VKØEK HEARD ISLAND 2016

Part 3 – RADIO OPERATIONS: The Sun, Wind, and Rain

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***AudioLog 23 March 2016**. It's 8:13 PM Heard Island time. It's dark. Just a few minutes ago a very light sprinkle started but we're all inside for several hours. We took a break from working to have that. We can report that 30 m is set up and ready to go and we're working on 40 m now. We don't know yet whether we can pull it all together to get on the air tonight or not.*

Preparation and Planning

Goals of the Radio Operation

VKØEK was a "full service" operation (all primary HF bands and modes). The radio operation goals were to log as many all-time new ones (ATNOs) as possible, to make a particular effort to provide contacts on the edge bands, and overall to make as many contacts as possible in the time that we were there. The radio activities were the keystone of the expedition, and they were complemented by the real-time display of contacts via DXA and an energetic social media presence powered by the US-based team. This enabled real-time outreach and education about Heard Island and the expedition. We also wanted to explore the use of modern technologies in amateur radio such as remote operation and high-efficiency propagation beacons. Although the main focus of the team was on the radio operation, this was balanced with achieving the expedition's scientific and exploration goals.

A key decision early in the planning of the expedition was to mount an operation of significant duration, so that we could achieve the radio goals even if there were periods of poor radio propagation. This was likely, given that we were heading to a sub-Antarctic location on the downswing of the sunspot cycle when propagation disturbances are common. We also simply needed time on the island in order to complete all the activities–the radio team comprised 12 operators, some of whom had significant non-radio fieldwork and science commitments to be built into their schedule as weather permitted. Two other expedition members were primarily focused on science and exploration, but fully participated in the radio camp setup, breakdown and maintenance.

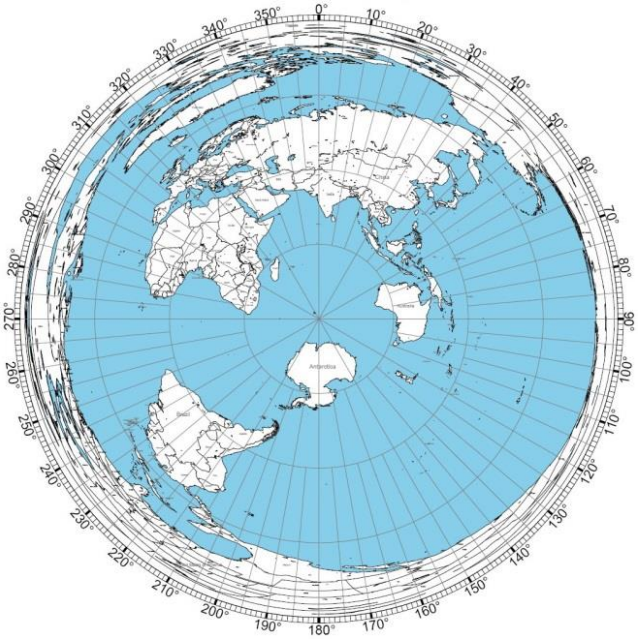

Figure 1 - The world as seen from Heard Island [Tom NS6T]

Propagation from Heard Island

Figure 1 shows a great circle map centered on Heard Island. There are three regions with large amateur populations that are less distant from Heard Island: Asia/Pacific, Europe/Middle East, South and Central America. North America (NA) is spread all around the perimeter of the globe and the antipodal point is somewhere in Saskatchewan, making radio contacts with NA more challenging. Communication to the south-east is made even harder by the volcano Big Ben at the center of Heard Island. Consequently, we were prepared to set up a second operating site at Spit Bay on the other side of the volcano, with a view to better serving central and western NA and the Pacific. Another complication for short path

communication to much of NA is that short path signals to central and western NA cross the southern polar region, and in fact this turned out to be an even greater challenge than the mountain.

A number of propagation resources helped both us and DX chasers in our planning, including the N6TU propagation service with personalized predictions, voacap.com's DXpedition plots, and N6BV's propagation charts. All this information and more was brought together by Rich, KY6R, in a detailed "propagation" page on the VKØEK.org website. Broadly speaking, worldwide propagation could be expected on 40-15 m on a fairly regular basis, with long openings to Europe and Asia and shorter operating windows to NA. We had originally intended the expedition to take place at an earlier date, which would have been preferable for 10/12 m operation. As it turned out, with a rapidly declining sunspot cycle, 10 m propagation was patchy at best. Supplementing these propagation resources, KY6R wrote a series of articles on VKØEK.org about "How to work VKØEK". Rich is a master at communicating the art of chasing DX, and his posts covered topics such as how to use propagation predictions, real-time propagation information such as the reverse-beacon network and WSPR, and how to crack a pile-up.

Radio Stations

Each station was based around an Elecraft K3S radio, with a P3 panadapter and a power amplifier. Having the K3S allowed us to eliminate an interface box, with control and audio signals going to the laptop via a single USB cable. To facilitate setup, we prepared eight "station in a box" setups in individual waterproof containers (the "green boxes") which were mostly configured to contain all of the station components including all necessary cables and accessories. This simplified set-up when we arrived on-island, since there was no need to go hunting in multiple containers for the components of a station.

Each station in a box was assembled and tested in California, and then disassembled and packed. Assembly included setting of key user-selectable parameters on the K3S, and loading a standard set of parameters on all the software so that everything would be ready to operate as desired upon arrival. Stations were tested on all modes into a dummy load at full operating power. Receivers were checked – could we hear signals? Did everything operate as expected? Once a fully functioning station was assembled and tested, it was then disassembled and everything packed into a green box ready for transport.

Figure 2 - Station in a green box – K3S, KPA500, P3, headphones and PSU are visible. Cables are under the bottom padding.

