclides to be measured include ^{226}Ra, ^{210}Pb, ^{210}Po and ^{7}Be. We have established techniques for concentration of these radionuclides from seawater and their measurement in the concentrates and in particles collected by filtration. The outcome will be knowledge of the flux of carbon from surface layers to the deep ocean in the region of the Bismarck sea adjacent to the Sepik River outflow and a contribution to understanding the fate of the material carried to the sea by the Sepik River.

While the TROPICS cruises are focused on the island of New Guinea, the knowledge that will be gained, and the links that will be (and have been) established with scientists from other institutions in Australia and overseas will be of great value in any future work in tropical Australia.

Cruise Track

The cruise will depart Cairns for the mouth of the Sepik River. If possible, a CTD station will be done in the Goodenough Basin for George Cresswell (CSIRO). The River plume will be located and surface samples will be collected en route to the Sepik. Water samples will be collected from the Sepik River and in the region of the River plume. Sampling in the mouth of the Sepik River from the Rescue boat will be necessary during daylight hours to obtain fresh-water end-members for a variety of parameters. We will then occupy four stations on the first transect from the river mouth to Manus Island. The ADCP will be used to locate the NGCU and one of the casts will be through the NGCU so as to characterise its properties. We will then steam south until we locate the NGCU and we will then occupy another four stations along the NGCU from about 147ºE to 143ºE. We will then steam to the Equator and occupy two stations at 143ºE and 150ºE. We will then move to the Bismarck Sea to sample over a number of hydrothermal vents in the region approximately bounded by 3ºS - 4.5ºS, 149ºE - 152ºE before finishing the cruise in Rabaul. The cruise track is given in Figure 1.

Time Estimates

Cairns - Sepik River - Manus Island - NGCU - Equator - Rabaul (» 2640 nm at 11 kt)	240 h
Station time	168 h

Sepik River	48 h
Contingency	24 h
Total	**480 h (20 days)**

4 x Stations (approximately) along:

3.7ºS, 144.5ºE to 2.2ºS, 146.5ºE
3.5ºS, 147ºE to 1.5ºS, 143ºE

Stations at:

0, 143ºE
0, 155ºE
3.1ºS, 151.4ºE

Conditions permitting, the rescue boat will be used to collect some samples from the Sepik River.

Note that these station locations are preliminary, and may change slightly due to the position of the New Guinea Coastal undercurrent, and ship safety considerations if the Sepik is in flood.

Piggy-back Projects (if any)

None at this time

Franklin Equipment

- CTD unit fitted with SeaTech, Transmissometer and PAR.
- 12 x 10 L rosette.
- Hydrowinch (covered with polyethylene, no spooling gear, and fitted with Kevlar wire).
- Clean sheave and meter block for hydrowinch.
- Rear A-frame and cable for the Megasucker.
- Rear A-frame for free-floating mooring deployment and recovery.
- Winch on rear deck capable of lowering 300 kg to 200 m.
- Clean Container (needs to be certified, air conditioning checked, all hoses and fitting located and anchor points to be provided for a large gas cylinder in the entrance).
- Biological Container for ^{14}C primary production measurements (with refrigerator and air conditioner working, plus over the side drain hoses for the sinks in the container).
- Anchor points to be provided for a large gas cylinder in the wet lab.
- Clean cabinet installed in the GP lab.
- Scintillation counter.
- Thermosalinograph.
- Ice machine.

- Refrigerator (in hold).
- Chest freezer (in hold).
- GPS.
- ADCP.
- Underway fluorometer for chlorophyll (WETStar).
- Meteorological data including PAR.
- Nutrients (including O_2, both high and low range analyses required).
- 180 L liquid N_2 transport Dewar and transfer tube (to be filled from Townsville immediately prior to departure).
- As many 5 L and 10 L Niskin bottles as possible.
- At least 12 ´ 10 L Niskin bottles to be fitted with silicone 'O' rings and either silicone or stainless steel closures.
- Storage for acids and/or organic solvents.
- Rescue dinghy for river sampling.
- Running seawater on the back deck (deck hoses fine).
- Flowing seawater (Wet lab and GP lab for general rinsing).
- A boom (10 m long?) for the deployment of lightweight (70 kg maximum) optical instruments off the Franklin stern quarter plus suitable block.
- Radio beacon to track the filtration mooring.

Equipment to be provided by applicants

- Optical Back-Scatterometer (to be interfaced to CTD if possible).
- Seabird CTD with Ion Selective Electrodes (pFe, pCu, and pCd).
- Trace metal Helmond-Byrne bottles.
- Trace metal bottle fittings, weights and messengers.
- Trace metal Niskin bottles.
- Kevlar hydrowire (4 mm) fitted to hydrowinch.
- Filtration systems.
- Fast repetition rate fluorometer.
- Liquid N_2 dewars and dry shippers.
- Equipment for collecting natural actinides.
- pH electrodes and pH meter.
- Large volume *in-situ* radiochemical sampling pumps.
- Flow injection analyser for Fe measurements.
- UV-Vis spectrophotometer.
- Trace element filtration equipment.
- Portable salinometer.
- Gas cylinders G size, HP nitrogen gas (X 2) and regulators.
- Infiltrix samples and mooring gear (wire, floats, lights).
- HPLC pump with UVF detector for humic substance measurements.
- Filtration box and pump for DOC filtration.
- Primary production incubator.
- Sodium ^{14}C-bicarbonate (25 mCi).
- Empty drums (2 ´ 200 L) to take radioisotope waste.
- PRR-600 profiling spectroradiometer and conducting winch, deployed from HIAB, using 10 m long boom over the stern quarter.
- PSICAM spectral absorption meter.

