

# The Science of the Aurora and How to Get Involved

Vincent Ledvina

NASA@ My Library

December 5, 2024



# Outline

- A Little Bit About Me
- What is space weather?
- What is the aurora?
- Citizen Science
- Activities



# A little bit about me... my aurora origin story

- Saw my first aurora in 2003 when I was four years old
- Grew up in Minnesota
- Eagle Scout
- Loved camping and being outdoors
- Became interested in photography in middle school
- Discovered auroras and space weather
- Took my first aurora photo when I was 16
- Moved to North Dakota to study physics





# People call me “The Aurora Guy”

While at the University of North Dakota...

- Astronomy club president
- LOTS of aurora chasing
- Became the “Aurora Guy”



My first internship at the National Solar Observatory



The post that caused be to become “The Aurora Guy”



# Aurora chasing adventures





# Aurora chasing adventures



Photos 1-3 by Justin Anderson  
High Hopes Aurora  
[@aurorajanderson](https://www.instagram.com/aurorajanderson)



# Aurora chasing adventures



Aurora borealis in Fort Yukon, Alaska; March 5, 2022 during the LAMP Sounding Rocket Campaign



# Now?

- Space Physics Ph.D. Student
- Living in North Pole, Alaska
- Sharing my love for the aurora
- Photographer
- Citizen scientist
- Researching auroras



The Science of the Northern Lights with “The Aurora Guy”



Did you see the aurora this year?

# The Northern Lights came to California — but will it happen again?

May 16, 2024

Robyn Schelenz, UC Newsroom



## Auroras and the Perseids make rare appearance together over Texas

The peak of the best meteor shower of the year combined with the aurora borealis for an unforgettable display over Texas.

By **Ariana Garcia**, Trending News Reporter  
Aug 12, 2024



Blake Brown spotted the aurora borealis and meteors from the peak of the Perseids near Amarillo overnight.  
Blake Brown Photography

## Auroral substorm sparks stunning northern lights visible at mid-latitudes (photos)

News By Daisy Dobrijevic published 6 hours ago

Aurora chasers were treated to a dynamic and vivid northern light display.

Facebook, X, YouTube, Pinterest, Email, Comments (0)

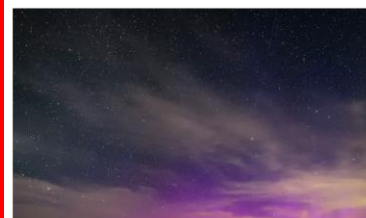
When you purchase through links on our site, we may earn an affiliate commission. [Here's how it works.](#)



Northern lights display viewed from Sutherland, Scotland, in the early hours of the morning.  
Monika Focht

## 'Skies were mostly clear': Northern lights captured near Las Vegas

By **Amy Graff**, Senior News Editor  
Dec 1, 2023



## 'Extreme' geomagnetic storm that painted Earth with auroras this weekend was the most powerful in 21 years

News By Harry Baker published May 13, 2024

Between Friday (May 10) and Sunday (May 12), people across the world were treated to stunning aurora displays as Earth's magnetic field experienced its biggest disturbance since October 2003. The geomagnetic storm disrupted satellite operations and caused power outages in several regions.

## 'Extreme' solar storm triggers Northern Lights as far south as Florida Friday

Skies across the U.S. lit in a spectacular colorful glow not seen in years to decades as massive solar flares slammed into Earth on Friday, triggering "extreme" levels of geomagnetic activity. And the show may not be over for a while.

By **Hillary Andrews** · **Scott Sistik** | Source **FOX Weather**

Facebook, X, YouTube, Email



### Latest Weather News



Some signs of life in Atlantic emerge as 2 areas now monitored through Labor Day



Strongest solar action in a decade impacting Earth right now

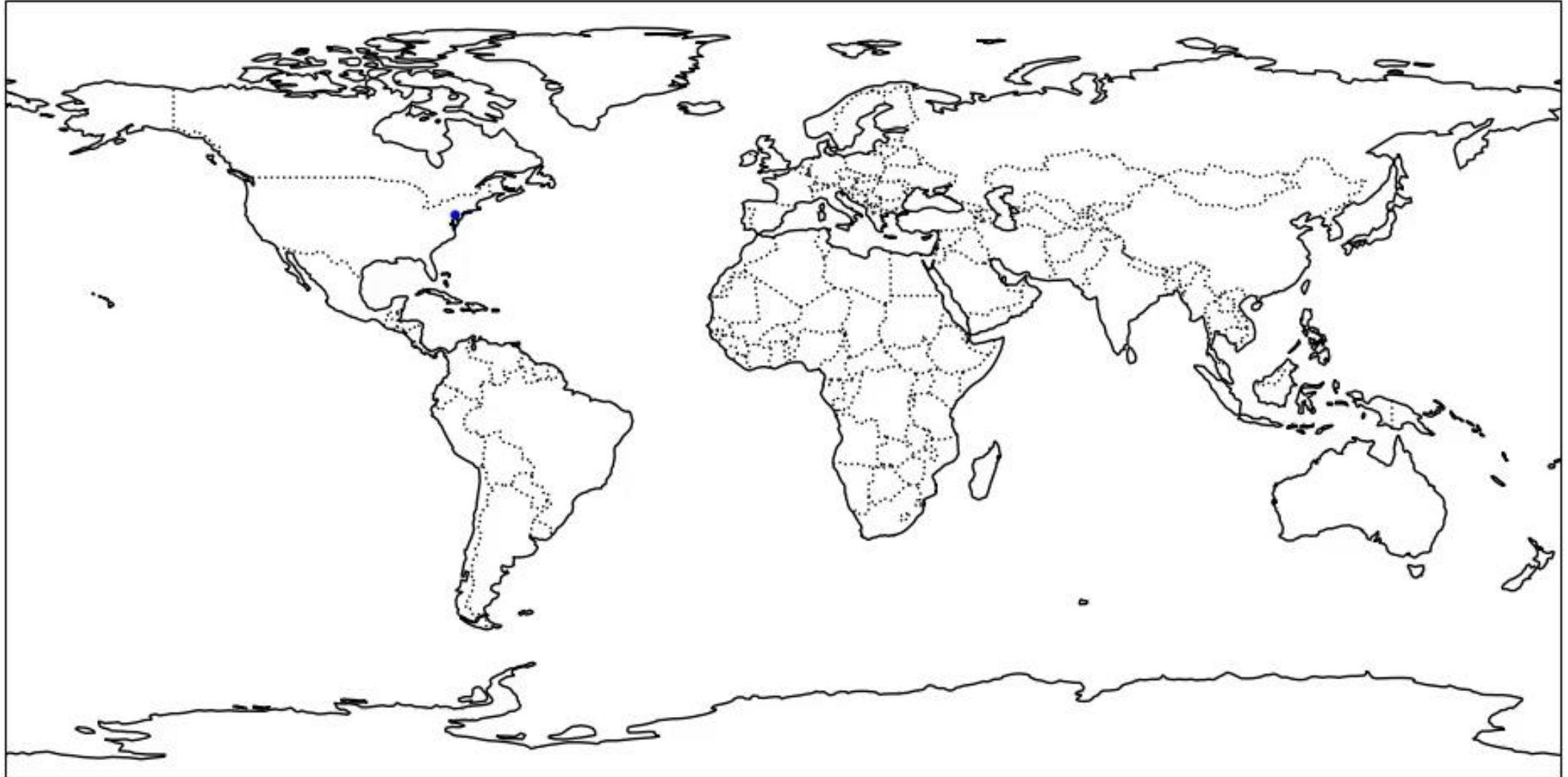
our site, we may earn an affiliate commission. [Here's how it works.](#)



