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In the period January-March 1994, the Directorate of Fisheries carried out a trial of the EUTELTRACS system on board F/F Johan Hjort. During this period, the vessel was for the most part located in the Barents Sea.

An important part of the trial was the comparison of positioning based on GPS and positioning for EUTELTRACS. The trial has given results showing good consistency between the position determinations of the two systems.

The trial has also shown that communications in this area via EUTELTRACS may be interupted from time to time.

Topic words
Euteltracs, satellite system, tracking, message transmission, the Barents Sea

Distribution

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1. INTRODUCTION

The Directorate of Fisheries is required by Parl. Bill no. 1 (1993-94) to conduct further trials into the use of information technology for surveillance of fishery activities (tracking) at sea based on satellite systems, as well as catch reporting via satellite.

During the first half of 1991, the Directorate of Fisheries carried out its first tracking trials using the ARGOS system. Subsequently, further trials were carried out in order to ascertain the degree to which tracking by satellite can indicate the prior fishery activities of a vessel (ARGOS 1993), and also trials of transmission of bit-mapped messages via satellite for quota control purposes (ARGOS/INMARSAT-C 1993). INMARSAT-C is also used by the Directorate of Fisheries in other connections.

It was therefore desirable and natural for the Directorate of Fisheries to also carry out practical trials with EUTELTRACS in order to appraise the qualities of this system with regard to fishery management and control, here with special emphasis on tracking and message transmission.

In cooperation with the Institute of Marine Research, EUTELTRACS equipment was mounted on board F/F Johan Hjort (910 gross tonnage/ 64.4 m. l. length) in the middle of January 1994. This vessel was selected because at this time she was about to begin a two months' expedition in the Barents Sea. The EUTELTRACS equipment was installed by EUTELTRACS own personnel. Although the antenna was placed high in the mast, approximately 30 meters above sea level, it was not placed at the top of the mast. It should be noted that if the antenna is not placed in the topmost position of the mast, either the messaging or ranging satellite may be blocked from time to time depending on the bearing of the vessel. This problem could occur with every geostationary satellite system.

EUTELTRACS coverage in Nordic areas is of special interest to the Directorate of Fisheries. The system is based on geostationary satellites in equatorial orbit. Therefore, a number of factors indicate that coverage in the far north will be defective. The most important of these factors is the angle of instream or the satellite's altitude above the horizon as seen from the mobile. Generally speaking, this altitude should be at least of a magnitude of 5°. Below 0° coverage cannot be expected, and the marginal area will be between 0° and 5°. The theoretical coverage area for the Barents Sea and the Norwegian Sea is shown in Appendix 1 "EUTELTRACS Nordic Coverage".

Although this expedition was not intended to cover so large an area as to give an actual map of the practical coverage area in relation to a theoretical coverage map, it was the opinion of the Directorate of Fisheries that by means of this expedition a useful first indication of coverage and a good starting point for possible new trials could be obtained.

The Directorate of Fisheries wishes to thank the Institute of Marine Research, Instrument Section, for their kind assistance during the trial.

2. EUTELTRACS

The EUTELTRACS system has been in operation since January 1991 as a commercial proposition from EUTELSAT. The system is particularly renowned as a proposition for mobile land communications for trailer traffic etc. The system in Europe is based on the use of EUTELSAT's geostationary satellites. A mobile user of the system must acquire a Mobile Communications Terminal (MCT). This can be mounted on a car or a vessel, and consists of a control unit, an antenna, a character display unit and a keyboard. The equipment is of a size which enables it to be easily mounted on a fishing boat.

Full utilization of the system calls for the use of two satellites. One of these is called Communication Satellite (CS) and the other, Ranging Satellite (RS). CS can send messages to the mobile unit and receive messages from it. A standard message can have a size of up to 1920 characters (6-bit), or up to 1440 Bytes. In addition, the CS will send Position Poll packets to the mobile unit at regular intervals. These packets are used to determine the position of the mobile unit. Position determination will, as standard practice, be carried out once an hour, but if desired, it may be carried out more frequently, for example every five minutes.

During the trial undertaken by the Directorate of Fisheries, position determination was carried out every 15 minutes.

Position determination is obtained by the RS sending a separate signal which is synchronized with the signal from CS. The mobile unit will receive both these signals, which reach the mobile station via two different routes. The signals will therefore be phase displaced when they meet. Information regarding this divergence is sent back to EUTELTRACS land station (Hub) over CS. Position determination using WGS-84 can then be undertaken there. The position is reported with a precision of one geographical second.

As one wishes position determination to be as precise as possible, it is important that the angular separation of the two satellites is above a certain minimal limit. The separation must be at least 6°. The adjustment arc is asymptotic, and only marginal improvements are obtained over about 15°. On account of the wish for convergence in the coverage area, angular separation cannot be too great.

EUTELTRACS guarantee a position-finding accuracy of 300 meters at any point in Europe [1]. Given angular separation of about 15°, 95% of position determination will fall within an error of maximum 240 meters, with an average of about 80 meters for maritime use [2].

The EUTELTRACS system gives coverage in European waters, and in the Atlantic Ocean up to a little beyond 30° West. Similar systems are to be found for American waters.

For further information regarding technical facts, please see publications from EUTELSAT [2].

3. THE TRIAL

3.1 Technical factors

During the Directorate of Fisheries' trial of January - March 1994, CS was used at 25.5° East and RS at 7° East. Angular separation is then around 18.5° [3], which should be near the optimal, see Fig.1.

As will be seen from the trial, the average position for the observations was around 71.5° North 34° East, see table 1. This, according to longitude, is a reasonably serviceable positioning with regard to the satellites. Due to the high latitude, the projections of two imaginary circles

