J3.7 AIR-SEA INTERACTION IN THE BAY OF BENGAL DURING THE POST-MONSOON PERIOD

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1. INTRODUCTION

In September 1999, *R/V Franklin* operated in the Bay of Bengal, measuring ocean and atmospheric structure, as part of the Joint Air-Sea Monsoon Experiment (JASMINE). The cruise track and methodology followed closely that adopted by scientists aboard the US *R/V Ronald H. Brown* during May 1999, at the onset of the Asian summer monsoon, as described elsewhere in this section.

2. METHODOLOGY

The location of instruments on the *Franklin* was generally as shown in Bradley et al (1991). Longwave and shortwave radiation instruments were mounted on the main mast, and a net radiometer 11m forward of the bow at the end of a boom. Air temperature and humidity were measured with aspirated psychrometers at 6m above the sea surface on the boom and at 13m on the foremast. Wind speed and direction came from instruments at 13m on the port side of the foremast and at 17m on the starboard side of the main mast. Sea temperature was measured with the ship's thermo-salinograph, a floating thermistor, and infra-red radiometers facing seaward and skyward.

On the transit from Darwin to the experimental area, one CTD cast and one radiosonde launch were made each day, and continuous flux observations. Intensive work began on September 10 (Julian Day 253) following the cruise track shown in Figure 1. The dots indicate the beginning of each day (GMT). Along the northerly transect, CTD casts were made to 1000db on each full degree of latitude and to 500db on each half-degree from 5ºS to 12ºN. The ship then spent a week near (12ºN, 88ºE) making ocean budget measurements around triangular tracks of 24 km side, with CTDs at each vertex and at the mid-point of each side. Each triangle took 8 hours to complete, initially at a fixed location but later moving down-current as far as the Indian EEZ. For the entire period from day 253 to day 266 surface fluxes were measured continuously and there were four radiosonde launches per day.

3 OBSERVATIONS

Meteorological conditions during the transect and survey are shown in Figure 2, where the time series have been hourly-averaged. Following a period of light winds near the equator, the wind set in from the SW and strengthened to around 10 ms^{-1}. There was some cloud but almost no rain during this period, and solar radiation peaked close to 1000 Wm^{-2} for each of the 12 days. Air temperature exhibited a daily cycle with no obvious longer-term trend. Sea temperature, however, increased by about 1ºC over the 7 days of the survey.

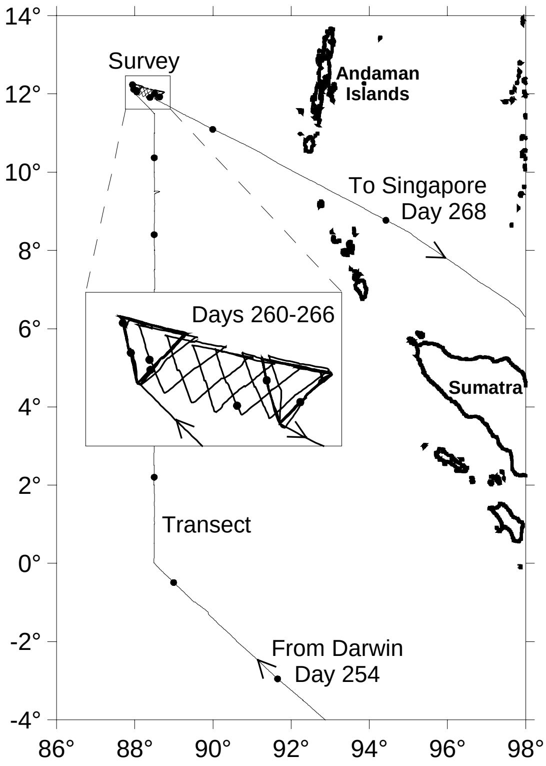

Figure 1. *R/V Franklin* cruise track September 1999

There are two time traces of sea temperature in Figure 2c; the thermo-salinograph reading at effective depth of about 1m and the skin temperature. The latter is obtained from models of the cool skin and diurnal warm layer within the COARE bulk algorithm (Fairall et al. 1996) and is the temperature actually used to calculate the heat fluxes. Samples of the model values shown here have been verified against the thermistor and IR radiometer measurements. The cool skin is evident with its expected value of 0.2 to 0.3ºC, but there is no sign of the 2 to 3°C temperature gradient frequently observed in the upper metre of the ocean during COARE. The strong insolation induced a near-surface diurnal temperature signal up to 1ºC amplitude, but wind and current driven mixing seem to inhibit daytime stratification

