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**Polarstern Expedition**

**ARK XXI/1b**

**13.08.2005 – 18.09.2005**

**Longyearbyen - Bremerhaven**

**Fahrtleiter / Chief Scientist**

**Eberhard Fahrbach (13.8.-27.8.)**

**Peter Lemke (28.8.-18.9.)**

**KOORDINATOR /COORDINATOR**

**Eberhard Fahrbach**

### **Summary and itinerary**

On 13 August 2005 POLARSTERN sailed as planned from Longyearbyen, leaving the Isfjorden and turning south towards Storfjorden. There were 45 cruise participants and 44 crew members on board. The scientists came from 11 nations and 10 institutes or organisations and covered a wide range of disciplines. A part of the group has also been on board during the first leg and continued their work in the new area of operations. The cruise aimed essentially for three working areas: the Storfjorden, Fram Strait and Yermak Plateau (see Figs. 1 and 2).

In Storfjord work was focussed on biogeochemistry. Measurements were carried out to better understand the processes which determine the role of the ocean in releasing the greenhouse gas methane into the atmosphere. During this short leg, the microbial-in-situ methane production in the upper ocean and the microbial oxidation in the whole water column were investigated. During the winter expedition in Storfjorden in 2003 an extended methane anomaly was detected with concentrations considerably exceeding the normal background values of <5 nM. The clear increase in concentrations from the sea surface to the sea floor suggested a release of methane from the sea bed during resuspension events of sediments. However, the concentration of the carbon isotope  $^{13}\text{C}$  in the methane indicated that it originated from recent bacterial activity in the water column. During this cruise it was confirmed that the presence of the methane anomaly in Storfjorden occurs also during summer. However, in contrast to winter time the maxima were detected in the upper water column confirming that the methane originated by bacterial activity in the water column. The work in the Storfjorden was terminated in the night from 15 to 16 August and POLARSTERN moved into Fram Strait. On the way to the North a meeting took place with the sailing vessel LOVIS with a group of students from the AWI school-project HIGHSEA on board.

In Fram Strait a long term programme in physical oceanography was continued by measurements and mooring work to observe the heat transport from the North Atlantic into the Arctic Ocean on an oceanographic section along  $78^{\circ}50'N$  (see Figs 3 and 4). Seven moorings with current meters as well as temperature and salinity sensors were recovered and redeployed. The instruments had worked perfectly. The data were read from the memories and have now been processed. Two inverted echo sounders with pressure recorders (PIES) were also recovered and redeployed. The data of bottom pressure and travel time of sound to the sea surface, which they recorded, will allow estimations of variations of the volume and heat transport through Fram Strait. Temperature measurements with the CTD (conductivity, temperature, depth) sonde indicated that the upper layers of the West Spitsbergen Current continued to warm as observed during the recent years. However, in contrast to last year, the intermediate layer had cooled again. The oceanography work kept on until the 19 August when Polarstern left the  $78^{\circ}50'N$  section for the “Hausgarten” of the deep-sea biology group.

The “Hausgarten” is located in the Fram Strait and is visited annually to keep up long term time series to detect effects of long term changes of oceanic condition on the deep-sea fauna. In rapid succession, water samples from the CTD/rosette, bottom samples from the multicorer and hauls with the Agassiz trawl were collected. All the samples had to be processed with great care. Three moorings with sediments traps were recovered and redeployed. Landers, which were used with traps, colonisation experiments and simulated foodfalls, were recovered and deployed. Only one mooring, which had been deployed next to a flume experiment, did not release. The ROV VICTOR6000 on board L'ATALANTE will be used to investigate why the releasing procedure failed. After having finalized the work in the “Hausgarten” on 26

August, some further oceanography work was done before returning to Longyearbyen for an intermediate stop.

The generally mild and calm weather was very favourable to the progress of work on deck and in the labs. Only on 27<sup>th</sup> August, stormy weather occurred. In the night from 20<sup>th</sup> to 21<sup>st</sup> August, POLARSTERN crossed some open fields of drifting ice floes, with a large population of seals. This remained the only encounter with sea ice during this first part of the cruise.

