Birds, Halos, and a Bowhead Whale

Journal Notes from Arctic Ocean 2002

Henrik Kylin

Front cover: Icebreaker Oden at 82° N. Photo Leif Anderson

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How then, am I so different from the first men through this way?
Like them I left a settled life, I threw it all away
To seek a Northwest Passage at the call of many men
To find there but the road back home again

Stan Rogers
Northwest Passage

Acknowledgments

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Preface

This report, “Birds, Halos, and a Bowhead Whale – Journal Notes from Arctic Ocean 2002”, is essentially a second edition of the report “Arctic Ocean 2002 – Journal notes with special emphasis on birds and halos” published as report no 2004:14 in the department’s report series 2004 (http://publikationer.slu.se/Filer/BirdsandHalosofAO-02.pdf). This revised report came about firstly because I managed to write a couple of papers on the bird observations, and secondly that other researchers took interest in the observations of halos and whales why I saw fit to improve these parts Consequently, those parts of the report that may be of most interest to people that were not onboard have been edited and improved. The two papers on birds are included here as the special notes at the end of the report, replacing the comments that were included there in the first edition. I also managed to get my son, Harald, many thanks to him, to digitalize a whole sky view of the halo display in 3 May which I also include here. In addition some errors and discrepancies have been corrected. I cannot promise that I found and corrected all errors, and if any remain I apologize for that. Generally, the texts in the special note at the back have been more thoroughly checked than the main text of the report that was mainly written for fun. If there are any discrepancies, the text in the special notes is the one that is correct.

Rosersberg 25 November 2010

Henrik Kylin

Introduction

The purpose of "Arctic Ocean 2002" (AO-02) was to investigate the late winter/early spring conditions in the Fram Strait between Svalbard and Greenland and the East Greenland Sea, particularly the East Greenland Current, with some complementing work in Storfjorden southeast of Svalbard. The East Greenland Current flows southward along the eastern coast of Greenland bringing with it ice far south. To be able to operate at sea in the heavy ice of the High Arctic – during AO-02 we went up to 82° N – you need a powerful icebreaker, and the Swedish icebreaker Oden was used as research platform. In addition to being an Arctic Class icebreaker – and one of the most powerful non-nuclear icebreakers in the world at that – Oden is a competent research vessel with permanent lab facilities and the possibility to carry extra containers for lab work. While operating as a research vessel she can also be equipped with an A-frame[1] and various winches for oceanographic work and various types of sampling.

Arctic Ocean 2002 was primarily an oceanographic expedition covering physical and chemical oceanography and various aspects of the ecology of plankton and bacteria in the Arctic Ocean and Greenland Sea. My own research project was in environmental chemistry and concerned the physical-chemical mechanisms by which organic contaminants, such as DDT and PCB, reach the Arctic. When I am out at sea I take samples for analysis after I come home. There is so much hassle installing the analytical equipment and getting it operational on the ship that it is normally not worth the trouble since the samples will keep well for several months in a freezer anyway. Not having to operate any instruments often leaves quite substantial time with little else to do than once in a while checking the sampling process; time that can be spent doing other things, *e.g.*, birding.

There was no ornithology programme on board during AO-02, but several interested amateur birders. Having the time, I took it on myself to compile the bird observations during the expedition. As all contributors first and foremost had other duties to perform within their own research projects, many birds that could have been spotted from the ship were probably missed. Therefore, with exception to the special notes at the back, this "trip report" is in no way quantitative, nor was any specifically scientific method of observation used to collect the data. It is merely a compilation of the random observations that either I made myself or that were brought to my attention by others. And as it is a compilation made for fun I have chosen not to question any identifications made by others, although if it comes to a discussion I will only assume responsibility for species identifications made by myself (se Appendix 2). Although I started out with the intention of writing a report of the bird observations I soon amended it with various other natural history observations and observations of other natural phenomena and notes on life on board, because that was how my notes were organised. Being just that, a compilation of random observations and notes, this opus is written mostly for my own pleasure in systematising my journal notes of the events during the expedition, but perhaps it may also find some interest among other expedition participants particularly those that contributed with natural history observations. Considering that few birders have ever had the opportunity to pass through the area we visited in late winter/early spring – if nothing else, it's an economic challenge to charter an Arctic Class icebreaker to do the job – maybe the observations may also be of some enjoyment and value to others interested in Arctic birds. Readers interested solely in birds will simply have to put up with my inclusion of notes on the daily events on ship during the expedition.

[1] An A-frame is a more or less A-shaped structure used to hoist various types of sampling equipment over board.

Several different nautical and meteorological parameters were logged continuously every five minutes en route. All of these data are of course available if anyone should be particularly interested, but for this presentation I only include the hourly positions (Appendix 3). The time used to log the positions is UTC (Universal Time Coordinated, formerly GMT Greenwich Mean Time). Using UTC makes logging scientific observations more logical, especially when you work over several time zones. It also makes life on board generally easier, especially when you work ship based at high latitudes. At high latitudes the distance between longitudes is small and you pass time zones very rapidly. If you were operating on local time you would have to adjust the time very often. And since it is full day light 24 hours a day at this time of year at the latitudes we were working during AO-02 there is no need to accommodate for nights. Therefore, it is simply most convenient to stick to one time zone during the whole expedition, and on a scientific expedition this will inevitably be UTC.

Journal Excerpts

April 20-25

Arctic Ocean 2002 started off April 20 from Gothenburg in very nice and sunny weather. The start of the expedition was more chaotic than most other expeditions I've participated in. The ship was open to the public during the morning as part of the start up of the yearly Gothenburg Science Festival. The evening before we left Gothenburg some of us participated in the start of the festival giving the final performance of "Arctic Odyssey", a dialogue seminar, or science theatre if you will, that Anders Karlqvist[2] organised after the 1989 expedition to the Canadian Arctic.

Two bird species were probably present on the ship already when we sailed from Gothenburg. One was a Redstart and the other was reported to me as "a small bird with grey and brown streaks". I never saw this latter bird myself and have not been able to find out what species the rather vague description refers to, but it sounds like a pipit or a lark. During the passage over Kattegat and Skagerrak small flocks or individuals of various migrating passerines passed the ship heading for Norway. The most interesting of these was a male Ringed Ouzel that probably was attracted to the ship during the first night and took shelter under one of the lifeboats. The lights from ships attract many migrating birds during night. The Ringed Ouzel disappeared soon after we reached the inner seaway in Norway.

The original plans were to pass Norway on the open sea, but already on the second day of the expedition a storm was anticipated and the expedition leader, Ingegerd Hagman, decided to take the Inner Seaway. The Inner Seaway, the route that Hurtigruten follows, runs mostly in shelter of islands from Southern to Northern Norway with only a few passages where we had to cross waters where heavy seas from the open ocean could reach us. Choosing this route is more expensive than the open ocean as it requires the ship having pilots on board for the whole length of the voyage from Stavanger to Tromsø. It was fascinating to follow the operation of the ship during the passage of the Inner Seaway. In some narrow passages Oden almost scraped the steep rock walls at either side. At one occasion there was only a meter or so open space on either side of the ship and even less between the smokestack and the bridge spanning the sound. The pilots made careful calculations of the tide so that we would reach the passage during ebb. It would not have been possible for Oden to pass during flood. At high water the smoke stack would have hit the bridge!

[2] Anders was the Director General of the Swedish Polar Research Secretariat. He retired 2009

The decision to use the inner seaway was taken to allow the expedition participants to gain their sea legs and to get all the instrumentation secured and running before having to face heavy weather in open water. This is especially important on an icebreaker. All icebreakers roll badly in open water, but, due to the special shape of her hull, Oden is probably worse than most others. Oden has a flat bow, which allows her to ride up on top of the ice to bend and push it downwards and then shoulder it aside under the ice on either side of the ship. This is an energy efficient mode of breaking heavy ice, much more energy efficient than what can be achieved with a "conventionally" designed icebreaker that has to ram its way through the ice and simultaneously push it aside. The pressure from the ice on the sides can sometimes be very large, and the greater the ice pressure the more energy is consumed pushing it aside. But the special construction of Oden is not very good in open water, especially not in hard weather. If she takes the seas from certain angles it's OK, but from all other angles you're in for a very bumpy ride.

For anyone sailing on Oden for the first time, it's ruff going when she takes the seas abeam. The ship will roll badly even in fairly moderate waves. But perhaps worst of all is when she takes the seas head on. Other, conventionally designed ships, cut through the waves, but with Oden's flat bow the water becomes very "hard". The seas hit the bow with a tremendous bang, which reverberates up and down the ship. The waves do not have to be very large for greenhorns to think that the ship has run aground for each new wave that hits the bow. I was tremendously scared the first time I experienced this sensation directly after setting out from Gothenburg on my first expedition with Oden in 1996. The wind was around 8 m/s at the time and the waves less than a metre high and I worried myself sick over what would happen during the autumn storms at the end of the expedition. It is also very tiresome to have constant bangs echoing through the ship.

The journey along the Norwegian coast gave several opportunities to see bird species that are only casual in Sweden, such as Shag, Gannet, Fulmar, and Puffin. Several of the Gannets were seen carrying "seaweed" as nest building material. On one occasion a couple of Great Skuas were seen harassing Gannets or Fulmars, and passing Bodø a White-tailed Eagle perched in a small tree on the cliff side close to the ship. I was on the fourth deck when we passed, at about the same height from the water as the eagle. I don't think I have ever been so close to a White-tailed Eagle ever before, only a few metres away.

Auks were fairly common all along the coast, although the weather at times made them difficult to see among the waves. Most plentiful were the Common Guillemots, but some razorbills, Black Guillemots, and Puffins were seen. There were reports of from others of the odd Brünnich's Guillemot in the northern fiords, but I saw none myself. Puffins were especially common around Fugløy, a major nesting colony.

Around Tromsø a couple of small groups of dolphins were seen. As far as I could make out, these were White-beaked Dolphins, although I cannot rule out other species, *e.g.*, Atlantic White-sided Dolphin, entirely. I also had a report of Killer Whales. As far as I understand this would have been somewhat out of season for Killer Whales in this area. But both White-beaked and White-sided Dolphins have fairly large dorsal fins and white markings, so I guess it is possible to mistake them for Killer Whales if you don't get a good look and are aware of the possible mix-up.

After leaving the protection of the Inner Seaway north of Tromsø on April 24 we were hit with the full force of a gale. Parts of the lower decks were declared off limits because of

waves breaking over. The passage out to the lab was not off limits, but never the less you ran the risk of getting thoroughly drenched if you ventured out there. In the hard wind the water from a large wave that broke over the bow was easily blown over the top of the lab. An impressive force is needed for this, as there was a set of containers with extra storage and lab space on top of the permanent lab. At one time I got in the way for one of these big ones. It felt as if I was hit by a piano, and all my clothes became so soaking wet that I might as well have jumped into a bathtub fully clad.

At first we took the seas almost abeam from starboard and the going was very rough for a while. Fortunately the seas eventually shifted so that we took them more or less from the aft. This eased the ships rolling sufficiently for the more experienced among us to get a nights' fairly good sleep. There were some complaints from the rookies though.

April 26-29

Our first scientific stations were in Storfjorden southeast of Svalbard. Reaching the ice in Storfjorden gave nice relief after the rough ride across the Barents Sea. AO-02 took place much earlier in the season than Swedish expeditions are normally out at sea. Normally, during "summer" expeditions the ice is fairly broken up and the mate on watch (who is the one responsible for the manoeuvring of the ship) often manages to find leads, *i.e.*, patches of open water, through the ice. It was still winter conditions in Storfjorden, and although I have participated in a number of expeditions this was the first time I experienced an almost continuous ice cover with very few leads. Making good speed in this continuous ice was difficult even with a ship of Oden's capacity. Constantly breaking ice also turned out to make life on board much bumpier and noisier than when you can pass through open leads, almost as tiring as banging head on into the waves.

In Storfjorden we encountered the first Ivory Gulls. The Ivory Gulls in Storfjorden were always seen in pairs and no large aggregations were seen. In other parts of the cruise track (*vide infra*) the Ivory Gulls were often seen in triads and in large aggregations. As discussed below we might have observed different aspects of the pair-bonding process of Ivory Gulls during different parts of the cruise. But here in Storfjorden pair-bonding seemed to have come further than in other places in spite of the early date. It is not unthinkable that Ivory Gulls adjust their pair-bonding and other nesting activities to the local climate, and much of the area around Svalbard certainly has a milder climate than other parts of the Arctic through which we travelled later on during the expedition.

As for other birds, a few Fulmars were seen and several flocks of Eiders crossed the sky. Interestingly, the Eiders flew in virtually all directions except due north and northeast. In most cases they were fairly high up and they could probably see open water in whichever direction they were heading. A couple of the flocks were also accompanied by the odd King Eider, although I cannot rule out that it was the same flock with a single accompanying King Eider that flew back and forth a couple of times. Two flocks of auks – impossible to say exactly which species – flew towards the northwest at fairly high altitude.

While we were in Storfjorden, some VIPs (Swedish journalists and administrators from Svalbard) visited Oden. The VIPs only stayed for a couple of days, but we also got a couple of stowaways that would follow us for a little longer. The first to be observed was a Snow Bunting that took up a singing perch on the port railing of the monkey's island.[3] The Snow

[3]The monkey's island (Swedish: bryggtaket) is on top of the bridge. You won't get any higher than this on Oden unless you climb the smoke stack.

Bunting was soon joined by an Arctic Redpoll that took up a singing perch on the starboard railing of the monkey's island. For a couple of days both birds could be seen singing on their respective perch.

April 30
After having completed our sampling in Storfjorden we passed west of Svalbard in splendid sunshine. The snow-clad mountains of Svalbard shone intensively in the sun. From a position on the monkey's island or the bridge you could see that the sea was full of small groups of auks flying just above the water, all hurrying east towards their nesting grounds on Svalbard. There must have been several tens of thousands in all. With exception of the Black Guillemot, if at a distance the larger auks in the Atlantic are difficult to identify on the wing. Those that I could identify all were Brünnich's Guillemots, quite as would be expected, as these should be the most common large auks here. The odd Black Guillemot was also seen, and I think there were some Common Guillemots, but I'm not entirely sure of the identification in these cases.

Apart from the Brünnich's Guillemots, Fulmars were the most plentiful bird species along the west coast of Svalbard. At a couple of places enormous flocks, more than a 1000 individuals each, together with some Kittiwakes and other gulls, showed a "feeding frenzy" around what must have been schools of Herring or other small fish. In both cases all the Fulmars and gulls fled as soon as a couple of Great Skuas joined in the feeding. It says something about the ferocity of the Great Skuas that two or three individuals can cause thousands of Fulmars and gulls to flee from a good food source.

The sea west of Svalbard is essentially ice-free all year round due to the warm water transported northwards with the Gulf Stream, but fields of rotting ice started to appear as we sailed further north. Scattered flocks of Eiders were also seen during the day. I was surprised to see some of them coming in from the north and northwest. Did they come from the open ocean or had they visited the marginal ice zone? Around noon we passed North-western Svalbard and headed east with the continuous ice within view to the north. Then one of these eider flocks flying in from the northwest contained a real ornithological sensation. Together with 11 Common Eiders were three Spectacled Eiders, two males and one female! Luckily I happened to be on the fourth deck (which is fairly high up giving a good view) changing the filters in my air samplers when they passed close to the ship.

There are only a handful of reports of Spectacled Eiders from the Western Palaearctic – a zoogeographic region essentially comprised of Europe, North Africa, and parts of the Middle East. Spectacled Eiders are native to the Russian Far East (mainly Chukotka) and Alaska and it was only recently (March 1995) that the major wintering area was discovered. The majority of the birds, 150 000 individuals, were found in 30 flocks in the pack ice of the Bering Sea.[4] The birds kept the water open by their mass and continuous movement. In March 1997 a complete photo census revealed nearly 400 000 birds in the same area. Considering the recent discovery of the winter behaviour of Spectacled Eiders, one may speculate that a few may also winter in natural polynias[5] in other parts of the Arctic, maybe even in polynias

[4] Petersen, M.R., Larned, W.W., Douglas, D.C. (1999), At-sea distribution of spectacled eiders: A 120-year-old mystery resolved. The Auk 116:1009-1020.
Petersen, M.R., Grand, J.B., Dau, C.P. (2000) Spectacled Eider. The Birds of North America, No 547.
Se also: http://aurora.ak.blm.gov/npra/final/html/3b6.html,

[5] Polynia (or polynya) is of Russian origin meaning permanently open water in the ice. The water may be kept open by up welling water or other oceanographic phenomena. This is not the same as a lead, which is a more ephemeral patch of open water that may open and close with changes in the currents, winds, or tides.

around Northern Greenland. There is, actually, a system of leads and polynias around the fringe of the Arctic Ocean that is kept more or less open by wind action and the tidal movement of the ice. I suspect that very few ornithologists have ever had the opportunity to actually visit this area during winter; it's not a very nice place for humans to visit in the pitch darkness of the High Arctic winter. Consequently there may be several interesting observations of wintering birds to be made in this area. It is, of course, not possible to draw any conclusions based on the single observation during AO-02.

While we still had the northernmost mountains of Svalbard in view, I noted that we had only one bird singing from the monkey's island. The Redpoll was still active while the Snow Bunting had disappeared. The reason may, of course, have been that the Snow Bunting had discovered that the ship was not a particularly good place to attract a mate, but another explanation was to become apparent on May 16. The Redpoll was to follow us for quite some time and was named "Reggie, the Resident Redpoll".[6] Reggie was a very nice and confiding acquaintance, almost unafraid of humans. On calm days when the sun was out he would eat cookie crumbs around – or even on – the feet of people taking their coffee outdoors.

In the evening we reached the continuous ice and prepared for an "ice-breaker". The captain ordered the engines to be stopped so that as many as possible of the crew and scientists could participate in the get-together. When you are going to spend several weeks together in a cramped space on an icebreaker it is necessary to have ice-breaking occasions like this to break the ice between, and bond the expedition participants and crew into a working unit. The diver also had the opportunity to do a test dive and check the status of the propellers before we proceeded into the heavy ice.

It was a very nice party, but I had my air samplers to look after also. After checking the samplers I brought out my telescope to study the wildlife. You don't get many opportunities to use a telescope on a ship – there isn't much point when she's moving – so you have to grab the chance when it's offered. The diver was in the water checking the propellers and a Ringed Seal studied the intruder while a few Fulmars passed close by. Around midnight fairly large flocks of Glaucous Gulls (34), Kittiwakes (64), and Ivory Gulls (>200) had settled on the ice. Interestingly, the birds kept to groups consisting of only one species, and these groups were clearly separated from each other on the ice. Most of the Glaucous Gulls and Kittiwakes had followed the ship into the ice feeding on the organisms that were caught on top of overturned ice floes. Some Ivory Gulls had also followed the ship, but most had aggregated after the ship had stopped and showed an interesting behaviour that I interpreted as part of their pair-bonding. This is discussed in further detail below.

In the wake of the ship a pool of open water had formed in which several individuals of different species of auks, Common, Brünnich's, and Black Guillemots, landed, ostensibly to wash and prune. The distance was short, so in this case I am quite certain of the species identification also of the Common and Brünnich's Guillemots. There were many other patches of open water close by, but the birds only used this particular one. Perhaps melt water from atop the ice had drained into the sea when we broke through, to leave a layer of slightly less salty, and thus less dense, water on top of the seawater, which the birds could use to rid their plumage of salt. Each individual would stay for a few minutes, splash around and prune their plumage and then leave. There were never more than two birds in the pool at any one time whether of the same or of different species, and new birds landed soon after the previous

[6] På svenska fick han, naturligtvis, namnet Sixten Snösiska.

birds had left. It almost gave the impression that a queue had formed somewhere out of sight, and that the next bird in the queue knew when it was the next birds turn to wash. But how could they know that it was this particular pool that was suitable to use for pruning?

While I was studying the birds, the expedition's first Polar Bear created a stir and there was a short intermission in the party.

May 1-2
During the first days in the ice we had a constant following of Glaucous Gulls and Kittiwakes and a few Ivory Gulls. An occasional Fulmar would also follow the ship at times. Some pair-bonding behaviour was observed among the Ivory Gulls. Also, there was a report from the aft deck scientists[7] of a possible Ross' Gull. However, in the afternoon of May 2 all the birds disappeared. At the same time the number of phytoplankton in the water samples decreased dramatically. Obviously we had reach waters with very low productivity at this time of year, and the birds could no longer find any worthwhile food supply in the ship's wake. The only bird that was seen at times was Reggie. But as it was also relatively cold, most of the time he sheltered in one of the ship's many hot air outlets. To help the little fellow I got some hulled oats and breadcrumbs from the galley and sprinkled out in places where there was some shelter from the wind.

May 3
We woke up to an astoundingly magnificent halo display! During the early morning hours we had reached an area that was kept open presumably by up-welling water with a temperature slightly above freezing. Whether this was a permanent polynia or not, I do not know. Evaporation from the "warm" water formed a distinct haze of ice crystals as the vapour crystallized in the air. A prerequisite for the formation of many halos is that both prismatic and plate like ice crystals are present in the air and that there are several different populations of each type of crystal that falls towards earth at different angles and spinning in different directions. Different refraction/reflection pathways of light in these ice crystals give rise to different halo phenomena. [8]

Another important contributing factor to the halo display was that the sun was at approximately 23° elevation above the horizon. This elevation of the sun seems optimal for the formation of many different halos.[8]

Unfortunately, not many on board seemed to realise how momentous an occasion this was, but Bertil Larsson, our expedition meteorologist, Tim Newberger and myself had several interesting discussions where we compared observations made independently and tried to summarise what we had seen. Unfortunately, we had no good halo literature on board at the time, but having consulted the literature[8] after we came home and compared it with drawings and notes, it was clear that we had observed at least 21 individual halo components. "Our" halo display was actually in par with the most elaborate halo displays described in the scientific literature.[8]

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[7] The aft deck scientists were those operating the main deep-water sampling equipment, a rosette with, in our case, 24 sampling bottles around a CTD. This contraption will allow sampling of water while conductivity (C), temperature (T), and depth (D), are measured *in situ*. In this case other parameters, *e.g.*, currents were measured with a special instrument attached to the CTD. All the rest of us depended on the aft deck scientists to obtain the deep-water samples that we needed for our own research.

[8] Walter Tape (1994) Atmospheric Halos. Antarctic Research Series, volume 64. American Geophysical Union. Robert Greenler (1980) Rainbows, Halos, and Glories. Cambridge University Press.

Some of the halos we saw are very rare and at least one halo element has not been described scientifically. I corresponded with Walter Tape, world-leading authority on halos, and he did not seem overly surprised that "our" halo display contained elements that have not been described previously. Apparently this is not all that uncommon, but there are few that actually take sufficient note of halo phenomena for good documentation. Sadly, this was also the case here as none of the available photographs show the previously not described elements. My own photographs were severely overexposed and are of no use what so ever.

A full list of individual halo components that we encountered reads as follows:

1. A 22° halo (a ring around the sun at an angle of 22°).
2. A parhelic circle (a ring around the entire horizon at the same elevation as the sun).
3. Parhelia at 22°, 46° and 120° (*i.e.*, a total of six parhelia). The common name for parhelia is sundogs[9]. The sundogs at 46° angles from the sun are rare although not unheard of.
4. Anthelion, a bright spot opposite the sun and at the same elevation, *i.e.*, on the parhelic circle.
5. A supralateral arc. This is an arc above the sun.
6. Left and right sublateral arcs. These together with the supralateral arc are often mistaken for a 46° halo. This halo does exist, but is apparently rare. There was some discussion if we had possibly first seen a 46° halo and that this could have developed into the sublateral and supralateral arcs. I'm not entirely sure about this, but as I read the literature it would not be impossible.
7. Upper and lower tangent arcs. These arcs bend outwards from the 22° halo above and below the sun.
8. Upper suncave Parry arc. This arc looks like an upper boundary of the upper tangent arc.
9. A Wegener or Hastings arc. These are oblique, oval arcs essentially across the entire sky with ends crossing in anthelion. These arcs are very similar and cannot readily be distinguished in the field, at least not by me.
10. A subhelic arc. Another oblique arc, but slightly wider than the Wegener and Hastings arcs and with ends crossing in an imaginary point below the horizon under the sun.
11. A zenithal arc. This is an arc that is visible around zenith on the same side as the sun.
12. A Kern arc. Together with the zenithal arc this forms a full circle around zenith. The Kern arc can be explained by modelling ray paths through different types of ice crystals. The Kern arc has been reported, but is apparently rare and there is no good photographic documentation of it. Too bad we didn't get any good photographs either.
13. Diffuse arcs and/or Tricker arcs. These are strange arcs forming an X-shaped structure with axes crossing in anthelion.
14. A 22° ring around anthelion. This has never been described previously. However, we were two persons that observed this independently. We can say for certain that it was approximately 22° as it formed around anthelion and just barely touched the horizon in the same way as the 22° halo on the opposite side of the sky.
15. Tangential arcs to the left and right of the 22° ring around anthelion. Another set of arcs that have never been described previously. Perhaps these three structures are actually formed by the same refractory pathways. Model calculations will have to elucidate this matter.