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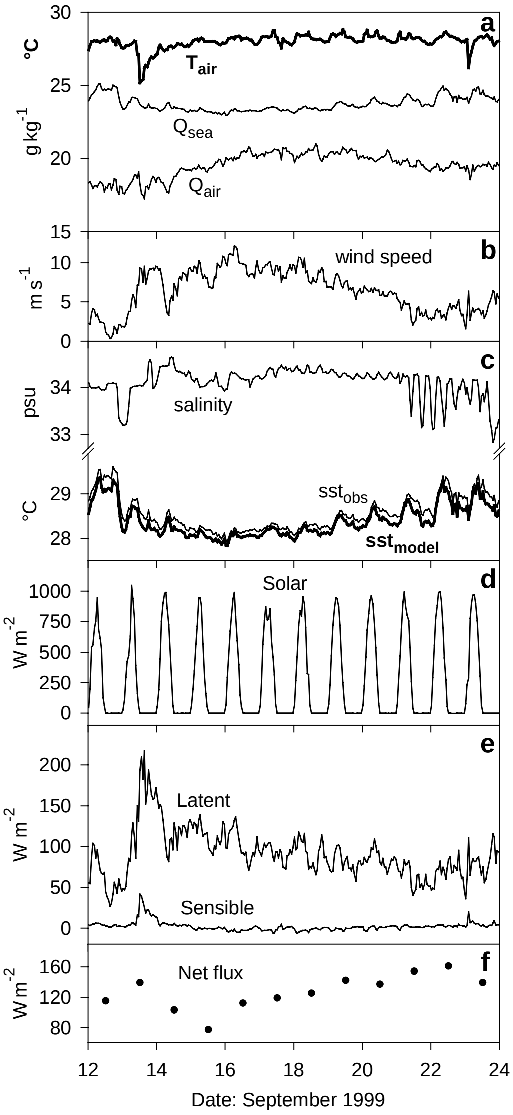

Figure 2. Time series of observations during cruise

The salinity trace shows a pattern of variability which persists around the triangle even with winds of 6-8 ms^{-1}, and is very marked in the lighter winds of the last two days. The source of the patch of freshwater was not obvious; no rain fell on the ship, and there is no record of storms in the vicinity.

4. DISCUSSION

Figure 2e shows sensible and latent heat fluxes calculated using an updated version (2.6a) of the COARE bulk algorithm. Initially, both fluxes increased in response to the wind gust, and total over 200 Wm^{-2}, but by 7ºN had dropped to around 120 Wm^{-2}, thereafter declining for the rest of the survey, despite the strong winds. The low latent heat fluxes arise from rather high atmospheric humidity. Figure 2a shows that the sea-air humidity difference is only around 3 gkg^{-1} for much of the time, which contrasts with COARE observations in the west Pacific where it was consistently 6-8 gkg^{-1}. Similarly, sea-air temperature differences in the west Pacific were usually at least 1°C, whereas here they were typically ±0.2°C.

Daily values of the net heat flux into the ocean are given in Figure 2f. The net longwave component (not shown) was fairly constant around –37 Wm^{-2}. The daily surface forcing of over 100 Wm^{-2} must be largely responsible for the remarkable SST increase of 1ºC in only 7 days, although advection is certainly important. This observation is notable in the context of JASMINE, since it illustrates that SST can change fast enough to couple significantly with IntraSeasonal Oscillations.

Preliminary calculations, using methods that closed the ocean heat budget to better than 10 Wm^{-2} in an earlier cruise (Godfrey et al. 1999), indicate that closure will be reasonable for the heat budget, but probably unsatisfactory for the freshwater budget.

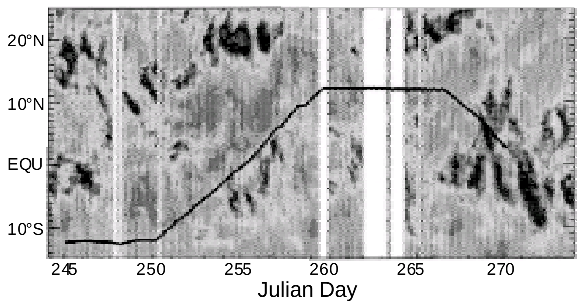

Figure 3. Brightness temperatures from METEOSAT-5

Climatic conditions on this cruise are quite similar to the early (quiescent) period of the May cruise of the *R/V Brown*, particularly the strong sun, absence of rain, and large positive net heat flux. However, it is worth noting that the outcome *could* have been quite different. Figure 3 shows brightness temperatures for the period of the cruise, averaged in the band 85º-95ºE (courtesy of Peter Webster). The ship track is a line in longitude-time space. We crossed the storm band on day 254, measuring 45mm of rain, and then experienced clear conditions for both the transect and survey. But had the survey started a week later the ship would have run into several days of stormy conditions, extending from 5ºS to 10ºN. In fact, heavy rains were reported from the Andaman islands, and the storms caught up with *Franklin* on day 268.

References:

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