In the night to the 27<sup>th</sup> August the scientific work during this leg ended and POLARSTERN returned to Longyearbyen. In the evening of the 27<sup>th</sup> August 3 additional cruise participants came on board by helicopter. Parts of equipment from the deep-sea biology group were flown to Longyearbyen. In the early morning of the 28<sup>th</sup> August 12 scientists disembarked. The deep-sea biology group left POLARSTERN to join the French research vessel L'ATALANTE with the remotely operating vehicle VICTOR6000 on board. The chief scientists changed in Longyearbyen as well. Eberhard Fahrback left POLARSTERN to return to Bremerhaven and Peter Lemke took over. This was necessary because the originally planned chief scientist Ursula Schauer had an accident and needed to be replaced at short notice.

On 28<sup>th</sup> August POLARSTERN steamed back to the mooring array to continue the recovery and re-deployment of the remainder of the 12 moorings (see Figs. 3 and 4 and Table 1). The exchange of the moorings went very well, due to calm weather and the excellent collaboration of scientists and crew. The recovery rate of instruments and data of 97% was the highest since the beginning of the mooring array in 1997.

After finishing the mooring work, POLARSTERN steamed north up to 81°36'N into dense pack ice towards two geological sites to take sediment samples. The aim of this part of the cruise was to take marine sediment cores with a box corer and a gravity corer to investigate the climatic history of the Arctic Ocean. The transit was difficult since at these latitudes winter has already set in. At -9°C it was possible to observe the different stages of sea ice formation in full detail. Nevertheless, the geological work finished successfully, and Polarstern steamed south to continue the hydrographic section towards the coast of Greenland. As during the transit north a second CTD section was taken across the slope of the Yermak Plateau and the ice edge. The analysis of the water samples show that an increased in situ methane production takes place at the ice edge, where the biological production is higher than in the open ocean and the ice covered areas.

This year the 79N section could be completed as far as 17°30'W (see Figs. 2 and 3). As compared to last year, the ocean surface temperatures indicate a warming in the east and a cooling in the middle and western regions of Fram Strait, so that we encountered more sea ice on our way to Greenland than the year before. At mid-depth (50-500m) the warming is continuing all across Fram Strait. In the middle of Fram Strait, the warming reaches depths of more than 2000 meters.

In addition to the work mentioned above, biogeochemical and bio-optical investigations as well as counting of birds and mammals, which occurred during the last leg, were continued. Samples were taken to determine the distribution of plutonium isotopes which serve as well as the measured chemical parameters as tracers for pathways of water mass transport in the Arctic Ocean and the Nordic Seas. Plankton organisms were filtered out of the sea water to determine proxy data for palaeo-oceanographic investigations of the temperature distribution in past geological times.

By means of bottom samples the bio-geographic pattern of deep-sea foraminifera were studied. These will be compared to similar species in the Antarctic by studying their DNA to determine whether they are genetically identical. This research will help to understand the characteristics of biodiversity and the processes of the evolution of life.

After completion of the Fram Strait hydrographic section Polarstern steamed south-east for its last research activity on this cruise to the Håkon Mosby Mud Volcano, which is located 145 nautical miles northwest of the northern tip of Norway. Temperature and salinity profiles were measured above the volcano, and water and sediment samples were taken. A temperature lance was deployed near the centre of the mud volcano for a long-term temperature observation. It will remain in the sediment for about one year and will be recovered in the course of an expedition of the French research vessel "Pourquoi Pas?" next summer. During this period of time, the lance will record sediment temperatures in order to obtain a more profound insight into the activity of the mud volcano and the associated mud and fluid flows.

With this activity the scientific programme of the cruise leg ARK XXI/1b was finished, and Polarstern steamed to Bremerhaven and reached port at 2am on 18<sup>th</sup> September 2005.

