

The North Dakota Dual Aurora Camera (NoDDAC), a Student-Led Citizen Science Project

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NDSGC 2021 Virtual Student Symposium & Affiliates Meeting

Outline

- Background
- Location and Facilities
- The Cameras
- Supporting Hardware
- Software and Processing
- Aurorasaurus
- Other Citizen Science Efforts
- Future Milestones

Background

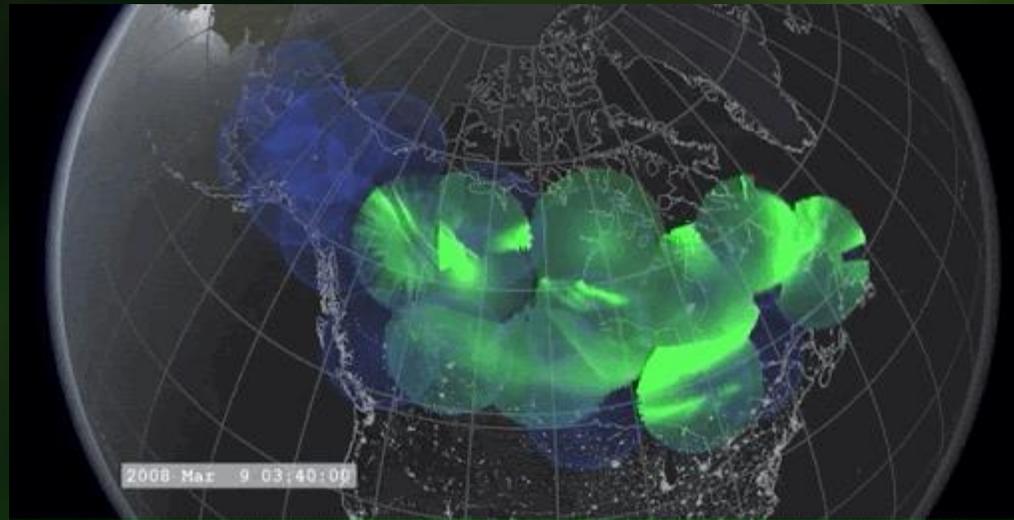
- Aurora cameras
 - Global network; deficit in mid-latitudes
 - Ground-truth visual data
 - Good indicator of auroral activity
 - Benefits many groups



STEVE seen north of Grand Forks, ND; March, 2021; Credit: Vincent Ledvina



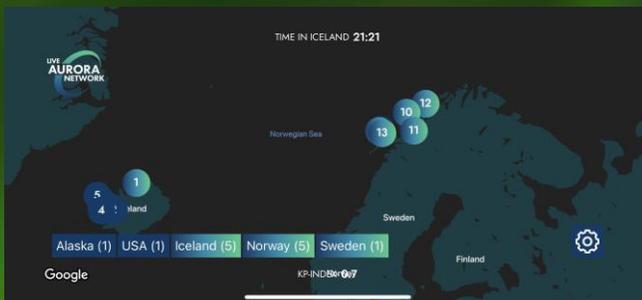
Aurora display north of Grand Forks, ND; credit: Vincent Ledvina



THEMIS allsky aurora camera network; credit: NASA

Background

- Aurora cameras
- Benefitting the public
 - Aurora chasers (especially at mid-latitudes)
 - Allsky cloud cover (for NoDDAC specifically)
 - Education
 - Virtual Resource



LiveAuroraNetwork aurora camera network



Screenshot from Cam 3 in Norway; credit: LiveAuroraNetwork



Aurora chasing in North Dakota; self-portrait of Vincent Ledvina

Background

- Aurora cameras
- Benefitting the public
- Benefitting science
 - High time-resolution data
 - Two views to triangulate aurora height
 - Higher probability of detecting rare phenomena (i.e., STEVE)

Solar System and Beyond

Mar 7, 2016

Citizen Scientists Help NASA Researchers Understand Auroras

Space weather scientist Liz MacDonald has seen auroras more than five times in her life, but it was the aurora she didn't see that affected her the most.

