Status and Highlights - 2021

BIRKELAND CENTRE FOR SPACE SCIENCE

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Birkeland Centre for Space Science (BCSS)

Abstract

The following is a summary for the activity at the Kjell Henriksen Observatory (KHO) in 2021. The current active personnel of the observatory are presented together with the operational instruments. The activity has been high despite the corona pandemic. The observatory has been fully operational with support of two major rocket campaigns. Our SuperDARN radar is rising. Highlights and achievements are listed together with strategy and future assessments.

(1) The observatory crew

Name	UNIS position	E-mail
Fred Sigernes	Professor, Optics and atmospheric Research, Head of KHO, Leader Ground-based Instrumentation Group BCSS. Adjunct Prof. NTNU AMOS.	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 Geophysical Department, Principal Investigator (PI) SuperDARN radar project, UNIS node leader of the BCSS	dagl@unis.no
Lisa Baddeley	Associate Professor, Radar applications, Head of the Doppler Pulsation Experiment Co-Investigator (Co-I), SuperDARN radar project	lisab@unis.no
Emma Bland	Researcher, Middle atmospheric physics	emmab@unis.no
Erkka Heino	Post Doc, Middle atmospheric physics	Erkka.heino@unis.no
Katie Herlingshaw	Post Doc, Upper atmospheric physics	katie.herlingshaw@unis.no
Lindis Bjoland	Post Doc, Upper atmospheric physics	lindis.bjoland@unis.no
Fasil Tesema Kebede	PhD candidate, Middle atmospheric physics	fasil.tesema@unis.no
Nina Kristine Eriksen	PhD candidate, Upper atmospheric physics	NinaKristine.Eriksen@unis.no
Charlotte van Hazendonk	PhD candidate, Space physics	charlottva@unis.no

Table 1. The Kjell Henriksen Observatory crew (2021).

The current crew of KHO is listed above. F. Sigernes headed and had the daily operational responsibility together with Mikko Syrjäsuo. Jørgen Jahr is our contact from the Norwegian Construction and Property Management Department in Longyearbyen who owns the building.

(2) 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 shows students on excursion to KHO. Here they are trained on observational techniques, instrument building and introduced to the state-of-the-art facilities for remote observations of the aurora.

A grand total of **45 ECTS** (European Credit Transfer and Accumulation System) have been taught. Two courses were cancelled in the autumn semester of 2021 due to the COVID-19 pandemic.

The following 6 courses have used KHO as a part of field work:

Fig.1. Fieldwork for AGF-301 happy students posing in front of the DSLR All-Sky camera at KHO. Date is March 2, 2021.

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~~
~~AGF-223~~	~~Remote sensing and space instrumentation~~	~~15~~

Table 2. UNIS courses at KHO in (2021). Strikeouts are due to cancellation related to the COVID-19 pandemic.

(3) Operational instrumentation

During the auroral winter season from November to the end of February, 29 optical instruments operate around the clock. The 17 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.

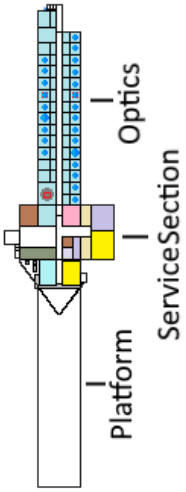


Fig. 2. Sketch of KHO.

