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 Summary No. FR06/99

Title

Joint Air-Sea Monsoon Investigation II (JASMINE II)

Itinerary

Departed Darwin 0830 hrs Thursday 2 September, 1999.
Arrived Singapore 0900 hrs Tuesday 28 September 1999.

Principal Investigators

Dr. J.S. Godfrey
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Scientific Objectives

This cruise follows a longer one in the same region, conducted in May 1999, using the US vessel *R/V Ron Brown.* The overall aim of the two cruises is to provide information of relevance to a number of questions regarding air-sea interaction in the eastern Indian Ocean, such as:

i) Is air-sea interaction an essential part of the "Intraseasonal Oscillation" events which control the net strength of the monsoon in a given year?

ii) Large currents occur in this region: does this imply that advection is a major part of the heat and freshwater balance?

iii) Can we close heat and freshwater budgets on the timescale of days, over a region of a few kilometers wide?

iv) Given TRMM satellite rain estimates, can we close the freshwater budget between the 2 cruises on Bay of Bengal scale?

In addition, we will perform a "thin" measurement of Indonesian Throughflow magnitude.

Cruise Objectives

Before leaving Darwin, we will deploy the boom and mount the meteorological instruments; with Flinders University personnel, set up the radar recorder; and set up the radiosonde launcher.

i) After leaving Darwin, we will undertake a long transect of accurate fluxes, by bulk measurement of all four components of the surface heat flux, plus precipitation. Rain will also be recorded on a radar recorder. This flux timeseries will be continued throughout the cruise. We will also start a "thin measurement of the Indonesian Throughflow, with three CTDs near (12¡S, 123¡E); (10¡S, 106¡E); (7.5¡S, 100¡E); plus XBTs every degree longitude from 122¡E to (5¡S, 94¡E). Radiosondes will be released at 1100 local every third day during this phase of the cruise, to coincide with ATSR overpasses.

ii) Repeat the survey undertaken by *R/V Ron Brown* in April, 1999, which consists of a section of 35 CTD casts from (5¡S, 94¡E) to 0¡, 88¡30'E), thence along 88¡30'E between 0¡S and 12¡N. Along this line, conduct CTD casts every 0.5 degrees latitude; to 1000db at even degrees, to 500db at half-degrees, with salinity, oxygen, standard nutrients. Radiosondes to be launched at 0000Z, 0600Z, 1200Z, 1800Z.

iii) Undertake a heat and freshwater budget closure and mixed-layer experiment, over an 8-day period near (12¡N, 88¡30'E). Exact location for this work will be chosen to minimise surface current strength. During this period, we will proceed around a triangle 11km across, with CTDs at corners to 400db; CTDs to 200db at the centre of each side. These will not have any chemistry or nutrients, except for one on the completion of each triangle - about every 4.5 hours. Radiosondes to be released 6 times/day, at 0000Z, 0400Z, 0800Z, 1200Z, 1600Z, 2400Z. Thus over seven days, we will complete 330 shallow CTDs, 42 of them with chemistry. Details of this procedure may alter, depending on results from JASMINE I.

iv) Sail for Singapore, dropping XBT's every 1¡ longitude to (7¡N, 98¡E). Drop XCTD at latter location, to complete thin Indonesian Throughflow measurement.

Cruise Track

See Figure 1.

Results

i) Thanks to 2-3 days work before the cruise by McLaughlan, Madsen, Adams, Bradley and Godfrey, the boom, meteorological instruments and radiosonde launcher and recorder were in place before the cruise left. (The rain radar recorder was not available in time for our cruise). As a result, a complete set of bulk surface flux estimates will be

possible for virtually the entire cruise. A preliminary version of these data are now available. After about four balloon launches that did not achieve adequate height, the GPS radiosondes gave generally good data until the helium supply ran out on 23 September; one batch suffered from frequent loss of humidity data. Three extra CTDs to 3000m were taken between (12¡S, 123¡E) and (10¡S, 106¡E), were also extended to 3000m. CTDs and XBT locations are shown on Figure 1.

ii) This objective was met essentially with no change, except that the five CTDs between 1¡S and 1¡N were taken to 2000m to look for extensive deep mixed layers, typically 50m thick, found below 1000m on an earlier cruise (Dengler et al, JGR, in press). Temperature and salinity encountered along the track are shown in Figure 2. Velocities found at 17m and 97m are seen in Figure 3.

iii) The duration of the experiment was seven days rather than eight, and the triangle side was made 22 km rather than 11 km, with CTD's every hour, giving completion of a triangle in eight hours. Triangle-average temperature and salinity are seen in Figure 4. Radiosondes were released four times/day rather than six times, so they lasted throughout the 7-day budget experiment. 63 GPS radiosondes were launched, mostly on a four per day schedule during the transect and budget work.

iv) This objective was completed as stated.