On the evening of Oct. 24, 2011, MacDonald was sitting in front of her computer at her home in Los Alamos, New Mexico. Forecasts predicted a geomagnetic storm would hit Earth that night and potentially create beautiful aurora. The aurora didn't come to Los Alamos, but MacDonald was still amazed — not by any bright, dancing lights in the sky, but by the number of aurora-related tweets on her computer screen.

People across the eastern United States, from Alabama to Chicago, tweeted about seeing the aurora in real-time. This storm became one of the first wide-scale documentations of aurora activity with social media.

After witnessing the viral response, MacDonald, now at NASA's Goddard Space Flight Center in Greenbelt, Maryland, founded Aurorasaurus — a citizen science project that tracks auroras through the project's website, mobile apps and Twitter. For the first time, citizen science observations are being used in a concerted effort to track auroras in real-time.

Since inception, Aurorasaurus and its users have documented some of the biggest and recent aurora displays. In a study published online on March 3, 2016, in AGU's Space Weather journal, the team found that citizen scientists are regularly able to spot auroras farther south of an area where prediction models indicated.

"Using these observations, we can make better short-term predictions of when and where the aurora is for aurora enthusiasts — and scientists," said MacDonald.

Improving Science with Citizen Reports

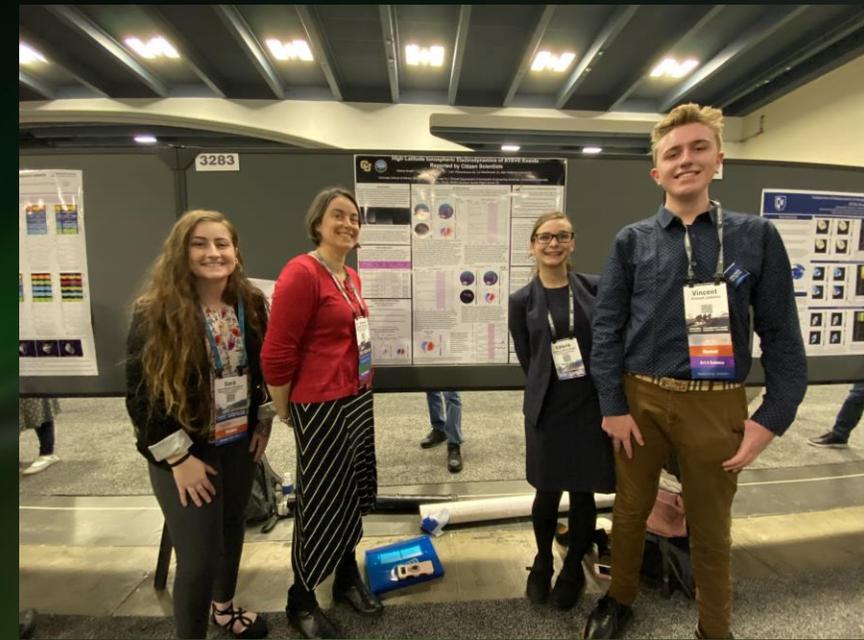
Improving forecasts and studying auroras are important because auroras are features of geomagnetic storms. While geomagnetic storms can lead to beautiful auroras, they can also cause power outages and interrupt satellite systems. Though many satellites study the sun and near-Earth space environment responsible for auroras, predicting precisely where, when and how strongly the dancing natural light display — and the geomagnetic storm — will occur on Earth is challenging. One reason is because large geomagnetic storms occur infrequently so scientists do not have as much data on them.



An aurora on March 8, 2012, swimming over snow-covered mountains in Fiskrudstjór, Iceland.

Credits: Image courtesy of Jónne Óskarsdóttir, used with permission; rights reserved.

