FINNISH INSTITUTE OF MARINE RESEARCH

CRUISE REPORT

R/V Aranda

Cruise 2 / 2003

26 March - 21 April 2003

The report is based on preliminary data and is subject to changes.

Finnish Institute of Marine Research
Lyypekinkuja 3
P.O. Box 33
FIN-00931 HELSINKI
FINLAND
http://www.fimr.fi

PHONE: +358 9 613 941
FAX: +358 9 61394 494

ACSYS-ABSIS 2003

Fram Strait, Arctic Ocean

(**Arctic Systems - Arctic Atmospheric Boundary Layer and Sea Ice Interaction Study**)

Cruise: 2/2003
(26 March 2003, Tromso, Norway – 21 April 2003, Longyearbyen, Svalbard)

Chief Scientist: Jouko Launiainen
(Burghard Brummer, University of Hamburg; airborne and buoy operations)

Master: Pertti Lahti

BACKGROUND AND AIM

Investigations of the Arctic sea ice and its variations and interaction with the atmosphere.
The Arctic sea ice cover and the ocean have experienced variations and trends during the three past decades. In the Arctic, the extent and thickness of sea ice has been decreased. Still, it remains uncertain up to a which degree those are signs and reflections from the Global warming and Global Change. However, investigations of the Arctic sea ice form a crucial issue. This follows because, in addition of being a sensitive signal of a Climate Change, the Arctic sea ice gives and generates an import global feed-back effect to the development of a change.

The study ACSYS-ABSIS 2003 was carried out as a joint project with FMR and the University of Hamburg, Meteorological Institute, Germany (UHAM).
The ACSYS-ABSIS 2003 main activities were to gather meteorological, sea ice and hydrographic observations to quantify the energy transfer and processes between the atmosphere and ice and the sea. As the regional forcing those control the ice transport in the Fram Strait i.e. sea ice export out from the Arctic Ocean which is a sink in the Arctic sea ice balance.
The expedition consisted of sea ice, marine meteorological, and remote sensing studies. In addition to the RV Aranda activities, UHAM performed meteorological aircraft studies during the measuring campaign and deployed sea ice drifters. The Aranda operations were concentrated in 78 - 81° N and 0 - 12° E.

The ACSYS-ABSIS 2003 campaign expedition was coordinated with the expedition of the RV Polarstern (Alfred Wegener Institute for Polar Research, Germany). During ARK XIX-1 expedition she deployed an ice station at 82° N, north from the Aranda operation area.

ACTIVITIES

The meteorological observations from Aranda covered radio soundings, automatic weather station observations and, turbulent and radiative flux measurements.
An east-west deep CTD section was made in the beginning of the expedition before the work in the ice zone.
Satellite images (esp. Radarsat) were used as a real time application for logistics and navigation,

and, for sea ice drift and dynamics studies in the later research stage.
The Aranda observations served, additionally, as the surface reference and ground check station for the flight missions and measurements of the well equipped meteorological aircraft Falcon (UHAM), operating from Svalbard. Falcon made 7 missions In the Fram Strait and over Aranda in 04.04 – 17.04.2003.
A FIMR meteorological profile mast (5- lev.) and some others sea ice gauges were deployed on the sea ice from RV Polarstern, connected with the co-operation of ACSYS-ABSIS 2003 and the ARK XIX-1 Ice Station.

The measurements from RV Aranda read as listed:

- Radarsat images (8 totally, Table 1), approx every third day; transferred in less resolution in "real-time" for the RV, full resolution for the later research phase
- Meteorological balloon soundings with GPS wind finding 3 h intervals; 140 totally
- Ship automatic weather station; 5 min logging interval
- Radiometric surface/snow/ice temperature observation (UHAM)
- Cloud base height by Ceilometer (Vaisala Co; UHAM)
- Hydrographic CTD section east - west at 79° 50' N - 79° 30' N; 11 stations
- Short period measurements of turbulent heat and momentum flux (by sonic anemometer) and radiative fluxes
- Regular sea ice and cloud observations (visual and video recording)
- Under-ice portable CTD measurements (< 150m) and short period under-ice measurements of turbulent heat and salt flux (UHOK).

The operations were carried out in the sea ice covered area, in order to take into account, location of the ice drift buoy array (deployed by UHAM), measuring flights of the meteorological Falcon aircraft, location and measuring campaign of the RV Polarstern, and, sea ice and weather conditions prevailing. These challenges put us to face this time to rather demanding sea ice conditions, both from the point of view of navigation and research. The latter was experienced in terms of difficulties to deploy from Aranda ice stations for any longer-time stationary and equipment-safety work. Finally, the conditions required that on her way back south from the Polarstern Ice Station at 82° N, RV Polarstern kindly helped the RV Aranda expedition getting out from the southern winds packed east-west ice zone at 80° 20' N.

The ship cruise track of RV Aranda is given in Figure 1. (The northernmost latitude reached was 81^{o} 01.4' N.)

