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Report on the Field Phase with Examples of Measurements

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UNI HAMBURG/SFB 318
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DNMI
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ARKTIS'93
REFLEX II

Meteorologisches Institut
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7. *Satellite data*

(S. Bakan, Max-Planck-Institut für Meteorologie, Hamburg)

7.1 *General remarks*

Satellite images of the actual atmospheric conditions are of central importance for the conduct of a field experiment. Especially the images from the NOAA series for polar orbiting weather satellites are very helpful for various reasons:

- Rather high ground resolution of a few kilometers allows to assess even small mesoscale surface and cloud structures with the images from the AVHRR (Advanced Very High Resolution Radiometer).
- Large viewing area (~2500 km across and along satellite flight direction).
- Image reception possible every 100 minutes between 03 and 20 UT.
- Easy access through various channels.

Details of the orbital elements, the satellite tracks, and the spectral and spatial resolution of the various instruments have been described (among others) in Lauritson et al. (1979).

A major drawback in the case of ice observation is the masking of surface details by clouds. This may be avoided with the help of microwave images, which are hardly susceptible to cloudiness. Unfortunately, there are no microwave images of a ground resolution similar to NOAA/AVHRR available. While the ground resolution of the rather easily accessible SSM-I passive microwave data of the Defence Meteorological Satellite Project (DMSP) is only about 50 km, the Russian OKEAN-satellite would provide such a resolution, but was not in operation during ARKTIS 1993. Therefore, in addition to DMSP/SSM-I ice data, ERS-1/SAR (synthetic apperture radar with high spatial resolution) image data where acquired for further campaign support.

7.2 *NOAA AVHRR data and APT images*

7.2.1. *NOAA/AVHRR on POLARSTERN*

The RV POLARSTERN is equipped with a TERRASCAN satellite receiving station, which enables the active reception of digital NOAA/AVHRR data. These can be displayed, manipulated and printed on board and may be archived for later use on EXABYTE tapes.

It was planned to receive as many satellite passes as possible to allow an uninterrupted loop of images of the whole campaign afterwards. Unfortunately, this was not possible all the time, mainly due to the very low temperatures in the middle of the measurement period which limited the free motion of the antenna. Also some data loss occurred due to a damaged tape.

All recorded passes are listed in the following Table 7.3.1:

Tape 1 Ark IX/1a

Satellite	Date	Time	Line
NOAA-11	93/03/01	06:14:48	4392
NOAA-9	93/03/01	10:20:52	4116
NOAA-9	93/03/01	16:57:05	4422
NOAA-10	93/03/02	09:55:40	3450
NOAA-11	93/03/02	12:44:31	2856
NOAA-9	93/03/02	15:07:11	3234
NOAA-11	93/03/03	05:50:10	3558
NOAA-11	93/03/03	07:30:51	2556
NOAA-11	93/03/03	09:10:40	2736
NOAA-9	93/03/03	11:34:51	2718

Tape 2 Ark IX/1a

Satellite	Date	Time	Line
NOAA-11	93/03/04	08:59:54	1308
NOAA-9	93/03/04	11:22:47	1524
NOAA-11	93/03/04	12:21:46	1026
NOAA-9	93/03/04	13:03:11	1668
NOAA-11	93/03/04	14:01:32	2058
NOAA-9	93/03/04	16:23:42	1644
NOAA-9	93/03/04	18:04:46	2268
NOAA-11	93/03/05	07:06:50	2304
NOAA-11	93/03/05	08:47:20	2100
NOAA-9	93/03/05	11:09:01	2340
NOAA-9	93/03/05	12:49:50	2454
NOAA-9	93/03/05	14:31:51	1758
NOAA-11	93/03/06	06:54:00	2388
NOAA-11	93/03/06	08:35:01	2064
NOAA-11	93/03/06	10:15:50	2256
NOAA-11	93/03/06	11:56:51	2406
NOAA-9	93/03/06	17:40:00	2718

Tape 3 Ark IX/1a

Satellite	Date	Time	Line
NOAA-11	93/03/07	06:41:50	1764
NOAA-11	93/03/07	08:22:40	2700
NOAA-11	93/03/07	10:03:30	2268
NOAA-10	93/03/07	11:14:30	2226
NOAA-11	93/03/07	11:46:14	1818
NOAA-11	93/03/07	13:26:00	2484
NOAA-09	93/03/07	15:45:41	2868
NOAA-12	93/03/07	17:37:40	2556
NOAA-12	93/03/07	17:37:40	2526
NOAA-11	93/03/08	08:10:52	1824
NOAA-11	93/03/08	08:10:52	1824
NOAA-11	93/03/08	09:52:07	1752
NOAA-11	93/03/08	11:32:30	2700
NOAA-11	93/03/08	11:32:30	2700
NOAA-10	93/03/09	07:04:10	3720
NOAA-11	93/03/09	04:34:33	3540

