Arctic Ocean 2002

Journal Notes with Special Emphasis on Birds and Halos

Henrik Kylin

Department of Environmental Assessment
Swedish University of Agricultural Sciences
Box 7050
SE-750 07 Uppsala
Sweden

2004 Rapport 2004:14

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

Sincere thanks to all expedition participants who contributed with observations. Tim Newberger is thanked for an exceptional number of bird reports and interesting discussions on everything from birds to halos and the construction of a violin. Special thanks also to Eric Dyring, Uppsala, who provided literature on halos and to Walt Tape, University of Fairbanks, Alaska, for fruitful discussions of halo phenomena. Thanks are also due to the Swedish Polar Research Secretariat and the officers and crew of the icebreaker Oden for making the expedition possible. Henk Bouwman, Philip Chiverton, Dave Mitchell, and Tim Newberger gave helpful comments on the manuscript at different stages of the writing process.

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 physico-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, this "trip report" is in no way quantitative, nor was any specific 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.

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

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

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, essentially 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!

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

[2] Anders is the Director General of the Swedish Polar Research Secretariat.

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 se 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 se 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 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 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.

[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.

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 se 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 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

[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.

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 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?

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

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]

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,

[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.

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.

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

[9] Swedish: bisolar.

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 se 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?

May 3-11

Our intention was to make a transect from north of Svalbard across 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 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.

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

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. The Bowhead population in the North Atlantic was all but exterminated during the heyday of whaling. As far as I can make out after a not too diligent literature search, there are a handful of Bowhead Whales sighted east of Greenland each year, whereas sightings off Svalbard are exceedingly rare today. Several of the expedition participants had seen

[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.

Bowheads in the Canadian Arctic where the populations are somewhat larger, so the species identification is in no doubt, however rare Bowheads are this side of Greenland.

May 12
A large aggregation of Ivory Gulls (>70) with several matings was seen 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 se 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 se 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,[12] 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 – 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.

[12] 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.

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 se 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[13] 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 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 defended his residence that

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

the buntings, although substantially larger than and outnumbering Reggie 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.[14] 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. 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.[13] 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.

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

[14] Guðmundur Guðmundsson, personal communication

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 (Scoresbysund) 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[15] 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 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

[15] 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.

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.[16] This species should not be present at all on Eastern Greenland. Apparently there is a small nesting population of Golden Plovers around Ittoqqortoormiit,[13] 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 impossible, but the jizz[17] 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.

[16] 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.
[17] Jizz is a term used among birders for the immediate general feeling you get of a bird of which you cannot se all the distinguishing details. With some training the jizz becomes a very important aid in species identification.

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 se 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 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 was picking up again. We were lucky to take the seas mainly from the aft. It was difficult to se 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 se them myself, and the reports where 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.[18]

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. 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[13, 19] 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

[18] Carwardine, M., Camm, M. (1995) Whales Dolphins and Porpoises. Dorling Kindersley, London, UK.
[19] D. W. Snow & C. M. Perrins (1998) The Birds of the Western Palearctic, concise edition vol. 1. Oxford University Press.

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.[13, 18]

On the way both in and out of the ice we were surrounded by enormous numbers of seals, the vast majority Hooded Seals[20] 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 se 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.

Just as we left the ice we, finally, encountered a Sabine's Gull. I had expected to se 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.[13] 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

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

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 se a single goose. At least I didn't se any myself, and no one else reported any goose observation either. I was also somewhat disappointed to se 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 se 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 se 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 Comments

Grey Plovers

I have substantial experience with Grey Plovers from many years of birding and I'm quite certain that the identification of these birds was correct. The light was perfect with the sun behind me and the distance was no more than 100-200 m. the birds showed the typical black "armpit" of Grey Plovers as well as the prominent white wingbar and rump.

Recently Grey Plover have been nesting on Disko Island in Western Greenland, but apart from that few observations are made on Greenland. Grey Plovers should not be present at all in Eastern Greenland. However, on May 25 two flocks of app. 200-300 birds each (perhaps one flock that had been split as they were close together) were seen off Ittoqqortoormiit (our position was app. 70° N 22° W). This seemingly strange observation gives rise to a couple of interesting thoughts, both of which, of course, are pure speculation until further observations have been made.

The first scenario is that there is a previously unobserved migration of Grey Plovers using great circle navigation between wintering areas in Southern USA and nesting areas along the Russian Arctic coast. Apparently, the odd Grey Plover from Canada has been found wintering in Africa[21], but it is probably easier to explain a few Canadian birds blowing astray during westerly autumn storms than is it to explain why Russian birds would winter in North

[21] Piersma, T., & Wiersma, P. (1996) Charadriidae (Plovers), pp. 384-442 in del Hoyo, J., Elliot, A., Sargatal J. (eds) Handbook of the Birds of the Word, vol 3, Hoaztin to Auks. Lynx ed., Barcelona.
Byrkjedal, I., Thompson, D. (1998) Tundra Plovers: The Eurasian, Pacific and American Golden Plovers and Grey Plover. T & AD Poyser, London, xxxiv + 422 pp.

