

**PORV SAGAR KANYA**  
**CRUISE SK 251**  
**Paradip - Chennai**  
**(23 October – 11 November 2008)**

**NATIONAL INSTITUTE OF OCEANOGRAPHY REGIONAL CENTRE**  
**(Council of Scientific and Industrial Research)**  
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# REPORT ON THE CRUISE 251A OF ORV SAGAR KANYA

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## 1. SUMMARY

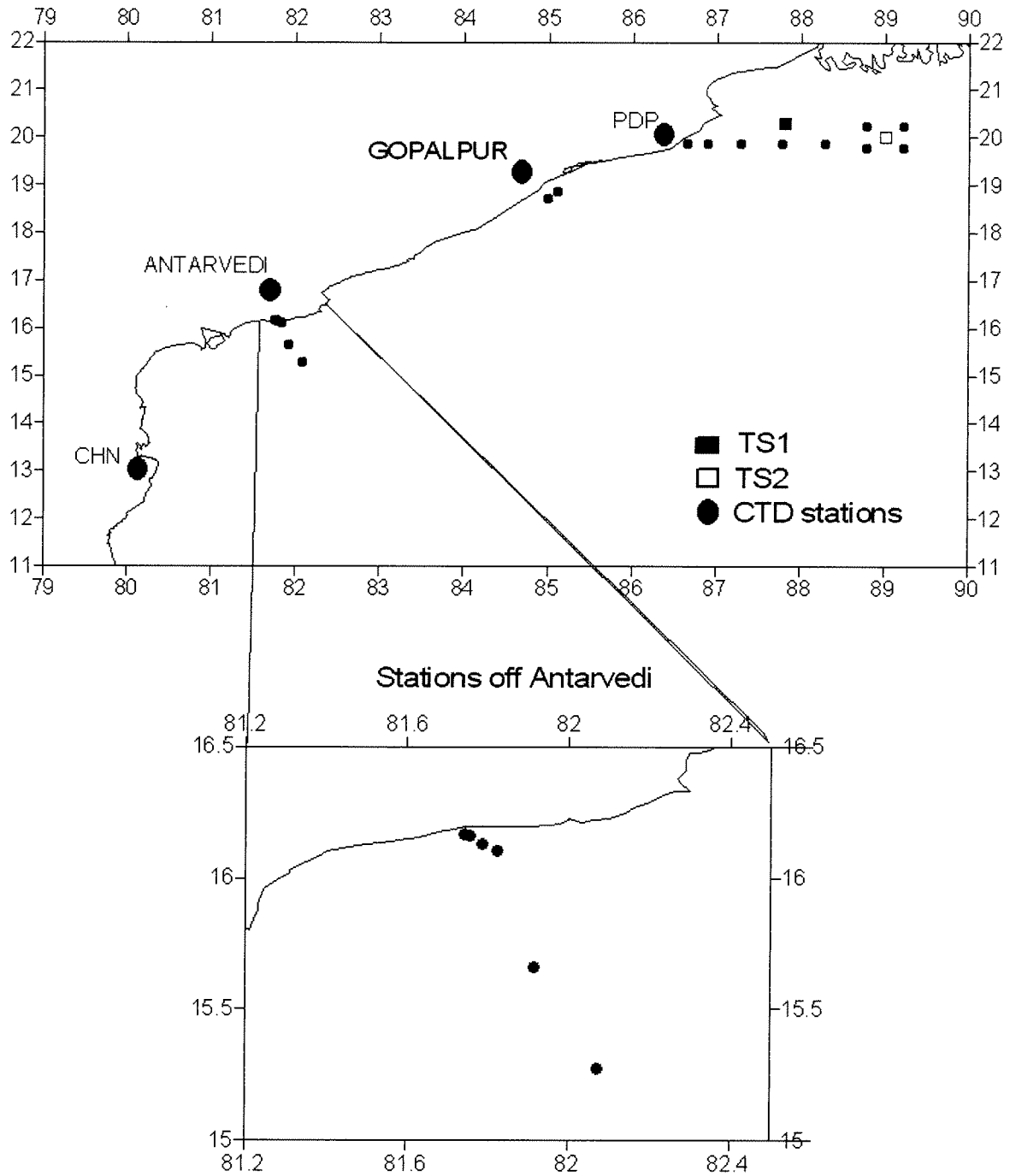
The Cruise SK251A is the continuation of the cruise SK251 which was started in Chennai and terminated at Paradip on 22 October 2008. The cruise SK251A participants from NIO RC-Visakhapatnam, IISc, Bangalore and Andhra University reached Paradip at 1100 hrs and boarded the vessel ORV *Sagar Kanya* at 1230 hrs on 23 October. Loading of the NIO equipment was completed by 1300 hrs. Some participants of cruise SK251 from IISc, INCOIS and NORINCO AMC technical staff continued their participation in cruise SK251A. The vessel sailed from Paradip port at 2030 hrs of 23 October with the total of 21 participants from NIO RC-V (7 nos), Andhra University (2 no.), IISc (4 nos.), INCOIS (1 no.), NCAOR (2 nos.) and AMC Engineers from NORINCO Pvt. Ltd. (5 nos). The first time-series station (TS1) was occupied at 20°42'N, 87°44'E on the continental shelf off Paradip at a shallow depth of 120 m to study internal waves in these waters. Hourly CTD casts and 4 hourly water sampling for nutrients, dissolved oxygen and chlorophyll were carried out from 06:40 hrs of 23<sup>rd</sup> October to 14:58 hrs of 25<sup>th</sup> October 2008 at this TS1 location. After 25 hours of observations, the vessel sailed towards the Indian coast as a safety measure due to the developing synoptic weather system over the central Bay of Bengal and its predicted movement towards the northern Bay of Bengal. The vessel drifted in the coastal waters off Gopalpur till the evening of 26<sup>th</sup> October and occupied two CTD stations off Gopalpur. The vessel reached the second time-series location (TS2) in the northern Bay at 20°N, 89°E for 10 days time-series observations on 28<sup>th</sup> October. The Ocean Buoy (OB-12) at 19°57.32'N, 089°01.04'E was sighted in its place at 06:30 hrs on 28<sup>th</sup> October with all its sensors intact. Time-series of temperature and salinity profiles started from 0800 hrs of 28<sup>th</sup> October and continued till 5<sup>th</sup> November 2008. At the end of time-series observations, while returning towards Chennai, 4 CTD stations were occupied around OB-12 on 6<sup>th</sup> November and 5 CTD stations were occupied along 19°51'N section to estimate the geostrophic flow in the observational area. The onboard Idronaut CTD and Sea Bird CTD and another Sea Bird CTD which was brought from NIO RC-V were used to obtain time-series of profiles of temperature, salinity, chlorophyll, Photosynthetically Active Radiation (PAR), dissolved oxygen, turbidity. Water samples were collected for salinity analysis using AUTOSAL.

Besides CTD time-series observations, Radiometer was also deployed to obtain time series profiles of irradiance in the upper 100 m. Continuous measurements of surface meteorological parameters, long-wave radiation, albedo of sea surface and Skin Sea Surface Temperature (SSST) were recorded from the beginning of sailing on 23<sup>rd</sup> October.

While returning towards Chennai along the east coast, the vessel encountered the strong equatorward flowing East India Coastal Current (EICC) and the vessel speed was enhanced up to 10 knots. With this, ETA Chennai could be advanced by more than 12 hours. This has been taken as advantageous for additional observations off Godavari (Antervedi) along a section normal to the coast and as such 6 additional CTD stations were occupied to capture the EICC and estimate its transport. A total number of 139 CTD casts were done in this cruise.

The ship made a good speed between 6 and 10 knots. The weather was fine during the sailing period, except during the development of tropical cyclone "RASHMI". The vessel reached Chennai port on 11<sup>th</sup> November 2008.

## 2. CRUISE TRACK



SK251A cruise track: 23 October – 11 November 2008

### 3. INTRODUCTION

The cruise SK251 is planned to study the upper ocean variability, surface heat budget and upper ocean heat budget using high-resolution data in the northern Bay of Bengal during early northeast monsoon period. The cruise was organized in two legs – one from Chennai to Paradip and the other from Paradip to Chennai. In the first part of the cruise, moorings with the fitting of meteorological sensors and ocean sensors were deployed. An Ocean Buoy (OB-12) was deployed by NIOT in the northern Bay at 20°N, 89°E in a separate cruise onboard *Sagar Nidhi*. In the second part of the cruise, it was planned to carry out time series observations of CTD operations in the northern Bay of Bengal closer to the OB-12. It was also planned to operate Radiometer to obtain time series of irradiance to study the heat budget of the region. Participants from Andhra University planned to collect the longwave radiation, skin sea surface temperature and surface meteorological data during the cruise. The deployment of thermistor chain mooring off Paradip was not materialized. The second part of the cruise was organized by the NIO Regional Visakhapatnam with the participants from NIO RC, IISc, Andhra University, INCOIS, NCAOR and NORINCO AMC engineers. Accordingly, the ship sailed from Paradip port in the late evening of 23<sup>rd</sup> October and sailed towards the first time series station off Paradip.

