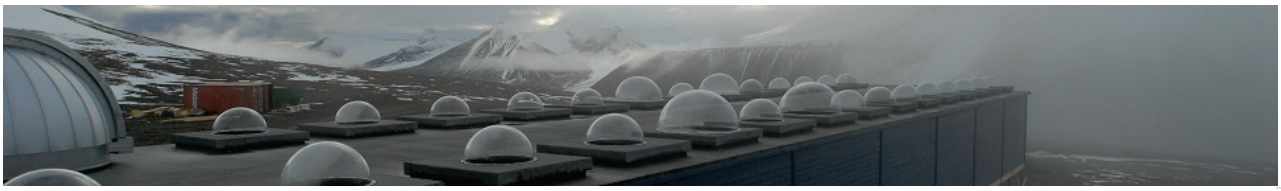

The Kjell Henriksen Observatory (KHO): Status and highlights - 2016

BIRKELAND CENTRE FOR SPACE SCIENCE

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Abstract

The following is a summary for the activity at the Kjell Henriksen Observatory (KHO) in 2016. The current active personnel of the observatory are presented together with the operational instruments. A brief summary of the progress of the new constructed Super Dual Auroral Radar Network (SuperDARN) radar is given in addition to project highlights from the Boreal Aurora Camera Constellation (BACC). Near future activity is suspected to be high.

The observatory crew

The current crew of KHO is listed below. F. Sigernes headed and had the daily operational responsibility together with Mikko Syrjäsuo.

Name	UNIS position	E-mail
Fred Sigernes	Professor, Optics and atmospheric Research, Head of KHO, Leader Ground-based Instrumentation Group BCSS.	freds@unis.no
Mikko Syrjäsuo	Head engineer	mikkos@unis.no
Noora Partamies	Associate Prof. Middle atmospheric physics	noorap@unis.no
Dag Arne Lorentzen	Professor, Upper polar atmosphere, Head of the SuperDARN radar project, UNIS node leader of the BCSS	dagl@unis.no
Lisa Baddeley	Associate Professor, Radar applications, Head of the Doppler Pulsation Experiment C0-Investigator, SuperDARN radar project	lisab@unis.no
Silje Eriksen Holmen	PhD candidate, Middle atmospheric physics	siljeh@unis.no
Xiangcai Chen	PhD candidate, Aurora physics	xiangcai.chen@unis.no
Pål Gunnar Ellingsen	Post Doc, Space physics	pale@unis.no
NEW Emma Bland	Post Doc, Middle atmospheric physics	emmab@unis.no
NEW Erkka Heino	PhD candidate, Middle atmospheric physics	Erkka.heino@unis.no

Table 1. The Kjell Henriksen Observatory crew (2016).

Our Norwegian Construction and Property Management Department in Longyearbyen contact is Tommy Frantzen (tofr@statsbygg.no).

Teaching and courses

KHO serves as the main laboratory for hands on training and teaching of students in the Space physics group at UNIS.

Fig. 1 show students on field work using both the EISCAT radar and KHO. They used state-of-the-art facilities to do in-situ observations of the aurora.

Fig.1. AGF-345 students at Breinosa. Photo: Njål Gulbrandsen

The following 5 courses have used KHO as part of field work:

Code	Course name	ECTS
AGF-216	The Stormy Sun and the Northern Lights	5
AGF-301/801	The Upper Polar Atmosphere	15
AGF-304/804	Radar Diagnostics of Space Plasma	15
AGF-345/845	Polar Magnetospheric Substorms	10
AGF-210	The middle polar atmosphere	15

Table 2. UNIS courses using KHO as laboratory (2016)

A grand total of **60 ECTS** (European Credit Transfer and Accumulation System) have been taught.

Operational instrumentation

During the auroral winter season from November to the end of February, 28 optical instruments operate 24 hours a day. The 13 non-optical instruments run all-year-round 24 hours a day.

The instruments at KHO are grouped into mainly five categories (#):

A. All-sky cameras and narrow field of view imagers,
B. Meridian scanning photometers,
C. Spectrometers / spectrographs
D. Scanning / imaging interferometers
E. Radio or non-optical instruments

A detailed description of the performance and the scientific objective of each instrument are found online. 21 different institutions from 13 nations are present at KHO. Figures 3 and 4 show a map of where the instruments are located. Table 3 lists all of the instruments according to institution and category (#).

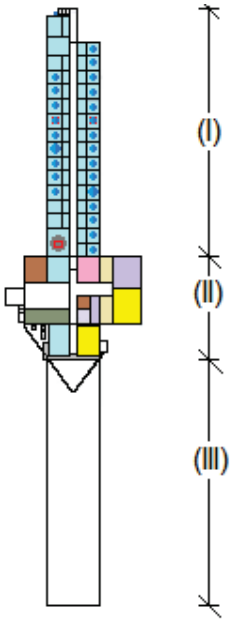

Fig. 2. Sketch of KHO: (I) Instrumental section, (II) Service section, and (III) Extended platform.

Note that out of 30 instrument domes; only 3 are currently not in use.