FIELD CHARACTERISTICS AND OUTCOME

Meteorological and sea ice conditions
The general sea ice conditions (sea ice border) in Greenland Sea and in the Fram Strait during ACSYS-ABSIS 2003 are given in Figure 2. Locally, the sea ice conditions in the Fram Strait and north from Svalbard were dynamic, drifting and unstationary, the highest observed ice drift velocities being up to 1.2 kn (southwards).

The meteorological conditions during ACSYS-ABSIS were variable and scientifically interesting, accordingly. Figure 3 shows the air and sea surface temperature time development. The low temperatures prevailed during the cold arctic air outbreak in the first part of the expedition, especially. The wind speed given in Figure 4 indicates the variable meteorological conditions as well.

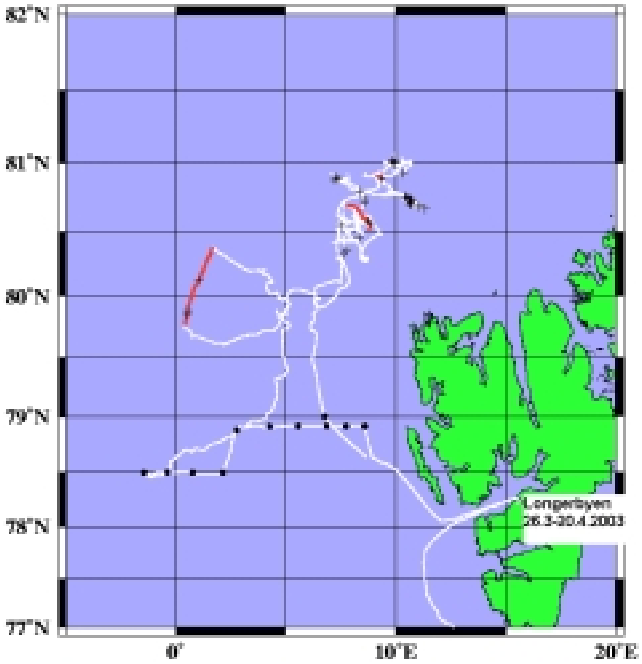

Figure 1. RV Aranda Arctic Expedition ACSYS-ABSIS 2003. Black dots and crosses give the sites of CTD casts and red (dark) lines indicate the drifting ship ice stations.

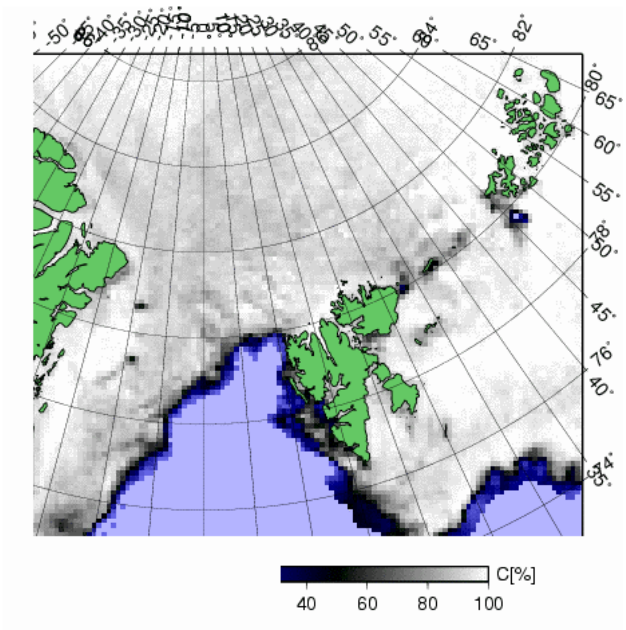

Figure 2. Sea ice border in the Greenland Sea and Fram Strait on 1st April, 2003. (NOAA satellite data processed by the University of Bremen, Germany, http://www.seaice.de/).

The low air temperature and moderate to high wind from north caused very large heat fluxes in the open ocean regions and from leads and cracks, during the first part and in the end of the expedition. Sensible heat flux bulk estimates occasionally even exceeded 600 Wm^{-2} and latent heat fluxes 200 Wm^{-2} (Figure 4). The latter caused condensation fog in the air over in-ice convection ponds. The highest total heat fluxes were of the order up to even 800 to 1000 Wm^{-2}. Accordingly, the weather conditions especially in the beginning and even in the end of the expedition were rather wintry-like, as compared with the time of the spring.

