

The Kjell Henriksen Observatory (KHO): Status and highlights - 2015



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Abstract

The following is a summary for the activity at the [Kjell Henriksen Observatory \(KHO\)](#) in 2015. 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 Total Solar Eclipse campaign and the Rocket Experiment for Neutral Upwelling 2 (RENU2) campaign.

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	noonap@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	lisab@unis.no
Margit Dyrland	Post Doc, Middle atmospheric physics	margitd@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

Table 1. The Kjell Henriksen Observatory crew (2015).

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

UNIVERSITY CENTRE IN SVALBARD UNIS BOX 156 9171 LONGYEARBYEN NORWAY

Operational instrumentation

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

Page | 2

Table 2 below lists all of the instruments according to institution and category (#).

	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	CCD spectrograph	Embry Riddle Aeronautical University (ERAU)	C	USA
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	Michelson Interferometer	ERAU	D	USA
17	Fabry-Perot interferometer	UCL	D	England
18	Scanning Doppler Imager	UCL	D	England
19	Monochromatic Auroral Imager	Polar Research Institute of China (PRIC)	A	China
20	All-sky Airglow Imager	University of Electro-Communications (UEC)	A	Japan
21	Fluxgate magnetometer	UiT	E	NO
22	2-axis search coil magnetometer	Augsburg College/Univ. of New Hampshire	E	USA
23	Fluxgate magnetometer	PRIC	E	China
24	Auroral Radio Spectrograph	Tohoku University	E	Japan
25	HF acquisition system	Institute of Radio Astronomy/UiT	E	Ukraine/NO
26	64xBeam Imaging Riometer	Danish Meteorological Institute (DMI)/UiT	E	Denmark/NO
27	Balloon Telemetry Station	Nobile/Amundsen - Stratospheric Balloon Center/Italian Space Agency	E	US/Italy
30	Hyperspectral tracker (Fs-Ikea)	UNIS	C	NO
31	All-sky hyperspectral camera	UNIS	C	NO
32	Narrow field of view tracker	UNIS	A	NO
33	Scintillation and TEC receiver	University of Bergen (UiB)	E	NO
34	Automatic weather station	UNIS	E	NO
35	4xWEB cameras (safety)	UNIS	A	NO
36	Celestron 4m Telescope	UNIS	A	NO
37	Internet radio link - Janssonhaugen	NORSAR	E	NO
38	Red Line all-sky Camera	University of Calgary	A	Canada

Table 2. Instruments at the Kjell Henriksen Observatory (2015).

During the auroral winter season from November to the end of February, 28 optical instruments operate 24 hours a day. The 10 non-optical instruments run all-year-round 24 hours a day. A detailed description of the performance and the scientific objective of each instrument are found [online](#). 21 different institutions from 10 nations are present at KHO. A map of where the instruments are located can be downloaded [here](#). Note that out of 29 instrument domes; only four are currently not in use.

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 4 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 3. UNIS courses using KHO as laboratory (2015)

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

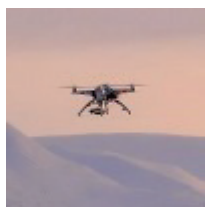
Graduated students



Master Norah Kaggwa Kwagala

June 2015

Congratulations to Master Norah Kaggwa Kwagala! She has studied dayside 630.0 nm emissions due to thermally excited O(1D) in the cusp region ionosphere over Svalbard using both KHO and Eiscat. She is now a PhD. student at The Birkeland Centre for Space Science ([BCSS](#)).



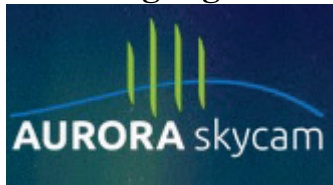
Snow mapping by drones

October 2015

We are happy to learn that Baptiste Vandecrux, Marco Marcer and Emiliano Cimoli have defended their masters successfully at the Technical University of Denmark (DTU) on snow distribution by the help of Radar, Quadrocopters and Optics. KHO salute you!