Antennas

Our antenna plan was devised to provide good operating effectiveness within the geographical constraints of our permit, which resulted in our camp being located close to sea level but distant from the shore, surrounded by hills and mountains in most directions. The antenna planning team comprised expedition members K3EL, UT6UD and KY6R, with input from many others including Tom, N6BT of "team vertical" fame, and Bill, AA7XT from Force 12, one of our major antenna sponsors. DXpeditions to island locations often use "verticals on the beach": vertical antennas are located close to the shore, with an over-water takeoff facing in the intended propagation direction. This can be extremely effective for DX because very low angle radiation is achieved. However, these conditions are not met at our Atlas Cove location on Heard Island where, by permit, the camp had to be located several hundred meters from the shore. Therefore, on the higher-frequency bands, we relied primarily on horizontal beam antennas. Still, we did also take vertical dipole arrays (VDAs) for 20/17/15 m, since there was the possibility of placing these on the flat expanse of the Nullarbor, to the south of our camp. The Nullarbor is a sandy plain that stretches between the Azorella Peninsula and the slopes of Big Ben. It is frequently overwashed by the sea, so the ground is saturated by salt water and could afford reasonable performance from vertical arrays. Having a mix of horizontal and vertical polarization on the higher bands also helped when operating two modes on one band simultaneously.

Yagis, loaned by Force 12, were supported on strongly-guyed Spiderbeam aluminum push-up masts. Two C3S were used on 10/15/20, and two WARC 22 Yagis for 17/12. These were placed for maximum separation around the operating tent. The rotatable VDAs were located to the south of the operating tent on the Nullarbor, and were used primarily for paths from the south to the west which had a shot across the Nullarbor and to the sea beyond.

On the low bands we used single-element verticals (160 and 80 m) or 4-square vertical arrays (40 and 30 m). These were positioned on the Nullarbor, taking advantage of the good ground conditions. The antenna bases were somewhat elevated to cope with the expected flooding (although at times some were submerged when rain, wind and tide combined to send a foot or more of water across our antenna field–at least those conditions provided a good ground plane!).

Figure 3 - Preparing to raise the 160 m antenna. A lifting pole is attached to the hinged base, and a ground-mounted winch was used to raise the antenna.

We also took a Battle Creek Special as a backup low-bands antenna, but this was never needed. The 80 m vertical was a simple, single-element near-full-size vertical, based on an 18 m Spiderbeam fiberglass pole. This was easy to erect with just a few people. The top-band antenna was conceived by Vadym, UT6UD. He is a strong believer that on top band, "bigger is better" (aren't we all?) and his design was based on a 24 m Spiderbeam aluminum mast, with top loading wires to bring it to resonance. He also devised and built a tilting base and a winch lifting system to get this monster into the air.

Our antennas needed to be robust enough to stay up during "normal" weather. This means near–constant winds in the 20-50 km/h range, frequent gusts of 100 km/h and occasionally even more severe squalls. So, for the Yagis, we preferred relatively low, strongly-guyed supports for greater mechanical stability based on the principle that an antenna at a modest height in the air is much more effective than a taller one that has just been blown over! There were no ridges or high spots within our permitted camp area, so unfortunately we could not take advantage of the terrain to get our Yagis higher. The verticals were also guyed at multiple levels for survivability in the wind. The biggest of all, the 160 m antenna, was guyed at five levels, and stayed up for the duration despite all that the Heard Island weather threw at it.

Figure 4 - 160 m antenna on the Nullarbor.

As with the radio equipment, the majority of the antennas were also tested before being packed for shipment. Some were shipped partially-assembled. Bases were prepared and all guys were pre-cut. To the extent possible, we wanted to reduce the amount of work that needed to be done upon arrival, while ensuring that everything we needed was working and in place.