America without a migration route across Greenland having been noticed previously. But, as far as I understand, Grey Plovers often migrate at fairly high elevation and are not always easy to observe even with a denser population of birders than there is on Greenland. Plovers migrating at high elevation may have been forced down to observable height by the strong catabatic wind that was blowing down towards the ship from the Greenland ice sheet (the summit of the ice sheet is at 3000 m above sea level).

There is, however, not much that speaks in favour of this scenario. If there is a flyway of Grey Plovers over Greenland there should be more observations of this species from Greenland. Also, in the early 1980s Thomas Alerstam and co-workers[22] made radar observations from a radar station off Ammassalik of birds migrating across the southern part of the Greenland inland ice. They observed nothing that could be assumed to be a major migration of waders eastward over the inland ice. However, the position at which I made the observations in 2002 is outside the reported range of the radar station in Ammassalik. And as there are exceedingly few ornithologists north of this position in early spring (there is no permanent habitation north of Ittoqqortoormiit) any eastward migration could have been missed. Even so, the lack of observations in more densely populated areas of Greenland makes this scenario less likely.

The second scenario is that the easterly storm that blew across the Norwegian Sea the days prior to the observations, forced a migrating flock of Grey Plovers out of their normal flyway along the Norwegian coast blowing them to Greenland. According to Bertil Larsson, the expedition meteorologist with several decades of experience as air force meteorologist and a couple of decades of experience of research in the Arctic (among other things he organised the radar observations at Ammassalik), the size of the cyclone was larger than anything he had seen previously. The winds were blowing all the way from the North Sea to the coast of Greenland. Possibly the birds were, assisted by the catabatic wind, hurrying back towards their intended nesting grounds when I spotted them. As described above, other clearly wind driven birds were seen around the ship during this storm. The weakness of this scenario is, of course, that you would not expect entire flocks to fly astray. Individual birds would have been more probable. More formal investigations if there is a regular eastward spring migration of waders from Greenland will have to be done to further elucidate this enigma.

It is noteworthy that small groups of Dunlins were also observed migrating eastward on the same day as the Grey Plovers. Although I cannot exclude that these Dunlins had been wind driven similarly to the speculations in scenario two above, they are more wide spread in Greenland than the Grey Plovers and also in both North America and Eurasia. It is, therefore, much more likely that there is a small eastward migration of Dunlins from Greenland than of Grey Plovers. It is also clear that several other bird species do migrate eastward across the Greenland inland ice in spring.[22]

Ivory Gulls

1. Pair-bonding

Excluding the gargantuan flocks of Little Auks and the possible Knots off Ittoqqortoormiit, Ivory Gulls were the species that was seen in highest total number throughout the ice bound sections of the expedition, although Kittiwakes or Glaucous Gulls dominated the odd day close to the ice edge. Most observations of Ivory Gulls were of pairs, although in the northern part of the expedition route the birds were frequently seen in triads. South of Svalbard the

[22] Alerstam., T, Hjort. C., Högstedt, G., Jonsson, P.E., Karlsson, J., Larsson, B., (1986) Spring Migration of Birds across the Greenland Inlandice. Meddelelser om Grønland. Bioscience Vol. 21, 38 pp

Ivory Gulls did not follow the ship, but once north or Svalbard and all along the Greenland coast the Ivory Gulls followed the ship in the same way as other gulls.

In comparison, while we were in Storfjorden southeast of Svalbard April 26-29, several pairs of Ivory Gulls were seen, but they did not show any special tendency to follow the ship or to aggregate, behaviours that were seen in all other areas where Ivory Gulls were observed. Whether this was simply due to that no expedition participant, as of yet, had observed these behaviours or that the birds for some reason did not perform these behaviours in this area of their range is difficult to say. Expeditions are always rather hectic the first few days before the participants learn how to work together, so many things that are not immediately necessary to take heed of will be missed. It is noteworthy, however, that the Ivory Gulls in different parts of the expedition route in more ways than one exhibited slightly different behaviours. The summer is short in the High Arctic and perhaps the Ivory Gulls have adapted to the varying seasons by triggering different behaviours at different dates as the nesting season rapidly progresses.