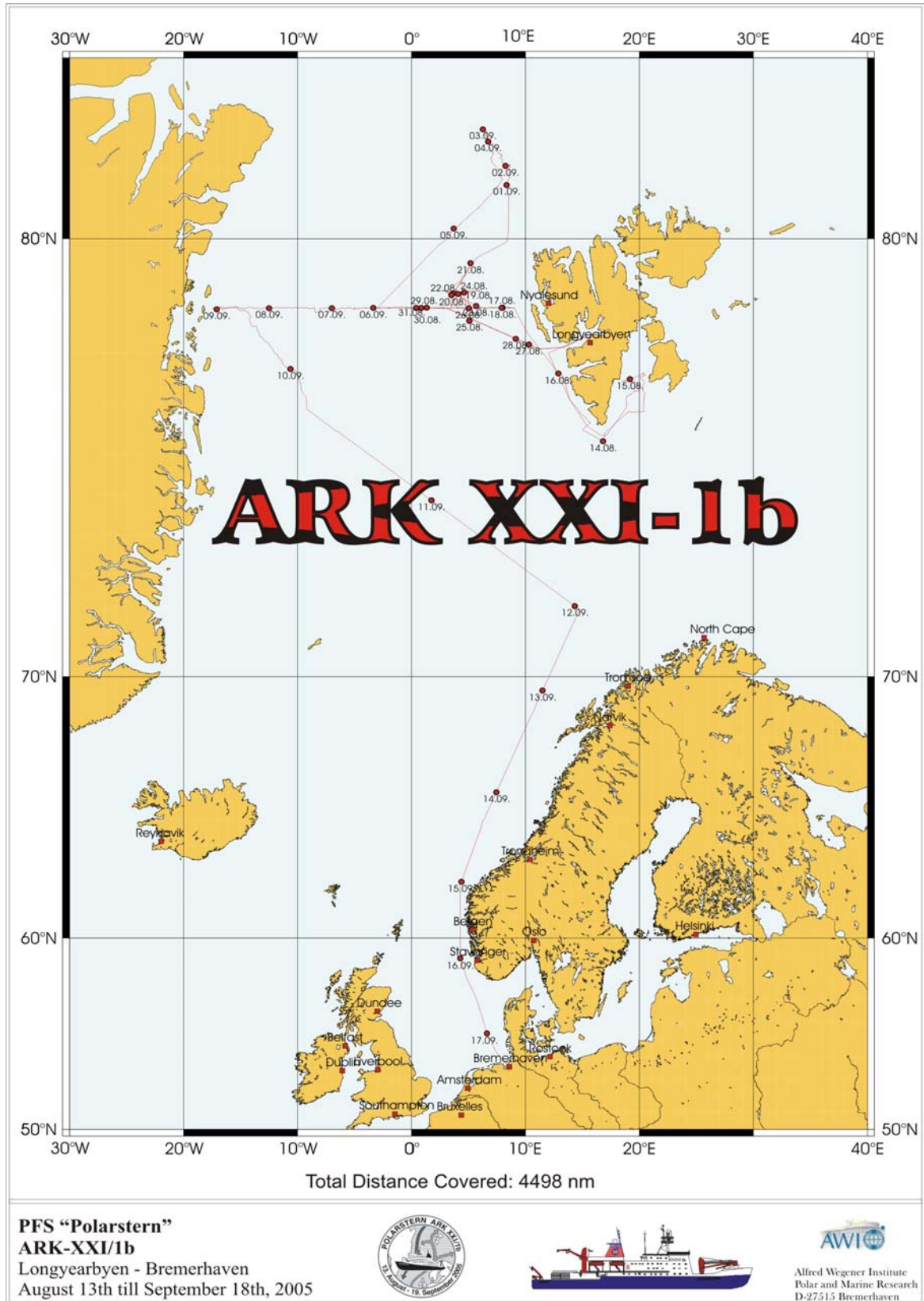


Fig.1: ARK XXI/1b Cruise track.