	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 color camera	University College London (UCL)	A	England
4	All-sky video camera	UNIS	A	NO
5	All-sky DSLR camera	UNIS	A	NO
6	All-sky Airglow Imager	UNIS	A	NO
7	Auroral meridian spectrograph	National Institute of Polar Research (NIPR)	C	Japan
8	Spectrographic Imaging Facility	The University of Southampton/UCL	C	England
9	Meridian-Scanning Photometer	University of Alaska Fairbanks/UNIS	B	USA/NO
10	1m S. Ebert-Fastie spectrometer	University of Alaska Fairbanks/UNIS	C	USA/NO
11	1m G. Ebert-Fastie spectrometer	University of Alaska Fairbanks/UNIS	C	USA/NO
12	1/2m B. Ebert-Fastie spectrometer	University of Alaska Fairbanks/UNIS	C	USA/NO
13	1/2m W. Ebert-Fastie spectrometer	University of Tromsø (UiT)	C	NO
14	Fabry-Perot interferometer	UCL	D	England
15	Scanning Doppler Imager	UCL	D	England
16	2 x Monochromatic Auroral Imager	Polar Research Institute of China (PRIC)	A	China
17	All-sky Airglow Imager	Kyoto University	A	Japan
18	Fluxgate magnetometer	UiT	E	NO
19	2-axis search coil magnetometer	Augsburg College/Univ. of New Hampshire	E	USA
20	Fluxgate magnetometer	PRIC	E	China
21	Auroral Radio Spectrograph	Tohoku University	E	Japan
22	HF acquisition system	Institute of Radio Astronomy/UiT	E	Ukraine/NO
23	64xBeam Imaging Riometer	Danish Meteorological Institute (DMI)/UiT	E	Denmark/NO
24	Hyperspectral tracker (Fs-Ikea)	UNIS	C	NO
25	All-sky hyperspectral camera	UNIS	C	NO
26	Narrow field of view tracker	UNIS	A	NO
27	Scintillation and TEC receiver	University of Bergen (UiB)	E	NO
28	Beacon Satellite receiver unit	Finnish Meteorological Institute (FMI)	E	Finland (FI)
29	Automatic weather station	UNIS	E	NO
30	4xWEB cameras (safety)	UNIS	A	NO
31	Celestron 4m Telescope	UNIS	A	NO
32	Internet radio link - Janssonhaugen	NORSAR	E	NO
33	UHF Ground station	National Institute for Aeronautics (LAPAN)	E	Indonesia
34	UHF Ground station	Technische Universität Berlin (TU)	E	Germany
35	All-sky Auroral Imager	Korea Polar Institute (KOPRI)	A	Korea
36	Boreal Auroral Camera Constellation	UNIS (KHO) and UiO (Ny-Ålesund)	A	NO
37	Meridian Imaging Spectrograph	UNIS	B	NO
38	HF Doppler Receiver	UNIS	E	NO
39	3 x GNSS Scintillation Receivers	Nagoya University	E	Japan
40	3 axis induction magnetometers	PRIC	E	China
41	VHF base station	Kongsberg Satellite Service AS (KSAT)	E	NO
42	TESS-W photometer	University of Madrid (UCM)/UNIS	B	Spain/NO
43	2 x Tracker cameras	UNIS	A	NO
44	3 x GNSS receivers	University of Colorado	E	USA

Table 3. Instruments at the Kjell Henriksen Observatory (2021).

24 different institutions from 12 nations are present at KHO. Figures 3 and 4 show a map of where the instruments are located. Table 3 lists all according to institution and category (#). Note that out of 30 instrument domes; 5 are currently not in use.

Note: 3 new instruments will be installed in 2022.