### 4. ITINERARY

Departure	:	Paradip port	- 23 <sup>rd</sup> October 2008
Arrival	:	Chennai port	- 11 <sup>th</sup> November 2008

## 5. CRUISE PARTICIPANTS

### 5.1 Scientific component

1.	Dr. V.Suryanarayana Murty	<b>Chief Scientist</b>	NIO RC-Vizag
2.	Miss Lata Gaude	JTA	-- do --
3.	Miss Bobbili Sridevi	JRF	-- do --
4.	Mr. Yerraguntala Steeven Paul	JRF	-- do --
5.	Mr. Peddinti Venkata Raghunadh Babu	Proj. Assistant	-- do --
6.	Mr. Mettu Naresh Kumar Reddy	Proj. Assistant	-- do --
7.	Mr. Vavilipalli Rajendra Prasad	Proj. Assistant	-- do --
8.	Mr. Chrukuri Venkata Ramu	Proj. Assistant	-- do --
9.	Mr. Cherukuri Venkata Ramu	JRF	Andhra University
10.	Mr. Bandi Mahendranath	JRF	-- do --
11.	Dr. D. Sengupta	Professor	CAOS, IISc
12.	Ms. Sindu Raj Parampil	Ph.D student	-- do --
13.	Ms. Arathy Menon	MSc. Student	-- do --
14.	Ms. Prajvala Kishore Kurtakoti	Proj. Assistant	-- do --
15.	Mr. Neelakandan Suresh Kumar	Engineer	INCOIS
16.	Mr. Biju Vikram Nair	AMC Engineer	NORINCO
17.	Mr. Palaniswamy Boopathy	AMC Engineer	NORINCO
18.	Mr. T. Ramesh	AMC Engineer	NORINCO
19.	Mr. Tachezhath Baiju	AMC Engineer	NORINCO
20.	Mr. Dipesh Kumar	Seaman	NCAOR
21.	Mr. Sameer Abdulgani	Seaman	NCAOR

### 5.1 Ship's complement

1.	Capt. Kulandai Samy Pandian	Master
2.	Mr. Meena Laljee Ram	Chief Officer
3.	Mr. Abdul Hameed Yusuf Kazi	Second Officer
4.	Mr. Vizia Kumar Akula	Second Officer
5.	Mr. Praveen Kumar Dwivedi	TNOC
6.	Mr. Constancio Monteiro	Radio Officer
7.	Dr. Piyush Kumar	Medical Officer
8.	Mr. Rommel Gregorio S. D'Silva	Purser
9.	Mr. C.N. Sasidharan	Chief Engineer Officer
10.	Mr. Dhananjay Kumar	Second Eng. Officer
11.	Mr. Gunna Ramakrishna Rao	Fourth Eng. Officer
12.	Mr. Sudhir V. Dicholkar	Fourth Eng. Officer
13.	Mr. Goutam Mistry	Electrical Eng. Officer
14.	Mr. Chandraprakash J. Singh	Electrical Eng. Officer
15.	Mr. Norman Joseph Dias	Catering Officer

## 6. OBJECTIVES

- 1) Collection of time series of temperature and salinity profiles at a shallow depth station off Paradip (TS1)
- 2) Collection of time series of temperature and salinity profiles at a deeper depth station in the northern Bay at TS2 location (20°N, 89°E).
- 3) Collection of profiles of ship-borne VM-ADCP currents
- 4) Collection of chemical and biological parameters at the time series locations.
- 5) Collection of time series of surface meteorological data from the onboard AWS
- 6) Collection of profiles of radiometer at the time series locations
- 7) Collection of bucket thermometer SST data and sea surface salinity data along the cruise track.
- 8) collection of temperature and salinity profiles at a number of stations

## 7. WORK ACCOMPLISHED

### 7.1 Work plan

### 7.2 Physical Oceanographic Observations

*[Team: V.S.N. Murty, D. Sengupta, B. Sridevi, Steeven Paul, C.V. Ramu, R. P. Sindu, Arathy Menon, K.K. Prajval and NORINCO Engineers]*

In this cruise, the onboard Idronaut CTD and Sea Bird CTD (19 plus) and that Sea Bird CTD (19plus) that was brought from NIO were extensively used to obtain the temperature and salinity and other parameter profiles. The onboard Sea Bird CTD did not record correct salinity during the leg 1 of this cruise. Therefore, a spare Sea Bird CTD was brought from NIO. The Idronaut CTD provides the profiles of pressure, depth, temperature, conductivity, salinity (two sets of sensors), oxygen, Photosynthetically Active Radiation (PAR), Turbidity and Altimeter (for safely lowering the system closer to the bottom). The SK-Sea Bird CTD provides the profiles of pressure, depth, temperature, conductivity, salinity, fluorescence, oxygen, PAR/Irradiance, Beam Transmission. The NIO-Sea Bird CTD provides the profiles of pressure, depth, temperature, conductivity, salinity, fluorescence and oxygen.

Soon after sailing, a shallow location at the water depth of 120 m was selected at 20°42'N, 87°44'E to study the internal waves on the shelf off Paradip. Hourly CTD operations and water sampling for dissolved oxygen, nutrients and chlorophyll at 4 hourly intervals were planned for 48 hours at the first shallow time series location. It was found during the SK251-Leg 1 cruise, the onboard Sea Bird CTD salinity was incorrect and needed checking with other similar equipment. It was intended to compare the salinity and temperature profiles of onboard Sea Bird CTD (19 plus) with that of the similar Sea Bird CTD (19 plus) brought from NIO. The Idronaut CTD has a provision for online display of the data and water sampling. Preparations for observations and water sampling started. Discussions were held with the Master about the plan of observations. It was decided that whenever the vessel drifted away from the time series location towards shallow depths (lesser than 120 m depth) or going away towards deeper depths, the vessel would be re-located closer to the time series location to maintain the observations at this location.

The problem of pump in the SK-Sea Bird CTD was checked in and all the three CTDs were lowered together at the shallow time-series station off Paradip. To the surprise of

participants, the SK-Sea Bird CTD was found measuring correct conductivity and hence salinity. The profiles of T and S of both Sea Bird CTDs are found comparable and the pattern of these profiles is also found comparable with the Idronaut CTD. Figure 1 shows the temperature profiles in the upper 100 m from Idronaut, SK-Sea Bird CTD and NIO-Sea Bird CTD at Station #03. The profiles of Idronaut CTD and NIO-Sea Bird CTD are closer and the deviation is minimum, where the SK-Sea Bird CTD showed wider deviation. Figure 2 shows the comparison of salinity profiles in the upper 100 m at the station #03. While the deviation in the profiles of Idronaut and NIO-Sea Bird CTD is minimum, the deviation is more in case of SK-Sea Bird CTD. A detailed intercomparison will be made at the shore laboratory using all the casts data wherein all the 3 CTDs were operated together.

At the TS1 station, 25 CTD casts were obtained at intervals of 1 to 3 hours. While time series operations were in progress at TS1 location in the northwestern Bay, a weather system developed over the central Bay. Based on the weather reports received from the IMD indicating the depression warning, the vessel was set sailing towards the Indian coast as a precautionary safety measure. So, the time-series operations at TS1 were halted. Satellite weather imageries and weather predictions issued by JTWC were received via e-mails from Mr. Venu, IISc, Bangalore. Also contacted Dr M. avichandran and the Madras Cyclonic Warning Center for the weather forecast on the progress of the synoptic system. The vessel waited off Gopalpur till the evening of 26 October when the weather predictions indicated that the cyclonic disturbance crossed the latitude of vessel's location in the evening of 26<sup>th</sup> October. It was predicted by JTWC that the disturbance would move towards the northern Bay and then towards Kolkatta.

While drifting off Gopalpur, calibration of VM-ADCP was attempted. The vessel moved over a distance of 1 nautical mile towards North, West, South and East in order to calibrate the ADCP currents in bottom track. This exercise was not found fruitful, as the measured current profiles showed differences among each direction of ship's movement.

Two CTD casts were taken off Gopalpur to capture the salinity and temperature of the Seasonal EICC.

From 28<sup>th</sup> October onwards, the vessel was located in the northern Bay at 20°N, 89°E to do time series observations for a 10 day long duration. The profiles were taken initially at 1 hour interval for 2 days and then continued at 3 hourly intervals. All the three CTDs were used to obtain as many profiles as possible.