	Instrument	Institution	#	Country
1	All-sky imager	University of Oslo (UiO)	A	Norway (NO)
2	All-sky intensified video camera	University Centre in Svalbard (UNIS)	A	NO
3	All-sky intensified camera	Finnish Meteorological Institute (FMI)	A	Finland
4	All-sky color camera	University College London (UCL)	A	England
5	All-sky video camera	UNIS	A	NO
6	All-sky DSLR camera	UNIS	A	NO
7	All-sky Airglow Imager	UNIS	A	NO
8	Auroral meridian spectrograph	National Institute of Polar Research (NIPR)	C	Japan
9	Michelson Interferometer	Embry Riddle Aeronautical University (ERAU)	D	USA/NO
10	Spectrographic Imaging Facility	The University of Southampton/UCL	C	England
11	Meridian-Scanning Photometer	University of Alaska Fairbanks/UNIS	B	USA/NO
12	1m S.Ebert-Fastie spectrometer	University of Alaska Fairbanks/UNIS	C	USA/NO
13	1m G.Ebert-Fastie spectrometer	University of Alaska Fairbanks/UNIS	C	USA/NO
14	1/2m B.Ebert-Fastie spectrometer	University of Alaska Fairbanks/UNIS	C	USA/NO
15	1/2m W.Ebert-Fastie spectrometer	University of Tromsø (UiT)	C	NO
16	Fabry-Perot interferometer	UCL	D	England
17	Scanning Doppler Imager	UCL	D	England
18	Monochromatic Auroral Imager	Polar Research Institute of China (PRIC)	A	China
19	All-sky Airglow Imager	Kyoto University	A	Japan
20	Fluxgate magnetometer	UiT	E	NO
21	2-axis search coil magnetometer	Augsburg College/Univ. of New Hampshire	E	USA
22	Fluxgate magnetometer	PRIC	E	China
23	Auroral Radio Spectrograph	Tohoku University	E	Japan
24	HF acquisition system	Institute of Radio Astronomy/UiT	E	Ukraine/NO
25	64xBeam Imaging Riometer	Danish Meteorological Institute (DMI)/UiT	E	Denmark/NO
26	Balloon Telemetry Station	University of Rome	E	Italy
27	Hyperspectral tracker (Fs-Ikea)	UNIS	C	NO
28	All-sky hyperspectral camera	UNIS	C	NO
29	Narrow field of view tracker	UNIS	A	NO
30	Scintillation and TEC receiver	University of Bergen (UiB)	E	NO
31	Beacon Satellite receiver unit	FMI	E	FI
32	Automatic weather station	UNIS	E	NO
33	4xWEB cameras (safety)	UNIS	A	NO
34	Celestron 4m Telescope	UNIS	A	NO
35	Internet radio link - Janssonhaugen	NORSAR	E	NO
36	Red Line all-sky Camera	University of Calgary	A	Canada
37	UHF Ground station	National Institute for Aeronautics (LAPAN)	E	Indonesia
38	UHF Ground station	Technische Universität Berlin (TU)	E	Germany
39	All-sky Auroral Imager	Korea Polar Institute (KOPRI)	A	Korea
40	Boreal Auroral Camera Constellation	UNIS (KHO) and UiO (Ny-Ålesund)	A	NO
41	Meridian Imaging Spectrograph	UNIS	B	NO
42	HF Doppler Receiver	UNIS	E	NO

Table 3. Instruments at the Kjell Henriksen Observatory (2016).

Two new groups from Indonesia and Korea have installed instruments at KHO in 2016.