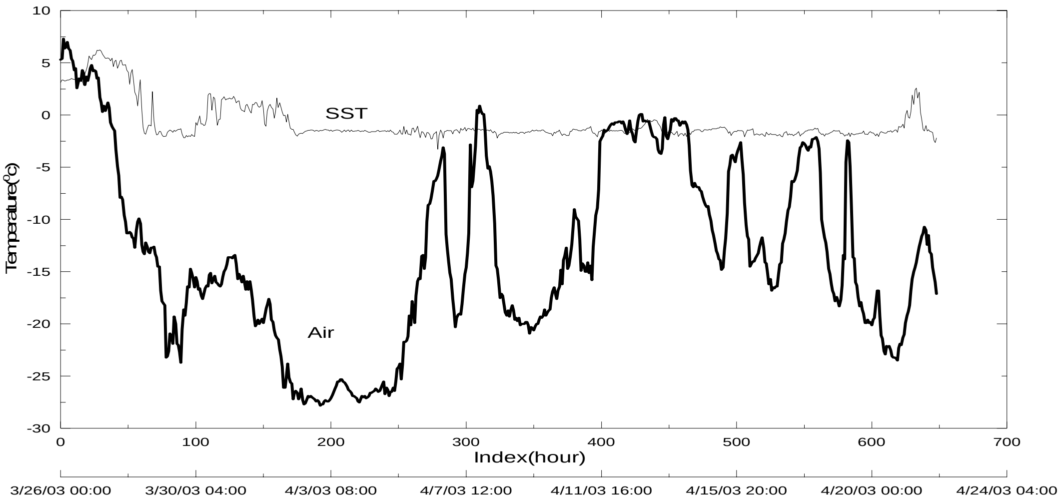

Figure 2. Air temperature and sea surface temperature (SST) at Aranda during the ACSYS-ABSIS 2003 expedition.

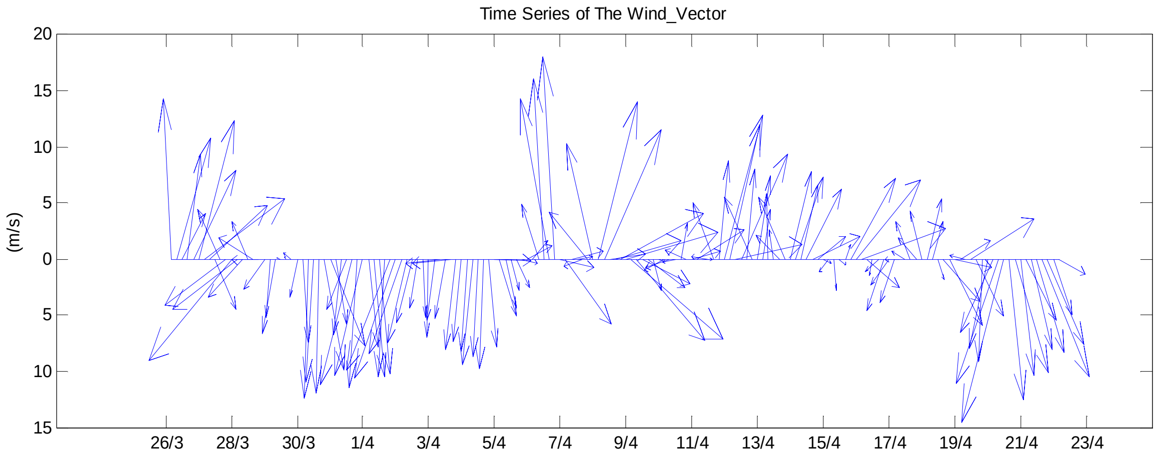

Figure 3. Time series of the wind vector during 26 March to 23 April, 2003.

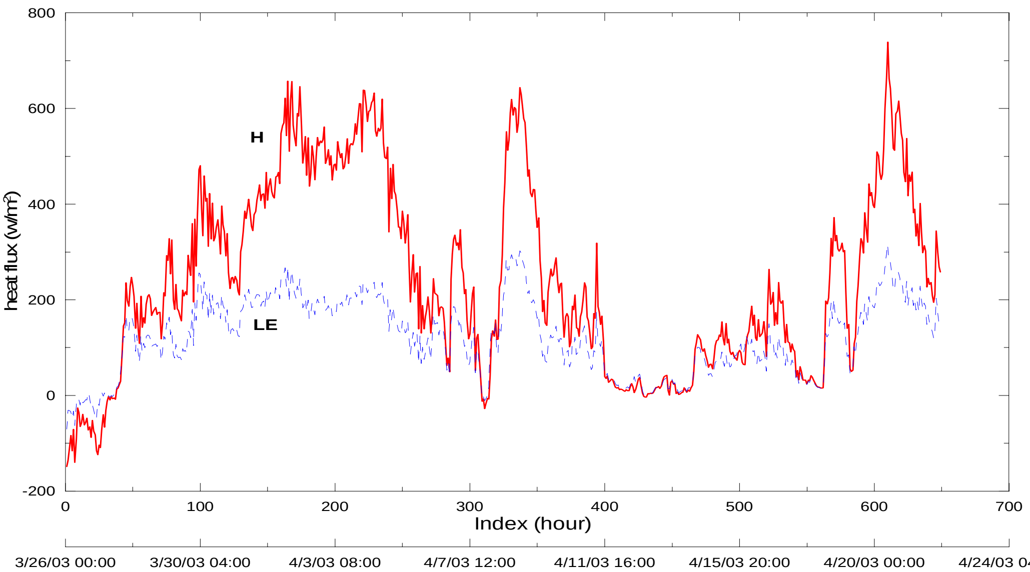

Figure 4. Sensible heat flux, H, (blue solid line) and latent heat flux, LE, (red, broken) from cracks and leads. (Estimation by bulk aerodynamic method, stratification taken into account.)