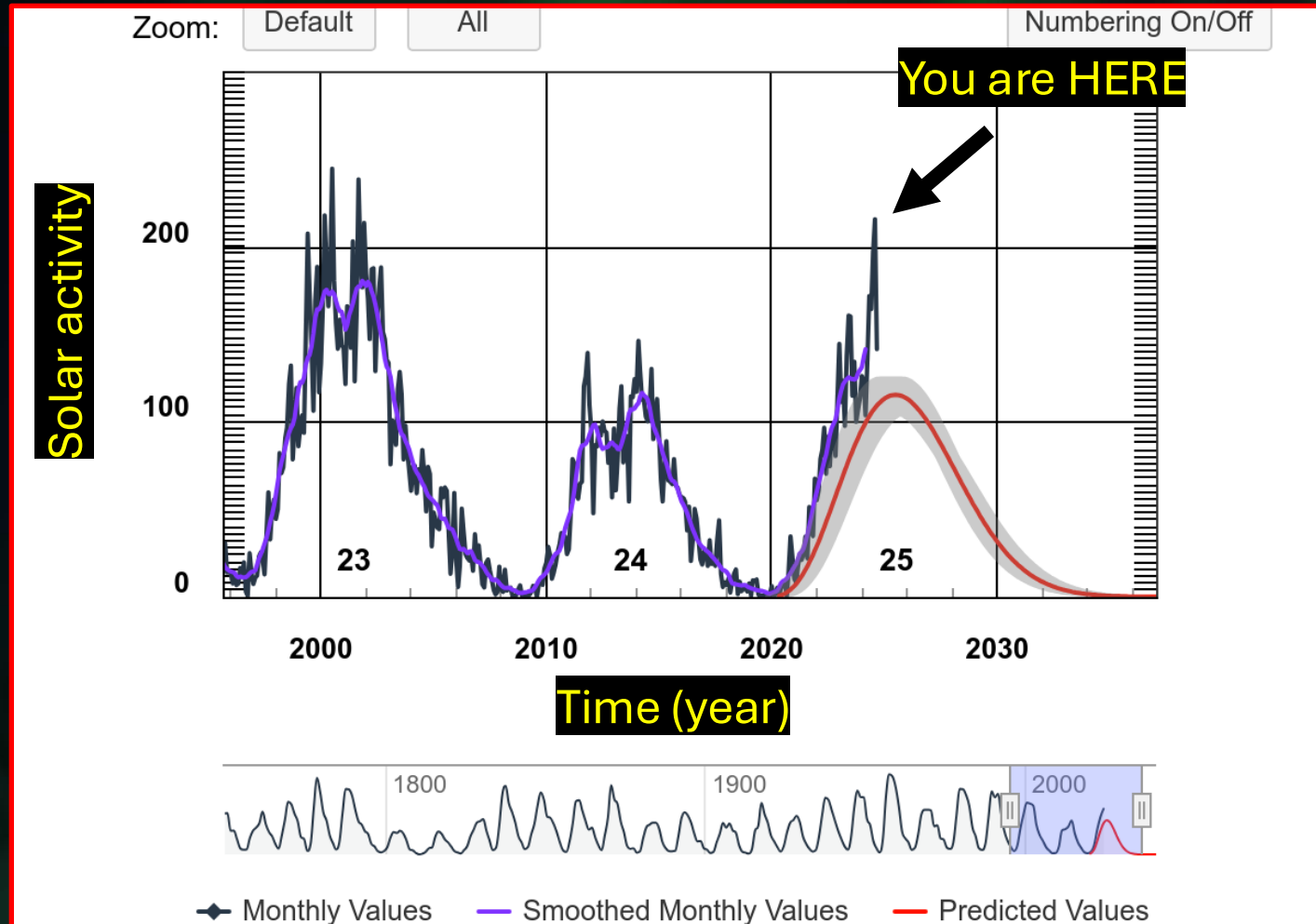
Northern lights were visible across large parts of the world between Friday (May 10) and Sunday (May 12). (Image credit: JFK/APA/AFP via Getty Images)



Aurora Reports During Geomagnetic Storm  
2024-10-10 00:00 UTC

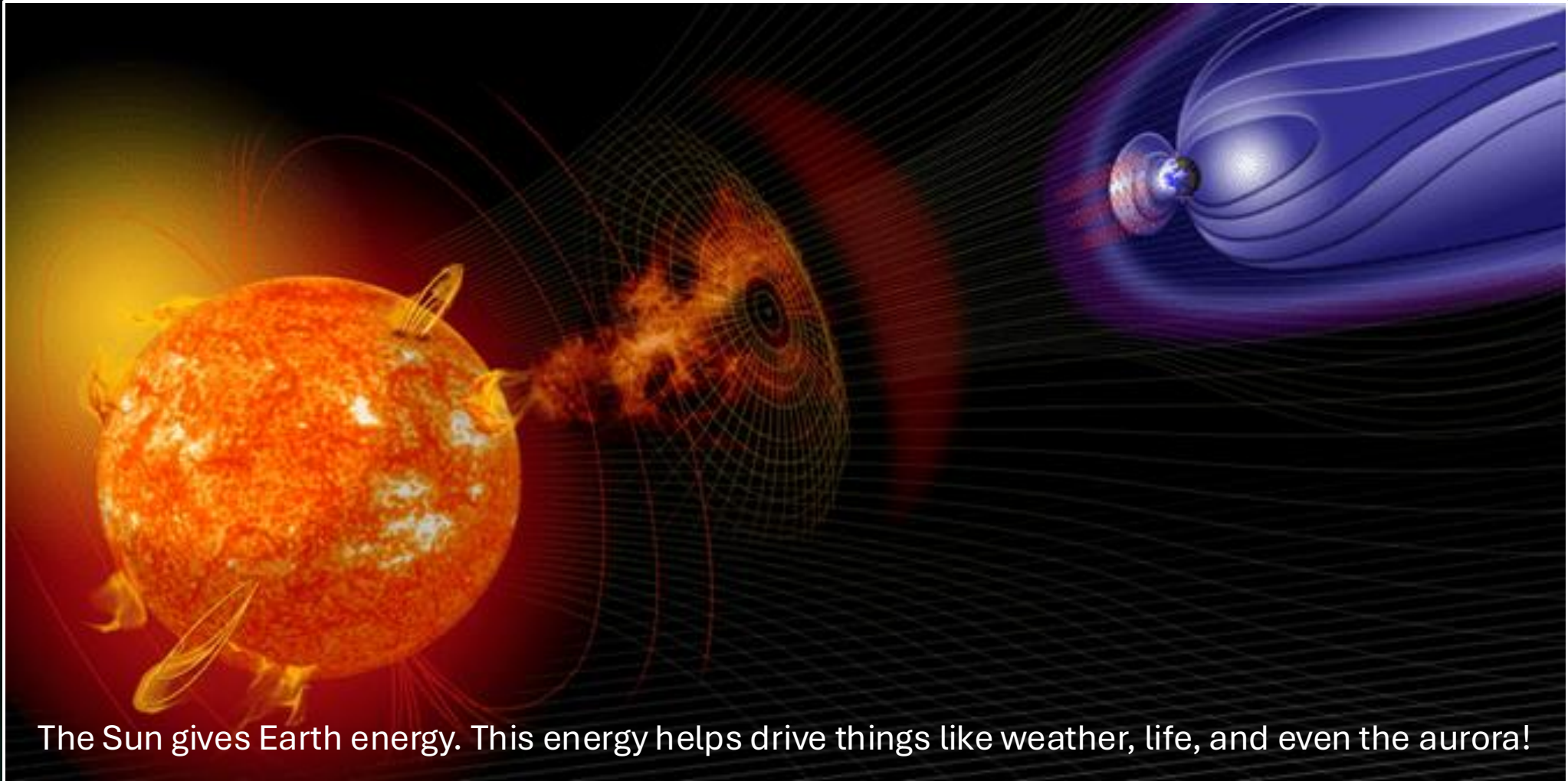


# What's going on with the Sun?





# Everything is connected to the Sun...



# What is space weather?

Space weather refers to conditions around a star, like our Sun, and its interplanetary space that may affect space- and ground-based assets as well as human life.



# What is space weather?

But, really...



# What is space weather?

**Shockwaves**

**But, really...**

**Aurora**

**Solar flares**

**Million-degree plasmas**

**Incredible space missions**

**Explosions!**

**Coronal mass ejections**

**Shockwaves**

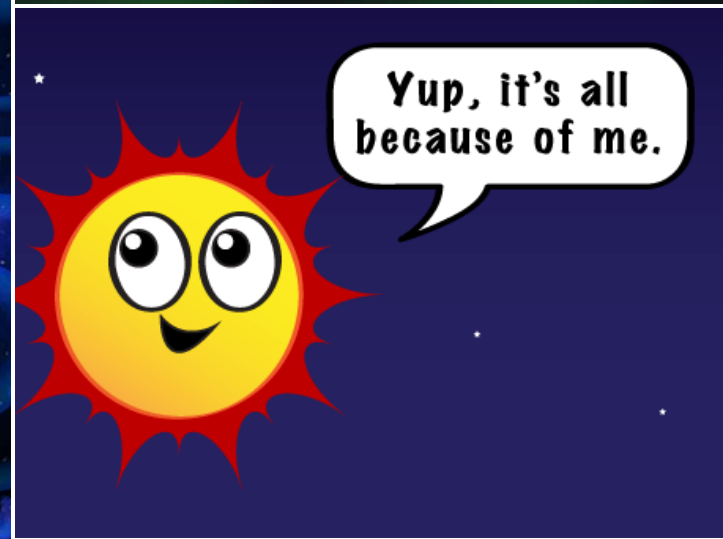
**Giant magnets in space**

The image is a collage of various space weather phenomena. At the top left, a blue pressure map shows a shockwave structure with a central black dot and a color scale labeled '1.80e+01'. Below this is a large green aurora over a snowy landscape. To the right, there are three panels: a blue-tinted solar flare, a yellow-tinted solar flare, and a red-tinted solar flare. Below these are two panels: a satellite in space and a close-up of a solar explosion. At the bottom left, there is a yellow-tinted solar flare and a diagram of magnetic field lines. The text '10/10/08 2' is visible in the bottom left corner of the collage.