Cruise Narrative

R/V Franklin repeated several aspects of the earlier Jasmine work, in a cruise from Darwin to Singapore from 2-28 September 1999 (Figure 1). Circles along the track represent 167 CTD stations (and one XCTD); the 30 dots represent XBT's. Intensive work began along the segment from 5¡S to 12¡N, with CTD's every half degree latitude; those on the full degree were to 1000db, those at half-degrees to 500db. Twelve samples were taken for salinity, nutrients and oxygen at each station. Of interest in Figure 2 is the salinity maximum near 0 degrees, 100m, which coincides with a (rather unseasonal) appearance of the Equatorial Undercurrent (Figure 3, right hand set of vectors). The freshest water occurred in a surface tongue near 2 degrees N, associated with strong southwestward flow, while the relatively salty water at 7 degrees N is associated with southeastward flow (Figure 3, left set of vectors). Surface salinities as low as 32 were encountered during the return to Singapore, consistent with a source for the fresh jet of Figure 2 in the far eastern Indian Ocean. The pattern of Figure 1 was designed to provide a measurement of the Indonesian Throughflow; 2-knot westward currents encountered along the early part of the track suggest an unusually large value.

A week was spent near 12 degrees N, 88 degrees E (inset, Figure 1) performing budget measurements around triangular tracks, with CTDs about one hour apart. SST warmed up by 1 degree C over the week we were present. It appears most of this was due to surface heating, though advection is certainly important - for example, the lower panel of Figure 3 shows strong surface freshening, despite the almost complete absence of rain. Surface fluxes were measured along the entire track, using the same methods that resulted in budget closure of better than 10 W/m squared in an earlier cruise (Godfrey et al., 1999). These showed net surface heat fluxes of over 100 W/m squared on each day of the budget experiment, confirming the impression that surface heating was a major cause of the temperature rise. Such rapid SST rise due to surface heat fluxes are significant to the overall aims of JASMINE, since it illustrates that SST can

change fast enough to couple significantly with the IntraSeasonal Oscillations that were a prime motivation for JASMINE. The large heat fluxes occurred occurred in the presence of south-westerly winds averaging from 8 to 10 m/s at the beginning of the survey period, and increased significantly as winds abated to around 4 m/s at the end. The large heat fluxes despite the moderately high wind speeds appear to be primarily due to unusually high surface humidities, suppressing latent heat loss. for much of the time, our triangle crossed into a sharp salinity front; as a result, the heat and freshwater budget closure are not likely to be as accurate as on the earlier cruise (Godfrey et al, 1999). Advection dominates the freshwater budget even more strongly than before.

References

J.S. Godfrey, E.F. Bradley, P.A. Coppin, L.F. Pender, T.J. McDougall, E.W. Schulz and I. Helmond (1999). *Measurement of upper ocean heat and freshwater budgets near a drifting buoy in the equatorial Indian Ocean*. J. Geophys. Res. 104, 13269-13302.

Summary

Overall, we (Frank Bradley and Stuart Godfrey) were very happy with performance of all personnel, and of the instruments. The usual care exercised by the ship's crew was much in evidence in maintaining stations, and the tedious business of repeated CTDs. the radiosonde work would not have been possible without the willingness of Profs Karoly and Tapper of Monash University to loan their Marwinsonde unit at short notice, and several Bureau of Meteorology personnel supplied valuable advice by email as we coped with this unfamiliar equipment. Erik Madsen's willingness to deal with leaking CTD units outside his shift is much appreciated, as was the enthusiasm and contributions of the two students. And enjoyable and productive cruise.

Personnel

Stuart Godfrey	CMR	Cruise Leader
Frank Bradley	CLW	Principal Investigator (meteorology)
Tara Ansell	Student (Uni of Melbourne)	Meteorology
Bob Beattie	Franklin	Computing
Gary Critchley	Franklin	Hydrology
Neal Johnson	Franklin	Hydrology
Val Latham	Franklin	Hydrology
Dan McLaughlan	Franklin	Meteorology
Erik Madsen	Franklin	Electronics
Mark Rayner	Franklin	Hydrology
Matthew Wells	Student (ANU)	Meteorology
Neil Cheshire	Master	
Arthur Staron	Chief Officer	

Paul Ware	2nd Officer
Gordon Gore	Chief Engineer Officer
David Jonker	1st Engineer Officer
Hugh McCormick	2nd Engineer Officer
Mal McDougall	Bosun
Graham McDougall	I.R.
Tony Hearne	I.R.
Terry Ganim	I.R.
Howard Davies	Greaser
Ron Culliney	Chief Steward
Gary Hall	Chief Cook
Ian Lock	2nd Cook

Stuart Godfrey, Chief Scientist.