Tape 4 Ark IX/1a

Satellite	Date	Time	Line
NOAA-11	93/03/10	07:48:39	1344

Missing data due to hardware trouble

Tape 5 Ark IX/1a

Satellite	Date	Time	Line
NOAA-11	93/03/15	10:06:40	2430
NOAA-11	93/03/15	11:46:50	2964
NOAA-9	93/03/15	12:24:56	1686
NOAA-9	93/03/15	15:42:41	2958
NOAA-11	93/03/16	08:16:34	1302
NOAA-10	93/03/16	09:17:11	2538
NOAA-9	93/03/16	10:27:11	3018
NOAA-11	93/03/16	11:34:23	3030
NOAA-11	93/03/16	13:25:41	3282
NOAA-9	93/03/16	15:29:50	3120
NOAA-12	93/03/16	16:02:40	3552
NOAA-9	93/03/16	17:10:50	3438
NOAA-9	93/03/16	8:53:07	2838
NOAA-11	93/03/17	06:19:20	3270
NOAA-10	93/03/17	07:12:50	3528
NOAA-11	93/03/17	08:04:23	1470
NOAA-11	93/03/17	09:42:07	2472
NOAA-12	93/03/17	10:40:20	3090
NOAA-11	93/03/17	11:22:52	2844
NOAA-11	93/03/17	13:03:30	2430
NOAA-9	93/03/17	15:17:01	2964
NOAA-12	93/03/17	15:41:30	3234
NOAA-9	93/03/17	16:58:01	3546
NOAA-9	93/03/17	18:39:34	3186

Tape 6 Ark IX/1a

Satellite	Date	Time	Line
NOAA-11	93/03/18	04:26:01	3012
NOAA-11	93/03/18	06:07:11	3366
NOAA-10	93/03/18	08:29:11	3510
NOAA-9	93/03/18	10:01:30	3528
NOAA-12	93/03/18	10:18:50	3360
NOAA-11	93/03/18	11:10:02	3222
NOAA-9	93/03/18	11:42:31	2088
NOAA-11	93/03/18	12:51:10	3288
NOAA-10	93/03/18	15:09:40	2754
NOAA-9	93/03/18	16:45:10	3654
NOAA-9	93/03/18	18:26:36	3156
NOAA-11	93/03/19	04:14:02	3336
NOAA-11	93/03/19	05:55:01	3420

Tape 7 Ark IX/1a

Satellite	Date	Time	Line
NOAA-11	93/03/20	09:04:50	2826
NOAA-10	93/03/20	09:26:43	1746
NOAA-9	93/03/20	09:35:57	3576
NOAA-11	93/03/20	10:46:57	2610
NOAA-12	93/03/20	11:16:53	2616
NOAA-11	93/03/20	12:28:29	1908
NOAA-9	93/03/20	12:57:58	3450
NOAA-10	93/03/20	14:21:45	1950
NOAA-9	93/03/20	14:38:35	3216
NOAA-10	93/03/20	16:04:42	1830
NOAA-9	93/03/20	16:19:31	1638
NOAA-10	93/03/20	17:42:50	2154
NOAA-9	93/03/20	18:02:05	1572
NOAA-9	93/03/20	19:42:58	1446
NOAA-11	93/03/21	05:31:06	2676
NOAA-10	93/03/21	08:57:30	2436
NOAA-9	93/03/21	09:23:00	2460

7.2.2 NOAA imagery at Longyearbyen

a. From Tromsø satellite station (TSS)

At TSS (Tromsø satellite station) NOAA/AVHRR data are received on a regular schedule. For archiving these data are transformed in the standard ESA SHARP format. Also a quicklook data file is produced by resampling these images with a reduced resolution (of about 4 km/pixel) into an appropriately chosen polar stereographic projection. A visible and an infrared quicklook scene of 768 x 512 pixels each are available within about one half hour of the satellite pass over Tromsø.

The AWI installed an X25 modem connection to the mainland telephone network. Via this connection their SUN workstations were able to access a server at TSS using internet. Four times per day the infrared quicklook of the area around Spitsbergen was transferred via FTP. At the headquarters these transferred scenes were put on a data disk, transported to the main briefing room for printout and display.

In general, the quality of these quicklook images are satisfactory. In some cases the overlay grid with its coastlines is shifted considerably as compared to visible land contours. In Appendix C one infrared quicklook scene per experiment day is displayed for reference.

b. APT images

The AWI had also available a Skyceiver Silver (Technavia) satellite receiver, that was able to receive the APT (automatic picture transmission) images from NOAA satellites. This format itself represents a quicklook product for which on board the satellite a rough geometric correction for view angle distortion and a resolution reduction (to about 5.6 km per pixel) is applied. An analogue signal of the image is then sent line-by-line as the satellite moves along.

The location of the antenna on top of the hangar's roof was good enough to allow excellent reception with this system, with the display being located in the briefing room. Some image manipulation and the printing of hardcopies were possible.

As these images lack grids and coastlines the scene identification is usually difficult. Therefore, a gridline program (written by T. Martin, Universität Hamburg) was implemented on an accompanying PC, that allowed to superimpose grid and coast lines over an image, that has been transferred before from the image receiving system. Unfortunately, the whole procedure is somewhat lengthy and could, therefore,

not be used regularly. But, as Spitsbergen was rather clearly visible in most of the scenes, and as the precision quicklook from TSS gave a good impression of what should be visible, the identification of the scene was no problem normally. This system helped in filling the gaps of a few hours from the latest TSS-quicklook to the actual situation, which was occasionally helpful for airplane mission decisions.