[9] Swedish: bisolar.

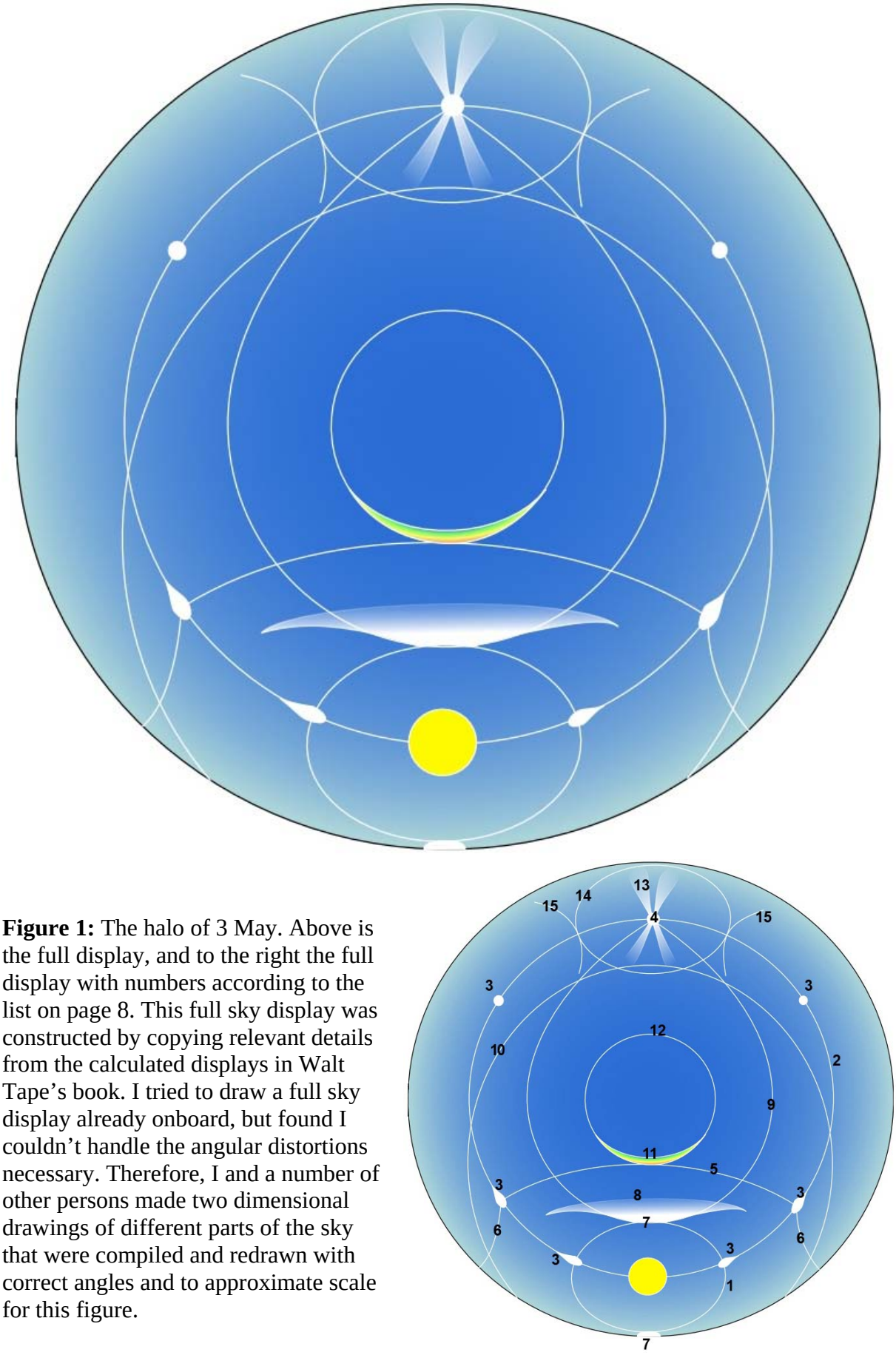
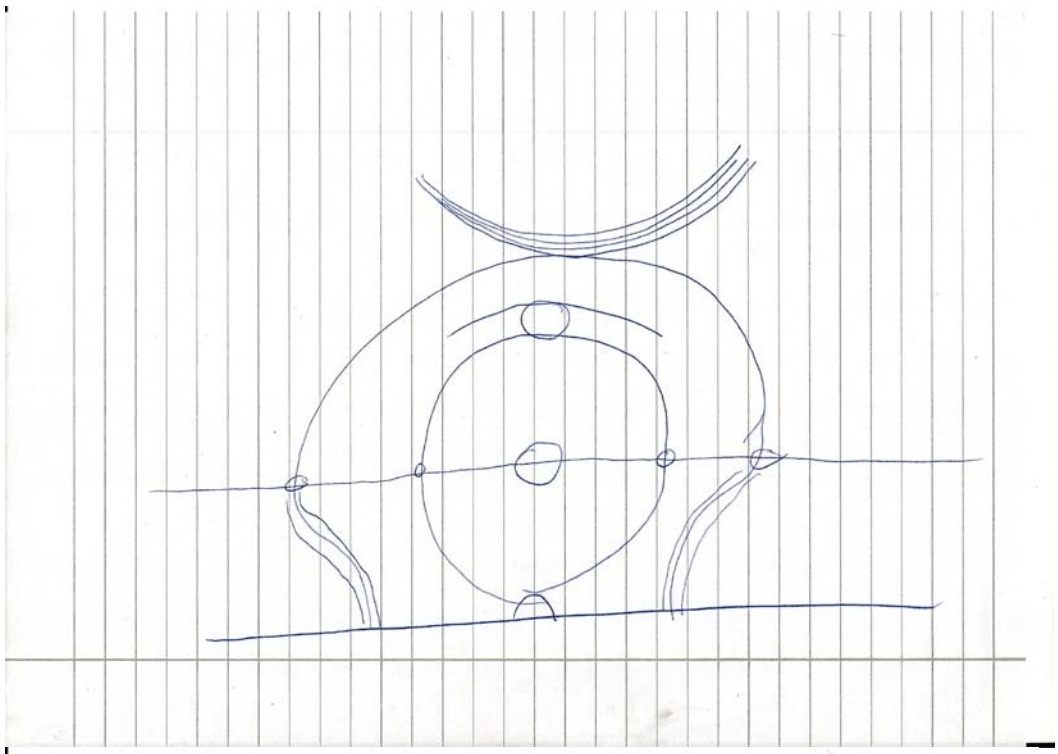
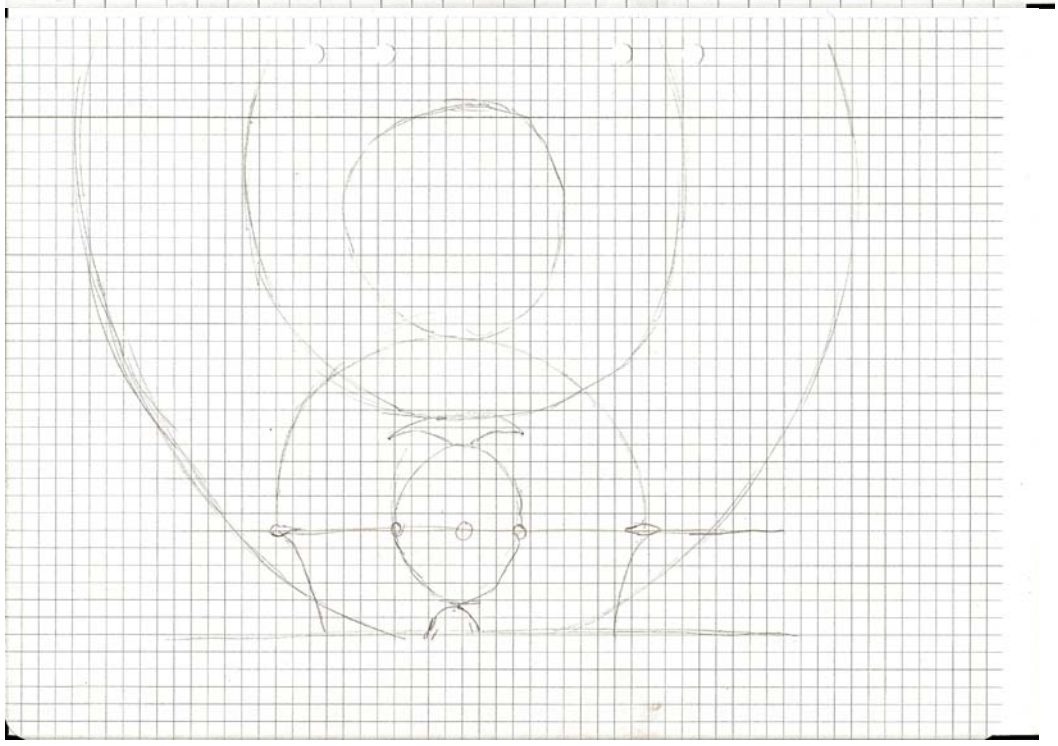
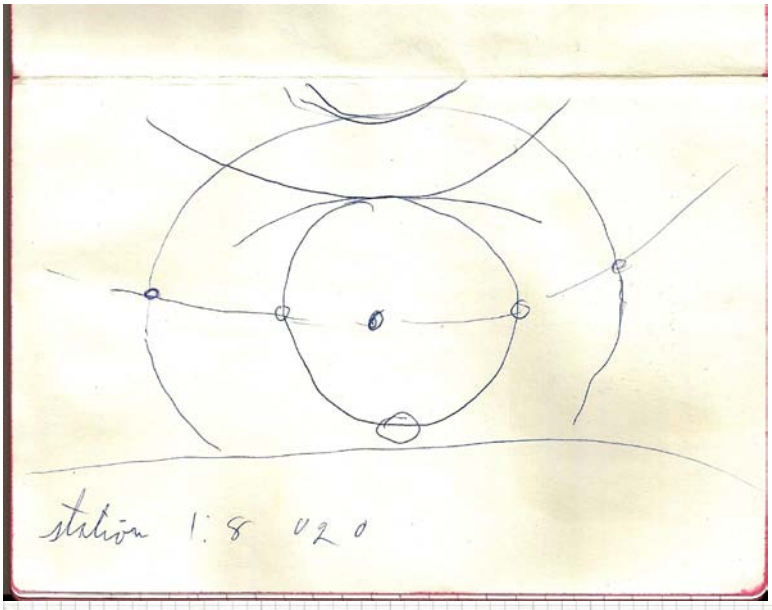


Figure 1: The halo of 3 May. Above is the full display, and to the right the full display with numbers according to the list on page 8. This full sky display was constructed by copying relevant details from the calculated displays in Walt Tape's book. I tried to draw a full sky display already onboard, but found I couldn't handle the angular distortions necessary. Therefore, I and a number of other persons made two dimensional drawings of different parts of the sky that were compiled and redrawn with correct angles and to approximate scale for this figure.

Figure 2: Here follows the series of drawings that were the basis for interpreting the whole sky view in Figure 1. The persons that handed in sketches to me only included the peak of the halo display. Three of these were only of the main view towards the sun because the vantage point of these artists had the view towards the north blocked. One person handed in drawings of both the view to the south and to the north, while my own sketches show some of the development of the halo display. Some artists indicated halo elements with spectral colours, others, including myself, did not as these tended to vary throughout the display.



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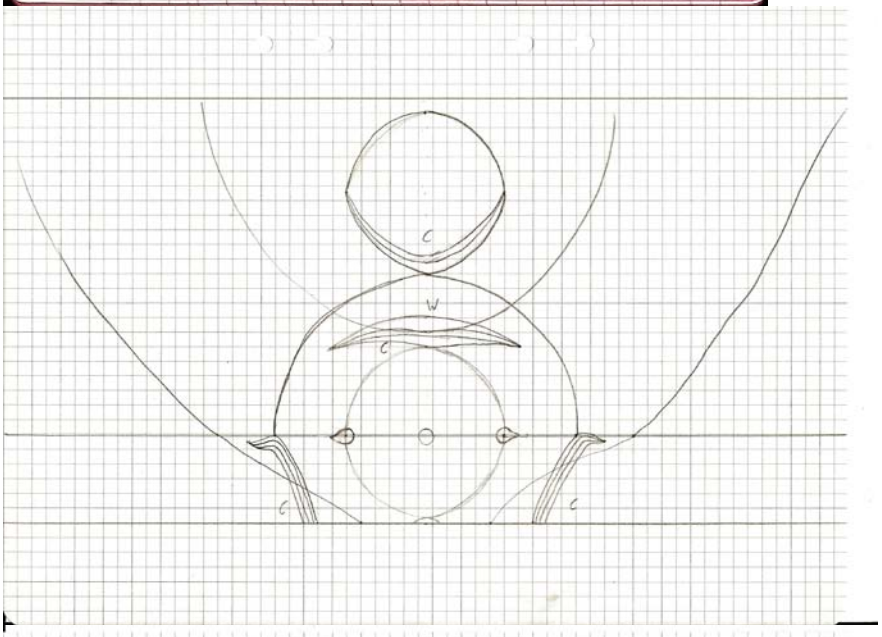

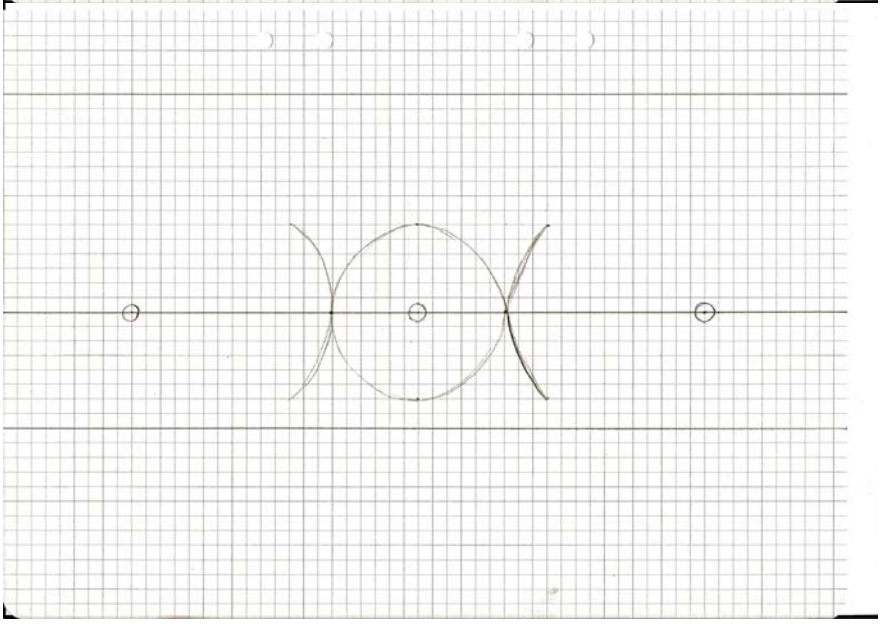

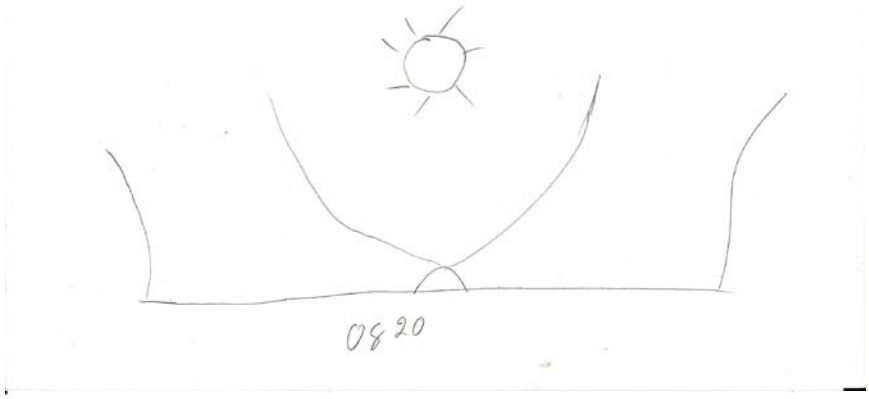
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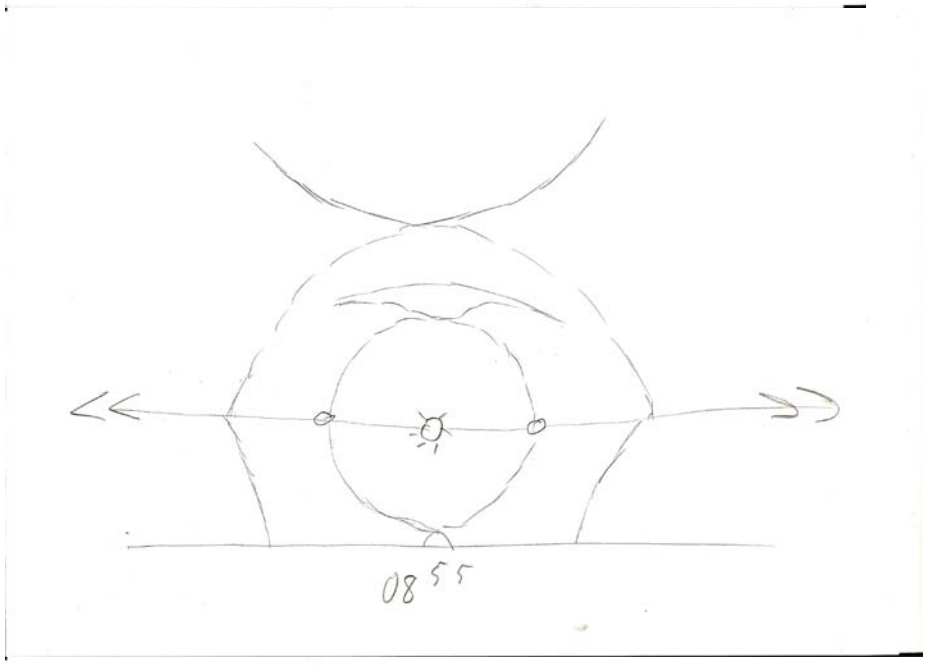
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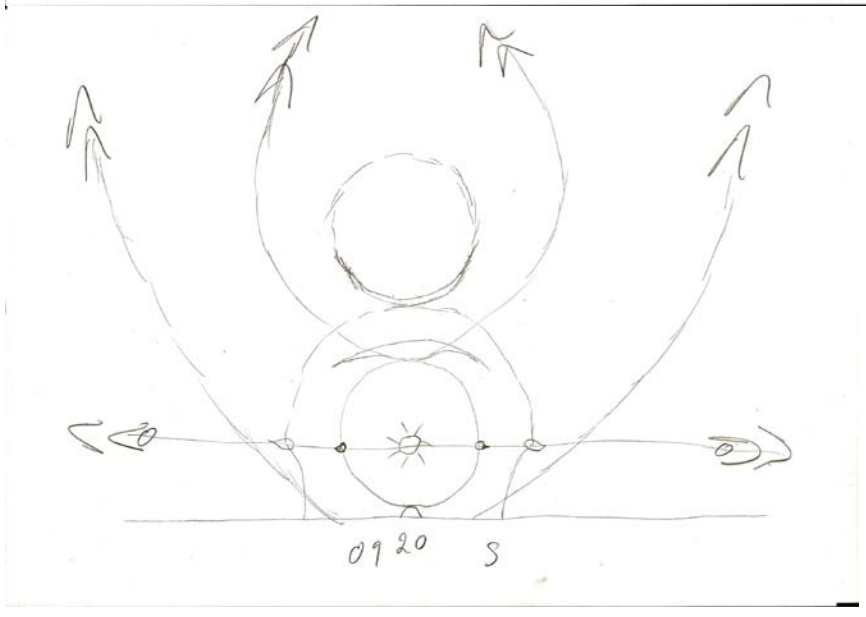
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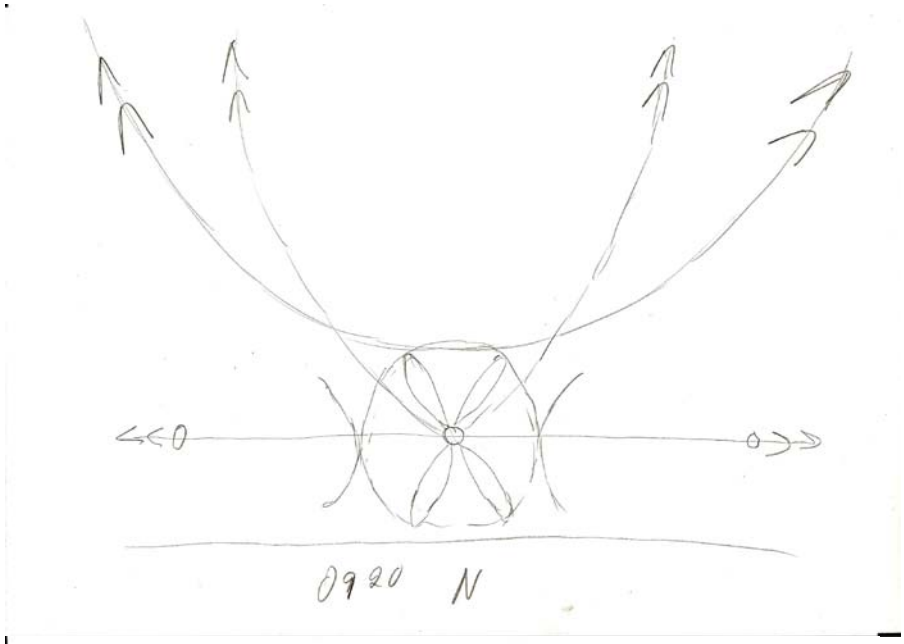
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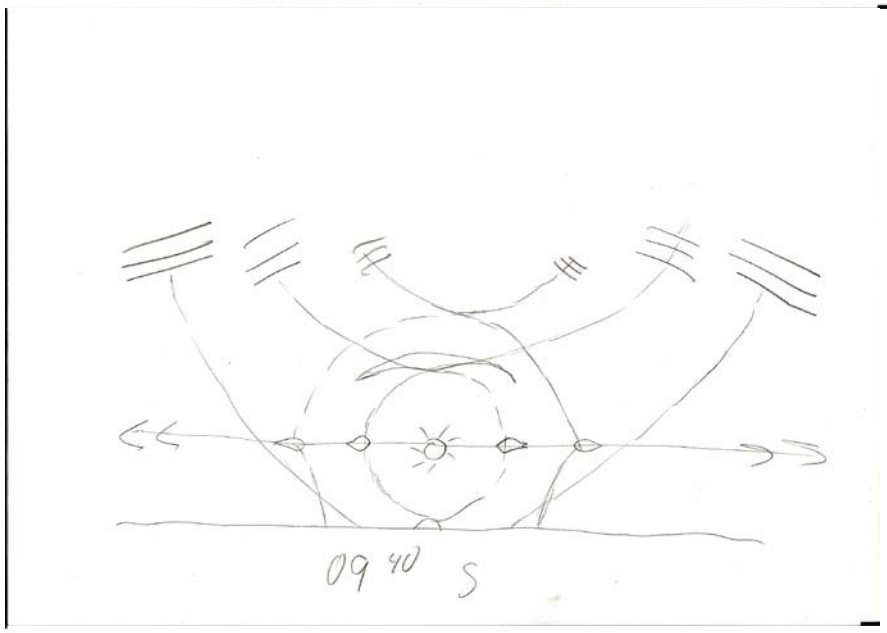
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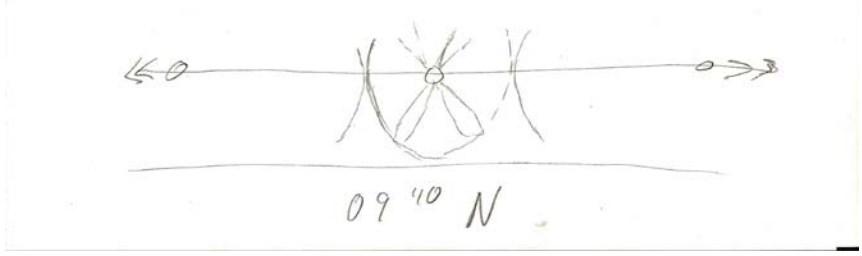
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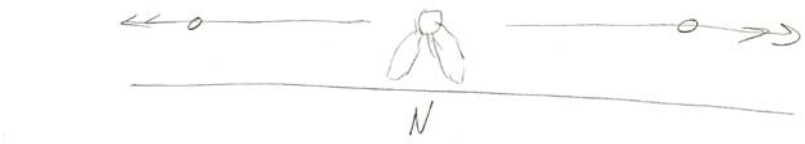
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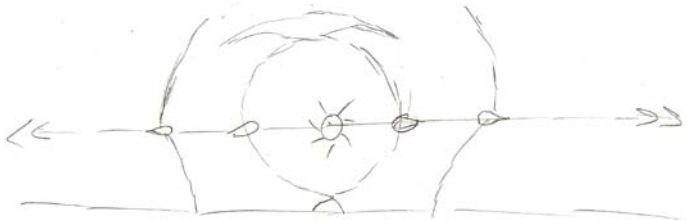
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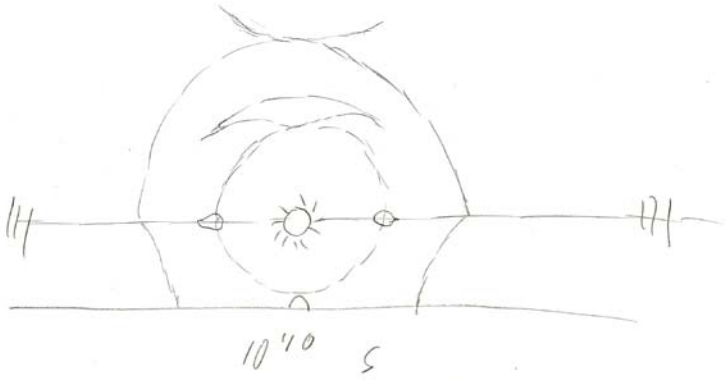
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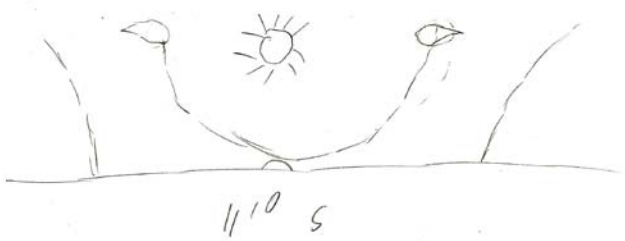
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Many of the rare halo elements we saw are formed by refraction of light in "Parry oriented crystals", *i.e.*, prisms with two surfaces horizontal. Intuitively the possibility of crystals falling through the air with such orientation seems strange, or – rather – impossible, but model calculations of light paths in different types of ice crystals give very good resemblance with observations. Although we had no particular device to collect ice crystals, my air samplers contained both plate like and prismatic crystals.