The NIO Sea Bird CTD was tied to a ship's life buoy and kept in the surface waters (with a line tied to the ship) to measure the surface temperature and salinity in Mooring Mode to understand the diurnal variation in these parameters. The near-surface time series data was obtained for 8 days. Interestingly, along with the diurnal variation of temperature, there is a diurnal variation in the sea surface salinity. This had created interested to examine the diurnal variation for a longer days. It was noted that the salinity variation coincided with the ship's drift in a day, i.e. diurnal variation of SSS is due to the location of the ship in the study area, rather than temporal variation.

The Radiometer also was placed in the surface (the sensors were close to the surface within 50 cm from surface) for some days, and it was found that the near-surface temperature and salinity were consistent with that of CTD variations. However, interesting results were found which would be studied further.



A total of 95 CTD casts were done at the TS2 location from 28<sup>th</sup> October to 5 November.

Four CTD stations were occupied around the OB-12 within 50 km apart on 6 November. On the way to Chennai, it was planned to sail along the coast to capture the EICC currents in the VM-ADCP in bottom track mode. While moving towards the Indian coast, a zonal section was occupied along 19°51'N latitude and 5 CTD stations were occupied.

While approaching Chennai, another section was occupied off Godavari and 6 CTD stations were occupied to estimate the seasonal EICC transport..

The samples of VM-ADCP data obtained in navigation mode were sent to the RD Instruments to examine why the measured currents do represent the ship speed rather than the actual water currents. While awaiting for the detailed report from RD Instruments, the ADCP currents were being acquired using VMDAS.

### **Surface meteorological measurements**

[Team: Mr. B. Mahendranath, Mr. C. V. Ramu, Andhra University]

Surface meteorological parameters such as Skin Sea Surface Temperature (SSST), Long wave Radiation, Albedo of sea surface, wind speed, barometric pressure, dry bulb temperature, wet-bulb temperature, humidity, dew-point temperature data were recorded using different instruments. The Net Pyrgeometer and Pyranometer are installed onto a boom on 25<sup>th</sup> October. The length of the boom is nearly 5 m and is extended outward away from ship's structure. The sensors are faced upward and downward facing the sea surface. The Net Pyrgeometer and Pyranometer measure the net long wave radiation and albedo of the sea surface respectively. The Pyranometer has two sensors - CM 6B and CM 7B. The CM 6B is designed for measuring the irradiance (radiant-flux, watt/m<sup>2</sup>) on a plane surface. The CM 7B is based on two CM 6B sensors and it measures the net global radiation and/or albedo over surface of different nature.

Net Pyrgeometer specifications: irradiance : -250 to 250 w/m<sup>2</sup>  
Spectral range: 5 to 25  $\mu$ m  
Sensitivity : between 10 and 18  $\mu$ V/wm<sup>-2</sup>  
Accuracy :  $\pm$  10% plus window heating effect

Pyranometer Specifications: Irradiance : 0 – 1400 w/m<sup>2</sup>  
Spectral range : 305-2800 nm  
335-2200 nm  
Sensitivity : between 9 and 15  $\mu$ V/wm<sup>-2</sup>

MICROTOPS II - Ozone monitor & Sunphotometer: The MICROTOPS II is a hand-held multi-band sunphotometer capable of measuring the total column ozone and optionally the water vapour column as well as aerosol optical thickness.

Infrared Radiation Pyrometer (Model No: KT 19.85 II) is used to measure the sea surface skin temperature. This is suitably installed on 03<sup>rd</sup> November.

Pocket Weather Tracer: A pocket weather tracer is used to collect surface meteorological data such as wind speed, dry bulb temperature, Wet bulb temperature, Pressure, Humidity, Dew point temperature etc.

All the sensors worked satisfactorily during the cruise. The preliminary examination of the data shows that the study area in the northern Bay encountered a thick layer of aerosols during the observational period.

The skin SST is compared with the Sea Bird CTD measured time series SST data at 10 minute interval. The Pyrometer recorded the diurnal variation of skin SST and it was found that the skin SST was larger than the bulk SST recorded by CTD at 1.5 m depth. Figure 3 shows the difference of NIO-Sea Bird CTD SST and skin SST as measured by Pyrometer for 4 November. It is interesting to see that the difference is minimum during evening and night hours, with Pyrometer readings were lesser than CTD and the skin SST was higher by about 1.9°C by 1500 hours.

Further data processing and analysis will be carried out at the Department.

### **Surface meteorological measurements**

[Team: NORINCO AMC engineers]

The ISRO installed AWS recorded surface weather data were provided by the NORINCO engineers. Quality of this data is to be worked out. The winds data are to be supplemented with the ship's navigation information for its use.

### **Salinity analysis using AUTOSAL**

[Team: Mr. Dipesh and Mr. Sameer, NCAOR participants].

The AUTOSAL was recalibrated in this cruise with a new standard seawater sample. Water samples were collected from many depths at a number of CTD stations. Besides CTD casts water sampling, these participants collected surface salinity samples using bucket thermometer and the surface water samples were analyzed for salinity. AUTOSAL was used to analyze the water samples for salinity. The AUTOSAL salinity values are yet to be compared with those obtained from CTD casts.

### **Radiometer observations**

[Team: D. Sengupta, R.P. Sindu, N. Suresh Kumar, Steeven Paul, CV Ramu]

The Satlantic Radiometer was operated at the TS2 time series stations. The operations were chosen in between the CTD casts. Radiometer operations were commenced from 29<sup>th</sup> October and continued till 5<sup>th</sup> November 2008. A total of 88 operations were carried out. After the end of operations at TS2 time series location, the Radiometer was used in buoy mode to record the temperature and salinity data from the near-surface depth (say, ~50 cm to 1 m). Figure 4 shows the typical profile of irradiance at a station. The profiles show the occurrence of maximum irradiance at sub-surface depths (between 15 and 20 m). Below the subsurface maximum, the irradiance decreased with depth. Also the near-surface temperature and salinity collected in buoy mode are compared with the NIO-Sea Bird CTD data at about 1.5 m depth. Figure 5 shows such comparison on 6<sup>th</sup> November. The deviation in temperature is minimum during the diurnal cycle. Maximum SST is noticed at 1200 hrs, and the diurnal range is about 0.3°C.

### 7.3 Biological Oceanography Observations

[Team: G. Lata, V. Rajendra Prasad, NIO RC-Visakhapatnam]

Water samples were collected from a number of CTD casts to study the phytoplankton and chlorophyll in the water column. Samples were filtered onboard and the filtrates were collected for further analysis at the shore laboratory in NIO RC-V. Table 2 gives the details of the sampling carried out in the cruise. Out of the total 138 CTD casts, water samples were collected only from 31 stations.

### 7.4 Chemical Oceanographic Observations

[Team: P.V. Raghunath Babu, M. Naresh Kumar Reddy, V. Rajendra Prasad, NIO RC-Visakhapatnam]

Seawater samples were collected from both TS1 and TS2 time series CTD casts from various depths for the analysis of dissolved oxygen, nutrients and particulate and dissolved trace metals. Details are given in the Table 7.2. Onboard analysis was done for dissolved oxygen, nitrite, phosphate, silicate and urea. Samples were preserved in the deep freezer for nitrate analysis at the shore laboratory.

Analysis of the samples for Dissolved Inorganic Matter, Dissolved Organic Matter, Total Suspended Matter, Total particulate Matter will be carried out at the shore laboratory. Details of parameters to be analyzed is given in Table 7.2.

## 8. PERFORMANCE OF THE EQUIPMENT USED

The following equipments were used during the cruise.

**Sea Bird CTD 19plus** The onboard Sea Bird CTD 19plus with all its fitted sensors was extensively used and found working satisfactorily. The profiles of these CTD are compared with those of NIO-Sea Bird CTD (19plus). Some deviations in temperature and salinity profiles were noticed. On some stations, both these CTDs were lower together with the Idronaut CTD and further intercomparison will be made in NIO RC-Visakhapatnam.

**Idronaut CTD.** The onboard Idronaut CTD is extensively used in this cruise with all its fitted sensors. Water sampling was also carried out with out much problem. Initially we used the 1.7 l capacity Niskin samplers and later 5 l capacity Niskin samplers were used for the requirement of more water samples from each depth. Water sampling was done up to the maximum of 200 m while Idronaut CTD was lowered up to 1000 m depth. A comparison of Idronaut CTD temperature and salinity profiles were found closer to the NIO-Sea Bird CTD profiles.

**AWS** The onboard fitted ISRO installed two **AWS sensor** units recorded data and the NORINCO engineers provided the soft copy of this data. However, this AWS data was not supplemented with ship's navigation data. Hence, the true wind data and position of observation GPS data can't be obtained.