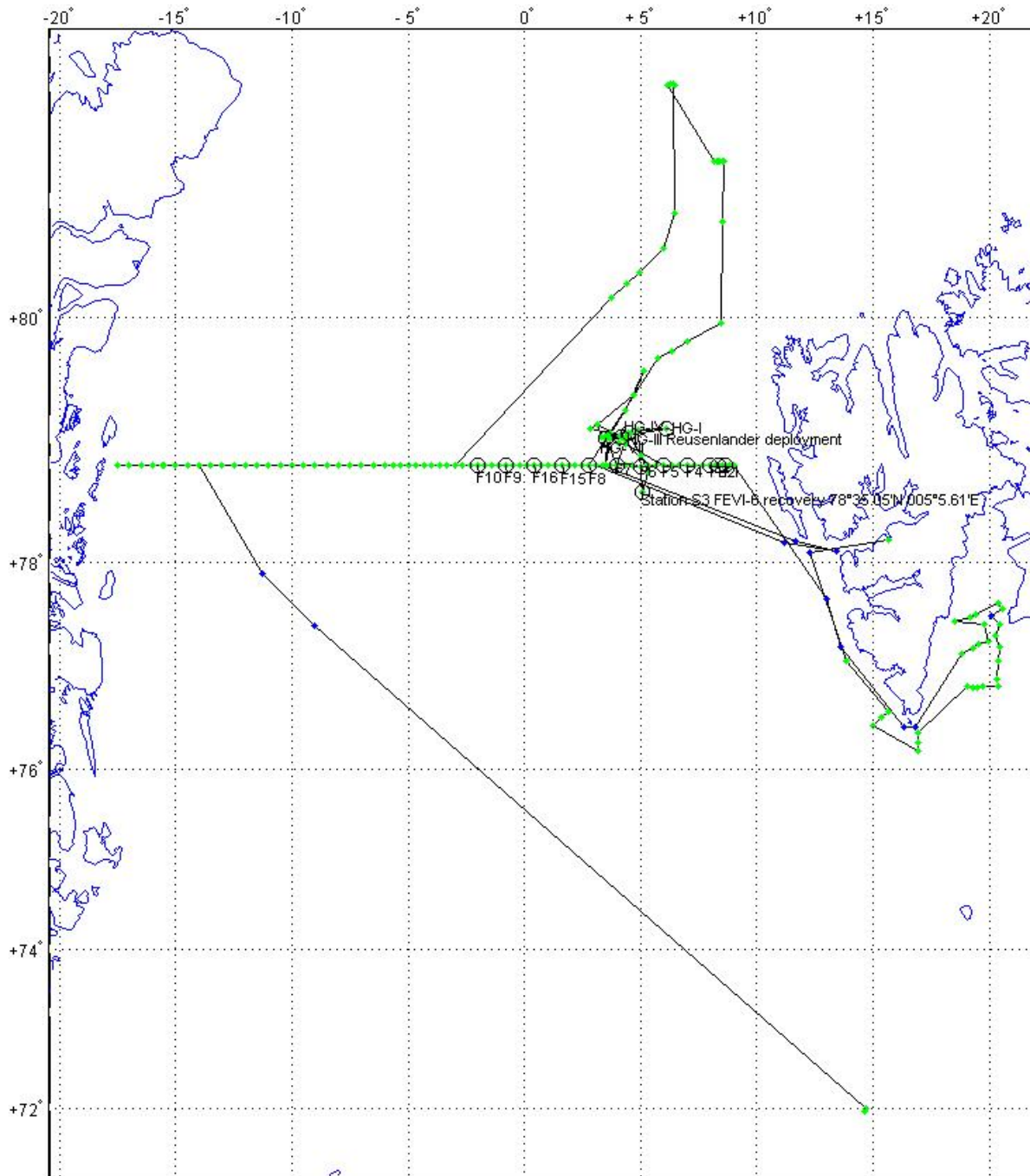


Fig 2: Station map of ARK XX1/1b. Green dots indicate station work. Blue squares denote way points.

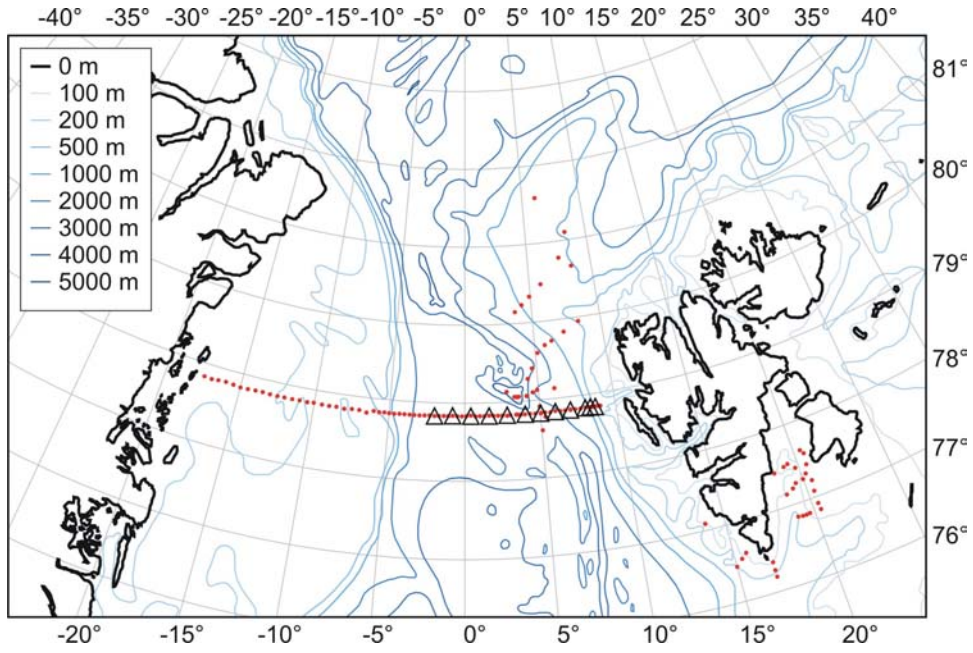


Fig.3: Map with positions of moorings (triangles) and CTD stations (dots) during ARK XXI/1b

