

SK 244 Tropical Indian Ocean Programme



Cruise report

27th January to 13th February 2008

ACKNOWLEDGEMENT

We the scientific team of SK 244 onboard Sagar Kanya thankfully acknowledge the Secretary, Ministry of Earth Sciences for all the helps provided by him for the successful implementation of the Tropical Indian Ocean Programme. We are grateful to Director NCAOR and Dr. Sudhakar, GD OSSG for their constant encouragement in the planning and execution of this expedition and for providing us the invaluable ship time of Sagar Kanya. We thank the Captain, all SCI Officers and crew members onboard Sagar Kanya for their efficiency in navigating the vessel and the support provided by them in collection of oceanographic data successfully along the predefined cruised track. We acknowledge the catering officer and all his supporting staff for serving us delicious and homely food. We thank NORINCO Engineers regarding the service provided by them for operating all the required scientific equipments onboard for the successful completion of this cruise.



[N. ANILKUMAR]

CHIEF SCIENTIST

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1. Embarkation

Sagar Kanya sailed from Marmagao port at 20:15 hrs after the embarkation of all scientists and crew members onboard. The vessel headed to 10°N 69°30'E, the first location for all the scientific operations of this cruise programme. A pre cruise meeting was held onboard including all Scientists, Ship Officers and Norinco engineers for discussions regarding the operations to be carried out in the predefined cruise track.

2. Objectives and expected results

1. A comprehensive understanding of the physical, chemical, geological and biological aspects of the tropical Indian Ocean. Studies related to the Warm pool, Equatorial Current system, Water masses and Zonal transport are the key importance of this investigation.
2. Microscopic studies using diatoms and coccolithophores obtained from water sample collected.
3. To assess the amount of chlorophyll present in the water column using Fluoro probe
4. To understand the nutrient chemistry of the study region from the water sample collected from different depths.
5. The meteorological archive will be useful for a comprehensive understanding of the climatic variabilities
6. To determine the total quantity of chlorophyll by spectrophotometric method.
7. To study the abundance of zooplankton.
8. To determine total bacterial biomass
9. Microbial studies.

The results obtained from the hydrographic data (XBT, CTD) collected in the tropical Indian Ocean during 27th January -13th February, 2008 when compared to the previous studies attributed to the significant annual changes occurring in the upper ocean thermal structure and vertical extent of the warm pool. This data is essential for understanding variation in the boundary of the equatorial current system and its east west transport in the equatorial region. This strong current system can influence the vertical variation of

diatoms present in this region. Diatoms are unicellular, sometimes colony forming eukaryotic microscopic algae, which live free floating or attached to surfaces in fresh-waters and in the oceans. Diatoms are extremely abundant in both fresh-water and marine environments and comprising approximately 23% primary productivity of the world. In sea waters, phosphates and nitrate are usually limited compared to fresh-water conditions and that is why, mostly, open oceans are oligotrophic (poor in nutrients), reflecting on the species composition of diatoms. In order to assess the amount of chlorophyll present in the water column an instrument named “Fluoroprobe” was operated. This is an instrument, which gives *in situ* Chlorophyll amount along with the algal classes present. Variations of equatorial current system are highly correlated with seasonal changes of Indian monsoon. Tropospheric aerosols have always been a subject of research and attraction due to high variability in their optical properties, the transport and their contribution to the overall climate radiative forcing. To analyze the impact of aerosols on global/ regional level, understanding, measurement and behavior of these is to be done /taken at local level and over different environments.

With a view to understand and analyze the climatology over marine environment and particularly over part of Indian Ocean, hand held Sunphotometer that measures the Aerosol Optical Depth (AOD) in five different wavelengths was used in the expedition from Lat : 15°N to 6°S on all clear sky conditions. This was also clubbed with the measurement of aerosol carbon particles. The diurnal variation of AOD has been measured on all clear days of the expedition. These have to be studied in relation with the meteorological parameters for their optical properties and the behavior.

For understanding the biogeochemistry of the tropical Indian Ocean a detailed data collection was planned at every one degree latitude from 10°N onwards including the water sample collection from different depths. These all data archive will be useful for detailed approach for climatic variabilities.

3. Participating Organizations

- 1. NATIONAL CENTRE FOR ANTARCTIC & OCEAN RESEARCH (NCAOR)**
- 2. INDIAN INSTITUTE OF REMOTE SENSING (IIRS)**
- 3. NORINCO**