Read all: [\[1\]](#) [\[2\]](#)

Other highlights



Aurora Skycam

18.05.2015

KHO has teamed up with Aurora Skycam - a camera network with professional photographers that aims to provide real-time displays and alert systems of the aurora across the northern hemisphere. More info: [\[3\]](#)

Page | 4



ICI-4 Launched

20.02.2015

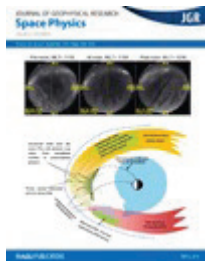
AGF-304/804 Master and PhD students provided radar support for the University of Oslo sounding rocket named ICI-4 that was launched successfully from Andøya Space Centre at 23.06 LT on 20th of February, 2015. See more info here: [\[4\]](#).



Queen Sonja

05.02.2015

Her Royal Majesty Queen Sonja of Norway has visited KHO. Together with friends she inspected key instruments and was given an update on our research on aurora and airglow. The global weather machine and solar impacts was also discussed in relation to possible climatic changes. We are very happy for the Queens interest in our work.



Front cover of JGR

09.11.2015

Our PhD student Xiangcai Chen has together with space physics colleagues from China made the front cover of the Journal of Geophysical Research (JGR). The paper is an extensive study of diffuse dayside aurora during quiet geomagnetic conditions, over a time period of 7 years. A new type of diffuse aurora is observed at magnetic noon and is named throat aurora. More info: [\[5\]](#) [\[6\]](#)

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. Mains power and optical fiber connections were also installed in 2015. First radar functionality tests were carried out in November 2015 and routine operations are expected to begin in early 2016.

In addition a new HF transmitter is deployed to Hornsund to study small scale ionospheric and gravity waves. The receiver is installed at KHO.



Fig. 2. The SuperDARN radar under construction. Photo: Mikko Syrjäsoo/UNIS.

The total solar eclipse campaign on Svalbard



Fig. 3. High Dynamic Range (HDR) image of the total eclipse composed by 20 images from a 400 mm telescope at Nordlysstasjonen in Adventdalen.

The total solar eclipse on Friday 20th March 2015 started in the western Atlantic, 650 km west of Canada's Labrador coast and 450 km south of the southern tip of Greenland. It then raced across the Atlantic ocean touching land at only two places: the Faroe Islands between Scotland and Iceland, and the Svalbard Archipelago (particularly, Spitsbergen Island).

In Longyearbyen, Svalbard, the first contact, the start of the partial eclipse, started at 09:11:53UT. About 59 minutes later, at 10:10:43UT second contact took place, marking the start of totality.

After a mere 2 minutes and 27 seconds, third contact occurred at 10:13:10UT, which marked the end of totality and the disappearance of the corona. This was followed by a partial phase of about another 59 minutes before fourth contact and the end of the solar eclipse at 11:12:21UT.

Our campaign was divided into 7 parts using the old Auroral Station in Adventdalen, KHO, UNIS in Longyearbyen and the Dornier at Lufttransport AS. Table 4 lists the PI's and their objectives.

	Objective	Site	PI
1	Teaching	UNIS	P. Brekke
2	Public outreach	UNIS	P. Brekke
3	Coronal imaging	Nordlysstasjonen	P.G. Ellingsen
4	Auroral measurements	KHO	S.E. Holmen
5	Airborne hyperspectral imaging	Dornier	F. Sigernes
6	Coronal dynamics and spectra	UNIS	J. Pasachoff
7	High resolution spectra	Nordlysstasjonen	S. Habbal

Page | 6

Table 4. The total eclipse team at UNIS. Nordlysstasjonen refers to the old auroral station in Adventdalen.

The UNIS course AGF-216: The Stormy Sun and Northern Lights, was offered to students and local people from Longyearbyen. High resolution ground-based spectral measurements were out by a team from the Institute for Astronomy at the University of Hawaii. They used the old station in Adventdalen. Coronal dynamics was studied by a group from Williams College, Massachusetts. KHO was operative to see if we were lucky to detect aurora. In addition, an airborne experiment was conducted to image the event with a new hyperspectral camera. For more info on the campaign see [7].