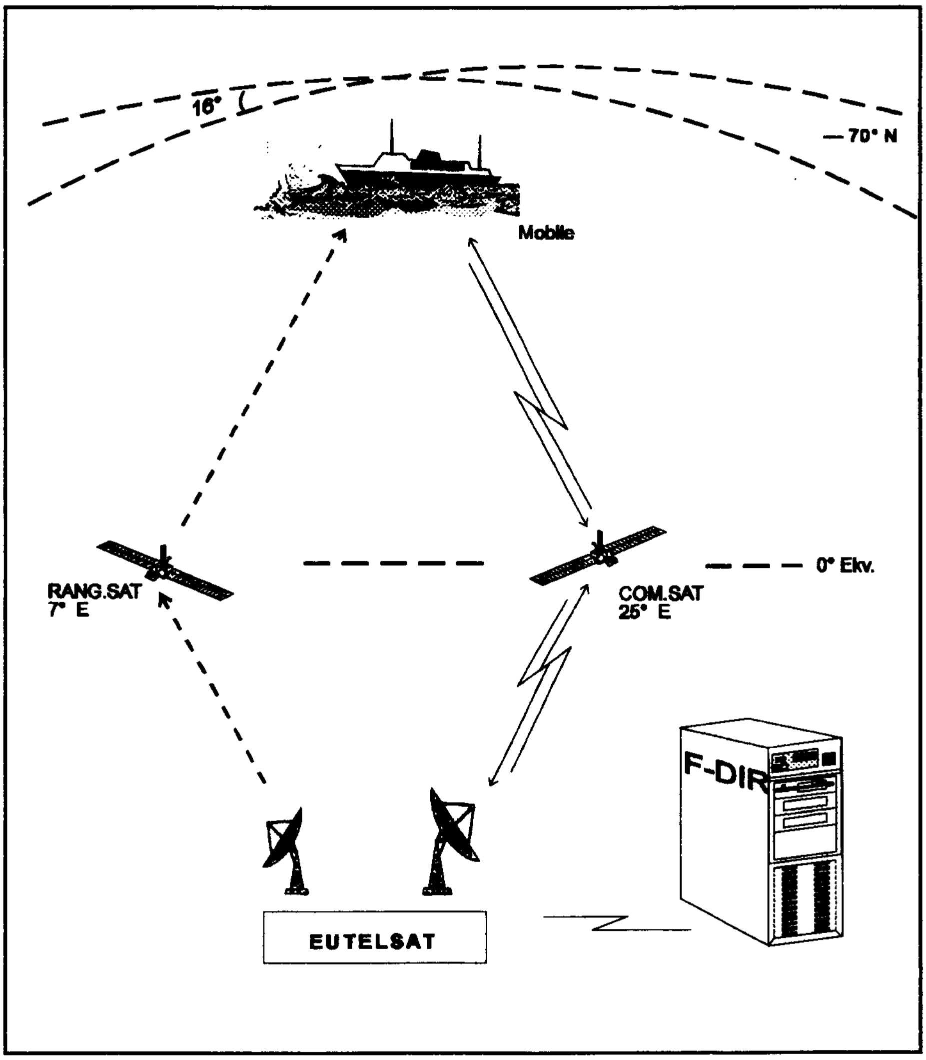


Figure 1 Schematic overview of EUTELTRACS

centered in the satellite positions will, however, intersect at a relatively narrow angle, around 16° [4]. This angle is important in determining the longitude of the mobile unit. As we shall see, the measured error of longitude in our trial is also greater than the error of latitude.

During the trial, a mobile station with Id.no. 24896 and software release 10.30 were used. The Directorate of Fisheries was connected to EUTELTRACS as Main Account through a standard modem connection.

The equipment was mounted on board the vessel in Tromsø 1994-01-17, and demounted in Bergen 1994-03-20. During the trial period, F/F Johan Hjort made in all 5 excursions to the Barents Sea. Charts of these excursions are shown in Appendix 2.

F/F Johan Hjort has also 2 sets of GPS equipment on board for position determination. One of these sets is connected to the ship's echo sounder. The vessel's position is continuously logged on board in machine-readable form as WGS-84. This log is active so long as the vessel is carrying out research work. Normally the log is not active when the vessel is in port.

The vessel's position from GPS is logged every 5th minute, as degrees with three decimals. The position is, however, also logged in connection with a number of special tests. This entails an improvement in the total frequency of position determination logged from GPS, in total an average of 3.1 minutes. From a total of 23.376 measure intervals during the testing period, 75% of these were less than 5 minutes.

The GPS equipment used for logging during this expedition was of the type Trimble Navigation GPS/Loran 10X, No. 11433-31, serial no. 2950A00609.

The vessel's typical behaviour during an expedition of the type covered by our analysis will be long periods of steaming at relatively high speed, around 11 knots. These periods are followed by shorter periods of sample taking, during which the vessel lies almost motionless. Such motionless periods may last for about 20 minutes. On an average, there may be intervals of approximately 3 hours between these tests. At times the vessel may also carry out trawl hauls. Speed may then be reduced to around 3 knots [5].

3.2 Method

The aim of our investigation was twofold. The most important task was to investigate the degree of coverage and regularity regarding use of EUTELTRACS position determination and message transmission service in the southern Barents Sea. In addition, it was also desirable to obtain a provisional appraisement of the accuracy of position determination, as against GPS.

Message transmission service and coverage area are comparatively easy to test if one does not wish to pay special attention to causal agencies in the case of coverage deficiencies.

With regard to the accuracy of position determination, the case differs somewhat. If one has no absolute positions against which to measure, then accuracy of position must take the form of an error analysis. We have chosen to measure the errors against standard GPS. It is customary experience that a present day GPS position has a maximum error of 100 meters as compared with true position. This is, however, a maximum figure. In general practice the average error is less, and many would consider an error of 50 meters to be a normal average figure. One must, however, be aware of the fact that the uncorrected errors in the GPS system are "random". Thus, with respect to a mobile unit, one cannot come to any definite conclusion as to the accuracy of every single reading. Theoretically EUTELTRACS may have a permanent real error not more than 100 meters with the two satellites chosen.

We have seen that the EUTELTRACS system has a position determination error that is dependant upon several factors [2]. The last important section of our analysis covers the time error factor between the measurements which are to be compared. For the purposes of our trial, it was not possible to obtain simultaneous measurements by simple means. This is a point of great importance for a mobile platform. A vessel travelling at a speed of 5 knots will cover a distance of 150 meters in one minute. If the speed is 10 knots, the distance covered will be 300 meters.

During most of the time covered by our trial, F/F Johan Hjort had a speed of at least 10 knots. If measurements are not simultaneous, then the vessel will have changed position between the two measurements to be compared. However, attention should be drawn to the fact that this movement may also have an effect which may partly compensate a possible measurement error, given that the time difference is small proportionate to the measurement errors and the speed of the platform.

In our analysis, we have chosen to take the individual position determinations from EUTELTRACS as our point of departure, and to compare these with the GPS position which is closest in time. A complicating element in this connection has been that EUTELTRACS has not given an exact correct time reading. EUTELSAT has informed us that the time difference per 1994-03-21 was 3 minutes 41 seconds (slow), and that the difference had increased by about 10 seconds a month [6]. Thus by the middle of February, the time delay was in the region of 3 minutes 15 seconds. Clock time in the vessel's GPS log is taken from a UNIX work station. When control measuring was undertaken in Bergen 1994-04-21, this clock was about 3 minutes 3 seconds slow. For our analysis, we have therefore decided NOT to attempt to compensate for clock time error. The main reason for this is that the time reported together with the position from EUTELTRACS is only given to the nearest whole minute. The GPS time is given as exact time, but in our analysis is rounded off to the nearest whole minute before adjustment. In the EUTELTRACS system, time of position is given by the Central Hub Station. Complete time down to the second can be provided if required, and could have proved an advantage for our trial.

3.3 Position determination

Positions are reported in degrees to three decimal places. The distance between the given positions from EUTELTRACS and GPS are automatically calculated as the length of the hypotenuse using standard trigonometry based on measured differences of longitude and latitude. For the sake of simplification, approximate formulas have been used to calculate the extent in meters of the minutes of latitude and longitude on the individual degrees of latitude. Results from calculations based upon this formula work are shown in Appendix 3, in comparison with calculations based on the international ellipsoid. As can be seen from this table, error is greatest with regard to latitude, up to 2 meters compared to 1859 meters round 70° North. This error is infinitesimal, a little over a thousandth, and is insignificant in that it is only applied to the difference in position. This difference is merely a fraction of a geographical minute.

The calculations are carried out on a PC using own program in FORTRAN-77.

3.4 Measurement results

The measurement results are given in table 1 - table 4.

Table 1 gives measured error between position determination by EUTELTRACS and GPS where the time error is not more than that which is caused by rounding off (± 0.5 minute) and other "random" differences in clock time between measurement times. In the table text, for the sake of simplification, this has been called NO TIME DIFFERENCE. The results are distributed on latitude in such a manner that all the results for EUTELTRACS positions between 68.000° and 68.999° are grouped under the line 68° etc. The number of measurements is given in column 2, and thereafter the average latitude and longitude measurements for these observations. Further, average time differences between the measurements are given in minutes, in Table 1 ideally zero. Next comes the average distance between the two positions, on the line for 68° as 170 meters, and finally, average error in measured longitude and in measured latitude.

It can be seen from Table 1 that from the group of over 1.038 measurements without significant time error, an average distance of 260 meters between the positions given on the basis of EUTELTRACS and GPS measurements has been registered. The best concurrence, 170 meters, has been registered on 68.9° North (39.9° East), but the number of observations, 15 in all, is here so small that one should not attach too much importance to measure. But in the line for 70°, the number of observations is greater, and the average distance is measured at 206 meters. One can also see that in general the measured distance is greater the further north one goes, and that, on the average, measurement error is greatest for longitudinal measurements. This latter is not unexpected.