Unless there are small particles that can function as condensation nuclei in the air, the relative humidity has to be 800 % for water vapour to form droplets or ice crystals. In this case, the halo display started at the horizon. As we approached the open water the halo display grew in front of our eyes and culminated an hour or so after we had moored down in the ice for the sampling then to recede. The recession of the halos occurred more rapidly on the monkey's island than on the lower decks. A possible interpretation of this sequence of events is that the ice crystals could not been form in the clean Arctic air before we came there because of the lack of condensation nuclei. As a halo can be observed even if there are only crystals close to the observer, and the halo display developed close to the horizon and grew upwards, the first halo elements may have developed in crystals that formed close to the ship as we approached. There will always be some condensation nuclei emitted from the ship and from the breaking ice. As we approached open water the air would be increasingly over-saturated with water vapour also at higher elevation, and as we injected condensation nuclei – or simply put, soot from our exhaust – into the air, crystal formation would be rapidly induced. After we had moored down and shut down the engines the ice crystals high up in the air would start falling. At the same time there would now be many condensation nuclei in the air close to the water, and any water vapour released from the open water would rapidly form crystals there never reaching a higher elevation. Thus, ice crystals would be depleted from the higher air layers around the ship while there would still be many ice crystals in the lower air layers, explaining why the recession of the halo display was observed first high up on the ship.

I cannot here go into detail of how each individual halo element is formed. Those who are interested in the light paths, crystal types, or other information about halo phenomena should consult the references given.[8]

To me, this magnificent halo display alone made participating in AO-02 worthwhile. It has been one of my life dreams to see something like this ever since I started taking an interest in halos when, as child, I first saw the "Mock Sun Painting"[10] in Storkyrkan, the cathedral of Stockholm. This painting depicts a halo phenomenon, almost as magnificent as ours, observed in Stockholm on April 20 1535. This type of elaborate halo display is rare outside the Polar Regions and the people of the day saw it as a bad omen. Sure enough, later that year there was an uprising instigated by German merchants among discontent (ig-)noblemen. The uprising was soon squelched, but, worse, the queen died! What ominous events could now await us and our expedition?

May 3-11

Our intention was to traverse Fram Strait from north of Svalbard to Greenland at 82° N. We managed to follow this latitude to begin with, but it soon became increasingly difficult to find suitable leads in the ice. Also, the ridges of pack ice grew to dimensions that not even the most experienced Arctic veterans among us had ever seen. The estimated height was 10-15

[10] The "mock suns" were the parhelia and the anthelion. This is the oldest preserved painting of Stockholm. Swedish: Vädersolstavlan.

metres. A ridge that rises 10 meters above the water surface will reach a depth of 100 m. This was extremely impressive scenery and many of us would have liked to stay a while longer. But to ensure that we could perform as much as possible of the scientific programme we opted to take a more southerly route where the ice situation would, supposedly, be better.

For the next couple of days work went smoothly until suddenly, on May 6, the ill omen of the halo struck. The mate at the helm headed for what looked to be an ice floe that would split easily. Instead we got thoroughly stuck! There was no way we could get out of the entirely cramped position. But times change, and modern-day scientists can afford not to believe in omens. And although many an Arctic research vessel from yesteryear have perished in this type of situation, Oden runs no such risk. She is far too sturdy for that. Even if stuck for a few days there is no risk to the ship or crew. The greatest risk would have been that a Polar Bear had climbed aboard, something that very well could have happened as ice had piled up all the way to the railing on the starboard side of the bow.

Oden has several systems to enable the passage through the ice. The ice in front of Oden is continuously flushed with enormous amounts of water that acts as a lubricant when the ship rides up on the ice to bend and break it. It is also possible to flush water out the sides of the bow. The ship is substantially wider over the bow than amidships which enables rapid manoeuvres in the ice, as there is always open water alongside the ship. A heeling system[11] with large tanks on either side of the ship between which several hundred cubic metres of water is flushed in a few seconds from one side to the other makes the ship "rock" back and forth, shifting the pressure on the ice so that it breaks. But nothing we could do was to any avail. We simply had to wait for five hours for the tide and currents to shift the ice so that we could proceed.

While stuck in the ice, four Ivory Gulls were seen. With the notable exception of Reggie the Resident Redpoll, these were the first birds to be seen since May 2. Another indication that we were again heading for more productive waters was that the water samples contained more phytoplankton. Increasing numbers of Ivory Gulls were seen the next few days, but it was not until May 11, as we again approached open water, other bird species were seen. Fulmars and Glaucous Gulls appeared in the morning hours and Kittiwakes around noon. By 15.00 Kittiwakes were again the most numerous bird species around the ship, a situation that we had not seen since we left the open water north of Svalbard. There were also seals and some Polar Bear tracks on the ice. For a while we had the company of a playful bruin that slid down the ice ridges on its belly. In the afternoon the leads in the ice were teeming with Brünnich's Guillemots accompanied by a few Black Guillemots. I will not swear that there were no Common Guillemots around, but all would-be Common Guillemots that came sufficiently close to the ship for me to be sure of the identification turned out to be Brünnich's.

In spite of the reappearance of birds, the real treat of the day on May 11 was a Bowhead Whale sighted at 80°16.53´ N 2°55.03´ W! The Bowhead population in the North Atlantic (known as the "Svalbard population") was all but exterminated during the heyday of whaling. After decades of very few sightings in the North Atlantic recent there has been a recent

[11] Yes, the technical term is a "heeling system", but there is always someone each expedition that points out that it would be more logical (at least to non-sailors) to call it a "heaving system". It's a very special feeling when the healing system is in operation, quite different from the rolling of the ship in open water. Oden also starts to "sing" as air is pressed in and out of swan-neck vents from various tanks. The crew claims that she sings of joy when she is allowed to use her full capacity.

increase.[12] This may, in part, be due to an increased number of scientific and tourists expeditions in the area, but seems there does seem to be a real increase as well. Perhaps there is still hope for a recovery the Svalbard population after having been protected since 1911.

May 12
A few Ivory Gulls were seen, including some matings on the ice, and there were the odd Brünnich's and Black Guillemots in the leads. A Greater Black-backed Gull accompanied the Glaucous Gulls and there were several Kittiwakes around the ship.

May 13
We were enveloped in dense fog for most of the day. The only birds that came sufficiently close to the ship to be seen were some Fulmars and Ivory Gulls.

The fog gave rise to another interesting optical phenomenon: a fogbow. This is an ark similar to a rainbow but formed in fog droplets and all white. Similarly to the halo display the fogbow was a new experience to many expedition participants, mainly, perhaps, because no one has pointed out a fogbow to them previously. I regularly see fogbows at home, particularly in late autumn or early spring when dense morning fog has not yet been dispersed by the sun, so, in contrast to magnificent halo displays, you need not go to the Polar Regions to see one.

May 14
As we were making a transect through the ice westward towards the Greenland coast the echo sounder all of the sudden read only 48 metres where the chart said it should be 200 metres. The Polar Secretariat and the shipping company had set the safety depth to 50 m, as the charting of these waters is poor. Accordingly, we changed course and headed eastward again. Few ships ever sail here and there has been little opportunity to survey the sea floor in these constantly ice-covered waters. All data on Oden's position during the expedition, together with soundings and all other types of data that were collected were logged and reported to the appropriate authority to be used for future charts of the area.

Sverker, the bosun,[13] caught me red handed sprinkling the deck with hulled oats. He had been slightly irritated to find breadcrumbs and other food on the deck, and had complained over the bad discipline among the scientists as someone was obviously cluttering the deck and wasting food. However, he accepted my explanation that I was feeding our "stowaway" – Reggie the Resident Redpoll, *i.e.* – with good humour. Sverker has been bosun on several expeditions and has had ample experience of us crazy scientists.

Not many birds during the day, only a few Ivory Gulls and the odd Glaucous Gull.

May 15
We reached open water around noon. During the morning the ice had been full with Polar Bear tracks. Although I'm a fairly expedition-hardened Arctic veteran, I had never seen that many fresh tracks on the ice before. The bears were, obviously, hunting the seals in the area –

[12] Gilg, O., Born, E.W. (2005) Recent sightings of the bowhead whale (*Balaena mysticetus*) in Northeast Greenland and the Greenland Sea. Polar Biol 28: 796–801. Wiig, Ø., Bachmann, L. Øien, N., Kovacs, K.M. Lydersen, C. (2010) Observations of bowhead whales (Balaena mysticetus) in the Svalbard area 1940-2009. Polar Biol. 33:979-984.
[13] The boatswain, petty officer of the deck crew. På svenska "båsen", kortnamn för båtsman. Båtsman är förman på däck och inte alls någon S:t Bernhardshund.

after all there is not really anything more sensible a Polar Bear can do. Out here close to the open water the Ringed Seals that are widespread all over the ice-covered parts of the Arctic Ocean, were replaced by larger species, mostly Harp Seals, but also some Hooded and Bearded Seals. A couple of ice floes were bloody and had some remains of bears' meals. But, in spite of all the tracks, not a single bear was seen. Once again we were reminded of how difficult it is to spot the bruins in their natural environment.

As we approached open water the number of birds also increased. The expedition's first Iceland Gull was seen among the Glaucous Gulls. Other species were Fulmar, Kittiwake, and Ivory Gull. Before we left the ice we also saw a first flock of Little Auks – a small flock, only ten thousand individuals or so – some Black Guillemots and a number of Brünnich's Guillemots.

When we had come out in open water a female Wheatear landed on the fore deck. The Wheatears nesting on Greenland and Eastern North America winter in Africa so they have to migrate over a vast body of open water back and forth. Not knowing she was there, I inadvertently scared the poor thing out from under the capstan. She was so exhausted that she just fluttered over the railing and dropped into the water where a Glaucous Gull made a meal of her.

The number of Brünnich's Guillemots was surprisingly high even quite far out on the open sea.

In the evening we had a party with a hat parade. Fantasy flowed freely. I dressed up with a winged hat and wings on my shoes symbolising Hermes. I hadn't thought of it myself, but everybody else thought I was dressed as a "birdman". Quite properly, I guess.

May 16
A couple of wheatears were seen, but the main event of the day was the migrating Snow Buntings. As far as it appeared in the middle of the North Atlantic this was their big migration day. I had not expected to see any Snow Buntings as I thought they would be too small and migrate at too a high elevation to be seen. But to many birds, a ship in the middle of the sea appears as an island and will attract their attention as a possible resting place. Perhaps this was the reason why we saw the buntings from Oden.

The Snow Buntings nesting in Greenland winter on the Russian steppes, passing their kin nesting in Northern Fennoscandia spring and autumn. Several small groups of Snow Buntings were seen during the day. The size was mostly 5-6 birds, but a couple of times they seemed to be alone and on one occasion a group of ten was seen. Calculating the number of birds from my own observations and those reported to me by others, and trying to estimate the time of the various observations to avoid counting them twice, made the total to maybe as much as 40-50 birds.

The literature I have available[14] states that the Snow Buntings return to Greenland in March or April. This seems reasonable as I have myself seen Snow Buntings in April in a heavily snow covered Iqaluit (Frobisher Bay on older maps), Baffin Island. Our observations during AO-02 would, therefore, seem to be on rather a late date for migrating Snow Buntings. But considering the high latitude at which we were, north of 75° N, it is possible that the

[14] Génsbøl, B., Tofte, C.C. Grønlads dyr & planter. Gads Forlag, København, 1998.

Snow Buntings we saw belong to a population inhabiting the northeastern and coldest part of Greenland. If so, it may be beneficial for these birds to be programmed for a rather late arrival date to avoid at least some of the worst cold.

Tim Newberger, working on the aft deck, reported that at one time a group of buntings went in for landing on Oden. But so fiercely did Resident Reggie defend his residence that the buntings, although substantially larger than Reggie and outnumbering him fivefold, fled the onslaught. What to Reggie must have seemed an infinite supply of hulled oats was obviously worth fighting for! It occurred to me that the aggressive behaviour Reggie showed here might have been the reason why the Snow Bunting that had competed with him for access to monkey's island while we passed Svalbard left the ship.

Although the migrating Snow Buntings and their dealings with Reggie were fascinating, what surprised me the most was the high number of guillemots seen here in the middle of the Norwegian Sea, essentially as far from land as you can get. Every time I had the opportunity to leave the lab to do some birding, there were auks around the ship. As previously, I cannot say that no Common Guillemots were around, but all birds that were possible to identify to species were Brünnich's Guillemots, with exception of a few Black Guillemots. At the sampling station furthest from land, 74° 59.92´ N, 0° 0.44´ E, there were at least four Brünnich's Guillemots and one Black Guillemot.

I have not gone into the original literature, but apparently at least Brünnich's Guillemots are known to forage quite far from land.[15] But it seems unlikely that nesting birds or birds preparing to nest would fly quite this far to forage. According to satellite images the ice east of Greenland was some 300 km away, a shorter distance than any land mass. Perhaps the birds perceive the ice as the closest land. Even so, 300 km is a very long distance. Perhaps these birds were still on migrating to their nesting areas. Although we saw many Brünnich's Guillemots arriving to their nesting cliffs on Svalbard three weeks earlier, but perhaps some birds nesting on Eastern Greenland will arrive later to their nesting area as the ice keeps its grip longer there than on Svalbard. Alternatively, these birds may not at all be set out to nest this year, but would instead spend much of the summer out at sea.

May 17
This was a rather slow day with nothing very interesting to report.

May 18
After we had once again entered the ice covered waters off Greenland five Redpolls were, much to my surprise, spotted on the ice. I didn't get any really good look at them, but I think that the flock contained both Arctic and Common Redpolls. Common Redpolls should dominate the coastal area of South-eastern Greenland, whereas the Arctic Redpolls dominate in the northeast.[14] Judging from the distribution maps, both species would be possible along the coast where these Redpolls were spotted. Amazingly, from their behaviour it seemed as if they were able to find something to feed on even on the ice. It is difficult to believe that there could have been any wind-driven seeds out where we were, but perhaps Redpolls as well as gulls can forage on things left on the overturned ice in the ships wake.

[15] Guðmundur Guðmundsson, personal communication

May 19
The first Lesser Black-backed Gull we had seen since off Norway followed the ship for most of the day. Here, it was the western subspecies *Larus fuscus graellsii* that nests on Iceland and the British Isles, or at least a subspecies very similar to *graillsii*. A Turnstone landed on the helicopter deck. I never saw it myself although I searched the ship as well as I could.

The weather report indicated bad weather approaching. To avoid having to sample in open water during a storm, which would have been impossible anyway, the morning planning meeting decided to change the cruise track so that we could work in the ice for another couple of days rather than having to head for open water.

May 20
Scattered reports came in during the morning that the Turnstone was still on board. This time I organised a search party and after searching the ship up and down a couple of times we finally cornered the wretched bird and caught it. It was very weak and exhausted and did not manage to take to its wings. We put it in a large cardboard box to let it regain strength. Lacking mealworms or other arthropods we tried to feed it pieces of cheese and smoked turkey and gave it an ample supply of water. It ate frantically.

Large flocks of Little Auks were seen during the day. For Little Auks the flocks need to reach a size of several tens of thousands before they are regarded as large.

May 21
The Turnstone died this morning while I was still asleep. As I didn't have anyone to work shift with my working hours were fairly irregular and I had to be prepared to work around the clock. Therefore, I sometimes slept over important events. When I woke up the Turnstone had, to my immense frustration, already received a burial at sea. This was unfortunate as it should have been frozen and turned over as specimen to the Natural History Museum. The personnel at the museum shared my frustration over the lost specimen. I, therefore, suggested that the museum give the Polar Secretariat the standing request that all small animals found dead on board the ship during expeditions should be frozen and handed over to the museum.

As the wind picked up the visibility diminished making bird observations more difficult. Most of the day there were Glaucous Gulls around the ship. Also an Iceland Gull was present and I spent quite some time trying to get the feeling for how to distinguish the two species. It's much more difficult than you would think if they are not side-by-side. All the Gulls fled the field at the mere rumour of a Great Skua approaching, once again reminding us of the ferocity of these magnificent birds.

May 22-24
The easterly storm created heavy ice pressure towards Greenland and progress in the ice was slow. Our average speed over ground was no more 2.5 knots with all four main engines running at full power. Running Oden at full power means that she burns more than 80 m^3 of marine diesel per day! Here in the East Greenland Current, just drifting with the ice gave us an average speed of 2 knots over ground and a straighter course than when running the engines. Therefore, the engines were shut down and we drifted with the ice for a couple of days. It was nice being on a ship that was quiet for change. The soft murmur of the generators replaced the constant roar of the main engines and the crashing of breaking ice. At times when the tide decreased the ice pressure the engines were started up and we moved actively for a

while. But as soon as the tide turned and the ice pressure increased again the engines were shut down.

The relative quite on board gave us the opportunity to celebrate a couple of birthdays among the crew. The scientists took over the responsibility in the galley for a day to let the crew sleep it off, at least those whose duties did not preclude them from the intake of alcohol. Much of the time the visibility was close to zero as the storm developed into a blizzard. At times the weather cleared up and the mountains around Ittoqqortoormiit (Scoresbysound) were clearly visible at a fairly close distance.

The storm was caused by a large, deep low pressure that covered the entire North Atlantic. The cyclone covered such a large geographical area that Bertil, our meteorologist with more than 30 years experience as air force meteorologist and more than 20 years experience of research in the Arctic, said he had never seen any low quite this large. The cyclone was essentially blowing air from the North Sea to our location, making the wind more or less easterly or north-easterly at our position. Few birds were visible in the storm, but there were a couple of eastern vagrants – accidental visitors, *i.e.* – that had obviously been blown off course. Notably a Common Snipe and a House Martin, neither of which should be present on Greenland, paid the ship brief visits, but were soon blown further towards Greenland. A Sanderling landed for a while on the helideck. This is not necessarily a strange species for Greenland, but under the circumstances it is very likely that this also was a wind-driven individual. We were close to some nesting colonies of little auks and we saw increasing numbers of them in leads in the ice, but they were clearly reluctant to take to their wings in the storm. The flocks that we saw during the storm were small, a few thousand or so. Apart from the little auks we also saw some Brünnich's and Black Guillemots, some gulls, and the odd Dunlin. Once again a Lesser Black-backed Gull was seen. It had similar damage to some of the primaries and tail feathers as the gull we saw five days ago, so perhaps it was the same individual.

Sadly, Reggie lost his residence during the storm. I was on the bridge when he went bird over board. Something had startled the little fellow out of his shelter in a hot air outlet. I watched him desperately trying to get back to the ship, struggling intently against the wind. Alas, the wind was so strong that he didn't move the slightest forward however much he tried. He struggled for maybe 20 seconds before he gave up and blew away towards Greenland. I hope he found a good territory to defend there now that he had lost his residence on the ship.

May 25

The low pressure had moved on and we woke up to a bright and sunny day. As the storm subsided it was replaced with a strong catabatic wind[16] from high up the Greenland ice plateau. Even at our position outside the territorial waters of Greenland, the wind at times was more than 30 m sec^{-1}. As before, we sometimes drifted with the ice and sometimes moved actively. This was to turn out to be a day with real ornithological treats.

Enormous flocks of little auks, possibly 100 000 or more in each, followed the catabatic wind out to the sea in the morning hours. The first flocks of Eiders pressing north with quite some effort in the strong side wind appeared some hours before noon. Flocks that passed us later did not have to spend so much energy fighting the wind, but presumably there is sufficient benefit for those birds that reach their nesting grounds in the very short summer of

[16] In this case the catabatic wind (Swedish: fallvind) is caused by cold air "falling down" from high up the inland ice cap. The top of the ice cap has an elevation of around 3000 m above sea level.

North-eastern Greenland to spend some energy migrating under less than optimal conditions. In this case the early bird did not gain much, but you have to dare to win. At least four flocks with forty to fifty birds in each passed the ship during the day.

As the catabatic wind subsided, small flocks of Dunlins, 5-10 birds in each flock, flew out towards the east. They flew very intently eastward in a way that I can only interpret as migration. The total estimate for the day was 70 birds in ten flocks, the last ones in the early evening. Why they had not drawn advantage of the catabatic wind I do not know. Perhaps some did, but neither I nor anyone else saw any while the wind was still strong. In late afternoon two flocks with about 50 Sanderlings each, the first flock containing also a couple of Purple Sandpipers and the second a couple of Dunlins, flew in from the southeast heading for nesting areas in Greenland. These observations of waders migrating in both directions on the same day were, and still are, somewhat puzzling to me. Perhaps the flocks migrating eastward consisted of birds that had been wind-driven to Greenland in the easterly storm and that were now trying to get back to their normal nesting areas. However, it is noteworthy that all birds observed migrating eastward were Dunlins while those migrating westward were Sanderlings and Purple Sandpipers.