Our data analyzes show promising results and was presented at the AGU 2015 fall meeting in San Fransisco (invited talk). Two highlights are presented in Figs. 4 and 5.

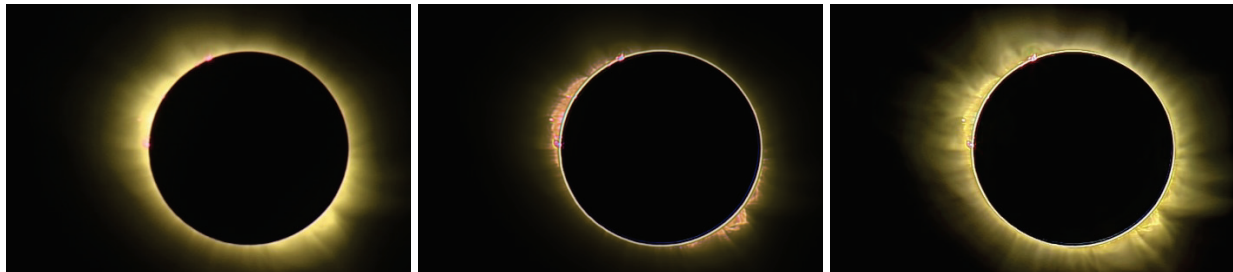


Fig. 4. Accumulated video highpass cascade filter technique applied to live broadcast from NRK of the total solar eclipse on Svalbard 2015. Left: Stabilized summation of 448 video frames (raw image). No filter applied. Middle: Accumulated frames with 5x5 pixel highpass cascade filter. Right: Accumulated 3x3 highpass cascade image fused with raw image.

KHO was also operative, but did not detect any dayside auroral signatures. The background sky condition was too bright during totality for the auroral cameras. The airborne hyperspectral data will be used to cluster and classify active solar regions with prominences from the background continuum. The video from the plane of the eclipse shadow was published by several media companies worldwide.

