Chasing the Aurora Borealis Below the 45th Parallel

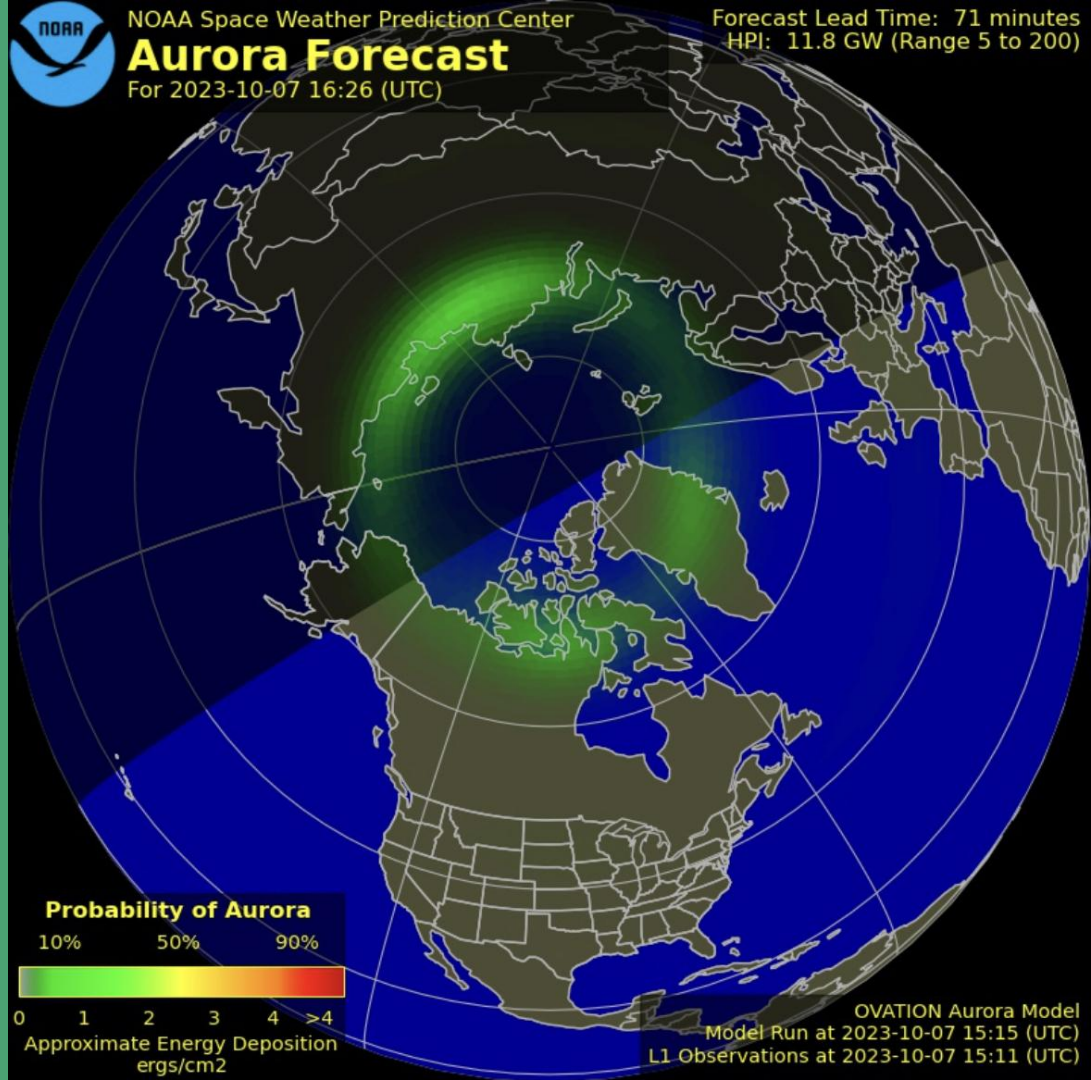
Advice and Q&A with Melissa F. Kaelin

Let's take a pulse...

Is it a good idea to chase Aurora tonight?

Insider Tip: Check the conditions during the day, so you can compare them to the conditions at nightfall.

When it comes to catching Aurora, how conditions are **trending** is often more important than one snapshot in time.



About the Author

Melissa F. Kaelin is a writer, artist and social media guru who moved to Michigan in 2018, after living in Minnesota and Ohio. She has published many books, including a creative anthology and “Below the 45th Parallel,” the beginner’s guide to Aurora Chasing.

In 2017, she co-founded the annual **Aurora Summit**, a retreat celebrating the art, culture, science and photography of the Northern Lights. She has moderated the Great Lakes Aurora Hunters and other groups. In January 2021, she founded the Michigan Aurora Chasers.

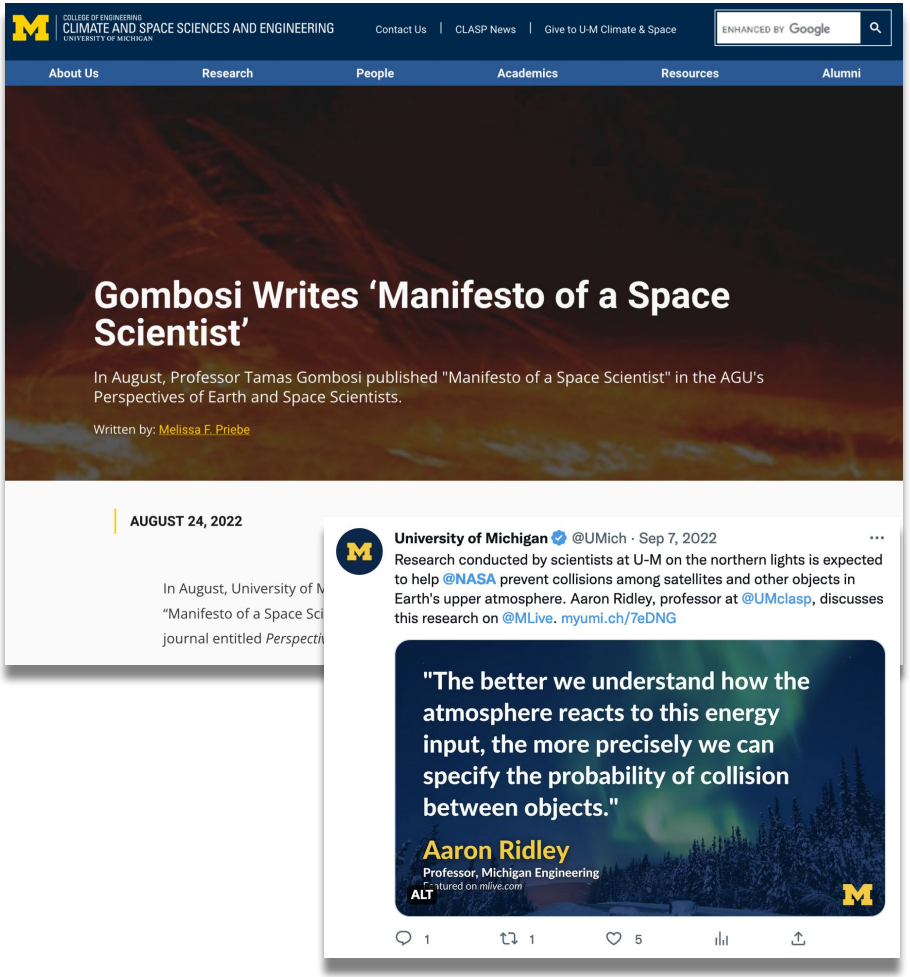
Residing in Ann Arbor, Michigan, Melissa has chased Aurora for 12 years. She’s has witnessed dozens of Aurora displays across four states, and she has led hundreds (maybe thousands) of beginners to their first Aurora sighting.

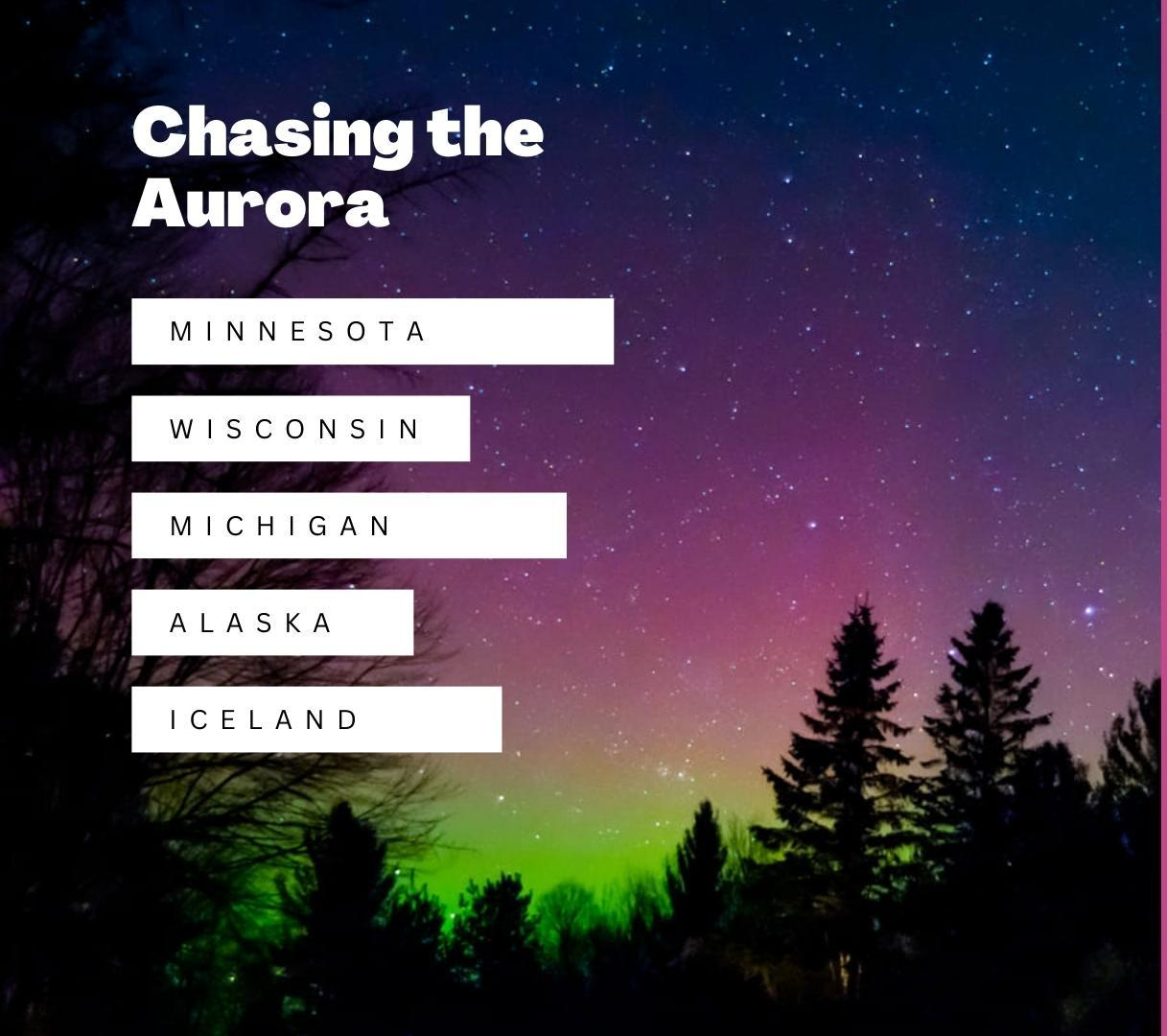
Melissa F. Kaelin
KaelinArt.com

… and Science Communicator!

In the office, Melissa works as Manager of Marketing & Communications for the **University of Michigan Department of Climate & Space Sciences & Engineering.**

- Interviews researchers in fields of space weather & climate change
- Writes breaking news in partnership with NASA, NOAA and other agencies
- Manages websites, social media, marketing and press relations at U-M





THE NIGHT AURORA CHASED ME

Driving home from the Inaugural Upper Peninsula Dark Sky Festival along Lake Superior's Shore in the Upper Peninsula of Michigan, April 23-24, 2023.

Photo by Jessica Ellis Rorman

#LiveChase!

Led a Live Chase on May 10, 2024, during historic G5 Storm in Dexter, Michigan. We celebrated 100K with a successful Statewide Live Chase on June 10, 2024!

Photo by Patricia Parker

Photo by Lauren Kovich

Photo by Karen Serwatowski

How to Catch the Northern Lights

What it takes to see Aurora

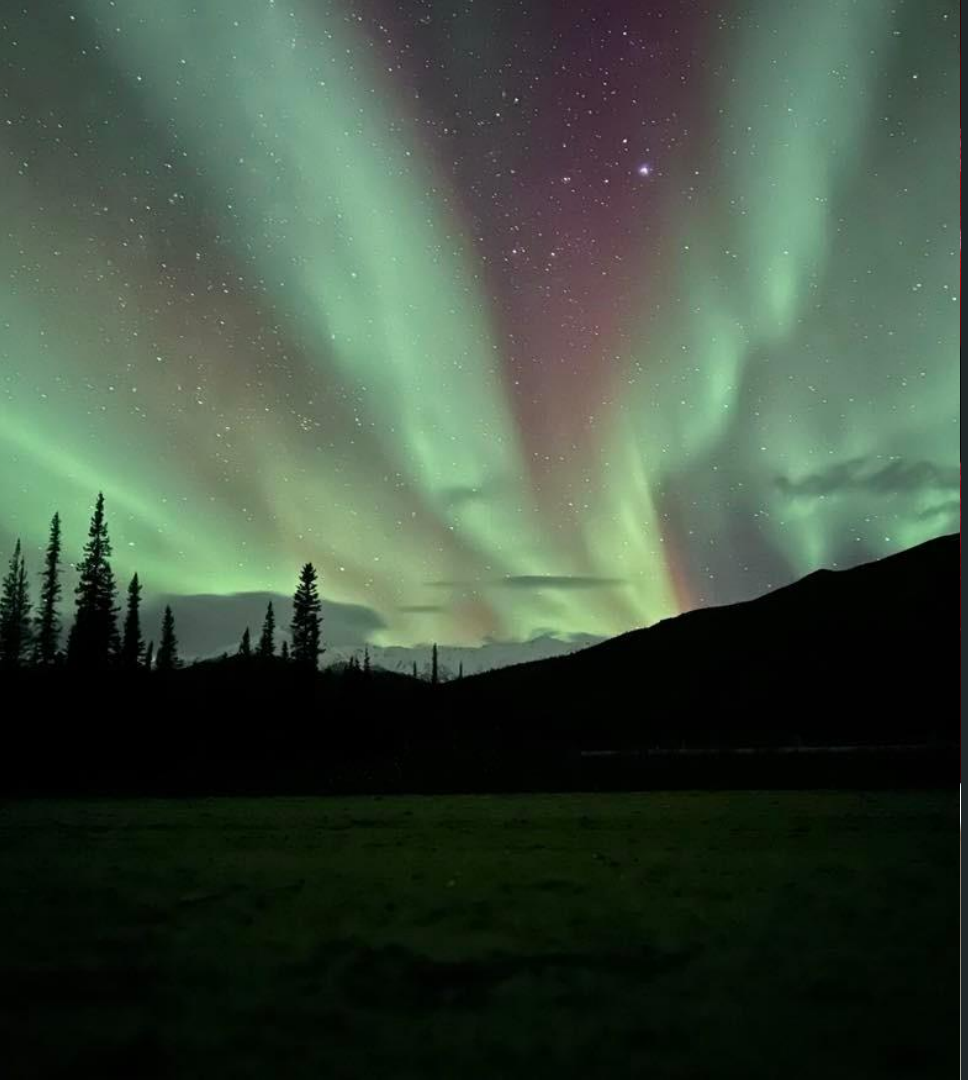
Many factors have to align to create the Northern Lights, on Earth and in Outer Space!