The big treat of the day was the Grey Plovers! Two substantial flocks, a couple of hundred birds each, pressed out towards the northeast.[17] This species should not be present at all on Eastern Greenland. Apparently there is a small nesting population of Golden Plovers around Ittoqqortoormiit,[14] but I am quite certain that the birds I saw were Grey and not Golden Plovers. Anyway, it would make little sense for the Golden Plovers to migrate in an easterly direction if they were to nest on Greenland. This enigma is discussed further below.

There seemed to be an influx of Lapland Longspurs from the southeast a couple of hours after noon when the catabatic wind had subsided. They arrived in small groups of up to five birds. I saw a total of four such groups. There is, apparently, some migration of Lapland Longspurs across the Atlantic from wintering areas in Scotland and Iceland. But they may also simply have been pressed far out over the ice by the catabatic wind, and were now returning towards the mainland.

Even though we were drifting in the ice most of the time there was always some open water around the ship. The ship, which is about the same height as a ten-story building, makes up a fairly large sail giving it a drift that is slightly different from that of the ice. This open water attracted various gulls. There were always Ivory Gulls around this open water, but as the catabatic wind subsided, increasing numbers aggregated. Almost all arrived in pairs and many of these mated on arrival. The vast majority arrived from the southern sector, clearly indicating that there was a northward migration of Ivory Gulls taking place. As with the Grey Plovers the occurrence and behaviour of the Ivory Gulls is discussed further below.

In the evening massive flocks of Little Auks flew back towards Ittoqqortoormiit. In total there must have been several hundreds of thousands. At the same time fairly large flocks of a bird clearly larger than the little auks migrated northwards along the coast. The position of the sun was unfavourable and together with the distance this made certain identification

[17] It is not possibility to give the exact flight direction. The flight direction had to be estimated after comparison with the heading of the ship, which was constantly logged.

impossible, but the jizz[18] was that of a large *Calidris*-wader. The size compared to the little auks indicated that most, if not all, were Knots.

Once again the ice was covered with Polar Bear tracks. We were close to one of the main denning areas for Polar Bears, and often a set of large tracks was accompanied with one or two smaller sets of tracks: tracks of cubs. Only female Polar Bears ever go into a den, and then only to give birth. They stay in the dens for a couple of months until the cubs are large enough to follow their mother. A couple of times we saw females with one or two cubs.

Here and there the Polar Bear tracks were also accompanied by even smaller tracks; tracks that were dwarfed even by the tracks of the smallest cubs; tracks of Arctic Foxes. An Arctic Fox in winter fur is totally white whereas a Polar Bear is yellowish. This, and, of course, the much smaller size of the foxes, make the foxes even harder to spot than the bears. In spite of this I managed to spot a couple of foxes in a far distance, mostly because the carcase on which they were feeding, leftovers after a Polar Bear's meal, showed up in contrast to the white background.

We also witnessed an astronomic event that is not often seen by us southerners. At midnight (true astronomical midnight that is, not midnight UTC) we had the sun due north and the full moon due south. To have a chance to see something like this you have to be in a place not too far north of the Arctic Circle for the full moon to appear during summer and also be lucky with the weather. At about the same time at least ten, maybe more, Long-tailed Skuas flew in from the east heading for Greenland.

May 26

Finally the ice let go of its grip! Heading with good speed for open water, it was a little sad seeing Greenland disappear beneath the horizon. A certain breaking-up mood has started to manifest itself. It's an interesting phenomenon. On all expeditions you sense this mood a week or two before the expedition is scheduled to end whatever the length of the expedition. There most certainly are individual variations, but as a collective we seem to be somehow predisposed to adjust to the length of the expedition, be it six weeks or four months long.

A very distinct change has taken place among the gulls as well. The former dominance in numbers of Glaucous Gulls over Iceland Gulls has been reversed. Now Iceland Gulls are more numerous than Glaucous Gulls. A similar change has taken place among the auks. Further north I had not seen any Common Guillemots that I could identify with certainty, but now they appear in approximately equal numbers to Brünnich's Guillemots.

May 27

Even though the weather had been nice the last couple of days there was some swell on the open sea and the ship rolled substantially when we took the seas abeam. Approaching the northern coast of Iceland there seemed to be a westward migration of Pomarine Skuas. It's difficult to give an absolute number of birds as I could only count them intermittently, and although most were flying intently westward at least one or two also engage in foraging, *i.e.*, harassed the Kittiwakes. A minimum of twelve birds, more probably at least double that figure, passed the ship in this westward movement. In addition to the Pomarine Skuas, a couple Parasitic Skuas were harassing the Kittiwakes. Also, a few Arctic Terns, and all North Atlantic species of auks except Little Auk were seen. To my surprise four Whooper Swans

[18] Jizz is a term used among birders for the immediate general feeling you get of a bird of which you cannot see all the distinguishing details. With some training the jizz becomes a very important aid in species identification.

and a couple of Barrow's Goldeneyes flew in from the north. Why they were coming from the north I had a hard time understanding, but according to Guðmundur Guðmundsson, an Icelandic ornithologist, it may not be all that strange that waterfowl migrate around Iceland at quite some distance from land and approach the nesting area from a seemingly strange direction.

May 28
A foggy day; the wind successively picked up again. We were lucky to take the seas mainly from the aft. It was difficult to see any birds because of the dense fog, but the first Gannet in a couple of weeks flew alongside the ship for a while. At one occasion I startled a couple of Knots out from under the capstan on the foredeck. They disappeared rapidly in the fog. I cannot say what physical condition they were in, if they had taken refuge on the ship because of exhaustion or if they thought they had found an Arctic island to nest on. I doubt the latter though, as their nearest normal nesting area is further north on Greenland and not on Iceland which was the closest land.

There were also reports that a number of "small whales" were seen during the day. I didn't see them myself, and the reports were too unspecific for certain identification. One informant gave descriptions that sounded as if it could have been Minke Whales. Another informant gave me the impression she was describing Pilot or, maybe, Beaked Whales. Yet another claimed that Porpoises or Dolphins had visited the ship. Perhaps different species had been seen by different persons or, perhaps, a mixed flock? Mixed flocks of Minke and Pilot Whales together with various dolphins are noted in the literature.[19]

May 29
Another foggy day with a fairly strong north-easterly wind. The great bird event of the day was a female Merlin that took refuge on the ship. As the strong wind was blowing directly from Iceland this was with all certainly where she came from. She made several courageous attempts during the day to fly back towards Iceland. Because of the strong wind the first three trials I witnessed failed and she landed on the ship for some rest. At the fourth attempt she didn't manage to get back to the ship although she tried. The wind was too strong and her energy reserves depleted why she blew passed the ship towards Greenland.

May 30
Here in the south the ice of the East Greenland Current was disintegrating. Consequently we made unexpectedly rapid progress in the sampling programme. But close to the coast the ice was again rock-hard, and we abstained from the innermost planned sampling stations. I suspect that this decision was in part due to the general weariness that had spread among the scientists; it was very much time to go home. The completion of the last station was celebrated with champagne on the aft deck as the sampling rosette came out of the water for the last time. The official expedition photograph was taken with all personnel, except those on watch on the bridge or in the engine, on the helicopter deck.

As we were leaving the last station there was some unrest among the gulls. I guess I was also affected by the general homeward-bound feeling, as I didn't give much heed to this at first. I just automatically assumed that there must be a Great Skua around. Gulping down the last champagne I noticed that one of the "Iceland Gulls" looked and behaved very strangely. After having mangled my perhaps somewhat woozy brain, I realised that it was a Gyrfalcon.

[19] Carwardine, M., Camm, M. (1995) Whales Dolphins and Porpoises. Dorling Kindersley, London, UK.

It was the first time I had ever seen a white Gyrfalcon, a colour phase that is more common among the Gyrfalcons of Greenland than elsewhere, and as we were some distance out at sea I just assumed that a white bird must be a gull. Even if we did see Gyrfalcons quite far out over the open water during the 1999 tundra expedition in Arctic Canada, I still wondered a bit why this bird was out here and why its presence quite obviously disturbed the gulls. It was my understanding that Gyrfalcons are essentially specialised on Ptarmigans. But why would the presence of a raptor specialised on ptarmigans bother the gulls? After consulting the literature[14, 20] it's clear that Gyrfalcons are not as specialised on Ptarmigans as I had assumed. Of course, Swedish Gyrfalcons are indeed mostly specialised on Ptarmigans, but in other parts of its range they may take other prey depending on what is present. Gyrfalcons with coastal nesting sites live principally of seabirds and marine diving ducks.[14, 19]

On the way both in and out of the ice we were surrounded by enormous numbers of seals, the vast majority Hooded Seals[21] with some Harp Seals and the odd Bearded Seal. In contrast the number of Ringed Seals has diminished successively as we have come further south even in the heavy ice close to the coast. Ringed Seals have adapted specifically to a life underneath the permanent ice. This far south, where the ice on the open sea melts every summer the conditions are not optimal for Ringed Seals and this species is replaced by the other larger seals, although there are supposedly some Ringed Seals in the protected waters of the fiords.

On the way out we had a stop in middle of the "seal-field" to let the diver make a final check of the propellers before heading out on the open ocean again. While the diver was in the water we had ample opportunity to compare the characteristics of Glaucous and Iceland Gulls that roosted together on the ice. I can't get over how difficult it is to separate the species. And, of course, it becomes even more difficult if you only see one species at the time. An experience like this should humble even the most experienced birder!

In places along this southernmost transect through the ice there were small, insignificant birds scattered between the ice floes. In the general bustle of the ending expedition I didn't look very closely on these at first, just automatically assumed that they must be Little Auks simply because that was what all small birds on the water had been further north. For all I know some of them may have been Little Auks, but when I finally got my binoculars out and took a closer look the birds around the ship turned out to be Red Phalaropes. During the rest of the day I took closer looks at all small birds and there were both Red and Red-necked Phalaropes. Because of the work I lost count, but I believe there were several tens of each species.

The evening saw an influx of Arctic Terns, a minimum of 20 individuals, towards the Greenland coast. We also saw a small flock of five Red-breasted Mergansers flying in from the east or northeast and continuing towards Greenland. I can by no means claim to have done an exhaustive literature search, but although there seems to have been few actual records of migrating birds, at least some literature suggests that the Red-breasted Mergansers nesting on Eastern Greenland winter off Iceland or Britain.

[20] D. W. Snow & C. M. Perrins (1998) The Birds of the Western Palearctic, concise edition vol. 1. Oxford University Press.

[21] Our position was in the middle of the major moulting area for Hooded Seals and there were seals "as far as you could see in every direction", see http://www.pagophilus.org/index.html

Just as we left the ice we, finally, encountered a Sabine's Gull. I had expected to see many more during the expedition. But, according to the literature, we visited Greenland waters a little too early for this nice little gull to have returned to its nesting grounds.[14] Sabine's Gull migrates to the waters off Southern Africa during winter and returns to Greenland in June.

May 31-June 6
As soon as the samples from the final station had been collected and processed, packing of scientific equipment commenced. All scientific programmes were now terminated. All except mine. I continued to sample air and surface water as long as was possible on our way home. The lab was successively emptied. What had been a crowded, bustling place, populated with hordes of wild scientists, constantly trafficking water samples from the aft deck and with work going on around the clock, now became an empty void. It was pretty lonesome at times.

All alone in the laboratory I had time to ponder over the bird observations made during the expedition. As a whole, we saw many things that I had not expected, especially the small passerines migrating to Greenland, and, of course, the Spectacled Eiders and the Grey Plovers. However, there were also things that I had expected to see that we did not see. In the discussions I had with professional ornithologists before we set out it was suggested that we should look out for migrating geese; large birds that fly at not too high altitude. We didn't see a single goose. At least I didn't see any myself, and no one else reported any goose observation either. I was also somewhat disappointed to see so few Ross' and Sabine's Gulls, but looking in the literature we where too early for the Sabine's Gulls and most of the time we spent in waters where Ross' Gulls are a rarity anyway. We have, of course, been on more or less constant move, so the observations are by necessity more erratic than they would have been if we had stayed on a specific observation point. We could also have made better observations, and above all better documentation of the observations, if there had been an ornithology programme on board with good field ornithologists on the lookout around the clock.

South of Iceland we found ourselves in the middle of an area with feeding Humpback Whales. We were fortunate to see a breach and some flipper waving. In the same area a couple of Basking Sharks were skimming plankton at the surface, and the expedition's second Sabine's Gull was seen.

A Black-tailed Godwit sat on a piece of driftwood in the middle of the sea. Other migrating waders, a couple of Dunlins, a Purple Sandpiper, visited the ship. These were fairly exhausted and unwilling to take to their wings and probably dropped out of flocks migrating at higher altitude. A Whimbrel, far from exhausted, accompanied us for some hours. It first landed on the helideck. For extended periods it then flew in circles around the ship. It was fascinating to stand on the bridge and look down on the back of a flying Whimbrel, at times hanging almost still much like a gull in the turbulence created by the ship. The Whimbrel had a somewhat strange plumage with only a narrow white cigar on the rump and back. It looked like a mix between the plumages typical of the Eurasian and North American subspecies, but I guess it may simply be within the natural variation of the Eurasian subspecies.

To my great disappointment the visibility was rather poor when we passed between Fair Isle and Orkney. Otherwise I would have expected this to be a prime area to see many seabirds. Still some Shearwaters and Storm Petrels could be added to the expedition's species list. A bit further southeast the fog lifted and a pair of Roseate Terns paid a brief visit to the

ship. This was a very nice treat indeed as Roseate Terns are rather uncommon and localised in Europe. Of course, there were always some Gannets, Fulmars and gulls around the ship while passing the North Sea.

I stopped my sampling soon after having entered the North Sea. This was of pure necessity as I ran out of sampling material. Packing up all my equipment only took a couple of hours. I've learned much about how to organise things on board during my years of polar research. The first expedition I participated in packing took several days.

The social interactions on board have successively taken a new turn during the five-day journey after leaving the ice. There is a mildly indulgent interest among us "old-timers" observing how these interactions develop among those who do their first expedition. By necessity, most of the greenhorns are young. And if you lock up a number of young, healthy people in a limited space for a number of weeks, it's inevitable that special bonds are tied. As we approach the end of the expedition and our homes are getting closer again, old established social relations are to be resumed and bonds tied on board severed. Everybody knows this and it creates certain new tensions. It's a mixture of loss and anticipation very difficult to describe.

The journey from Greenland to Gothenburg was intentionally fairly slow so as not to arrive too early. Even so we reached Swedish waters early and had to spend the last night cruising up and down the coast off Gothenburg to arrive on schedule. There was quite a lot of activity in the harbour when we arrived as the yachts participating in the Volvo Ocean Race around the world were in Gothenburg at the time, preparing for their last leg to Kiel. One of the Swedish yachts actually came out and greeted Oden as we entered the harbour.

In contrast to other expeditions in which I've participated, homecoming ceremonies at the quay were fairly rapidly over and done with. Partly, I presume, because many of the participating scientists make their homes in Gothenburg, but also because Oden had other engagements soon after we came home. It was also a fairly short expedition so, perhaps, there was no real need for much ceremony. As a whole, it was a very pleasant expedition with good co-operation between all scientists and crew. Even the crew expressed their appreciation of the participating scientists and agreed that it had been a particularly pleasant experience as expeditions go. I've collected much more samples than I had ever hoped for, and the data that other groups have collected will enhance the possibility to interpret my data. However, there is still much work to be done with the samples using the heavy instrumentation in my home laboratory. It will be another couple of years before all the analytical data have been processed. It's nice to know that I have meaningful work for several months to come.

Special Notes

Ivory Gulls

The following paper has been accepted for publication in "Polar Research" published by Blackwell Publishing for the Norwegian Polar Research Institute. The final version will be available some time during 2011 from www.blackwell-synergy.com.

At-sea observations of the spring migration and pair bonding of ivory gulls (*Pagophila eburnea*) around Svalbard and east Greenland

Abstract

The Swedish expedition "Arctic Ocean 2002" investigated the waters around Svalbard and the east coast of Greenland in late winter/early spring. Because of logistic constraints little previous information exists on ivory gulls (*Pagophila eburnea*) from the area during this time of the year. The ivory gull was essentially absent from open water areas, but was the most common seabird species seen in areas with pack ice, showing behavioural differences depending on the conditions of the specific area. Generally, the number of ivory gulls was low when there was little plankton in the water. Ivory gulls would or would not follow the ship depending on the availability of food items in the wake in or on the ice, and also depending on competition from other species, particularly glaucous gulls (*Larus hyperboreus*). Although ivory gulls were present in most of Fram Strait and the northern part of the East Greenland Current 6-19 May, the number of sightings was generally low essentially correlated to the amount of plankton in the water. Aggregations of several hundred were seen on the ice where copulation and other social interaction took place. A previously undescribed pair bonding behaviour during which females seemed to select between two competing males was observed north of Svalbard on 30 April-1 May. Off Scoresby Sound on 25 May, more than 700 birds were seen migrating north, while farther south along the Greenland coast on 30 May there was little indication of migration although many ivory gulls were seen.

Introduction

The knowledge of the occurrence and behaviour of sea birds in the High Arctic is largely limited to observations in open-water areas and during seasons when travel is relatively easy, while observations during seasons with extensive ice cover are few or non-existent (Hjort et al. 1997; Vuilleumier 1996). Thus, any observations in the High Arctic outside of the seasons when observations are normally done, i.e., winter and spring, contribute to the knowledge of the arctic avifauna.

The Swedish expedition "Arctic Ocean 2002" (AO-02) set out in April 2002 to investigate the chemical and physical oceanography of the area around Svalbard and the East Greenland Current in late winter/early spring. To handle the ice conditions the arctic class icebreaker Oden was used as research platform. There was no formal ornithology project onboard during AO-02, but bird observations were recorded whenever the scheduled work allowed (Kylin 2004).

The expedition moved in and out of the pack ice several times. With the exception of large flocks of little auks (*Alle alle*) off Scoresby Sound, the ivory gull (*Pagophila eburnea*) was the seabird species encountered in the highest total number while in the ice, although other species sometimes were present in higher numbers around the ship when close to the ice edge. In this paper I describe at-sea observations of ivory gulls throughout the expedition. This includes observations of a previously not described pair bonding behaviour north of Svalbard and a prominent spring migration northwards along the east coast of Greenland. Competition for food items with other gull species is also discussed.

Material and methods

While the ship was in motion observations were done with a pair of handheld binoculars, complemented with telescope observations whenever the ship lay still in the ice. Observations were usually done two 10-minute periods per hour 07:00 to 23:00 each day with some variation to adapt to the officially scheduled work. On 15 and 26 May only the part of the day spent in the ice was used for averaging; no birds were seen in open water. Observations while the ship was in motion were from the bow in front of the main laboratory (~10 m a.s.l.). All birds observed in a 180°-sector in front of the ship were recorded. The speed of a ship varies considerably during ice breaking making it difficult to calculate densities why no such attempt was made. Because of this and the scarcity of birds in much of the area covered by the expedition, all identified birds were registered irrespective of distance to the ship and whether they were flying or perched on the ice. The birds following the ship were checked twice each hour and registered separately. To avoid double counting, birds circling the ship appearing in the forward sector and then returning aft were registered only as following the ship.

Three times (30 April – 1 May, 25 May, 30 May) the ship made extended stops in the ice during which time bird movements around the ship were monitored continuously for about 80% of the time on station. While still, observations were from vantage points 20-30 m a.s.l. allowing a 360° view of the horizon with little lateral movement. Flight directions were estimated in 30°-sectors, with north determined from the ships heading. Ship operations and activities were recorded in UTC (Universal Time Coordinated). Most of the observations were done at latitudes with midnight sun, why diurnal variations in activity because of shifting time zones are of little consequence for the results.

The amount of plankton in the surface water was continuously monitored with a flow through fluorescence cell measuring chlorophyll coupled to a seawater intake. In addition, discrete samples were taken for species identification and counting, and chlorophyll measurement (Wulff 2003). Depth profiles of chlorophyll were also taken at each sampling station (Wulff 2003). Discrete samples were also analysed for bacteria (Granéli 2003).

Results

The cruise track is shown in Figure 1. Large aggregations and observations in the forward sector are summarized as pie charts of the daily averages of the number of ivory gulls observed per 10 min period. The total numbers of observations, including ivory gulls foraging in the ship's wake, are summarized in Table 1. No ivory gulls were seen in open water although the observation efforts were similar to within the ice. A few days, 20-24 and 28-29

May, visibility was so low as to make observations impossible. The ivory gulls were almost always observed in even numbers, mostly in pairs.

The cruise track can be divided into six distinct sections where the ivory gulls behaved differently. These sections were separated in time and by transit through open water, except the second and third sections that were separated by three days, 3-5 May following ~82 °N westward, during which no seabird of any species was seen.

In the northernmost sections of Fram Strait and the East Greenland Current the occurrence of ivory gulls coincided with the occurrence of plankton, including bacteria, in the surface water. There were clear north-south and west-east gradients with less plankton and bacteria in areas with heavy ice in the north and west and more close to the ice edge (Mats Kuylenstierna pers. com.; Granéli 2003; Wulff 2003). In these northern sections, ivory gulls would follow the ship in areas where the plankton count was high, but did not do so when the plankton count was low.

Storfjorden, 26-29 April
In Storfjorden, ivory gulls were always seen in single pairs except for one sighting of four birds. The birds showed no interest in the ship and flight directions were random. Sightings were more frequent close to the ice edge than in the centre of the ice-covered fjord.

Northern transect, 30 April - 2 May
After having entered the ice north of Svalbard on April 30, the ship was accompanied by up to 10 ivory gulls, and also glaucous gulls (*Larus hyperboreus*) and black-legged kittiwakes (*Rissa tridactyla*), foraging in the wake. When the ship was moored the three species perched on the ice in single-species groups. After the birds settled more ivory gulls were attracted. The highest number counted simultaneously was >200, but due to pressure ridges the exact number is not known. In contrast to the ivory gulls, the glaucous gulls (N = 34) and black-legged kittiwakes (N = 64) were essentially silent once they had settled, were not seen to attract new individuals to their respective group.

Many of the ivory gulls arriving new to the aggregation were in groups of three and a peculiar behaviour, presumably part of the pair bonding process, ensued. Newly arrived birds were greeted with calls, head-bobbing, and low jumps from birds close by in the aggregation, greetings that were answered similarly by the newly arrived birds. Soon after arriving to the aggregation, two of the birds in the triad (presumably males) would take turns mounting the third (presumably female). Mountings were followed by head-bobbing and calls within the triad. After one or more rounds of this “copulation ceremony” the female chased one of the males along the ice, at times assisted by the other male. This would result in either the chased male flying away or in a renewed copulation ceremony. As many as five copulation ceremonies were observed by a single triad, but mostly the bird chased away would leave after one or two rounds of the ceremony. Once one of the males had left the triad the remaining two birds copulated several times. Between approximately 21:00 April 30 and 02:00 May 1, a total of 27 triads were observed arriving to the aggregation with subsequent copulation ceremony. During the subsequent three hours of observation no additional ivory gulls arrived, but the aggregation continued to be noisy and socially active.

On 2 May the water contained successively less plankton (Mats Kuylenstierna pers. com.). As the plankton decreased the glaucous gulls became increasingly aggressive towards the other species, pirating food items. With increased aggression from the glaucous gulls, first the black-legged kittiwakes and then the ivory gulls left, leaving a dwindling number of glaucous gulls in the ships wake. After the last glaucous gull had left the ship no seabirds were seen for three days.

Fram Strait and East Greenland Current 6-15 May, ~81-77 °N
During 6-15 May Oden cruised successively farther south through dense pack ice. From about 81 °N the amount of plankton gradually increased (Mats Kuylenstierna pers. com.) and ivory gulls again started to appear in low numbers. On 6-10 May no other seabird species was seen. During 9-15 May, the number of ivory gull observations were lower west of 5 ºW, where the ice was heavier, than east of this latitude. The same pattern was shown by the number of plankton in the water samples (Mats Kuylenstierna pers. com.).