7.2.3 NOAA/APT images on VALDIVIA

On board the RV VALDIVIA another Skyceiver Silver APT receiver (from Technavia) was installed. Again the grid program by Thomas Martin was used to provide orientation in these images. As no other system was available this combination was heavily used and proved reliable and helpful.

7.3 ERS-1/SAR image data

In the framework of the ESA project "Use and verification of SAR sea ice imaging during a special observation period of the GSP/ARKTIS 1993" it was possible to acquire many SAR images of the experimental region. Due to the common interest of this project as well as of other ESA principle investigators the SAR image mode was switched on during March 1993 virtually always when ERS-1 passed the Greenland sea region north of 75°N.

7.3.1. Data sources and data flow

During the field phase SAR data were accessed through different channels.

- Fax products from the German BDDN point at the BSH/Hamburg:
  The MARINE WEATHER SERVICE at the BSH previewed the data distributed through the BDDN, analyzed them, and sent hardcopies of the images or zoomed subareas of special interest with scene interpretation comments via Fax to the RV Polarstern (as long as possible) and to the campaign headquarters in Longyearbyen. The quality of these Faxes in Longyearbyen was, unfortunately, not high enough to render this distribution path particularly useful for the campaign planning and steering.

- SAR image scheduling information from the anonymous FTP-server at ESRIN/Frascati:
  Via an X25 router the experiment headquarters had access to all data provided on the anonymous FTP-server at ESRIN/Frascati. Especially the image scheduling information prooved to be very helpful in planning details of the activities

in accordance with available SAR-scenes. Two additional information aspects were felt to be missing. Unfortunately, the DESC program does not provide any information on the time of acquisition of a certain scene (it gives only orbit and frame), which is important for detailed flight planning. Also it would be nice to know not only the planned QL-frames, but all the frames planned for acquisition.

- QL products from the anonymous FTP-server at ESRIN/Frascati:
  In a few instances of especially interesting scenes, the QL image file was transferred to the campaign headquarters via FTP. Due to slow data line parts, the transfer of one scene took around 1 hour during night time, much more during the day. This, of course, limited the access to this data base considerably, but basically it turned out to be a very convenient way to access SAR quicklook products.

- High spatial resolution products from the German BDDN knot at the BSH/ Hamburg:
  The responsible people at the BSH and at the Univ. in Hamburg scanned the potentially relevant high resolution data distributed via the BDDN. In a few instances scenes of 1024x1024 pixels around the POLARSTERN's position were cut out of the original high resolution image and transferred via FTP to the campaign headquarters.

The data were displayed on a SUN workstation and printed on a Canon FP 510 color printer, which allowed also for high quality greylevel prints.

Due to the limited quality of telefax reproduction, and as the RV Polarstern could no longer be reached by telefax service north of 79°N, the people on board the ship could not take advantage of the mentioned fax image information during most of the campaign. On one occasion, printed images were brought by one of the research airplanes to POLARSTERN and dropped on the ice near to it's location. These images proved to be useful for the decision on local ice studies.

Quicklook (UILR) and high resolution (UI16) images are stored for later reference at the MPI and at the BSH, Hamburg. Precision images (PRI) of various scenes around the ice edge were ordered by the group of W. Alpers, IfM, Hamburg, and are stored there. Also the AWI group ordered some PRI scenes.

The general area around the ice edge in the Frame Strait was passed and imaged along the flight path almost daily by ERS-1. But due to the small image size the specific location of the RV POLARSTERN was only covered in a few instances (especially 6,12, 15, 18, 21 March 1993).

7.3.2. *Potential and importance of SAR image data for the campaign*

a. *Use of SAR images during the campaign*

We concentrated on the SAR images around the nominal and lateron around the actual position of the RV POLARSTERN. Inexperienced, as we were, this turned out to be rather difficult , as the sea ice showed not very much structure initially. Smaller and larger areas of different grey shades and occasional very dark linear elements did not allow an easy interpretation. Finally, the RV POLARSTERN took position at the north-western edge of a somewhat larger dark area (Figure 7.3.1). This represented obviously a region with young and thin ice as parts of it were even ice free by the time the RV POLARSTERN was looking for a final position. This feature refroze after the passage of RV POLARSTERN and remained virtually unchanged until March 19 (Figure 7.3.2), when the whole ice area had reached the ice edge at around 80.5°N and broke apart.

It was originally hoped by the project participants, that the RV POLARSTERN crew would use these SAR images for their navigation purposes through the ice. Unfortunately, however, several reasons acted together to hinder this use. First of all, there is a considerable discrepancy between high radiometric and ground resolution of the images and the fact, that the area of interest is only covered every third day. While the resolution yields very detailed information on ice state and structure, the time step is too coarse to follow changes near the ice edge. Depending on the atmospheric conditions ice fractures can open and close within hours. Also, the ice motion may change considerably within several hours in reaction to changes in the synoptic conditions. Therefore, a three day repeat cycle was too long for actual coverage of the ice edge region as a basis for the decision where to enter the ice and where to go. In addition, the image access time (either from Frascati or from the BDDN knot in Hamburg) was much too long for use in a shortterm decision process. Also the scene size is somewhat too small to overview the whole area of interest from the ice edge to the nominal goal about 100km into the ice. At the same time, the reduced ground resolution of the quicklook images is good enough for navigation purposes as required in the present case. Much more than the available high spatial resolution a larger field of view, a short repeat cycle, and online data access would help the ship navigation.