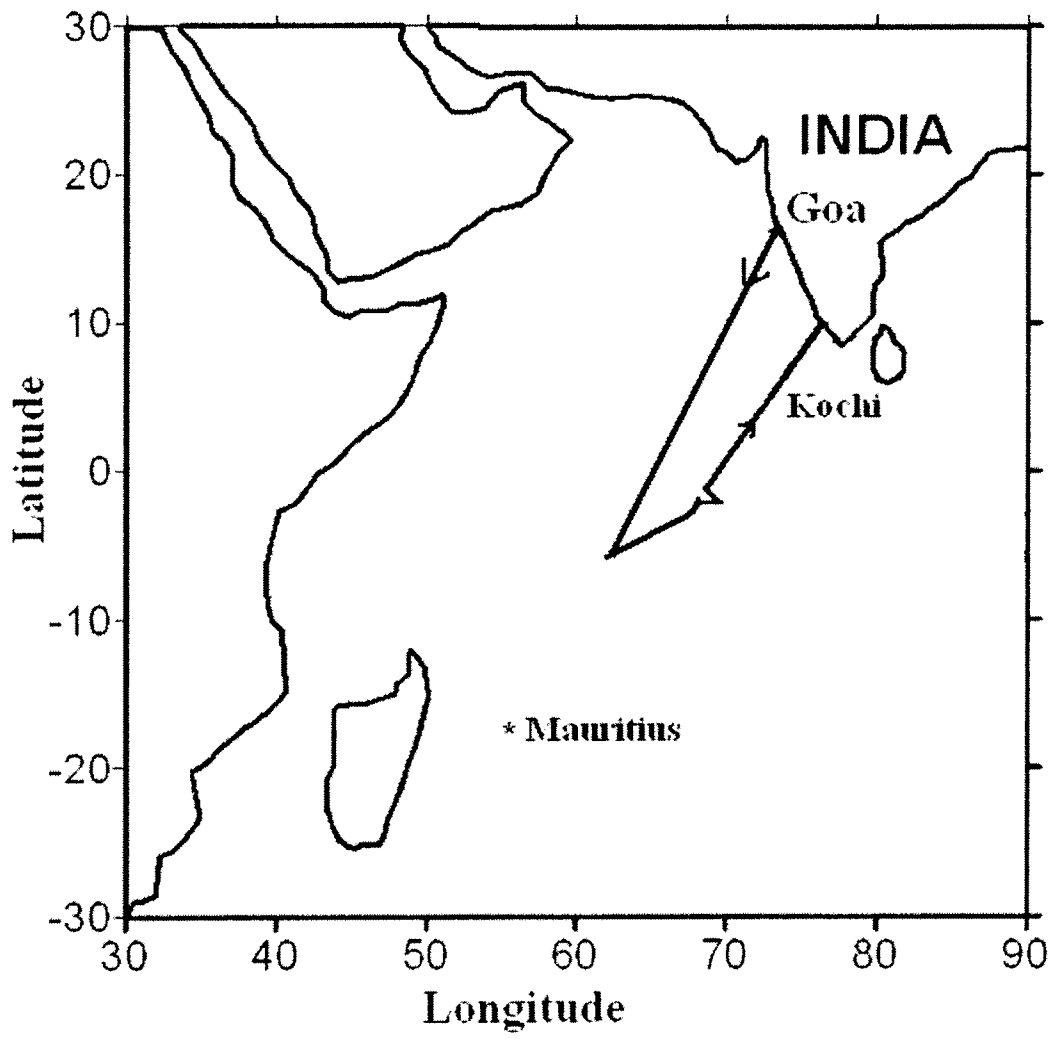


Fig. 1 Cruise track

4. List of participants

Sl. No.	NAME	ORGANISATION
1	Dr. N. Anilkumar (Chief Scientist)	NCAOR, GOA
2	Dr. Zeena Jayan (Dy. Chief Scientist)	NCAOR, GOA
3	Dr. Sunil Kumar Shukla	NCAOR, GOA
4	Mr. Shramik M. Patil	NCAOR, GOA
5	Ms. Racheal Chacko	NCAOR, GOA
6	Ms. Sharon Noronha	NCAOR, GOA
7	Mr. Manoj M. C	NCAOR, GOA
8	Dr. Yogesh Kant	IIRS, DEHRADUN
9	Mr. Biju V. Nair	NORINCO
10	Mr. Hafizur Rehman	NORINCO
11	Mr. Mathew Mebish	NORINCO
12	Mr. P.P. Raigon	NORINCO
13	Mr. Vithu Naik	NORINCO
14	Mr. Sandeep Chavan	NCAOR, GOA (Ship board trainee)
15	Mr. Manish Bamania	NCAOR, GOA (Ship board trainee)

5. Equipments operated

- 1) Single beam Echo sounder
- 2) Fluoroprobe
- 3) Conductivity Temperature Depth [CTD] with rosette samplers
- 4) Expendable Bathythermograph (XBT)
- 5) Gravity corer
- 6) Automatic Weather Station
- 7) Meteorological observations
- 8) Wind sensor, Wet Bulb-Dry Bulb and atmospheric pressure
- 9) Sunphotometer and Aethalometer

6. Observations (Day to day basis)

Table-1 Observation details

STN. No	DATE	START TIME [IST]	END TIME [IST]	LAT	LONG[E]	STN. DEPTH[m]	INSTRUMENTS OPERATED
1	29-Jan-08	13:00	19:30	10 00.00N	69 30.00	4520	CTD,FLUROPROBE, ARGO,DRIFTER
2	30-Jan-08	04:00	07:00	09 00.00N	68 56.99	4600	CTD,FLUROPROBE
3	30-Jan-08	14:00	17:00	08 00.00N	68 21.99	4600	CTD,FLUROPROBE, ARGO
4	30-Jan-08	23:00	02:00	07 00.00N	67 49.99	5515	CTD,FLUROPROBE
5	31-Jan-08	09:00	13:25	06 00.00N	67 18.99	3780	CTD,FLUROPROBE, MPN, ARGO
6	31-Jan-08	20:00	22:30	05 00.00N	66 41.00	4600	CTD,FLUROPROBE, MPN
7	01-Feb-08	06:30	09:30	04 00.33N	66 11.10	3534	CTD,FLUROPROBE, MPN,ARGO
8	01-Feb-08	17:30	20:00	02 44.99N	65 32.99	5327	CTD,FLUROPROBE, MPN
9	02-Feb-08	03:00	06:30	02 00.00N	65 04.00	3615	CTD,FLUROPROBE, MPN,ARGO,DRIFTER
10	02-Feb-08	13:00	16:00	01 00.00N	64 34.99	3784	CTD,FLUROPROBE, MPN
11	02-Feb-08	20:30	00:00	00 30.00N	64 18.99	3900	CTD,FLUROPROBE
12	03-Feb-08	04:15	07:00	00 00.00	64 02.91	3253	CTD,FLUROPROBE, MPN,ARGO,DRIFTER
13	03-Feb-08	11:00	14:00	00 29.99S	63 46.99	2900	CTD,FLUROPROBE
14	03-Feb-08	18:00	21:00	01 00.00S	63 31.00	4800	CTD,FLUROPROBE, MPN
15	04-Feb-08	04:00	07:00	02 00.00S	62 56.00	4000	CTD,FLUROPROBE, MPN,ARGO,DRIFTER
16	04-Feb-08	13:00	23:00	03 00.00S	62 31.90	4448	CTD
17	05-Feb-08	07:00	11:30	04 00.00S	61 56.76		CTD,FLUROPROBE, MPN,ARGO,DRIFTER
18	05-Feb-08	22:30	02:30	05 00.16S	61 23.44	3500	CTD
19	06-Feb-08	12:35	16:00	05 56.77S	60 48.85	4282	CTD,ARGO,DRIFTER
20	06-Feb-08	18:25	20:25	03 30.23S	65 14.67	1636	CTD
21	08-Feb-08	02:15	04:30	03 00.00S	66 07.23	4223	CTD,FLUROPROBE, MPN
22	08-Feb-08	09:30	11:00	02 31.85S	66 23.06	3185	CTD
23	08-Feb-08	14:30	17:30	02 00.00S	66 40.05	2523	CTD,FLUROPROBE, MPN
24	09-Feb-08	00:30	04:15	02 02.00S	67 52.00	2835	GRAVITY CORER
25	09-Feb-08	12:15	14:35	01 30.00S	66 57.25	3000	CTD

The cruise track of this expedition is given in Fig. 1 and the station locations in Table 1. It was planned in the pre cruise meeting to carry out XBT observations at 1° interval in the entire cruise track. Sea surface temperature (SST), Sea surface Salinity (SSS) and meteorological parameters will be measured at three hourly intervals every day.