# It all starts with the Sun...

Just like the Sun creates weather on Earth (clouds, rain, wind, storms, etc.) on Earth,  
The Sun creates weather in space, too!

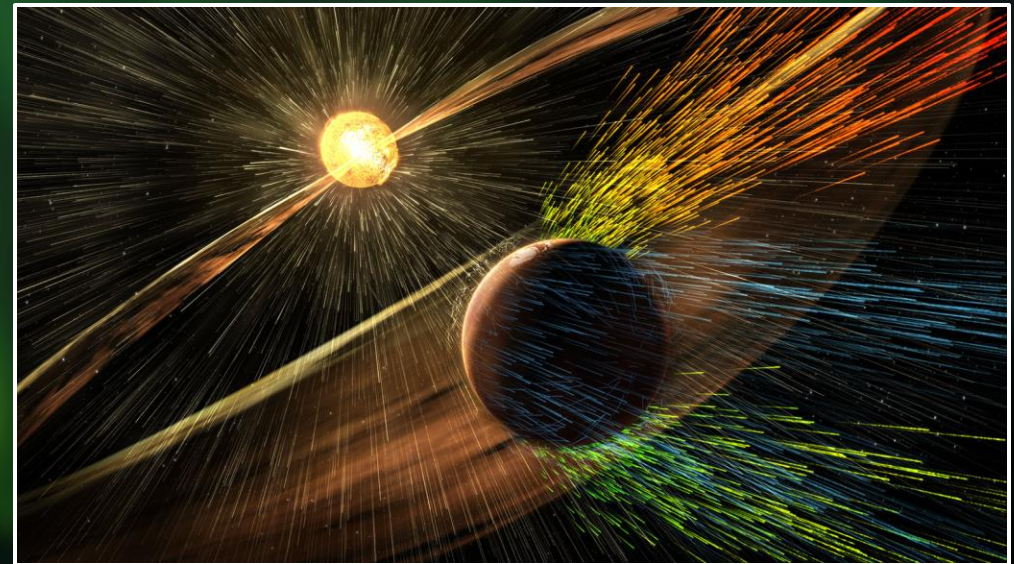




# The Sun blows a wind through space...

The Sun gives us warmth and life – it also gives us space weather!

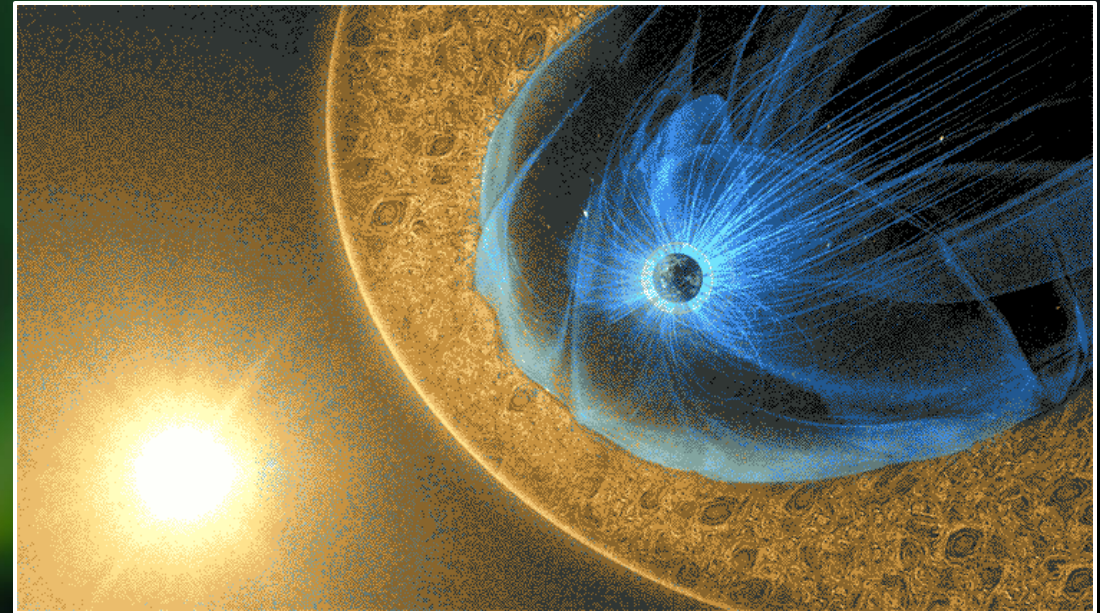
- The Sun is constantly changing every minute, hour, and day!
- The Sun creates a wind that blows out into space.
- This wind is usually calm, but it can become strong and fierce!
- This wind is full of electricity.



# Shields up! The Earth is protecting us!

Earth's protective shield helps channel the solar wind to the poles

- Earth is protected by a magnetic bubble, like a force field or shield.
- When the Sun's wind hits this bubble, some of the electricity in the wind flows in.
- When our magnetic shield charges up auroras happen around the geomagnetic poles.



# What is the aurora?

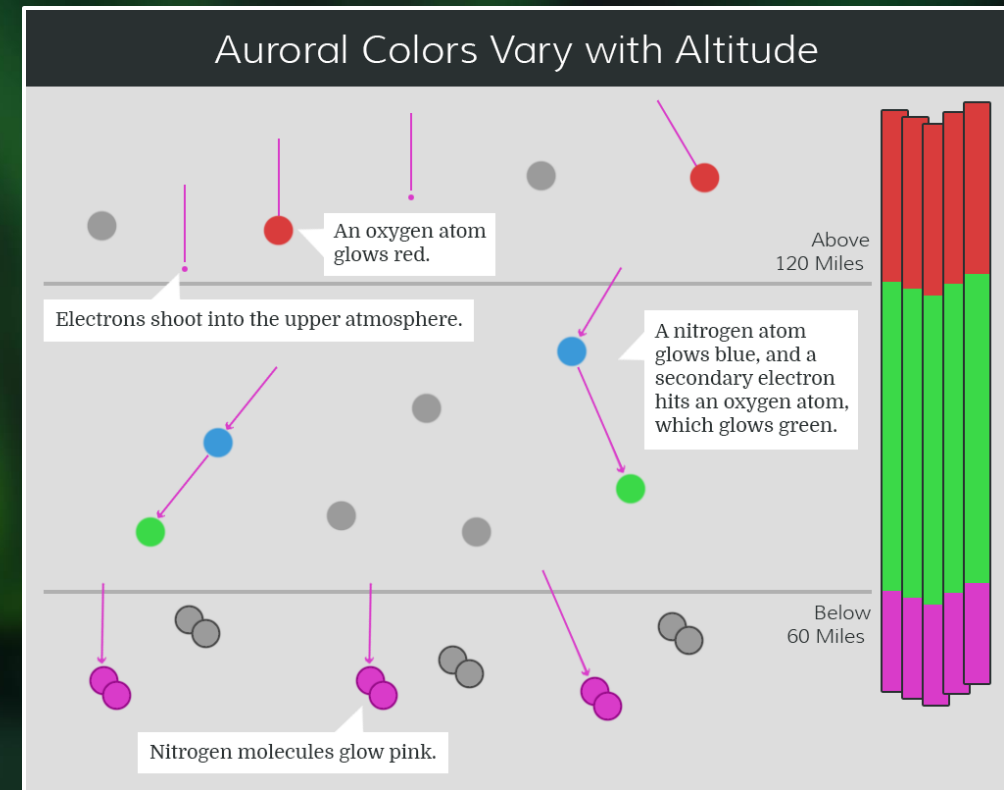
Nature's most beautiful light show!



# How do auroras form?

Charged particles from space make gas in our atmosphere glow!

- The electricity in our force field is directed towards the poles as charged particles.
- These particles rain down on us from outer space, guided by Earth's magnetic field, like surfers riding waves.
- These particles hit our atmosphere and gases, releasing light.
  - Nitrogen glows red and blue.
  - Oxygen glows red and green.