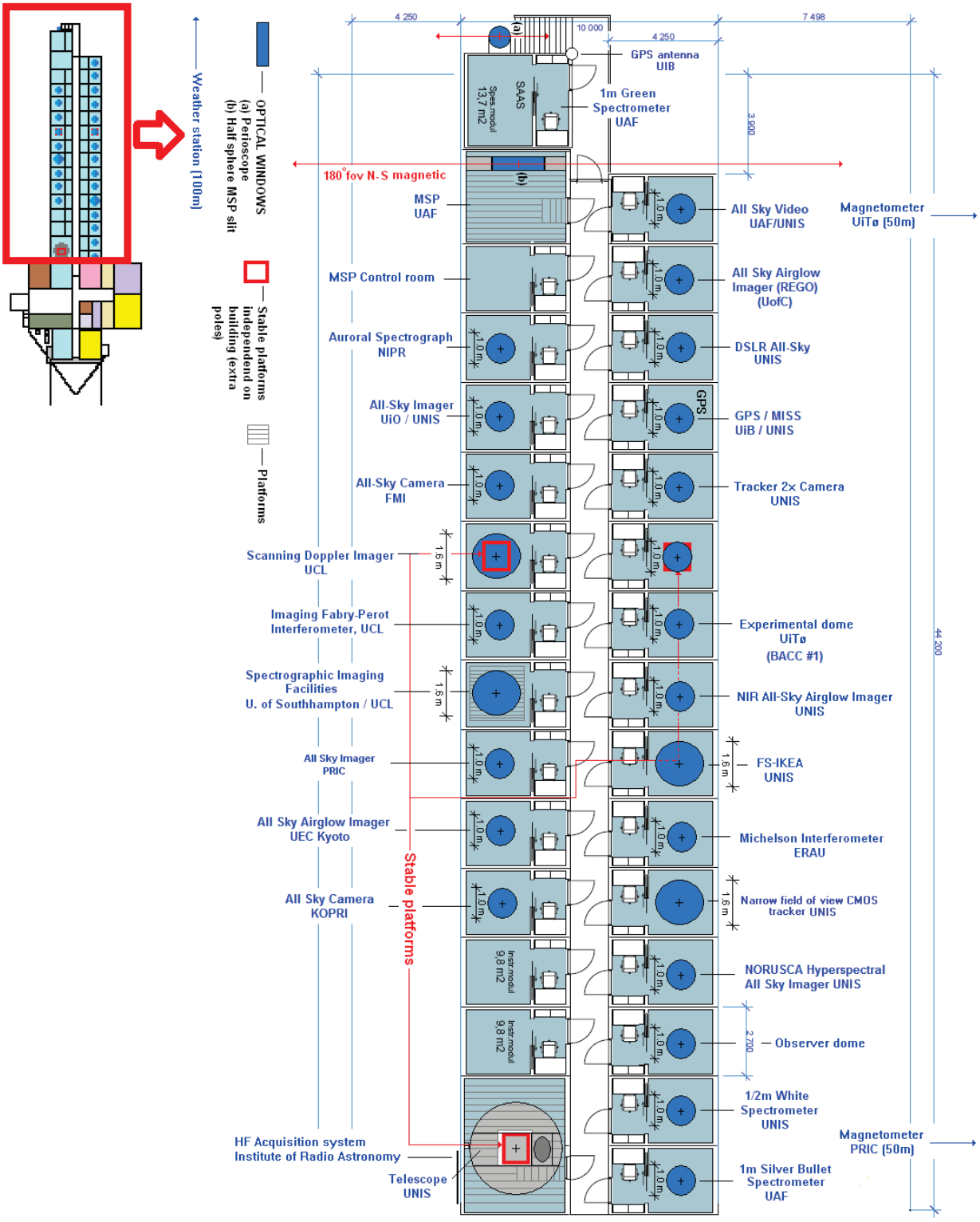

Fig.3. Map of the optical instruments at the Kjell Henriksen Observatory (2016).

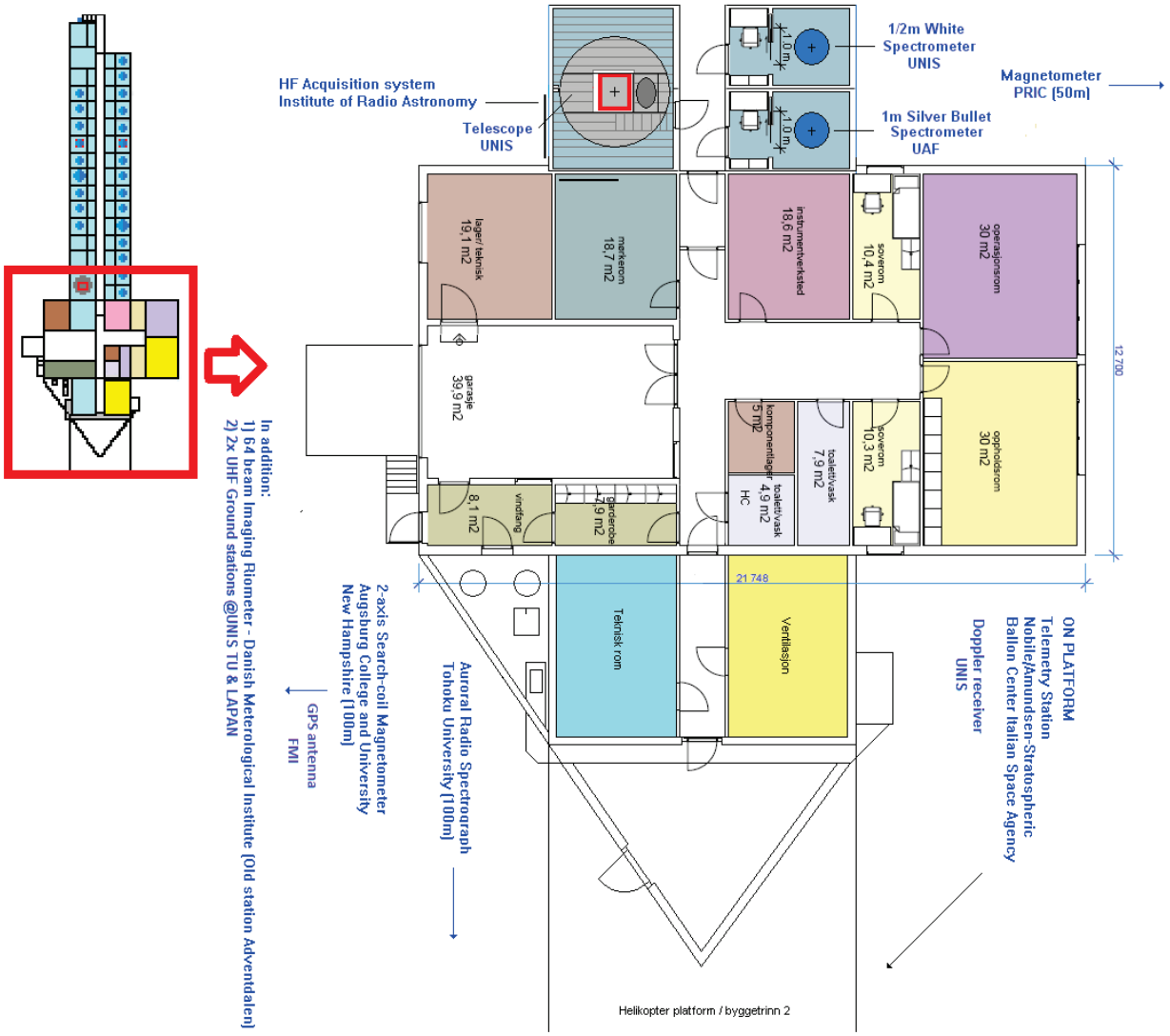

Fig.4. Map of the service section at the Kjell Henriksen Observatory (2016).