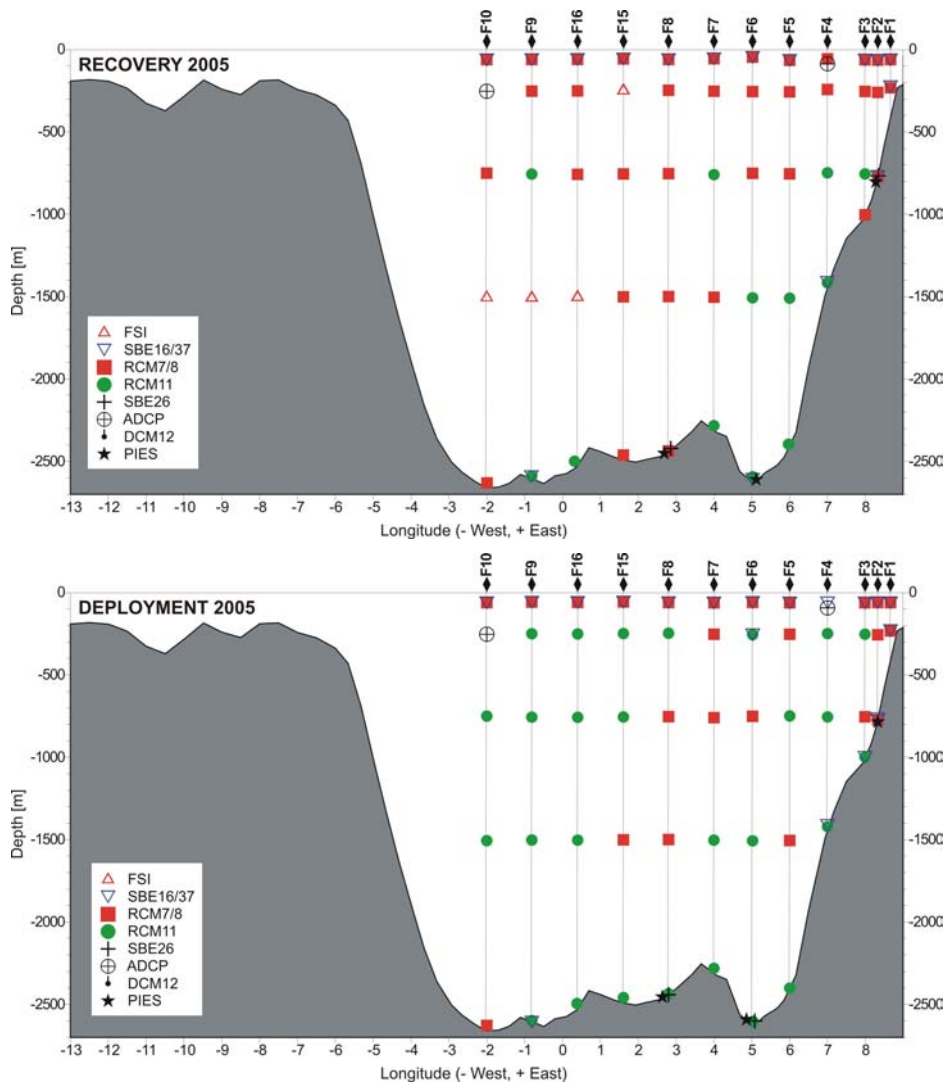


Fig. 4 Section across Fram Strait with the moored instruments recovered (upper plot) and deployed (lower plot) during ARK XXI/1b.