The Right Conditions in Space

- Solar activity
- Direction of the solar wind
- Solar wind composition: Speed, Density, Bt, Bz
- A favorable Bz: This is essentially the gatekeeper
- Conditions can change instantly

The Right Conditions on Earth

- Starry nights
- Dark skies
- Moon phase & obstacles
- Northern location
- Eyesight visibility



Things to Consider

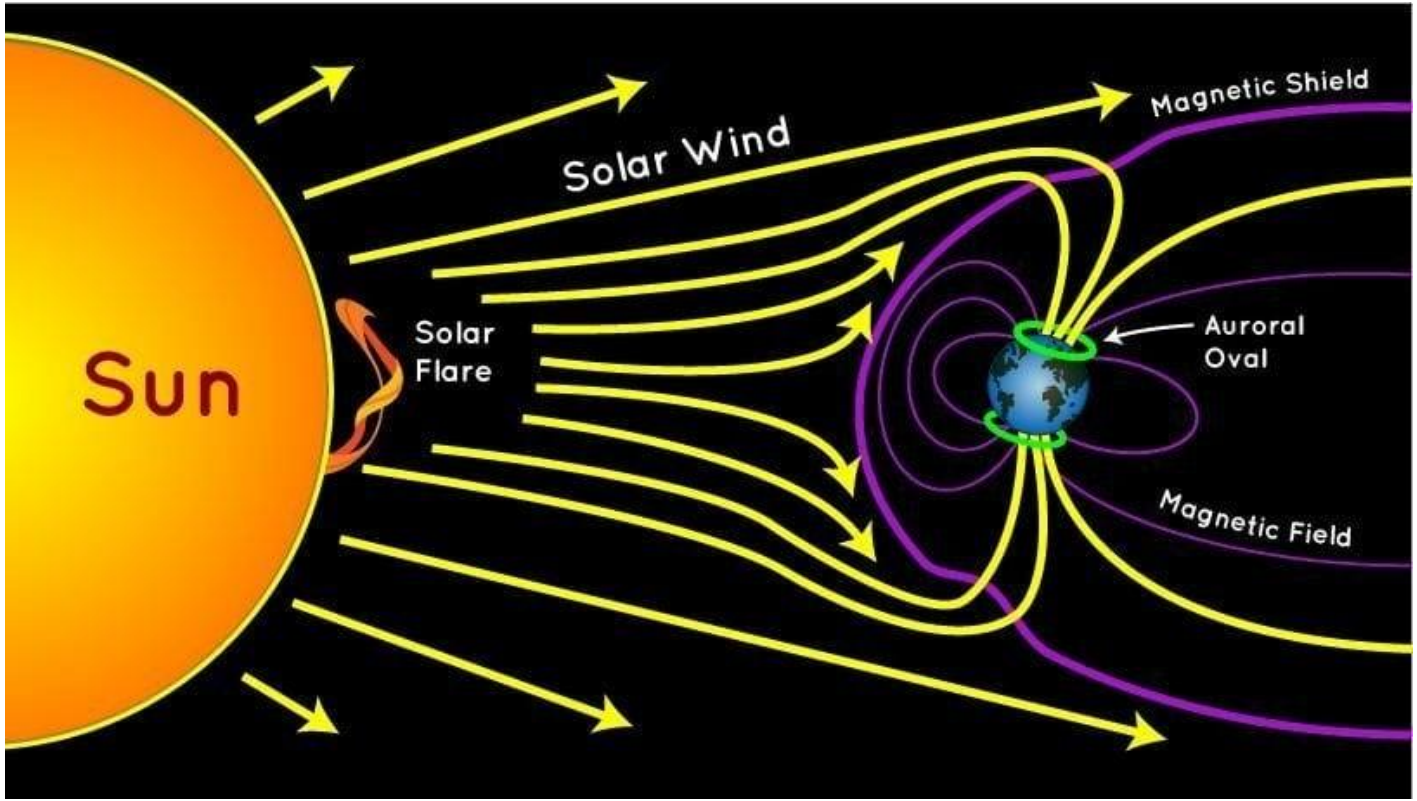
- Scout Out a Location
- Light Pollution or Dark Sky Maps
- Cloud Cover & Weather
- Sunset, Twilight & Moonrise
- Reliability of the Forecasts
- Patterns of the Northern Lights
- Safety, Sleep & Sanity

Number #1 Tip: Plan something exciting in case you get aced!

Understanding What Causes Aurora: The Solar Wind

Solar Activity

- Solar Plasma
- Eruptions
- CMEs
- Coronal Holes
- Filaments
- Glancing Blow
- Co-rotating Interactive Regions
- Ever Present Solar Wind

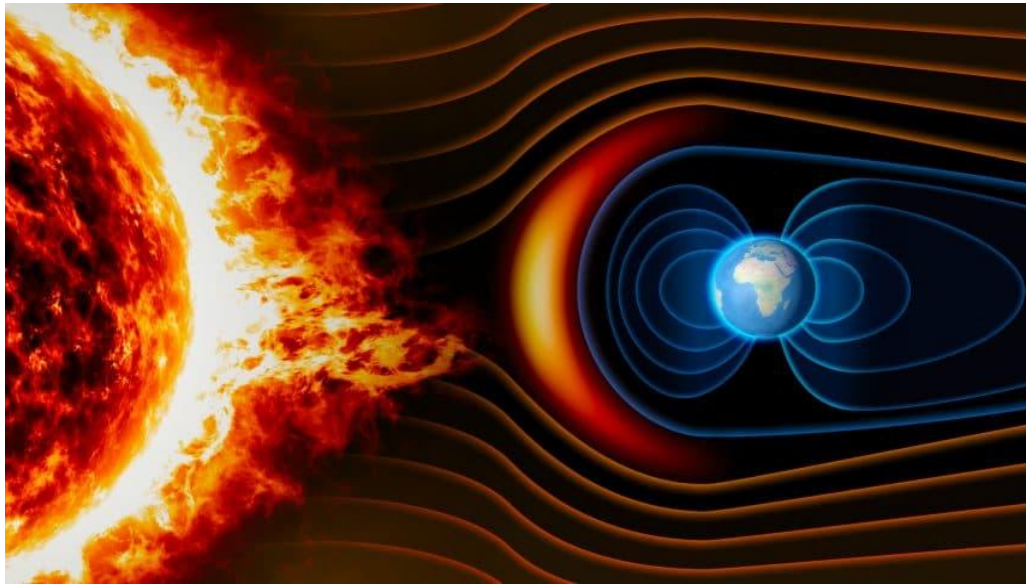


Source: Space Weather Prediction Center

The Solar Wind’s Journey to Earth’s Magnetic Field

Weather Traveling in Space

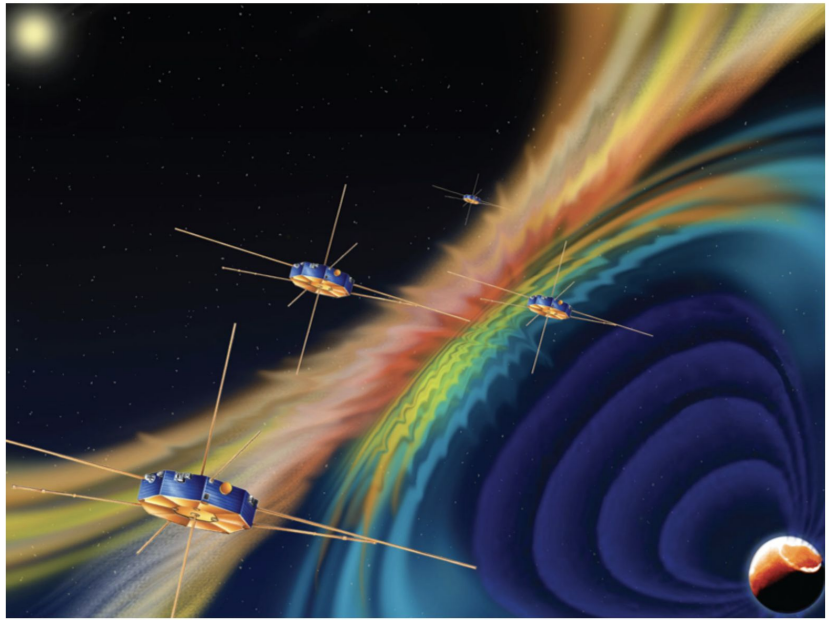
- Monitor the Sun
  — Parker Solar Probe
  — Solar Orbiter
- Monitor the Earth
  — Solar Dynamics Observatory SDO
  — Advanced Composition Explorer ACE
  — Solar and Heliospheric Observatory SOHO
- Many types of data
- Magnetic Field Impacts
- The dreaded dud



Source: Earth.com

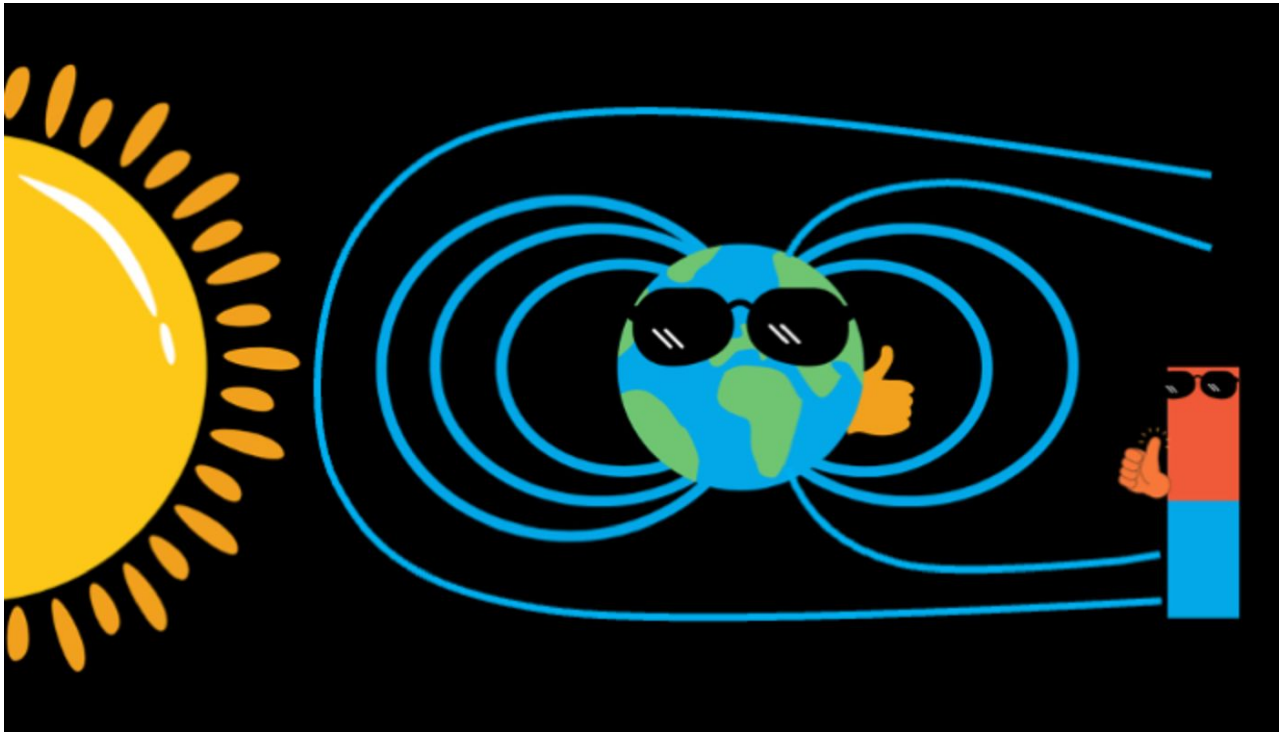
Did you know the Bz naturally protects us?

“Advice from the Northern Lights”



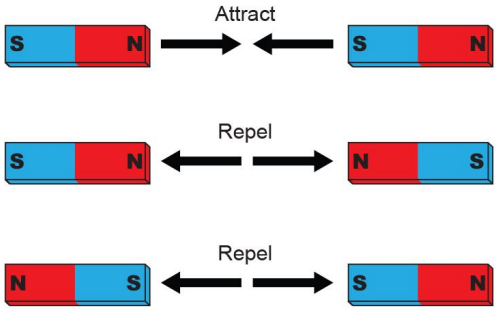
Reconnecting magnetic field lines, which accelerate energetic electrons, are illustrated here along with the spacecraft of NASA’s Magnetospheric Multiscale mission. Credit: Southwest Research Institute, CC BY 2.0

What is the “Bz”? Meet the “Gatekeeper”



- Southward Bz
- More Negative
- Oscillate back and forth
- Like an open door

#ThatPeskyBz



Award-winning image courtesy of EGU Blog

Particles Collide with Air Molecules to Emit Light

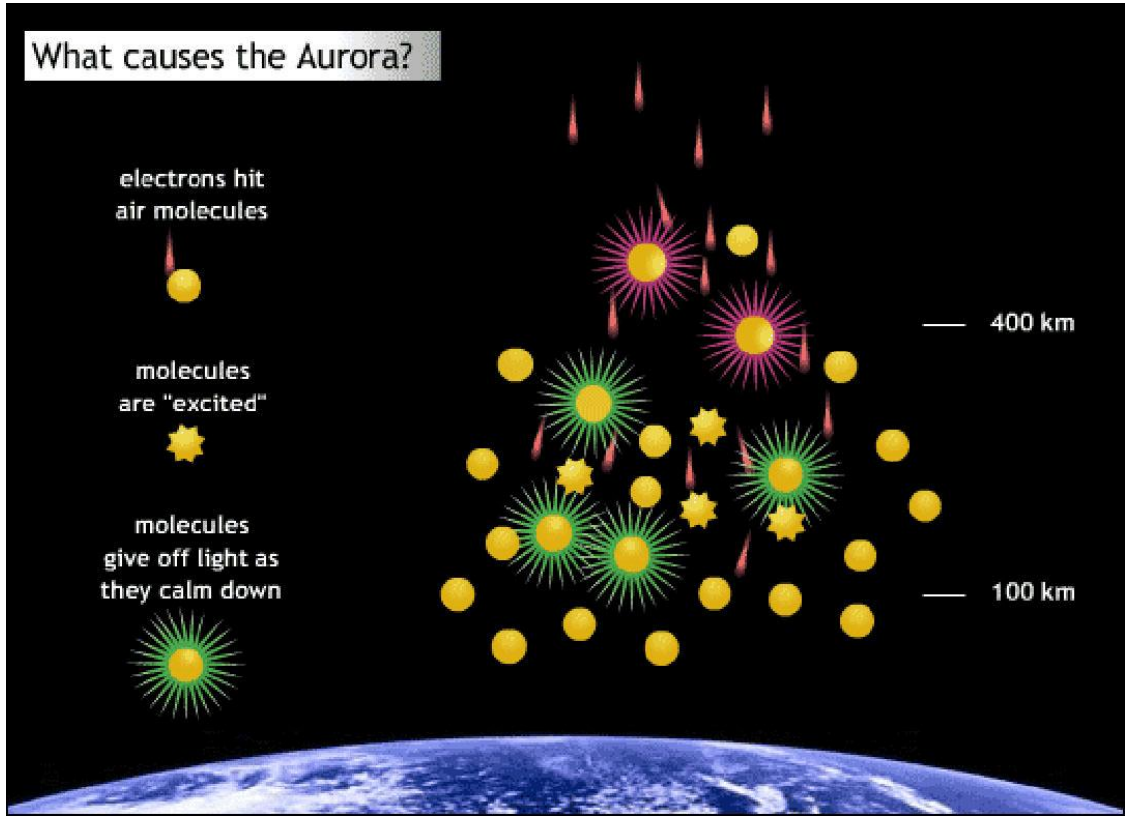
Colors are created when excited particles entering Earth's atmosphere interact with molecules like oxygen, hydrogen and nitrogen to emit light.