27th January, 2008

Ship was heading to the first CTD station at 10° N. SST, SSS and meteorological observations were carried out at three hourly interval.

28th January, 2008

XBT probes were launched at 14°49'N, 72°50'E, 14°N 71°43'E and 13°N 71°08'E.

29th January, 2008

Station-1 was arrived at 1340 hrs. Station Position 10°N 69°30'E. CTD and Fluoroprobe were operated. Argo Float was deployed at 1930 hrs and vessel sailed to next station position.

30th January, 2008

Arrived station-2 at 0400 hrs. Station Position 9°N 68°57'E. CTD and fluoroprobe were operated. After completion of the operations vessel headed to 8°N latitude.

Station-3 (8°N 68°22'E) was arrived at 1415hrs. CTD and Fluoroprobe operations were carried out. Argo Float was deployed. After completion of these operations the ship sailed towards 7° N.

Station-4 was arrived (07°N' 67°50'E) at 2330 hrs Fluoroprobe and CTD observations were carried out.

31st January, 2008

The ship left from Station-4 at 0200 hrs. Station-5 was arrived at 0900 hrs. Station position 06°N 67°19'E station depth 3780 meters. CTD, Fluoroprobe, Multiple Plankton Net (MPN) were operated at this station. Argo float was deployed. The vessel sailed to the next location at 1325 hrs.

Station-6 was arrived at 2000 hrs. Station location 05°N 66°41'E. Station depth 4600 m. CTD, Fluoroprobe and MPN were operated.

1st February, 2008

Arrived Station-7 at 0630hrs. Station location 04°N 66°11'E. Station depth 3534m. CTD, Fluoroprobe and MPN operations were made at this station. Vessel left the station at 0930 hrs.

Station 8 was arrived at 1730 hrs. Station position 02°45'N 65°33'E. Station depth 2600 m. CTD, Fluoroprobe and MPN operations were carried out at this station.

2nd February, 2008

Arrived Station-9 at 0300 hrs. Station position 02°N E 65°04'E. Station depth 3615 m. CTD, Fluoroprobe and MPN were operated.

Argo floats and surface drifters were deployed. Vessel sailed from the station at 0630 hrs

Reached Station-10 at 1300hrs. Station location 01°N' 64°35'E. Station depth 3784 m. CTD, Fluoroprobe and MPN observations were carried out.

Vessel arrived Station-11 at 2030 hrs. Station location 00°30'N 64°19'E. Station depth 3900 m. Operations: CTD and Fluoroprobe.

3rd February, 2008

Arrived Station-12 (equator) at 0415 hrs. Station location 00° 64°3'E. Station depth 3253 m. CTD, Fluoroprobe and MPN were operated. Argo float and surface drifters were deployed. Vessel left the Station at 0700 hrs.

Arrived Station-13 at 1100 hrs. Station location 00° 30'S, 63° 47'E. Station depth 2900 m. CTD and Fluoroprobe were operated. Vessel sailed from Station-13 at 1400 hrs.

Arrival at station 14: 1800 hrs. Station location 01° S, 63°31'E. Station depth 4800 m. CTD, Fluoroprobe and MPN were operated. The vessel left the Station at 2100 hrs.

4th February, 2008

Arrived Station-15 at 0400 hrs. Station location 02°S, 62°56'E. Station depth 4000 m. CTD, Fluoroprobe and MPN were operated. Argo float and surface drifters were deployed. After completion of above operations, vessel sailed from station 15 at 0700 hrs.

Arrived at Station-16 at 1300 hrs. Station location 03°02'S, 62°32'E. Station depth 4400m. Weather was bad and sea state was ~5. Only CTD operation was carried out and it took more than 10 hrs to complete the operation due to bad weather. Vessel left station at 2300 hrs.

5th February, 2008

Arrived at Station-17 at 0700 hrs. Station location 3°59.67'S, 61°56.76'E. CTD, Fluoroprobe and MPN were operated. Argo floats and surface drifters were deployed at this location. Ship sailed from the Station at 1130 hrs.

Arrived Station- 18 at 2255 hrs. Station location 5°0.16'S, 61°23.44'E. Station depth 3500m. The weather was not sub-sided, hence, the Fluoroprobe and MPN were not operated. Only CTD was operated.

6th February, 2008

Vessel left the station 18 at 0230hrs. Arrived station 19 at 1235 hrs. Station location 5°56.77'S, 60°48.85'E. Station depth 4282 m. CTD was operated. Other operation could not be carried out due to the high sea state (more than 5) and strong winds (nearly 22.0 Knots). Argo floats and Surface drifters were deployed. After completion of all operations vessel headed back to India.

7th February, 2008

Arrived Station-20 at 1825 hrs. Station location 3°30'S, 65°40.67'E. CTD operation was carried out. Vessel left the station at 2015 hrs.

8th February, 2008

Arrived Station-21 at 0235 hrs. Station location 3°S, 66°7.23'E. Station depth 4223 m. CTD, Fluoroprobe and MPN were operated.

Vessel left the Station 0430 hrs and reached Station-22 at 0930 hrs. Station location 2°31.85'S, 66°23.06'E. Station depth 3185 m. CTD operation was carried out. Vessel left from Station-22 at 1050 hrs and arrived Station-23 at 1435 hrs. Station location 02°S, 66°40'E. Station depth 2523 m. CTD, Fluoroprobe and MPN were operated. Vessel left the Station at 1730 hrs.

9th February, 2008

Vessel headed to the coring location (2°2'S, 67°52'E). Arrived Station 24 [coring location] at 0125 hrs. Station depth 2835 m. Gravity corer was operated. A core of length 5.4 m was collected. The core was sub-sampled into 1 m length and kept in the cold room for further analysis. Vessel left the Station-24 at 0435 hrs and reached Station-25 at 1215 hrs. Station location 01°30'S, 66°57.25'E. Station depth 3000 m. CTD operation was

done. The vessel left the Station at 1435 hrs and headed to Kochi for Port call. All the synoptic observations were continued till the end of cruise.

10th February, 2008

Argo float and surface drifters were deployed at 01°68.16'E

11th February, 2008

Argo float was deployed at 03°6923'E. The vessel was heading to Kochi. All the synoptic observations were continued.