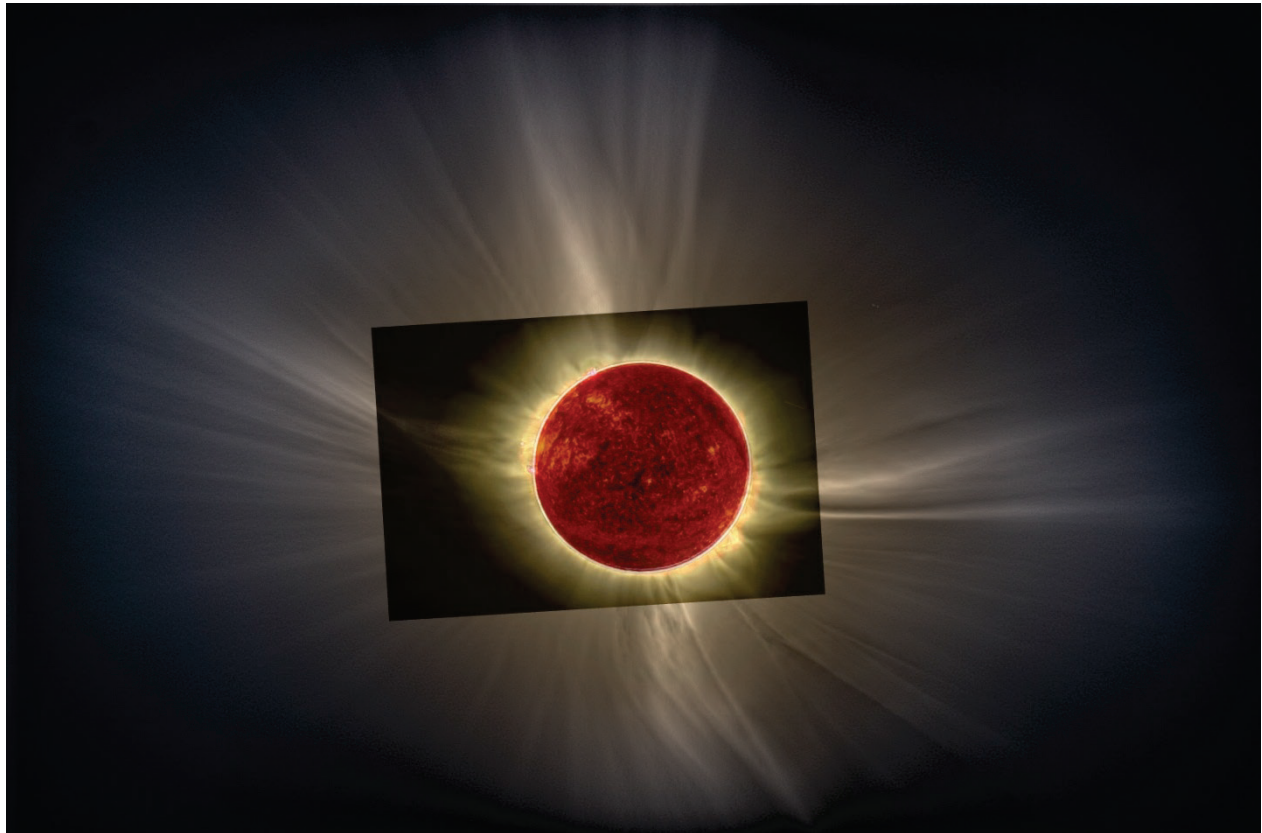


Fig. 5. High Dynamic Range (HDR) image fused with the highpass cascade video sequence from NRK and the Solar Dynamics Observatory (SDO) image at 304 nm.

The Rocket Experiment for Neutral Upwelling 2 (RENU2)

KHO has successfully supported the Rocket Experiment for Neutral Upwelling 2 (RENU 2) campaign. Our instruments together with the Eiscat radar identified and tracked the target - the dayside aurora - and the rocket was launched on the 13th of December 2015 at 07:34 UT from Andøya Space Centre.

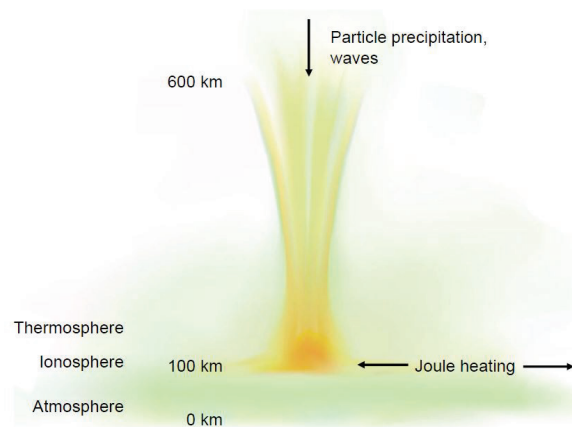


Fig. 6. Sketch of the upwelling effect in the cusp region.

The Principal Investigator (PI) Dr. Marc Lessard from the University of New Hampshire headed the campaign using KHO as his headquarter.

The rocket (Black Brant XII) flew through the Magnetospheric cusp during a neutral upwelling. The mission successfully acquired new in-situ data that will provide us with a fresh perspective on understanding the effect of upwelling.

The payload was built by NASA Wallops,



Fig. 7. The RENU 2 rocket team in the operation room of KHO looking towards North. Back row from left to right: Meghan Fisher, Mikko Syrjäsoo, Noora Partamies, Pål Gunnar Ellingsen, and Bruce Fritz. Front row from left to right: Marc Lessard (PI) and Fred Sigernes.

and included instruments from University of New Hampshire, Dartmouth College, Cornell University and Aerospace Corp. The mission was supported the SuperDARN HF radars in Finland and Iceland. The mainland and Svalbard EISCAT radars were also operative. Telemetry was received by Andøya Space Center, NASA, KSAT Tromsø and KSAT Svalbard.

See more information: [8] [9].

We expect several publications to come out of this launch.

Intercalibration workshop and 42 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 2015 to check and verify the Swedish and Finnish calibration sources. The Space physics group at UNIS also attended the 42nd Annual European Meeting on Atmospheric Studies by Optical Methods (42AM), Hermanus, Western Cape, South Africa, September 14-18, 2015.