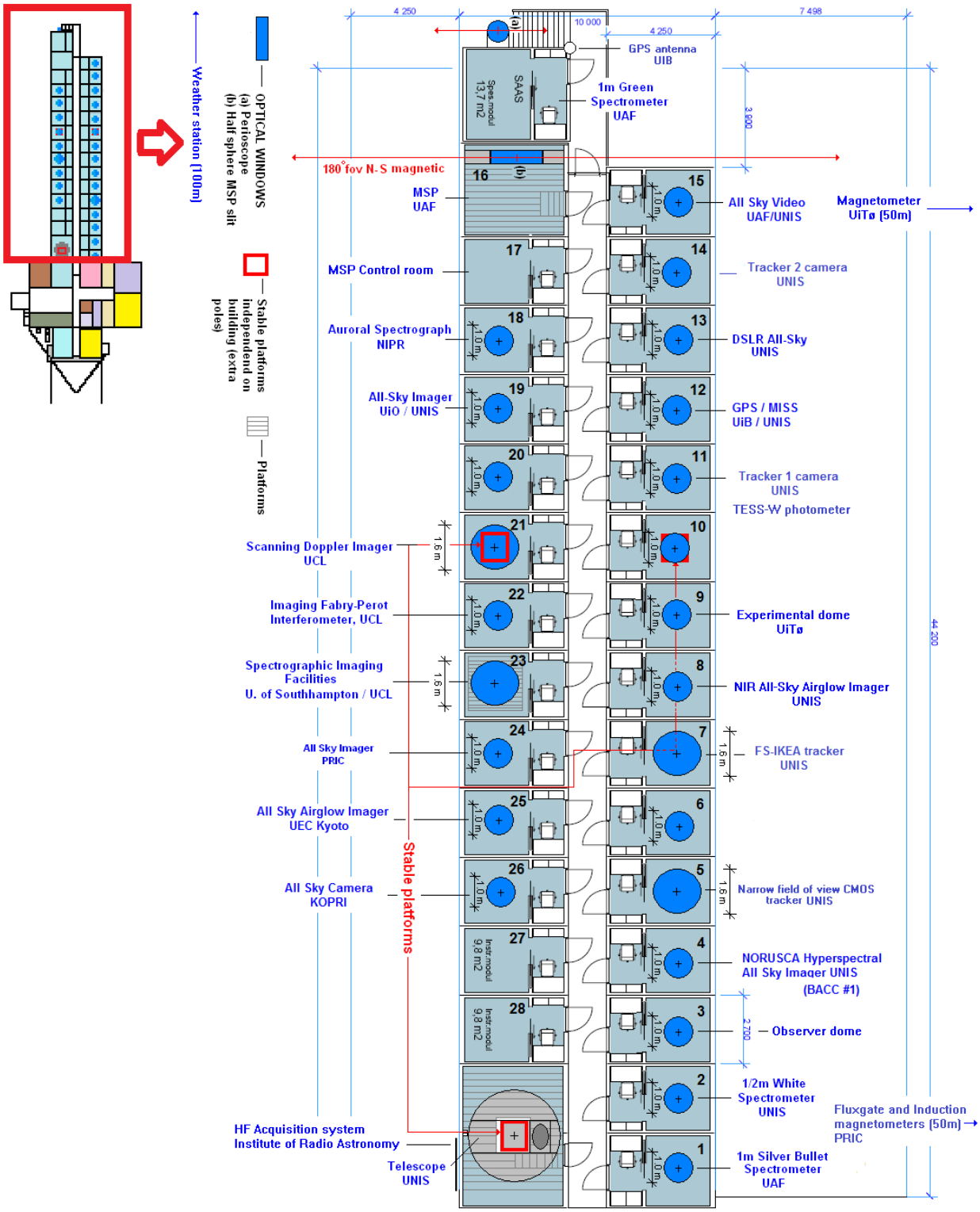


Fig.3. Map of the Instrumental section (Optics) at the Kjell Henriksen Observatory (2021).