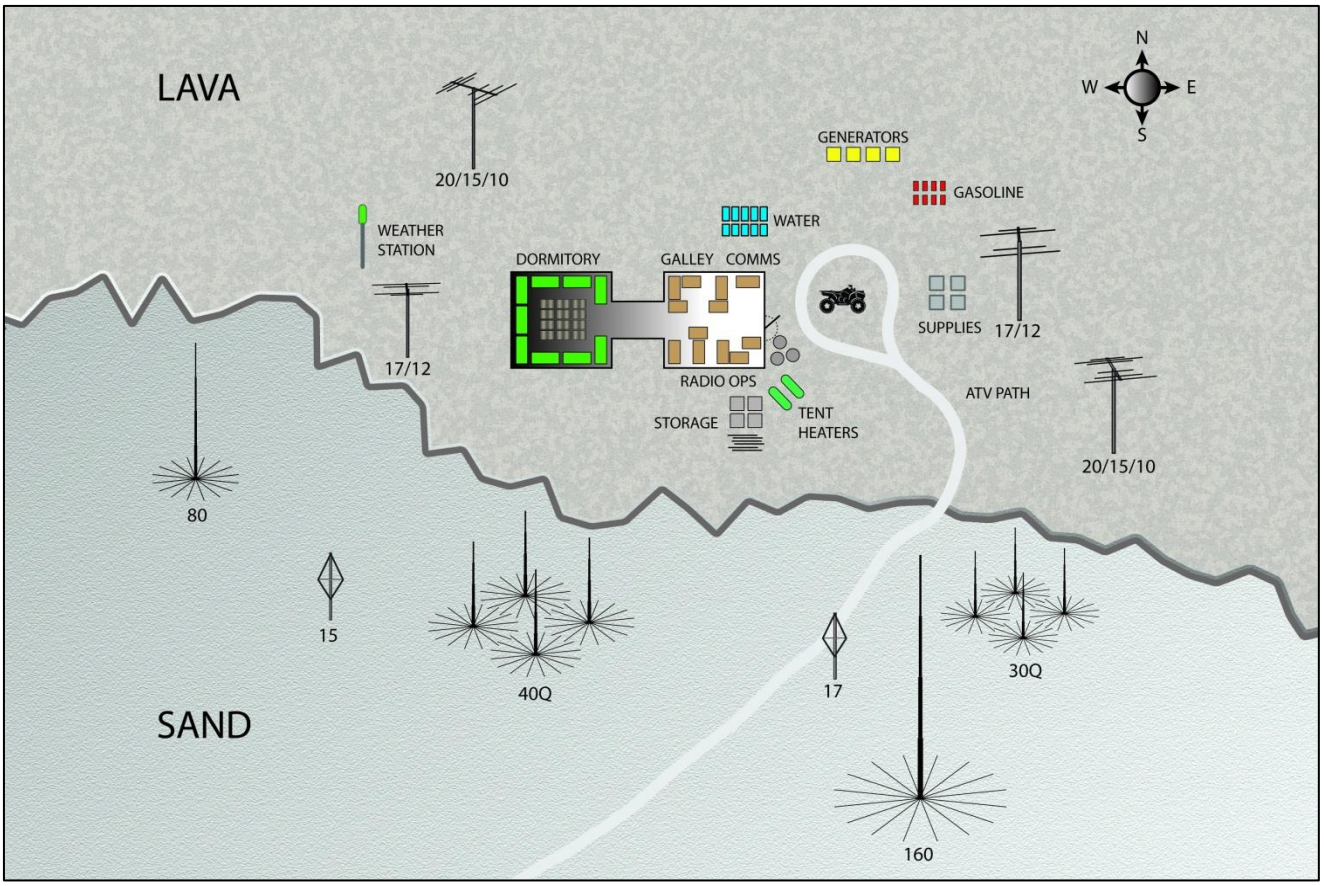

Figure 5 - Layout of the VKØEK campsite. The antenna layout has been expanded in this drawing about 2x for clarity. The ANARE and AAD areas are located about 100m to the NW of the campsite.

Arrival and Setup

After years of planning and preparation and two weeks at sea, we were delighted to sight the cliffs of Heard Island. We were thankful for relatively calm weather and a forecast of more of the same for a day or so which would allow us to land and set up. An evening first landing allowed us to confirm our expectations for the general layout of the Atlas Cove site. The Nullarbor did look attractive for antenna placement, but copious amounts of fresh and rotting seaweed revealed the frequency with which it flooded. Excited, the team prepared to depart at first light the next morning. An advance party left to identify the best location for the camp: there is a slightly elevated lava flow to the north of the Nullarbor, but we needed to find a suitably-large flat area where we could place and stake down the AirBeam tents. While we searched for a suitable campsite, equipment was ferried to the beach in dozens of small boat trips. The tents and other material necessary for survival came first in case of a sudden change in the weather. Radios and antennas came later.

Figure 6 - King Penguins coming to say hello to the visiting "Sandbag Penguins". Alan, VK6CQ, Fred, KM4MXD and Gavin, VK2BAX are filling the sandbags.

A suitable location for the tents was soon identified; indeed, it was more than suitable, ideal even. Close to the edge of the lava flow, just above the Nullarbor, it meant we could put all our vertical antennas on the Nullarbor with relatively short runs of coax, and it was easy to access using our ATV and

trailer to transport all the equipment. As team members came ashore, they were immediately told to start moving rocks, filling sandbags, or hammering stakes into the ground–the VKØEK chain-gang got to work. The king penguins came to visit and were fascinated by the sandbaggers–a filled, tied-closed sandbag standing upright looks a bit like a penguin! By early afternoon the AirBeams were positioned, inflated and tied down. With our survival system in place, we could start work on installing radios and antennas. As night approached, we concentrated on completing a couple of stations for 30 and 40 m that we could use during the hours of darkness.

Operating from Heard Island

Operating Teams

The operating schedule was built around three teams of four operators each, operating a minimum of two four-hour sessions per day. Each team had designated leaders (K3EL, UT6UD and HB9BXE), who were responsible for developing an operating plan for each day, taking into account expected propagation, feedback from the support organization, and band/mode totals as the operation proceeded. For each shift, the team lead would decide, in partnership with team members, which bands/modes would be used in that session.

The schedule was designed to support a minimum of four stations on the air continuously, but also to allow some of the team time for performing experimentation and fieldwork to realize the expedition's science goals. We had two more operating positions that were used by ops outside of their formal schedule–anyone not busy with other work could jump on an available radio–so that six stations could be on the air at any one time (propagation permitting–which was not always the case). Also, of course, some time off the radio was spent on support activities, such as maintaining antennas, refilling generators, or the inevitable human needs of sleeping, eating, and chilling out.

First Contacts

Some 15 hours after our morning landing all the team were ashore, tents were up, we had a basic power grid, two stations and antennas for 30 and 40 m ready for operation, the LAN, satellite links and DXA were all working, we were ready to go. The honor of opening the operation fell to Bob, KK6EK, who tuned up on our 40 m SSB frequency, announced our presence with a (relatively) short address to the expected waiting multitudes, and then passed me the microphone to call CQ and make the first QSO. So I called CQ, lowering the volume in expectation of the hoards that would descend upon "5 down". There were no hoards. Just static. Call again. Nothing. Are they all calling up? No, no signals up on the panadapter. Another CQ and still nothing. The radio is working fine, the amp is putting out power, the antenna seems to be ok–so where are they? At the other station I can see Hans-Peter, HB9BXE, ready to call CQ on 30 m CW, he's just waiting for me to make the first QSO. CQ again, nothing. I announce that I'm going to switch to 40 m CW, and Hans-Peter decides that's enough, and starts CQing on 30 m, immediately generating a pileup and working SM3GSK for the opening QSO of VKØEK. My CQ on 40 m CW generates an instant response also, and 30 s later SM3EVR is in the log. We operated 30 and 40 that night, chilled to the bone but happy that VKØEK was on the air. We had already planned the next day's activities. We would all focus on putting together more stations, getting the Yagi antennas in the air, setting up more generators–in short, completing the major remaining infrastructure activities. The 30 and 40 m stations shut down as the sun rose and we turned our attention to the day's work. I must admit, at that time, I completely forgot that we were supposed to be the most connected and internet-savvy DXpedition ever. While the team beavered away on Heard Island, DXA went quiet and our signals disappeared from the bands. While the on-island team erected antennas, assembled stations, and transferred material, our off-island support team was bombarded with questions about whether we were swept away by a storm, whether DXA was broken, and other doomsday scenarios. No, nothing was wrong, we were just doing the necessary work to be fully operational, but on-island we had not yet fully understood the power of the real-time social media monster that had been unleashed. When we checked in with the off-island team at the end of the day, we were mortified to learn of all the wild speculation that they had had to deal with. As dusk fell we were back on the air and going forward we were more attentive to keeping the guys back home informed as to what we were doing.