Oxygen - High Altitude: Red

Hydrogen, Helium: Purple, Pink

Oxygen - Low Altitude: Green

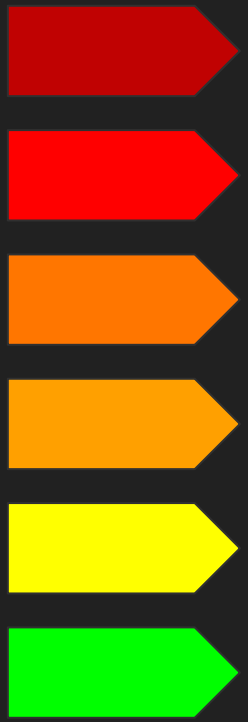
Nitrogen: Blue



Many Methods for Predicting Aurora

Beginner	Apps, Kp Alerts, Webcams
Beginner	K-Index, Predictions, Ovation Model, HPI
Intermediate	Space Weather Live, Real Time Solar Wind
Intermediate	Coronographs, SolarHam, Ap-Index
Advanced	WSA-Enlil, CME Scoreboard, Magnetometer Plots
Advanced	Analyzing CMEs, Understanding Flux Ropes

K-Index & Geomagnetic Storm Scales



Kp 9 • G5 Storm	Extreme Geomagnetic Storm
Kp 8 • G4 Storm	Severe Geomagnetic Storm
Kp 7 • G3 Storm	Strong Geomagnetic Storm
Kp 6 • G2 Storm	Moderate Geomagnetic Storm
Kp 5 • G1 Storm	Minor Geomagnetic Storm
Kp 4 or Less	Below Storm Levels

The Limitations of the K-Index: Be Weary of Kp

The K-Index actually describes the strength of geomagnetic activity associated with Aurora. When referred to as a “planetary average,” this is called Kp. Kp is not a perfect tool.

Aurora Chasing

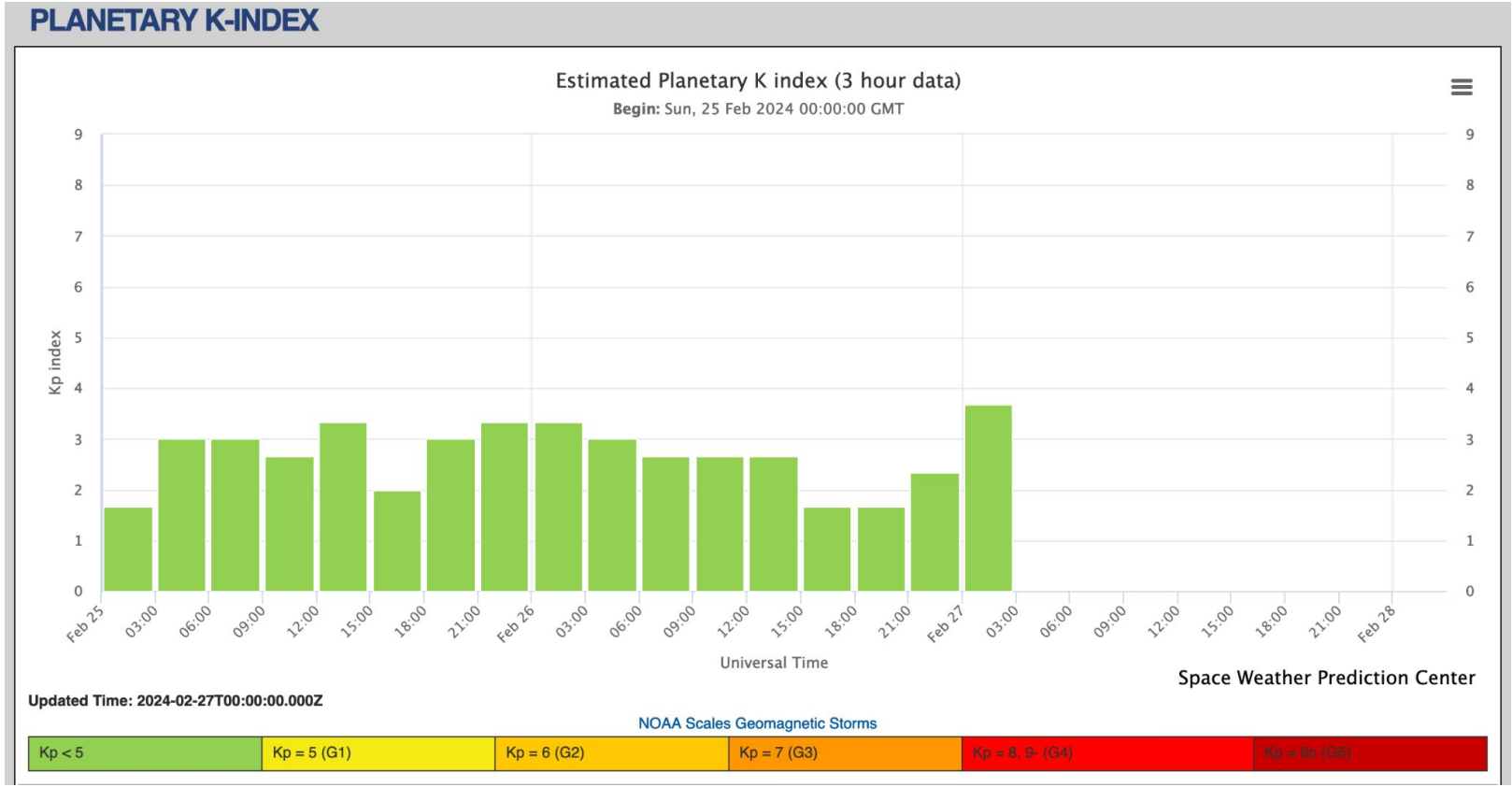
The Pros and Cons of Relying on Kp

When you’re trying to catch the Northern Lights for the first time, it’s natural to wonder when you can see them and where. The answer to these questions, it turns out, is not so easy.

- The national forecasting standard
- A forecasting tool, not a good real-time tool
- Data from magnetometers across the world
- An average over 3 hours
- Often refers to the past
- Available on many apps, which may lag
- Not an exact science
- Other data becomes more important

Plotting out Geomagnetic Activity with Kp

Aurora strength measured on a scale of 0-9, often given in a 3-hour average (Kp)



NOAA's Geomagnetic Storm Scales

A Geomagnetic Storm is essentially an Aurora happening at storm level conditions.

G5 Storm (aka K9)

G4 Storm (K8)

G3 Storm (K7)

G2 Storm (K6)

G1 Storm (K5)

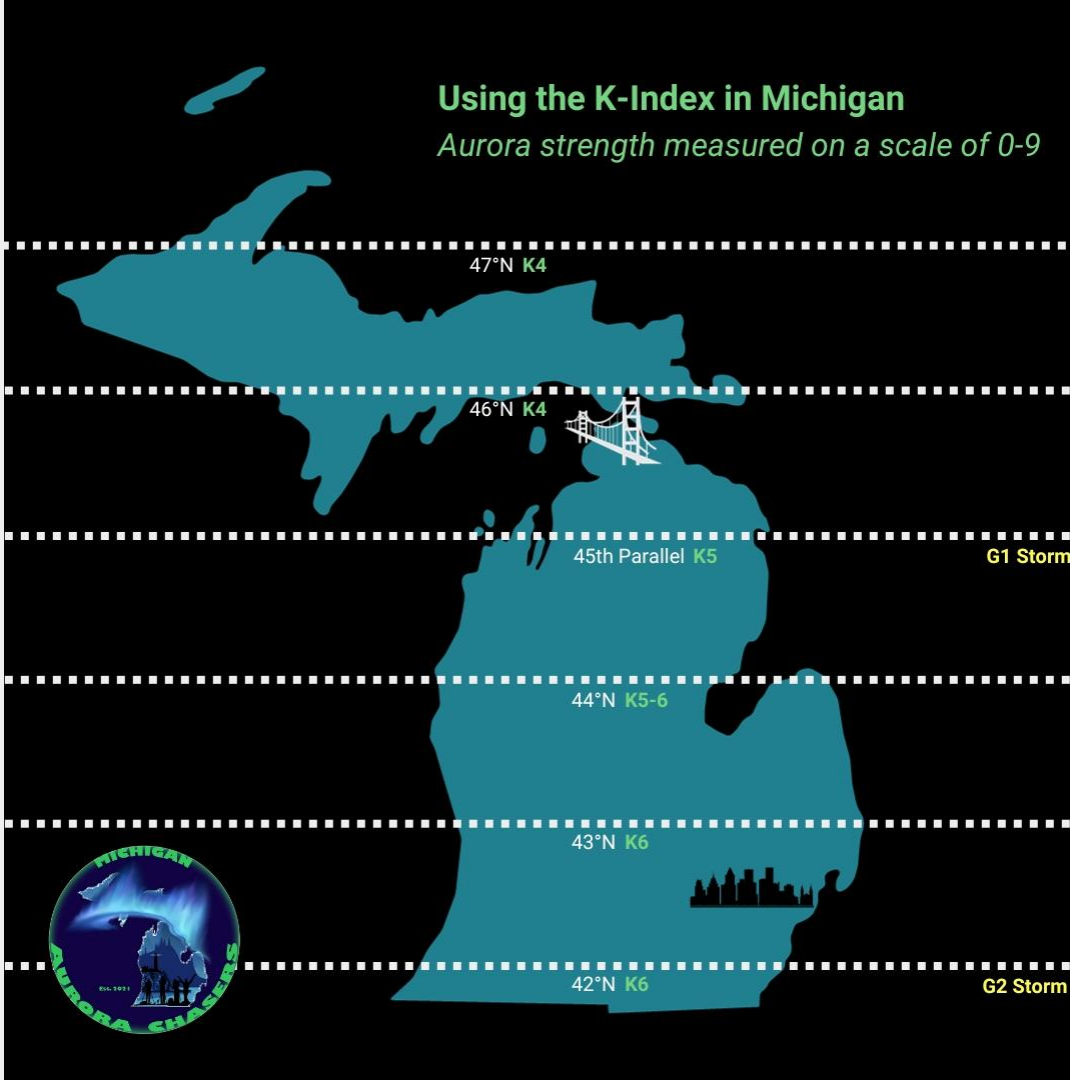
K4 or Kp4 is below storm levels.

Scale	Description	Effect	Physical measure	Average Frequency (1 cycle = 11 years)
G 5	Extreme	**Power systems:** Widespread voltage control problems and protective system problems can occur, some grid systems may experience complete collapse or blackouts. Transformers may experience damage. **Spacecraft operations:** May experience extensive surface charging, problems with orientation, uplink/downlink and tracking satellites. **Other systems:** Pipeline currents can reach hundreds of amps, HF (high frequency) radio propagation may be impossible in many areas for one to two days, satellite navigation may be degraded for days, low-frequency radio navigation can be out for hours, and aurora has been seen as low as Florida and southern Texas (typically 40° geomagnetic lat.).	Kp = 9	4 per cycle (4 days per cycle)
G 4	Severe	**Power systems:** Possible widespread voltage control problems and some protective systems will mistakenly trip out key assets from the grid. **Spacecraft operations:** May experience surface charging and tracking problems, corrections may be needed for orientation problems. **Other systems:** Induced pipeline currents affect preventive measures, HF radio propagation sporadic, satellite navigation degraded for hours, low-frequency radio navigation disrupted, and aurora has been seen as low as Alabama and northern California (typically 45° geomagnetic lat.).	Kp = 8, including a 9-	100 per cycle (60 days per cycle)
G 3	Strong	**Power systems:** Voltage corrections may be required, false alarms triggered on some protection devices. **Spacecraft operations:** Surface charging may occur on satellite components, drag may increase on low-Earth-orbit satellites, and corrections may be needed for orientation problems. **Other systems:** Intermittent satellite navigation and low-frequency radio navigation problems may occur, HF radio may be intermittent, and aurora has been seen as low as Illinois and Oregon (typically 50° geomagnetic lat.).	Kp = 7	200 per cycle (130 days per cycle)
G 2	Moderate	**Power systems:** High-latitude power systems may experience voltage alarms, long-duration storms may cause transformer damage. **Spacecraft operations:** Corrective actions to orientation may be required by ground control; possible changes in drag affect orbit predictions. **Other systems:** HF radio propagation can fade at higher latitudes, and aurora has been seen as low as New York and Idaho (typically 55° geomagnetic lat.).	Kp = 6	600 per cycle (360 days per cycle)
G 1	Minor	**Power systems:** Weak power grid fluctuations can occur. **Spacecraft operations:** Minor impact on satellite operations possible. **Other systems:** Migratory animals are affected at this and higher levels; aurora is commonly visible at high latitudes (northern Michigan and Maine).	Kp = 5	1700 per cycle (900 days per cycle)

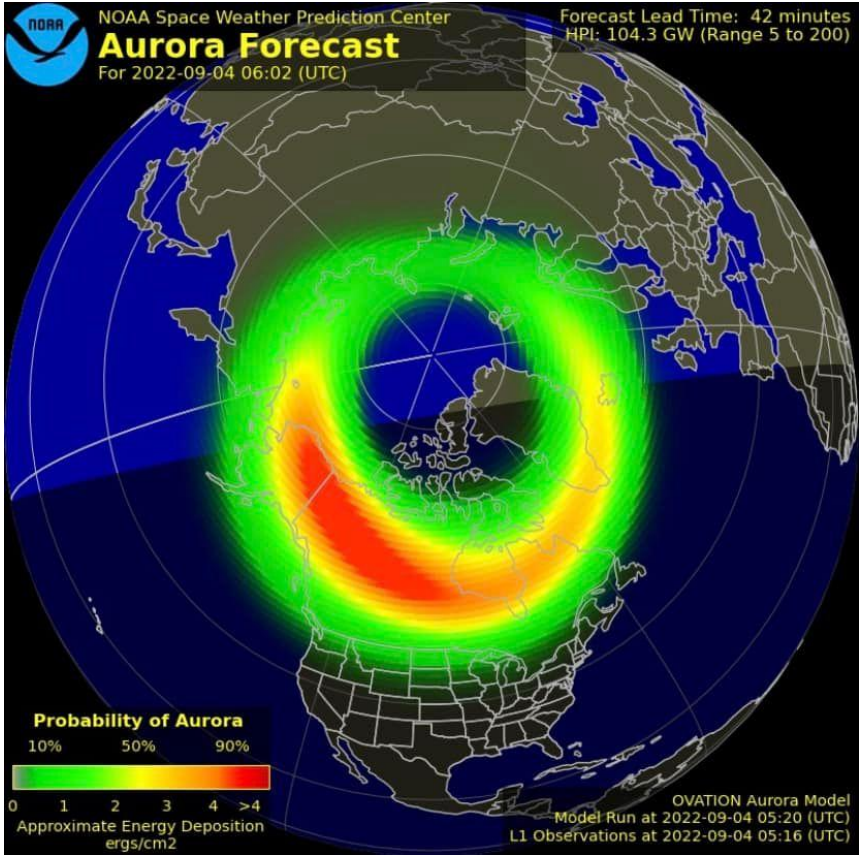
Forecasting by Latitude

The K-Index can be used to understand how far south Aurora may appear based on anticipated conditions. It also works well to compare displays with historic data.