Table 1 - NO TIME DIFFERENCE AFTER ROUNDING OFF

Lat.	Quant	Average pos N	Average pos E	±Time	±Distance	±Lat. →	±Long ←
68°	15	68.87	39.89	-	170 m	137 m	82 m
69°	97	69.54	38.85	-	226 m	171 m	108 m
70°	448	70.60	32.42	-	206 m	153 m	96 m
71°	171	71.47	38.34	-	212 m	142 m	119 m
72°	86	72.41	35.70	-	284 m	135 m	210 m
73°	105	73.58	33.88	-	408 m	311 m	177 m
74°	94	74.38	27.76	-	414 m	225 m	279 m
75°	22	75.33	30.31	-	492 m	326 m	264 m
Total	1.038	71.51	34.06	-	260 m	177 m	138 m

Table 2 - TIME DIFFERENCE UP TO 1 MINUTE AFTER ROUNDING OFF

Lat	Quant	Average pos N	Average pos E	±Time	±Distance	±Long	±Lat
68°	27	68.89	39.65	0.4	223 m	171 m	120 m
69°	216	69.55	38.71	0.6	277 m	215 m	132 m
70°	1.048	70.58	32.53	0.6	223 m	165 m	107 m
71°	455	71.48	38.42	0.6	248 m	161 m	143 m
72°	191	72.43	36.19	0.5	321 m	158 m	232 m
73°	248	73.61	32.17	0.6	416 m	304 m	189 m
74°	227	74.37	27.81	0.6	427 m	236 m	287 m
75°	42	75.39	30.64	0.5	450 m	312 m	226 m
Total	2.454	71.52	34.03	0.6	282 m	191 m	153 m

However, not all the position determinations from EUTELTRACS have corresponding GPS co-ordinates without time error. One has therefore also produced Table 2, which comprises as a group all the position determinations that may be compared if one puts allowed time error at ± 1 minute, and Table 3 where the allowed time error is ± 2 minutes.

Table 2 then contains 1.038 measurements without significant time error in addition to 1.416 measurements with time error ± 1 minute.

Table 3 - TIME DIFFERENCE UP TO 2 MINUTES AFTER ROUNDING OFF

Lat	Quant	Average pos N	Average pos E	±Time	±Distance	±Long	±Lat
68°	36	68.90	39.64	0.8	295 m	224 m	159 m
69°	288	69.55	38.83	0.9	309 m	238 m	154 m
70°	1.305	70.56	32.76	0.9	248 m	186 m	118 m
71°	666	71.47	38.47	1.1	279 m	182 m	163 m
72°	250	72.43	35.76	0.9	349 m	166 m	254 m
73°	334	73.61	31.88	0.9	448 m	304 m	222 m
74°	315	74.37	27.81	1.0	444 m	238 m	300 m
75°	62	75.38	30.62	1.0	574 m	367 m	317 m
Total	3.256	71.56	34.16	0.9	314 m	209 m	173 m

In Table 4, all observations with the same time error are listed, together with the average distance between the EUTELTRACS and GPS positions within the three groups. As expected, the distance increases with increasing time error, as the vessel has, for the most part, been in motion. The average measured distance between the positions has increased from 260 to 296 meters, that is to say by 36 meters during the first minute. During the second minute the distance has increased by 106 meters, from 296 to 402 meters.

Table 4 - OBSERVATIONS WITH SAME TIME DIFFERENCE

±Time	Quant	Average pos N	Average pos E	±Distance	±Long	±Latitude
0	1.038	71.51	34.06	260 m	177 m	138 m
1	1.416	71.53	34.00	296 m	200 m	162 m
2	802	71.66	34.58	402 m	259 m	231 m

From a purely arithmetical point of view, one then obtains a proportionate number showing that the error between the positions has increased by around 142 meters in 2 minutes, thus around 70 meters a minute, which may express the measurement error caused by the vessel's average movement in the space of time between the two measurements.

Caution should be exercised against reading too much into this train of thought, but such a relative movement constitutes a distance of 35 meters in the course of 0,5 minutes, which is the greatest uncorrected time error towards the end of the trial period (pt. 3.2)

We shall content ourselves here by establishing the fact that the average error measured between the positions, 260 meters, must be apportioned among four factors:

1) Measurement error EUTELTRACS
2) Measurement error GPS
3) Measurement error TIME
4) The vessel's movement between the measurements

A factor which we have not attempted to analyse further is the local top which appears in measured distance at slightly lower latitudes. See, for example, the distance of 277 meters at 69.5° in Table 2. The number of observations here is small, but the tendency can also be seen in both Table 1 and in Table 3. These are positions in the southeasterly part of the expedition area.

A possible explanation may be that in this area the vessel has had a generally higher speed, so that the number of stations that were examined, with corresponding stops, has been less. There may also be other possible explanations.

Further, the results are generally good in the latitude interval of 70.00° to 70.99°. This interval also includes Vadsø harbour, around 70.1°N 29.7°E. F/F Johan Hjort called at Vadsø several times during the expedition period. To the extent that the GPS positions were then logged, there will have been periods during these calls with position determination taken while the vessel was lying alongside the quay.

Investigating whether this has been the case, we have found one such occasion, namely from 31 January at 13:00 until 1 February at 18:45. During this period, EUTELTRACS logged a total of 105 positions, see table 5.

Table 5 - STATIONARY VESSEL AT VADSØ HARBOUR					
Quant	±Interval	±Time	±Distance	±Long	±Lat
15	0	-	124	104 m	45 m
65	1	0.8	139	107 m	63 m
105	2	1.2	142	109 m	63 m

Be aware that the time interval is not significant when the vessel does not move. The distribution by time interval is therefore only given to allow comparisons with tables 1 - 3.

Apart from help finding the reason for the bias in positioning by latitude, the purpose of table 5 is to give an idea of what differences in positioning would exist at 70° north if the inherent inaccuracies of the two systems were the only sources of error. In this respect the last line of the table is the most significant.

3.5 Degree of coverage

During the trial period, the Directorate of Fisheries wished to receive a position report every 15th minute. Loss of communications is in this report defined as periods during which such regular position reporting is absent. The vessel must be in contact with both RS and CS for position determination to be possible. During the whole of the trial period, the vessel was in easterly longitudes, and comparatively further from RS than from CS. The connection with CS must also be two-directional. The connection with CS is usually the critical factor also for position determination. The trial period lasted from 1994-01-18 until 1994-03-20, and was completed when the vessel returned from Hammerfest to Bergen in the period 1994-03-06 to 1994-03-20. During the trial period, 24 cases of loss of position reporting lasting more than 60 minutes were registered. These cases are shown in Table 6.

Two of these cases will here receive special comment. One of them, no. 14, lasted for over 100 hours. The reason for the long interruption is, according to EUTELSAT, that the installed version of EUTELTRACS software could not manage to re-establish the connection automatically subsequent to the interruption. This first became clear after the vessel had returned to Vadsø harbour 11 February. Following instructions, power was turned off at the EUTELTRACS station which was then restarted. The connection was then re-established. After this, the vessel was instructed to use this procedure on its own initiative if interruption of communications lasting more than a few hours should occur.

Upon approaching EUTELSAT in connection with this interruption, the information obtained indicated that the initiating cause here had been defective contact with CS.

Interruption no. 22 is also of long duration. However, this is concurrent with the demounting of other antenna equipment in Hammerfest, and cannot be considered as an interruption of communications in our connection.

Thus the number of significant interruptions of communications is 23.