Meteorological soundings

Meteorological balloons (Vaisala DigiCora radiosondes with GPS wind finding) were launched every 3 h day and night during the intensive period (30.03. - 21.04.2003). The total amount of soundings was 164 pieces. In a possibility the sea ice conditions allowed, the balloons were launched from above the sea ice. An example of a sounding profile of temperature, moisture and wind is given Figure 5, indicating an inversion in the lowermost 150 m.

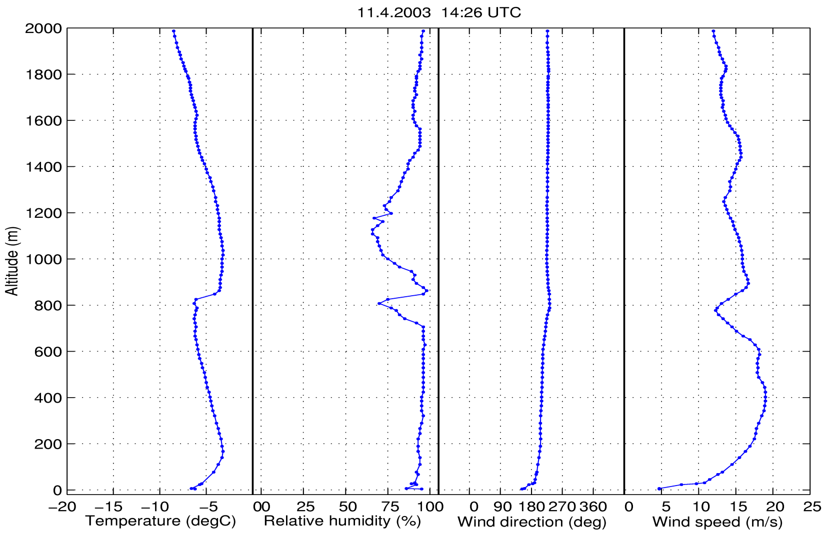

Figure 5. Example of a vertical meteorological sounding profile of temperature, moisture and wind above the sea ice.

Sea ice drift

In the marginal sea ice zone the RV Aranda operated, up to 60 nm deep inside the sea ice fields, the sea ice drifted by the wind, typically. The wind-driven drift was favoured by the stratification in the ocean below the ice. A well-mixed ocean layer (Figure 10) isolated the sea ice from the ocean drag effectively. An example of the wind driven ice drift is given in Figure 6 which shows the drift of the Aranda Ice Station n:o 1 during strong northern wind in 2 to 5 April, 2003. From the results one can nicely see the ice drift to have been $\sim 40^{o}$ to the right from the wind.

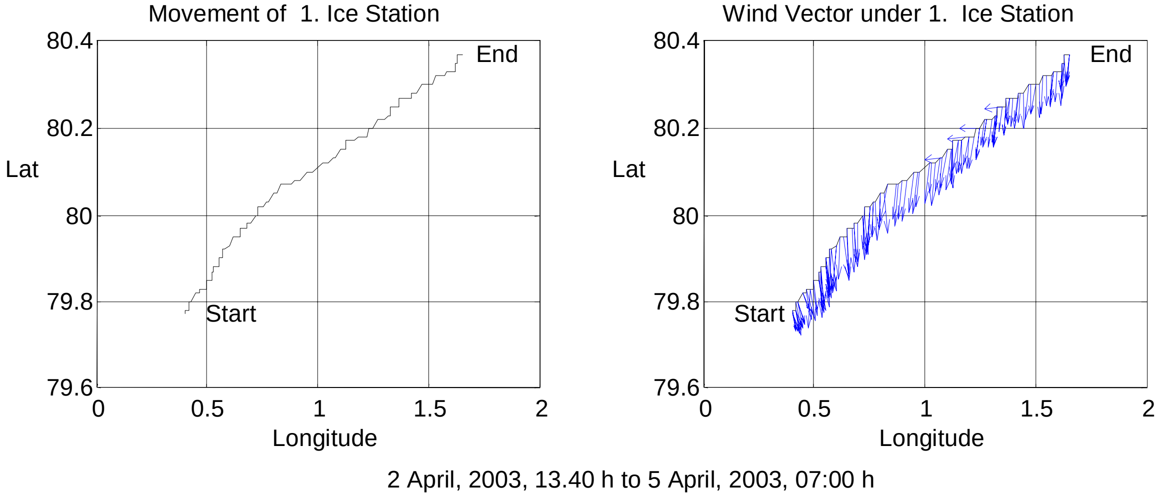

Figure 6. Drift of the ice floe of the Aranda Ice Station 1. (left), accompanied with the wind vector during the drift (right).