In real time, Kp is not a good indicator of Aurora activity.



Ovation Model



Source: Space Weather Prediction Center

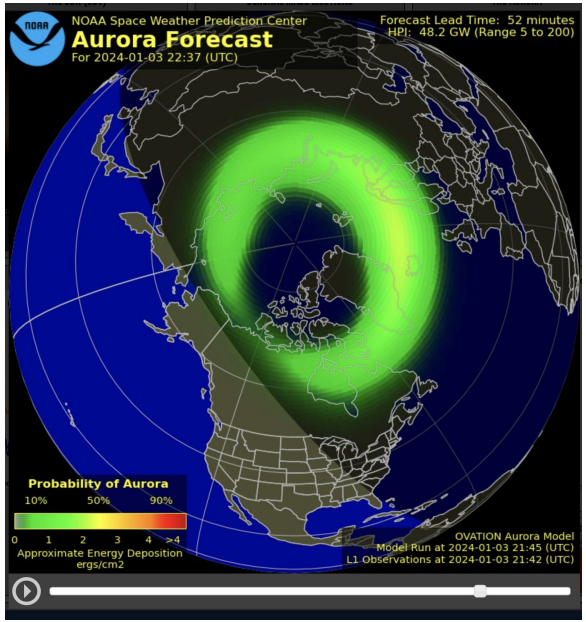
Components of the Ovation

The model uses the solar wind velocity and interplanetary magnetic field measured at the L1 orbit position, located one million miles from Earth, to calculate three types of electron precipitation and proton precipitation which strongly correlate with the aurora. (SWPC)

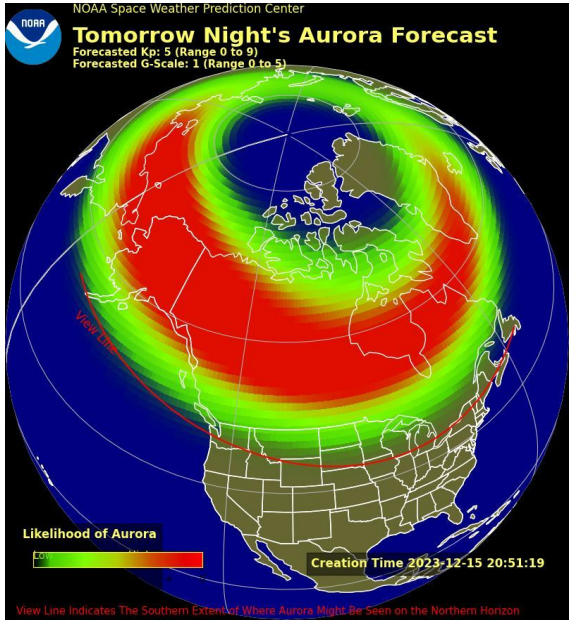
- Simpler than it looks, beginning with labels & dates
- Top left: Agency name, Forecast, Date of Forecast
- Top right: Covers important aurora strength details
- HPI (Hemispheric Power Index) — Hemispheric Power is another measure of aurora strength.
- Lead Time
- Bottom right: Times of the last model run and actual observations
- Bottom left: Legend with colors showing the probability
- Energy Deposition: Measures the energy flux or amount of energy Aurora is putting into the atmosphere

Variations of Ovation

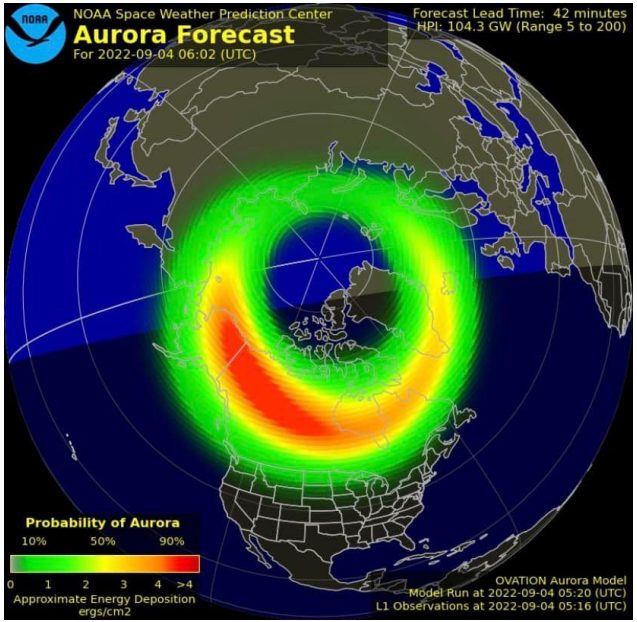
Many sources give you the Ovation Model in a video loop, but only the last second or so refers to the forecast. The new “Aurora Forecast” version is overstated. The still image forecast model is more reliable.



Video



Tomorrow Night’s Forecast Version

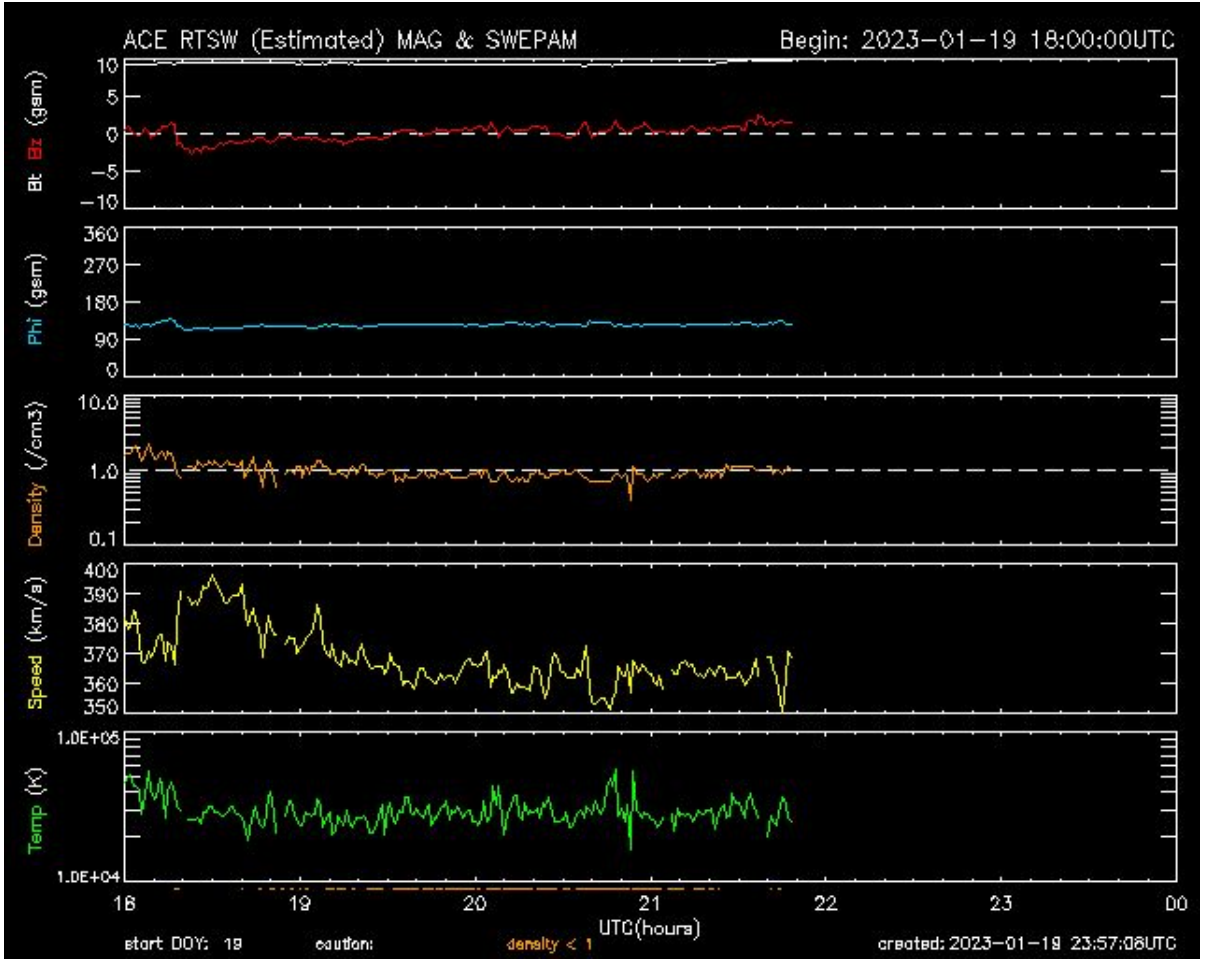


30-Minute to Real-Time Model

Source: Space Weather Prediction Center

What's trending?

The NASA Advanced Composition Explorer (ACE) satellite enables the SWPC (Space Weather Prediction Center) to give advance warning of geomagnetic storms. This 6-hour plot shows the conditions of the solar wind, from speed, density and temperature to Phi, Bz and Bt.

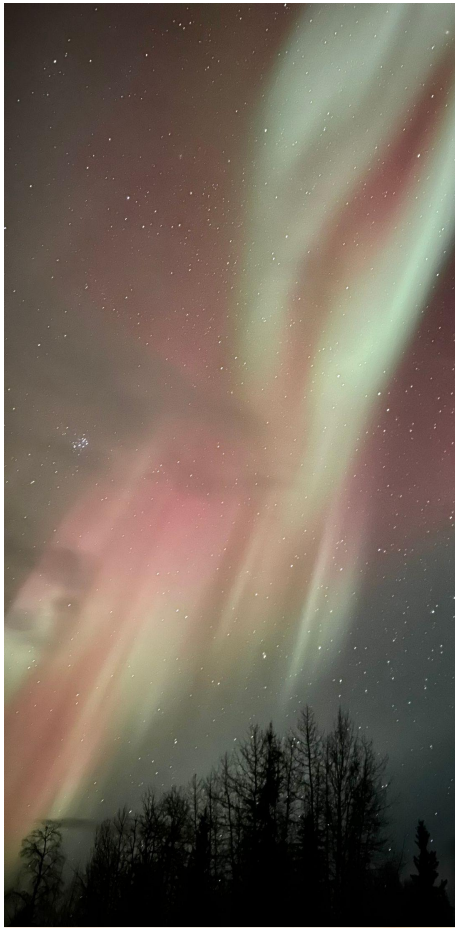


Source: SWPC

How to Monitor Activity & Solar Wind

Solar Activity
Location on the Sun
Type/Class/CME
Earth-Directed
Polar Orientation

Real-Time Solar Wind
Speed: 500 km/s
Density: 10 p/cm3
Bt: 8 nT
Bz: - 10 nT (Southward)
“The Gatekeeper”



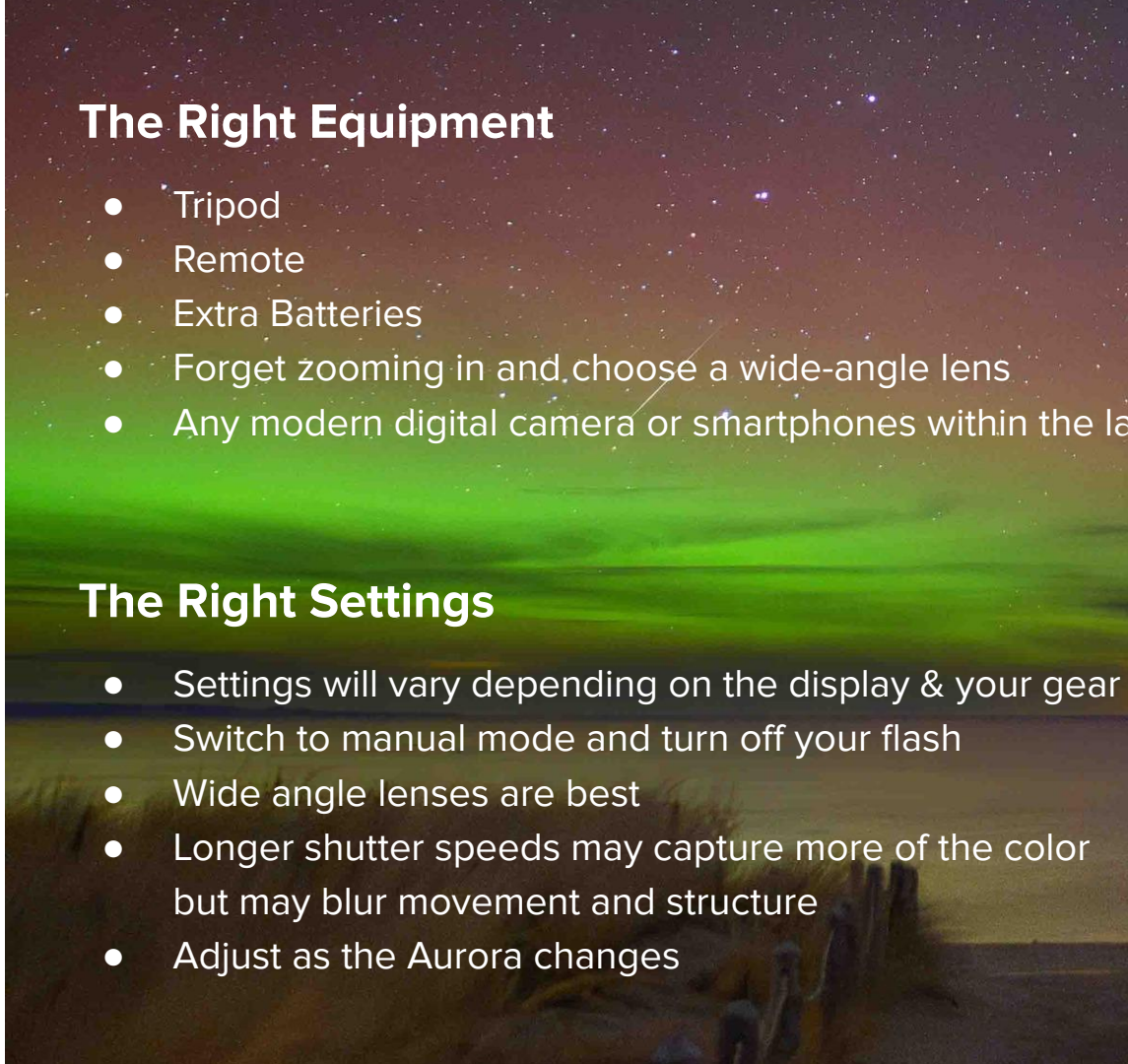
Alaska Aurora Photos Taken on iPhone 14

How to Photograph the Northern Lights

What it takes to photograph Aurora

Aurora photography is subjective: it's an art form. Camera settings will vary with each display.