East Greenland Current 17-19 May, ~75-73 °N
The observations of ivory gulls were relatively few, but the majority (>60%) arrived to the ship from the south and left towards the north indicating a northward migration.

East Greenland Current 25-26 May, ~72-69 °N
On 25 May Oden's position was ~70 °N, 22 °W off Scoresby Sound drifting at 0.5-2 knots southwards, creating a pool of open water in its wake where up to 20 glaucous gulls were foraging. As the storm of the preceding days receded, a large aggregation of ivory gulls was discovered about 75-100 m from the ship on the far side of the pool. Pair bonding behaviour in the form of head-bobbing, low jumps, and copulation was observed. But these behaviours were less intense than in the aggregation north of Svalbard, and all ivory gulls arrived in even pairs, 2-8 birds together. Neither triads nor copulation ceremony were seen. The total number of ivory gulls observed was >900. Almost all ivory gulls arrived from the south and left to the north (Figure 2). The ivory gulls only rarely ventured to forage in the pool; the few that did were pirated by glaucous gulls. During 26 May many additional ivory gulls were seen before the ship reached open water, all flying northwards and showing no interest in the ship.

East Greenland Current 30 May, ~65 °N
The vast majority of ivory gulls seen during 30 May were in loose flocks roaming the ice foraging on loose skin and excrements from the many moulting seals in the area. In all other sections only adult ivory gulls had been seen. In contrast, here about 10% of the birds retained juvenile plumage. Birds in various stages of moulting were present; some were in entirely juvenile plumage including dark face, some had only dark spots on the primaries and tail, while others were intermediate. The only indication of migration was three pairs flying intently northwards.

Discussion
The behavioural differences displayed by the ivory gulls in the six sections may be due to differences in the timing of various behaviours related to migration, pair bonding, and nesting. There is a great variation throughout their range when the ivory gulls arrive to their nesting areas (Blomqvist & Elander 1981). In Svalbard, ivory gulls have been reported already in

March, long before nesting, while they arrive to north-eastern Greenland in early June, shortly before nesting (Salomonsen 1967).

The gregarious behaviour of the migrating ivory gulls was interesting. Based on these observations it seems that migration is mostly in single pairs or a few pairs together, but that these are attracted to aggregations on the ice for various types of social interaction. The copulation ceremony observed 30 April - 1 May is particularly intriguing. For the time being any interpretation of the behaviour of the triads has to be tentative, but it would seem that the behaviour is part of the female's mate selection process followed by pair bonding. Whether or not the copulation ceremony entailed actual copulation is not known. The only other aggregation that was possible to study in any detail was that on 25 May. Even though behaviour indicating pair bonding took place, no triads were seen. As this second aggregation was observed three weeks later, the females may already have selected a suitable male. I have not found any studies of the mate selection/pair bonding process among ivory gulls other than those at the colony mentioned by Haney & MacDonald (1995). From the observations presented here it appears that at least some of the pair bonding takes place during migration, possibly to save time once the gulls reach the nesting grounds.

The different behaviours towards the ship in different areas were also striking. Ivory gulls fed in the wake of the ship most intensively in the far north. In the southernmost section the ivory gulls showed no interest at all for the ship and preferred easily available food items on the ice. Chardine et al. (2004) observed no ivory gulls feeding in the wake of the ship, the birds instead preferring other sources of food close at hand, while other observers have noted foraging in the wake of the ship (Bensch & Hjort 1990). Seemingly, ivory gulls adjust to the conditions at hand. They will forage in the wake of a ship if few other food sources are present, but prefer other sources when available. However, the picture may be complicated by the presence of other species competing for food items.

A concentrated spring migration of ivory gulls has, to my knowledge, not been reported previously, although an autumn migration southwards along the East Greenland Current (Hjort 1976). My observations indicate that off Scoresby Sound most ivory gulls migrate quite far out in the pack ice too far from land for a land-based observer, which may explain why it has not been observed previously. Lyngs (2003) suggested that the spring migration takes place north of Greenland, making the ivory gull the only species to circumnavigate Greenland during migration. This cannot be ruled out, but seems less likely after these observations. With an arrival time at the nesting grounds in north-eastern Greenland in early June (Salomonsen 1967), a northward passage of ivory gulls along the East Greenland Current in late May is logical. In the early 1990s, 400-500 pairs of ivory gulls were estimated to nest in north-eastern Greenland (Falk et al. 1997), while a more recent estimate gives some 900 pairs in Greenland most of which in the northeast (Gilg et al. 2009). In addition, there are probably still unknown colonies in the area (Gilg et al. 2009). If all the ivory gulls seen from Oden on 25 May headed for north-eastern Greenland, a substantial part of the total population nesting there passed Scoresby Sound in a single day. However, as ivory gulls were already present at 81 °N when we passed two weeks earlier, ivory gulls must arrive to Fram Strait by other routes or at other times also.

The ivory gulls seen on 30 May behaved strikingly different to the ivory gulls seen off Scoresby Sound only five days earlier. Some of these birds may nest on the adjacent coast, but as many were clearly in their second summer it may be that these birds would not attempt nesting for another year. Non-breeding Ross's gulls (*Rhodostethia rosea*) spend the summer roaming the ice fields of the Arctic Ocean (Hjort et al. 1997). Perhaps ivory gulls in their second year and non-breeding adults similarly spend much of the summer in flocks foraging in the pack ice wherever there is an ample supply of food.

Globally, the ivory gull is a rare species (<14 000 pairs), and reported to decline in at least parts of its range (Chardine et al. 2004; Gilchrist & Mallory 2005). Climate change with an earlier ice melt is suggested as a serious threat to the ivory gull (Gilg et al. 2009). The observations during AO-02 indicate that much pre-breeding social interaction takes place in the pack ice, and an earlier ice melt may force the birds to perform these activities elsewhere. Additional observations over the entire distribution range of the ivory gull and during seasons when observations have rarely been done will be necessary to devise proper management and preservation plans for the species.

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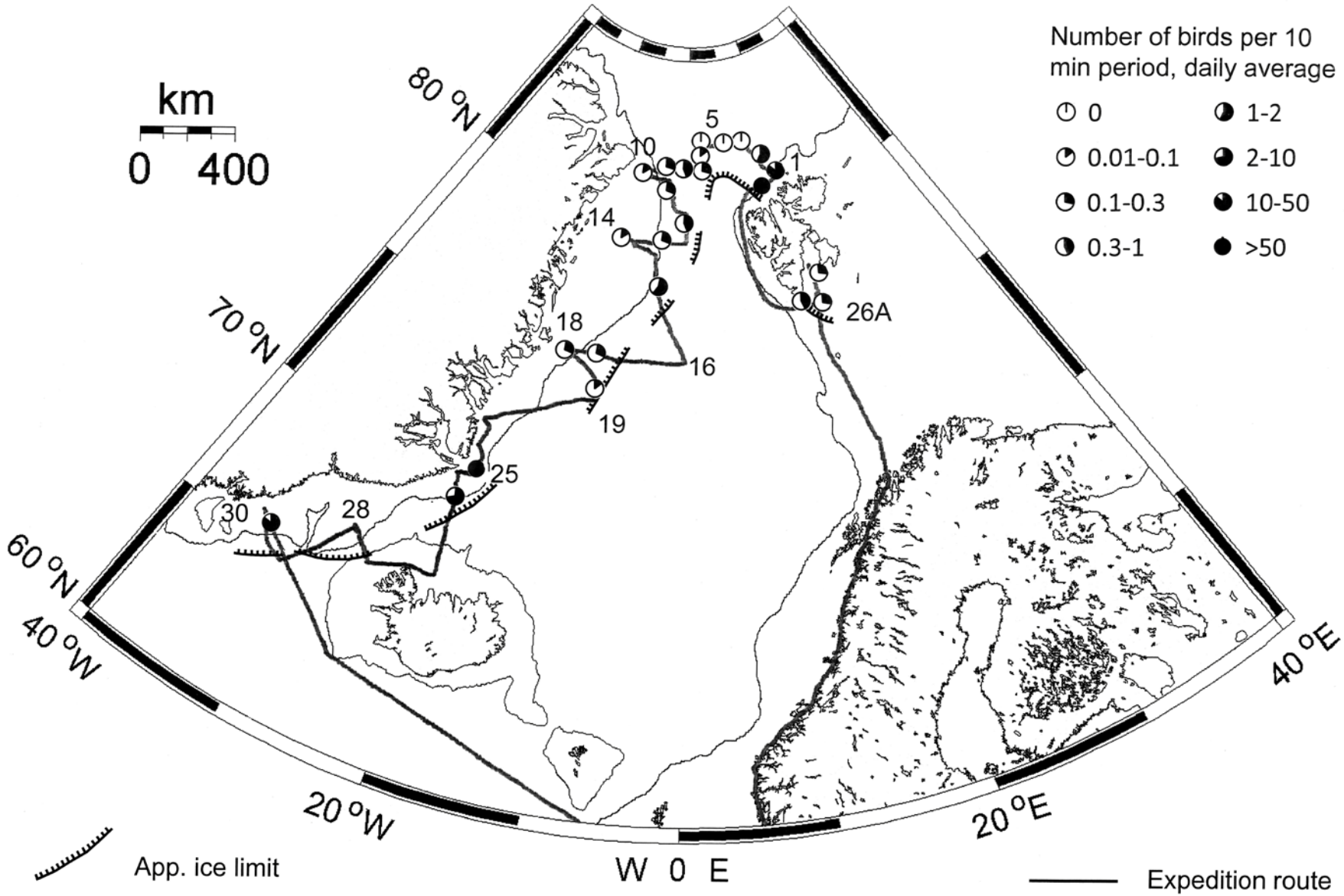
Figure legends

Fig. 1 Cruise track of IB Oden during the expedition Arctic Ocean 2002 with daily averages of the number of ivory gulls observed per 10 minute period during days when visibility was sufficient for observations. On 30 April and 25 and 30 May large localized aggregations were seen. No ivory gulls were seen in open water areas although the observation effort was similar to ice covered areas. Numbers indicate dates when a specific point in the cruise track was visited (26A is 26 April, all other dates are in May). The approximate extent of ice when the ship passed that specific area is indicated as based on observations from the ship and analysis of satellite data received by the ship for navigation.

Fig. 2 Distribution of arrival (N=724) and departure (N=704) directions of ivory gulls on migration off Scoresby Sound on 25 May 2002 (~70 °N, 22 °W). At any one time 200 to 400 birds perched on the ice close to the ship.


km
0 400
80 °N
70 °N
60 °N
40 °W
20 °W
W 0 E
20 °E
40 °E
Number of birds per 10 min period, daily average
0
0.01-0.1
0.1-0.3
0.3-1
1-2
2-10
10-50
>50
1
5
10
14
16
18
19
25
26A
28
30
App. ice limit
Expedition route

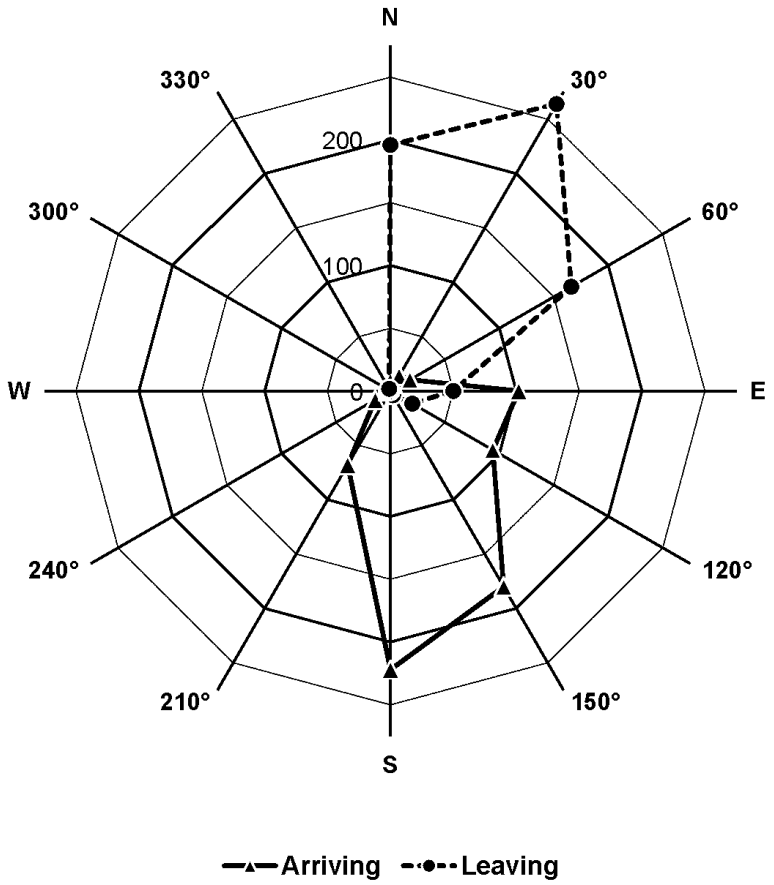

N
30°
60°
E
120°
150°
S
210°
240°
W
300°
330°
200
100
0
Arriving
Leaving

Table 1 Summary of observations. Large localized aggregations were seen while the ship was more or less stationary. The average number of ivory gulls seen per 10 min of observation refers to the forward sector while the ship was in motion, as separate from birds actively following the ship and foraging in the wake.

Date	Localized aggregations	Average per 10 min of observation	Individuals following the ship	Comments
26-29 April		0.20	None	
30 April		1.54	Continuously, 5-10	
30 Apr–1 May	>200	-	-	Peculiar copulation ceremony among triads. Position ~80.5 °N, 12,5 °E
1 May		12.3	Continuously, 2-8	Two aggregations on the ice (~30 birds in each) bring up the average
2 May		1.31	Continuously 2-8	Observations before noon only. In the afternoon no ivory gulls were seen.
6 May		0.06	None	
7 May		0.25	Occasionally, 2-4	
8 May		0.48	Mostly, 2-4	
9-14 May A		0.13	None	West of 5 °W
9-14 May B		0.33	Mostly, 2-8	East of 5 °W
15 May		1.49	Continuously, 2-10	Observations only before 10:00 h while in ice
17-19 May		0.26	Mostly, 2	>60% fly northwards
25 May	Total number >900 >700 migrating northwards	-	-	Distinct northward migration. Position ~70 °N, 22 °W
26 May		2.01	Continuously, 2-8	Observations only before 09:15 h while in ice
30 May	>70	-	-	Total number of sightings >400, presumably two flocks (>40 birds) seen several times, plus some individual birds or small groups. Three pairs flying northwards.

Grey Plovers

The following paper was published in 2006 as a Short Report in Ornis Svecica published by the Swedish Ornithological Society volume 16(3):164-167. The intention was to make the observations of the Grey Plovers more generally available than they would have been if published only in this report.

Birds off Scoresby Sound, Eastern Greenland, in the spring of 2002

Fåglar utanför Scoresbysund, Östgrönland, våren 2002

The Swedish expedition Arctic Ocean 2002 (AO-02) set out in April 2002 to investigate the chemical and physical oceanography of Fram Strait and the East Greenland Sea in early spring. The Arctic Class Icebreaker Oden was used as research platform as the sea in most of the research area is covered with heavy ice until late summer. Because of the difficulty of travelling in the early spring, few observations of the spring migration of birds over the ice-covered sea have been possible.

There was no formal ornithology programme onboard during AO-02, why no systematic bird observations were made. However, because of the scarcity of previous spring observations, observations done by interested amateur birders participating in other types of research programmes were summarized (Kylin 2004).

One day in particular, 25 May, when more systematic observations were possible, is discussed in more detail here. Even though the observations were more systematic than otherwise during the expedition they had to be adjusted to other work that had to be done. Therefore, these observations are at best semi-quantitative, but still of interest because of the scarcity of information from the area. The observations on 25 May were made possible because much of the scheduled work had come to a standstill because of an easterly storm the previous days.

The storm was a result of a huge low-pressure over the Norwegian Sea. The cyclone covered almost the entire North Atlantic with heavy winds blowing for three days almost all the way across the Atlantic from Norway to Greenland. To avoid open water during the storm the ship took refuge in the ice and the engines were turned off, leaving us drifting with the ice for a couple of days. Observations were mostly from deck 4 (~20 m a.s.l.) or the bridge (~25 m a.s.l.), approximately 30 minutes out of every hour for most of the day, the ship operating on UTC (Universal Time Coordinated). The morning position was ~70° N, 22° W, drifting with approximately 2 knots southwards in the East Greenland Current off Scoresby Sound. As the storm abided it was replaced with a strong catabatic wind from the top of the ice sheet. A catabatic wind arises with cold air “falls” down a slope. At the ship, outside the territorial waters of Greenland, gusts up to 30 m/s were measured.

The area around Scoresby Sound is an important breading area for Little Auk *Alle alle*. Large numbers were seen on the water during the storm the previous days. As the storm abided in the morning hours the Little Auks took to their wings and flew out to sea, presumably to forage, with the reverse movement in the evening. Low tens of Brünnich’s Guillemot *Uria lomvia* and Black Guillemot *Cepphys grylle* were seen both foraging and flying.

Among the gulls, there were always 15–20 Glaucous Gulls *Larus hyperboreus* around the ship the entire day. The Glaucous Gulls seemed to be more or less stationary, while Black-legged Kittiwakes *Rissa tridactyla* tended to visit the ship briefly and then move on. There was no uniform pattern of movement among the Glaucous Gulls or Kittiwakes as the directions from which they came and moved away from the ship were random, possibly because the originated from breeding colonies in the Scoresby Sound area (Gilg et al. 2005).

There was a prominent northward migration of Ivory Gulls *Pagophila eburnea* during the day. The total number was at least 700 individuals, although the actual number was probably higher as counting could only be upheld intermittently. Migration was usually pairwise in single pairs, but occasionally four to eight birds would migrate together. Many of the Ivory Gulls aggregated around the pool of open water that was created around the ship because of wind action (the ship acts a large sail). Pairs would arrive to the aggregation from the south and when leaving flew north. Many pairs copulated in the aggregation. At one occasion at least 400 Ivory Gulls were perched on the ice around the ship at the same time. But as the birds aggregated around ice ridges the actual number must have been substantially higher, perhaps 500–600 in all.

Flocks of Common Eider *Somateria mollisima* started migrating north while the catabatic wind was still very strong. Although the catabatic wind came from the side, it was clearly difficult for the first flocks stay on track and fly straight. The last flock passed the ship after the catabatic wind had subsided and did not have the same difficulties.

While the catabatic wind was still blowing two flocks (200–300 birds each) of Grey Plovers *Pluvialis squatorala* migrated in a northeasterly direction. The two flocks were quite close together and may have been a larger flock split in two. After the catabatic wind had subsided around midday, small flocks (5–10 birds) of Dunlins *Calidris alpina* migrated eastward. At least 10 flocks with a total of 70 birds had migrated in the same direction by 1600. Around 1900 a couple of flocks with 50–80 Sanderlings *Calidris alba*, intermixed with a few Purple Sandpipers *Calidris maritime* and Dunlins, migrated from the sea towards the northwest. In the evening when the Little Auks were returning from the sea large flocks of *Calidris*-waders migrated northwards along the coast. Based on their size compared to the Little Auks most of these were presumably Red Knots *Calidris canutus*, although species identification is not absolutely certain in this case.

In the early afternoon a small flock of Lapland Buntings *Calcarius lapponicus* flew towards the northwest. And the late evening saw a westward movement of Long-tailed Skuas *Stercorarius longicaudus*.

Of particular interest are the observations of migrating waders and Ivory Gulls. As far as I have been able to find, this is the first report of a concentrated spring migration of Ivory Gulls along the East Greenland Current. However, as a concentrated autumn migration southwards has been observed previously (Hjort 1976), it is not surprising that there is a northward migration in the same waters in spring. Even so, Lyngs (2003) suggested that the Ivory Gulls nesting in NE Greenland circumnavigate the island so that the spring migration should take place north of Greenland. This seems not to be the case. The spring migration observed in 2002 may have gone unobserved because of the logistic constraints involved in working at sea in the early spring ice. Ivory Gulls nesting in Northern Greenland arrive at their nesting grounds in early June (Salomonsen 1967). This fits well with a northward

migration past Scoresby Sound in late May. An in depth discussion of observations on Ivory Gulls during the entire expedition will be published separately.

The Grey Plovers were a great surprise as these should not be present on Greenland at all. The most likely explanation for this observation is that a group of plovers had been driven by the easterly storm from their normal migration pathways east of the Atlantic and that these were now hurrying back towards their nesting grounds when the storm had subsided. According to the expedition meteorologist, the cyclone covered an exceptionally large geographic area, much larger than the average storm (Bertil Larsson, personal communication).

Even though Grey Plovers migrating northwards over Western Europe would not normally have any problems with a storm on the North Atlantic, conditions may have been different with this exceptionally large cyclone.

It is interesting to note, though, that the Grey Plovers were observed in a location and flying in a direction that is part of a great circle from wintering areas in Southern USA and nesting areas along the Russian Arctic Coast. However, radar studies made at Angmassalik in southwestern Greenland of birds migrating across the Greenland Ice Sheet indicated no such flyway (Alerstam et al. 1986), and as Grey Plovers are rarely seen on Greenland it is unlikely that there is any regular migration flyway across the island for this species. Even so, further observations may be warranted to solve this enigma.

Although eastward and westward migration of waders was observed on the same day, it is noteworthy that the eastward migration was earlier in the day than the westward migration. The species also differed. Apart from the Grey Plovers, the eastward migration was in small groups of a handful birds only and took place at an earlier time of day than the westward migration, which was in larger flocks. Although the sun is up 24 hour a day, it is my experience that there is a diurnal variation in bird activities, so that more birds are active during what should have been the morning and evening hours. It may be that the Dunlins that migrated east and the other waders that migrated west started out at about the same time and that the difference in when they were observed at the ship simply reflects that the eastward migrants had a shorter distance to fly to the ship than the westward migrants.

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Sammanfattning

Under den svenska expeditionen “Arctic Ocean 2002” tillbringades några dagar drivande i isen utanför Scoresbysund, Östgrönland, i skydd undan en storm på Nordatlanten. När stormen avtog 25 maj kom flyttningsrörelser igång bland flera olika fågelarter. Mest intressant är mer än 700 ismåsar som flyttade mot norr. Flera samlades också runt fartyget där olika parbildningsbeteenden och parning iakttogs. Ett par flockar kustpipare flög mot nordost; en mycket märklig observation eftersom kustpipare normalt inte skall finnas på Grönland. Kärrsnäppor sågs flytta både i östlig och västlig riktning, d.v.s. både in mot och bort ifrån Grönland, medan sandlöpare och skärsnäppor endast flyttade mot väster mot Grönland. Under kvällen iakttogs ett omfattande sträck norrut längs med kusten av småvadare, förmodligen mest kustsnäppor. Flyttning iakttogs också bland ejder, fjällabb och lappsparv, medan vittrut, tretåig mås, spetsbergsgrissla, tobisgrissla och alkekung sågs under födosök.

Table 1. Birds observed off Scoresby Sound 25 May 2002. Position at 00.00 h 69°59.08'N 21°28.76'W, and at 24.00 h 69°41.67'N 21°50.07'W.
Fåglar observerade utanför Scoresbysund 25 maj 2002. Position kl. 00.00 69°59.08'N 21°28.76'V och kl. 24.00 69°41.67'N 21°50.07'V.