Graduated students

1. *Kwagala, Norah Kaggwa*, Master, June 2015, Dayside 630.0 nm emissions due to thermally excited O(1D) in the cusp region ionosphere over Longyearbyen, Svalbard, University of Bergen.
2. *Marco Marcer and Baptiste Vandecrux*, Masters, August 2015, Snow Distribution Statistical Modelling and UAV-borne remote Sensing of Snow Reflectance in the Arctic, Technical University of Denmark.
3. *Emiliano Cimoli*, Master, August 2015, Determining Snow Depth Distribution from Unmanned Aerial Vehicles and Digital Photogrammetry, Technical University of Denmark.

Public outreach

A large number of presentations, visits and interviews (~50) 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 total eclipse campaign generated 85 news articles alone (source: Meltwater). Live streaming of the event by NRK was followed by more than 600 000 people. The number for TV2 is not known.

Summary

The Kjell Henriksen Observatory (KHO) is part of the Birkeland Centre for Space Science (BCSS) and the activity has been high in 2015 with three major events. It started with a revisit of Her Royal Majesty Queen Sonja of Norway in February. The Total Solar Eclipse campaign in March and the RENU 2 (Rocket Experiment for Neutral Upwelling 2) rocket launch in December were both successes and generated high public interest. The SuperDARN (Super Dual Auroral Radar Network) radar and a High Frequency (HF) receiver were finished constructed in November. The latter will receive signals from the polish station in Hornsund to study upper atmospheric gravity waves. Two instrumental groups have joined KHO. The University of Calgary installed a new red line auroral all-sky camera and NORSAR (Norwegian Seismic Array) is now routing all data communication from their station at Janssonhaugen through KHO. In addition, two new optical instruments have been prototyped and tested. Five UNIS courses have used KHO as the main laboratory for teaching and four master students have graduated.

New plans KHO – near future

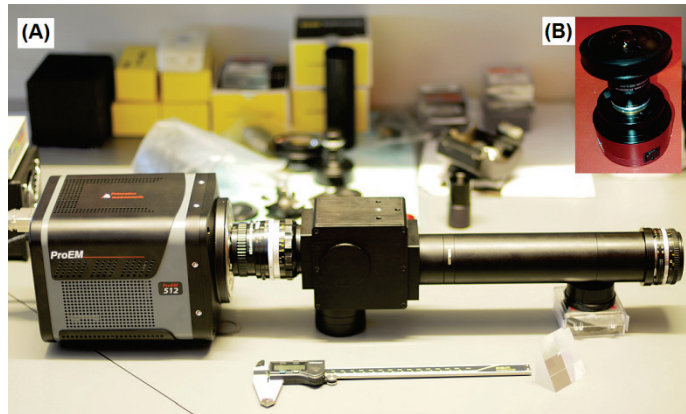


Fig. 7. New instruments at KHO 2015. Panel (A): Meridian Imaging Svalbard Spectrograph (MISS). Panel (B): The ZWO ASI174MC F/1.4 all-sky color camera.

The need to operate instruments during periods with high background sky illumination when the moon is up forces us to develop instruments with increased dynamic range without damaging the detectors. The arrival of new EMCCD and CMOS detectors enables us to construct and test new instruments that can operate under any background sky conditions including scattered light pollution. A new Meridian Imaging Svalbard Spectrograph (MISS) has been prototyped at KHO during the winter 2015-2016.

Page | 10

The MISS has no moving parts using a high sensitive CCD (Sony ICX825 EXview). Full characterization and detailed quantitative comparison to our Meridian Scanning Photometer will be carried out during the next season. In addition, a new low cost F/1.4 color all-sky camera with the new back illuminated CMOS (Sony IMX174) sensor designed to operate especially for Sun and Moon imaging is under test. The camera is a candidate for a proposal to deploy a large network of cameras in Scandinavia to image and forecast aurora. The proposal is called “The Boreal Auroral Camera Constellation (BACC)”.

The internal research funding of UNIS is used to acquire new sensors and parts for these test instruments. 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.