In addition to the duration of the interruption, Table 6 also gives information regarding position when contact was lost. Interruption may be connected with low altitude above the horizon of one or both the satellites. We have therefore calculated satellite altitude at the loss positions for both RS and CS, based on a general algorithm applying to geostationary satellites [6]. Even though these calculations cannot be completely accurate, they give a good indication of where the vessel was positioned in relation to the satellites' theoretical coverage area. These altitudes are given in column 1F4/25.5° (CS) and 2F4/7° (RS). Based on the calculated satellite altitudes, it is not a simple matter to get an idea of any unequivocal connection between the vessel's position and communication conditions. However, we note that RS is generally positioned 1 - 2° lower than CS. The lowest altitude for RS during loss was 4.5°, calculated for 1994-01-28. From the plots in Appendix 2 it can, however, be seen that the vessel has also been in similar unfavourable positions on other occasions without our having registered interruption.

Table 6 - Communication loss of over 60 minutes											
No	Min	GMT				Position		1F4	2F4	
		From		To		N	E	CS	RS	
1	64	1994-01-25	05:05	1994-01-25	06:09	73.976	21.246	7.4°	6.9°	
2	131	1994-01-26	02:36	1994-01-26	04:47	74.636	24.921	6.8°	6.0°	
3	106	1994-01-26	14:18	1994-01-26	16:04	75.224	26.570	6.2°	5.3°	
4	61	1994-01-26	16:18	1994-01-26	17:19	75.436	27.374	5.9°	5.0°	
5	70	1994-01-27	12:01	1994-01-27	13:11	74.339	29.618	7.0°	5.8°	
6	64	1994-01-27	20:18	1994-01-27	21:22	75.465	30.491	5.9°	4.7°	
7	118	1994-01-28	09:47	1994-01-28	11:45	75.239	33.703	6.0°	4.5°	
8	72	1994-01-29	15:06	1994-01-29	16:18	74.366	30.942	7.0°	5.6°	
9	61	1994-01-29	20:24	1994-01-29	21:25	73.990	31.066	7.3°	6.0°	
10	99	1994-02-02	05:49	1994-02-02	07:28	69.774	34.247	11.5°	9.3°	
11	61	1994-02-02	09:49	1994-02-02	10:50	69.515	35.463	11.7°	9.4°	
12	70	1994-02-02	13:38	1994-02-02	14:48	69.273	36.633	11.8°	9.4°	
13	75	1994-02-04	20:32	1994-02-04	21:47	73.980	39.707	6.9°	4.8°	
14	6822	1994-02-06	15:23	1994-02-11	09:05	72.649	46.185	7.6°	4.7°	
15	90	1994-02-15	05:38	1994-02-15	07:08	71.463	44.321	8.9°	6.0°	
16	76	1994-02-15	21:41	1994-02-15	22:57	71.621	41.748	9.1°	6.4°	
17	183	1994-02-15	22:57	1994-02-16	02:00	71.551	41.798	9.1°	6.4°	
18	89	1994-02-19	10:00	1994-02-19	11:29	71.758	41.495	8.9°	6.3°	
19	79	1994-02-23	05:57	1994-02-23	07:16	69.350	41.558	11.3°	8.3°	
20	66	1994-03-02	08:07	1994-03-02	09:13	74.143	31.076	7.2°	5.8°	
21	69	1994-03-04	14:36	1994-03-04	15:45	71.951	36.219	6.2°	7.1°	
22	1373	1994-03-05	11:42	1994-03-06	10:35	70.723	30.660	10.7°	9.0°	
23	69	1994-03-10	12:59	1994-03-10	14:08	70.518	30.925	10.9°	9.2°	
24	66	1994-03-11	02:41	1994-03-11	03:47	70.524	30.886	10.9°	9.2°	

Generally from a technical point of view there may be two possible explanations for these interruptions. Either the power of the return link could be a limiting factor, and therefore an increase of the MCT's power could have solved the problem. Secondly one might have been in a position where the clear view to the satellite was impeded by the mast.

It could be interesting to investigate as to whether other conditions, such as meteorological, could explain the interruption of position reports. The most obvious in this respect is wave height. Greater wave height will cause greater antenna movement, which could possibly be of significance in marginal communication conditions.

The Directorate of Fisheries therefore approached Bergen Meteorological Center. Presumed wave heights for these positions/times will be made available as soon as they have been calculated.

A total of 3912 position reports were received from EUTELTRACS during the expedition. 146 position reports have time intervals of 30 minutes or more. With these time intervals not taken into account the remaining 3765 reports have an average time interval of 18.2 minutes between position reports.

3.6 Message transmission

An important part of the functionality of the EUTELTRACS system is its capacity for the sending of messages. According to EUTELTRACS, in maritime applications, 99% of the messages will be transmitted between the Hub and the mobile station in the space of half a minute [2]. In addition comes the time for message transmission between the Hub (EUTELSAT) and the subscriber, in our case the Directorate of Fisheries.

In this trial, the message transmission portion was not an important part of the test. Messages were, however, sent to/from the vessel inasmuch as this served other purposes. In all, 10 messages were sent to the vessel and 6 messages were received from it. Three messages were not received by the vessel. These were messages sent during interruption no. 14, which is further described in pt. 3.5. In some cases, however, it has taken some time to obtain modem contact with EUTELSATS's Hub in France. This is probably due to the lack of in-going lines there. If another communication scheme had existed this would not have been a problem.

A point worth noting is that EUTELSATS present software does not handle Norwegian letters (Æ-Ø-Å) in the message transmission service.

4. OTHER FACTORS

For use with the stationary part of the subscription (MAIN ACCOUNT), in our case the Directorate of Fisheries, EUTELTRACS offer software for tracking as well as for message transmission. For our test, software GeoTrek (tm) release # 2.4 from IDL Tech, for handling of bit-maps.

As the map basis for the Barents Sea, a fairly large-scale overview map with unsuitable projection, was not good, the practical advantages were somewhat limited. With adequate map basis, the system provides the necessary information for following a vessel in a general manner, but cannot indicate actual fishery activity in its true form. After the conclusion of this trial EUTELTRACS has provided the Directorate of Fisheries with other maps that are scannings of maps used by Norwegian authorities, and therefore well suited.

5. FURTHER TRIALS

In connection with loss of communications 1994-02-06, it was discovered that the software installed by EUTELTRACS on board F/F Johan Hjort for the purposes of our trial was release # 10.30, whereas release # 10.52 was available and was expected to function better in conjunction with the installed equipment.

It was not possible to do anything about this matter during the remaining time with regard to the expedition plan, and with it the duration of the trial.

The Directorate of Fisheries is at the same time also interested in carrying out further trials with EUTELTRACS. It has therefore been decided that the trial shall continue for another 12 months from, and including, April 1994. The Institute of Marine Research has kindly placed F/F Johan Hjort at our disposal also for this part of the trial.

This will render possible a further test of the message transmission part of the trial, with special regard to the transmission of bit-mapped messages.

It will also provide further information regarding degree of coverage for EUTELTRACS, with special reference to Nordic areas.

This continuation of the trial has now begun. For this purpose, the EUTELTRACS equipment on board the vessel, as well as the software, was changed in Bergen ultimo April. This should resolve problems as experienced as interruption no. 14 in table 5.

For this part of the trial, EUTELTRACS has further placed at our disposal fishery related maps of bit-map type. Also tracking of vessels has thus been rendered more expedient.