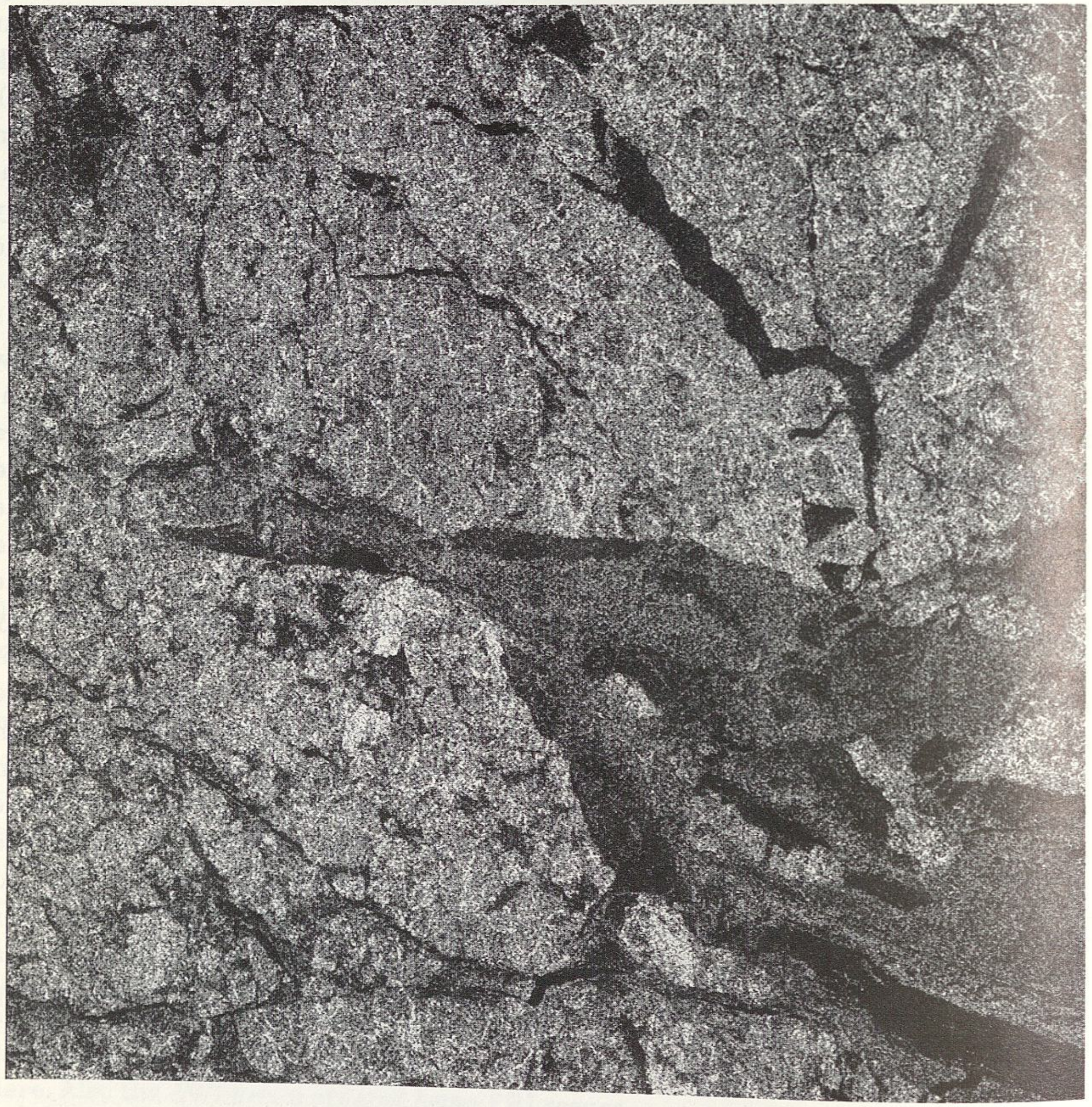

Figure 7.3.1: Subscene of an original high resolution SAR image product (UI 16) of 12 March, 1253 UT, as received at the BSH, Hamburg. The image shows the surrounding of the POLARSTERN ice station, with the ship being recognizable as a bright spot in the upper left part corresponding to a geographical position of 81° 9'N and 6° 29'E.