7. Geological Sampling for Paleoclimatic Studies

Water samples:

The water samples from 10°N to 6°S in the onward track and 3°S and 2° S in the return track were sampled at 0, 50, 100, 150 and 200 of water depth to assess the snap shot variation in coccolithophores (calcareous) and diatoms (siliceous). These two groups of micro fauna are important because they transfer a huge amount of carbon to the ocean bottom. The water samples collected were filtered onto weighed nucleopore filters of 0.4 micron. Dried on board, for analysis on shore using a Scanning Electron Microscope. The data generated would be correlated with the in situ data of the physical parameters at these locations. Further, it would be interesting to understand the variation down the southern latitudes as different water masses are encountered.

Sediment core sample:

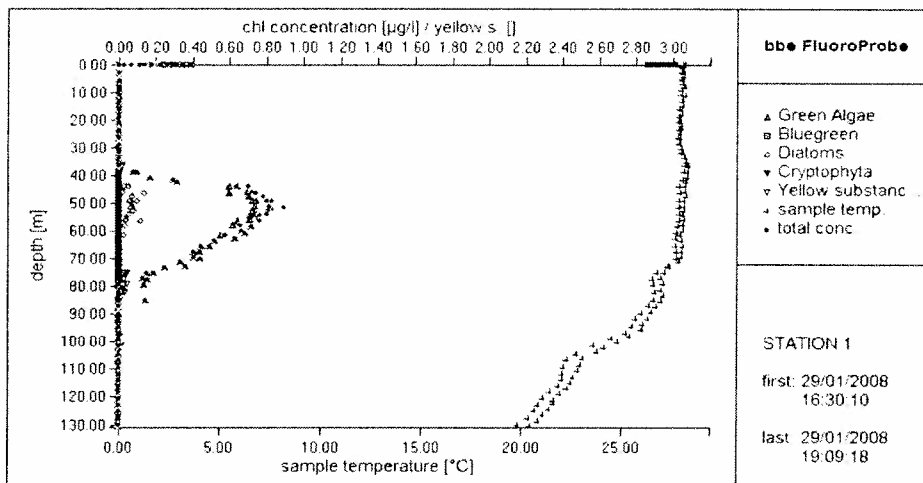
A sediment core (gravity core) was taken at 2°02'S latitude and 67°52' E longitude degree at a water depth of 2500 m. It was a near 5.4 meter core (540 cm). The core was sub sampled into 1m length and sealed with core caps. The sub sampled core samples were stored in a cold room for further analysis in the Laboratory on shore.

The two reasons for selecting such a site was primarily to assess the dominance in this region since this area could be the boundary of the eastward flowing South Equatorial Counter Current [SECC] and westward flowing South Equatorial current [SEC]. Secondly to assess whether physiography of the area (ridge system-in close vicinity) plays a role in the sedimentation pattern.

Fluoroprobe:

In order to assess the amount of chlorophyll present in the water column an instrument named “Fluoroprobe” was operated. This is an instrument, which gives in situ Chlorophyll amount along with the algal classes present. The Chlorophyll maximum is important as all biological processes happening are all directly or indirectly dependent on the production of chlorophyll. The chlorophyll maxima are around 50-65 m of water depth in the area of sampling.

a)



b)

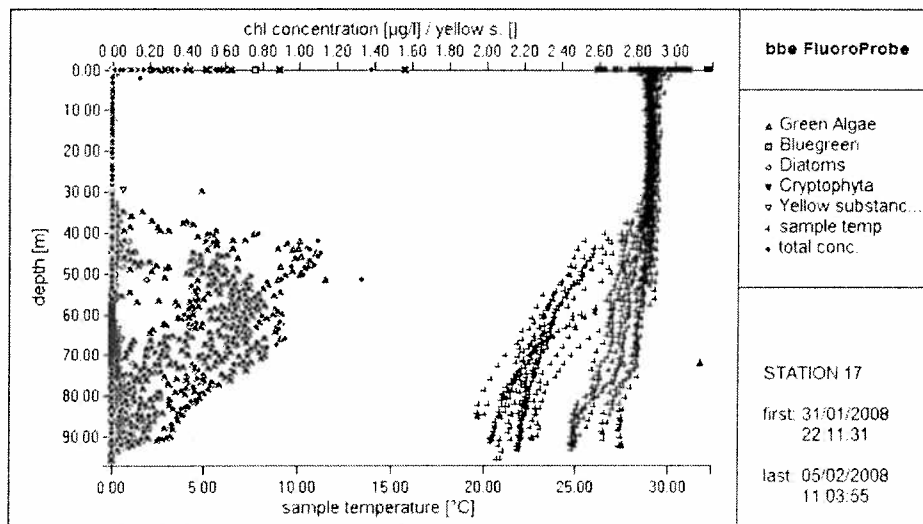


Fig. 2 Chlorophyll concentration at a) 10°N and b) 06°S

8. Hydrographic parameters

Table-2 Argo Floats deployment details

Sl. No.	Float No.	Source	Date of Reset	Time of Reset	Actual Deployment Location	Date of Deployment	Time of Deployment	3 - Plugs to be removed	Remarks	
					Latitude	Longitude	hrs [IST]		Stan Depth[m] & ship speed [knots]	
1	2699	UK MET OFFICE	29-01-08	10:25	09 59.81N	69 29.77E	29-Jan-08	19:30	yes	4530m, 1.2knt
2	2701	UK MET OFFICE	29-01-08	10:30	07 59.98N	68 21.99E	30-Jan-08	17:00	yes	4600m, 1.1knt
3	2700	UK MET OFFICE	31-01-08	01:55	05 59.76N	67 18.88E	31-Jan-08	13:25	yes	4334m, 1.8knt
4	2697	UK MET OFFICE	31-01-08	23:45	03 59.90N	66 10.89E	01-Feb-08	09:45	yes	3534m, 1.5knt
5	2999	NIOT	01-02-08	18:02	01 59.90N	65 03.78E	02-Feb-08	06:45	yes	3615m, 1.8knt
6	2929	NIOT	01-02-08	18:04	00 00.13S	64 02.67E	03-Feb-08	07:30	yes	3253m, 1.8knt
7	3002	NIOT	01-02-08	18:06	02 00.16S	62 55.95E	04-Feb-08	07:05	yes	3986m, 1.8knt
8	2930	NIOT	01-02-08	18:09	03 59.42S	62 04.33E	05-Feb-08	12:40	yes	6081m, 1.8knt
9	2928	NIOT	01-02-08	18:11	05 56.76S	60 50.55E	06-Feb-08	13:20	yes	4000m, 1.8knt
10	2927	NIOT	01-02-08	18:13	01 00.25N	68 16.40E	10-Feb-08	09:25	yes	3695m, 1.6knt
11	2926	NIOT	01-02-08	18:15	03 10.00N	69 23.15E	11-Feb-08	00:30	yes	3415m, 1.8knt