AudioLog 26 March 2016. 10:35 AM local. *As far as we know there are DX is out there who want to hear from us, and we want to hear from you as well. We have now logged approximately 8000 QSOs.*

***AudioLog 30 March 2016 8:30 PM local**. We're continuing to log contacts right now. Were on 40 sideband, 30 CW, 20 sideband, and 17 CW. Total as of this moment is 30,308, of which 24,000 are CW and almost 6000 are single sideband.*

On the Air

Within a couple of days we had settled into a rhythm of operating. The three teams took their shifts, and other ops would fill in the remaining stations. Operating on the low bands was generally a pleasure, since the local noise level was very low. On 160 m, Vadym and I shared the radio with UT6UD on the air from around dusk to 3 am local. He would work some western NA at our dusk, then JA followed by EU. I would then take over, and on most nights it was pretty slow until an hour or so before our dawn, when eastern NA would start coming in followed by stations further west. Because of their relative proximity, Asia and EU were easier to work, as evidenced by the QSO numbers. Of course, the band conditions varied from night to night, but especially at the beginning of the expedition we had a couple of nights of excellent propagation to NA, including into the plains states. On other nights, other areas were favored, but later in the expedition conditions were generally less good.

With our satellite internet capabilities, we logged into the Low Bands DX Chat most nights–this was an excellent way to let people know what stations were active, to get feedback on band conditions, and to provide some encouragement for operators at both ends of the QSO. One frustration on 160 was the number of ops who were clearly trying to "game" a QSO–several calls would be followed by repeated reports and then multiple TUs, the whole sequence to be repeated a few moments later. Of course, this behavior is easily spotted by stations local to the gamers; I wonder how many of them realized how they were being discussed by their neighbors on the low band chat? We were careful to try and avoid being caught out and if the timing of a response seemed off, would do a repeat until the QSO was certain. The 160 m operation made over 3200 contacts; we believe this is a record for a subantarctic DXpedition. Vadym deserves great credit for this, especially for his insistence that we have the biggest antenna possible.

80 m was also a productive band, with nearly 6000 QSOs. Conditions generally followed those on 160 m, with daily QSO numbers higher towards the beginning of the expedition. Ken, NG2H, became a bit of an 80 m specialist, and he would often work the dusk and dawn shifts, and quite a lot of the time in-between. 40 m was fairly reliable at night with good rates, although there were often quiet times in the wee hours. Radio quiet, that is, although it could be pretty loud in the operating tent as Carlos, NP4IW hunted for our next 40 m phone contact. Forty was our second most productive band after 15 m. It would have been good to have two stations simultaneously on 40 m, unfortunately our second 40 m antenna suffered wind damage on a couple of occasions and so we ended up with just one 40 m station that switched between CW, SSB and RTTY.

Figure 7 - Dave, WJ2O, operating 40 m

30 m was a workhorse both night and day, except for a few hours in the afternoon. There was a particularly good opening to NA in our morning hours which became a regular feature of our schedule. We had originally planned to operate RTTY only on 40 and 15 (to maximize new mode QSOs rather than band-fills), but we decided that this opening was too good to miss, and toward the end of the expedition Arliss, W7XU, became a regular on 30 m RTTY.

20 m was a little disappointing, closing very quickly around dusk. It did, however, give us one of our most important and generally reliable openings, long path for an hour or two in the morning to western NA. We tried not to miss this because, as expected, short path to W6 was a challenge. The propagation predictions suggested that at the same time we should also have short path openings to eastern and central NA, and on multiple occasions we looked for these openings but with only modest success. It may be that somewhat disturbed geomagnetic conditions were a hindrance on paths that pass through the southern polar region.

17 m and 15 m were our day-time money bands, and we would often have two stations on one or both,

with huge pileups for hours on end. EU and JA would dominate for most of the day. Later in our afternoon NA would start coming in and the operating tent would be filled with the sound of Jim, N6TQ's booming voice, as he worked to get the SSB pileups to play nice during the relatively short NA/SA opening.

12 m was reasonably reliable from around 0700 to 1300 UTC, while 10 gave us slightly shorter openings on many days. As K9LA's propagation discussion explains, conditions were simply too marginal for reliable communication on the longest paths. The vast majority of these contacts are likely to be new-band QSOs, since 10 and 12 were hardly open at all for VKØIR at the bottom of the sunspot cycle.

While we were on the island, we had frequent feedback from the support team who were receiving helpdesk tickets from around the world. They would triage the input, and tell us what they thought was most important for us to know. It was particularly helpful to have detailed, thoughtful suggestions from pros like John, K6MM who was processing the DXers' feedback and who also understood what it was like on the DXpedition. We would swap notes and analyses, and then plan accordingly.

Sometimes a forwarded email was all that was needed, like the note asking for 15 m RTTY that read "We are three Argentine stations, LU8EKC, LU3CQ and LU2DSL. LU8EKC will reach into the honor roll with VKØEK, LU3CQ, will be close to and LU2DSL will be a new one for him. We are OLD TIMERS and thought if we lose this expedition, probably will not be here for the next one, hi hi". My response the next day read "worked them all". Rich was able to transform some of these interactions into news items on the website, like PD7RB's note to Freshdesk saying that there was too much noise at his home QTH, and he was going to try operating mobile by the sea shore that weekend, using his K3 with 100 W to a mobile whip– he hoped we would be on 20 m on Saturday. We were, and later we heard he had made a 20 m CW QSO for an ATNO. Rich posted the story and video to VKØEK.org.

Did Someone Turn Off the Radios?

On April 2nd, we thought things were going pretty well. Then, suddenly, radio conditions took a huge turn for the worse. *Figure 8* shows the moving average of the QSO rate and the k-index as a function of time over the course of the expedition.