Collaborations between citizen scientists and researchers (and projects like NoDDAC) lead to real discoveries



Aurorasaurus members at AGU 2019

New science in plain sight: Citizen scientists lead to the discovery of optical structure in the upper atmosphere

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DSLR photographs of aurora (low-tech measurements) lead to major discoveries about STEVE; images from Notanee Bourassa (fig 1)

Background

- Aurora cameras
- Benefitting the public
- Benefitting science
- What is NoDDAC?
 - Dual aurora cameras
 - North-facing and allsky views
 - Live-streamed video of aurora
 - COTS equipment
 - Blueprint for citizen scientists



NoDDAC north-facing camera



Aurora seen on NoDDAC north-facing camera



Aurora seen on NoDDAC allsky camera (right of frame)



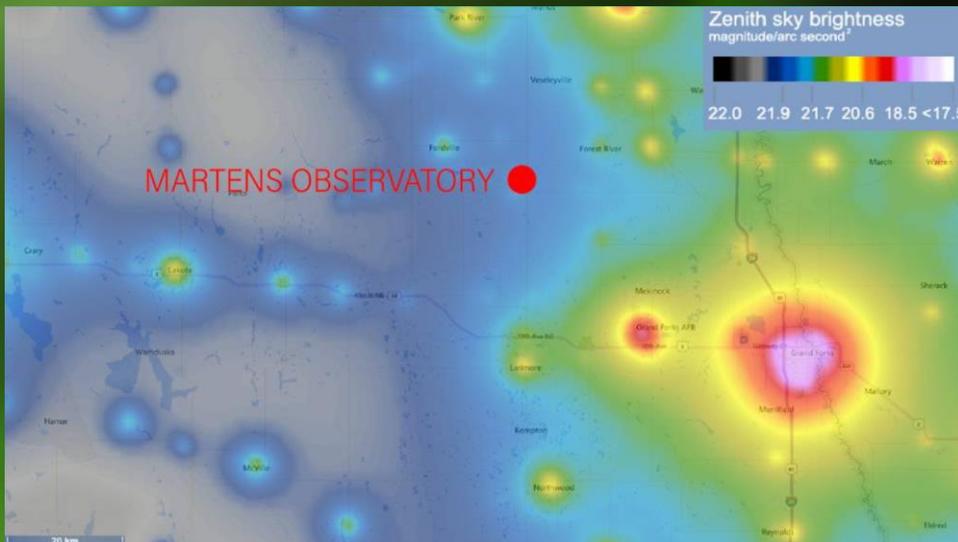
NoDDAC allsky camera

Location and Facilities

- UND Martens Observatory
 - Low light pollution (bortle-2)
 - On-site internet and power
 - Clear view of northern horizon
 - Easily accessible



Martens Observatory; Credit: Tim Young



Light pollution levels at Martens Observatory; source: World Atlas 2015



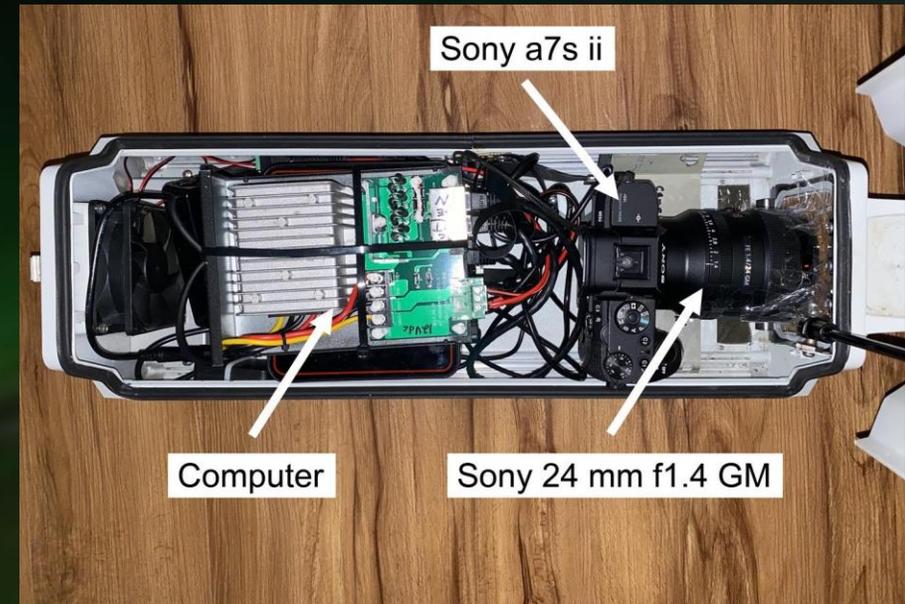
Dome in operation; credit: Elijah Matthews