REFERENCES

[1] Eutelsat
"EUTELTRACS, Satellite Communications for Mobiles"

[2] Eutelsat
"EUTELTRACS, The European Experience on Mobile Satellite Services"

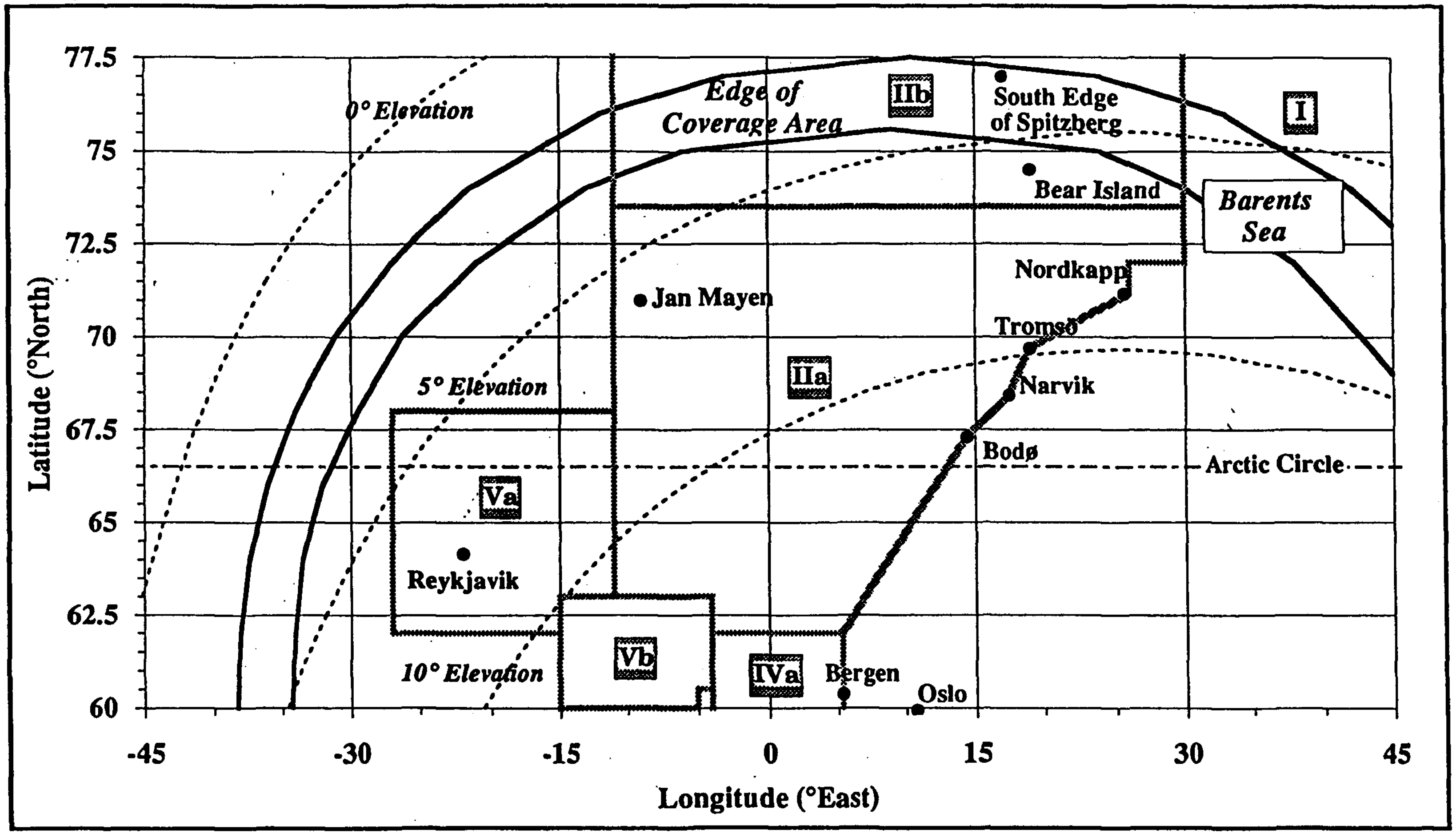
[3] EUTELTRACS
Oral information February 1994