A coronal hole caused a jump in the k-index to six and it stayed high for hours. Our radios suddenly went quiet. The QSO rate dropped by 80%, and remained in the doldrums for two days. Frustration at both ends of the DX circuit! For the on-island team, the disappointment was compounded because the weather on those days was awful and so we could not even take advantage of the decline in radio propagation to go outside and commune with the penguins. Conditions picked up somewhat, but after three days there was another solar storm which quieted our radios once more. One small compensation for the on-island team is that we can say we saw the Aurora Australis, although our display of the southern lights was muted by the cloud cover. Our lesson from this experience: If you can walk outside at 2 am and the sky is glowing, you should probably just head to your sleeping bag and forget about calling CQ!

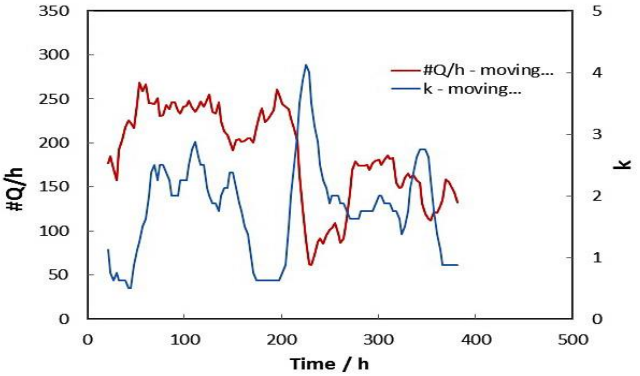

Figure 8 - Moving average (24 h) of QSO rate and k index.

Following these propagation hits, we had to consider how to best fulfill our objective of giving an ATNO to as many DXers as possible. We decided to identify some of our operating positions as "ATNO Stations" in the last days of the operation. These specifically asked for ATNO contacts or new mode contacts during the final weekend and DXers were requested to only call these stations if a QSO with Heard Island gave them an ATNO or new mode. I've tried "ATNOs only" before on a previous DXpedition, and been disappointed with the results. Calling for ATNOs *or* new mode contacts was less restrictive and we hoped that people would follow those instructions. Also, since we had networked logs, we were able to police the callers: "XX9YYY, you're already in the log on SSB, please, only ATNOs or new mode contacts". I was pleased that most callers followed our operators' instructions and helped their fellow hams make those special QSOs.

***AudioLog 3 April 2016 1:12 PM local**. Right now we are sitting at 51,189 QSOs. Unfortunately we are experiencing a major solar storm, perhaps a flare, so there is almost no propagation. We cannot hear any stations and apparently no stations can hear us*.

To Spit, or not to Spit?

An idea from the early days of planning the expedition was that we should consider activating a second site on Heard Island, at Spit Bay on the north-east coast. The driver for this was the mountain, Big Ben, at the center of Heard Island that blocks low-angle signals to the east and south–so limiting communications of western and central NA, and even VK and ZL. By putting a second camp on the other side of Big Ben we should improve our signals in these areas. So, we prepared and transported equipment for a possible Spit Bay operation. The Australian Antarctic Division (AAD) had shelters in place at Spit Bay that they allowed us to use, and this location had previously been the site of research expeditions. So, it seemed feasible to propose an operation from Spit Bay with a few operators and a minimal amount of equipment. However, as with any plan on a subantarctic island, a backup, and a backup to the backup are needed. The weather and conditions at the time may cause you to revise plans that were conceived based on the best available prior information.

The first blow to the Spit Bay operation came when the AAD draft permit arrived a few days before the expedition departure, and it included restrictions on travel in the Spit Bay/Stevenson Lagoon area. We knew landing at Spit Bay would be challenging, and exit via Stevenson Lagoon provided a possible alternative escape route in case we were cut off by poor sea conditions on the northern coast. The permit conditions removed this possibility. Once we arrived on Heard Island, we were able to see for ourselves the swell and surf that pummeled the north shore. Matt Jolly, skipper of the Braveheart, was on the lookout for a suitable weather window that would allow a safe landing and exit, but this never arrived. Meanwhile, we were analyzing the logs, especially looking at QSOs with western NA. Our analysis was that the long path openings were giving us reasonable numbers of contacts, in line with other parts of the continent. The sentiment within the team was in alignment, we expected western NA to be hard, but it was not proving to be impossible by long path. Spit Bay could give a propagation advantage to California, but given the prevailing weather we might remove operators from Atlas Cove and find that in the end we couldn't land them at Spit and have them bobbing around at sea for days, thus reducing our QSO total everywhere. A decision was made, we would not send a radio team to Spit Bay, but operate only from Atlas Cove and continue to use the best propagation we had to the hard-to-contact areas shielded by the volcano. The Braveheart would still depart to Stevenson Lagoon on the south-eastern end of Heard Island, taking KK6EK and our two research-focused team members, Gavin and Fred, while the 11 remaining radio team members continued our operations from Atlas Cove.

Jim Colletto N6TQ log. 5 April 2016. *Just about the time the radio team starts to get into a routine, a huge aurora hits above Antarctica, crushing radio propagation, and it takes almost 72 hours to recover. The day after the aurora, we have an opportunity to see the lingering effects above Big Ben at night.*

Summary of the Operation

In total, VKØEK logged over 75,000 contacts on 10 through 160 m with over 21000 unique callsigns (28%). 19.4% of our contacts were with our hardest continent, NA. *Figure 9* shows the QSOs by time and band throughout the expedition. The diurnal variation is clear, with only 30 and 40 m providing high rates during the long hours of darkness just after the autumn equinox. The pronounced drops in rate caused by two solar storms are apparent in the second half of the expedition.

A high proportion of the contacts were made by CW. This in part reflects the composition of the team and our operating preferences, but also the effectiveness of CW under the relatively marginal and often disturbed propagation conditions that we encountered.

An emphasis on the edge bands (*Figure 10*) resulted in a record number of 160 m QSOs, although 10 m numbers were constrained by the propagation that was fairly marginal given the state of solar activity in the decline of this solar cycle.