Small aggregations of Ivory Gulls, 20-40 birds, were seen in several places along the cruise track. But the largest aggregations, sometimes hundreds of birds, were seen when the ship stopped in the ice. Whether this is simply due to the time factor (more time to do the observations when the ship stopped) or whether it was a reality is difficult to say. My general feeling was that there was a correlation between the extent of open water in the wake of the ship and the number of gulls aggregating: the more open water the ship produced the higher the number of Ivory Gulls aggregated.

As far as I could observe, the large aggregations were started off by the Ivory Gulls following the ship, usually 4-6 (-10) birds, settling on the ice. As soon as the birds settled they would show display behaviour with many calls between the birds, head bobbing, heads stretched upwards or backwards with the neck bent fully backwards touching the back, and, sometimes, the performance of a “dance” with low jumps into the air. The calls of the first birds seemed to attract other Ivory Gulls from far around. In the East Greenland Sea almost all gulls arrived from the south. It may be that birds migrating northwards would have approached the ship anyway, but aggregations of birds halted the migration temporarily. After half an hour several pairs of Ivory Gulls had gathered to the original pairs or triads. In the north, during April 30 to May 2, aggregations of up to at least 200 birds were seen. Further south, especially on May 25 off Ittoqqortoormiit (Scoresbysund), more than 400 birds were seen on one occasion. The exact number was hard to assess because of the difficulty to count white birds on the white snow covering the ice, especially as they often gathered on or around a pressure ridge. The birds behind the ridge could, obviously, not be counted.

When aggregating, the Ivory Gulls showed a couple of interesting behaviours. When a new couple arrived to the aggregation of birds, they would show display behaviour. After the display between the birds in the newly arrived couple, they would engage in a display with other birds that had already gathered. Head bobbing by the newly arrived was answered by head bobbing by other birds that had arrived earlier, after which they would chase one another, head down with wings stretched backwards. This behaviour was observed more than 100 times mainly while passing the East Greenland Current.

In the far north the birds arrived to the aggregations in triads and on April 30 another peculiar behaviour was noted. For convenience I number the birds so that the behaviour is more easily described. Immediately upon the arrival of a triad to an aggregation bird #1 would

mount bird #2, presumably copulating. Immediately after this first copulation ended bird #3 would mount bird #2, and immediately after the second copulation bird #2 (presumably a female) and either bird #1 or #3 (presumably both male birds) would chase the third party along the ice. Sometimes this would end with a renewed "copulation ceremony", sometimes the roles would be reverse so that the male bird first chased would turn around and together with the female chase the male that first took part in the chase. In some cases, the bird that was chased would give up and fly away still chased by the other two birds in the air. In most cases, birds that flew away left the aggregation. However, in some cases the couple left the chase of the third bird of the triad while still in view of the ship and returned to the aggregation. In these cases the display behaviour and mating would be resumed but with only the two birds participating.

As the observations were not made in any systematic manner the interpretation is difficult. But it would seem as if the triads in the north consisted of one female and two males. Perhaps this behaviour is a way for the female to select a suitable male. It is impossible to say with any certainty whether or not copulation actually took place or if the mounting was only a ceremony in preparation for proper copulation once a male had been selected.

In the northern aggregations north of Svalbard virtually all of the arriving triads showed the display and copulation behaviour. Although some copulations were observed also among the pairs aggregating further south along the East Greenland Current the percentage of couples copulating decreased the further south we came. In the southernmost aggregations only a minority of the pairs (5-10%) seemed to copulate. As the observations were not continuous, there is a possibility that copulations were missed in the south. But it is also possible that the copulation behaviour is part of the early stages of pair-bonding and that the attachment between the birds that would eventually form the couples had progressed further in the southern part of the cruise track that was visited at a later date. The northernmost observations were done more than three weeks prior to the southernmost.

2. Spring migration

Along the east coast of Greenland, we had long periods when we drifted with the ice instead of actively breaking it. Here it was quite clear that the absolute majority of all Ivory Gulls that joined the aggregations came flying from the "south", *i.e.*, from the sector between southeast and southwest. Whenever it was possible to determine the flight direction of Ivory Gulls observed while we were breaking ice, all came invariably from the southern sector and left the ship northwards. It is quite clear that there was a substantial spring migration of Ivory Gulls northwards along the east coast of Greenland. A conservative estimate is that at least 1000 individuals were seen along the Greenland Coast.

There was also a difference in the occurrence of the age classes. The first Ivory Gull with juvenile plumage was seen off Ittoqqortoormiit. Ivory Gulls gain their adult plumage during their second winter, so individuals in juvenile plumage during spring should have hatched the previous summer. The number and density of juveniles increased the further south along the Greenland coast we came. In the southernmost sections of the expedition the number of birds with juvenile plumage was approximately 5% of the total.