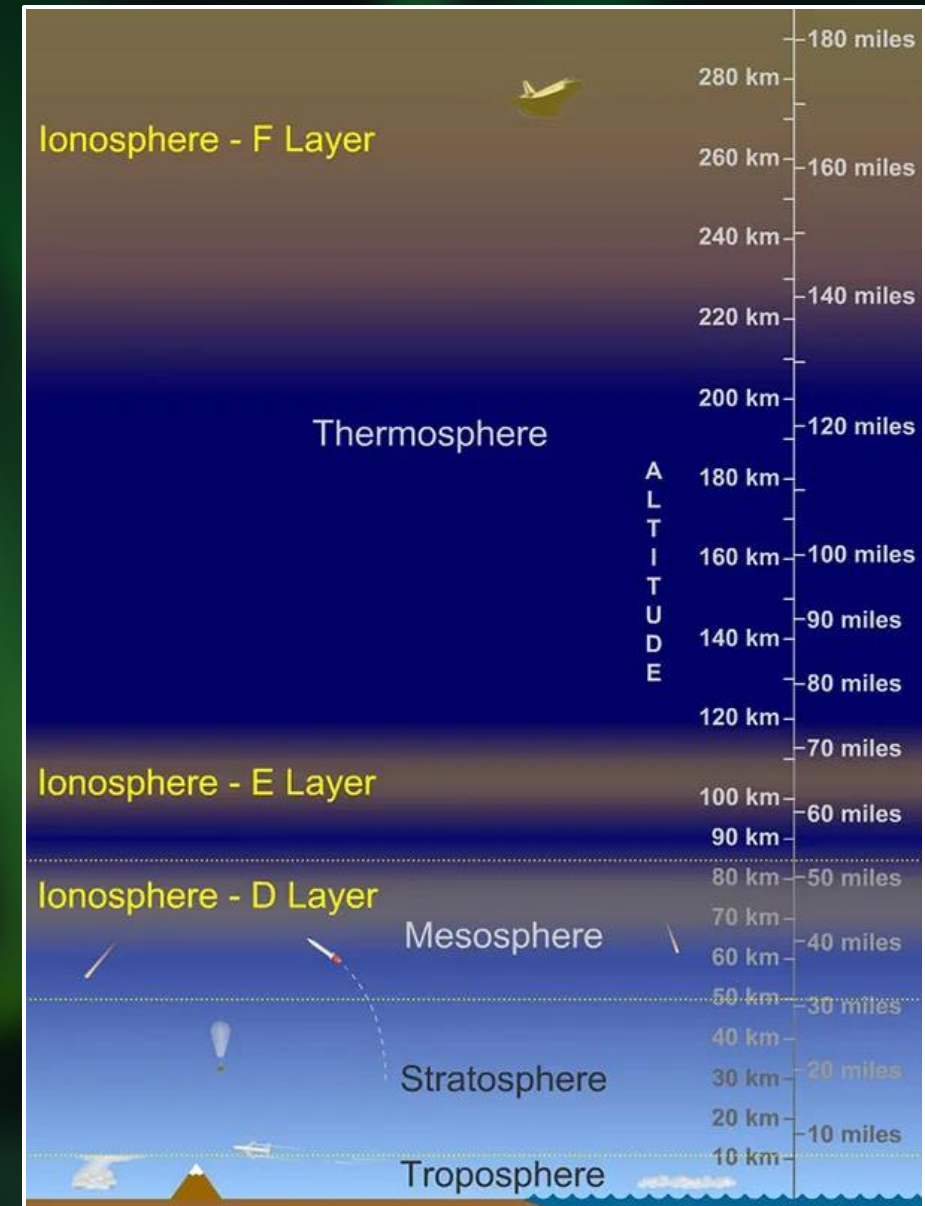


Credit: Aurorasaurus

# Where are auroras created?

Auroras are created in the ionosphere!

- The ionosphere is one of the highest layers in our atmosphere!
- 15-50 times higher than a plane flies!
  - Higher than the weather we experience on the ground, like rain or snow!
- The ionosphere is full of gas which can become electrified, glowing in certain colors, like green, red, and blue!



Credit: UCAR

# What is the aurora?

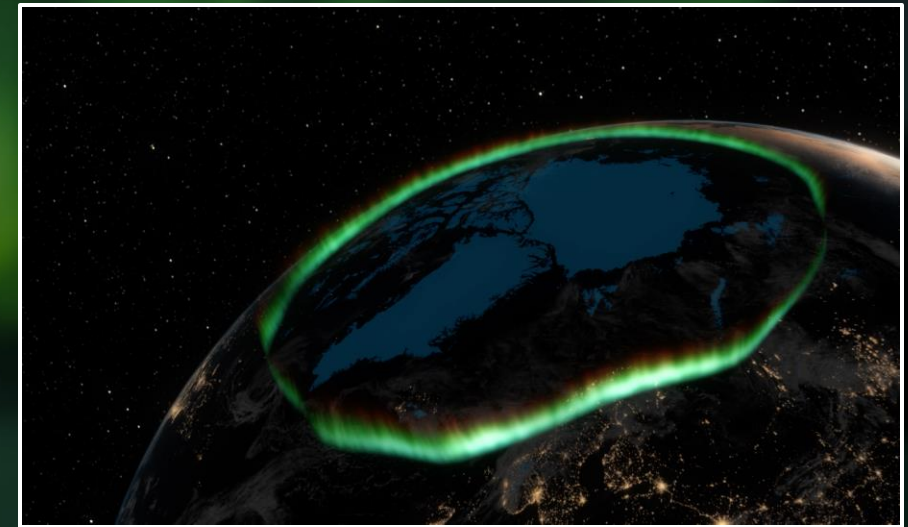
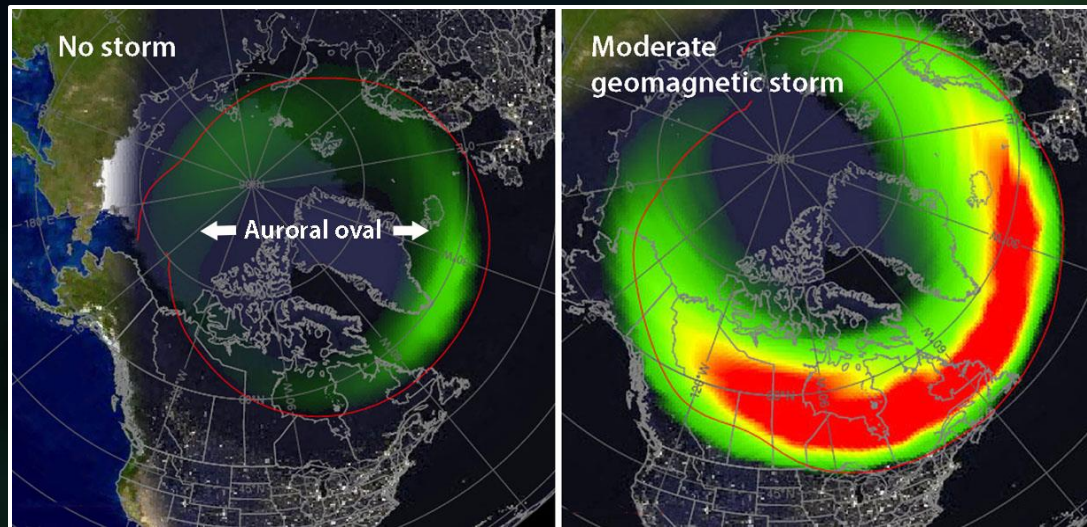
A giant neon lamp in the sky?





# How can you see the aurora?

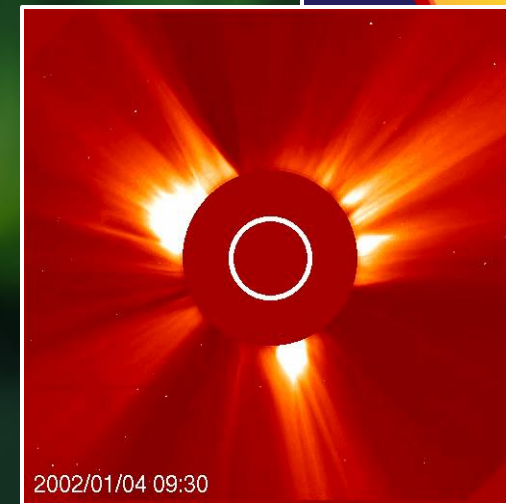
- Travel to a place under the auroral ovals
- It needs to be clear and dark
- The auroral ovals expand during geomagnetic storms – you could see the aurora from your own backyard!