AudioLog 10 April 2016 11:49 AM local*. We have two radios operating at the moment, on 20 m and 40 m, but when the higher band goes out this evening we will stay on 40 m through the night. In the morning that will be shut down and we will be QRT.*

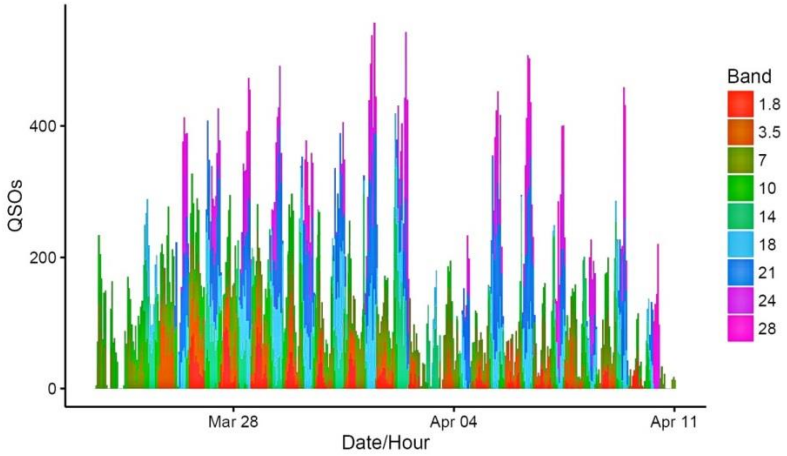

Figure 9 QSOs by band and date throughout the expedition.

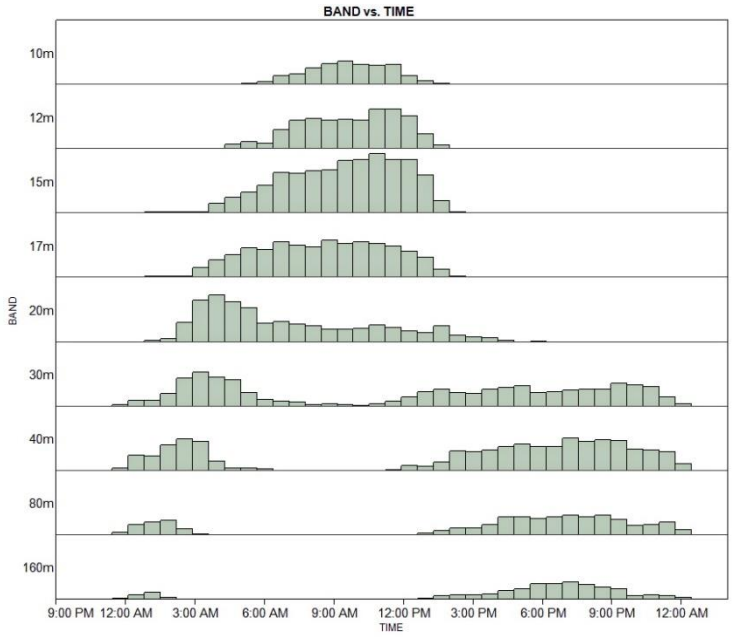

Figure 10 - Histogram showing the relative number of QSOs for each band as a function of UTC time.

Comparison with the Previous Heard Island DXpedition

It is interesting to note that VKØEK accumulated most QSOs during the daylight hours peaking around 11-12 UTC, while for VKØIR (1997) the QSO maximum occurred around 16 UTC. This can probably be explained by the solar conditions and the time of year when the VKØEK and VKØIR operations took place. VKØEK was on the air just after the equinox in March/April with near equal-length days and nights. Solar flux was low in 2016 and there were multiple solar disturbances during our time on-island in this declining solar cycle. VKØIR took place in January, the middle of the austral summer, and consequently nights were quite short. Solar flux was even lower for VKØIR but with fewer propagation disturbances.

The long hours of darkness for VKØEK meant that the high bands were closed for a half to two-thirds of the time. 20 m propagation was patchy and disappeared almost entirely at night (*Figure 10*). In contrast, for VKØIR, large numbers of contacts were logged on 20 m throughout the day and night; the low solar flux was adequate to keep 20 open during the long days and through the brief night, and calm solar conditions may have resulted in less polar absorption. Consequently, VKØIR made nearly 38% of their contacts on 20 m. In March/April 2016, VKØEK had propagation during the long nights only on 30-160, resulting in relatively lower night-time rates. On the other hand, the relatively higher solar flux in 2016 allowed intermittent propagation on 10/12 and hot daytime conditions on 15/17, with 15 being our most productive band.

VKØEK Propagation (Contributed by Carl Luetzelschwab, K9LA)

From March 23 through April 11 of 2016, the VKØEK DXpedition made a little over 75,000 QSOs with Amateur Radio operators worldwide. The breakdown by band is shown in *Figure 11*.

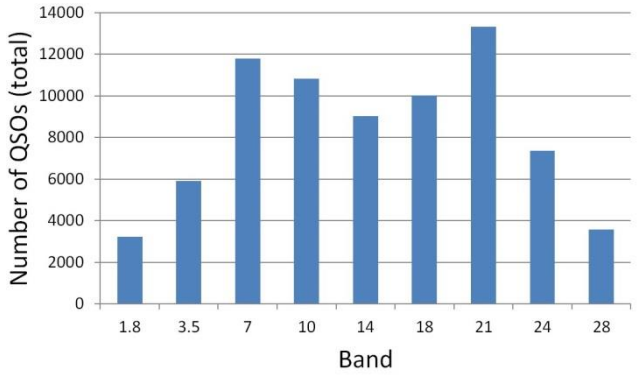

Figure 11 - QSOs by band

One of the obvious observations seen in here is the drop off in QSOs on 12-Meters and even more on 10-Meters. In fact, the QSO total on 10-Meters wasn't much more than the QSO total on 160-Meters. What that tells us is solar activity wasn't high enough to provide consistent worldwide 10-Meter openings. Indeed, the time frame of the VKØEK DXpedition was when the smoothed 10.7 cm solar flux was around 95. This just isn't high enough for consistent worldwide 10 m openings.