It is unfortunate that proper wind data, with navigation data integration, is not available onboard. During the synoptic weather disturbance which crossed over the study area in this cruise, we were not having winds data, corrected to ship's heading and speed. The scientists and the navigating officers were to depend on the weather bulletins. However, we were

fortunate that the Ocean Buoy-12, deployed by NIOT, Chennai, provided the winds data in the northern Bay of Bengal (20°N, 89°E) even during the tropical cyclone, RASHMI.

**AUTOSAL** was used for salinity analysis for the water samples from a number of stations check the accuracy of the CTD salinity. Its performance was satisfactory. However, the AUTOSAL suitable water sample bottles were not enough in number onboard. The NCAOR participants regularly collected surface water sample and analysed for surface salinity.

**Sub-bottom profiler** (SBP) was continuously operated underway, as a part of AMC.

**Autoanalyser** was not used in this cruise. The participants from NIO RC-Visakhapatnam brought with them the necessary reagents and analysed the samples for dissolved oxygen and nutrients.

**Oxygen-Titration Unit** – This unit was not used in the cruise.

**Thermosalinograph** – was not used in this cruise.

## 9. PERFORMANCE OF THE SHIP

- The vessel speed was between 6 and 8 knots. The speed gained when the vessel was sailing in the direction of the seasonal strong coastal current. Most part of the cruise, vessel was in the stationary position in the northern Bay for time series measurements.
- AC in the forecastle cabins and dry-lab port is not satisfactorily. AC in the Hydrosweep Lab maintained to the required temperature.
- CTD winch worked satisfactorily without any problem for the cruise period.
- The Atlas crane was used for deploying the CTD in the surface waters.
- Dynamic Positioning System (DPS) and Bow thrusters were used during the cruise.

## 10. CONCLUSIONS

The cruise SK-251A was successfully completed with all the planned time-series operations without any problem or loss. One time-series station (TS1) at a shallower depth (~120 m) off Paradip for 25 hours and another time-series station (TS2) at 20°N, 89°E for 10 days and 17 CTD stations in the coastal region were collected. Three CTDs – the onboard Idronaut CTD and onboard portable Sea Bird CTD (19 plus), and one portable NIO-Sea Bird CTD (19 plus) were used in this cruise. Intercomparison of the temperature and salinity profiles from these CTDs is comparable. Besides the CTD operations, Radiometer was also operated and profiles of irradiance were obtained in the northern Bay of Bengal. On some days, the NIO - portable Sea Bird CTD was deployed in Mooring Mode for capturing the diurnal variation of near-surface temperature and salinity. AWS surface meteorological data were collected continuously. The AU participants installed Pyrgometer and Pynometer on a boom and collected continuous data on long wave radiation and albedo of sea surface. These participants also collected the skin sea surface temperature data for the period of the cruise. Though the VM-ADCP was used to acquire the profiles of water currents, its performance is not satisfactory. VMDAS software was used for acquisition. Ship's gyro data was fed. However, the ADCP was recording the currents without subtracting the ship's heading and speed.

## 11. RECOMMENDATIONS

The following recommendations are made:

- Installation of a Thermosalinograph Unit (with spare temperature and conductivity sensors) and the sea water pump for the same are highly recommended for recording the near-surface temperature and salinity information.
- An Automatic Weather Station with GPS and Gyro integration for obtaining true wind data and position for each record, along with other meteorological parameters is very essential.
- It is also recommended that the daily cloud pictures (from Kalpana satellite) may be supplied to the Master, ORV Sagar Kanya to know the prevailing weather in the area of the survey. During SK251A cruise, Kalpana satellite derived daily cloud pictures were sent from IISc and INCOIS to the Chief Scientist / Master. This helped us in a great way when a tropical cyclone developed over the central Bay of Bengal and moved over to the northern Bay. These cloud pictures and the JTWC weather bulletins helped the Master to steer the vessel to a safety location to avoid any onward fall out of the cyclone. The cloud pictures can be downloaded from the IMD web site [www.imd.gov.in](http://www.imd.gov.in).

## 12. ACKNOWLEDGEMENTS

The Chief Scientist and his team are thankful to the Master, Chief Officer, Chief Engineer Officer and their respective teams and the deck crew for providing excellent services and cooperation in all the time-series CTD operations and several CTD stations. The cooperation among the participants and between the participants and the ship's officers and crew, leading to the successful accomplishment of the objectives of the cruise, is highly appreciated. The services provided by the AMC NORINCO Engineers are highly acknowledged. Special thanks to Mr. Bhoopathi, NORINCO Engineer, who helped the AU participants to properly install the IR Pyrometer.

The Chief Scientist and his team are thankful to Dr. S.R. Shetye, Director, NIO. The scientific team is also thankful to Dr. Shailesh Nayak, Secretary, Ministry of Earth Sciences (MoES), Govt. of India, Dr. Rasik Ravindra, Director, NCAOR, Vasco, Goa, Dr. M. Sudhakar, Group Director, OSSG, NCAOR for allotting the required ship time for making time series observations. Mr. MM Subramaniam, NCAOR made all necessary arrangements and cruise related logistics support. The Chief Scientist is thankful to Dr. M. Ravichandran and Mr. E. Pattabhi Rama Rao, INCOI, Hyderabad and Mr. Venu, IISc, Bangalore for providing the Kalpana-Satellite Cloud Imagery for each day and the JTWC bulletins during the RASHMI cyclone period.

The Chief Scientist and participants are thankful to the Radio Officer for handling all the incoming and outgoing e-mails. The participants expressed their thankfulness to the Chief Catering Officer, Assistant Chief Catering Officer and Chief Cook for serving a palatable food with varieties and specials.

Fable 7.1

Details of CTD stations during SK251A (Paradip to Chennai).

Stn No.	SBE PORTABLE CTD		IDRONAUT		TIME (IST)		LONGITU DE	Depth	Water Sampling	
	NCAOR RAW	NIO RAW	ID CAST	RAW	START	END				LATITUDE
1	SBE1-001	SBE2-001	1	TS101	06.40	07.04	20° 17.91' N	87° 51.82' E	100 m	Yes
2	SBE1-002	SBE2-002	2	TS102	08.07	08.21	20° 17.24' N	87° 48.94' E	100 m	No
3	SBE1-003	SBE2-003	3	TS103	09.09	09.27	20° 16.97' N	87° 47.05' E	100 m	No
4	SBE1-004	SBE2-004	6	TS104A	10.36	11.03	20° 16.70' N	87° 44.26' E	100 m	Yes
5	SBE1-005	SBE2-005	7	TS105	11.50	12.10	20° 16.46' N	87° 41.97' E	90 m	Yes
6	SBE1-006	SBE2-006	9	TS106A	14.20	14.32	20° 12.34' N	87° 46.92' E	90 m	Yes
7	SBE1-007		10	TS107	19.25	19.48	20° 12.47' N	87° 43.90' E	100 m	Yes
8	SBE1-008		11	TS108	21.30	21.45	20° 11.86' N	87° 39.67' E	100 m	No
9	SBE1-009		12	TS109	22.35	22.53	20° 11.96' N	87° 37.51' E	100 m	No
10	SBE1-010		13	TS110	23.40	23.57	20° 12.48' N	87° 35.44' E	100 m	No
11	SBE1-011		14	sk251a015	00.52	01.00	20° 13.21' N	87° 33.40' E	92 m	No
12	SBE1-012		15	TS112	01.32	01.40	20° 13.62' N	87° 32.30' E	94 m	No
13	SBE1-013		16	TS113	02.35	02.43	20° 13.45' N	87° 32.79' E	95 m	No
14	SBE1-014		17	TS114	03.33	03.43	20° 13.45' N	87° 33.41' E	95 m	No
15	SBE1-015		18	TS115	04.39	04.56	20° 12.85' N	87° 33.46' E	100 m	No
16	SBE1-016		19	TS116	05.33	05.48	20° 12.94' N	87° 33.90' E	100 m	No
17	SBE1-017		20	TS117	06.36	06.43	20° 11.39' N	87° 30.29' E	100 m	Yes
18	SBE1-018		21	TS118	07.31	07.47	20° 11.39' N	87° 28.44' E	100 m	No
19	SBE1-019		22	TS119	08.27	08.38	20° 11.15' N	87° 26.52' E	100 m	No
20	SBE1-020		23	TS120	09.32	09.50	20° 10.89' N	87° 24.48' E	100 m	Yes
21	SBE1-021		24	TS121	10.43	11.11	20° 10.44' N	87° 22.44' E	100 m	Yes
22	SBE1-022		25	TS122	11.52	12.04	20° 09.84' N	87° 20.49' E	100 m	No
23	SBE1-023		26	TS123	12.32	12.42	20° 09.44' N	87° 19.42' E	100 m	No
24	SBE1-024		27	TS124	13.35	13.51	20° 08.62' N	87° 17.75' E	100 m	No
25	SBE2-025		28	TS125	14.36	14.58	20° 07.18' N	87° 16.18' E	100 m	Yes
26	SBE2-026		29	TS126	10.56	11.14	18° 52.00' N	85° 06.30' E	100 m	No
27	SBE2-027		30	TS127	16.05	16.29	18° 41.77' N	84° 59.69' E	100 m	Yes
28	SBE2-028		31	TS2001	08.03	08.19	19° 57.37' N	89° 03.63' E	200 m	No
29	SBE2-029		32	TS2002	09.06	09.45	19° 56.83' N	89° 04.86' E	200 m	Yes
30	SBE2-030		33	TS2003	10.03	10.24	19° 56.17' N	89° 05.94' E	200 m	No
31	SBE2-031		34	TS2004	11.04	11.27	19° 54.75' N	89° 06.80' E	200 m	No
32	SBE2-032		35	TS2005	13.30	13.56	19° 55.21' N	89° 01.56' E	200 m	Yes
33	SBE2-033		36	TS2006	15.09	15.35	19° 52.25' N	89° 00.59' E	200 m	Yes
34	SBE2-034		37	TS2007	16.42	17.11	19° 49.35' N	88° 59.04' E	200 m	Yes
35	SBE2-035		38	TS2008	18.22	18.46	19° 48.18' N	88° 57.85' E	200 m	No
36	SBE2-036		39	TS2009	19.18	19.39	19° 46.76' N	88° 56.15' E	200 m	No
37	SBE2-037		40	TS2010	21.21	21.40	19° 52.52' N	88° 57.27' E	200 m	No
38	SBE2-038		41	TS2011	22.07	22.37	19° 51.04' N	88° 55.62' E	200 m	No
39	SBE2-039		42	TS2012	23.04	23.26	19° 52.37' N	88° 55.01' E	200 m	No