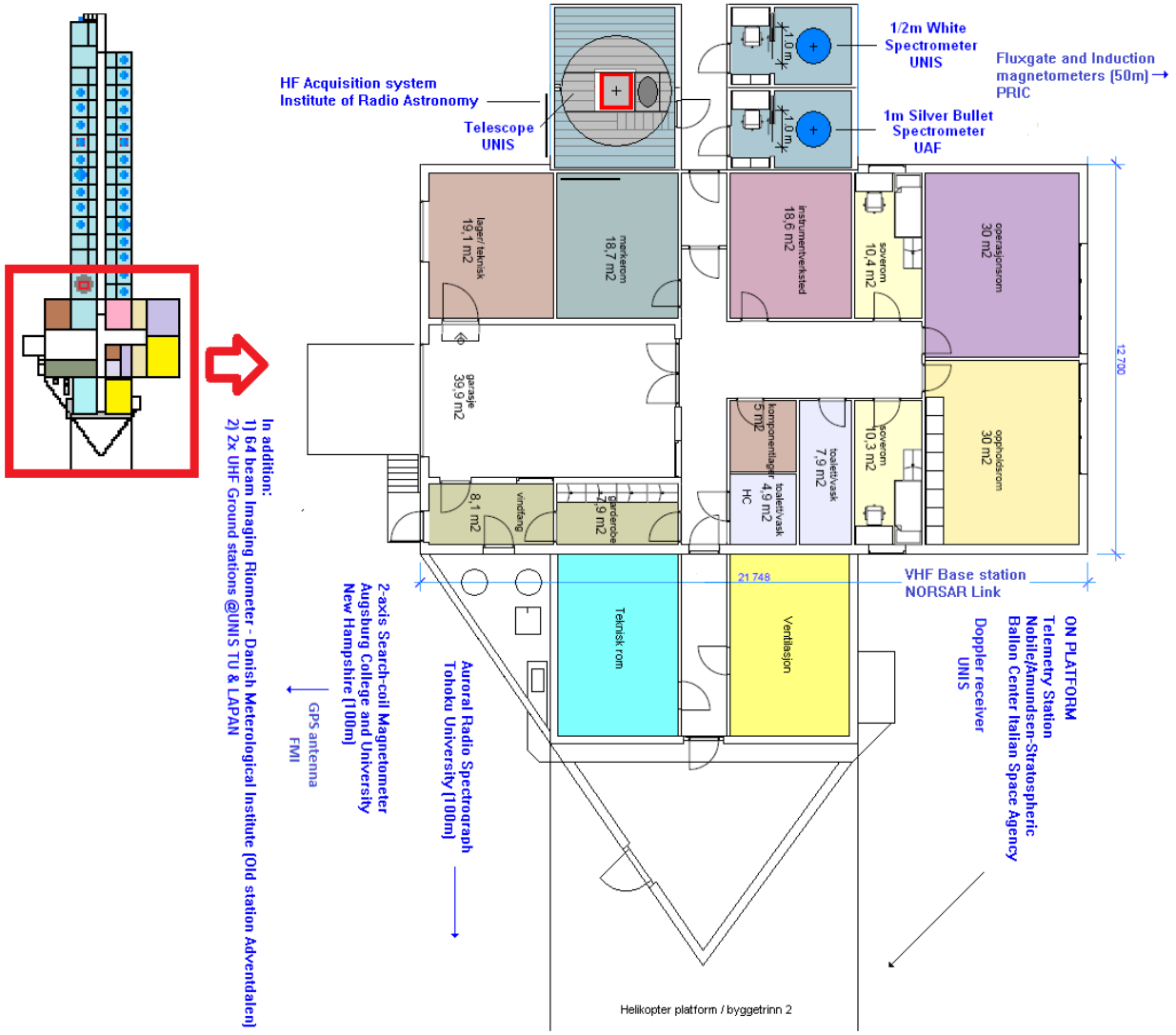


Fig.4. Map of the Service section at the Kjell Henriksen Observatory (2021).

(4) State of the building

All gas-discharge emergency light tubes in the observatory have been replaced by Light Emitting Diodes (LED). The electrical noise generated by the gas-discharge light tubes was thought to be the reason for electrical noise. The Silver bullet spectrometer is still detecting random large spike count noise patterns - even with the detector high voltage turned OFF.

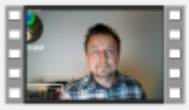
Two urgent item remains to be fixed. The fresh water supply tubes are made of copper and needs to be replaced with stainless steel tubes in order to prevent future erosion and water leaks. This is highly recommended by the chief technician Espen Helgesen at the EISCAT Svalbard radar, where eroded copper pipes caused extensive water damage and total inside renovation and repairs. Secondly, Svalbard Bygg AS has promised to improve their solution to fix leaks between the domes and the roof. This has not yet been fixed!

The UPS system is up for a major 10-year service in 2022. All 256 6V cells need to be replaced by new ones in order to secure service lifetime guarantee by the supplier, Schneider Electric. The estimated cost is approximately 1000k NOK. This will be the third change of batteries at KHO since first operational back in 2007.

(5) Major Highlights – News events

Day / Nightside aurora? December 29, 2020

Our very own Professor Dag Lorentzen explains the difference between dayside and nightside aurora. This article was also published in the local newspaper **Svalbardposten**. See Norwegian translation **here**.
Read English version **here**.



Aurora Forecast 3D Demo January 20, 2021

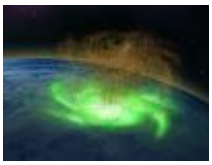
The Aurora Forecast 3D is a tool to track down where the aurora is located in the sky from any location on planet. It renders Earth in 3D with rotation and scaling at your fingertips. This video demonstrates the app.
Watch YouTube **video**.

Video trip! January 15, 2021

Do you want to see the inside of KHO? Join Head engineer Mikko Syrjäsuo, and PhD students Katie Herlingshaw and Nina Kristine Eriksen on a video trip through the observatory.
Watch YouTube **video**.

Doctora K. Herlingshaw January 18, 2021

Salute! Katie Herlingshaw has defended her PhD thesis titled: "Characterizing Mesoscale Fast Flow Channels in the Polar Cap Ionosphere" The defense was on Friday 22nd of January 2021.
Read thesis **here**.



Space Hurricane February 22, 2021

Our very own Director Prof. Jøran Idar Moen and Adjunct Prof. Kjellmar Oksavik at UNIS have together with an international team discovered a polar ionospheric Space Hurricane, which is published in Nature. This discovery sheds new light on how Earth is coupled to space.
Link to paper **here**.

Pulsating aurora and O_3?

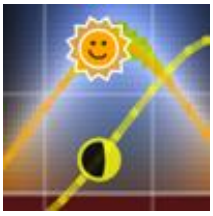
Mars 12, 2021

Our PhD candidate Fasil Tesema Kebede has published work on how high energetic electron precipitation causing pulsating aurora may affect upper atmospheric chemistry and ozone destruction.
More details **here**.

High HSI compression ratio

Mars 24, 2021

Erasmus + Trainee Adrienne Esmeralda Oudijk has published her work on Hyper Spectral Imaging (HSI) compression. The spectral data cube is compressed by a factor of 10^{-5} with minimum loss of spatial resolution and spectral signature.
See IEEE Whispers **paper** and **video** presentation.



Sky colors

May 5, 2021

Version 7.4 of the Aurora Forecast 3D app is now released and reviewed by Apple and Google. It includes the Perez model for sky illuminance that simulates clear sky color conditions as a function of solar position - observed from any ground position on the planet. It runs stable on all platforms with less than 1 second background execution.