The new SuperDARN radar will provide 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 will be the ionospheric convection velocity. The data will be stored both locally and at the SuperDARN data storage facility at the British Antarctic Survey where it will be utilized to produce global ionospheric convection maps.

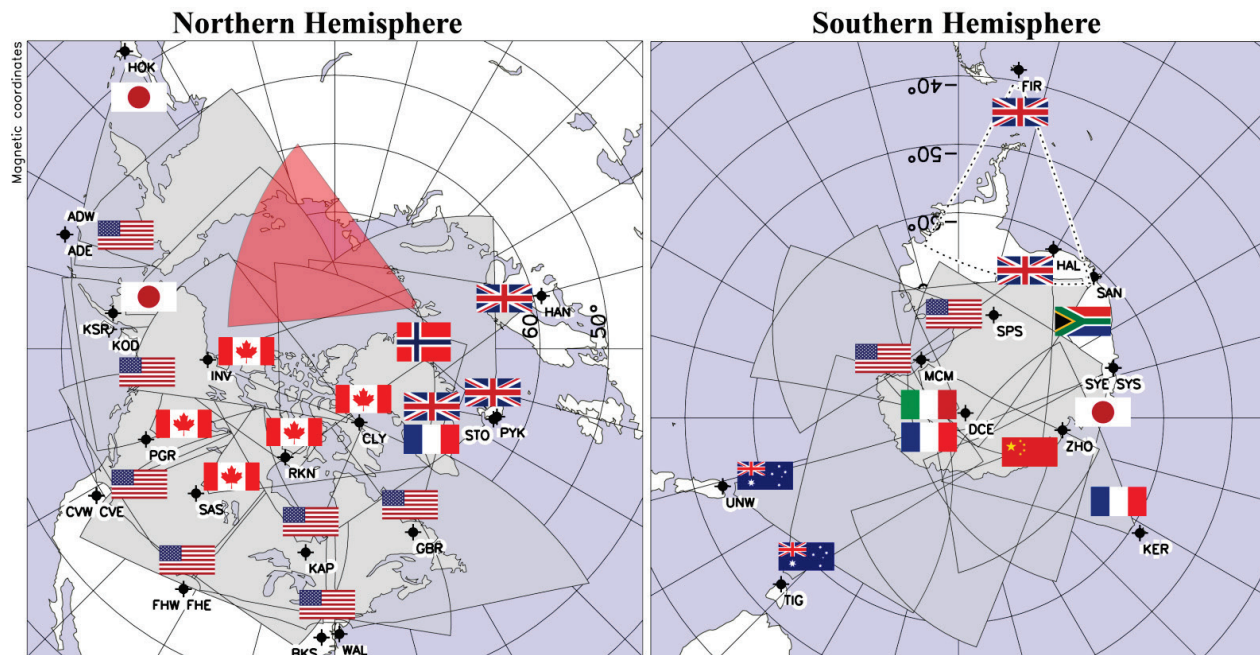


Fig.11. The SuperDARN radar network. The new Svalbard radar's field of view is mapped with red. Illustration modified from a diagram by Virginia Tech.

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.

Presentations 2015

1. Fred Sigernes, Pål Ellingsen, Silje Holmen, Pål Brekke, Arne Danielsen, Bernt Olsen, Mikko Syrjäso, Xiangcai Chen, Margit Dyrland, Noora Partamies, Lisa Baddeley, Dag Lorentzen, Marcus Krogtuft, Torstein Dragland, Hans Mortensson, Lisbeth Smistad, Kjellmar Oksavik, Craig Heinselman, and Shadia Habbal: THE TOTAL SOLAR ECLIPSE ON SVALBARD 2015 (**Invited**), AGU Fall meeting, 14-18 December, San Fransisco, USA, 2015.
2. Mark Conde, Miguel Larsen, Donald Hampton, Manbharat Dhadly, Michael Ahrns, Anasuya Aruliah, Yoshihiro Kakinami, Barrett Barker, Andrew Kiene, Fred Sigernes, and Dag Lorentzen: Winds and Ion Drifts Measured in the Thermospheric Footprint of Earth's Northern Magnetic Cusp During the C-REX Sounding Rocket Mission (**Invited**), AGU Fall meeting, 14-18 December, San Fransisco, USA, 2015.
3. F. Sigernes, P. G. Ellingsen, S. E. Holmen, P. Brekke, A. Danielsen, B. Olsen, M. Syrjäso, X. Chen, M. Dyrland, N. Partamies, L. Baddeley, D. A. Lorentzen, M. Krogtuft, T. Dragland, H. Mortensson, L. Smistad, K. Oksavik, and S. Habbal. Preliminary results from the total solar eclipse campaign on Svalbard 2015, The 42nd Annual European Meeting on Atmospheric by Optical Methods, Hermanus, South Africa, 14-18, September, 2015.