# The Sun can get angry!

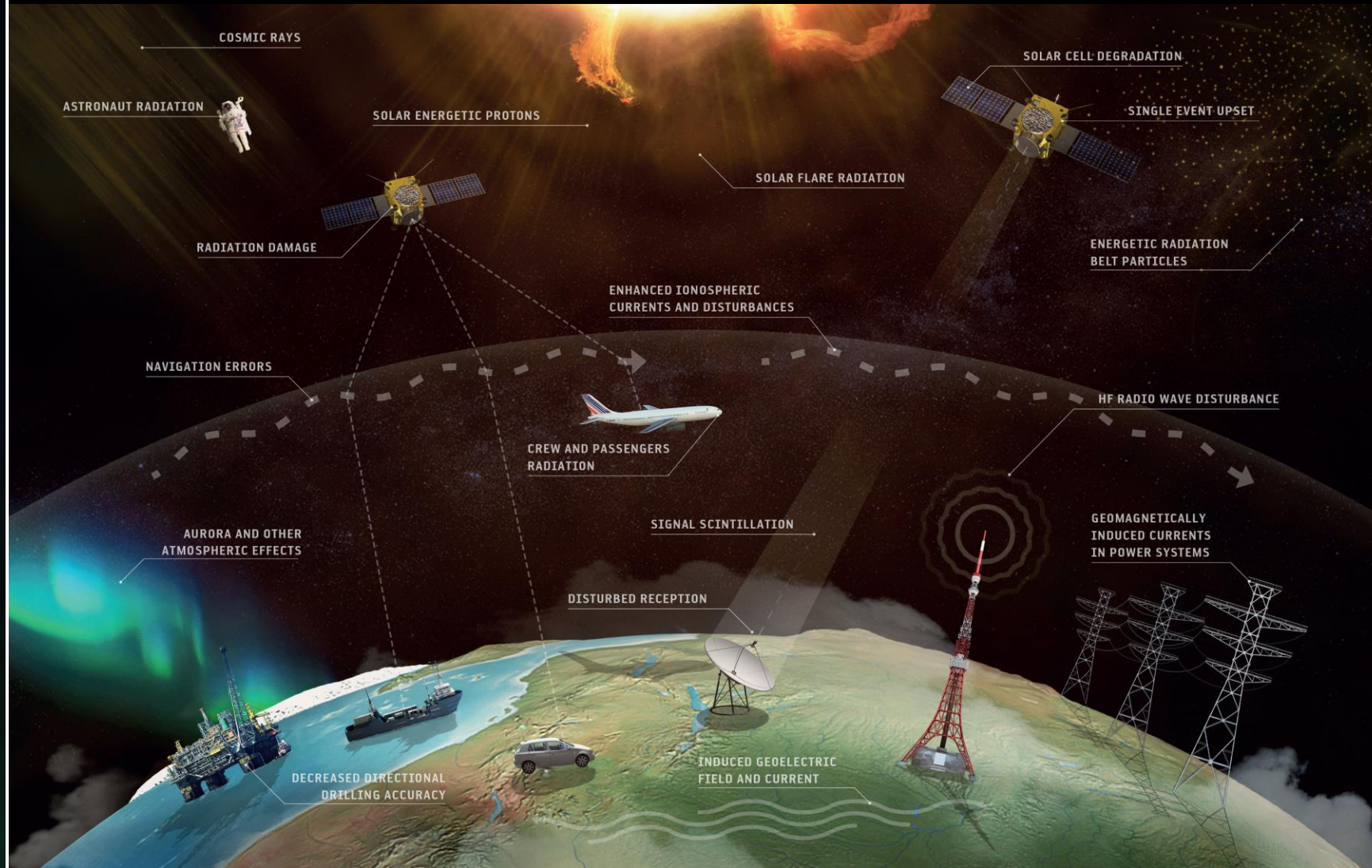
The gentle breezes of space weather can turn into giant storms.

- Sun “burps” or “sneezes” launch parts of the Sun’s atmosphere into space!
- These sneezes can take around 1-3 days to reach Earth.
- When they come close to our planet, some of the energy penetrates our force field!
- The electricity can flow into the aurora, charging them up!



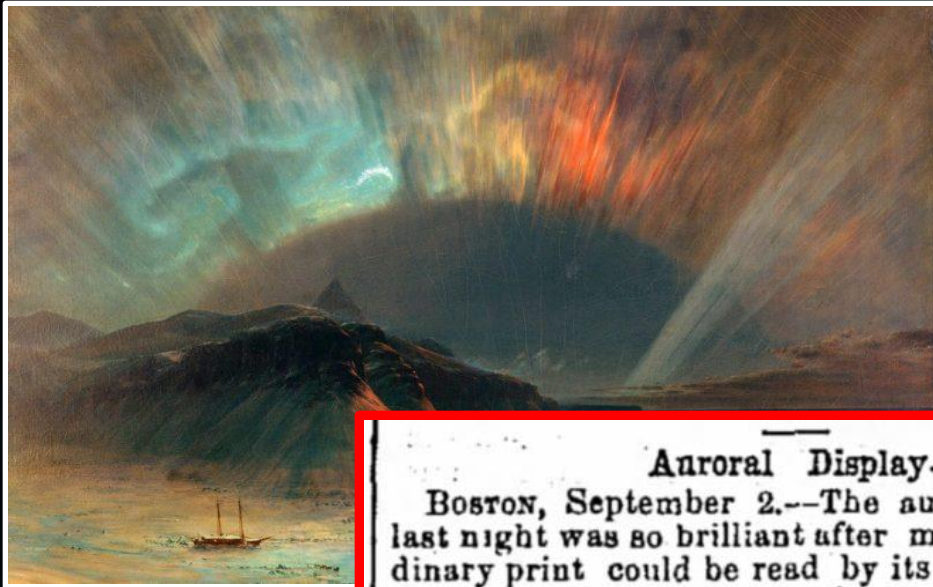


# Space weather could affect YOU!

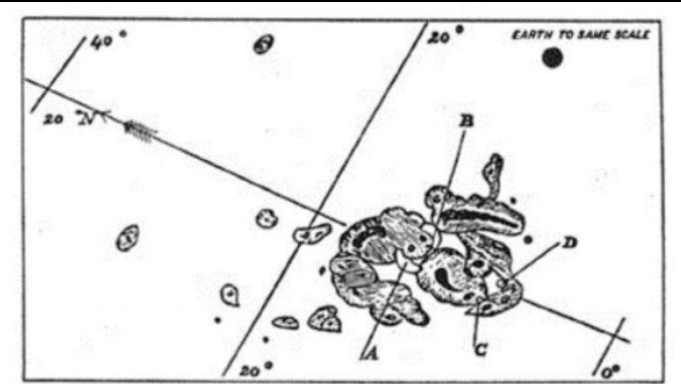
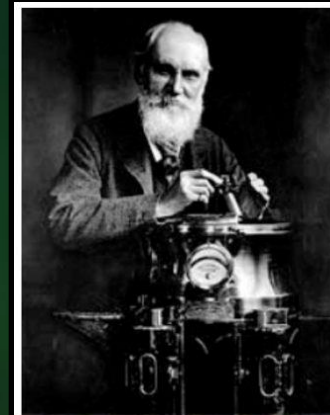




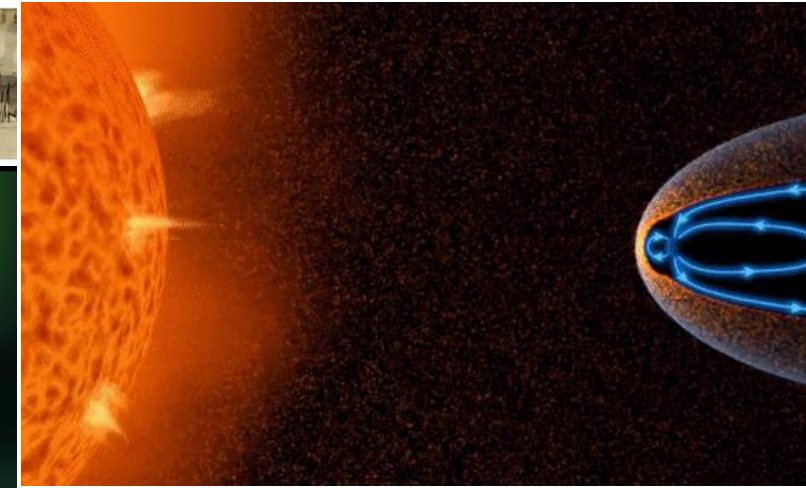
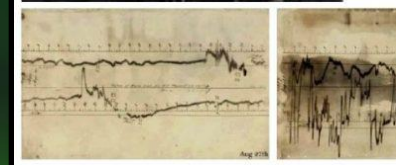
# The Carrington Event



**Auroral Display.**  
Boston, September 2.--The auroral display of last night was so brilliant after midnight that ordinary print could be read by its light. It considerably impeded the working of the telegraph lines, and its effects were continued up to noon of to-day. The auroral current from East to West was so regular that the operators on the eastern lines could send messages to this city without the usual batteries being applied; the same extraordinary effect was apparent on the National telegraph wires between Philadelphia and Pittsburg.