No data (human error)



75	SBE1-075	78	TS2047	31.10.2008	02.34	02.46	19° 56.42 N	89° 03.35 E	200 m	No
76	SBE1-076	79	TS2048	31.10.2008	05.40	05.53	19° 52.92 N	89° 05.72 E	200 m	No
77	SBE1-077	80	TS2049	31.10.2008	08.33	08.50	19° 48.71 N	89° 06.33 E	200 m	No
78	SBE1-078	81	TS2050	31.10.2008	11.31	12.11	19° 44.04 N	89° 04.95 E	200 m	Yes
79	SBE1-079	82	TS2051	31.10.2008	14.35	14.52	19° 39.59 N	89° 03.61 E	200 m	No
80	SBE1-080	83	TS2052	31.10.2008	18.34	18.53	19° 56.24 N	88° 59.81 E	200 m	No
81	SBE1-081	84	TS2053	31.10.2008	20.41	20.54	19° 54.23 N	88° 57.70 E	200 m	No
82	SBE1-082	85	TS2054	31.10.2008	23.14	00.04	19° 53.08 N	88° 55.07 E	200 m	Yes
83	SBE1-083	86	TS2055	01.11.2008	02.41	02.55	19° 53.45 N	88° 53.70 E	200 m	No
84	SBE1-084	87	TS2056	01.11.2008	05.41	06.16	19° 53.62 N	88° 59.54 E	200 m	No
85	SBE1-085	88	TS2057	01.11.2008	09.15	10.17	19° 53.60 N	88° 54.85 E	1000 m	Yes
86	SBE1-086	89	TS2058	01.11.2008	11.48	12.11	19° 52.43 N	88° 56.24 E	200 m	Yes
87	SBE1-087	90	TS2059	01.11.2008	15.20	15.32	19° 53.43 N	89° 01.41 E	200 m	No
88	SBE1-088	91	TS2060	01.11.2008	17.30	17.45	19° 57.77 N	89° 02.35 E	200 m	No
89	SBE1-089	92	TS2061	01.11.2008	20.39	20.51	19° 47.67 N	89° 03.53 E	200 m	No
90	SBE1-090	93	TS2062	01.11.2008	23.48	00.07	19° 44.64 N	89° 03.15 E	200 m	Yes
91	SBE1-090A	94	TS2062A	02.11.2008	00.22	00.33	19° 44.05 N	89° 03.00 E	75 m	Yes
92	SBE1-091	95	TS2063	02.11.2008	02.46	03.00	19° 42.68 N	89° 01.57 E	200 m	No
93	SBE1-092	96	TS2064	02.11.2008	05.33	05.44	19° 43.06 N	89° 00.01 E	200 m	No
94	SBE1-093	97	TS2065	02.11.2008	08.40	09.47	19° 55.89 N	88° 59.95 E	1000 m	Yes
95	SBE1-094	98	TS2066	02.11.2008	11.40	11.58	19° 55.32 N	88° 57.88 E	200 m	Yes
96	SBE1-095	99	TS2067	02.11.2008	14.43	14.54	19° 54.80 N	88° 56.12 E	200 m	No
97	SBE1-096	100	TS2068	02.11.2008	17.36	17.49	19° 54.70 E	88° 55.40 E	200 m	No
98	SBE1-097	101	TS2069	02.11.2008	20.37	20.47	19° 54.40 N	88° 55.36 E	200 m	No
99	SBE1-098	102	TS2070	02.11.2008	23.37	23.57	19° 53.69 N	88° 56.11 E	200 m	Yes
99	SBE1-099	103	TS2071	03.11.2008	02.36	02.48	19° 52.82 N	88° 56.58 E	200 m	No
100	SBE1-100	104	TS2072	03.11.2008	05.38	05.51	19° 53.63 N	88° 55.40 E	200 m	No
101	SBE1-101	105	TS2073	03.11.2008	08.36	09.25	19° 51.19 N	88° 53.90 E	1000 m	No
102	SBE1-102	106	TS2074	03.11.2008	11.41	12.00	19° 53.86 N	88° 55.73 E	200 m	Yes
103	SBE1-103	107	TS2075	03.11.2008	14.41	14.54	19° 52.92 N	88° 52.74 E	200 m	No
104	SBE1-104	108	TS2076	03.11.2008	17.36	17.47	19° 52.63 N	88° 50.13 E	200 m	No
105	SBE1-105	109	TS2077	System Hang	20.37	21.36	19° 52.19 N	88° 47.73 E	1000 m	Yes
106	SBE1-105A	110	TS2077A	03.11.2008	22.07	22.34	19° 52.33 N	88° 46.52 E	500 m	Yes
107	SBE1-106	111	TS2078	03.11.2008	23.36	23.53	19° 52.70 N	88° 45.38 E	200 m	Yes
107	SBE1-107	112	TS2079	04.11.2008	02.36	02.50	19° 53.67 N	88° 43.09 E	200 m	No
108	SBE1-108	113	TS2080	04.11.2008	05.33	05.45	19° 53.94 N	88° 44.09 E	200 m	No
109	SBE1-109	114	TS2081	04.11.2008	09.05	09.55	19° 56.16 N	89° 00.60 E	1000 m	No
110	SBE1-110	115	TS2082	04.11.2008	11.37	11.56	19° 54.87 N	89° 00.58 E	200 m	Yes
111	SBE1-111	116	TS2083	04.11.2008	14.38	14.50	19° 52.52 N	89° 59.48 E	200 m	No
112	SBE1-112	117	TS2084	04.11.2008	17.36	17.50	19° 50.29 N	89° 57.99 E	200 m	No
113	SBE1-113	118	TS2085	04.11.2008	20.34	20.46	19° 48.59 N	88° 56.03 E	200 m	No
114	SBE1-114	119	TS2086	04.11.2008	23.33	23.53	19° 47.87 N	88° 53.50 E	200 m	Yes
115	SBE1-114A	120	TS2086A	05.11.2008	00.22	00.27	19° 47.68 N	88° 52.68 E	10 m	Yes
116	SBE1-115	121	TS2087	05.11.2008	02.34	02.48	19° 47.47 N	88° 50.67 E	200 m	No
117	SBE1-116	122	TS2088	05.11.2008	05.37	05.50	19° 56.52 N	88° 00.03 E	200 m	No
118	SBE1-117	123	TS2089	05.11.2008	08.40	09.35	19° 56.19 N	88° 59.39 E	1000 m	Yes
118	SBE1-118	124	TS2090	05.11.2008	11.40	12.01	19° 55.17 N	88° 58.53 E	200 m	No