4. D.A. Lorentzen, M. Conde, P.G. Ellingsen, L. Baddeley, F. Sigernes, and D. L. Hampton., The C-REX sounding rocket – optical data, The 42nd Annual European Meeting on Atmospheric by Optical Methods, Hermanus, South Africa, 14-18, September, 2015.
5. Pål G. Ellingsen, Fred Sigernes, and Dag Lorentzen, Imaging the solar corona under the total eclipse 20th March 2015 on Svalbard, The 42nd Annual European Meeting on Atmospheric by Optical Methods, Hermanus, South Africa, 14-18, September, 2015.
6. Mark Conde, Miguel Larsen, Donald Hampton, Manbharat Dhadly, Jason Ahrns, Anasuya Aruliah, Yoshihiro Kakinami, Barrett Barker, Andrew Kiene, Fred Sigernes, and Dag Lorentzen, The C-REX Sounding Rocket Mission, EGU General Assembly, 17 -17 April, Vienna, Austria, 2015.
7. Gerard Fasel, Kate Kononenko, Ashley Rothballer, Alexandra Angelo, Mashaer Alyami, Taylor Brandt, Benjamin Fox, Alexander Grissom, Michael Gribble, Kristine Lysenstoen, Fred Sigernes, Dag Lorentzen, David Green, and Maxwell Freeman: A Study of the Different classes of Poleward-Moving Auroral Forms, AGU Fall meeting, 14 – 18 December, San Fransisco, USA, 2015.
8. Chen, X., D.A. Lorentzen, J. Moen, K. Oksavik, L.J. Baddeley, Simultaneous ground-based optical and HF radar observations of the ionospheric footprint of open/closed field line boundaries along meridian line, SuperDarn Meeting, Leicester, June 2015.
9. Noora Partamies, Daniel Whiter, Liisa Juusola, Kirsti Kauristie and Stefano Massetti, Evolution of auroral structures and heights at substorm onsets, The 42nd Annual European Meeting on Atmospheric by Optical Methods, Hermanus, South Africa, 14-18, September, 2015.
10. L. Baddeley and D. Lorentzen, Space Physics and Atmospheric Research at the University Centre in Svalbard (UNIS) British Antarctic Survey, Cambridge, UK **(invited)** - November 2015.
11. L. Baddeley, D. Lorentzen and K. Oksavik, Space Physics on Svalbard: Research and Infrastructure for investigating the auroral cusp region, Royal Astronomical Society Discussion Meeting - Current and Future Research with the Super Dual Auroral Radar Network, London, UK **(invited)** - November 2015D.
12. Lorentzen and L. Baddeley, Space Physics Infrastructure and Research at the University Centre in Svalbard (UNIS), Aberystwyth University, UK **(invited)** - December 2015.
13. Baddeley, L. J., D. A. Lorentzen, K. Oksavik, W. Denig , N. Partamies, and X. Chen, Co-ordinated EISCAT and optical measurements of multiple equatorward propagating auroral arcs, The 17th biennial EISCAT Symposium and 42AM Optical Meeting,

Hermanus, South Africa, September 2015.