Aurora at the observatory; credit: Elijah Matthews

The Cameras

- North-facing
 - Sony a7s ii & 24mm f/1.4GM
 - 84° field of view
 - 12.2-megapixel full-frame CMOS sensor
 - 24-hour YouTube livestream
 - Timelapse of previous night made every day
 - Video stills uploaded to FTP server



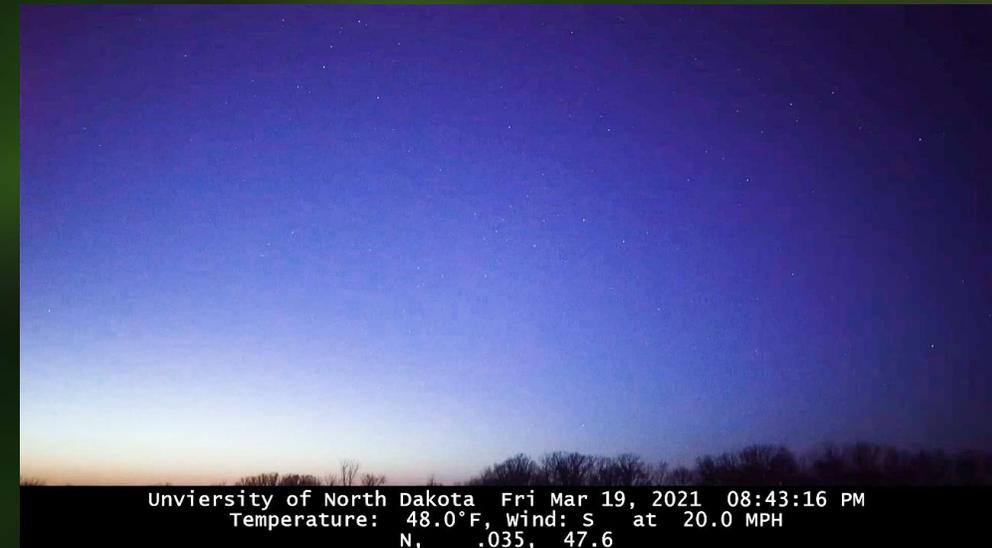
North-facing camera enclosure



Allsky camera



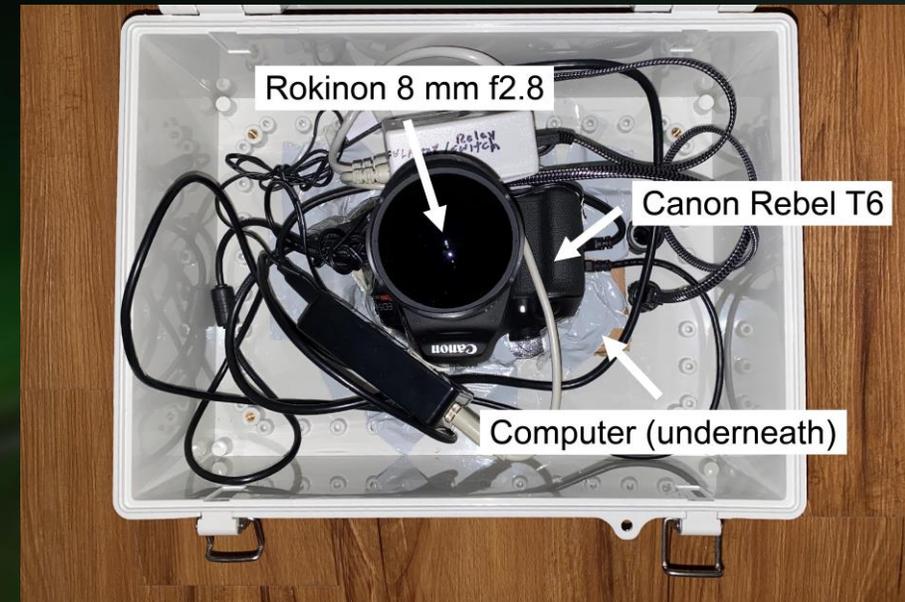
North-facing camera



Full-night timelapse of particularly active aurora in March, 2021

The Cameras

- North-facing
- Allsky
 - Canon T6 & Rokinon 8mm f/3.5 fisheye
 - Upgrading to Sigma 4.5mm f/2.8 for 180° FOV
 - 18.0-megapixel APS-C CMOS sensor
 - 30-second exposures with 2-minute cadence uploaded to FTP server
 - Timelapse of previous night made every day