Solar sketch, September 1, 1859, by R. C. Carrington

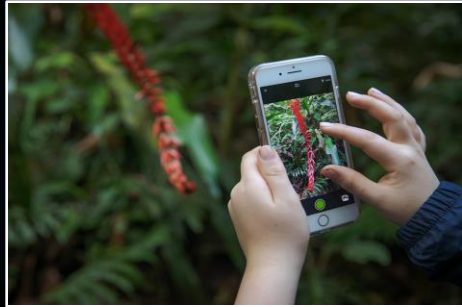


# Citizen Science

“Organized research in which members of the public engage in the processes of scientific investigations by asking questions, collecting data, and/or interpreting results (Citizen Science Central)”



# What does citizen science look like?

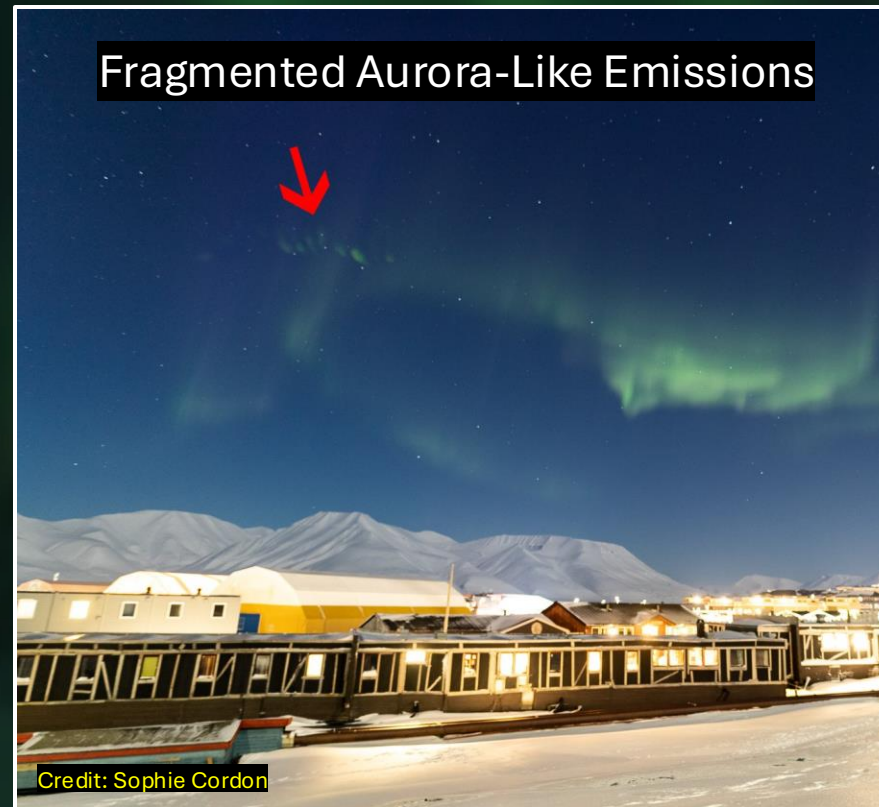


Credit: Rocky Raybell



# Recent aurora citizen science discoveries

Aurora chasers are pioneering the field of Heliophysics through participating in citizen science projects and contributing photos of aurora, including rare aurora or aurora-like phenomena!



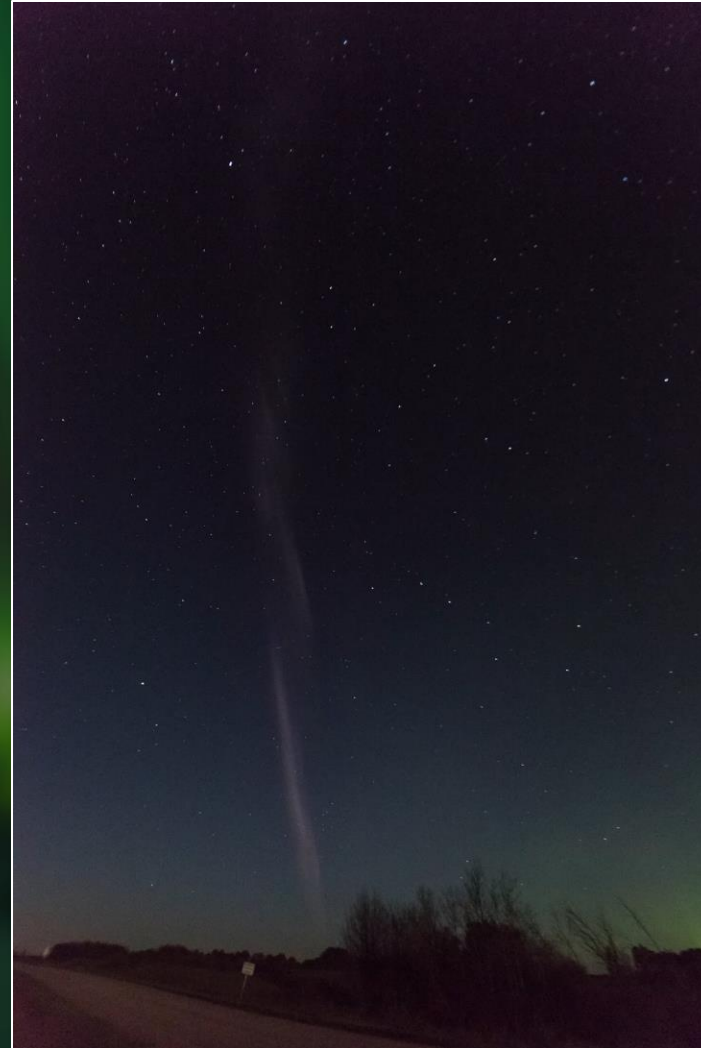
# STEVE – A Viral Citizen Science Story

- Carl Størmer first observed STEVE in 1911



Størmer called this formation a “feeble homogenous arc of great altitude”  
Figure from Hunnekuhl, MacDonald (2020)

- Starting around 2018, aurora chasers started noticing a strange purple arc in the sky and called it a “proton arc.”
- Scientists said “Hmm..., proton arcs aren’t visible to the eye, it must be something else!” While they worked to figure out what it was, aurora chasers named it “STEVE!”
- STEVE is not a normal aurora. It’s produced by a white-hot flow of gas high up in the sky.



Real-time video of STEVE by Justin Anderson

How can *you* (or your library patrons)  
**contribute to aurora science?**



# Report Auroras with Aurorasaurus

- If you see aurora, make a report!
- Data are made available for scientists and help validate aurora models like OVATION.
- Become an ambassador to promote aurora citizen science in your community.

**WHAT A STORM!**  
May 10-11, 2024

**FIRST**  
major storm ever captured primarily by digital cameras (largest since Halloween 2003).

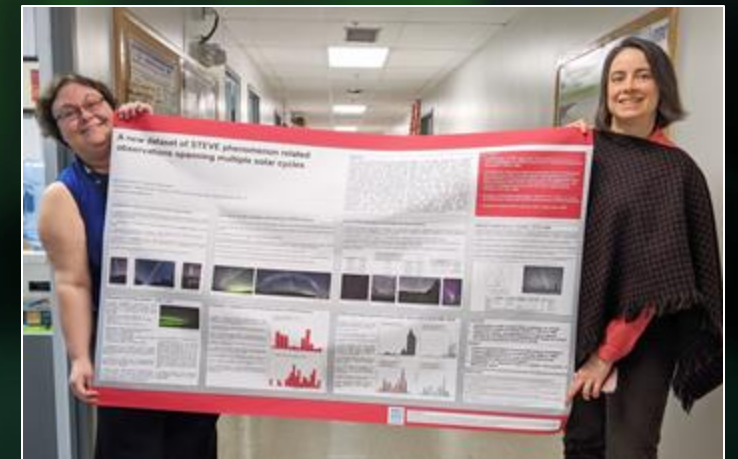
**5,000+**  
Aurorasaurus reports

**55+**  
countries on all 7 continents

**THANK YOU!**  
You can still science with us and make backdated reports to [aurorasaurus.org](http://aurorasaurus.org)!