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 se 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

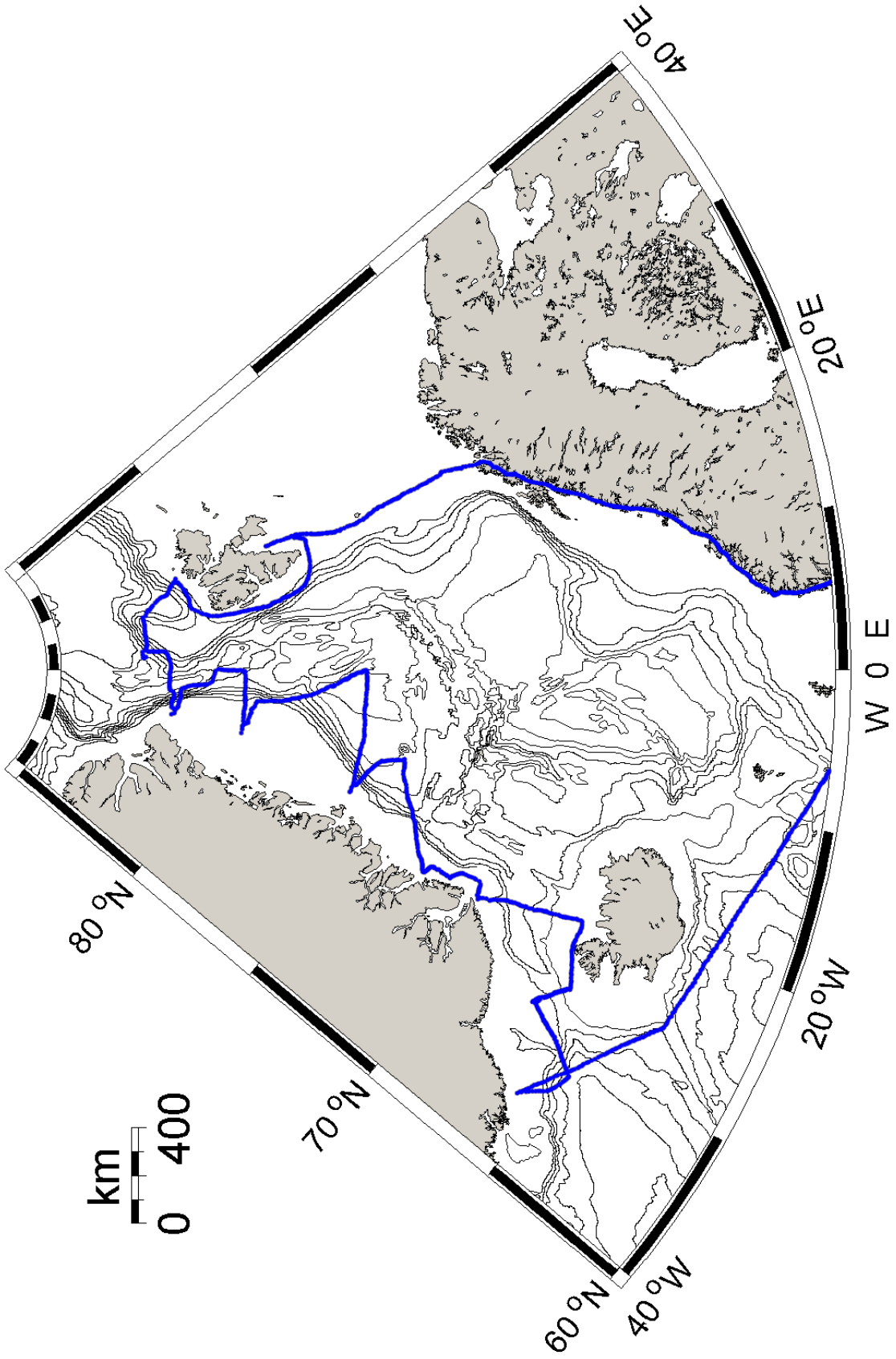
May	23		May	25		May	27	
00:00	71°23.32’ N	20°43.70’ W	00:00	69°59.08’ N	21°28.76’ W	00:00	68°48.42’ N	21° 6.10’ W
01:00	71°22.24’ N	20°44.03’ W	01:00	69°59.25’ N	21°30.66’ W	01:00	68°48.42’ N	21° 6.83’ W
02:00	71°21.15’ N	20°44.37’ W	02:00	69°59.49’ N	21°34.88’ W	02:00	68°48.11’ N	21° 4.64’ W
03:00	71°20.02’ 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

Arctic Ocean 2002

Journal Notes with Special Emphasis on Birds and Halos

ISSN 1403-977X