11 Argos sea ice drifters (most as parachute buoy from an aircraft) were deployed by UHAM in the beginning of the ACSYS-ABSIS period, north from the Aranda operation area. In addition to the location, the buoys had pressure and air temperature sensors. Figure 7 shows the buoy trajectories. Except one buoy, the buoy drift indicated a rather gradual overall drift to south in the eastern and central Fram Strait in 2003. For comparison, Figure 9 gives the ice buoy drift in 2002, from the joint FIMR-UHAM study FRAMZY 2002, and the results show the drift south to have been much faster in 2002.

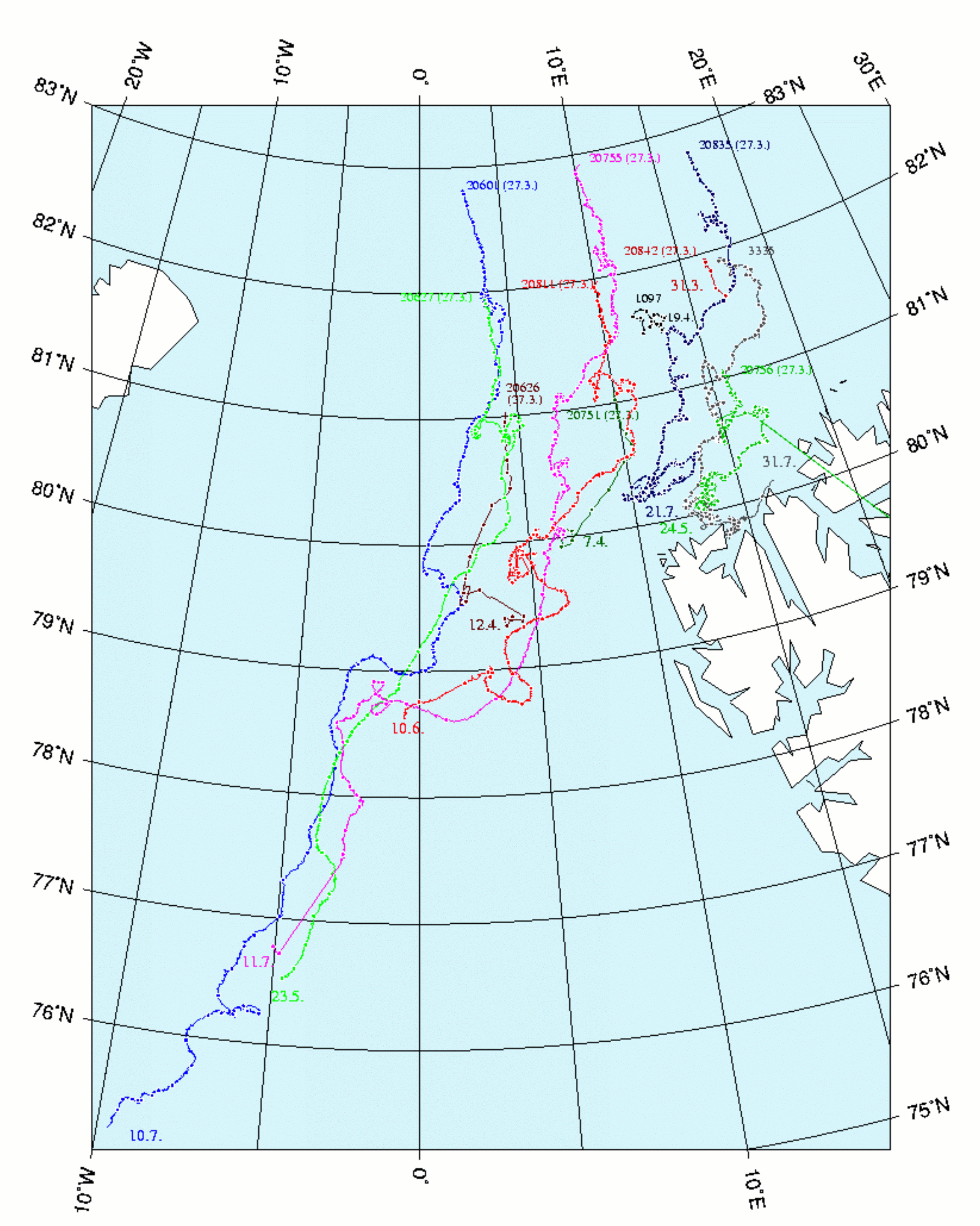

Figure 7. Trajectories of the UHAM satellite ice drift buoys in 2003.