Major Highlight

Doctora S. E. Holmen 19.12.2016

We are proud to announce that Silje Eriksen Holmen has defended her PhD thesis "Trends and variability of polar mesopause region temperatures attributed to atmospheric dynamics and solar activity". The defense was on Tuesday 19th of December 2016.

Read more

Other events

Aurora Forecast 3D released 06.12.2016

The new auroral forecast is now released. It is a cross-platform app for both Android and Windows computers. It is published on Google Play for android phones (version 4.0 and up). It forecasts the aurora oval up to +0, +1, and +4 hours ahead in time at any location on the planet using a 3D graphical layout. It got a rating of 4.5 with over 1K downloads in less than one month after release in Google Play.
More info

Storm ripped off our roof! 11.11.2016

The storm on Monday 7th of November ripped off half of our roof of the service section. It took off and landed 50m away from KHO towards Eiscat, right on top of the new magnetometer from PRIC. The Sensor survived the attack. Five minute average wind speeds were up to 30 m/s out of the Bolterdalen valley towards North. The Company Svalbard Bygg As has started the repairs. The finished 4th January 2017.
See damage: [**Images**]

Australian 60 Minutes 11.04.2016

The newsmagazine 60 Minutes from Australia has visited KHO. They learned about the origin of the Aurora and was given a tour of the Observatory and the EISCAT radars. The airborne footages of the radars by their Quadrocopter are really astonishing.
See YouTube: [**video**]

Philippe Boucher 15.04.2016

Philippe Boucher has broadcasted on the Euronews program "Learning World" a film about our activity on the mountain. The film called "Water Odyssey - The closest university to the North Pole" has been translated into 13 languages all over Europe including Arabic.
See film: [**movie**]

Public outreach

A large number of presentations, visits and interviews have been conducted at KHO. It is possible that in future a media relations person could help out with the outreach side of the station as currently the numbers of requests are too large to be dealt with purely by the scientific staff. The impacts of the 60 minutes and Philippe visits are not known. On the other hand, the forecast app is rated high and has reached over 1000 downloads in less than a month. The Facebook page for KHO has over 1000 followers and posts that have reached 15000 people.

Intercalibration workshop and 43 AM

In order to secure our long term trend data we aim to continue our work with the Nordic optical intercalibration workshops. Our laboratory spectrometer travelled to Sodankylä Observatory in August 2016 to check and verify the Swedish and Finnish calibration sources. The Space physics group at UNIS also attended the 43nd Annual European Meeting on Atmospheric Studies by Optical Methods (43AM) hosted by the University of Southampton, Winchester, UK, August 15-19, 2015.

The Svalbard SuperDARN (Super Dual Auroral Radar Network) HF Radar

Planning permission for the facility was awarded in May 2014 and construction on site began in October 2014. The antenna masts were mounted in August 2015.