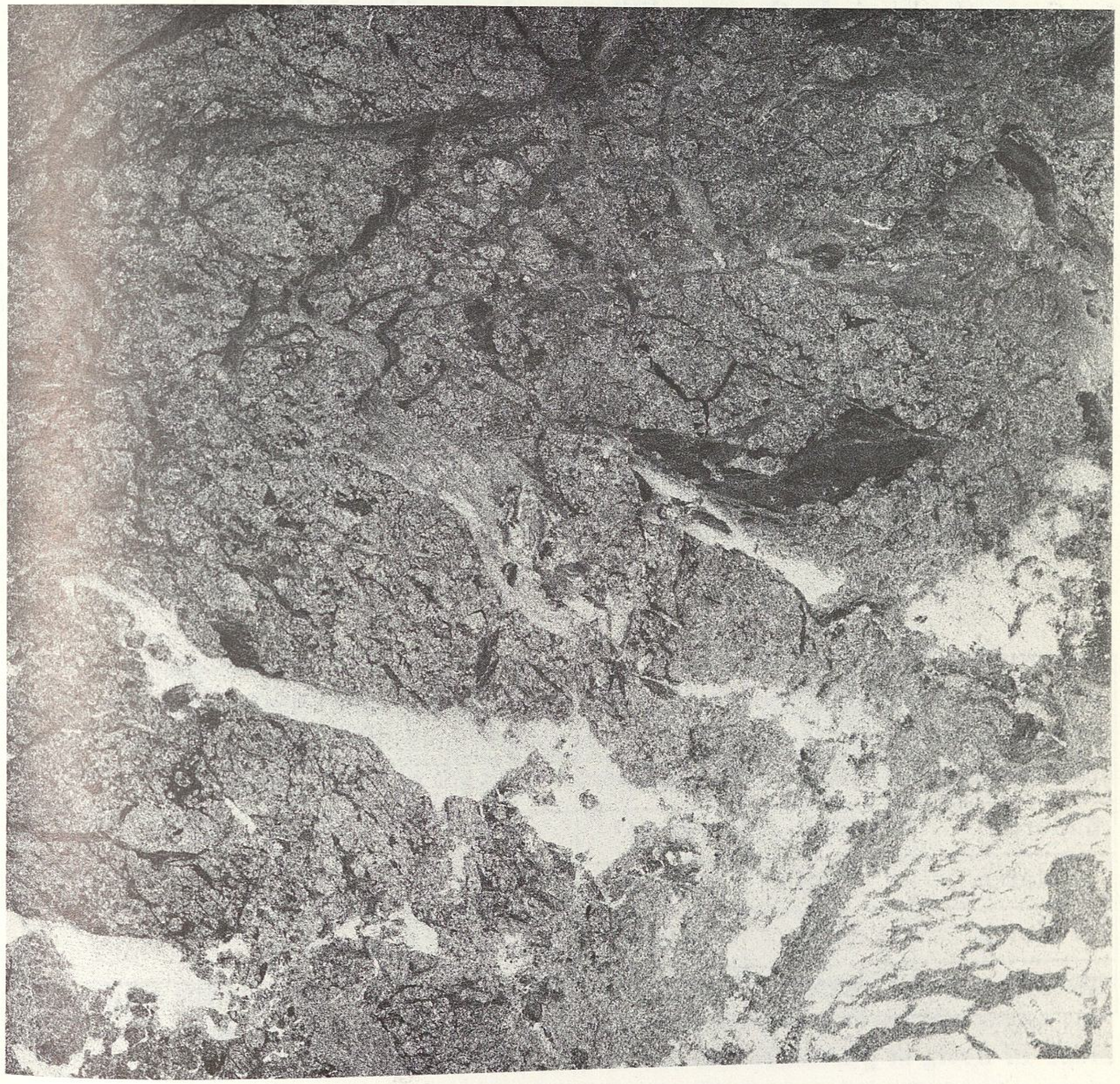

Figure 7.3.2: Low resolution full SAR scene (UILR) of the region around the POLARSTERN position on 18 March, 20 UT near the ice edge.

Therefore, the RV POLARSTERN navigation was based heavily on the information provided by NOAA/AVHRR throughout this initial phase of the campaign. As there is a receiving station for these data on board the ship, the actual image is immediately available after the satellite overpass. Around 80°N also consecutive NOAA passes overlap considerably, and as two satellites with almost perpendicular orbit planes are working, the area is covered throughout the whole day (between about 02 to 20 UT) at an interval of only 100 minutes. As long as clouds are not badly covering the scene, which was the case for most of the ARKTIS campaign due to predominantly northerly winds, these conditions can be considered almost ideal for navigation purposes. In case of uncertainties, helicopters on board the ship are available to survey the surrounding in detail for a passage possibility.

b. Ice motion during ARKTIS 93

The major feature observable in the SAR images was the rapid ice motion in the vicinity of the POLARSTERN position with almost no relative motion of various ice features. The whole ice region drifted at an average speed of about 10 cm/s towards south west. The following table contains the change in time of the geographic location of the ice area in which the POLARSTERN took final position. This region of obviously younger ice could already be recognized on an image taken down at 24 February, and turned out to remain virtually unchanged until the ice boundary, which was reached on 19 March.

Date	Time (UT)	Latitude (°N)	Longitude (°E)	Distance moved (km)	Speed (cm/s)
24 February	1255	82.60	11.84	-----	-----
6 March	1920	81.54	7.66	137.0	15.6
12 March	1253	81.15	6.48	47.5	9.6
15 March	1200	81.00	5.50	23.6	9.2
18 March	2000	80.55	4.63	51.7	18.0

c. Comparison with thermal images

Comparison of the SAR images with thermal imagery showed an impressive amount of coincidence of observed ice features. Two examples are given in the following.