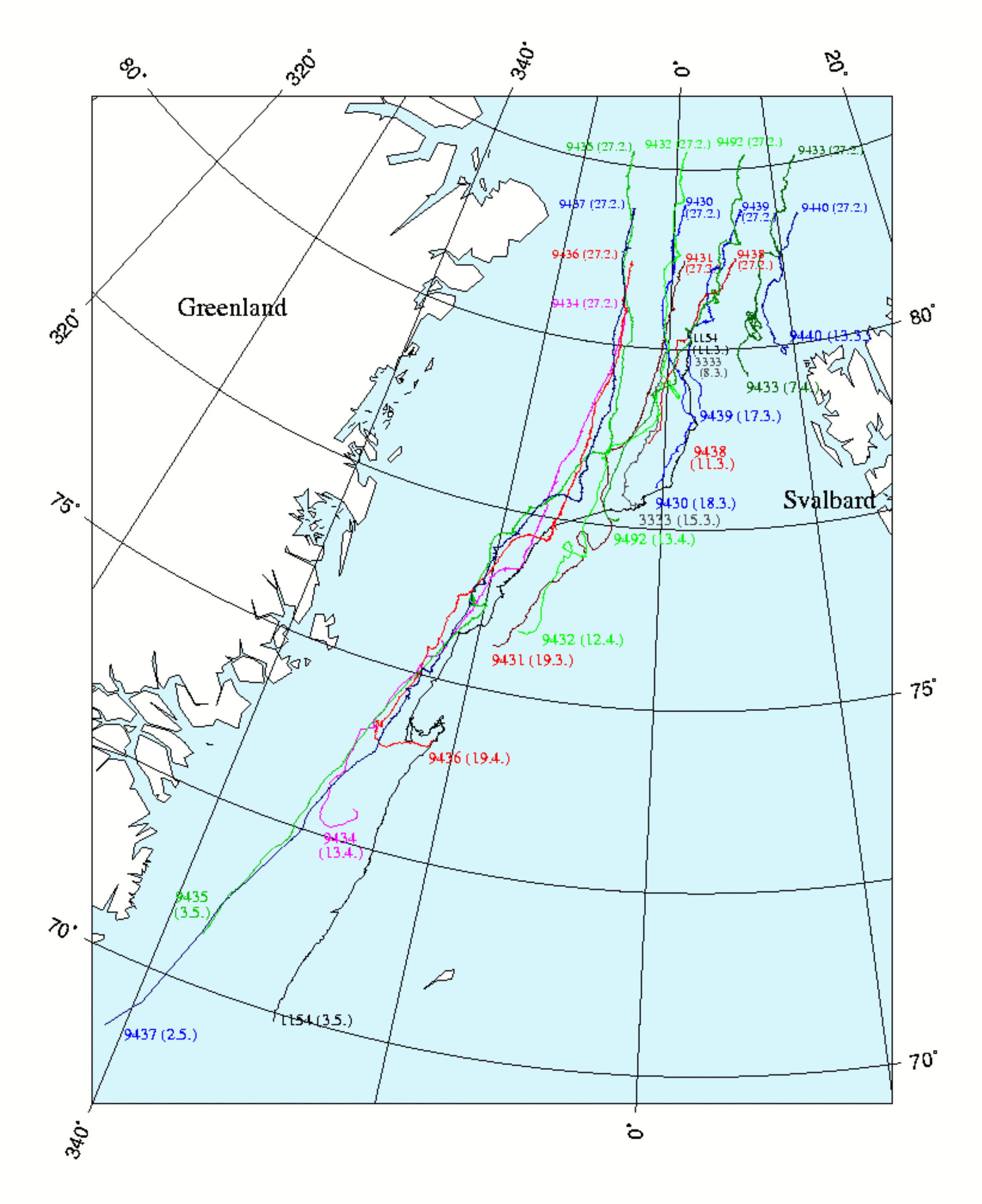

Figure 8. Trajectories of the FIMR-UHAM satellite ice drift buoys deployed in 2002, in FRAMZY 2002 study.

CTD and water samples

An east – west CTD section of 11 stations from the Svalbard coast westwards was taken (Table 2). The planned section at 79° 50’ N was hindered to take by sea ice in the west and some of the stations had to be taken at 79° 30’ N. A coarse drawing of the hydrographic section is given in Figure 9. The below-ice CTD casts made by portable CTD indicated a well-mixed layer below the ice, of 40 to 80m, as seen from the temperature profiles in Figure 10.