DELAYED DUE TO BUOY OVERLAPPED WITH CT

TD data quality less

CTD data quality less



119	SBE1-119	125	TS2091	05.11.2008	14.37	14.49	19° 53.97 N	88° 59.62 E	200 m	No
120	SBE1-120	126	TS2092	05.11.2008	17.37	18.03	19° 52.38 N	88° 59.70 E	500 m	No
121	SBE1-121	127	TS2093	05.11.2008	20.34	21.27	19° 50.89 N	88° 59.06 E	1000 m	Yes
122	SBE1-122	128	TS2094	05.11.2008	23.41	00.07	19° 49.49 N	88° 57.27 E	200 m	No
123	SBE1-123	129	TS2095	06.11.2008	02.36	03.33	19° 48.23 N	88° 55.62 E	1000 m	Yes
stations data										
124	SBE1-124	3	SK251A03	06.11.2008	06.46	07.25	19° 46.57 N	89° 13.55 E	600 m	Yes
125	SBE1-125	4	SK251A04	06.11.2008	11.34	12.14	20° 13.28 N	89° 12.85 E	600 m	Yes
126	SBE1-126	5	SK251A05	06.11.2008	16.03	16.41	20° 13.60 N	88° 45.91 E	600 m	Yes

127	SBE1-126A	6	SK251A05A	06.11.2008	17.16	17.20	20° 13.18' N	88° 44.27' E	75 m	Yes
128	SBE1-127	7	SK251A06	06.11.2008	21.40	22.22	19° 46.35' N	88° 46.51' E	600 m	Yes
129	SBE1-128	8	SK251A07	07.11.2008	03.07	04.38	19° 49.84' N	88° 16.76' E	1000 m	Yes
130	SBE1-128A	9	SK251A7A	07.11.2008	05.08	05.26	19° 47.59' N	88° 15.75' E	150 m	Yes
131	SBE1-129	10	SK251A08	07.11.2008	09.29	10.16	19° 50.40' N	87° 46.40' E	600 m	Yes
132	SBE1-130	11	SK251A09	07.11.2008	14.18	15.33	19° 50.29' N	87° 15.50' E	500 m	Yes
133	SBE1-131	12	SK251A10	07.11.2008	18.12	19.31	19° 50.29' N	86° 52.98' E	100 m	Yes
134	SBE1-132	13	SK251A11	07.11.2008	21.20	21.34	19° 50.95' N	86° 38.08' E	100 m	Yes
135	SBE2-126A	x	No cast	09.11.2008	12:05	12:15	16° 10.00' N	81° 44.58' E	57 m	No
136	SBE2-127	x	No cast	09.11.2008	13:15	13:30	16° 09.46' N	81° 45.30' E	100 m	No
137	SBE2-128	x	No cast	09.11.2008	14:45	15:15	16° 07.73' N	81° 47.02' E	315 m	No
138	SBE2-128A	x	No cast	09.11.2008	17:20	17:55	16° 06.13' N	81° 49.33' E	446 m	No
139	SBE2-129	x	No cast	09.11.2008	22:40	23:20	15° 39.50' N	81° 54.87' E	2007 m	No
140	SBE2-130	x	No cast	10.11.2008	05:25	06:15	15° 16.48' N	82° 04.30' E	2200 m	No

Total stations Operated

138

Number of IDRONAUT CTDoperated

140

Number of SBE - SK portable CTD operated

107

Number of SBE - NIO portable CTD operated

57

Number of casts operated together with NIO's and SK's CTD's

18

Table 7.2 Details of water sampling for biological and chemical parameters during SK251A cruise.  
[POM: Particulate Organic Matter, DO: Dissolved Oxygen, TSM: Total Suspended Matter,  
DOC: Dissolved Organic Carbon, DIC: Dissolved Inorganic Carbon]

Sr.No.	Stn. no.	Latitude	Longitude	Date	Time (IST) Start - End	Sampling depth (m)	Parameters analysed	
							Biology	Chemistry
1	1	20°17.1' N	87° 51.82' E	24.10.08	06:40 – 07:04	100	Chlorophyll (bulk)	DO, Nutrients (NO <sub>3</sub> , NO <sub>2</sub> , PO <sub>4</sub> , NH <sub>4</sub> , Si)
2	4	20°16.0' N	87° 44.26' E	24.10.08	10:36 -11:03	100	Chlorophyll (bulk)	Nutrients
3	6	20°12.4' N	87° 46.92' E	24.10.08	11:50 -12:10	90	”	”
4	8	20°12.7' N	87° 43.90' E	24.10.08	19:25 - 19:48	100	”	”
5	18	20°11.9' N	87°30.29' E	25.10.08	06:36 - 06:43	100	”	”
6	21	20°10.9' N	87° 24.48' E	25.10.08	09:32 - 09:50	100		POM
7	22	20°10.4' N	87° 22.44' E	25.10.08	10:43 - 11:11	100	Chlorophyll (bulk)	Nutrients
8	26	20°07.8' N	87° 16.18' E	25.10.08	14:36 - 14:58	100	”	”
9	28	18°41.7' N	84° 59.69' E	26.10.08	16:05 - 16:29	100	”	”
10	33	19°55.1' N	89° 01.56' E	28.10.08	13:36 - 13:56	200	Phytoplankton Chlorophyll (bulk), HPLC, Size fractionation, TBC, TVC	Nutrients, Urea, DO, TSM, pH, DIC, DOC, POM
11	41	19°52.4' N	88° 55.33' E	29.10.08	00:05 - 00:31	200	”	”
12	52	19°58.7' N	88° 59.05' E	29.10.08	12:06 - 12:44	200	”	”
13	63	19°55.5' N	89° 03.08' E	30.10.08	00:28 - 01:18	200	”	”
14	71	19°54.0' N	88° 56.70' E	30.10.08	11:38 - 12:10	200	”	”
15	72	19°54.0' N	88° 52.70' E	30.10.08	14:34 - 15:41	300, 500, 700, 900, 1000	-	POM
16	75	19°57.9' N	89° 01.32' E	30.10.08	23:41 - 00:07	200	Phytoplankton Chlorophyll (bulk), HPLC, Size fractionation, TBC, TVC	Nutrients, Urea, DO, TSM, pH, DIC, DOC, POM
17	79	19°44.4' N	89° 04.95' E	31.10.08	11:31 - 12:11	200	”	”
18	83	19°53.8' N	88° 55.07' E	31.10.08	23:14 - 00:04	200	”	”
19	87	19°52.4' N	88° 56.24' E	01.11.08	11:48 - 12:11	200	”	”
20	91	19°44.4' N	89° 03.15' E	01.11.08	23:48 - 00:07	200	”	”
21	95	19°55.2' N	88° 57.88' E	02.11.08	11:40 - 11:58	200	”	”

22	99	19°53.6' N	88° 56.11' E	02.11.08	23:37 - 23:57	200	”	”
23	103	19°53.6' N	88°55.73' E	03.11.08	11:41 - 12:00	200	”	”
24	107	19°52.0' N	88°45.38 ' E	03.11.08	23:36 - 23:53	200	”	”
25	125	19°46.7' N	89°13.55' E	06.11.08	06:46 -07:25	200	”	”
26	126	20°13.8' N	89°12.85' E	06.11.08	11.34 - 12.14	200	”	”
27	127	20°13.0' N	88°45.87' E	06.11.08	16:03 -16.41	200	”	”
28	127	20°13.8' N	88°44.27' E	06.11.08	17:16 - 17:20	75	”	”
29	128	19°46.5' N	88°46.51' E	06.11.08	21:40 - 22:22	200	”	”
30	129	19°47.9' N	88°15.75' E	07.11.08	05.08 - 05.26	150	”	”
31	130	19°50.0' N	87°46.40' E	07.11.08	09.29 - 10.16	200	”	”
32	133	19°50.5' N	86°38.08' E	07.11.08	21.20 - 21.34	200	”	”