[4] EUTELTRACS
Oral information March 1994

[5] The Institute of Marine Research
Oral information April 1994

[6] Norwegian Telecom Research Department "Telektronik" no. 4 1992

EUTELTRACS Nordic Coverage



EUTELSAT Div.3 (JNC) - 26/11/93

APPENDIX 2

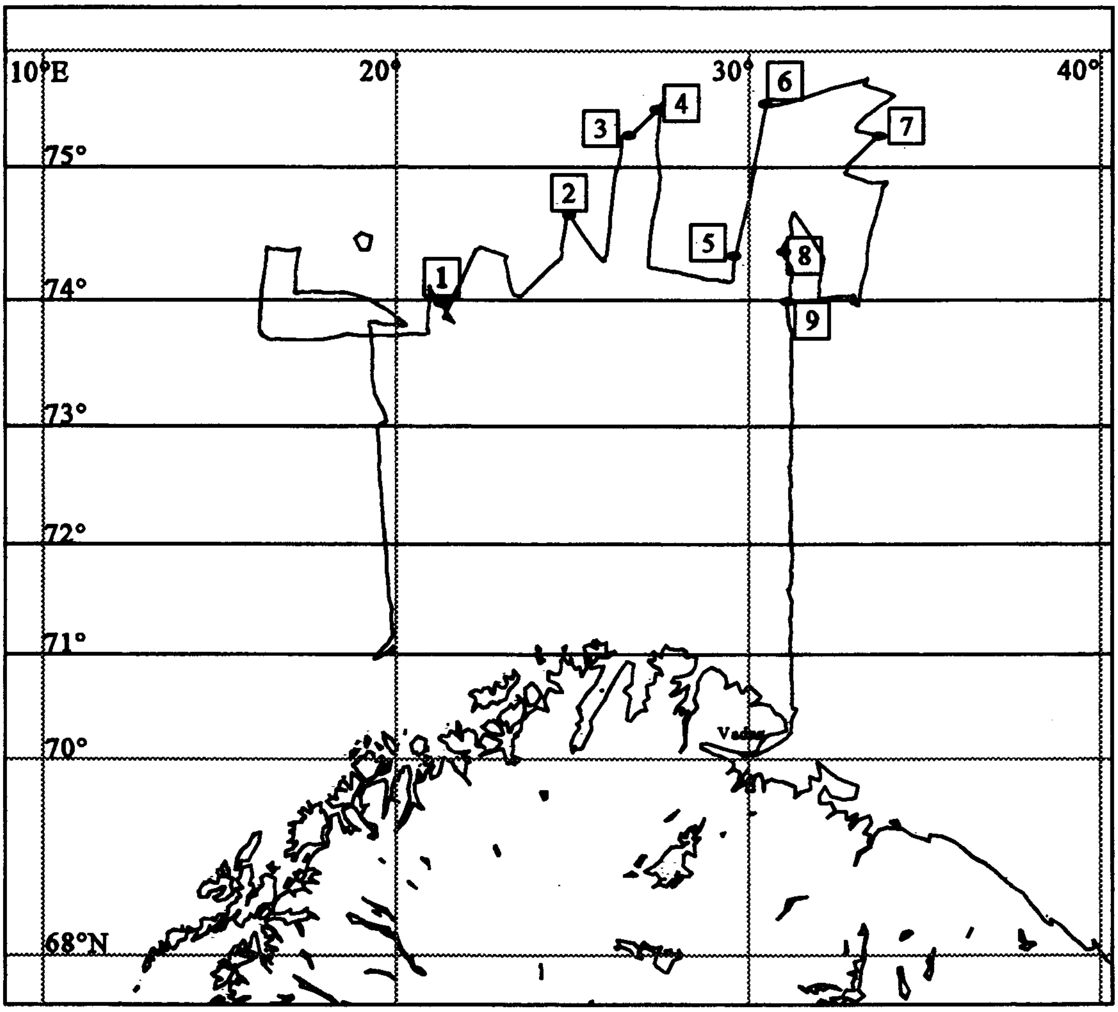


Figure 2 Excursion no. 1: January 21 - January 31, 1994

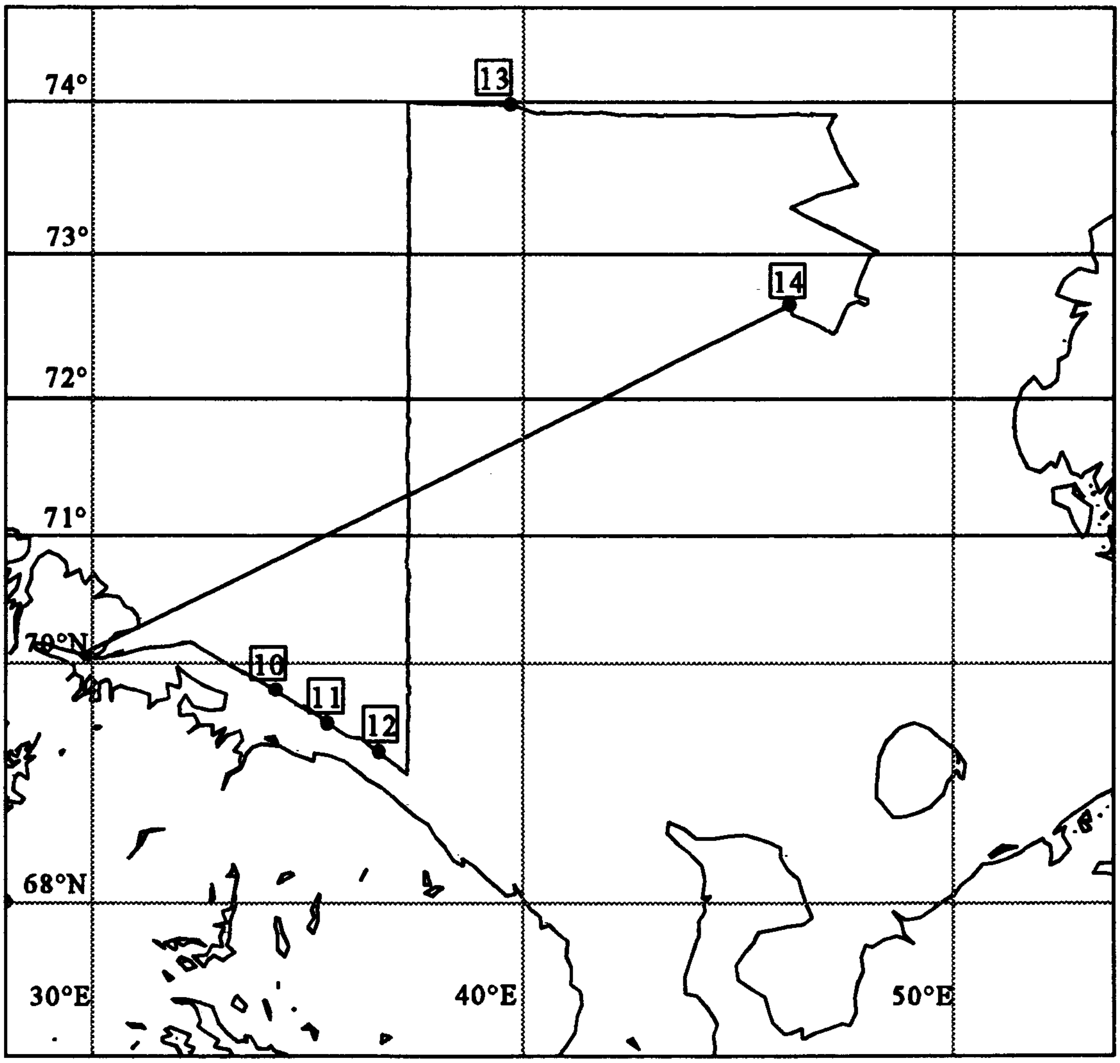