Species *Art*	Comments
Common Eider *Somateria mollissima* *Ejder*	A total of ~200 in four flocks migrating northwards.
Grey Plover *Pluvialis sqatarola* *Kustpipare*	Two flocks, ~200–300 birds each, migrating in a northeasterly direction.
Dunlin *Calidris alpine* *Kärrsnäppa*	~70 migrating eastward in 10 small flocks during the morning to early afternoon. Four individuals migrating northwestward in the evening together with the second flock of Sanderlings.
Sanderling *Calidris alba* *Sandlöpare*	Two flocks with ~50 + ~70 individuals migrating northwestward.
Purple Sandpiper *Calidris maritime* *Skärsnäppa*	7 individuals migrating northwestward together the first flock of Sanderlings.
Red Knot *Calidris canutus* *Kustsnäppa*	5 000–10 000 probable Knots (or possibly other *Calidris*-waders) migrating northwards along the coast in the afternoon and evening.
Long-tailed Skua *Stercorarius longicaudus* *Fjällabb*	>10 migrating westward in the late evening.
Glaucous Gull *Larus hyperboreus* *Vittrut*	15–20 around the ship during the whole day foraging in the pool of open water around the ship.
Black-legged Kittiwake *Rissa tridactyla* *Tretåig mås*	>70 visited the ship briefly and moved on. Some would forage in the pool of open water around the ship before moving on.
Ivory Gull *Pagophila eburnean* *Ismås*	>700 migrating northwards, most with a temporary stop by the ship. Maximum numbers aggregated around the ship at any one time >400.
Brünnich's Guillemot *Uria lomvia* *Spetsbergsgrissla*	~40 foraging in leads in the ice or flying.
Black Guillemot *Cepphus grille* *Tobisgrissla*	~15 foraging in leads in the ice or flying.
Little Auk *Alle alle* *Alkekung*	>100 000 in foraging movements out to sea in the morning and back towards land in the evening.
Lapland Bunting *Calcarius lapponicus* *Lappsparv*	5 migrating northwestward.

Appendix 1

List of birds seen during the expedition. In some cases the names in British and American English differ. In these cases I have put the American name in parenthesis.

No	English name(s)	Swedish name	Latin name
1	(Northern) Fulmar	Stormfågel	*Fulmarus glacialis*
2	Manx Shearwater	Mindre lira	*Puffinus puffinus*
3	(European) Storm Petrel	Stormsvala	*Hydrobate pelagicus*
4	Leach's Storm Petrel	Klykstjärtad stormsvala	*Oceanodroma leucorhoa*
5	(Northern) Gannet	Havssula	*Morus basanus*
6	(Great) Cormorant	Storskarv	*Phalacrocorax carbo*
7	(European) Shag	Toppskarv	*Phalacrocorax aristotelis*
8	Grey Heron	Gråhäger	*Arda cinerea*
9	Mute Swan	Knölsvan	*Cygnus olor*
10	Whooper Swan	Sångsvan	*Cygnus cygnus*
11	Greylag Goose	Grågås	*Anser anser*
12	Canada Goose	Kanadagås	*Branta canadensis*
13	(Common) Shelduck	Gravand	*Tadorna tadorna*
14	Mallard	Gräsand	*Anas platyrhyncos*
15	(Northern) Pintail	Stjärtand	*Anas acuta*
16	Tufted Duck	Vigg	*Athya fuligula*
17	Barrow's Goldeneye	Islandsknipa	*Bucephala islandica*
18	(Common) Eider	Ejder	*Somateria mollisima*
19	King Eider	Praktejder	*Somateria spectabilis*
20	Spectacled Eider	Glasögonejder	*Somateria fischeri*
21	Steller's Eider	Alförrädare	*Polysticta stelleri*
22	Common Scoter	Sjöorre	*Melanitta nigra*
23	Long-tailed Duck (Oldsquaw)	Alfågel	*Clangula hyemalis*
24	Red-breasted Merganser	Småskrake	*Mergus serrator*
25	White-tailed Eagle	Havsörn	*Haliaetus albicilla*
26	Northern Goshawk	Duvhök	*Accipiter gentilis*
27	Merlin	Stenfalk	*Falco columbarius*
28	Gyrfalcon	Jaktfalk	*Falco rusticolus*
29	Grey Plover (Black-bellied Plover)	Kustpipare	*Pluvialis squatorala*
30	(Common) Snipe	Enkelbeckasin	*Galinago galinago*
31	Dunlin	Kärrsnäppa	*Calidris alpina*
32	Sanderling	Sandlöpare	*Calidris alba*
33	Purple Sandpiper	Skärsnäppa	*Calidrins maritima*
34	(Red) Knot	Kustsnäppa	*Calidris canutus*
35	(Ruddy) Turnstone	Roskarl	*Arenaria interpres*
36	Red-necked Phalarope	Smalnäbbad simsnäppa	*Phalaropus lobatus*
37	Red Phalarope	Brednäbbad simsnäppa	*Phalaropus fulcarius*
38	Whimbrel	Småspov	*Numenius phaeopus*
39	Black-tailed Godwit	Rödspov	*Limosa limosa*
40	Great Skua	Storlabb	*Catharacta skua*
41	Long-tailed Skua (Long-tailed Jaeger)	Fjällabb	*Stercorarius longicaudus*
42	Parasitic Skua (Parasitic Jaeger)	Labb (Kustlabb)	*Stercorarius parasiticus*

43	Pomarine Skua (Pomarine Jaeger)	Bredstjärtad labb	*Stercorarius pomarinus*
44	Greater Black-backed Gull	Havstrut	*Larus marinus*
45	Herring Gull	Gråtrut	*Larus argentatus*
46	Lesser Black-backed Gull	Silltrut	*Larus fuscus*
47	Common Gull (Mew Gull)	Fiskmås	*Larus canus*
48	Black-headed Gull	Skrattmås	*Larus ridibundus*
49	Glaucous Gull	Vittrut	*Larus hyperboreus*
50	Iceland Gull	Vitvingad trut	*Larus glaucoides*
51	Sabine's Gull	Tärnmås	*Larus sabini*
52	(Black-legged) Kittiwake	Tretåig mås	*Rissa tridactyla*
53	Ivory Gull	Ismås	*Pagophila eburnea*
54	Ross' Gull	Rosenmås	*Rhodostetia rosea*
55	Arctic Tern	Silvertärna	*Sterna paradisaea*
56	Common Tern	Fisktärna	*Sterna hirundo*
57	Roseate Tern	Rosentärna	*Sterna dougallii*
58	Sandwich Tern	Kentsk tärna	*Sterna sandvicensis*
59	(Common) Guillemot (Common Murre)	Sillgrissla	*Uria aalge*
60	Brünnich's Guillemot (Thick-billed Murre)	Spetsbergsgrissla	*Uria lomvia*
61	Razorbill	Tordmule	*Alca torda*
62	Black Guillemot	Tobisgrissla	*Cepphus grylle*
63	Little Auk (Dovekie)	Alkekung	*Alle alle*
64	(Atlantic) Puffin	Lunnefågel	*Fratercula Arctica*
65	(Common) Wood Pigeon	Ringduva	*Columba palumbus*
66	House Martin	Hussvala	*Delichon urbica*
67	Rock Pipit	Skärpiplärka	*Anthus petrosus*
68	Meadow Pipit	Ängspiplärka	*Anthus pratensis*
69	Pied Wagtail	Sädesärla	*Motacilla alba*
70	(Common) Redstart	Rödstjärt	*Phoenicurus phoenicurus*
71	(European) Robin	Rödhake	*Erithacus rubecula*
72	Bluethroat	Blåhake	*Luscinia svecica*
73	(Northern) Wheatear	Stenskvätta	*Oenanthe oenanthe*
74	Fieldfare	Björktrast	*Turdus pilaris*
75	Ring Ouzel	Ringtrast	*Turdus torquatus*
76	(Common) Blackbird	Koltrast	*Turdus merula*
77	Song Thrush	Taltrast	*Turdus philomelos*
78	Redwing	Rödvingetrast	*Turdus iliacus*
79	(Common) Chaffinch	Bofink	*Fringilla coelebs*
80	Snow Bunting	Snösparv	*Plectrophenax nivalis*
81	Lapland Longspur	Lappsparv	*Calcarius lapponicus*
82	Arctic Redpoll (Hoary Redpoll)	Snösiska	*Carduelis hornemanni*
83	(Common) Redpoll	Gråsiska	*Carduelis flavirostris*

Appendix 2

Non-quantitative daily species account. For the sake of brevity, species number according to Appendix 1 is used instead of species name. Compare with Appendix 3 to find out which species were seen in what part of the expedition route.

April 20	1, 6, 14, 18, 44, 45, 46, 47, 48, 65, 70, 71, 74, 76, 78
April 21	1, 5, 44, 45, 46, 70, 71, 72, 75
April 22	1, 5, 6, 7, 8, 9, 11*, 12, 14, 15*, 16, 18, 24*, 26, 40*, 42, 44, 45, 46, 47, 48, 52, 59, 61, 65, 67, 70*, 72*, 74, 75, 76, 78, 83
April 23	1, 5, 6, 7, 8*, 9, 11, 13*, 14, 16, 18, 22*, 24, 40, 44, 45, 46, 47, 52, 56, 59, 61, 62, 64, 67, 70*, 74, 76, 77, 80*
April 24	1, 5, 6, 7, 11, 12, 14, 16, 18, 19*, 21*, 23*, 24, 25, 33, 40, 42, 44, 45, 46, 52, 59, 64, 74, 77, 80
April 25	1, 40, 44, 49, 52
April 26	1, 18, 52, 53 59? or more probably 60?
April 27	1, 18, 52, 53, 59? or more probably 60?
April 28	1, 18, 19, 41, 52, 53, 59? or more probably 60?, 80
April 29	1, 18, 19?, 49, 52, 53, 59?, 60, 80
April 30	1, 18, 20, 40, 44, 49, 52, 53, 59, 60, 62, 80, 82
May 1	1, 49, 52, 53, 82
May 2	1*, 49, 52, 53, 54*, 82
May 3	82
May 4	82
May 5	82
May 6	53, 82
May 7	53, 82
May 8	53, 82
May 9	53, 82
May 10	53, 82
May 11	1, 49, 52, 53, 60, 62, 82
May 12	1, 40, 44, 49, 52, 53, 60, 62, 82
May 13	1, 53, 82
May 14	49, 53, 82
May 15	1, 40*, 49, 50, 52, 53, 60, 62, 63, 73, 82
May 16	1, 49, 50, 52, 60, 62, 73, 80, 82
May 17	1, 40, 49, 50, 52, 53, 60?, 82
May 18	1, 49, 52, 53, 82, 83?
May 19	1, 35*, 46, 49, 50, 52, 53, 60, 82
May 20	1, 35, 49, 60, 63, 82
May 21	1, 18*, 35*, 40, 49, 50, 82
May 22	49, 50, 52, 53, 82
May 23	40, 49, 52, 53, 63, 82
May 24	30, 31, 46, 49, 50, 52, 60, 62, 63, 66, 82
May 25	18, 29, 31, 32, 33, 34?, 41, 49, 52, 53, 60, 62, 63, 81
May 26	1, 49, 50, 52, 53, 59, 60, 62, 63
May 27	1, 10, 17, 42, 43, 44, 52, 55, 59, 60, 61, 62, 64
May 28	1, 5, 34, 44, 52
May 29	1, 27, 49, 50, 52, 53
May 30	1, 18, 24, 28, 36, 37, 40, 44, 49, 50, 51, 52, 53, 55
May 31	1, 5, 44, 52
June 1	1, 2, 5, 31, 33, 38, 39, 40, 44, 52, 68, 70
June 2	1, 3, 5, 24*, 40, 43, 44, 45, 46, 52, 73
June 3	1, 2, 3, 4, 5, 6, 40, 42, 44, 45, 52, 59, 61, 64, 70
June 4	1, 2, 3, 4, 5, 6, 44, 45, 46, 52, 57, 58
June 5	1, 5, 6, 44, 45, 46, 47, 56, 58

? I am not totally sure of the identification.

* Observations reported to me by others. I did not see these species myself on those particular dates.

Appendix 3: Positions and cruise track

April	22		April	24		April	26	
00:00	61° 5.30´´ N	5° 3.34´´ E	00:00	68°19.67´´ N	15°54.69´ E	00:00	77° 8.29´ N	19°13.87´ E
01:00	61°14.20´ N	4°55.11´ E	01:00	68°31.08´ N	16°10.12´ E	01:00	77°10.51´ N	19° 9.06´ E
02:00	61°24.80´ N	4°50.74´ E	02:00	68°33.56´ N	16°30.30´ E	02:00	77°12.37´ N	19°10.19´ E
03:00	61°34.80´ N	4°57.19´ E	03:00	68°44.80´ N	16°45.30´ E	03:00	77°14.16´ N	19°10.77´ E
04:00	61°45.68´ N	4°58.61´ E	04:00	68°56.92´ N	17° 6.94´ E	04:00	77°15.29´ N	19° 7.22´ E
05:00	61°52.49´ N	5°12.83´ E	05:00	69° 6.61´ N	17°34.51´ E	05:00	77°15.89´ N	19° 3.23´ E
06:00	62° 0.29´ N	5° 9.48´ E	06:00	69°13.21´ N	17°57.51´ E	06:00	77°16.14´ N	19° 0.62´ E
07:00	62°11.33´ N	5° 1.68´ E	07:00	69°21.74´ N	18° 5.89´ E	07:00	77°15.33´ N	19° 0.72´ E
08:00	62°21.37´ N	5°14.97´ E	08:00	69°31.02´ N	18°25.02´ E	08:00	77°14.47´ N	19° 5.70´ E
09:00	62°26.63´ N	5°37.27´ E	09:00	69°37.82´ N	18°52.76´ E	09:00	77°14.90´ N	19° 6.45´ E
10:00	62°27.77´ N	6° 2.79´ E	10:00	69°46.37´ N	19°10.80´ E	10:00	77°14.29´ N	19° 8.16´ E
11:00	62°37.31´ N	6° 6.65´ E	11:00	69°51.07´ N	19°44.55´ E	11:00	77°13.76´ N	19° 7.77´ E
12:00	62°39.89´ N	6°25.61´ E	12:00	70° 2.05´ N	20° 5.47´ E	12:00	77°11.45´ N	19°12.96´ E
13:00	62°50.00´ N	6°39.53´ E	13:00	70°13.59´ N	20°26.27´ E	13:00	77°10.58´ N	19°18.67´ E
14:00	62°59.36´ N	6°56.56´ E	14:00	70°24.91´ N	20°43.85´ E	14:00	77°10.01´ N	19°21.69´ E
15:00	63° 3.70´ N	7°21.48´ E	15:00	70°36.74´ N	20°52.78´ E	15:05	77° 9.71´ N	19°21.33´ E
16:00	63° 8.50´ N	7°41.62´ E	16:00	70°49.45´ N	20°47.86´ E	16:00	77° 9.34´ N	19°20.81´ E
17:00	63°15.32´ N	8° 5.00´ E	17:00	71° 2.43´ N	20°41.66´ E	17:05	77° 9.00´ N	19°20.08´ E
18:00	63°22.90´ N	8°27.24´ E	18:00	71°15.37´ N	20°34.22´ E	18:05	77° 8.76´ N	19°19.21´ E
19:00	63°27.52´ N	8°52.42´ E	19:00	71°28.46´ N	20°26.62´ E	19:00	77° 8.59´ N	19°18.28´ E
20:00	63°33.69´ N	9°15.66´ E	20:00	71°41.70´ N	20°18.84´ E	20:05	77° 9.16´ N	19°15.05´ E
21:00	63°46.07´ N	9°16.50´ E	21:00	71°54.97´ N	20°10.93´ E	21:00	77°13.32´ N	19° 9.01´ E
22:00	63°57.44´ N	9°26.41´ E	22:00	72° 8.24´ N	20° 2.94´ E	22:00	77°15.16´ N	19°20.62´ E
23:00	64° 8.72´ N	9°38.47´ E	23:00	72°21.41´ N	19°54.58´ E	23:00	77°18.11´ N	19°14.61´ E

April	23		April	25		April	27	
00:00	64°18.52´ N	9°54.33´ E	00:00	72°34.56´ N	19°45.94´ E	00:00	77°20.59´ N	19° 7.08´ E
01:00	64°27.06´ N	10°15.18´ E	01:00	72°47.76´ N	19°37.14´ E	01:05	77°27.09´ N	19° 2.68´ E
02:00	64°35.90´ N	10°35.51´ E	02:00	73° 1.17´ N	19°28.12´ E	02:00	77°29.82´ N	19° 4.04´ E
03:00	64°44.13´ N	10°57.03´ E	03:00	73°14.40´ N	19°19.06´ E	03:00	77°29.26´ N	19° 3.30´ E
04:00	64°51.81´ N	11°16.33´ E	04:00	73°27.53´ N	19°10.00´ E	04:00	77°29.41´ N	19° 3.83´ E
05:00	65° 1.35´ N	11°34.62´ E	05:00	73°40.64´ N	19° 0.83´ E	05:00	77°34.40´ N	19° 9.91´ E
06:00	65°10.99´ N	11°51.30´ E	06:00	73°53.76´ N	18°48.88´ E	06:05	77°39.67´ N	19°13.68´ E
07:00	65°22.13´ N	12° 1.72´ E	07:00	74° 5.64´ N	18°20.62´ E	07:00	77°33.43´ N	19°19.54´ E
08:00	65°33.18´ N	12° 3.21´ E	08:00	74°20.85´ N	18°10.98´ E	08:00	77°27.00´ N	19°24.50´ E
09:00	65°44.26´ N	12°18.02´ E	09:00	74°36.47´ N	18° 6.98´ E	09:00	77°22.21´ N	19°34.22´ E
10:00	65°57.05´ N	12°25.91´ E	10:00	74°51.52´ N	17°57.26´ E	10:00	77°18.23´ N	19°33.75´ E
11:00	66° 8.60´ N	12°49.02´ E	11:00	75° 6.83´ N	17°51.82´ E	11:00	77°16.90´ N	19°40.96´ E
11:45	66°18.93´ N	12°57.06´ E	12:00	75°22.45´ N	17°53.97´ E	12:00	77°16.13´ N	19°41.90´ E
13:00	66°34.79´ N	13° 4.55´ E	13:00	75°37.76´ N	18° 4.36´ E	13:00	77°15.99´ N	19°41.37´ E
14:00	66°47.14´ N	13°18.24´ E	14:00	75°52.38´ N	18°24.04´ E	14:00	77°15.78´ N	19°41.06´ E
15:00	66°53.64´ N	13°31.32´ E	15:05	76° 7.97´ N	18°45.52´ E	15:00	77°15.54´ N	19°40.72´ E
16:00	67° 2.75´ N	13°50.88´ E	16:00	76°21.05´ N	19° 3.98´ E	16:00	77°15.36´ N	19°40.07´ E
17:00	67°15.05´ N	14°10.73´ E	17:00	76°34.27´ N	19°18.60´ E	17:00	77°15.29´ N	19°38.96´ E
18:00	67°27.17´ N	14°24.82´ E	18:00	76°44.44´ N	19°24.34´ E	18:00	77°15.34´ N	19°37.40´ E
19:00	67°36.23´ N	14° 2.91´ E	19:00	76°47.70´ N	19°23.88´ E	19:00	77°15.49´ N	19°35.80´ E
20:00	67°43.82´ N	14° 2.43´ E	20:00	76°52.70´ N	19°25.54´ E	20:00	77°15.69´ N	19°34.38´ E
21:00	67°53.15´ N	14°29.43´ E	21:00	76°57.67´ N	19°22.17´ E	21:00	77°15.82´ N	19°32.96´ E
22:00	68° 2.06´ N	14°57.50´ E	22:00	77° 2.70´ N	19°15.48´ E	22:00	77°15.81´ N	19°31.44´ E
23:00	68°10.69´ N	15°26.50´ E	23:00	77° 7.29´ N	19°13.97´ E	23:00	77°15.65´ N	19°30.08´ E

April	28		April	30		May	2	
00:00	77°15.44′ N	19°29.18′ E	00:00	77°43.73′ N	12° 2.98′ E	00:00	81°20.01′ N	17° 0.49′ E
01:00	77°15.16′ N	19°28.37′ E	01:00	77°53.97′ N	11°34.12′ E	01:00	81°23.58′ N	16°58.37′ E
02:00	77°14.78′ N	19°27.87′ E	02:00	78° 5.08′ N	11°12.63′ E	02:00	81°26.57′ N	17° 5.53′ E
03:00	77°14.35′ N	19°27.51′ E	03:00	78°16.27′ N	10°49.68′ E	03:00	81°30.36′ N	16°42.20′ E
04:00	77°13.93′ N	19°27.17′ E	04:00	78°27.55′ N	10°26.31′ E	04:00	81°35.86′ N	16°40.98′ E
05:00	77°13.55′ N	19°26.68′ E	05:00	78°38.82′ N	10° 3.76′ E	05:00	81°37.72′ N	16°20.06′ E
06:00	77°13.22′ N	19°25.95′ E	06:00	78°50.89′ N	10° 4.15′ E	06:00	81°38.50′ N	16° 5.11′ E
07:00	77°12.96′ N	19°25.08′ E	07:00	79° 2.81′ N	10° 1.58′ E	07:00	81°38.58′ N	16° 3.20′ E
08:00	77°12.75′ N	19°24.15′ E	08:00	79°14.37′ N	9°56.94′ E	08:00	81°38.45′ N	16° 4.08′ E
09:00	77°12.54′ N	19°23.32′ E	09:00	79°26.27′ N	9°56.45′ E	09:00	81°38.29′ N	16° 4.88′ E
10:00	77°12.29′ N	19°22.62′ E	10:00	79°38.28′ N	9°57.54′ E	10:00	81°38.13′ N	16° 5.46′ E
11:00	77°11.98′ N	19°21.94′ E	11:00	79°50.21′ N	9°56.25′ E	11:00	81°37.95′ N	16° 5.84′ E
12:00	77°11.64′ N	19°21.37′ E	12:00	80° 0.92′ N	10°18.81′ E	12:00	81°37.75′ N	16° 6.04′ E
13:00	77°11.26′ N	19°20.97′ E	13:00	80° 8.33′ N	11°10.52′ E	13:00	81°37.54′ N	16° 6.04′ E
14:00	77°10.83′ N	19°20.79′ E	14:00	80°14.84′ N	12° 7.86′ E	14:00	81°37.72′ N	16° 2.10′ E
15:00	77°10.39′ N	19°20.68′ E	15:00	80°24.80′ N	12°34.04′ E	15:00	81°42.71′ N	15°28.75′ E
16:00	77° 9.97′ N	19°20.63′ E	16:00	80°37.10′ N	12°40.96′ E	16:00	81°48.73′ N	14°48.80′ E
17:00	77° 9.65′ N	19°20.58′ E	17:00	80°37.61′ N	12°42.79′ E	17:05	81°56.94′ N	14°12.57′ E
18:00	77° 9.48′ N	19°20.52′ E	18:00	80°37.69′ N	12°44.09′ E	18:00	81°58.09′ N	14° 5.85′ E
19:00	77° 9.42′ N	19°20.42′ E	19:00	80°37.77′ N	12°45.52′ E	19:00	81°57.98′ N	14° 4.11′ E
20:00	77° 9.47′ N	19°20.29′ E	20:00	80°37.80′ N	12°46.61′ E	20:00	82° 5.18′ N	13°29.80′ E
21:00	77° 9.51′ N	19°19.97′ E	21:00	80°37.75′ N	12°47.02′ E	21:00	82°10.58′ N	12°49.86′ E
22:00	77° 9.54′ N	19°19.72′ E	22:00	80°37.70′ N	12°46.83′ E	22:00	82°10.37′ N	12°44.10′ E
23:00	77° 9.51′ N	19°19.62′ E	23:00	80°37.64′ N	12°46.31′ E	23:00	82° 9.74′ N	12°37.71′ E