- AWI airborne linescan camera:

On board the POLAR-2 airplane a linescan camera of the AWI was installed and operating on most of the flights over ice. The flight paths were chosen in accordance with ERS-1 passes to allow maximum intercomparison with SAR images. Due to the low sun elevation the visible channel of the linescan camera did not yield too much information. The second detector, covering the 10μm window region in the thermal infrared, was operated for the first time in a field campaign.

A preliminary evaluation of one flight track showed a surprisingly clear correspondence between features in the SAR image and those observed by the line scan camera. Dark areas in the SAR image, normally associated with younger ice, correspond to a higher (= warmer) surface signal of the line scan camera. This correspondence may be so very clear in this special case of very low air temperatures of about -40°C on the day of these measurements. Potential implications of this correspondence for the interpretation of the SAR images will be further studied at the AWI.

- NOAA AVHRR imagery:

Similar to the thermal image of the line scan camera the NOAA/AVHRR thermal image reveals surface details comparable to the SAR imagery, although with considerably reduced ground resolution. Bigger leads and fractures may be recognized in the NOAA images as well as in the SAR scenes. These features will be studied at the MPI, Hamburg.

d. SAR images over the open water

ERS-1/SAR scenes were also recorded when the satellite was over the ice edge zone and over the open water near the ice edge in the region of the Westspitsbergen current. A list of scenes archived as PRI data at the IfM Hamburg is given in Table 7.3.2. These scenes were selected in order to study how secondary flow patterns in the atmosphere (like cloud streets) modulate the roughness of the sea surface due to varying wind speed. If the horizontal gradients in surface roughness are strong enough this is seen by the SAR (Alpers and Brümmer, 1994). An example of street like patterns on the sea surface as seen by the SAR on 5 March 1993 at 1941 UT is given in Figure 7.3.3. The figure shows an areas of about 100 x 100 km. The distance between the streets is 1-2.5 km.

Table 7.3.2: List of ERS-1/SAR scenes of the ice edge zone in the region of the West-spitsbergen current. Latitude and longitude values represent the image corners. These scenes are stored as PRI products at the Institut für Meereskunde, Prof. W. Alpers, Hamburg.