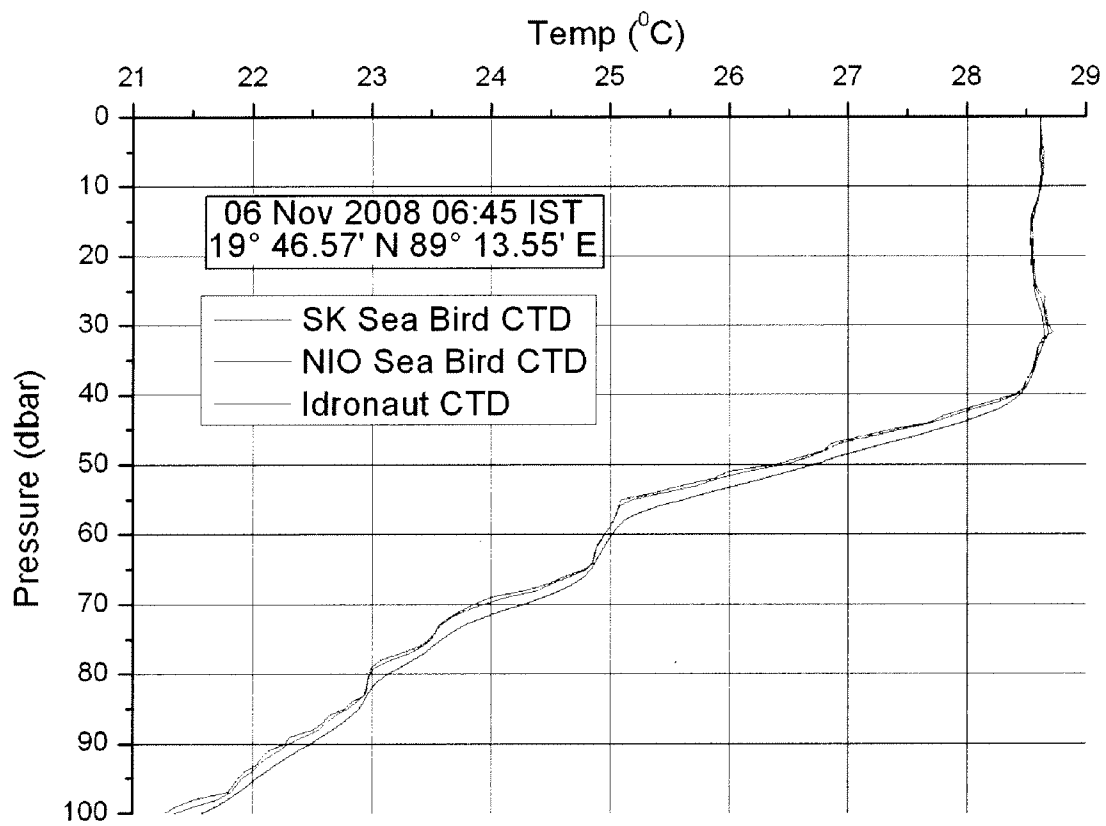
Total stations operated (for CTD): 138

Total stations for chemistry and biology parameters: 31

Table 7.3 **RADIOMETER DATA LOG - SK251A**

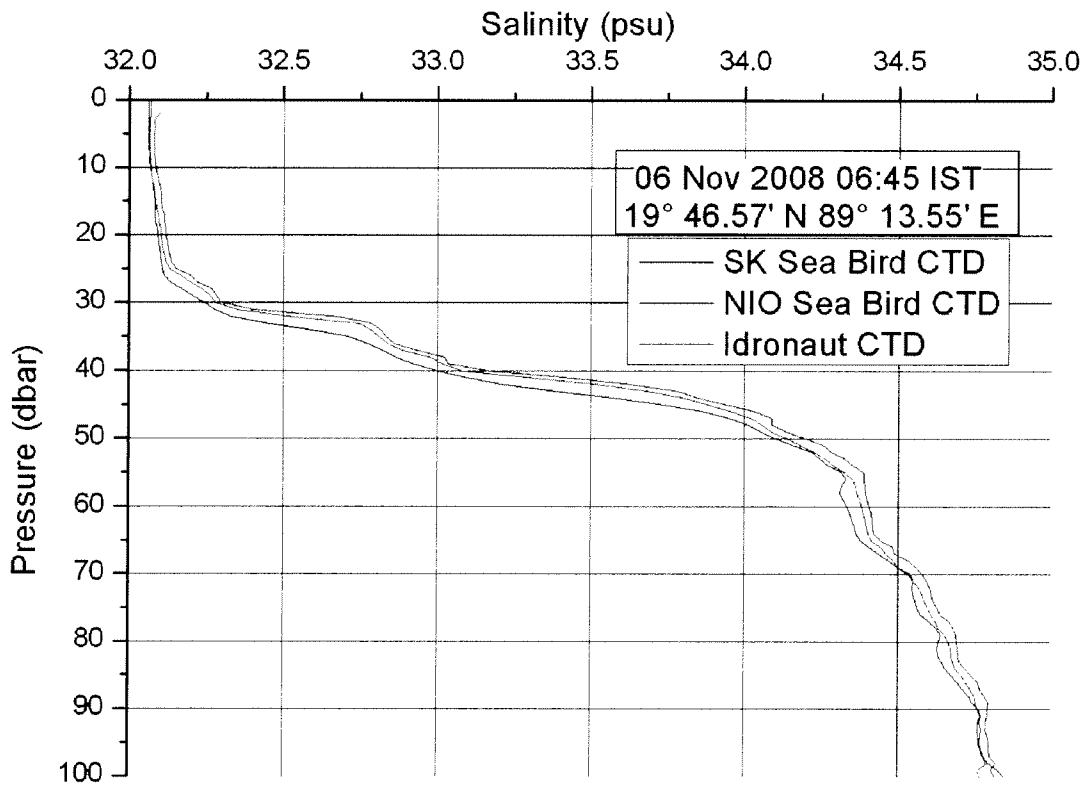
Meas. No	Date	Time (hrs)	Position		Station ID	Depth (M)	Remarks
			Lat ( $^{\circ}$ N)	Long ( $^{\circ}$ E)			
1	26-10-2008	12:00	20°10.60	87°23.07	St25	178	Partial cloud
2	28-10-2008	08:30	19°57.22	89°03.91	St26	1445	Partial cloud
3	28-10-2008	10:30	19°55.75	89°06.24	St27	1459	Sunny
4	28-10-2008	13:00	19°56.22	89°01.54	St28	1313	Sunny
5	28-10-2008	14:45	19°53.18	89°00.96	St29	1504	Sunny
6	28-10-2008	16:30	19°50.19	89°59.59	St30	1483	Clear Sky
7	29-10-2008	08:30	19°57.58	89°56.93	St31	1305	Sunny
8	29-10-2008	10:30	19°58.98	88°55.91	St32	1308	Sunny
9	29-10-2008	12:30	19°58.65	88°59.10	St33	1269	Sunny
10	29-10-2008	14:30	19°58.00	89°00.92	St34	1306	Sunny
11	29-10-2008	16:30	19°58.26	89°02.07	St35	1313	Partial cloud
12	30-10-2008	08:00	19°54.15	88°59.51	St36	1472	Sunny
13	30-10-2008	10:00	19°52.08	88°56.51	St37	1362	Sunny
14	30-10-2008	12:00	19°54.39	88°56.66	St38	1333	Sunny
15	30-10-2008	14:00	19°54.56	88°53.75	St39	1383	Sunny
16	30-10-2008	16:00	19°55.49	88°51.56	St40	1379	Sunny
17	31-10-2008	08:00	19°50.05	89°06.47	St41	1358	Sunny
18	31-10-2008	10:00	19°46.98	89°05.85	St42	1506	Sunny
19	31-10-2008	12:00	19°43.63	89°04.82	St43	1591	Sunny
20	31-10-2008	14:00	19°40.49	89°04.03	St44	3143	Sunny
21	11/01/2008	08:00	19°53.77	88°54.21	St45	1389	Sunny
22	11/01/2008	10:00	19°53.44	88°55.13	St46	1377	Sunny
23	11/01/2008	12:00	19°52.44	88°56.24	St47	1373	Sunny
24	11/01/2008	14:45	19°53.94	89°01.11	St48	1477	Sunny
25	11/01/2008	16:00	19°52.87	89°01.64	St49	1552	Cloudy
26	11/02/2008	08:00	19°56.09	89°00.24	St50	1312	Sunny
27	11/02/2008	10:00	19°55.59	89°59.14	St51	1257	Sunny
28	11/02/2008	12:00	19°55.25	89°57.63	St52	1296	Sunny
29	11/02/2008	14:00	19°54.92	88°56.54	St53	1329	Passing Cloud
30	11/02/2008	16:00	19°54.88	88°55.69	St54	1342	Passing Cloud





Comparison of Temperature profiles from the 3 CTDs at station #03

Figure 1 Intercomparison of water temperature profiles obtained from Idronaut CTD, SK-Sea Bird CTD and NIO Sea Bird CTD at station #03 in the northern Bay of Bengal.



Comparison of Salinity profiles from the 3 CTDs at station #03

Figure 2 Intercomparison of salinity profiles obtained from Idronaut CTD, SK-Sea Bird CTD and NIO Sea Bird CTD at station #03 in the northern Bay of Bengal.