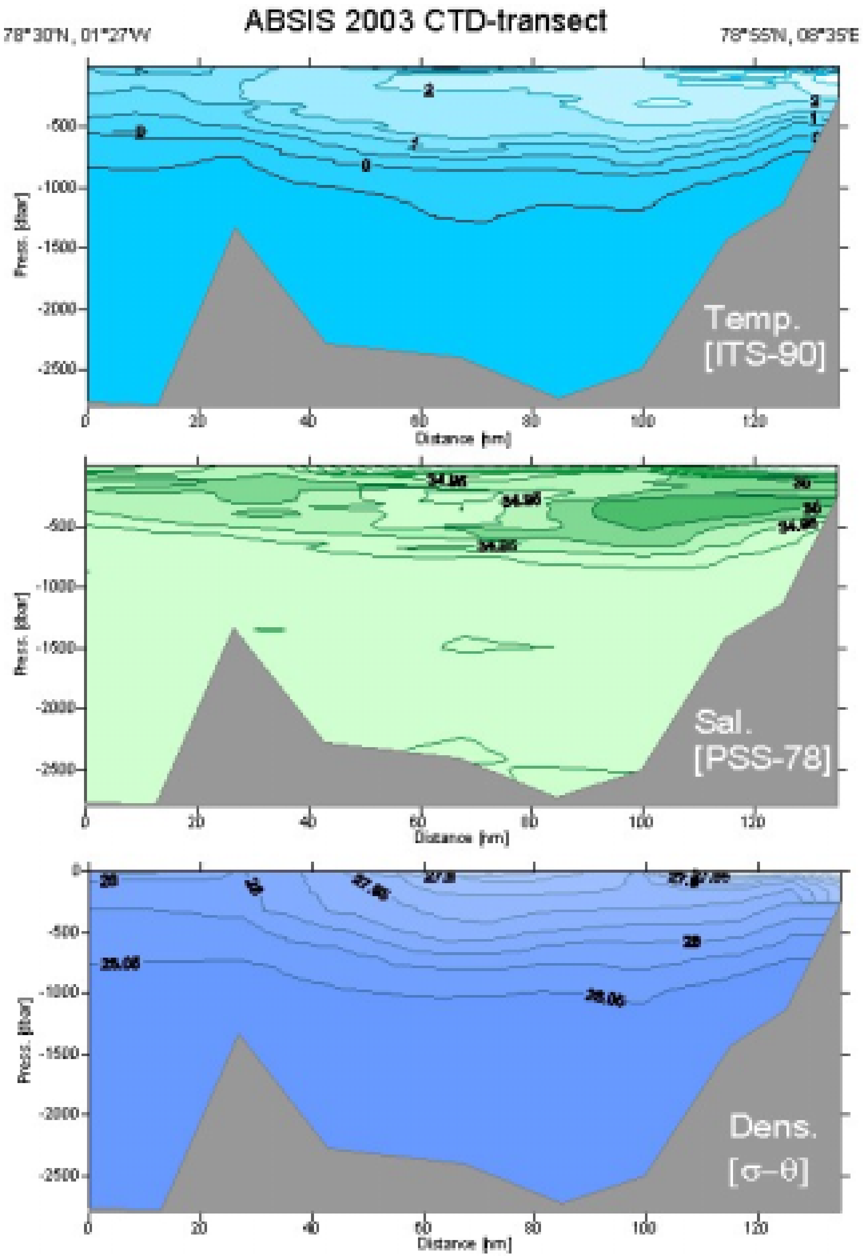

Figure 9. Hydrographic section at 79^0 50' N - 79^0 30' N (stations ABSIS01-ABSIS10, Table 1).

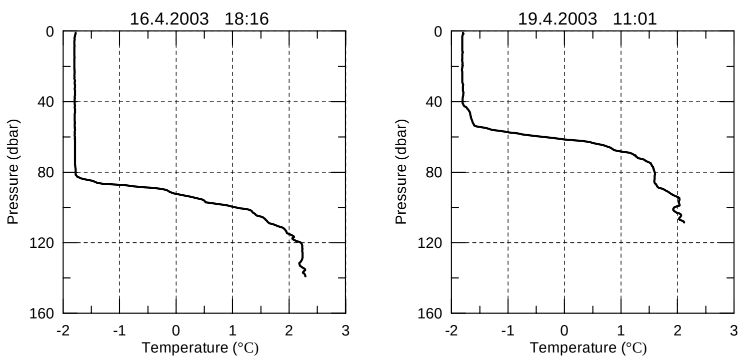

Figure 10. Examples of temperature profile under ice (for position, cf. Table 1).

Others

Because of very unstationary sea ice conditions, over-ice meteorological and turbulent eddy-flux and radiative flux stations could be erected for three short periods only; a flux station was deployed four times – and had to be emergency recovered four times - because of breakage of ice fields. A breakage usually happened after a strong wind; in relaxation and shear after heavy compression.

Generally however, the expedition combined with the Falcon aircraft missions of the University of Hamburg, as well as the cooperation with ARK XIX-1 expedition with RV Polarstern of the Alfred Wegener Institute for Polar Research, Germany, was very fortuitous.

The daring and enthusiastic work of the Personnel of and the scientists of the RV Aranda and is acknowledged.