Figures

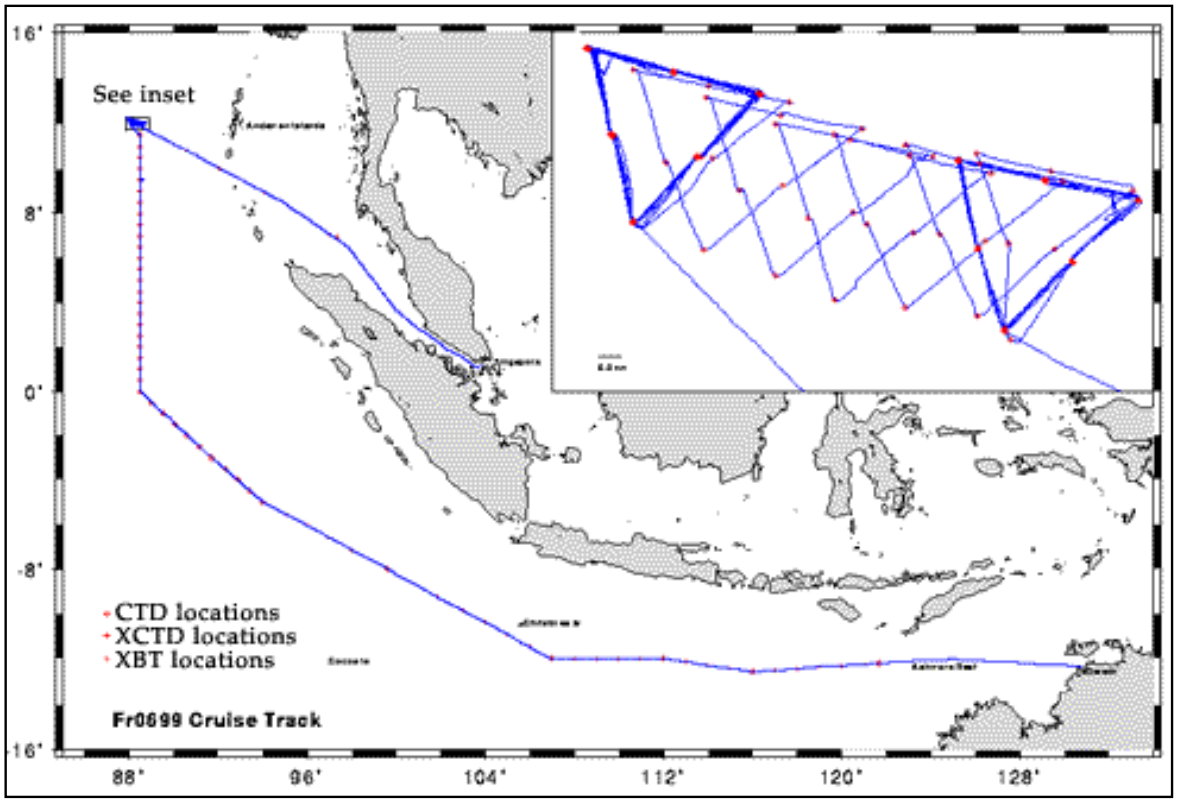

Figure 1: cruise track for FR06/99

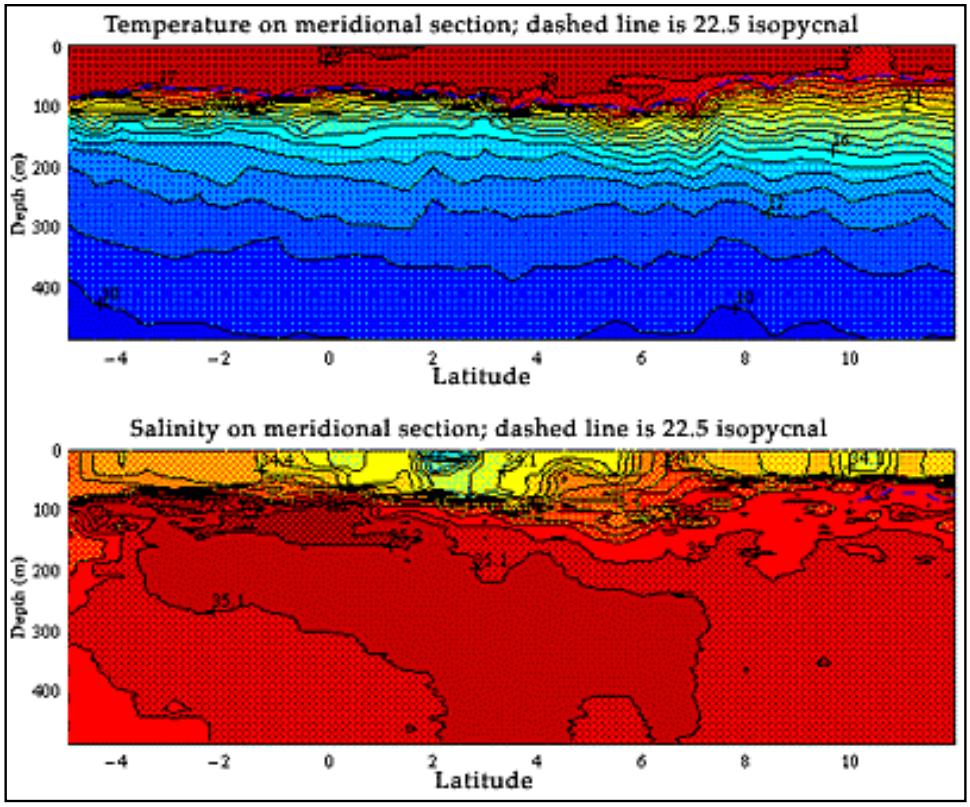

Figure 2: Temperature and salinity observations from 5 degrees south to 12 degrees north, 9-15 September 1999.