Day	Time	Orbit	Frame	Lat.	Long.	Lat.	Long.	Lat.	Long.	Lat.	Long.
1	11.58.41	8499	1971	80.25	10.88	79.72	14.98	79.00	12.04	79.50	8.0
1	11.58.56	8499	1989	79.50	8.09	79.00	12.04	78.26	9.45	78.73	5.6
1	11.59.12	8499	2007	78.73	5.66	78.26	9.45	77.50	7.15	77.94	3.5
4	12.04.00	8542	1971	79.73	13.61	80.26	9.47	79.50	6.63	79.00	10.62
4	12.04.00	8542	1989	79.01	10.66	79.51	6.66	78.30	4.19	78.26	8.02
4	12.05.00	8542	2007	78.27	8.05	78.74	4.22	79.94	2.05	77.50	5.71
5	19.50.47	8561	1611	79.22	4.66	79.72	8.66	78.96	11.19	78.48	7.3
5	19.51.02	8561	1629	79.93	1.60	80.47	5.74	79.72	8.66	79.22	4.6
5	19.51.17	8561	1647	79.93	1.63	80.46	5.81	81.19	2.38	80.61	1.9
6	12.41.33	8571	1953	80.98	3.33	80.41	7.56	79.72	4.20	80.25	0.1
6	12.41.48	8571	1971	80.25	0.10	79.72	4.20	79.00	1.26	79.50	-2.7
6	12.42.03	8571	1985	79.50	-2.69	79.00	1.26	78.26	-1.33	78.73	-5.2
7	12.09.56	8585	1953	80.98	11.24	80.41	15.47	79.72	12.11	80.25	8.0
7	12.10.11	8585	1971	80.25	8.01	79.72	12.11	79.00	9.16	79.50	5.2
7	12.10.26	8585	1989	79.50	5.21	79.00	9.16	78.26	6.57	78.73	2.7
7	12.10.41	8585	2007	78.73	2.78	78.26	6.57	77.50	4.28	77.94	0.6
8	19.56.17	8604	1593	78.48	5.91	78.96	9.75	78.17	11.97	77.73	8.2
8	19.56.32	8604	1611	79.22	3.22	79.72	7.22	78.96	9.75	78.48	5.9
8	19.56.47	8604	1629	79.93	0.16	80.47	4.31	79.72	7.22	79.22	3.2
8	19.57.02	8604	1647	80.61	-3.33	80.19	0.93	80.47	4.31	79.93	-3.4
10	12.15.41	8628	1953	80.98	9.80	80.41	14.03	79.72	10.67	80.25	6.5
10	12.15.46	8628	1971	80.25	6.57	79.72	10.67	79.00	7.73	79.50	3.7
10	12.16.11	8628	1989	79.50	3.78	79.00	7.73	78.26	5.13	78.73	1.3
10	12.16.26	8628	2007	78.53	1.34	78.26	5.13	77.50	2.84	77.94	-0.8
11	20.02.17	8647	1611	79.22	1.79	79.72	5.78	78.96	8.31	78.48	4.4
11	20.02.32	8647	1629	79.93	-1.27	80.47	2.87	79.72	5.78	79.22	1.7
12	19.30.40	8661	1611	79.22	9.69	79.72	13.69	78.96	16.22	78.48	12.8
12	19.30.55	8661	1629	79.93	6.63	80.47	10.77	79.72	13.69	79.22	9.6
12	19.31.10	8661	1647	80.61	3.13	81.19	7.39	80.47	10.77	79.93	6.6
13	12.21.26	8671	1953	80.98	8.36	80.41	12.59	79.72	9.23	80.25	5.1
13	12.21.41	8671	1971	80.25	5.13	79.72	9.23	79.00	6.29	79.50	2.3
13	12.21.56	8671	1989	79.50	2.34	79.00	6.29	78.26	3.70	78.73	-0.7
13	12.22.11	8671	2007	78.73	-0.09	78.26	3.70	77.50	1.40	77.94	-2.3
14	20.08.02	8690	1611	79.22	0.35	79.72	4.35	78.96	6.88	78.48	3.0
14	20.08.17	8690	1629	79.93	-2.71	80.47	1.43	79.72	4.35	78.22	0.0
15	19.36.25	8704	1611	79.22	8.25	79.72	12.25	78.96	14.78	78.48	10.9
15	19.36.40	8704	1629	79.93	5.19	80.47	9.34	79.72	12.25	79.22	8.2
15	19.36.55	8704	1647	80.61	1.70	81.19	5.96	80.47	9.34	79.93	5.1
16	12.27.11	8714	1953	80.98	6.93	80.41	11.16	79.72	7.80	80.25	3.6
16	12.27.26	8714	1971	80.25	3.69	79.72	7.80	79.00	4.85	79.50	0.9
16	12.27.41	8714	1989	79.50	0.90	79.00	4.85	78.26	2.26	78.73	-1.6
16	12.27.56	8714	2007	78.73	-1.53	78.26	2.26	77.50	-0.03	77.94	-3.7
17	11.55.49	8728	1971	80.25	11.60	79.72	15.70	79.00	12.76	79.50	8.8
17	11.56.04	8728	1989	79.50	8.81	79.00	12.76	78.26	10.16	78.73	6.3
17	11.56.19	8728	2007	78.73	6.37	78.26	10.16	77.50	7.87	77.94	4.2
18	19.42.10	8747	1611	79.22	6.82	79.72	10.81	78.96	13.34	78.48	9.5
18	19.42.25	8747	1629	79.93	3.76	80.47	7.90	79.72	10.81	79.22	6.8
18	19.42.40	8747	1647	80.61	0.26	81.19	4.52	80.47	7.90	79.93	3.7
19	12.32.56	8757	1953	80.98	5.49	80.41	9.72	79.72	6.36	80.25	2.2
19	12.33.11	8757	1971	80.25	2.26	79.72	6.36	79.00	3.41	79.50	-0.6
19	12.33.26	8757	1989	79.50	-0.54	79.00	3.41	78.26	0.82	78.73	-3.0
19	12.33.41	8757	2007	78.73	-2.97	78.26	0.82	77.50	-1.47	77.54	-5.1
20	12.01.34	8771	1971	80.25	10.16	79.72	14.26	79.00	11.32	79.50	7.3
20	12.01.49	8771	1989	79.50	7.37	79.00	11.32	78.26	8.73	78.53	4.9
20	12.02.04	8771	2007	78.73	4.94	78.26	8.73	77.50	6.43	77.94	2.8
21	19.47.55	8790	1611	79.22	5.38	79.72	9.38	78.96	11.91	78.48	8.0
21	19.48.10	8790	1629	79.93	2.32	80.47	6.46	79.72	9.38	79.22	5.3
21	19.48.25	8790	1647	80.61	-1.18	81.19	3.08	80.47	6.46	79.93	2.3
22	12.38.41	8800	1953	80.98	4.05	80.41	8.28	79.72	4.92	80.25	0.8
22	12.38.56	8800	1971	80.25	0.82	79.72	4.92	79.00	1.98	79.50	-2.0
22	12.39.11	8800	1989	79.50	-1.97	79.00	1.98	78.26	-0.61	78.73	-4.6
23	12.07.19	8814	1971	80.25	8.72	79.72	12.83	79.00	9.88	79.50	5.9
23	12.07.34	8814	1989	79.50	5.93	79.00	9.88	78.26	7.29	78.73	3.5
23	12.07.49	8814	2007	78.73	3.50	78.26	7.29	77.50	5.00	77.94	1.3
24	19.54.10	8833	1647	80.61	-2.61	81.19	1.64	80.47	5.02	79.93	0.8