Digging deeper into the 10 m openings, we find that stations in Asia made 1120 QSOs with VKØEK, stations in Europe made 2284 QSOs with VKØEK, and stations in North America made only 83 QSOs with VKØEK. *Figure 12* gives us insight why Asia and Europe were favored over North America.

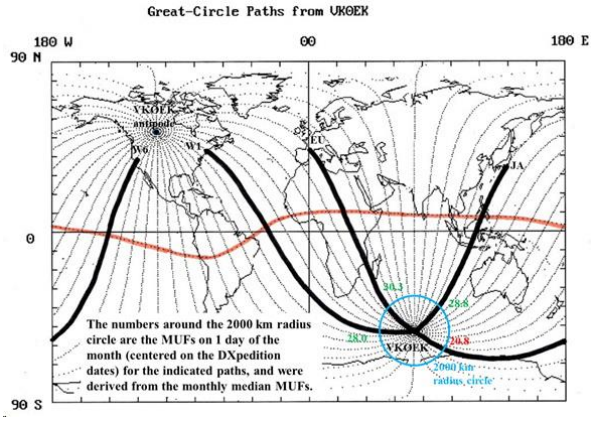

Figure 12 – Great circle paths from VKØEK

The basic map in *Figure 12* shows great circle paths out of VKØEK, with its antipode in VE5. The paths to Europe, Asia, North America W1 and North America W6 are highlighted as thick black lines. The meandering orange line above and below the geographic equator is the magnetic equator.

A 2000 km radius blue circle is drawn around VKØEK. 2000 km from VKØEK is the midpoint of a 4000 km hop via the F2 region. It has been empirically found that if the F2 region 2000 km away from the launch point can support propagation at the desired frequency, then it is likely that propagation along the entire path can be supported (the same criteria needs to be applied to the other end of the path, too). This concept is called the control point method, and it is used in our propagation prediction programs to assess F2 region propagation on long distance paths. As noted, we should look at both end of each path, but just looking at the VKØEK end gives us a reasonable idea of which paths could be productive on 10 m.

The model of the ionosphere in our propagation predictions is a monthly median model. The monthly median MUF at the 2000 km control point on the VKØEK end of the Europe path is 23.5 MHz. On one day of the month the Europe path could be supported at 30.3 MHz. On several days of the month the Europe path could be supported at 28.0 MHz. In a similar manner, on one day of the month the Asia path could be supported at 28.8 MHz. The North America W1 path was quite iffy–it had a very low, but finite, probability of being open. The North America W6 path was not predicted to have any openings on 10 m.

160 m Path	Distance [km]	Common Darkness
to Europe	13,056	7 hrs 44 min
to Asia	11,551	8 hrs 0 min
to North America W1	17,147	2 hrs 30 min
to North America W6	17,961	1 hr 7 min

The above analysis was for great circle paths. Skewed paths, similar to those seen on 10 m during the January/February 2014 FT5ZM DXpedition, could have been possible if people were looking in the correct direction with their directional antennas. Of course VKØEK being about two years farther down on Cycle 24 than FT5ZM wouldn't help matters. A final comment for 10 m is that trans-equatorial propagation

across the magnetic equator may have played a role in the large amount of Europe and Asia QSOs.

Now let's look at the other end of the spectrum–160 m. Digging deeper into the 160 m openings, we find that stations in Asia made 481 QSOs with VKØEK, stations in Europe made 2378 QSOs with VKØEK (about a hundred more QSOs than on 10 m!), and stations in North America made 294 QSOs with VKØEK. The table above gives the common darkness times for the paths from VKØEK to Europe, Asia, North America W1 and North America W6. The term "common darkness" refers to the duration of when the entire path is in darkness between the two locations. The durations of common darkness for Europe and JA are similar, as are the distances. The significantly reduced number of QSOs to North America is undoubtedly due to the significantly less duration of common darkness and the significantly increased distance.

If you were trying to work Heard Island during the January 1997 VKØIR DXpedition, you might remember that there was an area in southwest North America and extending to the upper Midwest of North America where working VKØIR was essentially impossible due to no common darkness in this area. With the recent VKØEK DXpedition going in late March/early April, this generally was not a big factor. It was close, though, for those straight south of the VKØEK antipode (cf., *Figure 12*).

Other Radio-Related Activities

Maritime Mobile Operations

In keeping with the tradition of many expeditions that have sailed on the Braveheart, we set up a /MM station in the forward saloon, with a trapped vertical antenna mounted on the railings of the upper deck. Many of the team members spent hours at sea operating /MM, with HB9BXE, UT6UD and N6TQ being particularly active. Others of us found that sitting operating radio brought on our sea-sickness, and so we stayed away from the pileups. Many of our contacts were with grid-square chasers, and we worked some stations multiple times as we slowly made our way across the southern ocean from one super-rare grid square to another. To begin with, signals were strong from the major population centers of NA and EU, but they started to fade as we headed further and further south. All told, the team made over 10,000 /MM contacts in the three and a half weeks we were at sea. Two thirds of the contacts were made on the way to Heard Island, only a third on the return; perhaps by then, even Hans-Peter needed a rest from the radio!

Figure 13 – The /MM QSL card

Coordination with FT4JA

Based on our original schedule for VKØEK, we did not expect to have another major DXpedition on the air at the same time as us. However, plans change, and as we and the FT4JA team finally locked in our transportation arrangements, it turned out that both these top-ten entities would be on the air at the same time. How would that possibly work? Well, in the end, it worked out fine due to early communication and cooperation between both teams. The expeditions agreed that VKØEK would work lower in the bands, and listen "down", while FT4JA would work higher in the bands, and listen "up". This arrangement caused some consternation within the VKØEK team to begin with; would people understand "down"? To mitigate this risk, both expeditions publicized the joint band plans well in advance, and "down" turned out not to be a problem. In the end this approach worked excellently for both teams, avoiding the mutual interference that would have occurred if we had not cooperated.