April	29		May	1		May	3	
00:00	77° 9.71′ N	19°21.01′ E	00:00	80°37.61′ N	12°45.61′ E	00:00	82° 9.75′ N	12°36.62′ E
01:00	77° 6.32′ N	19°23.43′ E	01:00	80°37.61′ N	12°45.11′ E	01:00	82° 8.91′ N	12°32.67′ E
02:00	77° 2.58′ N	19°29.73′ E	02:00	80°37.60′ N	12°45.14′ E	02:00	82° 9.94′ N	11°35.46′ E
03:00	76°59.94′ N	19°30.07′ E	03:00	80°37.57′ N	12°45.59′ E	03:00	82°12.74′ N	10°22.30′ E
04:00	76°58.49′ N	19°30.00′ E	04:00	80°37.55′ N	12°46.21′ E	04:00	82°14.94′ N	9°34.26′ E
05:00	76°52.86′ N	19°31.54′ E	05:00	80°37.54′ N	12°46.61′ E	05:00	82°14.97′ N	9°35.72′ E
06:00	76°45.86′ N	19°30.24′ E	06:00	80°38.84′ N	13°37.74′ E	06:00	82°14.93′ N	9°32.67′ E
07:00	76°38.66′ N	19°26.23′ E	07:00	80°39.68′ N	14°32.99′ E	07:00	82°16.55′ N	8°26.61′ E
08:00	76°36.23′ N	19°23.23′ E	08:00	80°39.74′ N	15°24.72′ E	08:00	82°20.14′ N	7°48.56′ E
09:00	76°25.19′ N	19° 6.42′ E	09:00	80°38.67′ N	16°35.52′ E	09:00	82°14.55′ N	6°55.01′ E
10:00	76°18.67′ N	19° 0.40′ E	10:00	80°44.01′ N	17°11.52′ E	10:00	82°14.24′ N	6°53.53′ E
11:00	76°18.61′ N	18°51.58′ E	11:00	80°51.77′ N	17°39.22′ E	11:00	82°14.04′ N	6°54.14′ E
12:00	76°19.47′ N	17°57.42′ E	12:00	80°54.33′ N	18°21.99′ E	12:00	82°11.57′ N	6°45.09′ E
13:00	76°20.12′ N	17° 2.18′ E	13:00	81° 0.59′ N	18°22.05′ E	13:00	82°14.65′ N	5°39.82′ E
14:00	76°22.20′ N	16° 4.82′ E	14:00	81° 0.47′ N	18°19.10′ E	14:00	82°14.31′ N	5°38.15′ E
15:00	76°25.27′ N	15°11.15′ E	15:00	81° 2.23′ N	18°10.75′ E	15:00	82°13.97′ N	5°36.69′ E
16:00	76°27.20′ N	14°20.88′ E	16:00	81° 7.78′ N	18° 7.04′ E	16:05	82°13.64′ N	5°34.98′ E
17:00	76°27.74′ N	14°19.27′ E	17:00	81° 8.71′ N	18° 2.71′ E	17:00	82°13.41′ N	5°33.56′ E
18:00	76°35.28′ N	14° 6.50′ E	18:00	81°11.41′ N	17°43.56′ E	18:00	82°13.22′ N	5°32.07′ E
19:00	76°45.96′ N	13°46.67′ E	19:00	81°12.85′ N	17°31.08′ E	19:00	82°13.07′ N	5°30.85′ E
20:00	76°57.86′ N	13°29.27′ E	20:00	81°12.97′ N	17°21.58′ E	20:00	82°12.96′ N	5°29.78′ E
21:00	77°11.23′ N	13°20.03′ E	21:00	81°12.84′ N	17°20.51′ E	21:00	82°15.28′ N	5° 8.86′ E
22:00	77°23.34′ N	13° 3.65′ E	22:00	81°12.66′ N	17°20.32′ E	22:00	82°22.33′ N	4°43.11′ E
23:00	77°33.59′ N	12°34.13′ E	23:00	81°20.16′ N	17° 1.44′ E	23:00	82°22.14′ N	4°43.59′ E

May	4		May	6		May	8	
00:00	82°21.64′ N	4°49.97′ E	00:00	81°49.04′ N	4°31.42′ E	00:00	81°23.24′ N	4°22.30′ W
01:00	82°16.58′ N	4°55.82′ E	01:00	81°49.64′ N	3°19.33′ E	01:00	81°22.91′ N	4°23.58′ W
02:00	82°17.83′ N	4°37.01′ E	02:00	81°41.68′ N	2°56.51′ E	02:00	81°22.57′ N	4°24.78′ W
03:00	82°21.86′ N	3°15.78′ E	03:00	81°41.26′ N	2°58.18′ E	03:05	81°22.16′ N	4°26.05′ W
04:00	82°20.46′ N	2°56.19′ E	04:00	81°40.63′ N	2°58.40′ E	04:00	81°21.79′ N	4°27.03′ W
05:00	82°13.68′ N	3°18.52′ E	05:00	81°34.52′ N	3°27.10′ E	05:00	81°21.39′ N	4°28.13′ W
06:00	82°12.51′ N	3° 7.64′ E	06:00	81°30.82′ N	3°37.87′ E	06:00	81°21.01′ N	4°29.16′ W
07:00	82°12.44′ N	2°41.42′ E	07:00	81°27.23′ N	3°59.67′ E	07:00	81°20.66′ N	4°29.81′ W
08:00	82°16.18′ N	3°18.81′ E	08:00	81°24.02′ N	3°59.50′ E	08:00	81°20.30′ N	4°30.03′ W
09:00	82°21.44′ N	2°47.51′ E	09:00	81°24.31′ N	3°37.91′ E	09:00	81°20.00′ N	4°30.29′ W
10:00	82°23.88′ N	2°27.93′ E	10:00	81°21.73′ N	2°49.75′ E	10:00	81°19.72′ N	4°30.41′ W
11:00	82°20.41′ N	3°29.20′ E	11:00	81°24.86′ N	2°28.41′ E	11:00	81°19.43′ N	4°30.32′ W
12:00	82°21.38′ N	3° 4.98′ E	12:00	81°27.15′ N	1°46.10′ E	12:00	81°19.14′ N	4°29.95′ W
13:00	82°21.11′ N	3° 5.70′ E	13:00	81°27.39′ N	0°44.11′ E	13:00	81°18.83′ N	4°29.43′ W
14:00	82°20.82′ N	3° 6.26′ E	14:00	81°29.78′ N	0° 3.34′ E	14:00	81°18.48′ N	4°28.92′ W
15:00	82°20.53′ N	3° 6.60′ E	15:00	81°29.70′ N	0° 1.86′ W	15:00	81°18.12′ N	4°28.53′ W
16:00	82°20.25′ N	3° 6.77′ E	16:00	81°30.09′ N	0° 9.20′ W	16:00	81°17.70′ N	4°28.44′ W
17:00	82°19.98′ N	3° 6.78′ E	17:00	81°30.06′ N	1°33.50′ W	17:00	81°17.26′ N	4°28.29′ W
18:00	82°19.98′ N	3° 8.00′ E	18:05	81°29.47′ N	1°36.42′ W	18:00	81°16.83′ N	4°28.16′ W
19:00	82°21.88′ N	3°40.37′ E	19:00	81°29.30′ N	1°36.54′ W	19:00	81°16.42′ N	4°28.00′ W
20:00	82°22.43′ N	3°42.56′ E	20:00	81°29.15′ N	1°37.11′ W	20:00	81°15.56′ N	5°33.97′ W
21:00	82°24.32′ N	3°33.45′ E	21:00	81°29.06′ N	1°38.33′ W	21:00	81°17.05′ N	6° 2.88′ W
22:00	82°25.91′ N	3°44.08′ E	22:00	81°29.03′ N	1°39.76′ W	22:00	81°19.50′ N	6°20.73′ W
23:00	82°24.19′ N	4°12.53′ E	23:00	81°29.00′ N	1°41.17′ W	23:05	81°19.57′ N	6°18.14′ W

May	5		May	7		May	9	
00:00	82°24.08′ N	4°12.74′ E	00:00	81°28.93′ N	1°42.66′ W	00:00	81°19.43′ N	6°17.04′ W
01:00	82°23.94′ N	4°12.90′ E	01:00	81°28.90′ N	1°43.93′ W	01:00	81°19.24′ N	6°15.93′ W
02:00	82°23.81′ N	4°13.16′ E	02:00	81°29.65′ N	1°34.97′ W	02:00	81°19.01′ N	6°15.05′ W
03:00	82°23.65′ N	4°13.28′ E	03:00	81°31.74′ N	2°41.17′ W	03:00	81°22.16′ N	6°59.70′ W
04:00	82°23.49′ N	4°13.45′ E	04:00	81°32.36′ N	3°16.74′ W	04:00	81°22.62′ N	7°19.73′ W
05:00	82°23.33′ N	4°13.67′ E	05:00	81°29.74′ N	3°38.30′ W	05:00	81°21.91′ N	7°15.72′ W
06:00	82°23.11′ N	4°13.05′ E	06:00	81°27.76′ N	3°50.46′ W	06:00	81°21.55′ N	7°15.12′ W
07:00	82°21.82′ N	3°50.83′ E	07:00	81°26.95′ N	4° 3.30′ W	07:00	81°21.25′ N	7°14.77′ W
08:00	82°20.10′ N	3°43.62′ E	08:00	81°26.80′ N	4° 4.03′ W	08:00	81°23.64′ N	7°13.61′ W
09:05	82°17.88′ N	4° 4.79′ E	09:00	81°26.68′ N	4° 4.79′ W	09:00	81°20.34′ N	7°20.73′ W
10:05	82°17.28′ N	4° 9.24′ E	10:00	81°26.56′ N	4° 5.55′ W	10:00	81°20.20′ N	7°20.29′ W
11:05	82°17.10′ N	4°10.35′ E	11:00	81°26.47′ N	4° 6.19′ W	11:00	81°20.41′ N	7°14.23′ W
12:05	82°16.94′ N	4°11.32′ E	12:00	81°26.37′ N	4° 6.86′ W	12:00	81°19.91′ N	7°17.55′ W
13:00	82°16.77′ N	4°12.28′ E	13:00	81°26.23′ N	4° 7.68′ W	13:00	81°19.69′ N	7°16.42′ W
14:00	82°16.58′ N	4°13.47′ E	14:00	81°26.04′ N	4° 8.58′ W	14:00	81°19.41′ N	7°15.32′ W
15:00	82°16.38′ N	4°14.59′ E	15:00	81°25.82′ N	4° 9.44′ W	15:00	81°17.59′ N	7°40.52′ W
16:00	82°14.65′ N	4°35.55′ E	16:00	81°25.57′ N	4°10.44′ W	16:00	81°15.86′ N	8°22.16′ W
17:00	82°11.45′ N	4°51.86′ E	17:00	81°25.32′ N	4°11.42′ W	17:00	81°15.54′ N	8°22.28′ W
18:00	82°10.28′ N	4°32.14′ E	18:00	81°25.03′ N	4°12.91′ W	18:00	81°14.50′ N	8° 9.56′ W
19:00	82° 5.02′ N	5°11.77′ E	19:00	81°24.74′ N	4°14.59′ W	19:00	81°17.47′ N	8°39.23′ W
20:00	81°59.91′ N	5° 7.29′ E	20:00	81°24.44′ N	4°16.45′ W	20:00	81°17.69′ N	8°56.74′ W
21:00	81°55.71′ N	5°37.32′ E	21:00	81°24.16′ N	4°18.22′ W	21:00	81°16.42′ N	8°58.35′ W
22:00	81°52.41′ N	5°52.90′ E	22:00	81°23.85′ N	4°19.91′ W	22:00	81°16.22′ N	9° 5.86′ W
23:00	81°48.27′ N	5°36.04′ E	23:00	81°23.55′ N	4°21.47′ W	23:00	81°15.94′ N	8°57.56′ W

May	10		May	12		May	14	
00:00	81°15.01′ N	9° 1.70′ W	00:00	79°20.44′ N	0°17.60′ W	00:00	79° 1.00′ N	7°50.78′ W
01:00	81°17.04′ N	8°57.38′ W	01:00	79°12.75′ N	0° 3.11°E	01:00	78°59.48′ N	7°58.73′ W
02:00	81°16.86′ N	9° 6.33′ W	02:00	79° 7.28′ N	0° 7.65°E	02:00	79° 0.53′ N	8° 4.02′ W
03:00	81°20.04′ N	9° 6.03′ W	03:00	79° 1.74′ N	0° 3.40′ W	03:00	78°59.42′ N	8°33.96′ W
04:00	81°19.59′ N	9°23.94′ W	04:00	79° 1.75′ N	0° 3.48′ W	04:00	79° 0.33′ N	9°12.66′ W
05:00	81°18.79′ N	9°28.04′ W	05:00	79° 1.64′ N	0° 2.96′ W	05:00	78°58.68′ N	9°43.18′ W
06:00	81°20.78′ N	9°12.70′ W	06:00	79° 1.42′ N	0° 1.90′ W	06:00	78°58.36′ N	9°56.76′ W
07:00	81°19.23′ N	9° 1.40′ W	07:00	79° 0.29′ N	0°27.14′ W	07:00	78°58.17′ N	9°56.87′ W
08:00	81°14.46′ N	8°40.00′ W	08:00	78°59.82′ N	1° 6.07′ W	08:00	78°57.92′ N	9°57.35′ W
09:00	81°14.17′ N	8°37.84′ W	09:00	78°59.66′ N	1°12.47′ W	09:00	78°57.64′ N	9°58.27′ W
10:00	81°14.21′ N	8°35.10′ W	10:00	78°58.97′ N	1°11.62′ W	10:00	78°57.39′ N	9°59.53′ W
11:00	81°13.89′ N	8°34.29′ W	11:00	79° 4.63′ N	1°26.58′ W	11:00	78°57.22′ N	10° 0.81′ W
12:00	81°13.69′ N	8°33.01′ W	12:00	79° 5.44′ N	1°54.12′ W	12:00	78°58.63′ N	10°17.17′ W
13:00	81°13.48′ N	8°31.64′ W	13:00	79° 0.69′ N	2° 2.66′ W	13:00	78°55.91′ N	11°14.29′ W
14:00	81°13.24′ N	8°30.29′ W	14:00	79° 0.46′ N	2° 3.25′ W	14:00	78°56.27′ N	11°16.23′ W
15:00	81°12.95′ N	8°29.22′ W	15:00	79° 0.21′ N	2° 3.77′ W	15:00	78°56.27′ N	11° 3.42′ W
16:00	81°12.59′ N	8°28.58′ W	16:00	78°58.78′ N	2°34.88′ W	16:00	78°59.50′ N	10°13.43′ W
17:00	81°12.23′ N	8°28.61′ W	17:00	78°58.82′ N	2°38.61′ W	17:00	79° 1.09′ N	9°33.82′ W
18:00	81° 9.94′ N	7°21.10′ W	18:00	79° 2.40′ N	2°58.11′ W	18:05	79° 2.61′ N	8°57.10′ W
19:00	81° 7.32′ N	6°12.37′ W	19:00	79° 2.02′ N	2°59.36′ W	19:00	79° 1.26′ N	8°41.14′ W
20:00	81°10.13′ N	5°13.15′ W	20:00	79° 1.63′ N	3° 0.67′ W	20:05	78°57.95′ N	8° 4.55′ W
21:05	81°12.38′ N	4°36.86′ W	21:00	79° 1.17′ N	3° 1.56′ W	21:00	78°57.20′ N	7°37.11′ W
22:00	81°10.69′ N	4° 9.42′ W	22:00	79° 0.80′ N	3° 2.78′ W	22:05	78°51.65′ N	6°55.42′ W
23:00	81° 7.32′ N	3°50.47′ W	23:00	79° 0.84′ N	3° 5.87′ W	23:00	78°50.42′ N	6°47.81′ W

May	11		May	13		May	15	
00:00	81° 7.10′ N	3°50.13′ W	00:00	79° 0.37′ N	3°50.71′ W	00:00	78°50.13′ N	6°46.41′ W
01:00	81° 8.20′ N	3°28.78′ W	01:00	79° 0.92′ N	3°58.59′ W	01:00	78°52.09′ N	5°56.72′ W
02:00	81° 8.69′ N	3°19.15′ W	02:00	79° 0.80′ N	3°59.33′ W	02:00	78°50.70′ N	6°13.06′ W
03:00	81° 5.98′ N	2°10.17′ W	03:00	79° 0.67′ N	4°25.91′ W	03:00	78°45.81′ N	6° 9.07′ W
04:00	81° 4.50′ N	2° 9.48′ W	04:00	78°59.50′ N	4°38.31′ W	04:00	78°43.36′ N	5°44.67′ W
05:00	80°59.84′ N	2°31.05′ W	05:00	78°59.02′ N	4°37.91′ W	05:15	78°33.99′ N	5°23.54′ W
06:00	80°57.85′ N	3°36.08′ W	06:00	79° 0.07′ N	5° 4.81′ W	06:00	78°28.26′ N	5° 6.92′ W
07:00	80°51.52′ N	3°18.66′ W	07:00	79° 0.86′ N	5° 9.31′ W	07:00	78°15.19′ N	5°13.18′ W
08:00	80°41.56′ N	3°35.25′ W	08:00	79° 0.56′ N	5°10.41′ W	08:00	78° 2.19′ N	5°16.91′ W
09:00	80°32.85′ N	3°58.76′ W	09:00	79° 0.33′ N	5°11.36′ W	09:00	77°49.23′ N	5°10.87′ W
10:00	80°23.33′ N	3°23.46′ W	10:00	79° 0.14′ N	5°12.50′ W	10:00	77°41.70′ N	5° 4.49′ W
11:00	80°13.66′ N	2°45.56′ W	11:00	79° 0.02′ N	5°13.61′ W	11:00	77°34.36′ N	4°35.25′ W
12:00	80° 7.44′ N	2°22.03′ W	12:00	78°59.95′ N	5°14.58′ W	12:00	77°28.17′ N	4°17.38′ W
13:00	80° 7.22′ N	2°20.99′ W	13:00	78°59.91′ N	5°15.29′ W	13:00	77°21.00′ N	4° 5.21′ W
14:05	80° 7.05′ N	2°19.53′ W	14:00	78°59.91′ N	5°15.74′ W	14:00	77°12.18′ N	3°48.89′ W
15:00	80° 4.59′ N	1°56.73′ W	15:00	79° 1.42′ N	5°27.44′ W	15:00	77° 4.99′ N	3°36.00′ W
16:00	79°58.53′ N	1°22.43′ W	16:00	79° 2.04′ N	5°15.49′ W	16:00	76°53.74′ N	3°15.46′ W
17:00	79°59.15′ N	0°27.40′ W	17:00	79° 3.54′ N	5°43.96′ W	17:00	76°44.67′ N	2°59.05′ W
18:00	79°48.33′ N	0°12.96°E	18:05	79° 2.87′ N	6° 7.16′ W	18:00	76°36.78′ N	2°46.21′ W
19:00	79°45.71′ N	0°58.84°E	19:00	79° 3.52′ N	6°20.16′ W	19:00	76°26.08′ N	2°27.03′ W
20:00	79°39.31′ N	0°18.86°E	20:00	79° 4.89′ N	6°29.44′ W	20:00	76°15.40′ N	2° 8.03′ W
21:05	79°31.43′ N	0°10.65°E	21:00	79° 4.26′ N	6°30.42′ W	21:00	76° 4.64′ N	1°49.04′ W
22:00	79°30.17′ N	0° 4.28°E	22:00	79° 2.47′ N	6°44.54′ W	22:00	75°53.88′ N	1°30.91′ W
23:00	79°24.41′ N	0°43.61′ W	23:00	79° 1.93′ N	7°25.24′ W	23:00	75°43.01′ N	1°12.41′ W

May	16		May	18		May	20	
00:00	75°32.29′ N	0°53.81′ W	00:00	74°59.78′ N	11°48.95′ W	00:00	72°59.63′ N	14° 1.07′ W
01:00	75°21.80′ N	0°36.29′ W	01:00	74°59.82′ N	12° 0.36′ W	01:00	72°58.40′ N	14° 8.62′ W
02:00	75°11.40′ N	0°18.99′ W	02:00	74°59.96′ N	12° 9.50′ W	02:00	72°54.10′ N	14°36.80′ W
03:00	75° 1.03′ N	0° 2.09′ W	03:00	74°59.61′ N	12°10.66′ W	03:00	72°48.77′ N	15°16.31′ W
04:00	75° 0.14′ N	0° 0.97′ W	04:00	74°59.96′ N	12°18.98′ W	04:00	72°45.31′ N	15°38.93′ W
05:00	75° 0.16′ N	0° 1.95′ W	05:00	75° 0.29′ N	12°30.44′ W	05:00	72°45.38′ N	15°39.60′ W
06:00	75° 0.26′ N	0° 2.72′ W	06:00	74°59.94′ N	12°31.21′ W	06:00	72°44.92′ N	15°43.23′ W
07:00	75° 0.58′ N	0°16.32′ W	07:00	74°58.27′ N	12°39.52′ W	07:00	72°40.44′ N	16°11.95′ W
08:00	75° 0.30′ N	1° 1.54′ W	08:00	74°57.82′ N	12°53.35′ W	08:00	72°37.59′ N	16°22.36′ W
09:00	75° 0.11′ N	1°46.21′ W	09:00	74°57.68′ N	12°54.02′ W	09:00	72°36.77′ N	16°23.60′ W
10:00	75° 0.52′ N	1°56.39′ W	10:00	75° 0.24′ N	13°19.86′ W	10:00	72°34.12′ N	16°29.90′ W
11:00	75° 1.28′ N	1°57.08′ W	11:00	75° 0.95′ N	14° 6.78′ W	11:05	72°33.28′ N	16°49.37′ W
12:00	75° 2.05′ N	1°57.21′ W	12:00	74°59.71′ N	14°18.22′ W	12:00	72°32.75′ N	16°50.69′ W
13:00	75° 2.48′ N	2°12.03′ W	13:00	75° 1.15′ N	14°31.35′ W	13:00	72°31.68′ N	17° 0.54′ W
14:00	75° 1.24′ N	2°56.83′ W	14:00	74°59.19′ N	14°50.32′ W	14:00	72°28.66′ N	17°23.82′ W
15:00	75° 0.00′ N	3°41.49′ W	15:00	75° 0.46′ N	15° 1.61′ W	15:00	72°28.06′ N	17°28.37′ W
16:00	74°59.60′ N	4° 0.37′ W	16:00	75° 1.59′ N	15° 8.38′ W	16:00	72°26.77′ N	17°36.40′ W
17:00	74°59.42′ N	4° 0.61′ W	17:00	75° 1.85′ N	15° 8.32′ W	17:00	72°24.34′ N	17°55.54′ W
18:00	75° 0.39′ N	4° 0.75′ W	18:00	75° 1.91′ N	15° 8.39′ W	18:00	72°23.17′ N	18°10.77′ W
19:00	75° 1.14′ N	4°17.37′ W	19:00	75° 1.67′ N	15° 9.32′ W	19:00	72°22.88′ N	18°12.70′ W
20:00	75° 0.51′ N	5° 0.43′ W	20:00	75° 4.86′ N	15°21.71′ W	20:00	72°22.01′ N	18°11.49′ W
21:00	74°59.76′ N	5°43.94′ W	21:00	75° 5.28′ N	15°25.88′ W	21:00	72°21.78′ N	18°13.56′ W
22:00	74°59.83′ N	5°59.52′ W	22:00	75° 3.44′ N	15°21.07′ W	22:00	72°21.49′ N	18°15.34′ W
23:00	74°59.74′ N	5°59.15′ W	23:00	75° 1.80′ N	14°55.02′ W	23:00	72°21.14′ N	18°17.16′ W