**AURORASAURUS**  
Reporting Auroras From the Ground Up

NSF  
NASA Partner



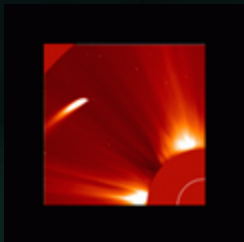
# Explore more citizen science projects!



EZIE MAG + more  
by Semeter, Young



Sungrazer



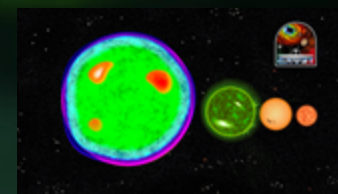
GLOBE



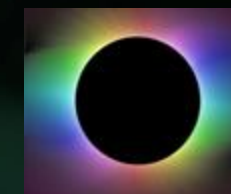
Aurorasaurus



Solar Patrol (GAVRT)



Citizen CATE

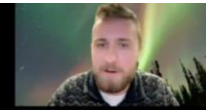


# Activities you can do to **teach** your library patrons **about aurora science**



# Thinking Like an Aurora Scientist

Who am I? → What is Space Weather? → What is the aurora? → **Activity** → Weird kinds of aurora... → You can help!



## Is it an aurora? What do you see? What are the differences?

### Instructions (10 min activity):

- Follow the link: <https://bit.ly/aurora-activity>
- Spend 5 minutes (40-60 sec. per photo) looking over the photos and for each photo, ask yourself/your small group:

### What do you see (colors, brightness, shapes)?

- example: is it one aurora or multiple, does it look sharp, fuzzy, etc.?

*Can work individually or in small groups.*

- Remaining 5 minutes: I will share my thoughts

Who am I? → What is Space Weather? → What is the aurora? → Activity → Weird kinds of aurora... → You can help!

Here's what I said...



- Very green
- Bright? The snow is green.
- Parallel Lines
- No aurora to the left of the main bands.
- Winter season
- Some fuzzy aurora to the right of the main bands.
- Bands are twisted.

The Aurora – Nature's Most Spectacular Light Show, Infiniscope, 10/17/2024 – Vincent Ledvina, vledvina@alaska.edu, theauroraguy.com

This activity is meant to have kids think like an aurora scientist by analyzing pictures of the aurora and discussing what they see!

# Clearinghouse activities

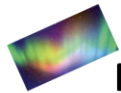
The screenshot shows the STARnet website interface. At the top, it features the STARnet logo (Science-Technology Activities & Resources For Libraries) and logos for Cornerstones of Science and STEM Activity Clearinghouse. A search bar is present. The breadcrumb trail reads: Collections > Sun > Living in a Bubble: Play with Magnets and Compasses. The main content area includes a thumbnail image titled 'The Earth's Magnetic Field' showing magnetic field lines around Earth. The activity title is 'Living in a Bubble: Play with Magnets and Compasses'. The description says: 'Use a bar magnet to make a model of Earth's magnetic field and sketch its shape!'. There is a green 'Open Activity' button and a 'Write a review' button. A sidebar on the right lists details: Content Area (Earth Science, Astronomy and Space), Age Group (Family, Upper Elementary, Tweens (9-12), Teens, Adults), Time to Complete Activity (10-20 minutes), Time needed to prep Activity (5-10 minutes), Cost associated with Activity Materials (\$5-\$10), Difficulty Level (by content) (Medium), and Mess Level (Low). At the bottom of the sidebar are buttons for 'Report a broken link' and 'Categorized Incorrectly? Let us know!'. Social sharing options (Tweet, Share, Pinterest) and utility options (Send to a friend, Print) are located at the bottom left.

Living in a Bubble: Play with Magnets and Compasses

The screenshot shows the STARnet website interface for a different activity. The breadcrumb trail reads: Collections > Earth > Neato-Magneto Planets. The main content area includes a thumbnail image showing purple magnetic field lines around Earth. The activity title is 'Neato-Magneto Planets'. The description says: 'Participants study magnetic fields at four separate stations: examining magnetic fields generated by everyday items, mapping out a magnetic field using a compass, creating models of Earth's and Jupiter's magnetic fields, and observing aurora produced by magnetic fields on both planets.' There is a green 'Open Activity' button and a blue 'How-to Video' button, along with a 'Write a review' button. A sidebar on the right lists details: Content Area (Earth Science), Age Group (Family, Upper Elementary, Tweens (9-12)), Time to Complete Activity (10-20 minutes, 40 minutes to 1 hour), Time needed to prep Activity (10-20 minutes), Cost associated with Activity Materials (\$1-\$5), Difficulty Level (by content) (Medium), and Mess Level (Medium). At the bottom of the sidebar are buttons for 'Report a broken link' and 'Categorized Incorrectly? Let us know!'. Social sharing options (Tweet, Share, Pinterest) and utility options (Send to a friend, Print) are located at the bottom left.

Neato-Magneto Planets

# Hands-on Aurora Activities with UAF's Museum of the North



## Make an Aurora Bracelet

Different gases in Earth's atmosphere, including oxygen and nitrogen, cause the different colors of the northern lights. Make a bracelet to remind you of the aurora colors!



### Materials Needed:

String (about 12 inches long), 2 red pony beads, 4 green pony beads, 2 purple pony beads, 1 "O" bead, 1 "N" bead, scissors.

**Note:** Pony beads can be found at most craft stores. If you don't have beads, you can make your own from paper. Follow the instructions here: [www.bigbeadlittlebead.com/guides\\_and\\_information/guide\\_to\\_making\\_paper\\_beads.php](http://www.bigbeadlittlebead.com/guides_and_information/guide_to_making_paper_beads.php)

### Instructions:

**Step 1:** Cut a piece of string about 12 inches long. Find the center of your string. Tie a red bead slightly to one side of the middle.

**Step 2:** String your aurora beads in order:

- One more red bead
- An O bead for Oxygen
- Four green beads
- An N bead for Nitrogen
- One purple bead

**Step 3:** Tie on the last purple bead to secure the beads.

**Step 4:** Tie the ends of the string together and wear your bracelet!



of the northern lights:  
[u/multimedia/gas.html](http://u/multimedia/gas.html)



## Watercolor Aurora Sky

Create a picture of the northern lights. Explore aurora mysteries!



### Materials Needed:

Crayola or other water-based markers (blue, green, red, purple, yellow), pencil, Sharpie or other fine black marker, watercolor paper, paintbrush, water, paper towels, circular stencil or compass.

This activity is adapted from the Watercolor Galaxy Sky Tutorial by artist Jen Aranyi. Watch the video here: [www.youtube.com/watch?v=Vps0E...](https://www.youtube.com/watch?v=Vps0E...)  
About the artist: [jenaranyi.com/about](http://jenaranyi.com/about)

### Instructions:

**Step 1:** Trace a circle on your watercolor paper with a pencil. Draw the horizon (hills or flat) across the bottom third of the circle.

**Step 2:** With the water-based markers, color in the aurora with green, red, or purple markers in the top two-thirds of the circle. Aurora can look like wavy bands across the sky or large areas of color over the horizon. Fill in the sky with blue marker. Leave the area under the horizon line white.

**Color Tip:** Combine green and yellow to make a bright green. Combining red with green is not recommended as it may result in a brown color.

**Step 3:** Apply water over the colored area with a paintbrush. Rinse the brush regularly to avoid a muddy effect. Let this dry completely. Don't worry if you still see marker lines; as the water dries, a smoother blend of colors will appear.

**Step 4:** Trace the horizon line again with your black fine-tipped marker. Add trees, hills, houses, or any landscape you choose in front of your sky. Younger children can use a water-based black marker, as long as the paper is completely dry. Alternatively, use paper collage to create the landscape instead.

**Optional:** Paint or draw tiny white dots on the sky for stars. Cut out your aurora watercolor art circle and glue onto a black sheet of paper!