Participants

(FIMR):	Jouko Launiainen	chief scientist
	Milla Johansson	scientist
	Pekka Kosloff	scientist
	Antti Kangas	res. assist.
	Tuomo Roine	"
	Kalevi Rantanen	lab engineer
	Henry Söderman	field technician.
(UHAM):	Werner Bicelli	technician
	Sacha Bellaire	res. assist
	Christian Wetzel	"
(CAA/China)	Mei Shan	scientist
(UHOK/Japan)	Kazutaka Tateyama	scientist

Onboard Polarstern:

(FIMR)	Patrick Eriksson	scientist

27.6.2003 Jouko Launiainen
jouko.launi@fimr.fi

Table 1. RADARSAT images for Fram Strait under ACSYS-ABSIS-2003.

Date	Time
29.3.2003	16:36:32
1.4.2003	16:49:02
5.4.2003	16:32:21
7.4.2003	07:15:02
10.4.2003	07:27:36
13.4.2003	07:40:07
17.4.2003	07:23:23
19.4.2003	16:23:57

Table 2. CTD casts.

Index	Station	Date	Time (UTC)	Lat	Lon	Press (db)	Sond
0050	AC03_01	28.03.2003	10:15	76.3942	13.1730	104	SBE 911+
0051	ABSIS01	30.03.2003	07:00	78.5498	08.3497	251	SBE 911+
0052	ABSIS02	30.03.2003	08:35	78.5501	07.4305	1136	SBE 911+
0053	ABSIS03	30.03.2003	10:30	78.5500	06.5093	1417	SBE 911+
0054	ABSIS04	30.03.2003	13:00	78.5502	05.3289	2496	SBE 911+
0055	ABSIS05	30.03.2003	16:40	78.5484	04.1565	2731	SBE 911+
0056	ABSIS06	30.03.2003	20:25	78.5292	02.4571	2431	SBE 911+
0057	ABSIS07	31.03.2003	08:05	78.2999	02.0699	2261	SBE 911+
0058	ABSIS08	31.03.2003	11:10	78.3008	00.4593	1314	SBE 911+
0059	ABSIS09	31.03.2003	13:40	78.3022	-00.2373	2785	SBE 911+
0060	ABSIS10	31.03.2003	17:10	78.3013	-01.2701	2780	SBE 911+
		03.04.2003	19:45	80.0739	01.0198	8	SBE 19
		04.04.2003	16:45	79.0739	00.3284	13	SBE 19
		04.04.2003	19:45	79.5153	00.3115	13	SBE 19
		09.04.2003	11:25	80.3385	08.4714	13	SBE 19
1		11.04.2003	08:20	80.5360	09.2081	19.75	SiS
2		11.04.2003	15:15	80.5560	10.2016	18.04	SiS
3		12.04.2003	13:50	81.0009	09.5393	37.24	SiS
4		12.04.2003	15:30	81.0008	09.5355	37.43	SiS + SBE 19
5		12.04.2003	18:07	81.0016	09.5201	44.64	SiS
6		12.04.2003	20:26	81.0041	09.5191	44.54	SiS + SBE 19
7		13.04.2003	02:30	81.0077	09.5207	40.93	SiS
8		13.04.2003	10:10	81.0111	09.5230	42.34	SiS + SBE 19
9		14.04.2003	08:40	80.4514	10.2627	40.92	SiS
10		14.04.2003	10:32	80.4489	10.3314	43.33	SiS + SBE 19
11		14.04.2003	13:10	80.4439	10.4134	42.64	SiS
12		14.04.2003	17:28	80.4370	10.4266	43.94	SiS
13		14.04.2003	23:33	80.4297	10.4063	43.53	SiS + SBE 19
14		15.04.2003	08:30	80.4226	10.3755	43.04	SiS
15		15.04.2003	11:31	80.4214	10.3942	92.53	SiS + SBE 19
16		15.04.2003	19:40	80.4126	11.0468	112.03	SiS
17		16.04.2003	08:00	80.4014	11.1934	143.02	SiS
18		16.04.2003	18:14	80.4544	10.2855	141.24	SiS + SBE 19
19		17.04.2003	08:19	80.4762	08.2176	143.63	SiS + SBE 19
20		17.04.2003	14:35	80.5399	07.1676	141.84	SiS + SBE 19
21		17.04.2003	22:30	80.5286	07.1399	142.24	SiS
22		18.04.2003	08:10	80.5298	07.2099	143.04	SiS
23		18.04.2003	16:10	80.4439	08.3229	136.82	SiS
24		18.04.2003	23:00	80.4276	08.3588	143.04	SiS
25		19.04.2003	11:01	80.3279	07.3007	110.44	SiS + SBE 19
26		19.04.2003	17:22	80.3452	8.4572	127.84	SiS
27		19.04.2003	22:56	80.2733	8.1879	137.64	SiS
28		20.04.2003	11:50	80.2155	7.4465	131.63	SiS
29		20.04.2003	17:35	80.1947	7.3663	73.63	SiS
0061	ABSIS11	21.04.2003	07:35	78.5991	06.4547	1258	SBE 911+