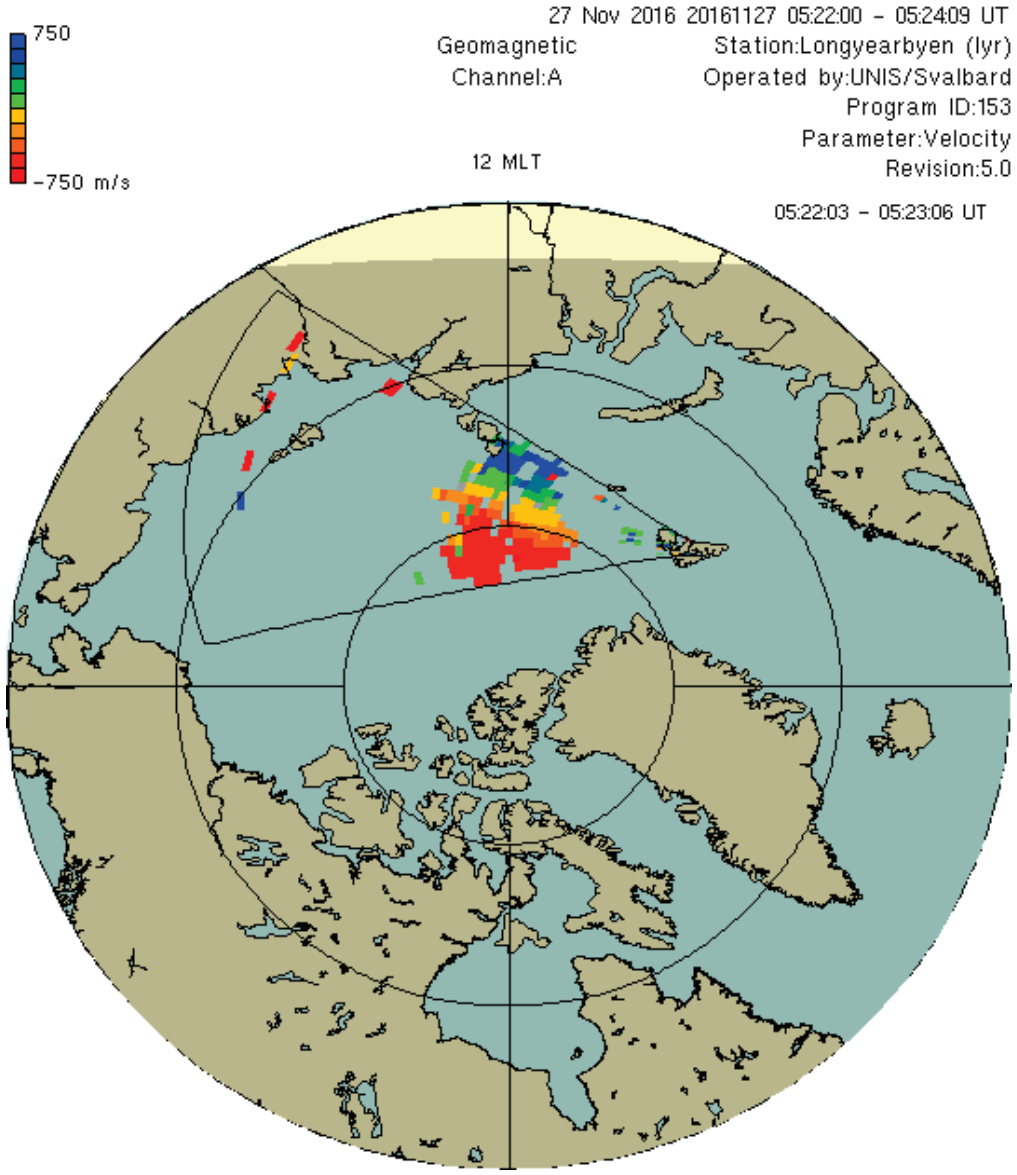

Fig. 5. Ionospheric velocity plot from the Svalbard SuperDARN radar 27th of November 2016.

Main power and optical fiber connections were also installed in 2015. First radar functionality tests were carried out in November 2015 and finally routine operations started autumn 2016. First radar functionality tests were carried out in November 2015 and finally routine operations started autumn 2016.

The new SuperDARN radar provides 24 hour data coverage of the ionospheric conditions to the North East of Svalbard. The field of view is orientated along the auroral oval providing observations of auroral conditions before they rotate into the field of view of the optical instruments at the KHO (facilitating possible improvements to the auroral forecast). The primary data product from the system is the ionospheric convection velocity. Figure 5 shows how the radar can locate the cusp before it enters the field of view of our optical instruments. The data is stored both locally and at the SuperDARN data storage facility at the British Antarctic Survey where it is utilized to produce global ionospheric convection maps in real time.

The Boreal Aurora Camera Constellation (BACC)

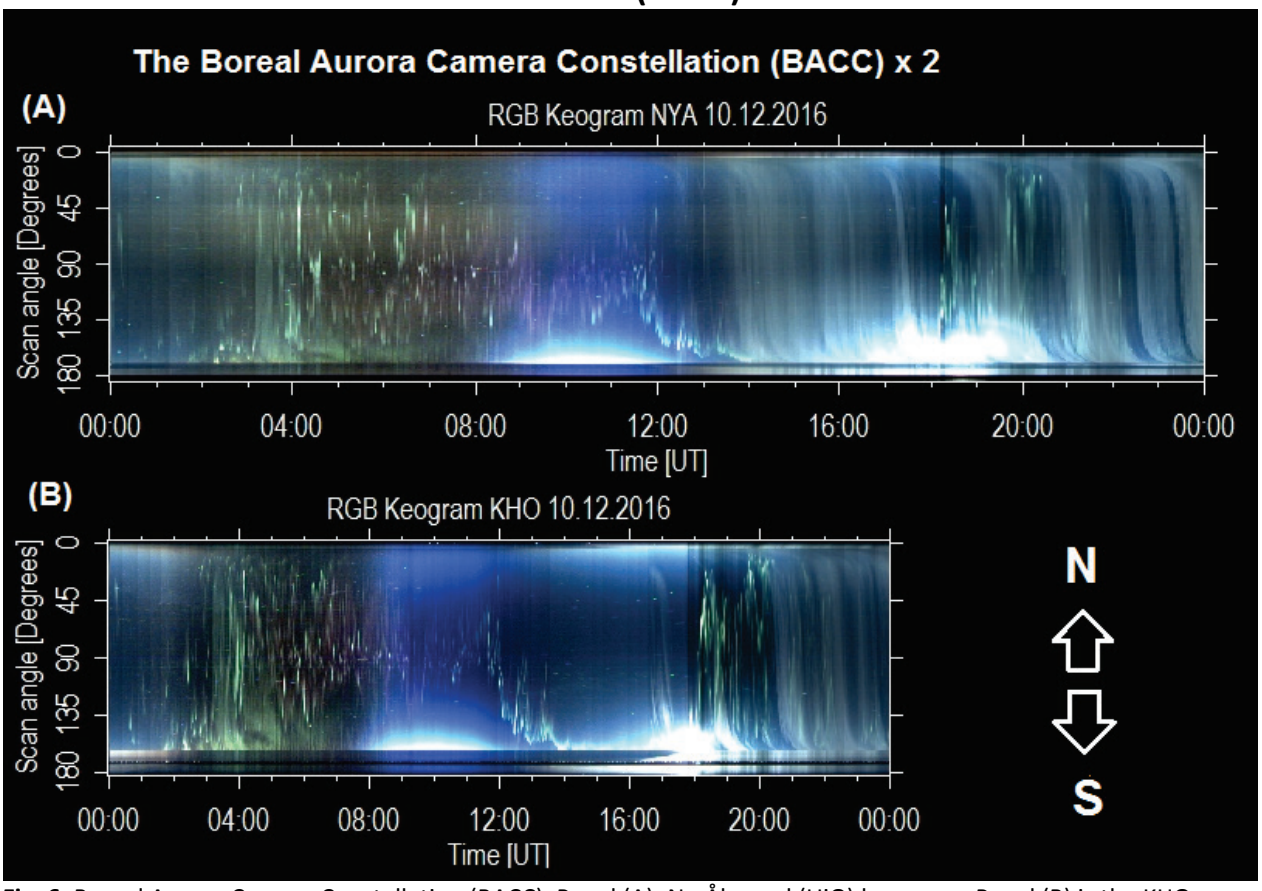

Fig. 6. Boreal Aurora Camera Constellation (BACC). Panel (A): Ny-Ålesund (UiO) keogram. Panel (B) is the KHO keogram. North – South (N-S) direction is along the geomagnetic meridian.