WSPR

When the /MM station was not being used, we would switch the antenna over to a weak signal propagation reporter (WSPR) beacon that K2ARB brought on the expedition. This GPS-connected 250 mW QRP Labs Ultimate 3S radio transmitted a WSPR protocol signal that was received by WSPR network stations around the globe, and could be followed on the wsprnet.org website.

The DXA Experience from the Operator's Perspective

Only a few of the team had used DXA prior to VKØEK, so we were very interested to see how this would impact the operation. In theory, DXA totally eliminates the need for duplicate contacts and the threat of pirates. These are significant advantages for the DXpedition and DXers. DXA also provides an extraordinary supplementary experience for the DXer –he has the sense of watching the action, and even participating. Meanwhile, if the DXA connection was lost for any reason, it did not affect our ability to continue making contacts. Since we had multiple BGAN terminals loaned to the expedition by Inmarsat, we were confident that any interruption in our satellite link would be temporary. If any glitches did occur they were quickly fixed by Bill, AEØEE, our on-island IT go-to guy.

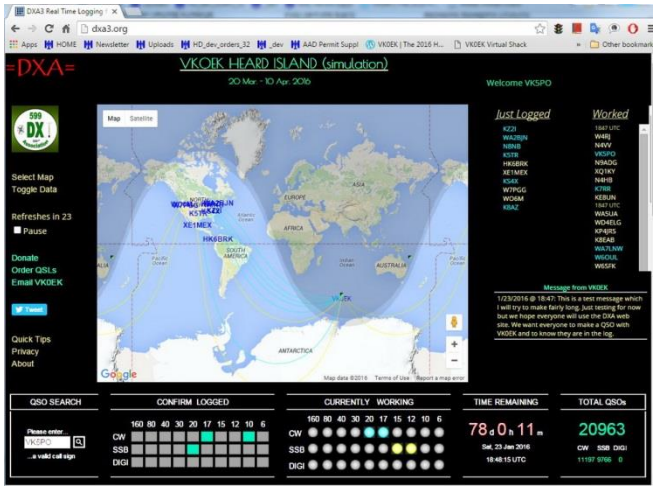

Figure 14 – A typical DXA web page update

Use of DXA is quite transparent to the operator at the radio. A QSO is made and logged on networked N1MM+. Separate from the logging computers, another networked laptop was running N1MM+ and the DXA console program; as the log was updated in N1MM+, the DXA console program read the log data, and this was transmitted via satellite to a central DXA server. This was then used to generate the information and graphics presented on the DXA website. All this is working in the background, while the ops are simply making and logging QSOs in the normal way.

We quickly understood that DXers were indeed enthusiastically viewing DXA. It was popular amongst the operators, too, since we could view DXA on the logging laptops and get a real-time view of who was being worked. Since the logging computers were all networked (necessary for DXA operation), we could also see each other's QSOs in the N1MM+ log as we worked. With the considerable bandwidth available to us due to Inmarsat's sponsorship, the ops also quickly determined that we could use tools such as the reverse beacon network, propagation sites, and chat rooms. During rest periods, I could even log in to DXA on my iPhone from the comfort of my sleeping bag, just to check on how the operation was proceeding.

One useful feature of DXA for the DXer is the set of lights indicating which bands are in operation. A band/mode indicator lights up when a QSO is logged on that band/mode combination, and stays lit until contacts stop being logged on that band/mode. On the DXpedition side, we realized that this could be a double-edged sword, because a station might be active and CQing, but people were not listening to that band because the DXA indicator showed no activity. We started to more actively use spots to indicate activity, and might occasionally send a dummy QSO (e.g., VKØEK/TEST) to DXA to turn on its lights when we started CQing.

Remote Radio

Prior to departure, we had speculated as to whether it would be possible to deploy an experimental package to remain on Heard Island that might include a remote-radio transponder. It became clear that the AAD would not permit this, but there was still interest in at least performing some tests while we were on Heard Island. Mike, KJ4Z, was keen to try remote operation and our sponsor Elecraft was also enthusiastic. Inmarsat's sponsorship gave us the required satellite bandwidth. Alan, VK6CQ, lent his VKØLD call to this operation so that it would be clearly distinguished from VKØEK.

The remote operation demonstration was carried out on 4th April, using 20 m CW. Bill, AAØEE set up a laptop running remote software on one of our K3S stations. Back in California, KJ4Z used a K3/0 to control the station on Heard Island. It was fascinating to watch the K3S making QSOs as Mike controlled the radio from his home in California. To an observer it seemed that there was some latency, and Mike confirmed this afterwards. To cope with the latency, he modified his pileup operating practice by slowing down the CW speed and sending the received station's call twice–otherwise, some stations would call again, thinking they had not been heard. The VKØLD QSOs clearly demonstrated the feasibility of a remote operation even to a location on the very edge of the BGAN satellite footprint, while highlighting some challenges in achieving a high rate.

The Last Words…

Figure 15 - The VKØEK QSL card

The 2016 Heard Island expedition was conceived and always planned to be a multi-disciplinary effort, combining radio, science and IT goals. The project plan evolved considerably, particularly when the switch to the Braveheart required us to reduce to a team of just 14. This required that the project be re-crafted to be a majority-radio operation, but still with significant science and exploration components. The proposal attracted an eclectic team, all of whom were hams but whose resumes included Antarctic research, climbing, caving and diving expeditions, as well as radio DXpeditions. The project's varied goals enabled us to tap into resources unavailable to a radio-only operation. They made the proposal to visit Heard Island more attractive to the controlling authority, the AAD. The project's many activities resulted in a span of social media and educational outreach that introduced amateur radio and the concept of a DXpedition to a broad audience. The VKØEK team was very pleased to be able to achieve the breadth of goals of the expedition, while at the same time moving Heard Island far down the most wanted lists.

***AudioLog 11 April 2016. Daily Report to the AAD**. Given the weather predictions, it seems clear that we made our exit just in time…*