Table- 3 Surface drifters deployment details

Sl. No.	Float No.	Deployer	Date of Reset	Time of Reset	Actual Deployment Location	Date of Deployment	Time of Deployment	Remarks
					Latitude	Longitude		
1	71137	NIO	2/2/2008	05:45 hrs	1° 59.75'N	65° 03.74'E	2/2/2008	06:50 hrs Station Depth 3651m. Ship Speed 2.2knt
2	71138	NIO	2/1/2008	05:45 hrs	1° 59.75'N	65° 03.74'E	2/2/2008	06:52 hrs Station Depth 3651m. Ship Speed 2.2knt
3	71139	NIO	3/2/2008	06:35 hrs	0° 00.15'S	64° 02.69'E	3/2/2008	07:33 hrs Station Depth 3253m. Ship Speed 2.3knt
4	71140	NIO	3/2/2008	06:35 hrs	0° 00.15'S	64° 02.69'E	3/2/2008	07:35 hrs Station Depth 3253m. Ship Speed 2.3knt
5	71141	NIO	3/2/2008	19:25 hrs	01° 00.13'S	63° 30.85'E	3/2/2008	20:59 hrs Station Depth 4800m. Ship Speed 2.3knt
6	71142	NIO	3/2/2008	19:25 hrs	01° 00.13'S	63° 30.85'E	3/2/2008	21:00 hrs Station Depth 4800m. Ship Speed 2.3knt
7	71143	NIO	4/2/2008	06:40 hrs	02° 00.20'S	62° 55.93'E	4/2/2008	07:30 hrs Station Depth 4800m. Ship Speed 2.3knt
8	24010	NIOT	24/01/08	17:30 hrs	03° 59 .55'S	62° 04.33'E	5/2/2008	12:45 hrs Station Depth 6081m. Ship Speed 2.6knt
9	21030	NIOT	24/01/08	17:30 hrs	05° 56.73'S	60° 50.50'E	6/2/2008	13:25 hrs Station Depth 4000m. Ship Speed 2.8knt
10	27600	NIOT	24/01/08	17:30 hrs	01° 00.35'N	68° 17.45'E	10/2/2008	09:25 hrs Station Depth 3695m. Ship Speed 2.6knt
11	24430	NIOT	24/01/08	17:30 hrs	-	-	-	- Not Deployed.

Table-4 XBT operations**SK-244 XBT Data**

Sl. No.	DATE	TIME	LATITUDE	LONGITUDE	DEPTH	SHIP SPEED	SST	SALINITY
					m	knts	deg C	ppt
1	28-Jan-08	02:50	14 49.34	72 50.17	963		27.5	34.28
2		10:45	14 00	71 42.82	1633	10.2		
3		17:15	13 00	71 07.52	2239	10.7	28	36.44
4		23:30	12 00	70 35.78	3490	11.1	26	36.11906
5	29-Jan-08	06:00	11 00	70 02.36	4356	10.4	27.5	33.75625
6		09:30	10 29.16	69 44.89	4489	9.7	27.5	34.44709
7		20:50	9 30.00	69 13.21	4366	10	28	33.8528
8	30-Jan-08	10:37	8 29.16	68 39.9	4602	11.01	29	34.19597
9		20:20	7 30.00	068 06.08	4706	10.8	27.5	35.47682
10	31-Jan-08	05:35	6 30.00	67 34.57	4597	10.8	28	34.3297
11		16:45	05 30.00	066 59.00	4514	11	28	34.15155
12	01-Feb-08	03:00	04 30.00	066 26.45	3921	10.5	28	34.02206
13		13:00	03 30.00	065 55.48	2888	11	29	34.75958
14		23:05	02 30.00	065 23.35	3150	11	28.5	35.13878
15	02-Feb-08	09:55	01 28.33	064 48.73	3914	10.9	28.5	35.17965
16	03-Feb-08	00:34	00 30.00	64 18.99	3900	5.7	28.5	35.17816
17		00:55	00 28.11	64 18.99	3900	10.4	28.5	35.17816
18		14:35	00 30.00S	63 46.39	3900	10	29	35.28139
19	04-Feb-08	01:15	01 37.69S	63 08.09	5206	10.5	28.5	35.30926
20		10:25	02 30S	62 40.77	4583	10.3	29	35.31874
21	05-Feb-08	03:05	03 30S	62 12.62	4477	7.9	28.5	35.23812
22		18:09	04 29S	61 39.3	3913		28.5	
23	06-Feb-08	06:51	05 29.85	61 04.56	3535		28	
24		18:40	05 30.00S	61 37.74	4251	10.4	28	34.58855
25	07-Feb-08	06:45	04 30.50S	63 24.85	3694	10.5	28	
26		12:20	04 00.00S	64 17.00	4252	11.7	28	34.63484
27		20:10	03 30.29S	65 15.05	6555	5	29	
28	08-Feb-08	06:00	03 00.00S	66 06.83	3843	5.8	28.5	35.05526
29		10:55	02 30.00S	66 24.25	4777	6.7	28.5	
30	09-Feb-08	18:35	01 00.00S	67 12.17	3291	9.5	28.5	
31		22:05	00 30.00S	67 28.86	3100	9	28	
32	10-Feb-08	01:40	00 00.00	67 44.90	3016	10	28	
33		05:15	00 29.34N	68 00.31	3188	9.4	28	
34		09:00	01 00.00N	68 16.55	4116	9.2	28	
35		13:00	01 30.00	68 34.00	3664	9.1	28.5	
36		20:40	02 30.00	69 06.37	3153	9	28	
37	11-Feb-08	04:05	03 30.00	69 38.74	3284	9.8	28	
38		11:10	04 30.00N	70 11.90	3184	10.1	28	
39		17:50	05 30.00	70 45.37	3531	9.9	29	
40	12-Feb-08	01:00	06 30.00	71 17.00	3972	9.8	28	
41		08:00	07 30.00	71 50.20	3429	9	27.5	
42		20:15	08 30.00	73 39.80	2406	11.2	28	