Master C.M. van Hazendonk!

June 2, 2021

Congratulations to Master Charlotte van Hazendonk! She studied cutoff latitudes of protons during solar energetic particle events using particle flux data from GPS satellites. In her **thesis**, she presented a new method for determining proton cutoff latitudes using GPS and GOES particle flux measurements and studied the behavior of cutoff latitudes in different solar wind and geomagnetic conditions.

Doctor Fasil Tesema!

June 17, 2021

Salute! Congratulation to Fasil Tesema Kebede. Today he successfully defended his PhD thesis titled: "Energetic electron precipitation of pulsating aurorae and their mesospheric effects".
Read more **here**.

Master Anton Goertz

September 2, 2021

Congratulations to Master Anton Goertz! His Masters project used All-Sky Camera data and Meridian Scanning Photometer data from Ny Ålesund and the KHO, along with SuperDARN radar data to investigate Poleward Moving Auroral Forms (PMAFs). In his **thesis** he used an archness index to quantify, for the first time, how the morphology of PMAFs changes as they move from the dayside auroral region and into the polar cap. He also studied instances of ionospheric plasma flow channels forming around the PMAFs as they move. He is heading off to Los Alamos, USA to continue with his studies. Good luck!

SS-520-3 launched!

November 4, 2021

Congratulation to **JAXA** (Japan Aerospace eXploration Agency) and **NIPR** (National Institute of Polar Research). Their SS-520-3 rocket was successfully launched at 10:09:25 UT by **Andøya Space** into the dayside cusp from the Svalbard Rocket Range (Svalrak) in Ny-Ålesund. KHO provided optical support for the campaign which is part of the Grand Challenge Initiative (**GCI**).

Coming Up!

November 12, 2021

KHO is part of the Cusp Region EXperiment 2A (C-REX-2A), a NASA sounding rocket mission that will release 20 artificial clouds into the ionosphere above the Greenland Sea. First possible launch window 01 - 16 of December. Watch Why to launch **video**?

FINALLY launched!

December 1, 2021

The C-REX-2A rocket was finally launched successfully today at 09:25:00 UT from Andøya Space. All twenty of the sub-payloads deployed as planned. Congratulations to the entire team at Andøya, KHO, Svalbard EISCAT radar, Ny-Ålesund and the NASA airplane over Greenland. See NASA press **release**.

SVALBIRD airborne!

December 16, 2021

Together with Eindhoven University of Technology (TU/e) we congratulate Brandon von Schaik on his Erasmus + Traineeship at UNIS. He has initiated and evaluated the possibility to use high altitude balloons or drones to detect aurora above the cloud layer of KHO. Read more **here**.

(6) Two rockets

KHO has in 2021 actively supported 2 rocket campaigns connected to the Grand Challenge Initiative (GCI). The optimal launch time to study the dayside cusp aurora has been provided to the Primary Investigators (PIs) of the rockets.

Fig.5. C-REX-2A rocket sub-payloads deployed as seen from KHO. Photo Mikko Syrjäsuo.

The first rocket named SS-520-3 from JAXA (Japan Aerospace eXploration Agency) was launched by Andøya Space from the Svalbard Rocket Range (Svalrak) in Ny-Ålesund at 10:09:25 UT on November 4, 2021. KHO provided optical support for the campaign. The Primary Investigator (PI) was Prof. Yoshifumi Saito from JAXA. The rocket was launched into the dayside sunlit cusp aurora South-West of Svalbard.

On 1 December at 09:25:00 UT, the second NASA rocket named C-REX-2A (Cusp - Region EXperiment-2A) was launched from Andøya Space. PI of the campaign was Prof. Mark Conde from The University of Alaska Fairbanks. The rocket released 20 Barium, Strontium and Tri-methyl aluminum clouds into the ionosphere over Svalbard. When the clouds were illuminated by the Sun, they acted as excellent tracers for the motion of charged and neutral particles in the ionosphere to study high altitude winds.

The clouds were tracked by ground-based optics from both Ny-Ålesund and KHO. In addition, a NASA aircraft was used to track the artificial clouds from a third observational point close to Greenland. The target of the rocket was again sunlit dayside aurora over the Greenland sea. In

this region, polar orbiting satellites experience high speed vertical winds that slows them down, reducing their lifetime. The mission main objective is to try to understand the processes that causes these vertical storms.

(7) The rise of the phoenix – The Svalbard SuperDARN radar

Fig.6. Students on security course climbing the new SuperDARN masts version 2 in September. Photo Noora Partamies.