Figure 3 Excursion no. 2: February 1 - February 11, 1994

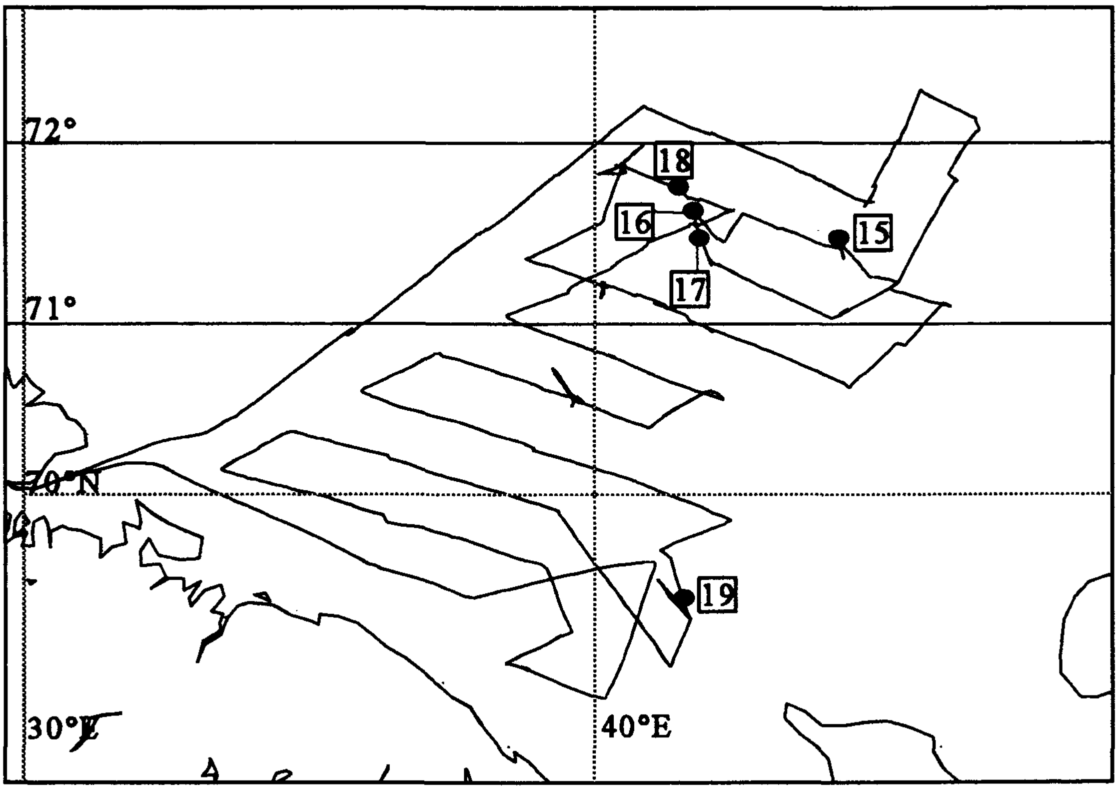


Figure 4 Excursion no. 3: February 11 - February 27, 1994

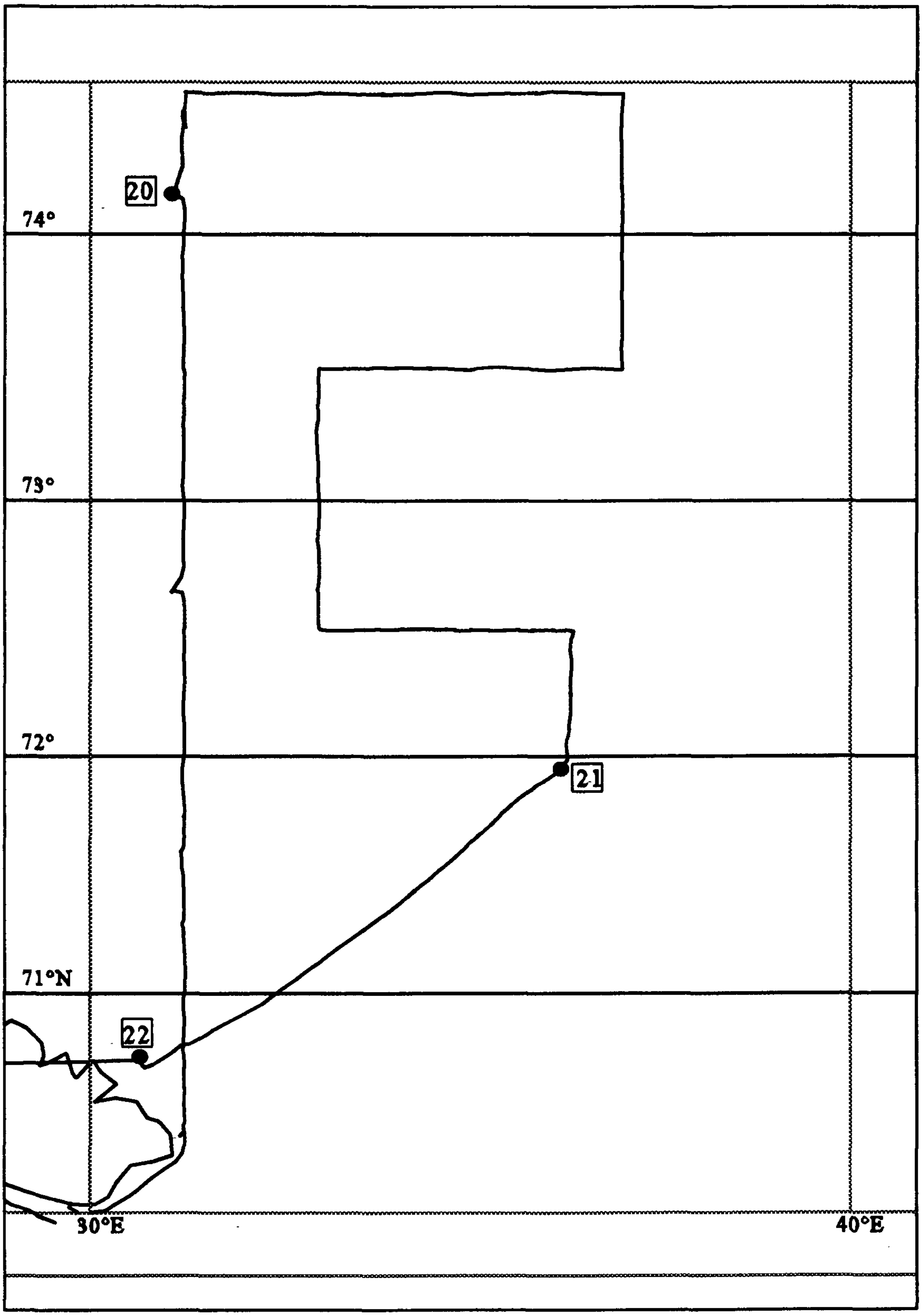


Figure 5 Excursion no. 4: February 28 - March 6, 1994

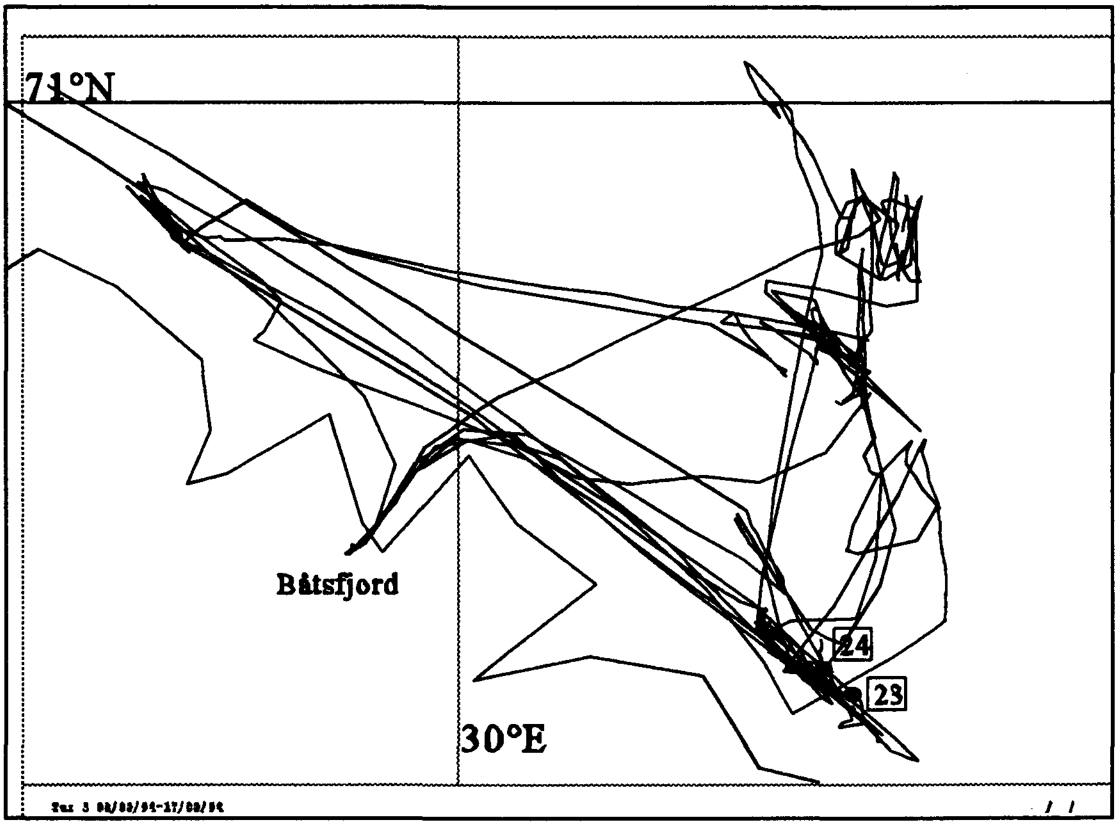


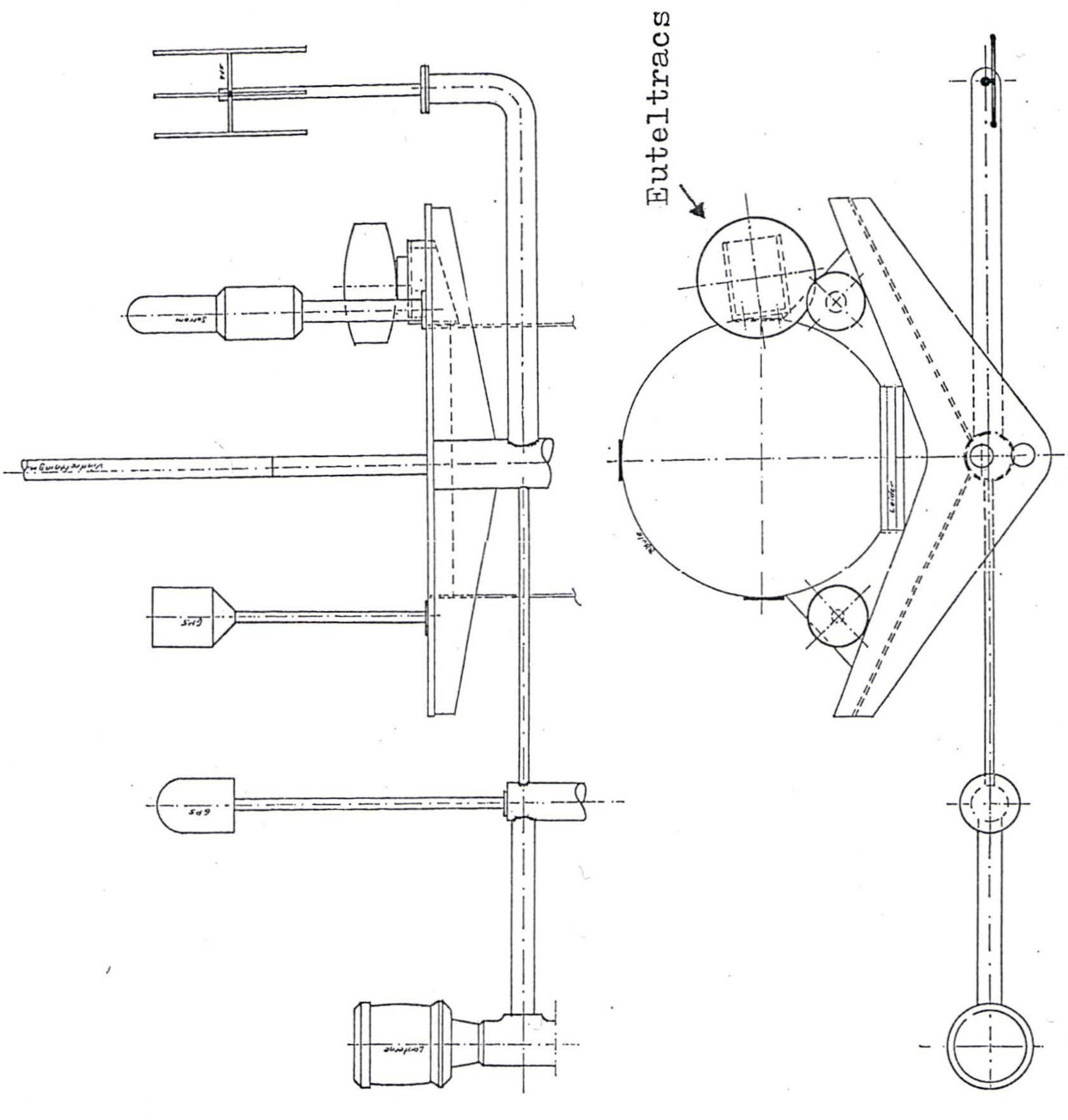
Figure 6 Excursion no. 5: March 8 - March 17, 1994