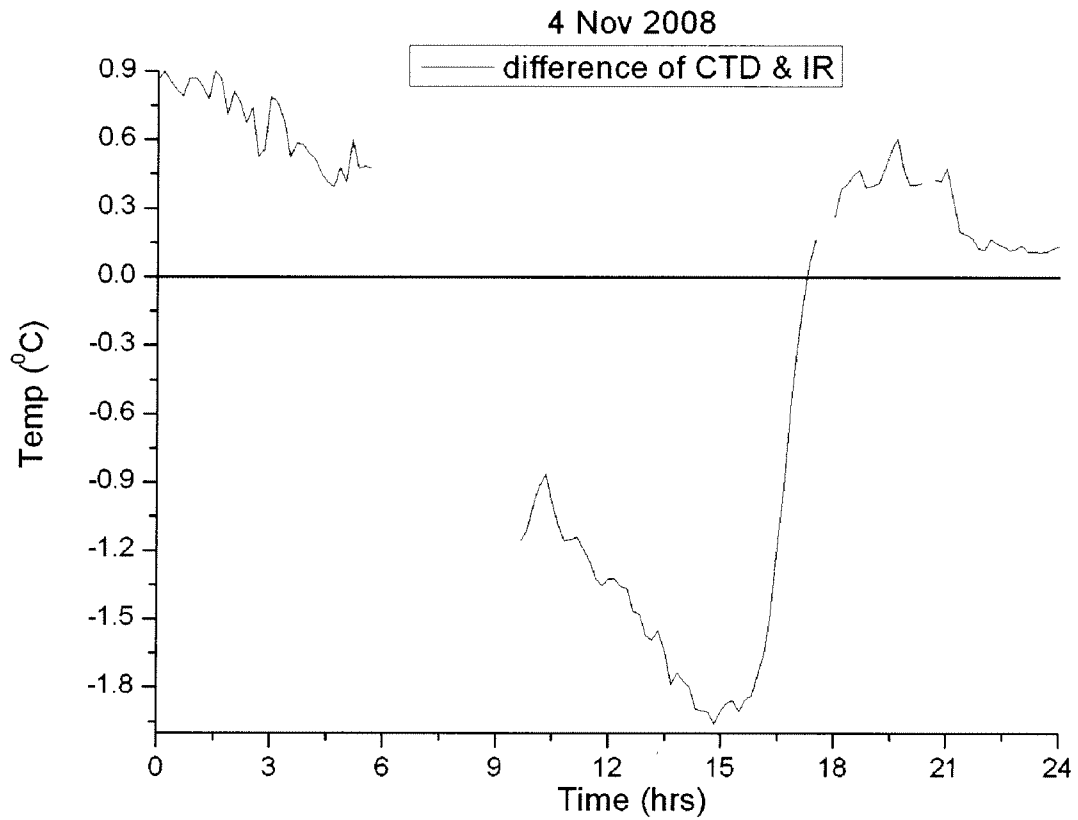


Figure 3 Difference of water temperature at 1.5 m depth as obtained from Sea Bird CTD and skin sea surface temperature as obtained from IR Pyrometer on 4 November 2008.

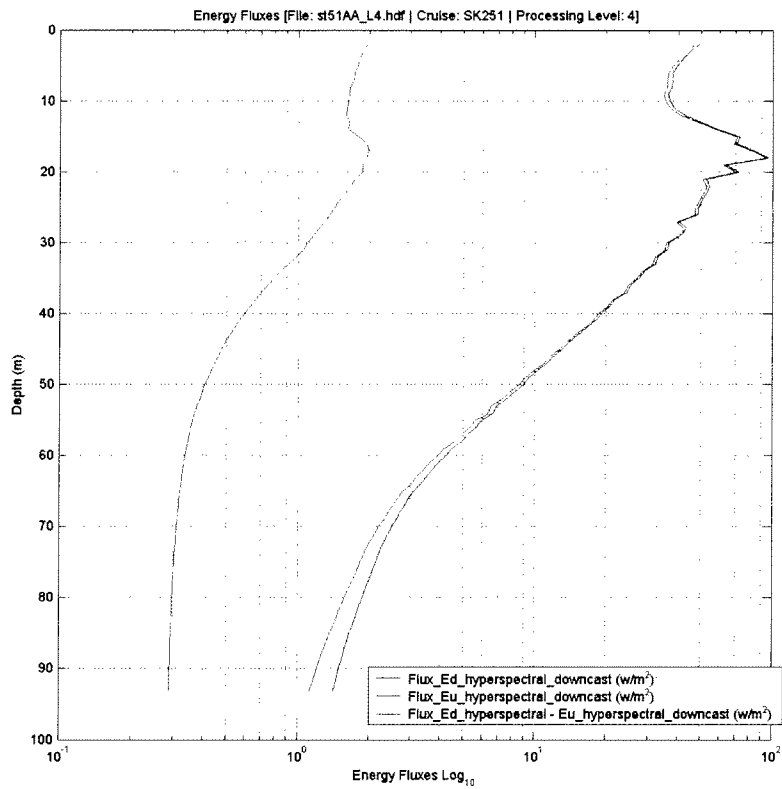
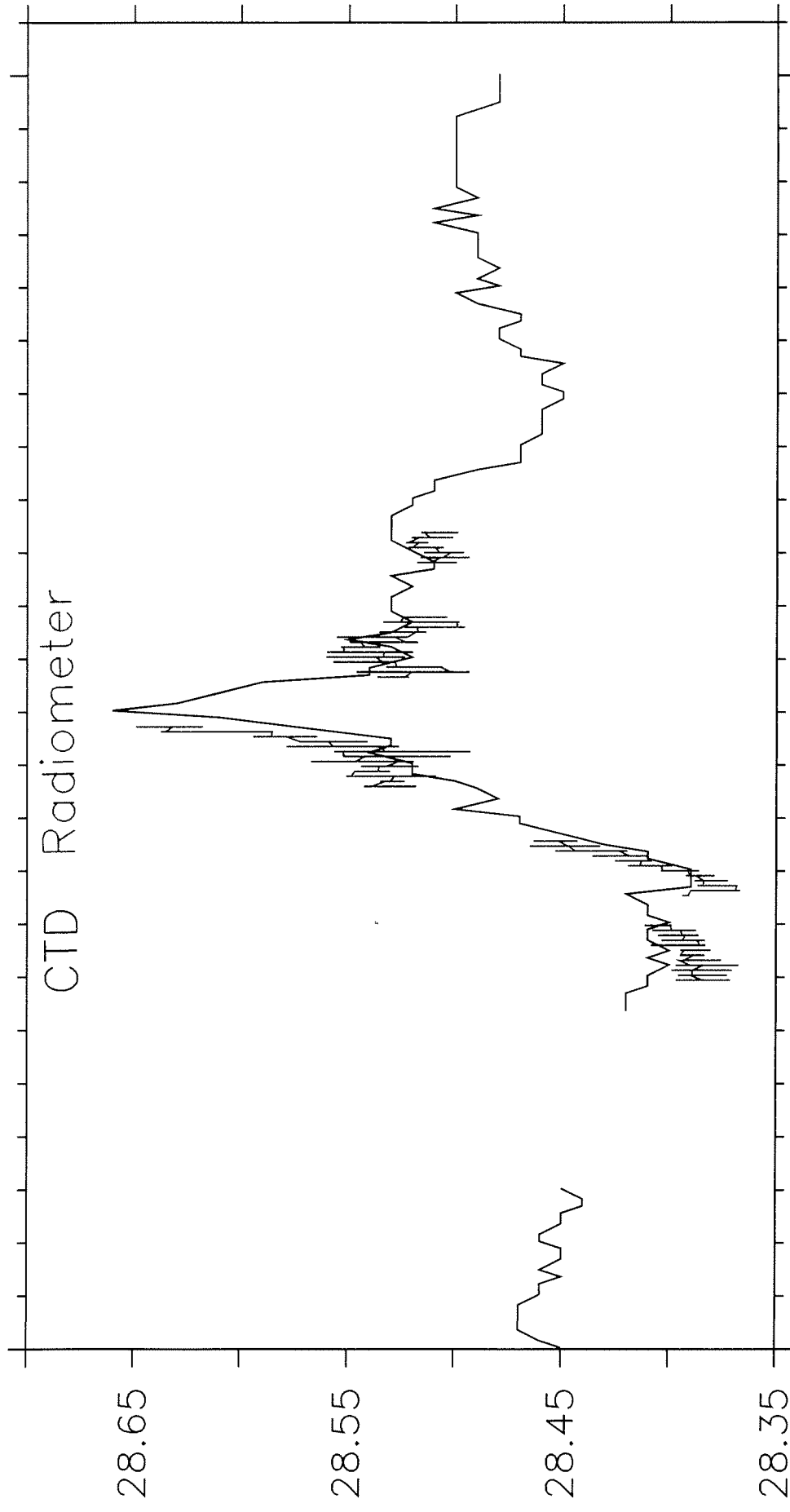


Figure 4 Profiles of Irradiance at a station as measured by Radiometer  
in the northern Bay of Bengal

SST (°C)



0001 0203 0405 0607 0809 1011 1213 1415 1617 1819 2021 2223 0001

NOV 5