Use the Exposure Triangle:
- Aperture
- Shutter Speed
- ISO



The Right Equipment

- Tripod
- Remote
- Extra Batteries
- Forget zooming in and choose a wide-angle lens
- Any modern digital camera or smartphones within the la

The Right Settings

- Settings will vary depending on the display & your gear
- Switch to manual mode and turn off your flash
- Wide angle lenses are best
- Longer shutter speeds may capture more of the color but may blur movement and structure
- Adjust as the Aurora changes

Northern Lights in Michigan

Au Train, Michigan's Upper Peninsula, March 20-21, 2021 | Photo by Bonnie Tiedt

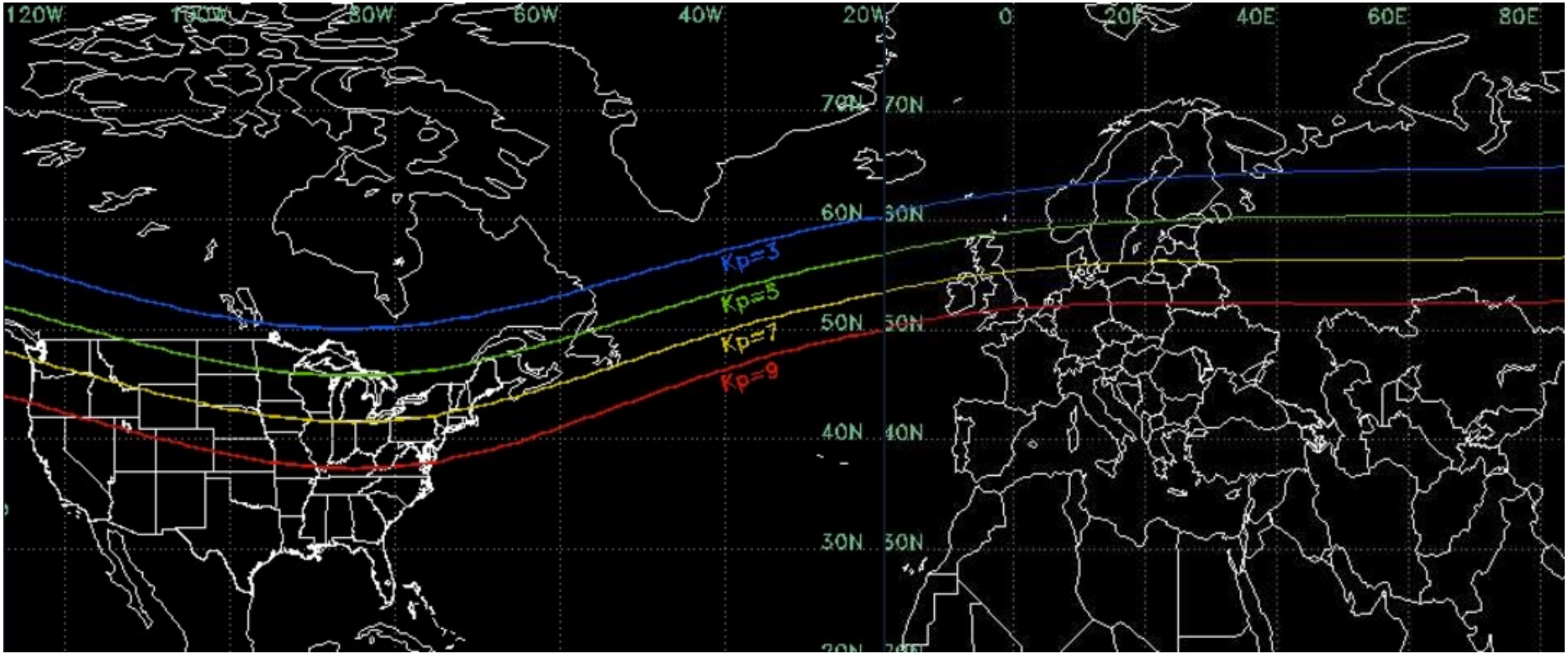
North of Flint, Michigan, March 23, 2023

East of Lansing, Michigan, Feb. 26, 2023

Chasing Aurora in Michigan

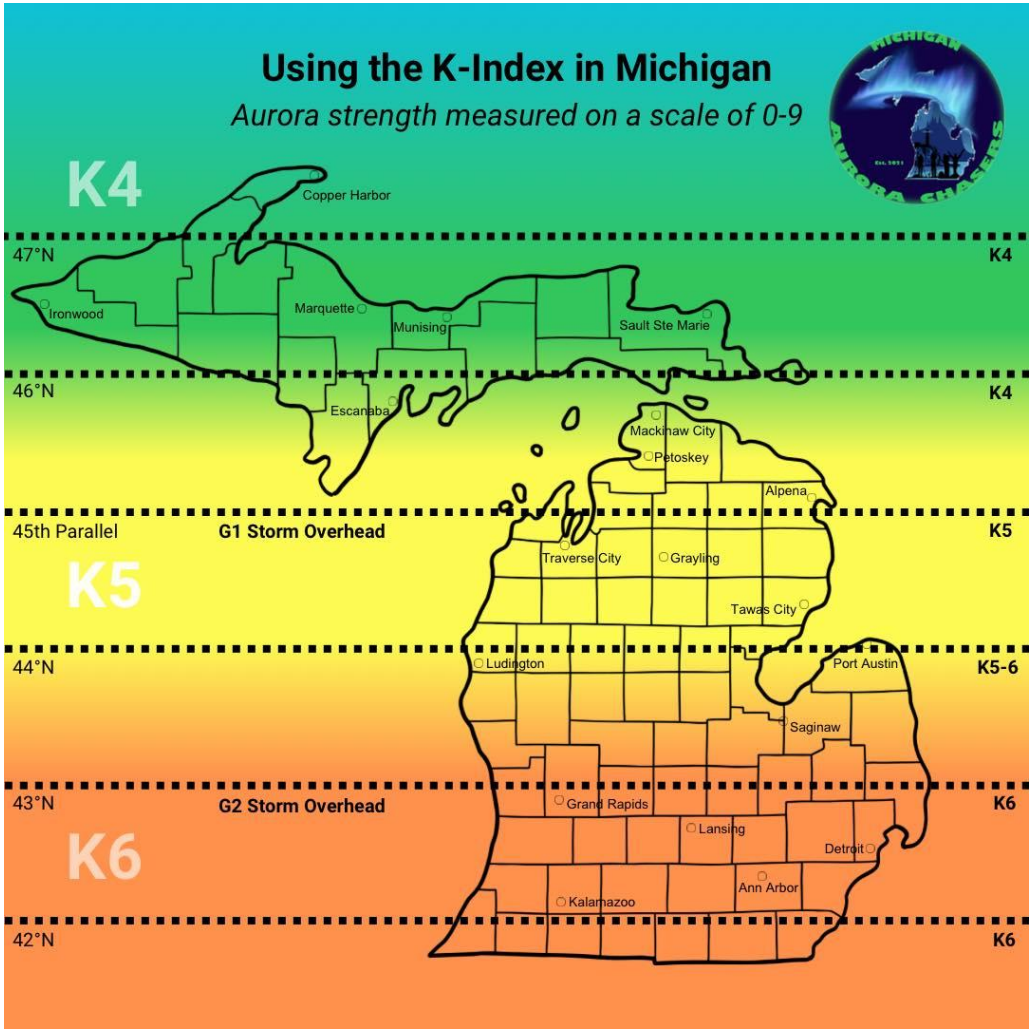
Mapping Out the Chase: Part I

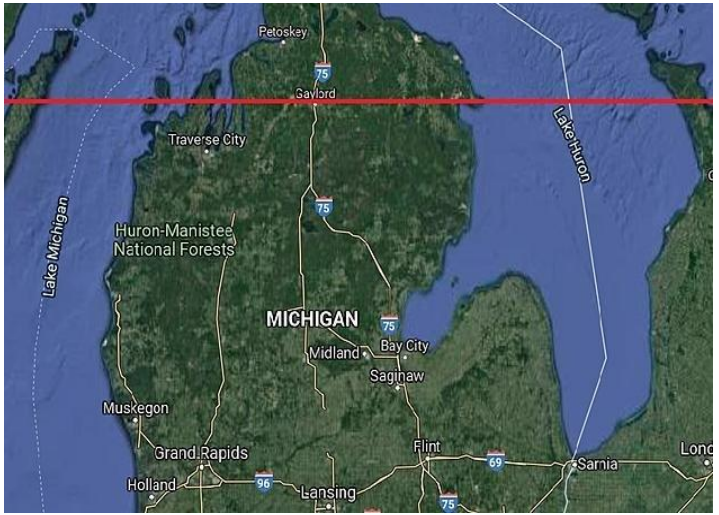
What value should you look for on the K-index? (K/Kp)



Source: Space Weather Prediction Center

Mapping Out the Chase: Part II





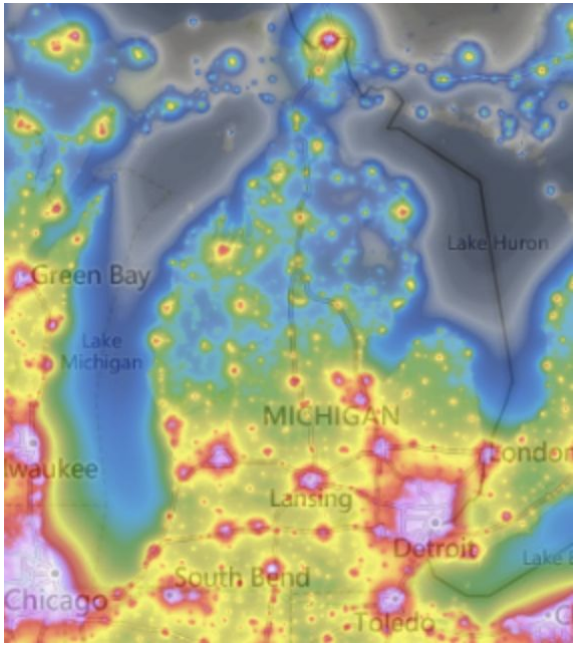
What parallel do you live near? The 45th Parallel is regarded as a magical line where northern life happens. But we believe that Aurora can frequently be seen as low as the 44th Parallel, in a line from Manistee to Houghton Lake to Tawas City to Port Austin.

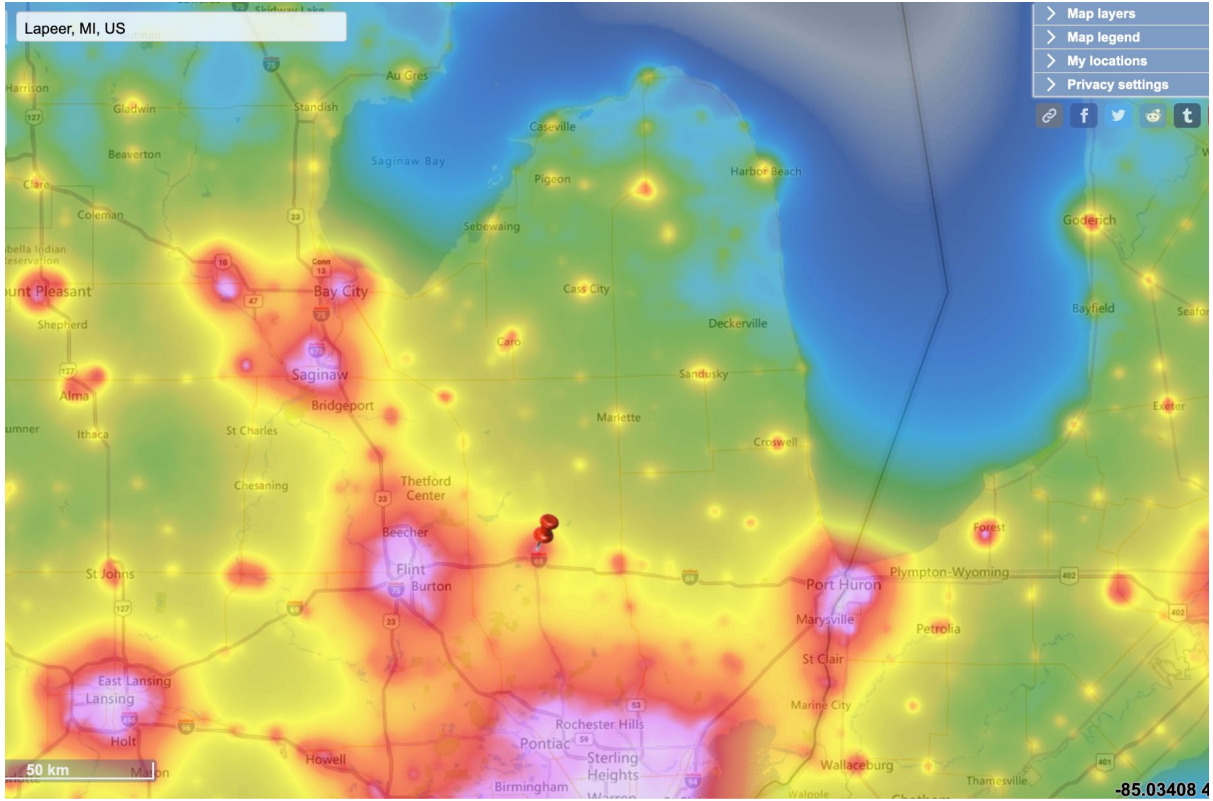
Mapping Out the Chase: Part III

Light pollution by Location

Search your area at

www.LightPollutionMap.info

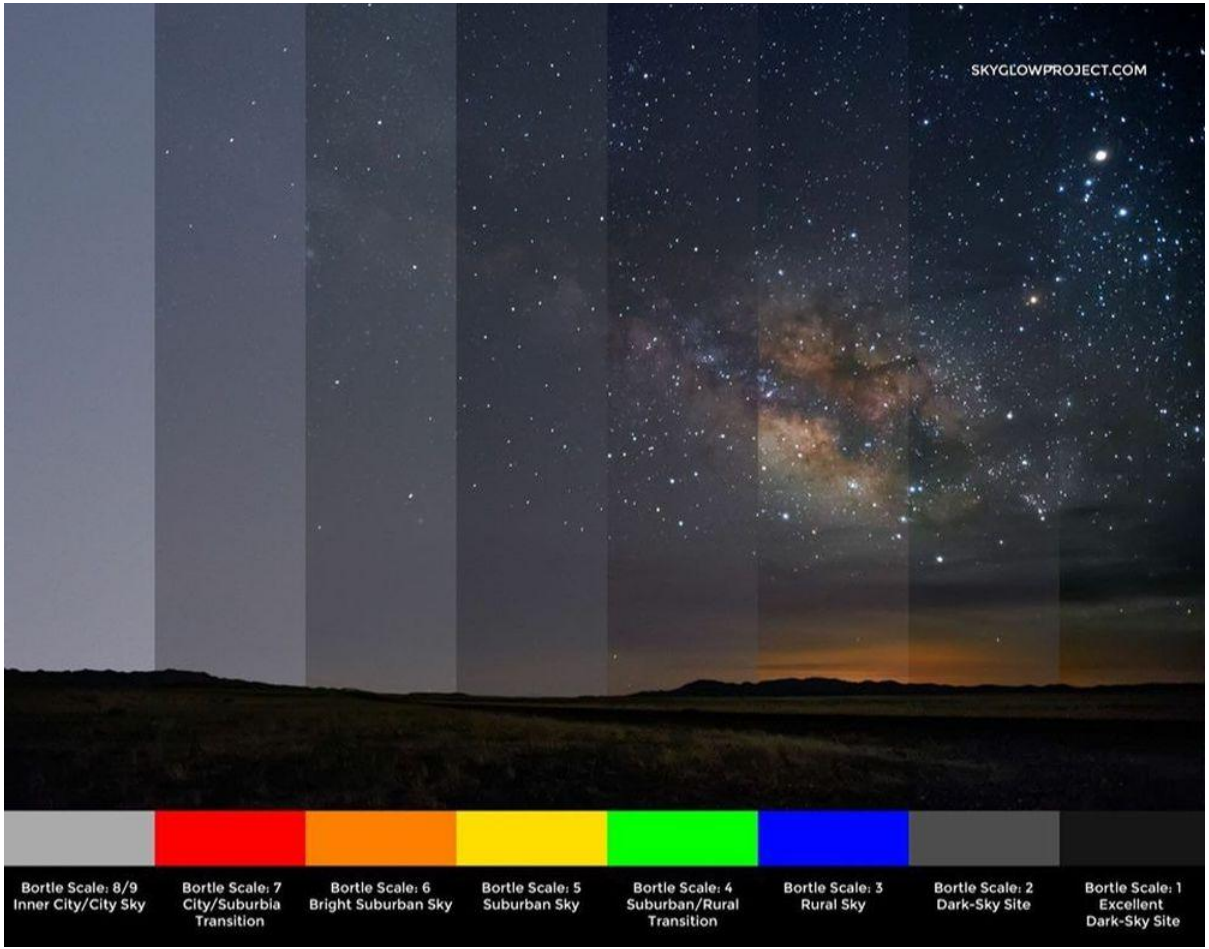




The Bortle Scale

Light pollution could be the only thing stopping you from catching the Aurora.