Allsky camera enclosure



University of North Dakota Allsky Cam Sat Mar 20, 2021 01:38:34 AM
Temperature: 39.0 F, wind: 5 at 17.0 MPH



University of North Dakota Allsky Cam Sat Mar 20, 2021 02:14:34 AM
Temperature: 37.0 F, wind: 5 at 17.0 MPH



University of North Dakota Allsky Cam Sat Mar 20, 2021 04:02:34 AM
Temperature: 37.0 F, wind: 5 at 16.0 MPH

Left:
Allsky camera images
record an intense
overhead auroral display

Supporting Hardware (supplied by LiveAuroraNetwork)

- Off-the-shelf PELCO enclosures waterproof cameras
- Intel NUC computers interface with cameras
- Single cable providing power-over-ethernet (data and power)



PELCO EU3512-3X used for north-facing camera



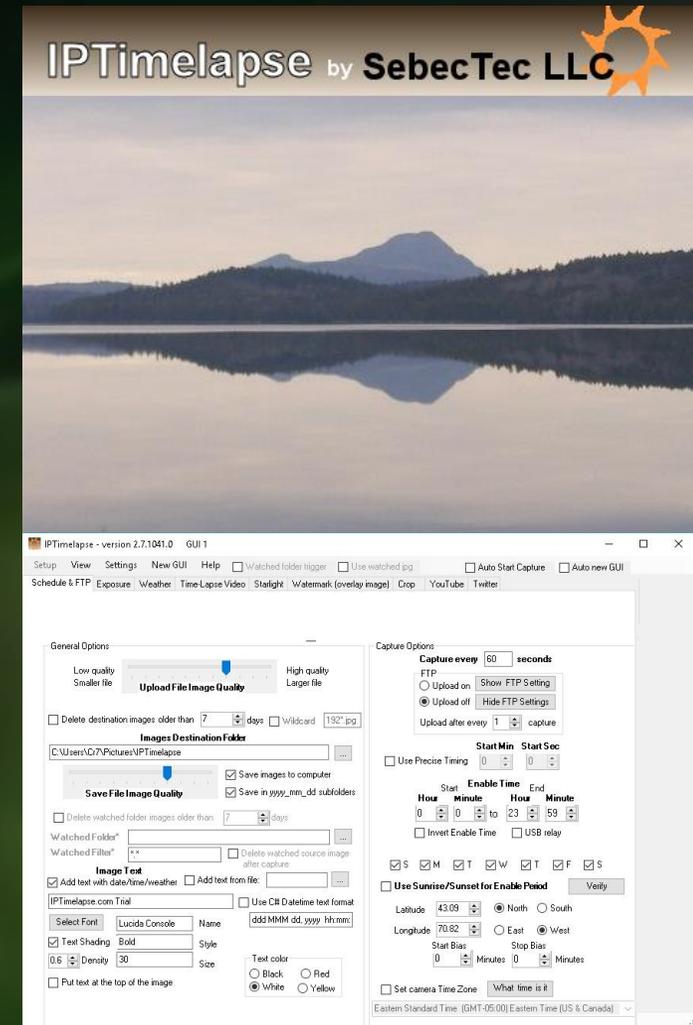
Intel NUC computer used for controlling the cameras (not exact model)