On 23rd October 2018 the initial Svalbard Super Dual Auroral Radar Network (SuperDARN) construction took a hard hit by bad weather conditions and went out of operation. Wind gusts exceeding 20 m/s in combination with icing conditions bended the masts 135 degrees down to the ground. 45 mm diameter ice tubes were super clued around the 6 mm support ropes, increasing the mass by 1.2 kg per meter rope.

A comprehensive study followed to make it more weatherproof. Additional supporting steel poles have been put into the ground at each end of the two mast arrays. The masts are now made more sturdy in solid aluminum. The rise of the first row of new masts started back in June 2021, and the radar is planned to be operational for the next aurora season starting in the late fall of 2022.

(8) Instrumental development

A new radiometer was installed at KHO in December 2021. The radiometer is designed to measure the spectral line of mesospheric ozone at 11GHz based on which it is possible to study the Ozone concentration variations in the middle polar atmosphere. It will eventually be a significant addition to the instrument KHO suite for the fieldwork during the UNIS course AGF-210. Now, the instrument is in the commissioning phase where the functionality of the hardware and software is being verified.

The main observational challenge observing the optical aurora is the cloud layer. An experiment called SVALBIRD is initiated to launch high altitude drones or balloons to detect whether we have aurora or not above the cloud layer over KHO.

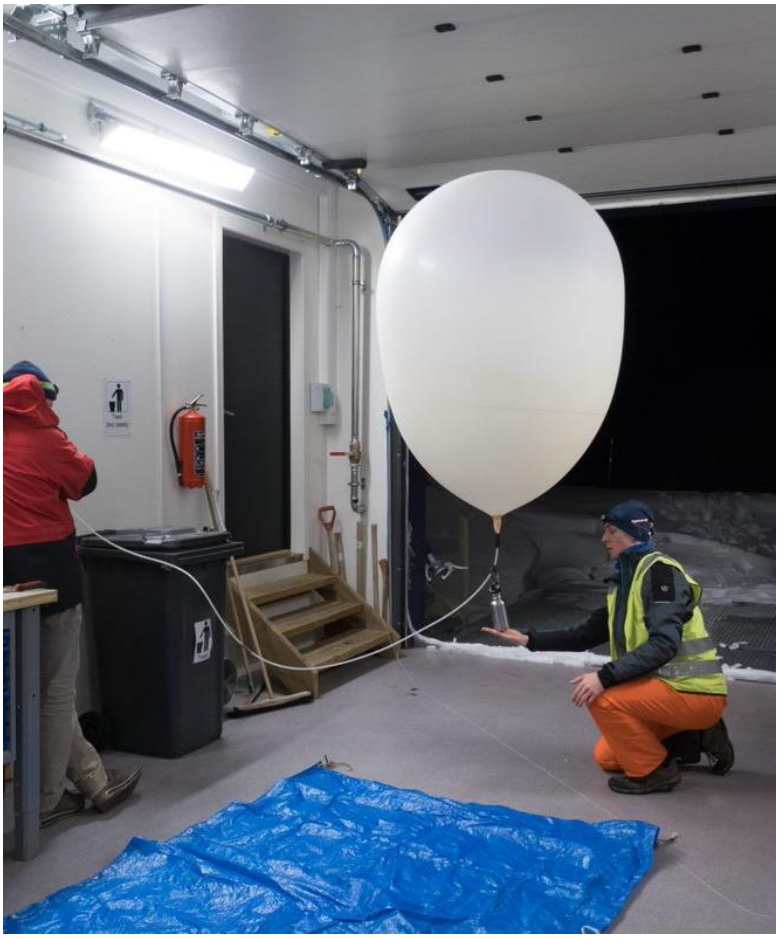


Fig.7. Launch of our first Stratospheric balloon from KHO. Date is 08.12.2021. Photo Mikko Syrjäsuo.

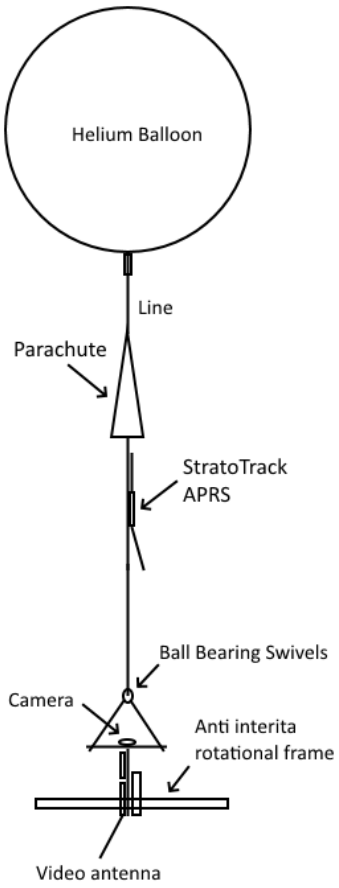


Fig.8. Experimental balloon setup

The initial tests are reported by Erasmus + student Brandon von Schaik. Note that our garage turned out to be an excellent location to fill the balloon and prepare the payload. It protected us from outside weather conditions prior to launch. The observatory is in other words a future balloon launch site candidate for other experiments as well.