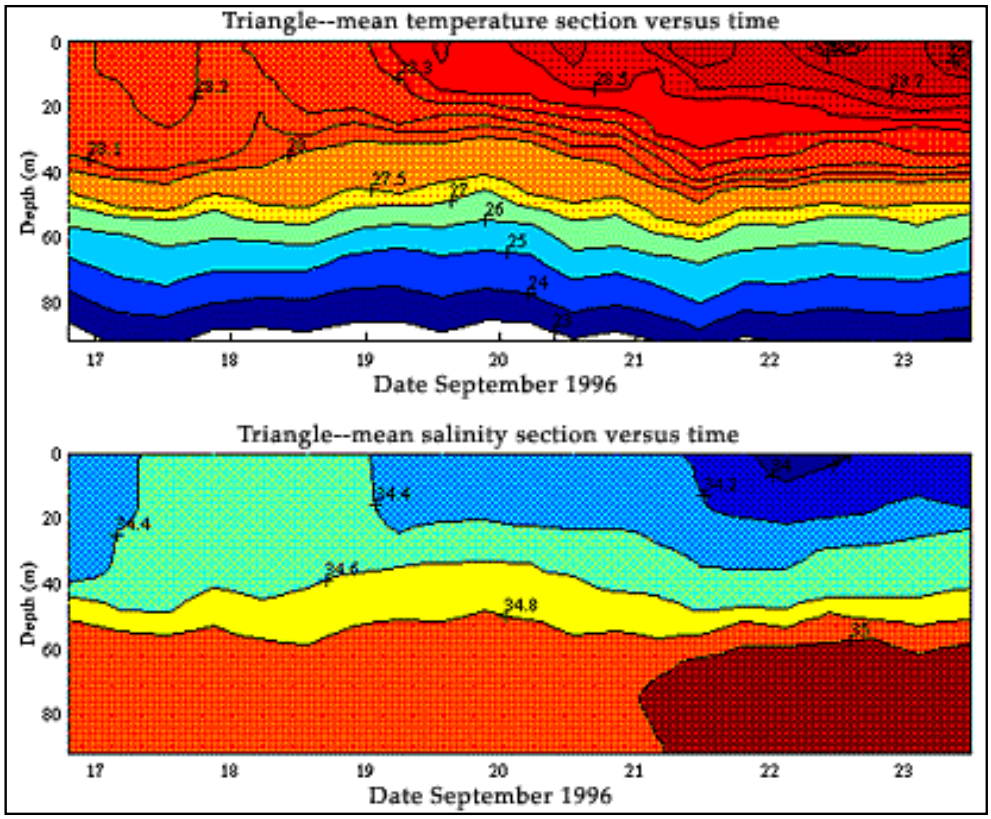

Figure 3: Means around each triangle of temperature and salinity, 16-23 September 1999.

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