POE Injector combining network and power to one cable

Software and Data Processing

- Cameras controlled with IPTimelapse software
 - Complete control of camera settings
 - Data can be offloaded to multiple FTP servers
 - Timelapse creation
 - Aurora-detection algorithm
 - Automated twitter posts for timelapses/aurora



IPTimelapse interface

www.aurorabackend.com - /cam8/timelapses/northdakota/2021/3/

[\[To Parent Directory\]](#)

3/1/2021	2:11 PM	19042345	northdakota_2021_03_01.mp4
3/14/2021	1:05 PM	11566558	northdakota_2021_03_14.mp4
3/15/2021	1:08 PM	18454951	northdakota_2021_03_15.mp4
3/16/2021	1:07 PM	18365234	northdakota_2021_03_16.mp4
3/17/2021	1:07 PM	18176163	northdakota_2021_03_17.mp4
3/18/2021	1:07 PM	17920701	northdakota_2021_03_18.mp4
3/19/2021	1:07 PM	17803322	northdakota_2021_03_19.mp4
3/20/2021	1:08 PM	17948765	northdakota_2021_03_20.mp4
3/21/2021	1:08 PM	17508226	northdakota_2021_03_21.mp4
3/22/2021	1:07 PM	17916220	northdakota_2021_03_22.mp4
3/23/2021	1:08 PM	17338899	northdakota_2021_03_23.mp4
3/24/2021	1:09 PM	17617283	northdakota_2021_03_24.mp4
3/25/2021	1:10 PM	17422684	northdakota_2021_03_25.mp4
3/26/2021	1:11 PM	16741151	northdakota_2021_03_26.mp4
3/27/2021	1:11 PM	17072914	northdakota_2021_03_27.mp4
3/28/2021	1:11 PM	16665539	northdakota_2021_03_28.mp4
3/29/2021	1:12 PM	16509089	northdakota_2021_03_29.mp4
3/30/2021	1:11 PM	16149834	northdakota_2021_03_30.mp4
3/31/2021	1:10 PM	16820389	northdakota_2021_03_31.mp4

FTP server interface with timelapses



NoDDAC twitter account

Aurorasaurus

- What is Aurorasaurus?
- NoDDAC and Aurorasaurus
 - NoDDAC tweets ~10s clip of aurora when detected; displayed on auroral oval map
 - Camera icons shown on auroral oval map with clickthrough to stream
 - This functionality will be coming soon!



Aurorasaurus auroral oval map with citizen scientist observations

Other Citizen Science Efforts

- NoDDAC plans to collaborate with other programs
 - HamSCI's Personal Space Weather Station
 - Zooniverse's Aurora Zoo
 - MANGO project

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UTAR

HamSCI

HamSCI Distributed Array of Small Instruments Personal Space Weather Station (DASI-PSWS): Architecture and Current Status

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HamSCI <http://hamsci.org>

NSF CEDAR Workshop June 2020

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HamSCI PSWS; credit: University of Scranton, Friswell et al.