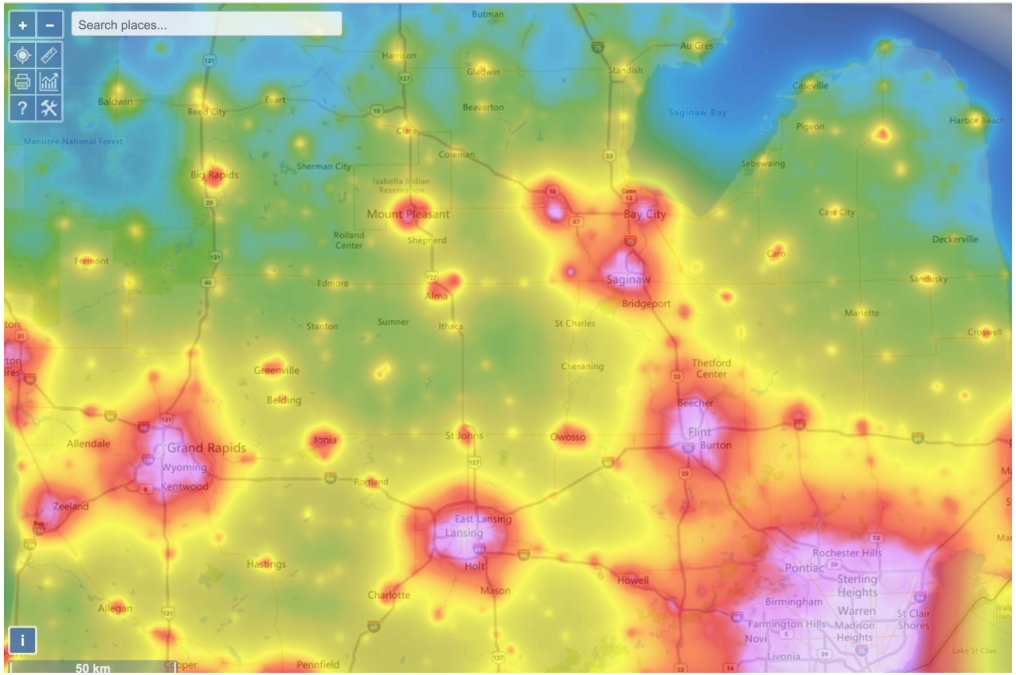
Q: How dark are your skies?

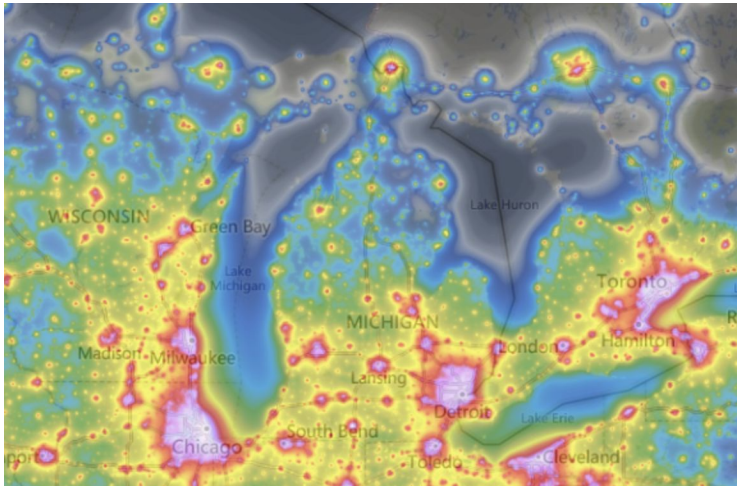


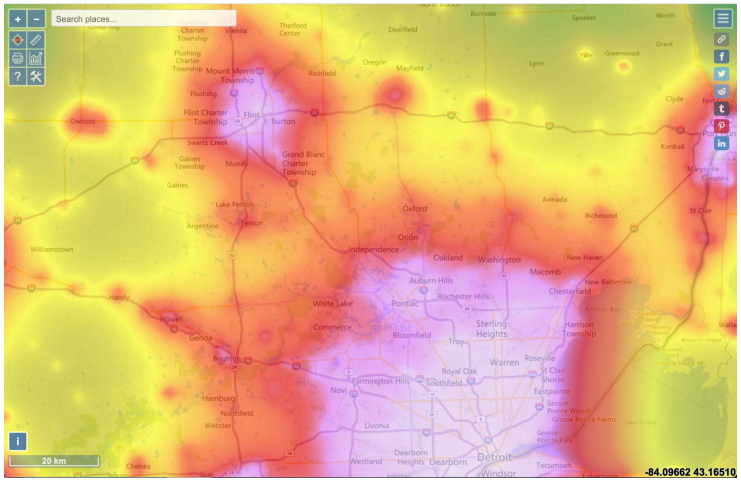
Mapping Out the Chase: Part III

Working Around Light Pollution Deserts

Westland skies rate Bortle 7. Though some areas may offer a small break in light pollution.



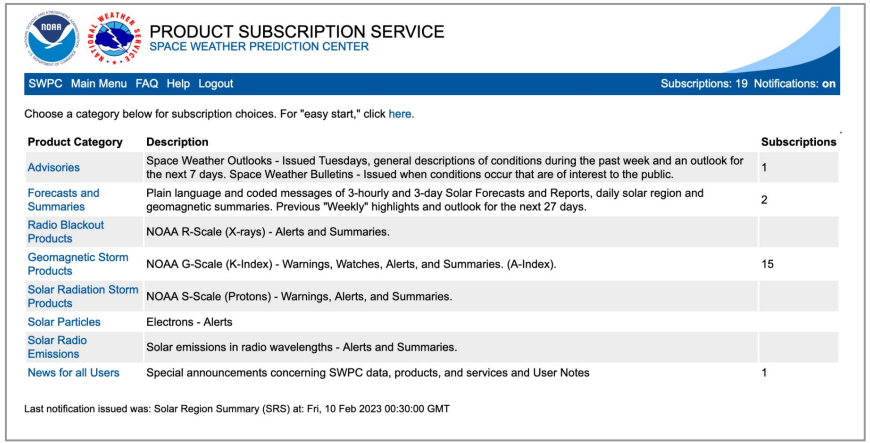




Space Weather Prediction Center

Break it down:

- **Universal Time** (UT) *Example: 0000-0300*
- **Kp** is given in **3-hour periods** of time.
  Kp is average aurora strength from 0-9.
- It's a **forecast** — a very difficult one at that!
  Space Weather is an emerging science.
- Understanding the **Rationale**



PRODUCT SUBSCRIPTION SERVICE
SPACE WEATHER PREDICTION CENTER

SWPC Main Menu FAQ Help Logout — Subscriptions: 19 Notifications: on

Choose a category below for subscription choices. For "easy start," click here.

Product Category	Description	Subscriptions
Advisories	Space Weather Outlooks - Issued Tuesdays, general descriptions of conditions during the past week and an outlook for the next 7 days. Space Weather Bulletins - Issued when conditions occur that are of interest to the public.	1
Forecasts and Summaries	Plain language and coded messages of 3-hourly and 3-day Solar Forecasts and Reports, daily solar region and geomagnetic summaries. Previous "Weekly" highlights and outlook for the next 27 days.	2
Radio Blackout Products	NOAA R-Scale (X-rays) - Alerts and Summaries.	
Geomagnetic Storm Products	NOAA G-Scale (K-Index) - Warnings, Watches, Alerts, and Summaries. (A-Index).	15
Solar Radiation Storm Products	NOAA S-Scale (Protons) - Warnings, Alerts, and Summaries.	
Solar Particles	Electrons - Alerts	
Solar Radio Emissions	Solar emissions in radio wavelengths - Alerts and Summaries.	
News for all Users	Special announcements concerning SWPC data, products, and services and User Notes	1

Last notification issued was: Solar Region Summary (SRS) at: Fri, 10 Feb 2023 00:30:00 GMT

Using SWPC Forecasts

```
Product: 3-Day Forecast
Issued: 2023 May 11 1230 UTC
Prepared by the U.S. Dept. of Commerce, NOAA, Space Weather Prediction
Center

A. NOAA Geomagnetic Activity Observation and Forecast

The greatest observed 3 hr Kp over the past 24 hours was 5 (NOAA Scale
G1).
The greatest expected 3 hr Kp for May 11-May 13 2023 is 6.67 (NOAA Scale
G3).

NOAA Kp index breakdown May 11-May 13 2023

             May 11       May 12       May 13
00-03UT       3.00         4.67 (G1)    3.00
03-06UT       3.00         5.67 (G2)    3.67
06-09UT       2.33         4.67 (G1)    2.67
09-12UT       1.33         4.00         2.33
12-15UT       2.33         3.33         1.67
15-18UT       2.67         3.67         2.33
18-21UT       4.33         3.00         2.67
21-00UT       6.67 (G3)    2.67         2.33

Rationale: Arrival of the anticipated CME later on 11 May/early 12 May
will likely lead to G1-G3 (Minor to Strong) storm levels. Unsettled to
active levels are expected on 13 May as CME influences wane.
```

Michigan Aurora Chasers

What did the Ovation Model Show on May 10, 2024?

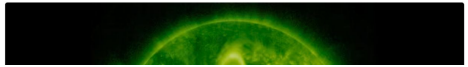
CLICK ON DETROIT

Join Insider Sign In

SPORTS FEATURES LIVE IN THE D ANN ARBOR CONTACT US NEWSLETTERS

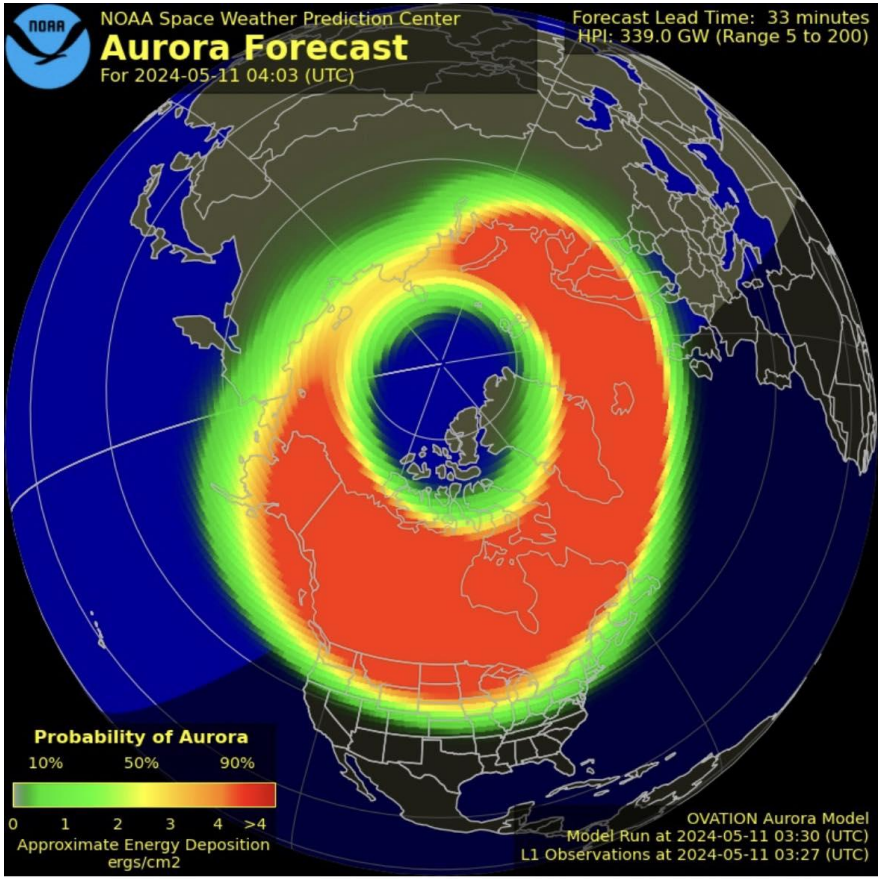
Severe geomagnetic storm watch issued for first time in nearly 20 years: What to know

CMEs expected to arrive midday Friday, May 10



USATODAY.COM

One week ago, the northern lights stunned America. When will it happen again?



Featuring the Michigan Aurora Chasers

Melissa F. Kaelin
September 5, 2022 ·

Our Michigan Aurora Chasers have been dancing like no one's watching, with the Northern Lights dancing above them September 3-5! We've had several nights of exciting chases, with Aurora captured all the way from the Keweenaw Peninsula in Michigan's Upper Peninsula down to Cleveland, Ohio! We even captured an unusually vivid and distinctive appearance of STEVE, the sub-auroral arc, and its "picket fence" as it stretched directly overhead in the Michigan night.

My own chase was plagued by clouds, but finally ended in a successful Aurora sighting in the sand dunes of Ludington after 2am Monday morning. It was a gorgeous night, with millions of stars and the Milky Way glimmering above Lake Michigan.

Congratulations to all of the photographers and viewers who caught the Northern Lights, and especially to those who found Aurora for the first time!

Photos by Pamela Hofacker Teachout, Lucas McIlvenna, Lucy McClellan-Hunter, Karen Farrell, Jeremiah Chappelle, Alicea Howell, Travis Stevens, Matt Honold, Luke Lauderback, Lisa Hunter, Tracy Gray Keck III, and Matt Shiffler.

#MiAurora #10YearsofAurora
Melissa F. Kaelin: Writer, Artist & Stargazer

Looking forward to The 5th Annual Aurora Summit!

LINK

Featuring the Michigan Aurora Chasers

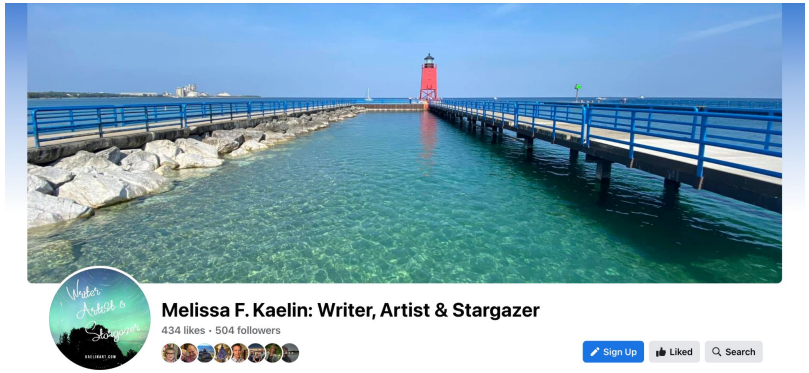
Melissa F. Kaelin
August 18, 2022 ·

Congratulations to all of the Michigan Aurora Chasers who caught the Northern Lights on August 17-18! It was a tough chase, but Aurora did appear above the 45th Parallel in Michigan, mostly on camera. Here are just a few of the early photos.