(9) Public outreach

Numerous presentations, visits and interviews have been conducted at KHO over the years. Visits from the local schools in Longyearbyen have also been popular activities. Unfortunately, the observatory has been partly closed to visitors depending on pandemic activity. The Aurora Forecast 3D app is rated as 4.8 and has reached over 50k+ active installs on Google Play for Android. On Apple iOS phones it is rated 4.5 with 1603 active users. The app is believed to be popular mainly in the auroral tourists' industry and in the amateur radio community. The Facebook page for KHO has 1.6k followers.

(10) Data policy and access

The access to data from KHO is open with quick looks and instrumental snapshots in real-time on our web server http://kho.unis.no. Raw data is available on requests to the PIs of the

instruments. Data from KHO are archived to the Norwegian e-infrastructure for Research and Education, UNINETT Sigma 2, using the project *Svalbard Space Physics Storage* for long-term storage.

(11) Internet security for web services?

The transfer of data between our servers and clients should be encrypted to increase data security. HTTPS should be enabled to avoid clear text communication. Both Google and Apple have started to insist on TLS/SSL encryption for their apps, which directly affects any further updates and development of our Aurora Forecast 3D app. It also applies to secure communication during rocket campaigns. This matter should be of *high priority.* UNIS IT has been notified 2 years ago to certify and secure our server. The matter not yet been fixed!

(12) General strategy statement – written in stone

The main purpose of KHO is to study processes in the magnetospheric cusp and how it connects to interactions between the Sun and our atmosphere. The unique location and the multi-disciplinary instrumental infrastructure such as radars and optics enable us to study the whole atmospheric vertical column to obtain a better understanding of space- and planetary weather. A vital key in this concept is to upgrade, develop and compare instruments as novel technology and knowledge emerge. Therefore, the aim is to strengthen the co-operation with our existing groups and invite new ones. We wish to be upfront as an attractive partner to large scale rocket and satellite campaigns both on the instrumental and observational side.

Vital importance

The internal research funding of UNIS is of vital importance in the future. 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 therefore 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.

(13) Future threats and concerns

The threats to KHO remain unchanged as identified in the last two-yearly reports. The main threat is the lifetime of Mine 7, which was expected to operate for a maximum of 18 more years. The Norwegian Government has decided that a new power plant for Longyearbyen with low CO_2 emissions should outsource the current one which is fueled by coal. As a response, SNSK has decided to close Mine 7 by 2023. This forces us to evaluate and discuss several scenarios up front. One immediate question arises: who will fund and maintain the road up to the observatory? The situation has become uncertain and forces us to think on how to adapt to the new state of affairs and politics to secure KHO.

If we stay co- located with the EISCAT Svalbard radar, the access to the mountain keeping the road up the mountain open all year, will most probably increase the operational costs. If we must move due to light pollution, then we will need a new road and infrastructure further away from Longyearbyen and Bolterdalen. One alternative could be to move deep into Adventdalen. Note that this is not compatible with the environmental plan to make inner Adventdalen a conservation area. Our concerns should be taken seriously in order to secure our mandate from

the Norwegian Parliament to operate an auroral observatory and respect the taxpayer's contribution.

The second threat for our operation is the growing number of dog yards by the foot of the mountain and the increasing light pollution they produce. When driving from Longyearbyen into Adventdalen the illumination from these yards look like a small city. This was not the case when we built KHO back in 2008. Numerous attempts through Svalbardposten to encourage to at least turn OFF lights when they are not in use have failed. Dialog is not working even though we have a political consensus from the local government that light pollution should be kept to a minimum. An action plan is needed, or KHO will have to move if the situation continues. It is a paradox that the tourist industry does not seem to understand the value of dark skies and aurora.

KHO has lately suffered from two severe power breaks which lasted longer than the Uninterruptible Power Supply (UPS) could survive after training the battery bank completely. The life time of the 256 6V cells (180 Ah) is approximately 12 hours when the station is in full operation (100 kW). This led to frozen sewage pipes and pump problems. New toilets had to be ordered with inside pipe system. It also damaged several instruments when the power spiked on return. In order to avoid this in the future, an external safety power generator system might be a solution to look into.