APPENDIX 3

LATITUDE	CALCULATION		ELLIPSOID	
degree	lat.min	long.min	lat.min	long.min
2	1843.3	1854.4		
4	1843.7	1851.2		
6	1844.2	1845.7		
8	1844.6	1837.9		
10	1845.0	1827.9	1843.5	1827.4
12	1845.4	1815.7		
14	1845.8	1801.2		
16	1846.3	1784.6		
18	1846.7	1765.7		
20	1847.1	1744.8	1845.1	1744.2
22	1847.5	1721.7		
24	1847.9	1696.5		
26	1848.4	1669.2		
28	1848.8	1639.9		
30	1849.2	1608.6	1847.6	1608.2
32	1849.6	1575.3		
34	1850.0	1540.1		
36	1850.5	1503.0		
38	1850.9	1464.1		
40	1851.3	1423.4	1850.7	1423.3
42	1851.7	1380.9		
44	1852.1	1336.8		
46	1852.6	1291.0		
48	1853.0	1243.7		
50	1853.4	1194.8	1853.9	1195.0
52	1853.8	1144.4		
54	1854.2	1092.7		
56	1854.7	1039.6		
58	1855.1	985.3		
60	1855.5	929.7	1857.0	930.0
62	1855.9	873.0		
64	1856.3	815.2		
66	1856.8	756.5		
68	1857.2	696.7		
70	1857.6	636.2	1859.5	636.5
72	1858.0	574.8		
74	1858.4	512.8		
76	1858.9	450.1		
78	1859.3	386.8		
80	1859.7	323.1	1861.1	323.2
82	1860.1	259.0		
84	1860.5	194.5		
86	1861.0	129.8		
88	1861.4	65.0		
90	1861.8	0.0		

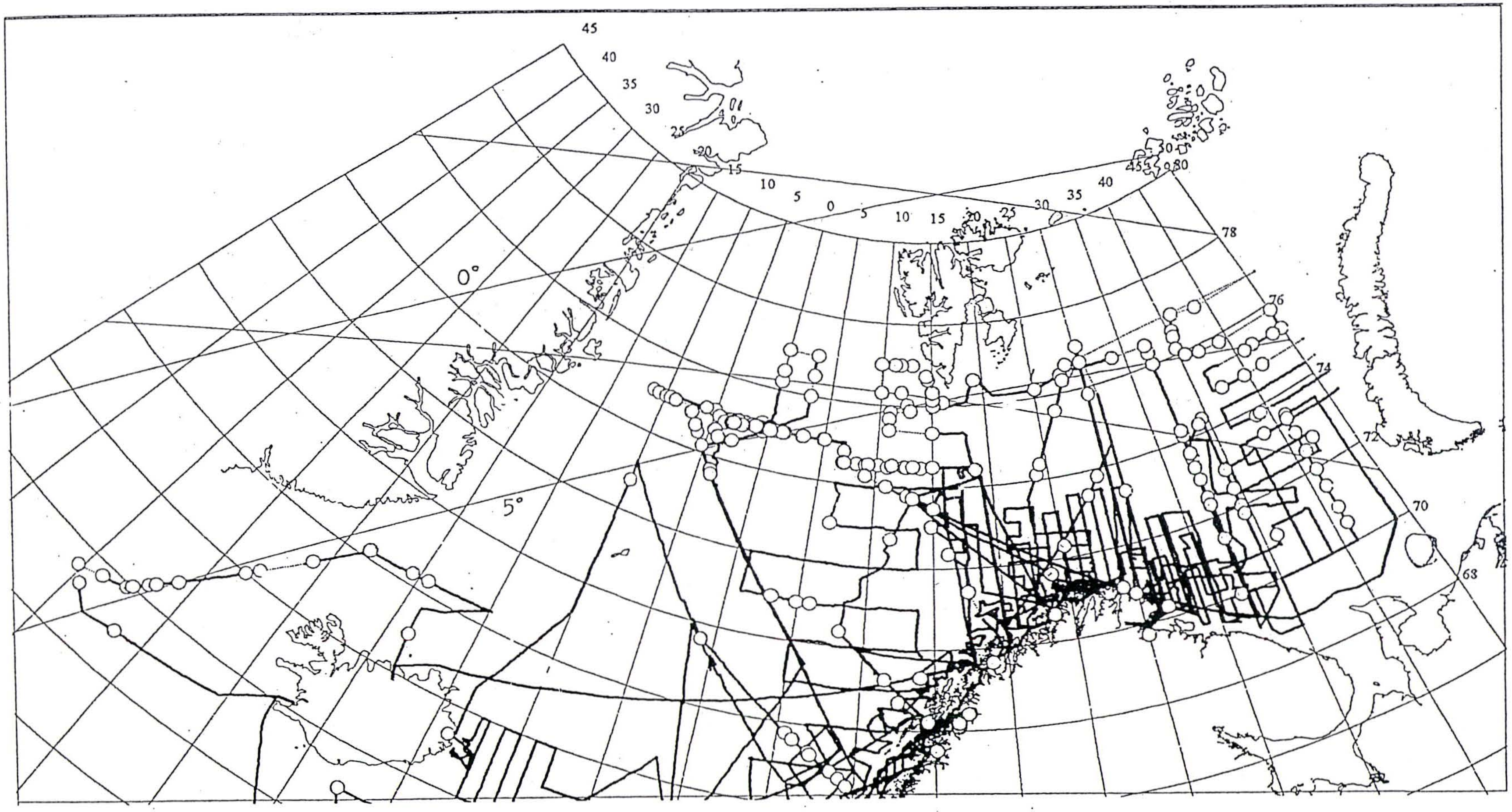
F/F Johan Hjort

Antenna arrangement



FISKERIDIREKTORATET

Provisional Chart



Euteltracs Test F/F Johan Hjort 03/94 - 03/95, 60 min interrupts and over