With no geomagnetic storm conditions, we had no luck at the 43rd Parallel Live Chase.

#MiAurora #LiveChase

LINK



Join us!

We lead an engaged and active community!

- Instagram
- Facebook Group
- Public Page
- Resources: #MiAuroraResources

MichiganAuroraChasers.com

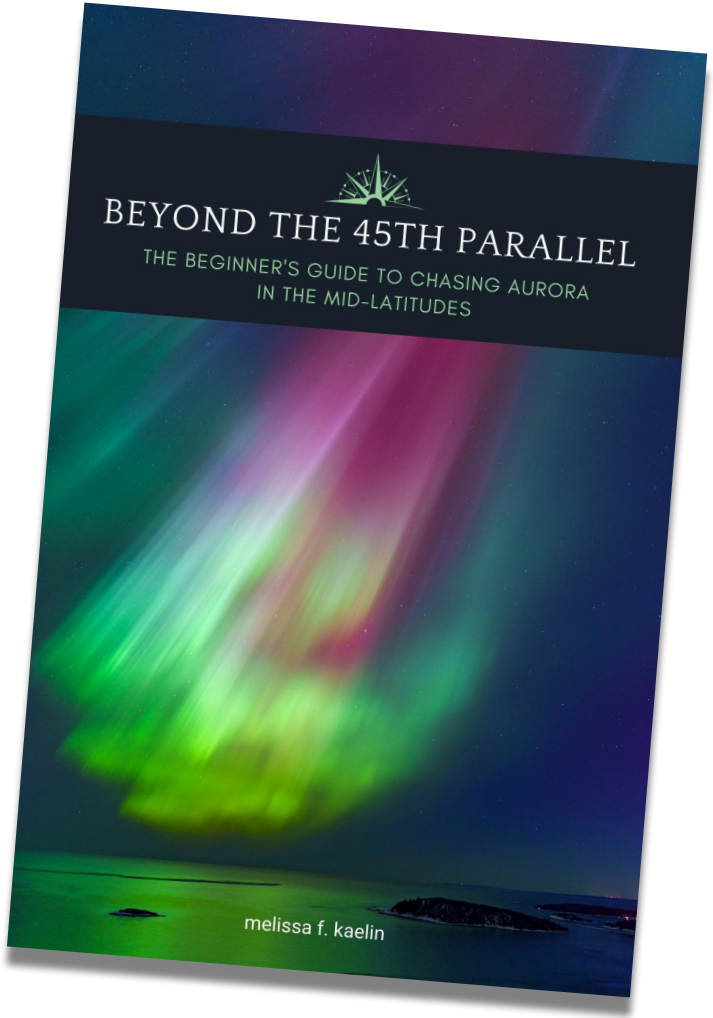
Beyond the 45th Parallel: 2nd Edition of Aurora Guidebook

The Beginner's Guidebook!
Designed to help beginners, this book will help you beat the dozens of obstacles Aurora Chasers face.

The guidebook has the information you need to finally catch an Aurora display near your home, complete with a Digital Resource Guide.

Featuring Cover Photo Artist Shannon Kivi, 906 Images, and Back Cover Photo Artist Michele Aucello.

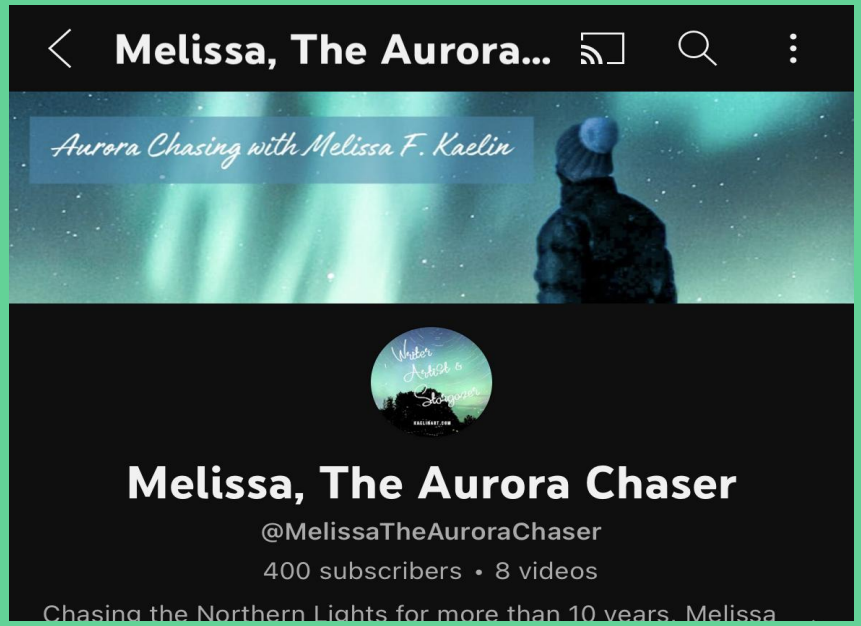
Pre-Order for July 5th!
KaelinArt.com/45thParallel

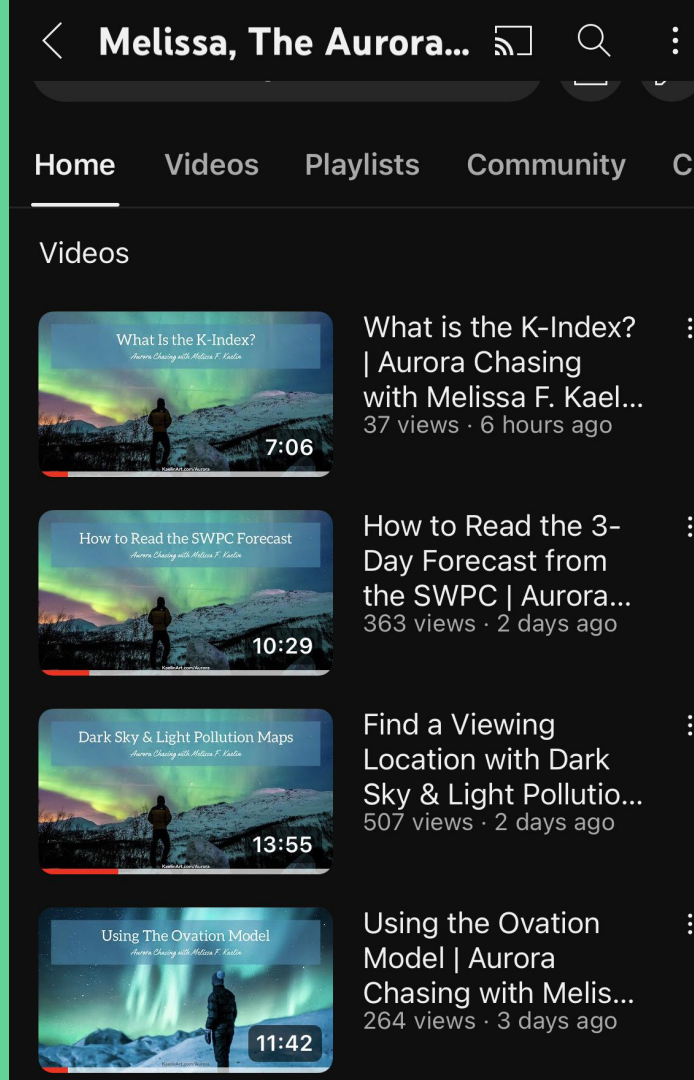


Now on YouTube!

If you'd like to spend more time learning how to use these tools, check out my channel.

Subscribe: YouTube.com/@MelissaTheAuroraChaser





Upcoming Events

Northeast Wisconsin Stargazers Meeting
June 19, 2024, Menasha, Wisconsin

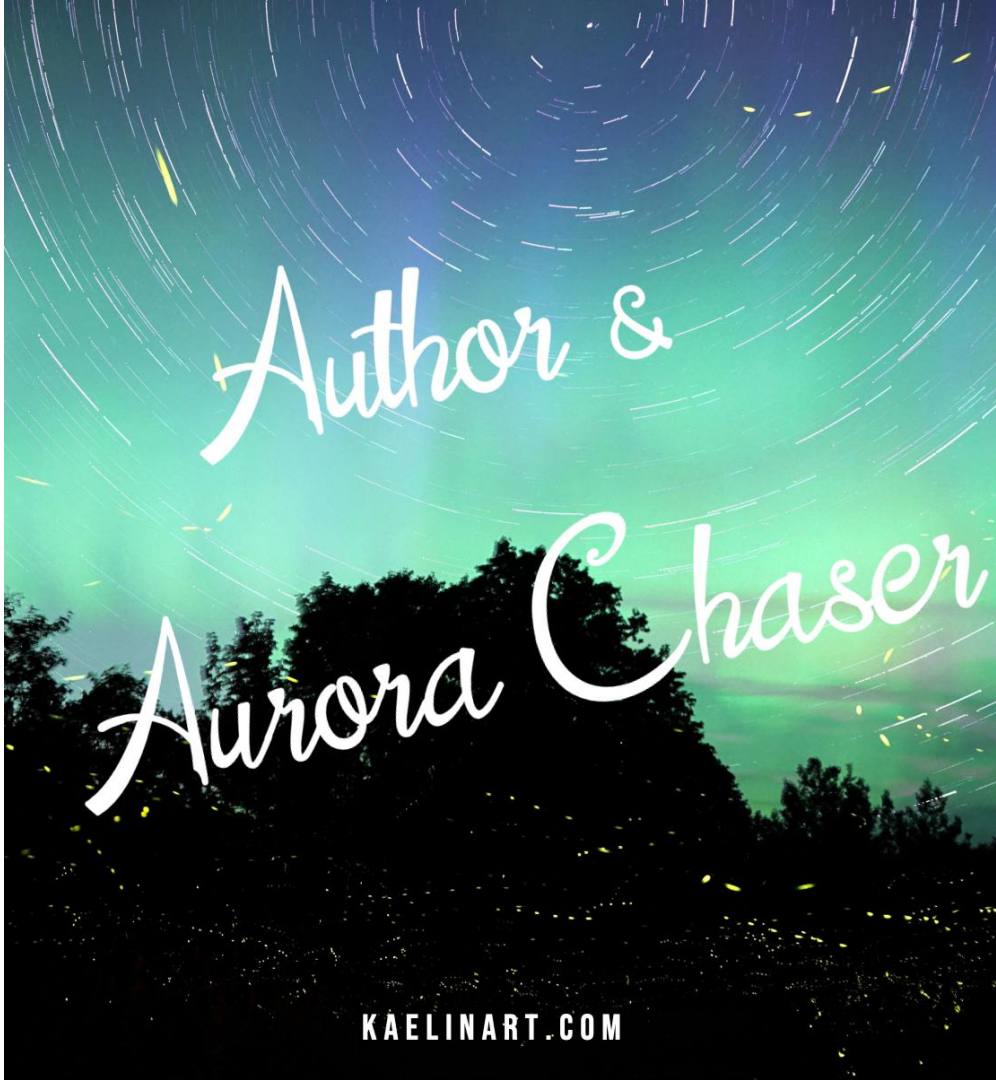
Official Book Release Party
July 5, 2024, Lansing, Michigan

The Instant Story Show: Podcast
August 8, 2024, Virtual RSVP on MeetUp.com

Astronomy on the Beach
September 20-21, 2024, Island Lake Recreation Area, MI

The 7th Annual Aurora Summit
October 18-20, 2024, Red Cliff, Wisconsin, $319 Admission
TheAuroraSummit.com

KaelinArt.com/events



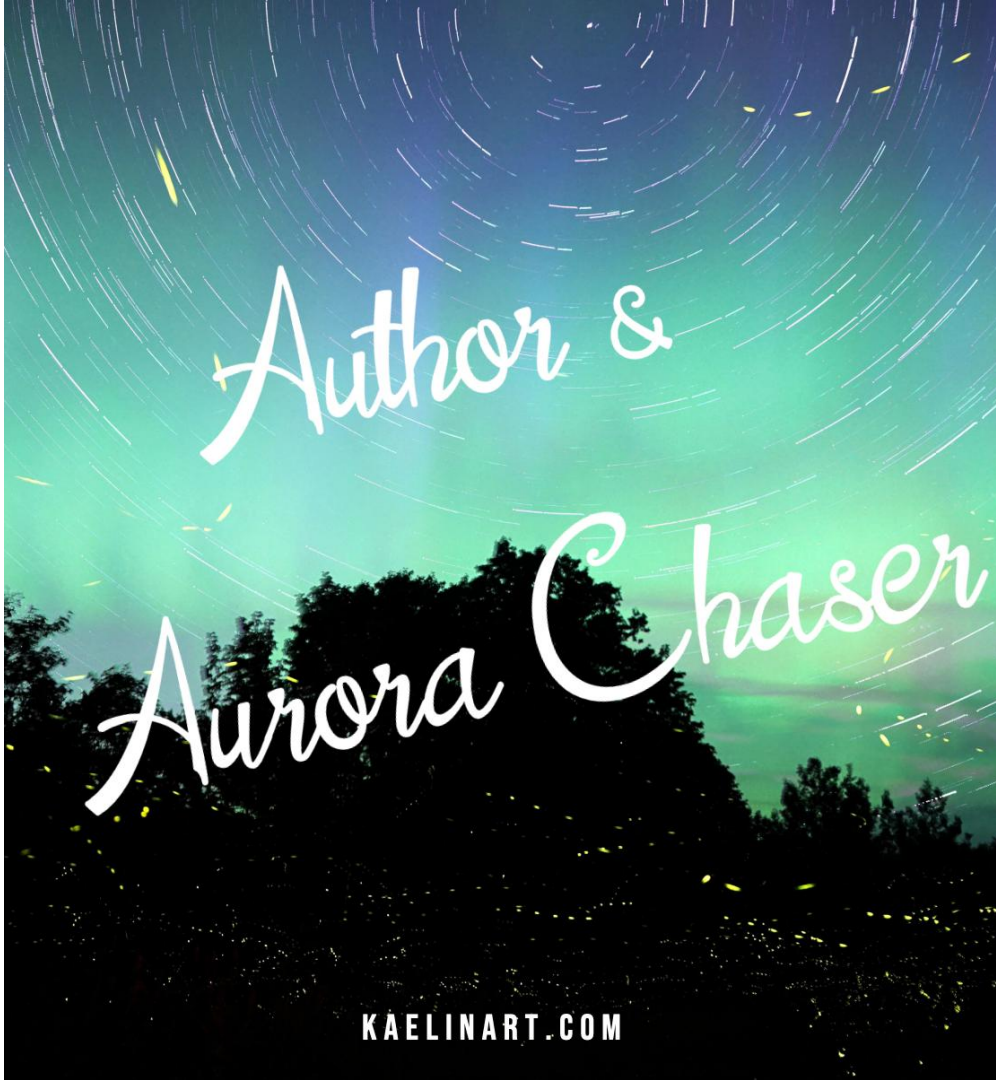
Annual Events

Michigan Aurora Chasers Workshop
March 16, 2024, Headlands International Dark Sky Park
(Equinox March 19, 2024)