(14) Summary

The activity at the Kjell Henriksen Observatory (KHO) has been high in 2021 despite the corona pandemic. The observatory has been fully operative since the start of the optical season in November. It is still attractive to the space science community with 24 external groups from 12 nations present. Two rockets have been launched as part of the Grand Challenge Initiative (GCI) with vital ground-based support from KHO. The new improved SuperDARN radar is raising out of the ashes. The major highlights were Katie Herlingshaw and Fasil Tesema Kebede successful PhD defenses in January and June, respectively.

Graduated students

1. *Katie Herlingshaw*, PhD, Characterizing Mesoscale Fast Flow Channels in the Polar Cap Ionosphere, University of Bergen / UNIS, January 2021.
2. *Charlotte Maartje van Hazendonk*, Master, On Solar proton cutoff latitudes measured by GPS satellites, Eindhoven University of Technology (TU/e)/ UNIS, May 2021.
3. *Fasil Tesema Kebede*, PhD, Energetic electron precipitation of pulsating aurorae and their mesospheric effects, University of Bergen / UNIS, June 2021.
4. *Anton Goertz,* Master, Poleward Moving Auroral Forms and Dayside Flow Channels, Goethe University Frankfurt / UNIS, August 2021.
5. *Brandon von Schaik*, Erasmus+ Trainee, SVALBIRD - A sustainable, multi-functional fixed-wing drone research platform, Eindhoven University of Technology (Tu/e) / UNIS, December 2021.

Public presentations 2021

1. D. A. Lorentzen, Svalbard's special northern lights, Svalbardposten 29 December 2020.
2. Dag Lorentzen, Svalbards spesielle nordlys, forskning.no, https://forskersonen.no/arktis-aurora-borealis-meninger/svalbards-spesielle-nordlys/1818799, Feb. 2021.
3. Gerard Fasel, Aine Merrit, Sun Hee Lee, Nick Omidi, David Sibeck, John Mann, and Fred Sigernes, Comparisons of two foreshock bubbles and their different impacts on the magnetosphere: Ionospheric signatures, AGU Fall 2021.
4. Gerard J. Fasel, Audrey Robison, Julia Pepperdine, Abrielle, Wang, John Mann, Fred Sigernes and Dag A Lorentzen, Possible New Dayside Auroral Signature of High Latitude Magnetic Reconnection, AGU Fall 2021.
5. Gerard J. Fasel, Minji Kim, Grace, McPhaill, Spenser Rapier, Audrey Robison, Aine Merritt, Julia Pepperdine, Abrielle Wang, John Mann, Fred Sigernes and Dag A Lorentzen, Origin of Poleward-Moving Auroral Forms, AGU Fall 2021.
6. Gerard J. Fasel, Sophie Tarditi, Audrey Robison, Aine Merritt, Julia Pepperdine, Abrielle Wang, Benjamin Swonger, Mariam Pavez, Jenna Cavanagh, Braden Yonano, Arman Manookain, John Mann, Fred Sigernes and Dag A Lorentzen, Dayside Auroral Activity, AGU Fall 2021.
7. Nina Kristine Eriksen, High Density Volumes Transit Over the Magnetic Polar Cap, SCOPE - 1st Student-led Conference on Polar Environment, UNIS 15 October 2021.
8. Mikko Syrjäsuo, Noora Partamies and Nina Kristine Eriksen, UNIS and Space physics research on Svalbard, Girls and Technology (J&T) visit to KHO and seminar at UNIS, September 2021.
9. Mikko Syrjäsuo, Noora Partamies, Emma Bland and Nina Kristine Eriksen, UNIS and Space physics research on Svalbard, Svalbardkurset visit to KHO, August 2021.
10. Bland, E.C., SuperDARN Radars, *Magnetosphere Online Seminar Series*, 3 May 2021, https://www.youtube.com/watch?v=OfUKS9lwjkA
11. Bland, E.C., The Svalbard SuperDARN Radar: Local and global observations of the Sun-Earth connection, SIOS Webinar Series: "An anchor point to a drifting world", Svalbard Integrated Arctic Earth Observing System (SIOS), 29 October 2021.

Publications 2021*

1. A. E. Oudijk, F. Sigernes, H. C. J. Mulders, S. Bakken and T. A. Johansen, "Quality Assessments of Standard Video Compression Techniques Applied to Hyperspectral Data Cubes," *2021 11th Workshop on Hyperspectral Imaging and Signal Processing: Evolution in Remote Sensing (WHISPERS)*, 2021, pp. 1-5, doi: https://doi.org/10.1109/WHISPERS52202.2021.9483989.
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*Listed presentations and publications do not include all instrumental groups at KHO, only from the KHO crew.