- Biospherical IMF 300 Profiling natural fluorometer (deployed from 10 m long boom over stern quarter.

Special requirements eg: Space, power accessibility etc

All CTD data is to be processed at 1 m bin depth intervals. This includes oxygen and the uncalibrated data from all the auxiliary instruments fitted to the CTD.

Nutrients will be required at both low range (nitrate 0 -7 m M, silicate 0-10 m M) and the normal range.

All raw burst data from all casts is required as well as averages and standard deviations.

12 of the 10 L Niskin bottles to be fitted with silicone O-rings and silicone closure ‘rubbers’ or stainless steel springs.

Sampling is required up to ca. 5 km upriver from the mouth of the Sepik River from the rescue boat.

We will be deploying free-drifting moorings with pumps and possibly sediment traps attached. Does Franklin have a radio beacon that we could put on the surface buoy to assist with tracking the mooring?

Issue ‘a notice to marriners’ regarding the drifting moorings.

All relevant winches and hydraulics to be serviced so as to minimise the leakage of oil.

Storage in the Vegetable Fridge of a small ‘Esky’ containing seawater samples.

Computer/electronics personnel to be able to provide real-time raw ADCP data so as to allow us to sample in the NGCU.

Personnel List

Denis Mackey, CMR, Cruise Manager, trace metals
Harry Higgins, CMR, Phytoplankton pigments, ISE operations
Brian Griffiths, CMR, Phytoplankton production, optics
Jeanette O'Sullivan, CMR, Trace metal sampling
Kathy Burns, AIMS, Organics
Dianne Miller, AIMS, Organics
Ron Szymczak, ANSTO, Radiochemistry,
David Shuen, ANSTO, Radiochemistry, flow injection iron analyses

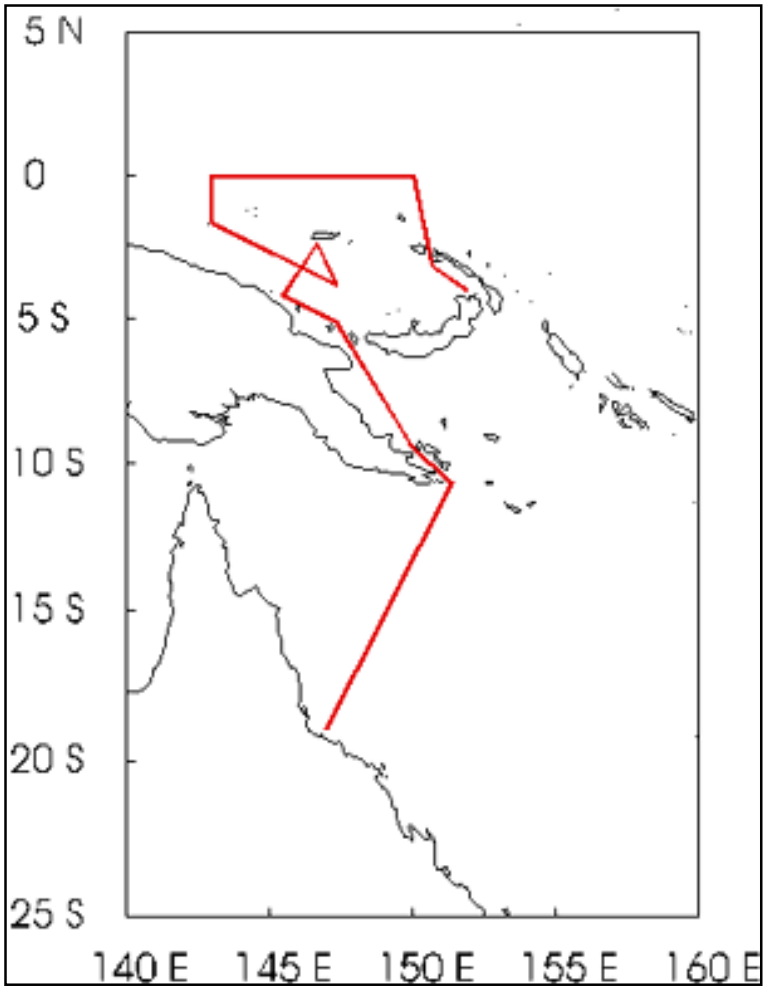
Franklin Support staff:

Bernadette Heaney, ORV, Computing
Phil Adams, ORV, Electronics
Val Latham, ORV, Hydrochemistry
Neale Johnston, ORV, Hydrochemistry

This cruise plan is in accordance with the directions of the National Facility Steering Committee for the Research Vessel Franklin.

Ships Manager
CSIRO Marine and Atmospheric Research

Figure 1. Cruise Ttrack for FR01/00



Updated: 31/01/03