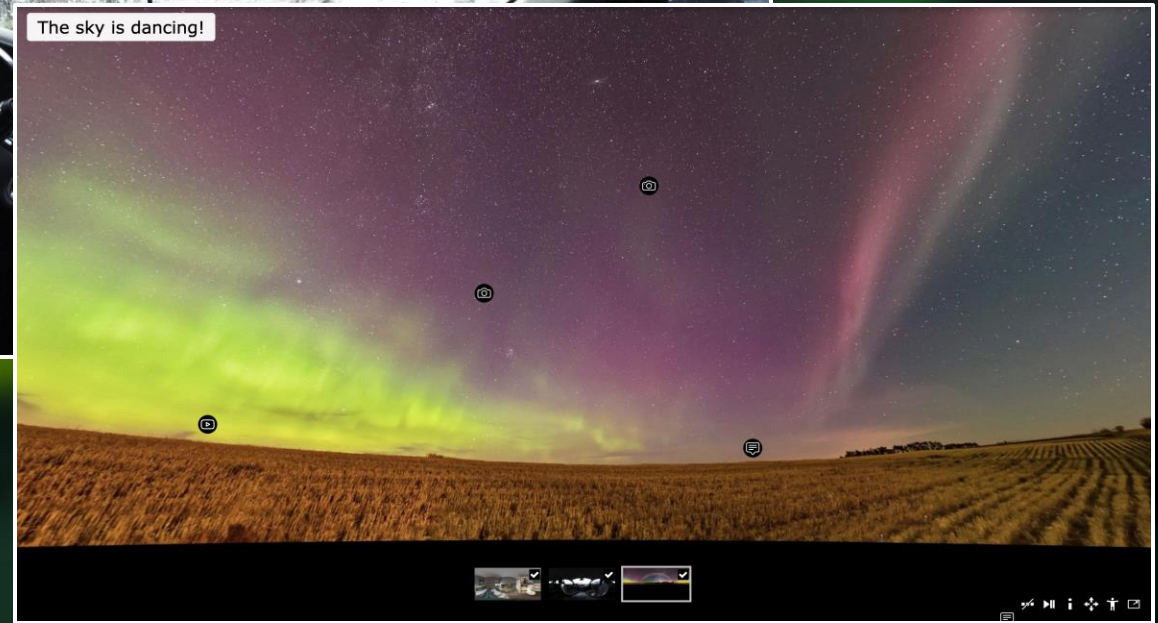
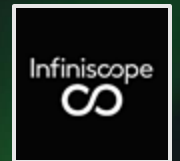
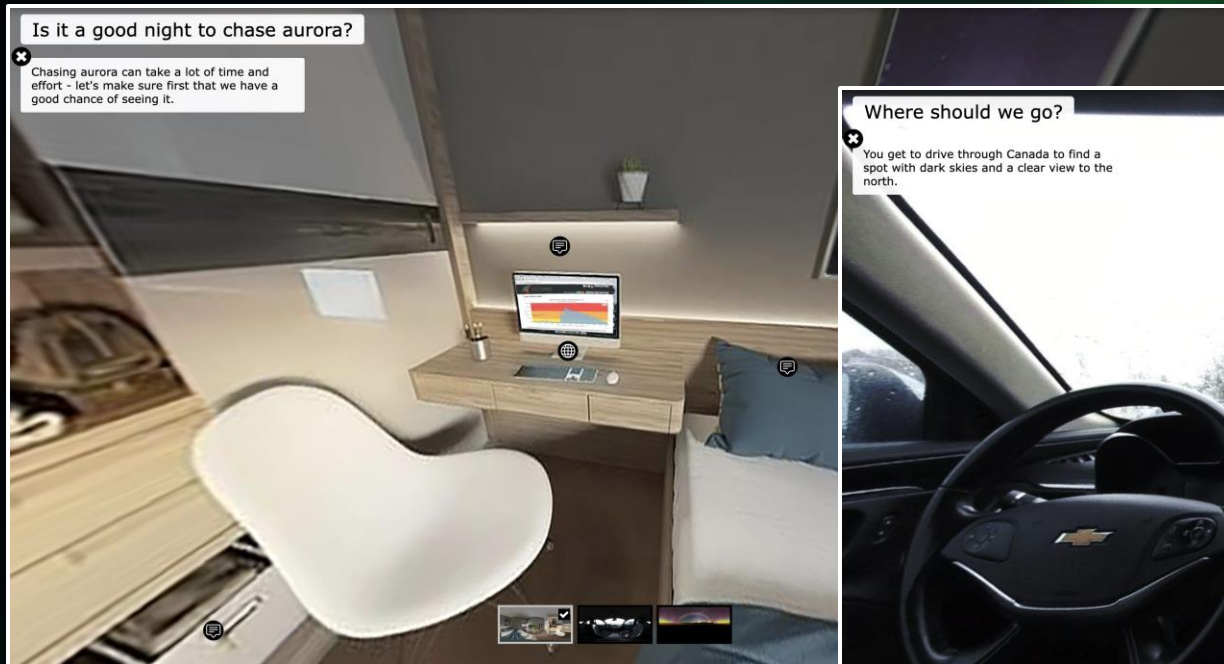
Some activities especially relevant to library presentations:

- Make an Aurora Bracelet
- Aurora Chalk Art
- Explore Magnets
- Paint the Aurora with Ice Cubes
- Pack a Northern Lights Backpack
- Watercolor Aurora Sky



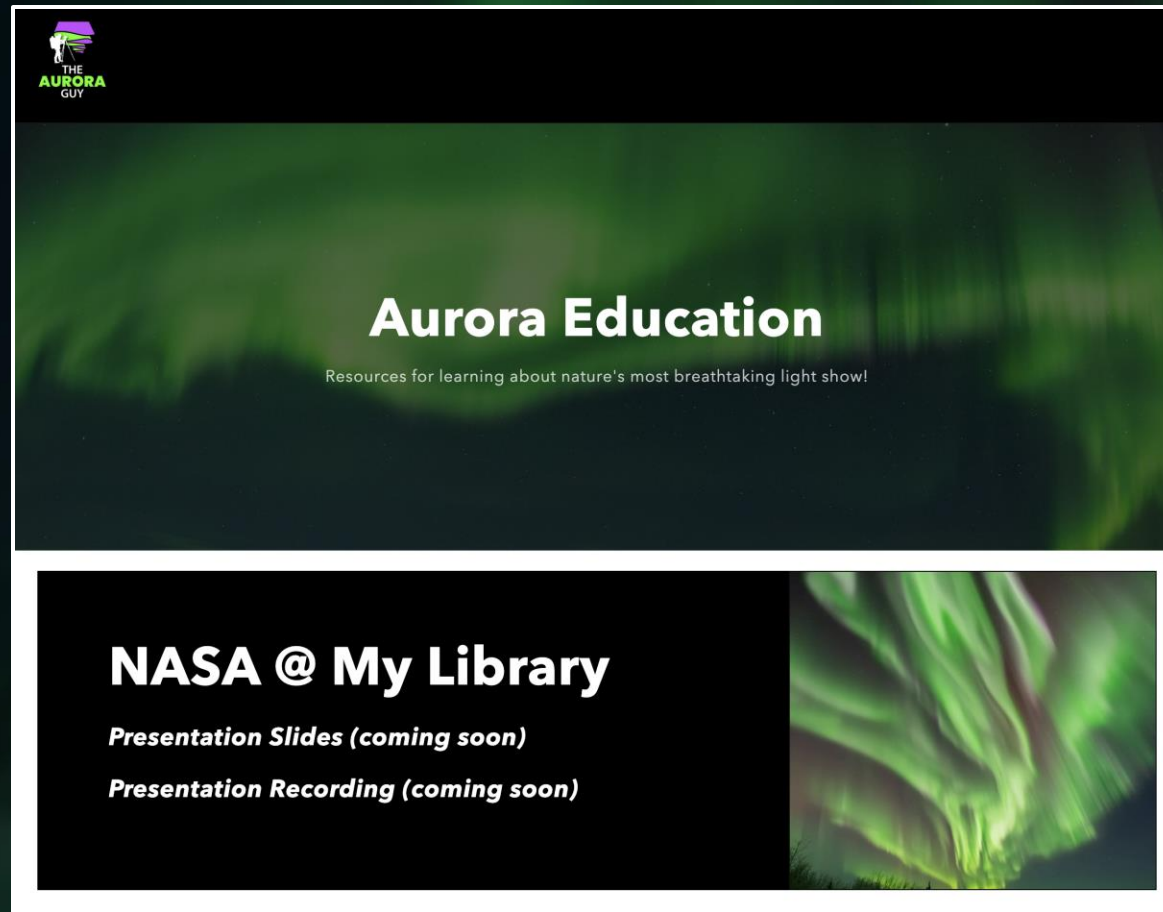


# Virtual Field Trip with Aurorasaurus and Infiniscope



Take your class to Alberta, Canada for a virtual aurora chase! Check data to decide whether the Northern Lights are likely to appear, find a prime location, and learn about the science behind these natural wonders.

Visit my website for more resources!  
[theauroraguy.com/pages/aurora-education](http://theauroraguy.com/pages/aurora-education)



# Questions?

vledvina@alaska.edu

[theauroraguy.com/pages/aurora-education](http://theauroraguy.com/pages/aurora-education)