14. Nosikova N.S., N.V. Yagova, V.A. Pilipenko, O.V. Kozyreva, L. Baddeley and D. Lorentzen, Spectral parameters of 1-4 mHz geomagnetic and auroral luminosity pulsations in the polar caps and near the polar boundary of the auroral oval, AGU Chapman Conference on Magnetospheric Dynamics, Fairbanks, Alaska, USA from 27 September - 2 October 2015.
15. Nosikova, N., N. V. Yagova, V. A. Pilipenko, O. V. Kozyreva, D. Lorentzen, and L. Baddeley, Does a 'substorm precursor' exist in the polar cap, EGU meeting , Vienna, April 2015.
16. Oksavik, K., C. van der Meeren, D. A. Lorentzen and L. J. Baddeley, Scintillation from poleward moving auroral forms in the cusp ionosphere (Poster), EGU Meeting, Vienna, April 2015.
17. van der Meeren, C., K. Oksavik and D. Lorentzen, Observations of simultaneous multi-constellation GNSS scintillation in nightside aurora over Svalbard (Poster), EGU Meeting, Vienna, April 2015.
18. Kwagala, N.K., K. Oksavik, D.A. Lorentzen and H.C. Carlson, Dayside 630.0nm emissions due to thermally excited O(1D) in the cusp region ionosphere over Longyearbyen, Svalbard (Poster), EGU Meeting, Vienna, April 2015.
19. L. Baddeley, High North Study Tour for the European Commission, EISCAT 3D and auroral research on Svalbard, July 2015.
20. N. Partamies and L. Baddeley, Space Physics Research on Svalbard, Studietur Nord, Svalbard, July 2015.
21. Baddeley, L., D. A. Lorentzen, Project Update: Energy Transfer from the Sun to the Earth, ConocoPhillips / Lundin High North Research Program meeting, Stavanger, June 2015.
22. Haaland, S., L. Baddeley and L. Maes, Using EISCAT vertical velocities to assess mechanisms for ion outflow, EISCAT Symposium and 42AM, Hermanus, South Africa, September 2015.
23. Haaland, S., M. Andre, L. Baddeley, A. Barakat, R. Chappell, V. Eccles, A. Eriksson, C. Johnsen, K. Li, B. Lybekk, L. Maes, A. Pedersen, R. Schunk, D. Welling, Cluster observations of cold ion outflow during the GEM storms, June (**Invited**)
24. Pål Gunnar Ellingsen, Aurora Borealis - One of the Seven Natural Wonders, Diplomatreisen 2015, UNIS, 2015-06-04.

Publications 2015*

1. Holmen, S. E., Hall, C. M., and Tsutsumi, M.: Neutral atmosphere temperature change at 90 km, 70° N, 19° E, 2003–2014, *Atmos. Chem. Phys. Discuss.*, 15, 15289–15317, doi: 10.5194/acpd-15-15289-2015, 2015.
2. Hall, C. M., Holmen, S. E., Meek, C. E., Manson, A. H., and Nozawa, S.: Change in turbo pause altitude at 52 N and 70 N, *Atmos. Chem. Phys. Discuss.*, 15, 20287–20304, doi: 10.5194/acpd-15-20287-2015, 2015.
3. Han, D.-S., X.-C. Chen, J.-J. Liu, Q. Qiu, K. Keika, Z.-J. Hu, J.-M. Liu, H.-Q. Hu, and H.-G. Yang (2015), An extensive survey of dayside diffuse aurora based on optical observations at Yellow River Station, *J. Geophys. Res. Space Physics*, 120, 7447–7465, doi: 10.1002/2015JA021699.
4. Bjoland, L. M., X. Chen, Y. Jin, A. S. Reimer, Å. Skjæveland, M. R. Wessel, J. K. Burchill, L. B. N. Clausen, S. E. Haaland, and K. A. McWilliams (2015), Interplanetary magnetic field and solar cycle dependence of northern hemisphere *F* region Joule heating, *J. Geophys. Res.*, doi: 10.1002/2014JA020586.
5. Chen, X.-C., D. A. Lorentzen, J. I. Moen, K. Oksavik, and L. J. Baddeley (2015), Simultaneous ground-based optical and HF radar observations of the ionospheric footprint of the open/closed field line boundary along the geomagnetic meridian, *J. Geophys. Res.*, doi: 10.1002/2015JA021481.
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*Listed presentations and publications do not include all instrumental groups at KHO, only from the KHO crew.