**Table 1: List of recovered and deployed moorings**

RV "Polarstern"  
Reederei F. Laeisz GmbH  
- Master -

On board, September 13., 2005

Research Cruise ARK XXI /1b - RV "Polarstern"  
13. Aug. – 19. Sept. 2005

**Moorings recovered:**

Recover	Description	Water depth	Latitude	Longitude
25.08.2005	FEVI – 6	2335 m	78°35,05'N	005°05,61'E
19.08.2005	FEVI – 7	2584 m	79°00,99'N	004°20,62'E
21.08.2005	FEVI – 8	2784 m	79°35,98'N	005°09,86'E
19.08.2005	Coltray1/04-2	2510 m	79°04,72'N	004°05,43'E
22.08.2005	Coltray2/04-1	2511 m	79°04,55'N	004°05,88'E
19.08.2005	Lander N_XXI/1-c	2510 m	79°04,90'N	004°05,52'E
17.08.2005	F 1-7	251 m	78°49,94'N	008°39,84'E
17.08.2005	F 2-8	798 m	78°50,14'N	008°19,64'E
17.08.2005	F 3-7	1042 m	78°50,30'N	007°59,55'E
17.08.2005	F 4-7	1454 m	78°50,17'N	007°00,01'E
18.08.2005	F 5-7	2466 m	78°49,93'N	006°00,10'E
23.08.2005	F 6-8	2687 m	78°49,80'N	005°01,33'E
23.08.2005	F 7-6	2336 m	78°49,99'N	004°00,03'E
29.08.2005	F 8-7	2491 m	78°50,05'N	002°48,09'E
29.08.2005	F 9-6	2652 m	78°50,33'N	000°48,74'E
29.08.2005	F 10-7	2726 m	78°49,88'N	002°00,06'E
29.08.2005	F 15-3	2558 m	78°50,00'N	001°36,59'E
29.08.2005	F 16-3	2580 m	78°50,05'N	000°23,81'E
17.08.2005	Pies 62.1	793 m	78°50,03'N	008°19,91'E
18.08.2005	Pies 141	2708 m	78°49,87'N	005°00,93'E
29.08.2005	Pies 71	2496 m	78°50,25'N	002°48,20'E

**Moorings deployed:**

Deployed	Description	Water depth	Latitude	Longitude	Top of unit below surface
25.08.2005	FEVI – 9	2334 m	78°35,06'N	005°05,63'E	43 m
23.08.2005	FEVI – 10	2582 m	79°01,00'N	004°20,62'E	80 m
21.08.2005	FEVI – 11	2791m	79°36,00'N	005°09,92'E	250 m
25.08.2005	Flume - 3	2340 m	78°36,35'N	005°04,11'E	2300 m
19.08.2005	Lander N_XXI/1b-c	5409 m	79°05,87'N	003°07,44'E	5407 m (*)
24.08.2005	Lander N_XXI/1b-f	2478 m	79°04,67'N	004°08,28'E	2475 m (*)
12.09.2005	Lander N_XXI/1b-h	1289 m	72°00,18'N	014°44,02'E	1287 m (*)
18.08.2005	Pies E	793 m	78°50,36'N	008°19,63'E	792 m
26.08.2005	Pies 62.2 – c	2587 m	78°49,97'N	004°54,60'E	2586 m
31.08.2005	Pies 141.2 – W	2485 m	78°49,88'N	002°50,63'E	2484 m
17.08.2005	AWI F 1-8	250 m	78°49,95'N	008°39,85'E	51 m
18.08.2005	AWI F 2-9	798 m	78°50,14'N	008°19,64'E	50 m
18.08.2005	AWI F 3-8	1038 m	78°50,32'N	007°59,52'E	50 m
18.08.2005	AWI F 4-8	1454 m	78°50,18'N	007°00,14'E	45 m
23.08.2005	AWI F 5-8	2466 m	78°49,97'N	006°00,21'E	50 m



<b>Deployed</b>	<b>Description</b>	<b>Water depth</b>	<b>Latitude</b>	<b>Longitude</b>	<b>Top of unit below surface</b>
26.08.2005	AWI F 6-9	2696 m	78°49,82'N	005°01,34'E	45 m
26.08.2005	AWI F 7-7	2342 m	78°50,01'N	004°00,10'E	50 m
31.08.2005	AWI F 8-8	2492 m	78°50,05'N	002°48,10'E	53 m
30.08.2005	AWI F 9-7	2663 m	78°50,30'N	000°48,66'W	52 m
06.09.2005	AWI F 10-8	2716 m	78°49,90'N	001°59,99'W	55 m
30.08.2005	AWI F 15-4	2547 m	78°49,98'N	001°36,60'E	50 m
30.08.2005	AWI F 16-4	2582 m	78°50,10'N	000°24,07'E	49 m
12.09.2005	Temp. Lance	1286 m	72°00,30'N	014°43,68'E	1288 m

Expected recovery for above: Summer 2006

(\*) Expected recovery by RV "L'Atalante" in Sept. 2005