May	17		May	19		May	21	
00:00	74°59.52′ N	5°56.77′ W	00:00	74°59.78′ N	14°25.50′ W	00:00	72°20.74′ N	18°19.06′ W
01:00	74°59.77′ N	6°21.66′ W	01:00	74°57.24′ N	13°38.42′ W	01:00	72°20.82′ N	18°27.99′ W
02:00	74°59.62′ N	7° 6.07′ W	02:00	74°56.76′ N	13°10.33′ W	02:00	72°17.59′ N	18°48.23′ W
03:00	75° 0.00′ N	7°51.20′ W	03:00	74°51.96′ N	12°56.65′ W	03:00	72°16.19′ N	18°52.50′ W
04:00	74°59.34′ N	7°50.28′ W	04:00	74°45.66′ N	12°43.41′ W	04:00	72°15.89′ N	19° 0.88′ W
05:00	74°58.92′ N	7°48.28′ W	05:00	74°37.55′ N	12°21.75′ W	05:00	72°14.58′ N	19° 9.94′ W
06:00	74°58.19′ N	7°45.81′ W	06:00	74°25.75′ N	11°55.43′ W	06:00	72°14.61′ N	19°41.39′ W
07:00	74°58.55′ N	8°18.25′ W	07:00	74°13.84′ N	11°32.09′ W	07:00	72° 8.06′ N	19°49.38′ W
08:00	74°59.79′ N	9° 4.36′ W	08:00	74° 1.89′ N	11° 7.09′ W	08:00	72° 7.09′ N	19°54.41′ W
09:00	75° 0.17′ N	9°18.86′ W	09:00	73°49.84′ N	10°42.44′ W	09:00	72° 7.90′ N	20° 7.20′ W
10:05	75° 0.35′ N	9°20.38′ W	10:00	73°38.05′ N	10°18.62′ W	10:00	72° 4.03′ N	20°21.41′ W
11:00	75° 0.32′ N	9°19.55′ W	11:00	73°29.98′ N	9°59.82′ W	11:00	72° 0.78′ N	20°33.79′ W
12:00	74°59.96′ N	9°38.03′ W	12:00	73°29.94′ N	10° 0.14′ W	12:00	71°59.63′ N	20°43.01′ W
13:00	75° 0.01′ N	10°23.13′ W	13:00	73°29.74′ N	10° 2.67′ W	13:00	72° 0.03′ N	21° 1.00′ W
14:00	75° 0.02′ N	10°43.43′ W	14:00	73°29.32′ N	10° 9.22′ W	14:00	71°59.56′ N	21° 1.65′ W
15:00	75° 0.04′ N	10°43.68′ W	15:00	73°23.90′ N	10°48.47′ W	15:00	71°58.57′ N	21°14.93′ W
16:00	74°59.75′ N	10°42.14′ W	16:00	73°18.97′ N	11°27.82′ W	16:05	71°57.50′ N	21°22.26′ W
17:00	74°59.90′ N	11° 1.50′ W	17:00	73°15.12′ N	11°59.82′ W	17:00	71°57.06′ N	21°22.65′ W
18:00	75° 0.35′ N	11°15.58′ W	18:00	73°15.06′ N	11°59.35′ W	18:00	71°56.51′ N	21°23.07′ W
19:00	74°59.64′ N	11°17.90′ W	19:00	73°14.46′ N	12° 1.18′ W	19:05	71°56.34′ N	21°19.23′ W
20:00	74°59.06′ N	11°19.49′ W	20:00	73°11.54′ N	12°26.06′ W	20:00	71°55.92′ N	21°15.79′ W
21:00	74°57.97′ N	11°20.45′ W	21:00	73° 6.74′ N	13° 5.79′ W	21:00	71°54.16′ N	21°13.69′ W
22:00	75° 0.12′ N	11°43.34′ W	22:00	73° 1.82′ N	13°44.52′ W	22:00	71°53.69′ N	21°12.53′ W
23:00	75° 0.04′ N	11°47.73′ W	23:00	72°59.97′ N	13°59.74′ W	23:00	71°52.39′ N	20°59.38′ W

May	22		May	24		May	26	
00:00	71°50.47′ N	20°52.87′ W	00:00	70°54.89′ N	20°22.73′ W	00:00	69°41.67′ N	21°50.07′ W
01:00	71°48.00′ N	20°41.58′ W	01:00	70°52.96′ N	20° 5.68′ W	01:00	69°40.91′ N	21°50.47′ W
02:00	71°45.77′ N	20°41.08′ W	02:00	70°47.09′ N	19°54.03′ W	02:00	69°39.81′ N	21°50.99′ W
03:00	71°44.50′ N	20°41.29′ W	03:00	70°42.65′ N	19°58.85′ W	03:00	69°38.42′ N	21°50.97′ W
04:00	71°43.57′ N	20°41.68′ W	04:00	70°40.90′ N	20° 7.23′ W	04:00	69°36.49′ N	21°49.57′ W
05:00	71°42.61′ N	20°41.89′ W	05:00	70°39.99′ N	20° 7.66′ W	05:00	69°35.42′ N	21°51.25′ W
06:00	71°41.60′ N	20°42.06′ W	06:00	70°39.12′ N	20° 7.93′ W	06:00	69°34.39′ N	21°48.93′ W
07:00	71°40.60′ N	20°42.25′ W	07:00	70°38.33′ N	20° 8.64′ W	07:00	69°32.94′ N	21°49.16′ W
08:00	71°39.53′ N	20°42.30′ W	08:00	70°38.50′ N	20° 2.29′ W	08:00	69°32.29′ N	21°49.63′ W
09:00	71°39.01′ N	20°42.27′ W	09:00	70°37.78′ N	19°45.64′ W	09:00	69°31.76′ N	21°49.80′ W
10:00	71°37.19′ N	20°42.27′ W	10:00	70°34.43′ N	19°40.43′ W	10:00	69°31.25′ N	21°49.86′ W
11:00	71°35.99′ N	20°42.23′ W	11:00	70°29.79′ N	19°49.19′ W	11:00	69°30.66′ N	21°50.23′ W
12:00	71°34.83′ N	20°42.15′ W	12:00	70°24.66′ N	20° 3.37′ W	12:00	69°29.23′ N	21°49.56′ W
13:00	71°33.73′ N	20°42.19′ W	13:00	70°18.37′ N	20° 8.99′ W	13:00	69°27.92′ N	21°40.66′ W
14:00	71°32.65′ N	20°42.32′ W	14:00	70°11.63′ N	20°12.63′ W	14:00	69°25.09′ N	21°37.39′ W
15:00	71°31.65′ N	20°42.44′ W	15:00	70° 3.82′ N	20°16.03′ W	15:00	69°23.04′ N	21°36.13′ W
16:00	71°30.71′ N	20°42.42′ W	16:00	70° 0.08′ N	20°14.66′ W	16:00	69°21.11′ N	21°28.84′ W
17:00	71°29.82′ N	20°42.48′ W	17:00	69°59.50′ N	20°16.59′ W	17:00	69°20.03′ N	21°30.90′ W
18:00	71°28.97′ N	20°42.59′ W	18:00	69°59.79′ N	20°33.59′ W	18:00	69°15.65′ N	21°25.97′ W
19:00	71°28.13′ N	20°42.79′ W	19:00	70° 0.02′ N	20°47.34′ W	19:00	69° 5.86′ N	21°15.84′ W
20:00	71°27.25′ N	20°43.02′ W	20:00	69°59.51′ N	20°49.97′ W	20:00	69° 5.37′ N	21°13.06′ W
21:00	71°26.36′ N	20°43.18′ W	21:00	69°59.27′ N	21° 1.30′ W	21:00	68°59.59′ N	21°13.23′ W
22:00	71°25.42′ N	20°43.31′ W	22:00	69°59.00′ N	21°12.04′ W	22:00	69° 0.62′ N	21°14.58′ W
23:00	71°24.40′ N	20°43.51′ W	23:00	69°59.85′ N	21°25.28′ W	23:00	68°58.66′ N	21°14.20′ W

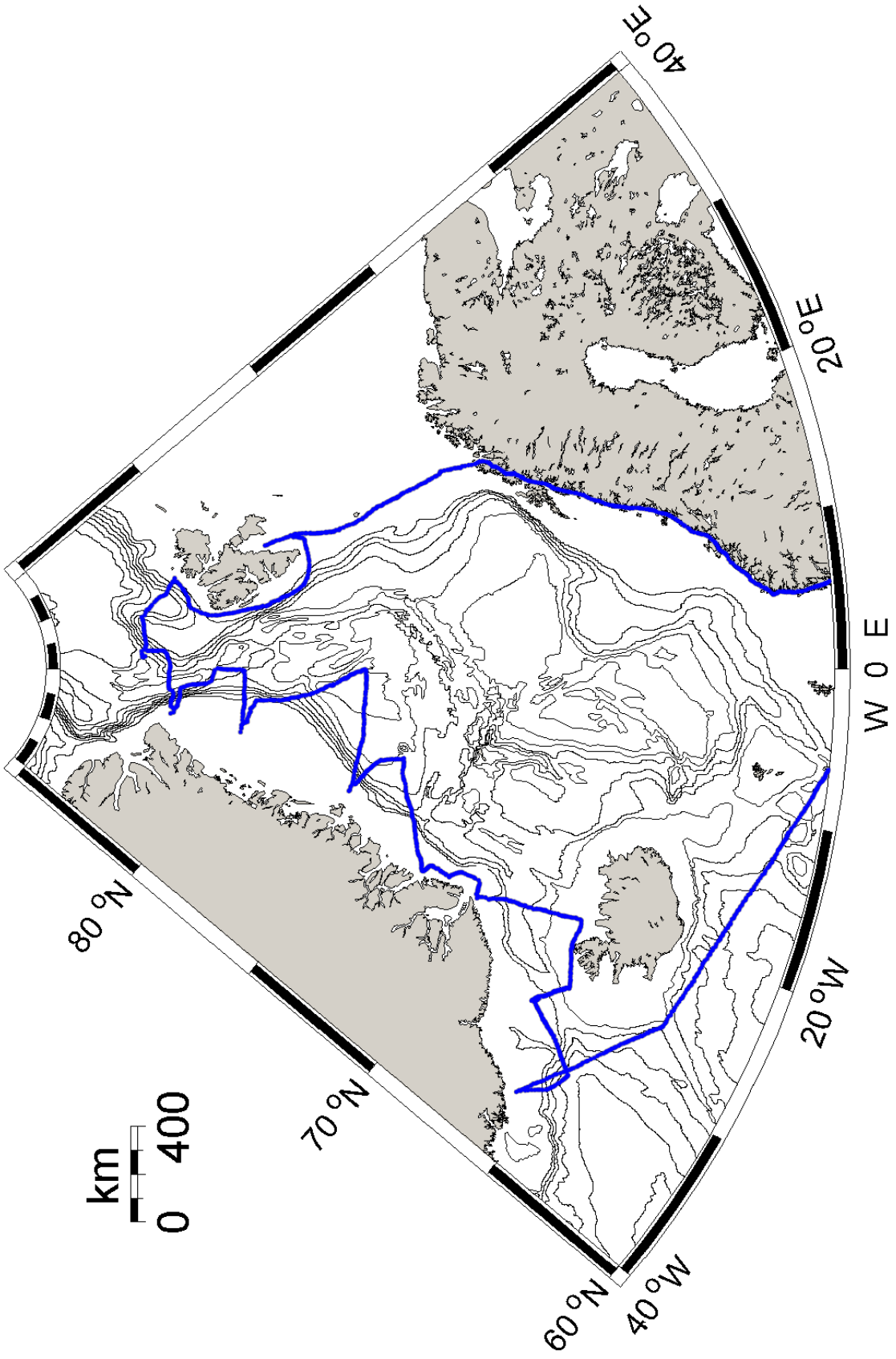
May	23		May	25		May	27	
00:00	71°23.32′ N	20°43.70′ W	00:00	69°59.08′ N	21°28.76′ W	00:00	68°48.42′ N	21° 6.10′ W
01:00	71°22.24′ N	20°44.03′ W	01:00	69°59.25′ N	21°30.66′ W	01:00	68°48.42′ N	21° 6.83′ W
02:00	71°21.15′ N	20°44.37′ W	02:00	69°59.49′ N	21°34.88′ W	02:00	68°48.11′ N	21° 4.64′ W
03:00	71°20.02′ N	20°44.72′ W	03:00	69°59.17′ N	21°38.89′ W	03:00	68°36.92′ N	21° 0.11′ W
04:00	71°18.84′ N	20°44.95′ W	04:00	69°59.79′ N	21°48.37′ W	04:00	68°24.79′ N	20°53.41′ W
05:00	71°17.67′ N	20°45.10′ W	05:00	70° 0.27′ N	21°58.22′ W	05:00	68°15.86′ N	20°47.56′ W
06:00	71°16.48′ N	20°45.26′ W	06:00	70° 0.01′ N	22° 0.22′ W	06:00	68°15.70′ N	20°47.83′ W
07:00	71°15.31′ N	20°45.42′ W	07:00	69°56.58′ N	21°59.81′ W	07:00	68° 7.23′ N	20°42.77′ W
08:00	71°14.17′ N	20°45.54′ W	08:00	69°54.52′ N	22° 0.56′ W	08:00	67°55.29′ N	20°36.17′ W
09:00	71°13.02′ N	20°45.67′ W	09:00	69°52.97′ N	21°55.32′ W	09:00	67°46.27′ N	20°31.14′ W
10:00	71°11.82′ N	20°45.67′ W	10:00	69°51.93′ N	21°54.35′ W	10:00	67°46.49′ N	20°30.85′ W
11:00	71°10.60′ N	20°45.64′ W	11:00	69°51.28′ N	21°54.68′ W	11:00	67°35.54′ N	20°27.81′ W
12:00	71° 9.34′ N	20°45.54′ W	12:00	69°50.76′ N	21°55.08′ W	12:00	67°23.32′ N	20°23.94′ W
13:00	71° 8.10′ N	20°45.39′ W	13:00	69°50.16′ N	21°55.68′ W	13:00	67°11.98′ N	20°20.39′ W
14:00	71° 6.89′ N	20°45.22′ W	14:00	69°49.50′ N	21°56.47′ W	14:00	67° 9.69′ N	20°18.22′ W
15:00	71° 5.73′ N	20°45.02′ W	15:00	69°48.81′ N	21°57.16′ W	15:00	66°57.92′ N	20° 7.07′ W
16:00	71° 4.64′ N	20°44.81′ W	16:00	69°48.11′ N	21°57.43′ W	16:00	66°50.41′ N	20° 0.20′ W
17:00	71° 3.65′ N	20°44.61′ W	17:00	69°46.52′ N	21°52.50′ W	17:00	66°49.55′ N	20°17.54′ W
18:00	71° 1.29′ N	20°45.64′ W	18:00	69°45.77′ N	21°52.86′ W	18:00	66°47.75′ N	20°49.24′ W
19:00	71° 0.43′ N	20°43.69′ W	19:00	69°45.34′ N	21°53.18′ W	19:00	66°46.00′ N	21°21.42′ W
20:00	71° 0.30′ N	20°40.95′ W	20:00	69°45.08′ N	21°53.73′ W	20:00	66°44.07′ N	21°52.41′ W
21:00	70°59.47′ N	20°37.45′ W	21:00	69°44.00′ N	21°51.92′ W	21:00	66°42.26′ N	22°22.48′ W
22:00	70°58.71′ N	20°27.13′ W	22:00	69°42.66′ N	21°49.68′ W	22:00	66°40.99′ N	22°51.22′ W
23:00	70°57.22′ N	20°23.80′ W	23:00	69°42.23′ N	21°49.65′ W	23:05	66°37.17′ N	23°20.78′ W

May	**28**		**May**	**30**		**June**	**1**	
00:00	66º30.59´ N	23º41.27´ W	00:00	65º18.30´ N	33º 5.83´ W	00:00	63º 4.13´ N	23º57.42´ W
01:00	66º22.19´ N	24º 2.72´ W	01:00	65º20.72´ N	33º11.94´ W	01:00	62º59.93´ N	23º32.30´ W
02:00	66º13.83´ N	24º23.22´ W	02:00	65º24.55´ N	33º21.14´ W	02:00	62º55.89´ N	23º 7.21´ W
03:00	66º12.69´ N	24º50.10´ W	03:00	65º35.36´ N	33º44.64´ W	03:00	62º51.45´ N	22º42.17´ W
04:00	66º14.37´ N	25º16.27´ W	04:00	65º36.15´ N	33º48.73´ W	04:00	62º47.40´ N	22º17.26´ W
05:00	66º15.36´ N	25º33.71´ W	05:00	65º41.63´ N	34º 3.28´ W	05:00	62º43.89´ N	21º51.70´ W
06:00	66º19.96´ N	25º43.32´ W	06:00	65º45.48´ N	34º15.95´ W	06:00	62º40.24´ N	21º26.29´ W
07:00	66º24.58´ N	25º53.21´ W	07:00	65º45.86´ N	34º18.22´ W	07:00	62º36.98´ N	21º 1.77´ W
08:00	66º27.09´ N	25º59.89´ W	08:00	65º46.88´ N	34º20.43´ W	08:05	62º33.33´ N	20º35.89´ W
09:00	66º32.53´ N	26º14.01´ W	09:00	65º48.41´ N	34º28.72´ W	09:00	62º29.27´ N	20º13.39´ W
10:00	66º32.62´ N	26º15.19´ W	10:00	65º49.44´ N	34º33.31´ W	10:00	62º25.30´ N	19º47.77´ W
11:00	66º39.97´ N	26º33.40´ W	11:00	65º51.18´ N	34º39.23´ W	11:00	62º21.56´ N	19º23.29´ W
12:00	66º45.46´ N	26º47.01´ W	12:00	65º52.48´ N	34º41.65´ W	12:00	62º17.74´ N	18º59.55´ W
13:00	66º47.09´ N	26º49.73´ W	13:00	65º52.61´ N	34º43.70´ W	13:05	62º13.82´ N	18º33.08´ W
14:00	66º55.46´ N	27º12.26´ W	14:00	65º52.67´ N	34º43.76´ W	14:00	62º 9.83´ N	18º10.56´ W
15:00	66º57.51´ N	27º17.56´ W	15:00	65º52.61´ N	34º43.53´ W	15:00	62º 5.71´ N	17º45.43´ W
16:00	67º 3.06´ N	27º32.26´ W	16:00	65º52.61´ N	34º43.51´ W	16:00	62º 1.90´ N	17º20.86´ W
17:00	67º 9.05´ N	27º48.34´ W	17:00	65º51.23´ N	34º39.55´ W	17:00	61º58.32´ N	16º56.62´ W
18:00	67º12.07´ N	27º55.72´ W	18:00	65º48.30´ N	34º32.79´ W	18:00	61º54.55´ N	16º32.99´ W
19:00	67º14.92´ N	28º 1.45´ W	19:00	65º42.95´ N	34º25.09´ W	19:00	61º50.79´ N	16º 9.53´ W
20:00	67º17.65´ N	28º 7.77´ W	20:05	65º36.93´ N	34º14.55´ W	20:00	61º47.09´ N	15º46.47´ W
21:00	67º17.74´ N	28º 8.79´ W	21:00	65º36.21´ N	34º14.88´ W	21:00	61º43.42´ N	15º23.64´ W
22:00	67º15.92´ N	28º 4.77´ W	22:00	65º35.59´ N	34º16.38´ W	22:00	61º39.62´ N	15º 0.07´ W
23:00	67º12.47´ N	27º56.63´ W	23:00	65º32.26´ N	34º10.97´ W	23:00	61º36.04´ N	14º37.72´ W

May	**29**		**May**	**31**		**June**	**2**	
00:00	67º 7.98´ N	27º48.49´ W	00:00	65º26.61´ N	33º50.74´ W	00:00	61º32.53´ N	14º15.83´ W
01:00	66º56.02´ N	28º 9.08´ W	01:00	65º20.31´ N	33º25.50´ W	01:00	61º29.12´ N	13º53.58´ W
02:00	66º52.27´ N	28º16.53´ W	02:00	65º13.93´ N	33º 1.32´ W	02:00	61º25.11´ N	13º31.29´ W
03:00	66º39.97´ N	28º37.19´ W	03:00	65º 7.94´ N	32º35.07´ W	03:00	61º21.29´ N	13º 9.05´ W
04:00	66º27.51´ N	28º56.75´ W	04:00	65º 2.25´ N	32º 8.01´ W	04:00	61º17.62´ N	12º46.45´ W
05:00	66º15.62´ N	29º17.56´ W	05:00	64º56.22´ N	31º42.20´ W	05:00	61º13.91´ N	12º24.69´ W
06:00	66º 2.88´ N	29º37.67´ W	06:00	64º50.39´ N	31º17.31´ W	06:00	61º 8.46´ N	12º 5.47´ W
07:05	65º49.34´ N	29º59.75´ W	07:00	64º44.12´ N	30º53.66´ W	07:00	61º 4.09´ N	11º44.54´ W
08:00	65º38.10´ N	30º18.39´ W	08:00	64º38.05´ N	30º28.97´ W	08:00	61º 0.60´ N	11º22.42´ W
09:00	65º25.62´ N	30º39.66´ W	09:00	64º32.45´ N	30º 4.72´ W	09:05	60º56.70´ N	10º58.19´ W
10:00	65º13.93´ N	30º59.91´ W	10:00	64º26.68´ N	29º40.64´ W	10:00	60º53.42´ N	10º37.75´ W
11:00	65º 2.18´ N	31º19.36´ W	11:00	64º20.69´ N	29º16.84´ W	11:00	60º50.06´ N	10º15.29´ W
12:00	64º50.08´ N	31º38.12´ W	12:00	64º14.65´ N	28º51.82´ W	12:00	60º50.10´ N	9º52.34´ W
13:00	64º46.43´ N	31º43.90´ W	13:00	64º 8.42´ N	28º26.82´ W	13:00	60º50.79´ N	9º29.00´ W
14:00	64º46.75´ N	31º44.18´ W	14:00	64º 1.73´ N	28º 1.63´ W	14:00	60º53.51´ N	9º 4.60´ W
15:00	64º51.00´ N	31º55.65´ W	15:00	63º55.03´ N	27º34.63´ W	15:00	60º55.60´ N	8º39.62´ W
16:00	64º58.58´ N	32º 9.30´ W	16:00	63º48.55´ N	27º10.40´ W	16:00	60º56.99´ N	8º14.93´ W
17:00	64º58.06´ N	32º 9.01´ W	17:00	63º42.36´ N	26º46.92´ W	17:00	60º47.23´ N	8º 3.92´ W
18:00	64º57.98´ N	32º 8.08´ W	18:00	63º36.53´ N	26º22.84´ W	18:00	60º37.10´ N	7º59.49´ W
19:00	65º 6.62´ N	32º31.51´ W	19:00	63º30.51´ N	25º58.29´ W	19:00	60º28.74´ N	7º47.75´ W
20:00	65º11.31´ N	32º38.68´ W	20:00	63º24.51´ N	25º34.02´ W	20:00	60º24.86´ N	7º25.28´ W
21:00	65º11.26´ N	32º37.90´ W	21:00	63º18.58´ N	25º10.21´ W	21:00	60º21.09´ N	7º 2.77´ W
22:00	65º15.93´ N	32º57.92´ W	22:00	63º13.25´ N	24º46.49´ W	22:00	60º17.22´ N	6º40.05´ W
23:00	65º16.73´ N	33º 1.96´ W	23:00	63º 8.24´ N	24º22.77´ W	23:00	60º13.60´ N	6º19.15´ W

June	**3**	
00:00	60°10.02´ N	5°58.46´ W
01:00	60° 6.59´ N	5°36.56´ W
02:00	60° 7.99´ N	5°13.93´ W
03:00	60°11.16´ N	4°52.86´ W
04:00	60° 3.15´ N	4°42.89´ W
05:05	59°59.27´ N	4°22.22´ W
06:00	59°56.37´ N	4° 4.42´ W
07:05	59°52.47´ N	3°43.49´ W
08:05	59°48.72´ N	3°23.72´ W
09:00	59°45.34´ N	3° 6.40´ W
10:05	59°42.59´ N	2°45.65´ W
11:00	59°38.25´ N	2°30.83´ W
12:00	59°31.87´ N	2°17.08´ W
13:00	59°25.54´ N	2° 2.99´ W
14:00	59°20.24´ N	1°47.00´ W
15:00	59°16.91´ N	1°29.05´ W
16:00	59°13.76´ N	1°10.78´ W
17:00	59°10.92´ N	0°52.73´ W
18:00	59° 8.71´ N	0°39.65´ W
19:00	59° 6.45´ N	0°26.30´ W
20:00	59° 4.25´ N	0°12.76´ W
21:00	59° 2.31´ N	0° 0.63´ E
22:00	59° 0.70´ N	0°13.59´ E
23:00	58°59.07´ N	0°25.13´ E

Positions were logged every 5 minutes, but the data presented here should be sufficient to show which area Oden passed any specific day. At times the computer logging the positions fell asleep and didn’t save the data. When this happened for an even hour the closest possible logged position was used in this table. Data was provided by Bertil Larsson as part of the general documentation of the expedition.



Expedition route

Photo: Rebecca Dickhut

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