2nd Annual Upper Peninsula Dark Sky Festival
April 12-13, 2024, Keweenaw International Dark Sky Park
(Total Solar Eclipse, April 8, 2024)

Aurora Summit: Celebrating the Art, Culture, Science and Photography of the Aurora
October 18-20, 2024, Red Cliff, Wisconsin
Register: TheAuroraSummit.com

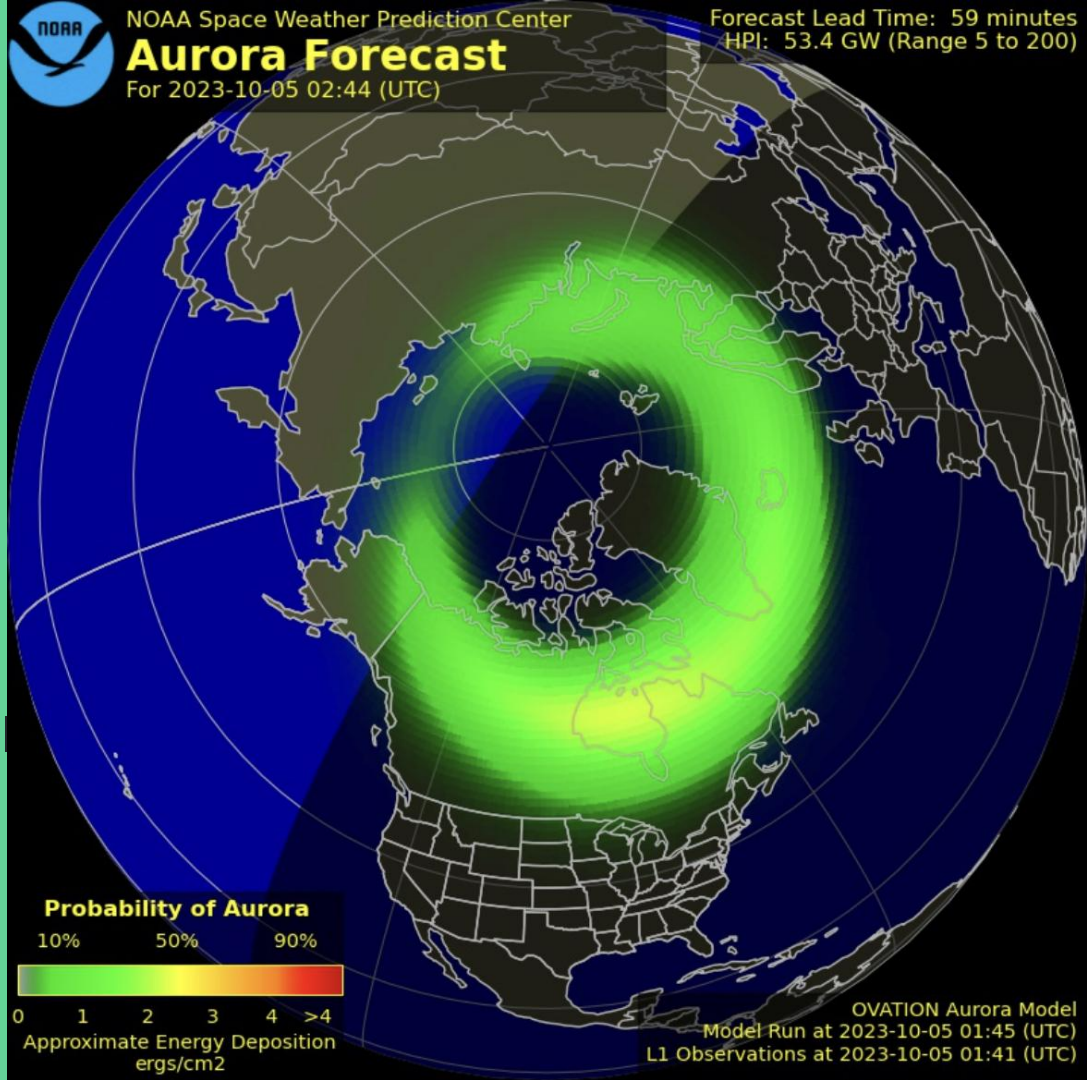
KaelinArt.com/Aurora



To chase or not to chase?

How are Aurora conditions trending now?

Refresh the Ovation Model!
You can find the real-time model on our link tree:
LINKTR.EE/MiAuroraChasers



Q & A

Find More Tips at KaelinArt.com/Aurora

Links

KaelinArt.com/Aurora

Instagram.com/mfkaelin

linktr.ee/mfkaelin

linktr.ee/MiAuroraChasers

Instagram.com/MiAuroraChasers

Facebook.com/MichiganAuroraChasers

More Resources

KaelinArt.com/Aurora — Melissa's Aurora Chasing Tips

swpc.noaa.gov — Space Weather Prediction Center

www.gi.alaska.edu — Geophysical Institute, UAF

SpaceWeatherLive.com — Also available in the app

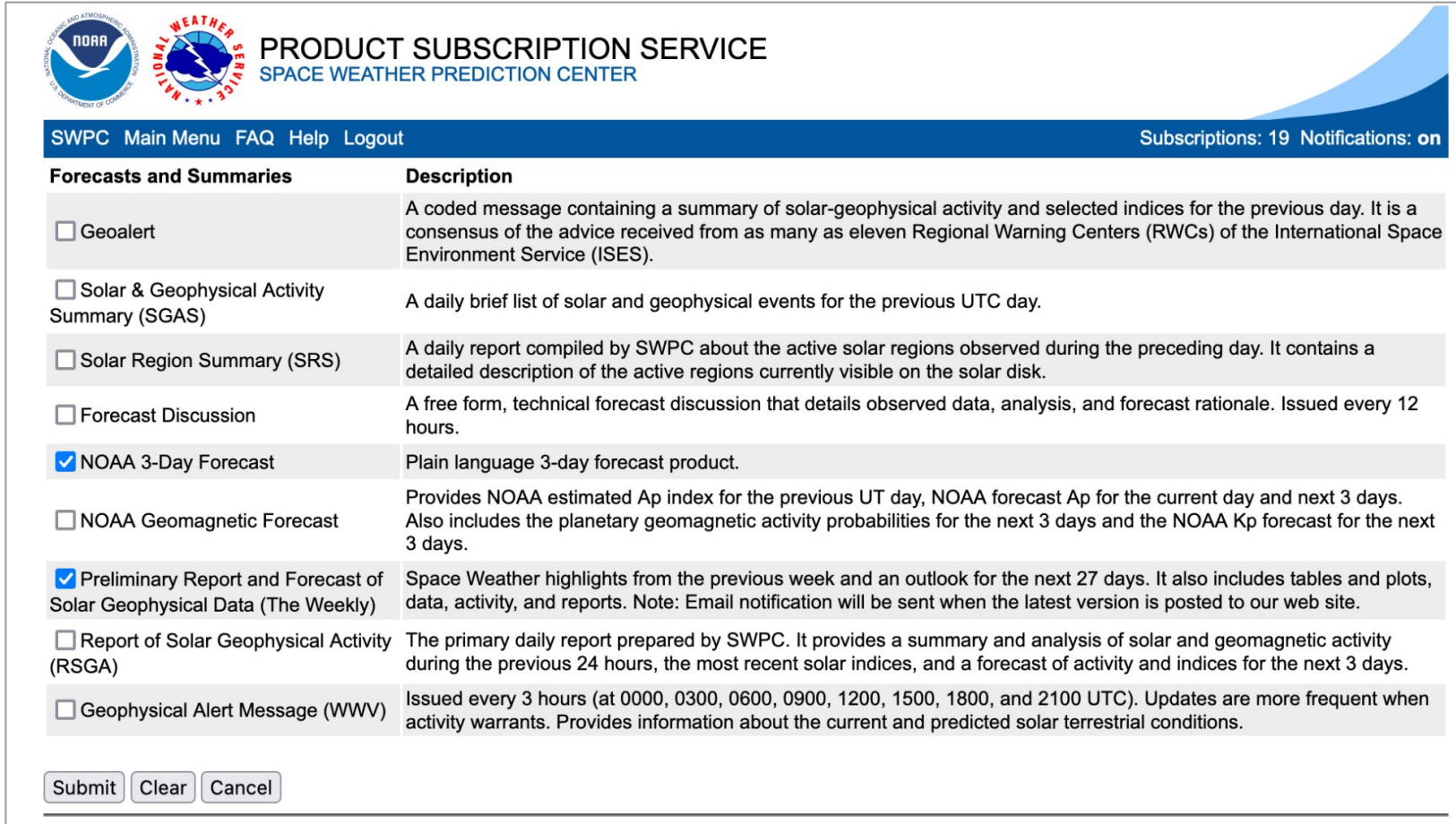
Facebook.com/SolarHam — Solar Activity & Forecasts

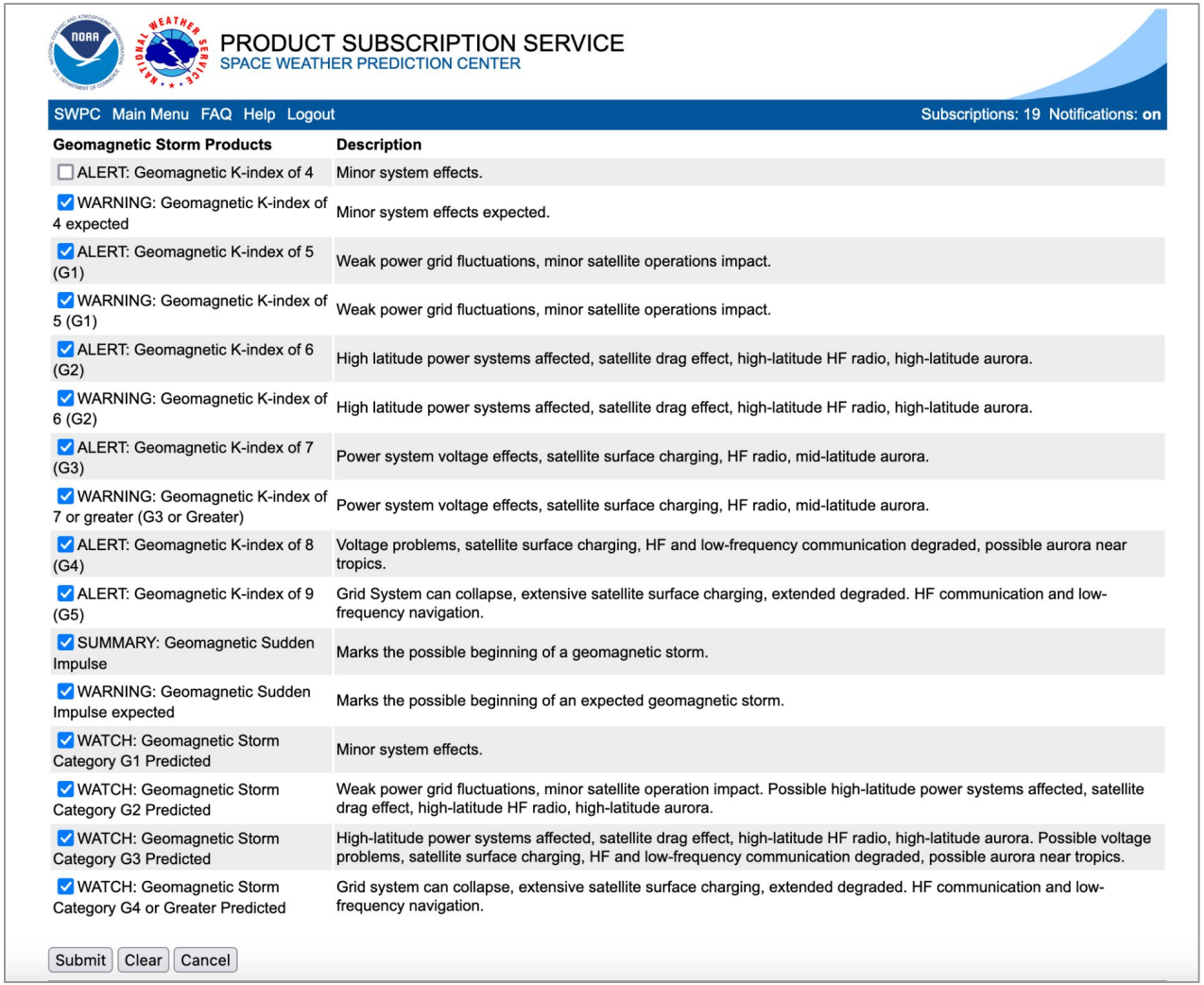
Apps: SpaceWeatherLive, The Glendale App, Aurora Forecast

Paid Alert Services: Aurora Notifier, SWPC Texts

Live Sightings: Michigan Aurora Chasers, Upper Midwest Aurora Chasers, Northern Lights Alert

How to Subscribe to SWPC Alerts





PRODUCT SUBSCRIPTION SERVICE
SPACE WEATHER PREDICTION CENTER

SWPC Main Menu FAQ Help Logout — Subscriptions: 19 Notifications: on

Geomagnetic Storm Products	Description
☐ ALERT: Geomagnetic K-index of 4	Minor system effects.
☑ WARNING: Geomagnetic K-index of 4 expected	Minor system effects expected.
☑ ALERT: Geomagnetic K-index of 5 (G1)	Weak power grid fluctuations, minor satellite operations impact.
☑ WARNING: Geomagnetic K-index of 5 (G1)	Weak power grid fluctuations, minor satellite operations impact.
☑ ALERT: Geomagnetic K-index of 6 (G2)	High latitude power systems affected, satellite drag effect, high-latitude HF radio, high-latitude aurora.
☑ WARNING: Geomagnetic K-index of 6 (G2)	High latitude power systems affected, satellite drag effect, high-latitude HF radio, high-latitude aurora.
☑ ALERT: Geomagnetic K-index of 7 (G3)	Power system voltage effects, satellite surface charging, HF radio, mid-latitude aurora.
☑ WARNING: Geomagnetic K-index of 7 or greater (G3 or Greater)	Power system voltage effects, satellite surface charging, HF radio, mid-latitude aurora.
☑ ALERT: Geomagnetic K-index of 8 (G4)	Voltage problems, satellite surface charging, HF and low-frequency communication degraded, possible aurora near tropics.
☑ ALERT: Geomagnetic K-index of 9 (G5)	Grid System can collapse, extensive satellite surface charging, extended degraded. HF communication and low-frequency navigation.
☑ SUMMARY: Geomagnetic Sudden Impulse	Marks the possible beginning of a geomagnetic storm.
☑ WARNING: Geomagnetic Sudden Impulse expected	Marks the possible beginning of an expected geomagnetic storm.
☑ WATCH: Geomagnetic Storm Category G1 Predicted	Minor system effects.
☑ WATCH: Geomagnetic Storm Category G2 Predicted	Weak power grid fluctuations, minor satellite operation impact. Possible high-latitude power systems affected, satellite drag effect, high-latitude HF radio, high-latitude aurora.
☑ WATCH: Geomagnetic Storm Category G3 Predicted	High-latitude power systems affected, satellite drag effect, high-latitude HF radio, high-latitude aurora. Possible voltage problems, satellite surface charging, HF and low-frequency communication degraded, possible aurora near tropics.
☑ WATCH: Geomagnetic Storm Category G4 or Greater Predicted	Grid system can collapse, extensive satellite surface charging, extended degraded. HF communication and low-frequency navigation.

Submit Clear Cancel

Watches, Warnings & Alerts Using NOAA Scales

Subscribe for free:

swpc.noaa.gov

> Subscribe