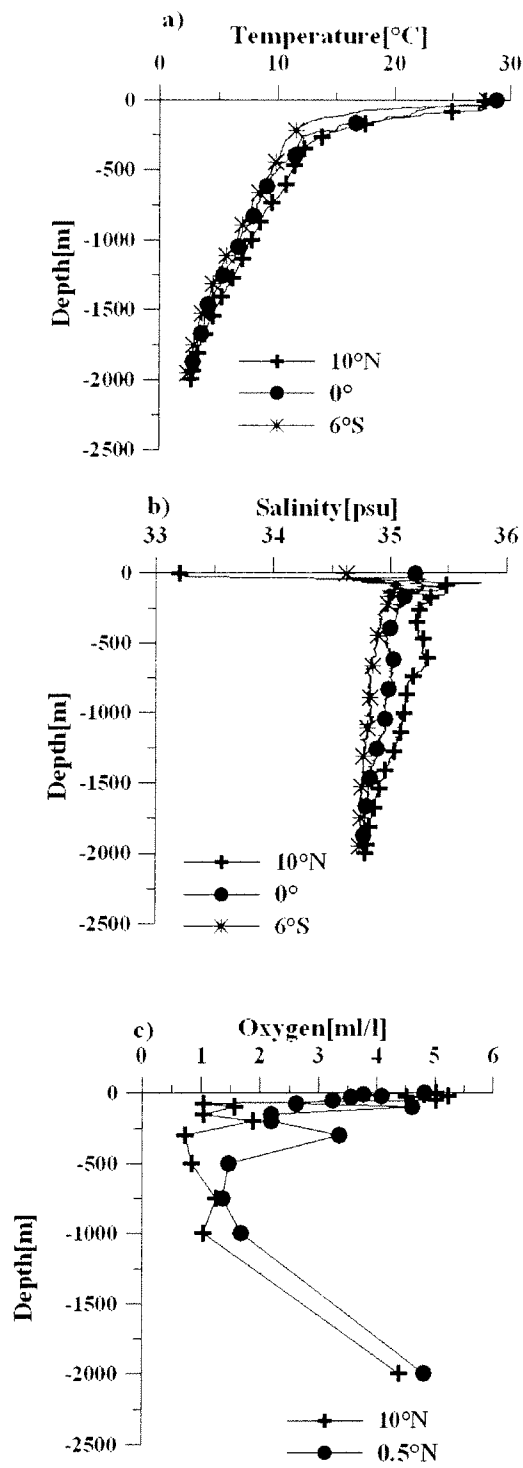


Fig. 3

The station locations of CTD and XBT observations are given in Table -1 and Table-4. The north-south variation of the hydrographic parameters is depicted in Fig. 3. The vertical temperature profile based on the Portable CTD data collected at 10°N equator and 6°S are given in Fig. 3a. The Mixed Layer Depth (MLD) is found to be reducing towards south (Fig. 3a). The salinity profiles at 10°N, Equator and 6°S are portrayed in Fig. 3b. Low saline water observed at 10°N could be an indication of the influence of Bay of Bengal water. Oxygen Minimum Layer in the Arabian Sea is predominant at 10°N and Equator (Fig. 3c)

9. Air Environment

Some of the preliminary results of Sunphotometer are described below:

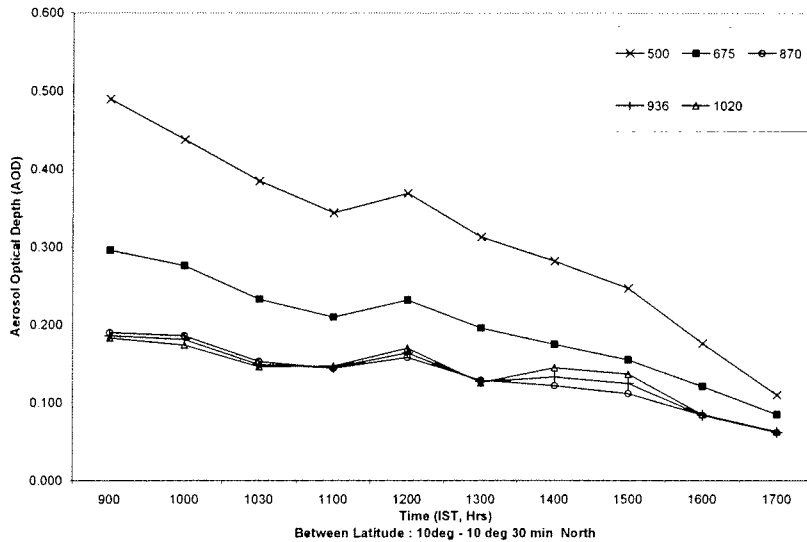


Fig. 4

Fig. 4 shows the diurnal variation of AOD between Latitude: 10deg - 10 deg 30 min North. The significant points are:

- AOD at shorter wavelengths are higher than the longer wavelengths depicting that there is more scattering at shorter wavelengths.
- High AOD's are observed in Forenoon (FN) in comparison to Afternoon (AF).
- Small peak in AOD for all wavelengths is observed at around 1200 Hrs.

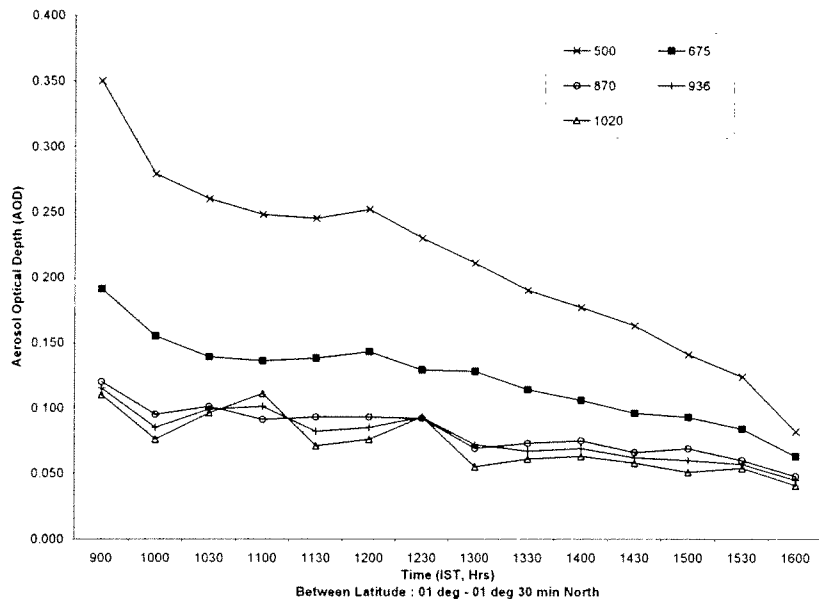


Fig. 5

Fig. 5 shows the diurnal variation of AOD between Latitude: 01 deg - 01 deg 30 min North. The significant points are:

- AOD at shorter wavelengths are higher than the longer wavelengths depicting that there is more scattering at shorter wavelengths.
- High AOD's are observed in FN as compared to AF values suggesting small size particles during AF hours.