The BACC project is starting to grow forming a constellation of low cost high sensitive all-sky color cameras monitoring the aurora oval at multiple sites. Two cameras are now operative. A detailed description of the system is found here. The latest camera (#2) was installed 8th of

December 2016 at the Sverdrup Station in Ny-Ålesund. It was handed over as a gift to the Space physics group from the University of Oslo.

Figure 6 shows dual site keograms from BACC at 10th of December 2016. A keogram is a time stack of intensities as a function of view angles. Or it may be defined as sliced sections of the all-sky images from geomagnetic North to South as a function of time. The above panels show clear sky and high auroral activity in the morning sector. Clouds started to move in from North at ~14:00 UT in Ny-Ålesund. The location of the oval and the dayside aurora are clearly identified from both sites. Both color processing and altitude estimation by triangulation can now be applied in real time as soon as we agree on robust methods to use.

The above cameras will be very useful during future rocket and radar campaigns. We now finally have identical cameras in both Longyearbyen and in Ny-Ålesund.

Governmental white paper on Svalbard

Our work has been positively noted in the Norwegian governmental white paper on Svalbard (Meld. St. 32 (2016-2016):

> *"Norge er ledende i nordlysforskningen, og Kjell Henriksen-observatoriet (KHO) utenfor Longyearbyen er kjernen i norsk og internasjonal nordlysforskning. Sammen med rakett- og satellittmålinger, samt radaranleggene EISCAT og SuperDARN, utgjør dette en unik forskningsinfrastruktur på Svalbard. Denne forskningsinfrastrukturen stiller Norge i en sterk posisjon for å delta i internasjonalt samarbeid på feltet.»*

In English this means that we are on track.

Summary

The Kjell Henriksen Observatory (KHO) is part of The Birkeland Centre for Space Science (BCSS) and the activity has been normal 2016 with several events. The newsmagazine 60 Minutes from Australia visited us in April. Our new cross platform Aurora Forecast 3D app is published at Google play with high rating and interest. The major highlight was Silje Eriksen Holmen's defense in December. One disaster struck us during the storm in early November. The roof of the service section blew off. Luckily, no instruments were damaged. It took the company Svalbard Bygg AS almost a month to repair the roof. Our SuperDARN (Super Dual Auroral Radar Network) radar was officially opened 19th of October. It now provides data to the rest of the world in real time. Two instrumental groups have joined KHO. The National Institute for Aeronautics & Space (LAPAN) from Indonesia installed an UHF ground station to communicate with their new satellite. The Korean Polar Research Institute (KOPRI) installed a new all-sky camera. In addition, our Boreal Camera Constellation (BACC) has started to grow. Finally, five UNIS courses have used KHO as the main laboratory for teaching and 1 PhD student has graduated with flying colors.

New plans KHO – near future

The next NASA rocket campaign that KHO supports is the VISIONS-2: Quantifying ion outflow in the cusp, which is planned to be launched from Ny-Ålesund in December 2018. In addition, a new CREX2 (Cusp Region EXperiment 2) mission is funded that will release artificial clouds to study high altitude winds in the cusp region. The Grand Challenge Initiative (GCI) cusp project is also expected to be launched in 2018-2019.

The planned rocket mission time tables gives us time to tune up our existing instruments and plan for new ones. The Meridian Imaging Svalbard Spectrograph (MISS) is finished and only needs operational software to contribute. Our tracker system need to be tuned up and tested. For the CREX 2 campaign, it is essential to select the optimal center wavelengths for the NORUSCA cameras.

The next BACC partner is Tromsø Geophysical Observatory (TGO), University of Tromsø. A new camera installed at the mainland Norway in Alta will enable us to view the active part of the auroral oval on the nightside. This will support and extend our forecast service in latitude.

A new initiative is started together with the Department of Engineering Cybernetics at NTNU and Andøya Space Center to launch a drone to detect aurora above the cloud layer. The Raptor EMCCD all sky color camera will be mounted on board. In return, we develop small hybrid 3D printed hyperspectral pushbroom imagers to NTNU. In addition, an experiment to launch a camera or a home seeking drone by a balloon is planned together with the ISTAR (International Science technology and Research) group.

The internal research funding of UNIS is of vital importance in future plans. It enables us to preserve the instrumental momentum and helps us keep track of new technology as it arrives. It seeds our research plans and proposals and is as a consequence strategically important to us. This must not be underestimated compared to our external funding which is more tied up or locked to predefined proposal tasks.

Graduated students

1. *Silje Holmen Eriksen*, PhD., Trends and Variability of polar mesopause region temperatures attributed to atmospheric dynamics and solar activity, University of Tromsø / UNIS, Norway, December 19, 2016.