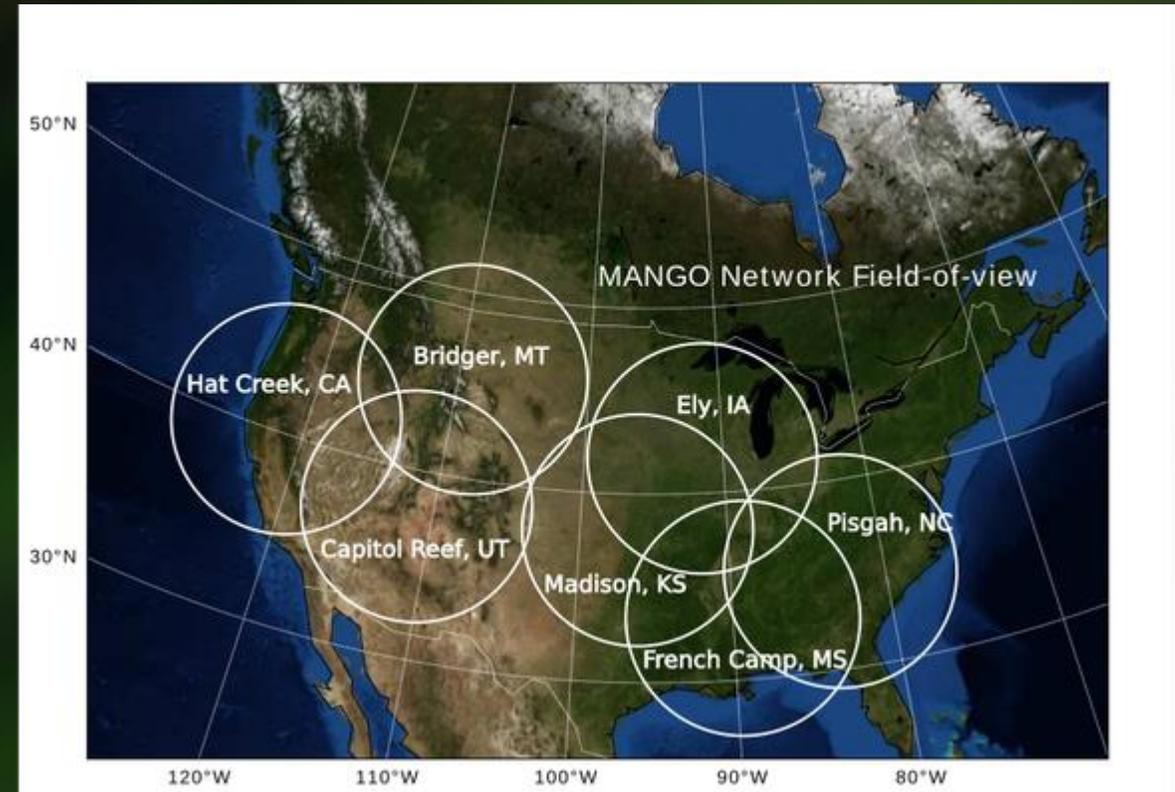
ABOUT AURORA ZOO
Find, classify and measure aurora!

We want to understand how energy is transferred from space into our atmosphere, and what it does when it gets there - and you can help! Using images from the ASK camera system in the high Arctic we can learn more about the northern lights and the science behind the beautiful shapes they form.

UNIVERSITY OF
Southampton

Aurora Zoo is a University of Southampton project. ASK is a collaboration between the University of Southampton and the Royal Institute of Technology (KTH), Stockholm. ASK and the Aurora Zoo project leader are supported by the Natural Environment Research Council (NERC) of the UK, under grant NE/S015167/1.

AuroraZoo Project; credit: Zooniverse, AuroraZoo



MANGO Project camera field of view; credit: MANGO

Future Milestones

- Upgrading allsky lens
- Color calibrating cameras
- Setting up twitter functionality
- Exploring science questions



X-rite ColorChecker Color Rendition Chart; credit: DxO PhotoLab 4



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Example view of Sigma 4.5mm f/2.8 fisheye lens; credit: Peter West Carey Photography

Thank you for your time