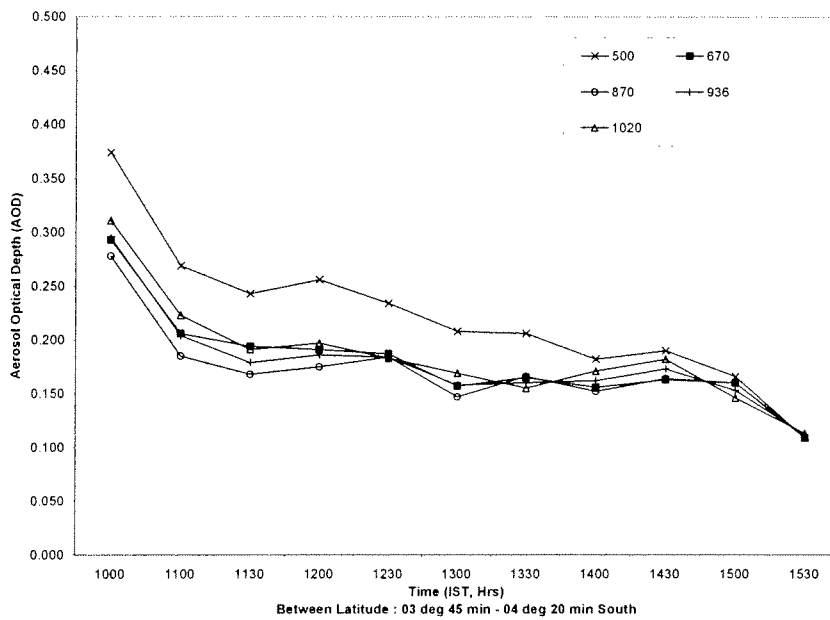


Fig. 6

A similar pattern in AOD for all wavelengths is observed between Latitude: 03 deg 45 min 04 deg 15 min South. The AOD values at all the wavelengths are high as compared to the previous latitude values.

10. Chemical Oceanographic Studies

Water samples were collected from the CTD stations and analysed for D.O. (Dissolved Oxygen), pH and nutrients (Nitrite, Nitrate, Silicate and Phosphate) from the standard depths (0,10,20,30,50,75,100,150,200,300,500,750,1000 and 2000m).

The results for 10°N and 6°S latitudes with graphs are as given below.

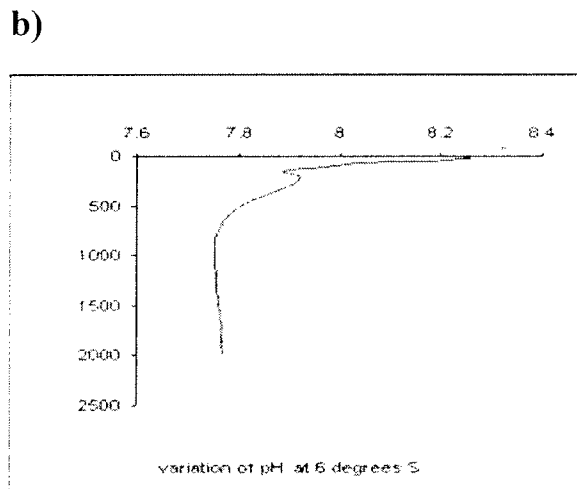
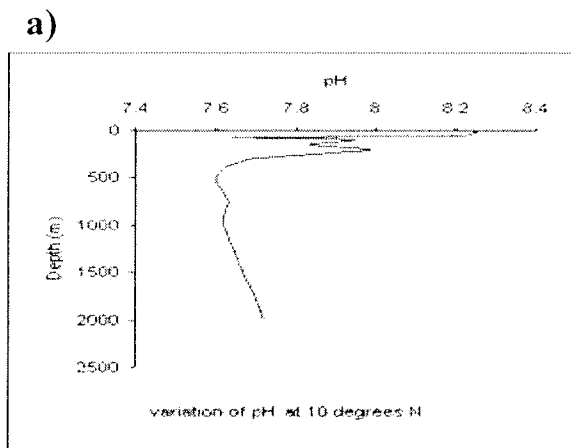
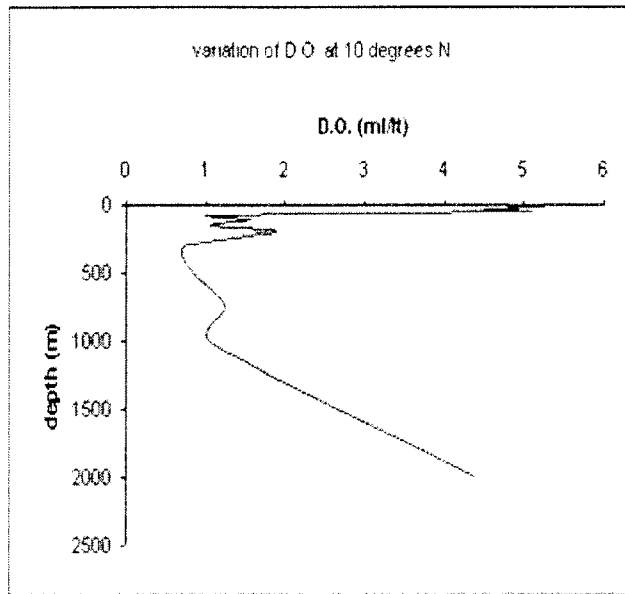


Fig. 7 Vertical profile of pH at a) 10°N and b) 6°S

pH gradually decreases from the surface to 2000m depth in all the stations.

a)



b)

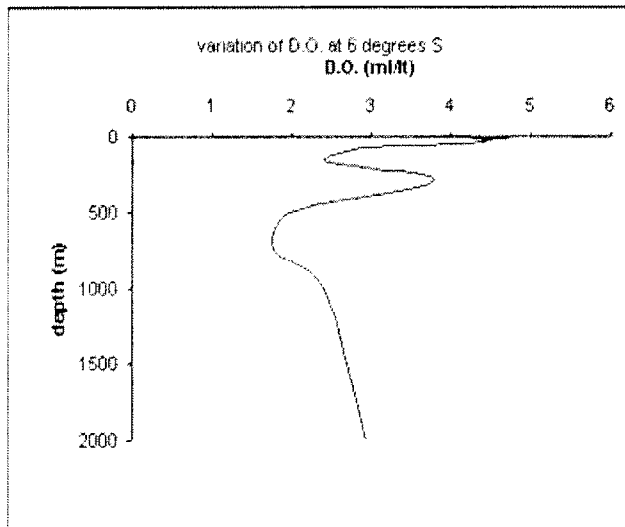


Fig. 8 Vertical profile of Dissolved Oxygen at a) 10°N and b) 6°S

D.O. values show an abrupt decrease at both sides of the equator (10°N and 6° S), below this depth D.O. decreases gradually and in deeper waters (1000m and 2000m) it increases slightly.