Presentations 2016

1. Fred Sigernes, Dag A. Lorentzen, Magnar G. Johnsen, Torsten Aslaksen, Mikko Syrjäsuo, Stefan Wacker, Jakob Abermann, Bjørn Lybekk, Espen Trondsen, Lasse Clausen and Jøran Moen, The Boreal Aurora Camera Constellation (BACC), The 43nd Annual European

Meeting on Atmospheric by Optical Methods, Winchester, UK, 15 -19 August, 2016.

2. F. Sigernes, Low Cost Hyperspectral Imaging for Drones, Summer Schools Arctic Earth Observation techniques, Norwegian Centre for Space-related Education (NAROM), Andøya Space Centre, 8-12 August, 2016.

3. L. Baddeley, E. Bland and S. E. Holmen, The Kjell Henriksen Observatory – a window into space (joint presentation and tour of KHO), Studietur Nord, Svalbard, August 2016.

4. L. J. Baddeley, D. A. Lorentzen, V. A. Pilipenko, N. Yagova, N. Nosikova, O. Kozyreva, V. Belakhovsky, N. Partamies, K. Oksavik, W. Denig, and X. Chen, Space Physics Research on Svalbard: Optical Observations of ULF Waves (invited talk), Leicester University, May 2016.

5. L. J. Baddeley, D. A. Lorentzen, N. Partamies, V. A. Pilipenko, K. Oksavik, W. Denig, and X. Chen, Co-ordinated EISCAT and optical measurements of multiple equatorward propagating auroral arcs, MIST (Magnetosphere – Ionosphere – Solar Terrestrial Physics) meeting, Lancaster University, UK , April 2016.

6. J. Baddeley D. A. Lorenzten, K. Oksavik, C. van Der Meeren and X. Chen, Space Physics and Atmospheric Research at the University Centre in Svalbard (UNIS), (L. Baddeley and D. Lorenzten co-presenters; invited talk), Space Research Institute of the Russian Academy of Sciences, Moscow, February 2016.

7. N. Partamies, D. Whiter, K. Kauristie, S. Massetti, and A. Kadokura, Characteristics of pulsating aurora, HEPPA-SOLARIS meeting, Helsinki, Finland, June, 2016.

8. N. Partamies, D. Whiter, K. Kauristie, S. Massetti, and A. Kadokura, Characteristics of pulsating aurora, The 43nd Annual European Meeting on Atmospheric by Optical Methods, Winchester, UK, 15 -19 August, 2016.

9. Ellingsen, P. G., Lorentzen, D., Partamies, N. and Syrjäsuo, M., Automated classification of aurora images and keograms, 43rd Annual European Meeting on Atmospheric Studies by Optical Methods; Winchester, UK, August, 2016.

10. Ellingsen, P. G., Aurora Borealis - A Natural Wonder. Physics Friday Colloquia; Trondheim, Norway, October 2016.

11. E.C. Bland, High frequency remote sensing of energetic particle precipitation in the auroral ionosphere, 43rd Annual European Meeting on Atmospheric Studies by Optical Methods, Winchester, UK, August 2016.

12. Pilipenko V., Kozyreva O., Lorentzen D., Baddeley L, The Correspondence Between Dayside Long period Pulsations and the Open closed Field Line Boundary, First VarSITI

General Symposium, Bulgaria, June 2016.

13. D. A. Lorentzen, L.J. Baddeley, M. Syrjäsuo and G. Chisham, The Svalbard SuperDARN radar – first light, SuperDARN meeting, Fairbanks, Alaska, June 2016.

14. X. -C. Chen, D. -S. Han, D. A. Lorentzen, K. Oksavik, J. I. Moen, L. J. Baddeley, Dynamic Properties of Throat Aurora Revealed by Simultaneous Ground and Satellite Observations, SuperDARN meeting, Fairbanks, Alaska, June 2016.

15. D.A. Lorentzen and L.J. Baddeley, Space physics research at the top of the world, research seminar University College London (UCL), April 2016 (invited talk)

16. D.A. Lorentzen and L.J. Baddeley, Space physics research infrastructure at Svalbard, Norway, 3rd International ANtarctic Gravity Wave Instrument Network (ANGWIN) science workshop, Cambridge, UK, April 2016.

17. D. A. Lorentzen, M. Conde, P.G. Ellingsen, L. Baddeley, F. Sigernes and D. L. Hampton, The C-REX sounding rocket experiment, MIST (Magnetosphere – Ionosphere – Solar Terrestrial Physics) meeting, Lancaster University, UK , April 2016.

18. Marc Lessard, T. A. Bekkeng, Lasse Boy Novoc, Clausen, James H Clemmons, Geoff Crowley, Pål Gunnar Ellingsen, Bruce Fritz, Meghan I Harrington, Spencer Hatch, James H Hecht, David L Hysell, David Ross Kenward, James W Labelle, Kristina A Lynch, Jøran Moen, Kjellmar Oksavik, Antonius Otto, Noora Partamies, Steven P Powell, Brent Sadler, Fred Sigernes, Mikko Syrjäsuo and Timothy K Yeoman, The "Rocket Experiment for Neutral Upwelling 2 (RENU2)" Sounding Rocket, AGU Fall meeting 2016, San Fransisco, USA.