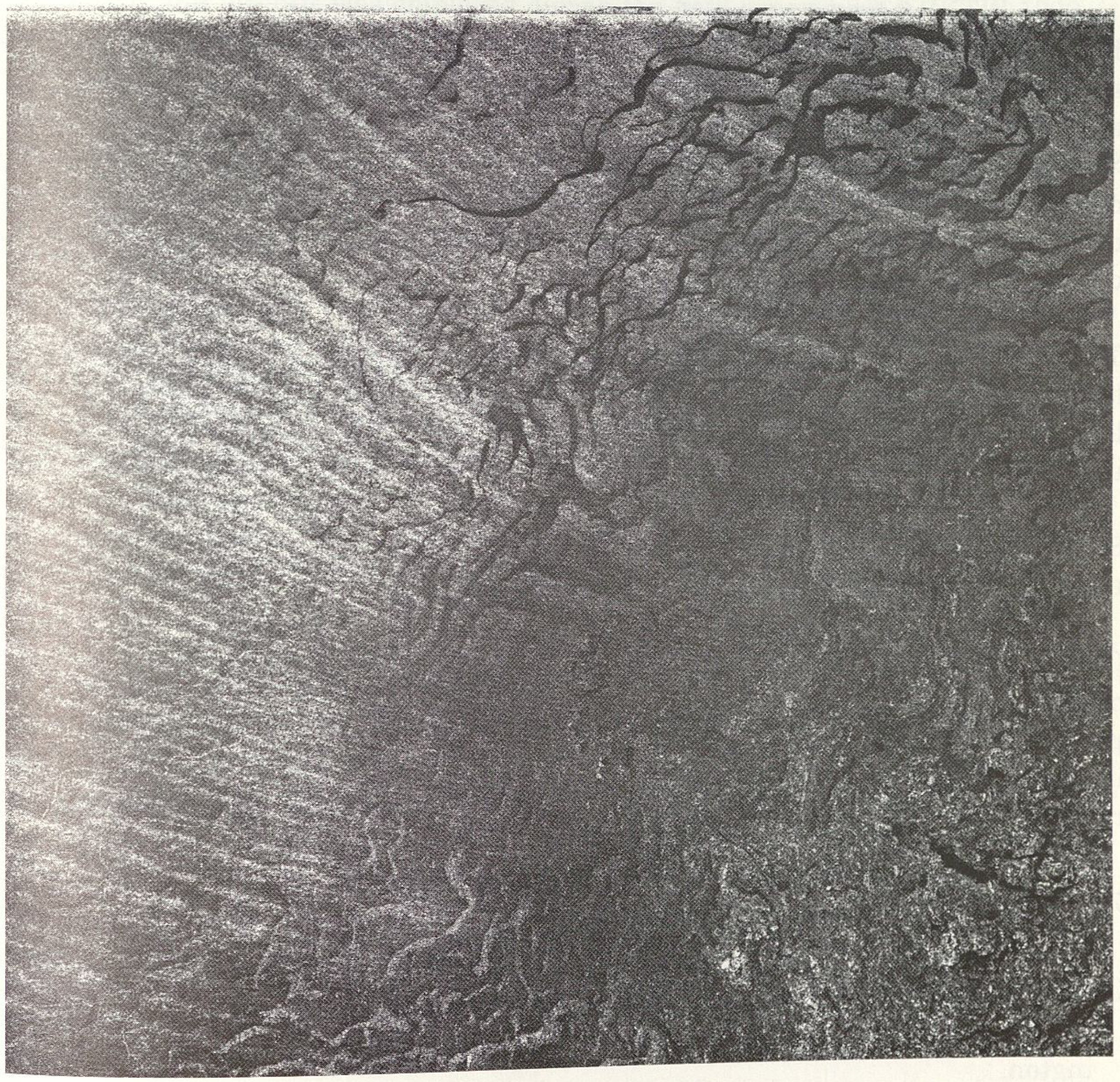

Figure 7.3.3: ERS-1/SAR scene (orbit 8561, frame 1629) on 5 March 1993, 1941 UT. The area presented is about 100 x 100 km. The geographical coordinate of the corner points are given in Table 7.3.2.

7.3.3. Conclusions and recommendations

ERS-1/SAR images turned out to be potentially valuable for the planning and steering of scientific experiments near the ice edge . Unfortunately, the logistic structure available to our campaign, did not allow to use this potential to any remarkable extent. Also the long repeat cycle of 3 days of ERS-1 poses basic problems for the use of these images for short term ship routing or for scientific measurement flight decisions.

But the biggest problem was posed by the data connections. There was no chance to send volume data of images, or even telefaxes, to the RV POLARSTERN once the ship was north of 79°N. This is due to the limitation of the geostationary INMARSAT relay satellite. Even the normal mission coordination with the ship was rather difficult as communications had to rely on ordinary radio frequency contacts. Only a direct receiving station on board the RV POLARSTERN would have provided a real chance to use SAR images extensively.

The use of these data at the campaign headquarteres in Spitsbergen was practically limited by the cost of image data transfer via telefone connections and by the time lag between the image acquisition and the practical availability of quicklook products.

Similar future use of these data has to be planned with considerably more lead time and dedicated efforts to avoid the experienced problems.

On the other hand, the available SAR images contain a wealth of information for offline studies. Especially the high resolution definition of the structures around the position of the RV POLARSTERN and the comparison of these with NOAA/AVHRR images or with AWI linescan camera data promise to reveal scientifically interesting results.

7.4 References

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