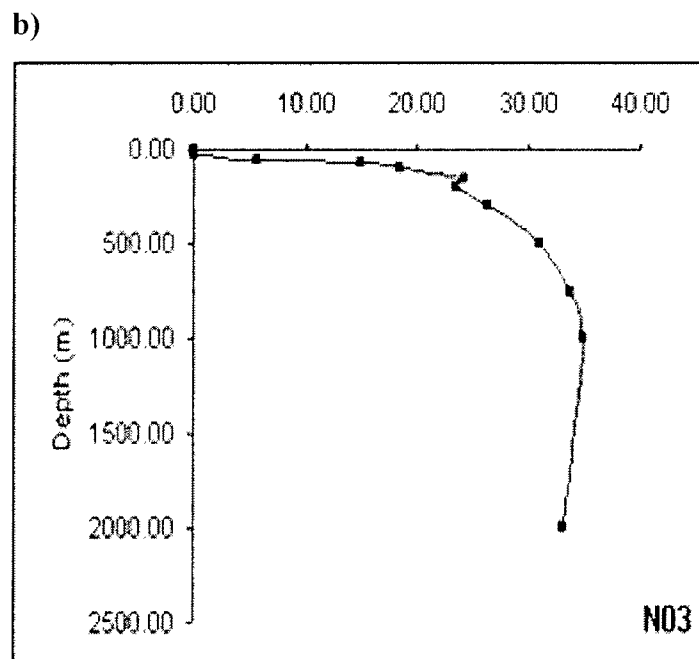
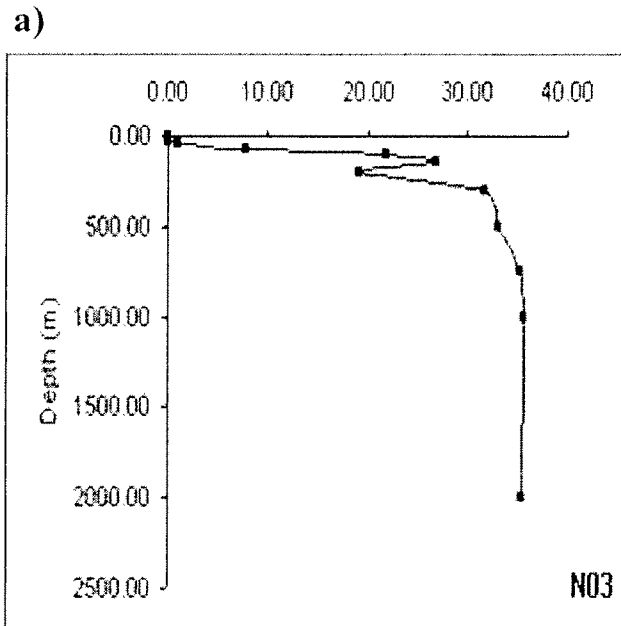


Fig-9 Vertical profile at a) 10°N and b) 6°S for nutrients.

For 10°N and 6°S nutrients show negligible concentrations till 50m depth. The concentration of all the nutrients increases with increase in depth. All the nutrients show maximum values at 10° N and decreases towards 6°S.

11. Biological oceanographic studies

Chlorophyll analysis:

This study is carried out to estimate the total quantity of phytoplankton in seawater. The equatorial region is high productive because of the mixing of currents in this area. The chlorophyll filtration is done onboard and filter papers are kept in dark and cooled place.

The chlorophyll samples are collected from 10°N, 69°30'E to 05°56.56'S, 60°48.84'E at ongoing track of vessel and 03°S, 66°07.23'E to 02°S, 66°40.04'E on return track of vessel.

For chlorophyll estimation Water samples (5 litre) were collected by Niskin Bottles up to 5 depth viz. 0.00 m, 50.0 m, 100 m, 150 m, and 200 m depths. And it filtered through GF/F filter paper. While filtering CaCO₃ added to prevent acidity. After filtration filter paper covered in aluminum foil and putted in dark and cooled place for further laboratory analysis.

For Total Bacterial Biomass:

Water samples were collected through Niskin Bottles up to 7-depth viz. 0 m., 50 m., 100 m., 150 m. 200 m, 500 m and 1000 m. depths. Transferred 5 ml samples in vial and added 0.2 ml buffered formalin and kept in cooled place for further analysis.

The water samples are collected from 10°N, 69°30'E to 05°56.56'S, 60°48.84'E

ATP analysis:

To know the total bacterial load in different depths of sea water samples (300 ml) were collected through Niskin Bottles up to 7 depth viz. 0 m., 50 m., 100 m., 150 m. 200 m, 500 m and 1000 m. depths and filtered through 0.22 µ filter paper. After filtration covered it in aluminum foil and kept in cool and dark place for further analysis.

Samples are collected from 10°N, 69°30'E to 05°56.57'S, 60°48.84'E at ongoing track of vessel.

Collection of water samples for microbial analysis:

Water samples (100 ml) were collected through Niskin Bottles up to 7 depth viz. 0 m, 50 m, 100 m, 150 m, 200 m, 500 m and 1000 m depths and kept in dark place for further microbial analysis.

Zooplankton:

To study the diversity and abundance of zooplanktons the sampling has been done using multiple plankton net (MPN) in 5 different depths 200-150 m, 150-100m, 100-50m and 50-0m and preserved in formaline for further analysis.

The zooplankton samples are collected from 06°N, 67°19'E to 05°56.57'S, 60°48.84'E at ongoing track of vessel and 03°S, 66°07.23'E to 02°S, 66°40.04'E in the return track of vessel.

Towards an attempt to estimate total carbon in oceanic water, some water samples (from surface and at 2000 m depths) were taken at selected locations between Lat: 10⁰ N to 4⁰ S. These would be analyzed for the total carbon (TC) content.