19. Marc Lessard , Lasse Boy Novock Clausen, James H Clemmons, Ian Cohen, Pål Gunnar Ellingsen, Charles J Farrugia, Bruce Fritz, Meghan Harrington, Spencer Hatch, James H Hecht, David L Hysell, David Ross Kenward, James W Labelle, Kristina A Lynch, Jøran Idar Moen, Kjellmar Oksavik, Noora Partamies, Steven P Powell, Brent Sadler, Fred Sigernes, Mikko Syrjäsuo, and Timothy K Yeoman, Observations of Poleward Moving Auroral Forms by the Rocket Experiment for Neutral Upwelling 2 (RENU2) Sounding Rocket (Invited), AGU Fall meeting 2016, San Fransisco, USA.

20. James H Clemmons , James H Hecht, Douglas G Brinkman, Marc Lessard, David L Hysell, Kristina A Lynch, Meghan I Harrington, Kjellmar Oksavik, Jøran Idar Moen, Fred Sigernes, Timothy K Yeoman, and Bruce Fritz, Structure of the Thermosphere during Energy Input through the Magnetospheric cusp: Measurements from the RENU2 Ionization Gauge, AGU Fall meeting 2016, San Fransisco, USA.

21. Gerard J Fasel, Taylor Glenn Brandt , Ashley Rothballer, Emma Harper, Uni Kim, Jacques Joubert, Juliet Elise Mills, Alex Booth, Connor Nam, Paige Grittner, Kaseba Chibwe, Simone Raeth, Karin Frizzelle, Charles Lammerding, Rachel Lockwood, Ben Fox, Michael

Gribble, Fred Sigernes, Dag A Lorentzen, Riley Josh, and Ashley Golla, The Brightening History of Poleward-Moving Auroral Forms, AGU Fall meeting 2016, San Fransisco, USA.

22. David Ross Kenward , Marc Lessard, Kristina A Lynch, David L Hysell, James H Hecht, James H. Clemmons, Geoff Crowley, Ian J Cohen, Fred Sigernes, Kjellmar Oksavik, Timothy K Yeoman, Sun-Hee Lee, and James L Burch, Cusp Electron Populations During a Neutral Upwelling Event: Measurements from RENU2 and MMS Conjunction, AGU Fall meeting 2016, San Fransisco, USA.

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1. E. Fedorov, N. Mazur, V. Pilipenko, and **L. Baddeley**, Modeling the high-latitude ground response to the excitation of the ionospheric MHD modes by atmospheric electric discharge, J. Geophys. Res. Space Physics (2016), 121, doi: 10.1002/2016JA023354.

2. **F. Sigernes**, P. G. Ellingsen, N. Partamies, M. Syrjäsuo, P. Brekke, S. E. Holmen, A. Danielsen, B. Olsen, X. Chen, M. Dyrland, L. Baddeley, D. A. Lorentzen, M. A. Krogtoft, T. Dragland, H. Mortensson, L. Smistad, C. J. Heinselman and S. Habbal, Video cascade accumulation of the total solar eclipse on Svalbard 2015, Geosci. Instrum. Method. Data Syst. Discuss., in press December 2016.

3. Savolainen, T., Whiter, D. K., and **Partamies, N.**: Automatic segmentation and classification of seven-segment display digits on auroral images, Geosci. Instrum. Method. Data Syst., 5, 305-314, doi: 10.5194/gi-5-305-2016, 2016.

4. Kauristie, K., Myllys, M., **Partamies, N.**, Viljanen, A., Peitso, P., Juusola, L., Ahmadzai, S., Singh, V., Keil, R., Martinez, U., Luginin, A., Glover, A., Navarro, V., and Raita, T.: Forecasting auroras from regional and global magnetic field measurements, Geosci. Instrum. Method. Data Syst., 5, 253-262, doi: 10.5194/gi-5-253-2016, 2016.

5. Tanaka, Y., Y. Ogawa, A. Kadokura, **N. Partamies**, D. Whiter, C.-F. Enell, U. Brandstrom, T. Sergienko, B. Gustavsson, A. Kozlovsky, H. Miyaoka, A. Yoshikawa, Eastward expanding auroral surges observed in the post-midnight sector during a multiple-onset substorm, *Earth, Planets and Space*, 67:182, DOI: 10.1186/s40623-015-0350-8, November 2015.

6. Hall, C. M., **S. E. Holmen**, C. E. Meek, A. H. Manson, and S. Nozawa (2016), Change in turbopause altitude at 52 and 70N, *Atmospheric Chemistry and Physics*, 16, 2299–2308, doi: 10.5194/acp-16-2299-2016.

7. **Holmen, S. E.**, C. M. Hall, and M. Tsutsumi (2016), Neutral atmosphere temperature change at 90 km, 70N, 19_E, 2003–2014, *Atmospheric Chemistry and Physics*, 16, 7853–7866, doi: 10.5194/acp-16-7853-2016.

8. **Silje Holmen Eriksen,** PhD. Thesis: Trends and Variability of polar mesopause region temperatures attributed to atmospheric dynamics and solar activity, University of Tromsø / UNIS, 2016.

9. van der Meeren, C, Oksavik, K, **Lorentzen, DA**, Paxton, LJ, Clausen, LBN, Scintillation and irregularities from the nightside part of a Sun-aligned polar cap arc, J. Geophys. Res, 121, 5723, 2016.

10. **Chen, X-C., Lorentzen, D. A**., Moen, J. I., Oksavik K, Baddeley L.J., and Lester M., F region ionosphere effects on the mapping accuracy of SuperDARN HF radar echoes, Radio Science, 51, 490, 2016.

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*Listed presentations and publications do not include all instrumental groups at KHO, only from the KHO crew.