

Active Experiment *Science Enhancement* through Citizen Science

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NASA Goddard
Sept. 2017



Introduction

- What is citizen science?
 - Eclipse examples
- Science Enhancement
- Plasma Physics on Twitter
- What can we now do? Aurorasaurus
- What can we do soon?

Who
am I?
@spaceyliz

Amateur aurora hunter

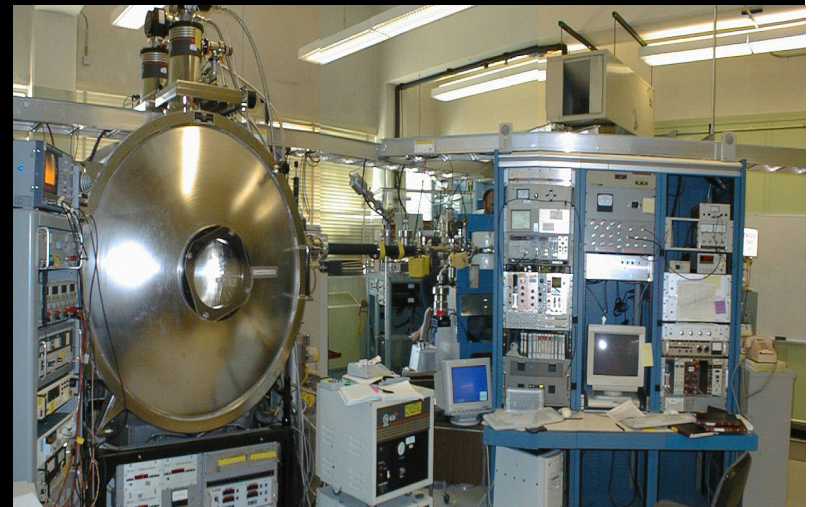
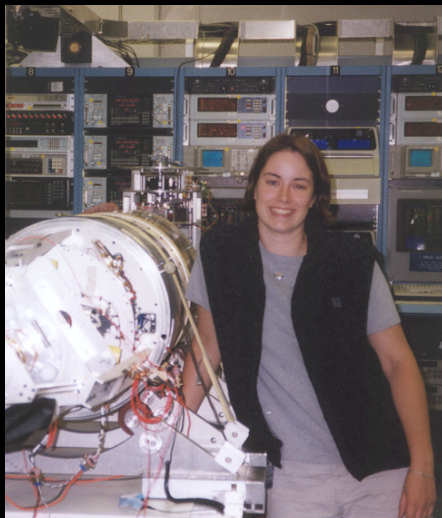
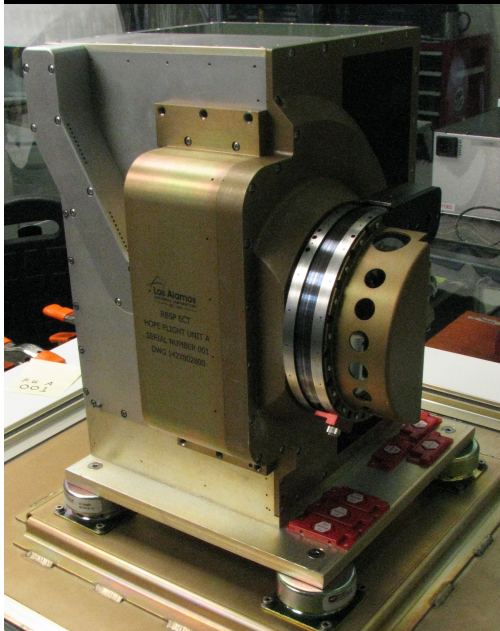
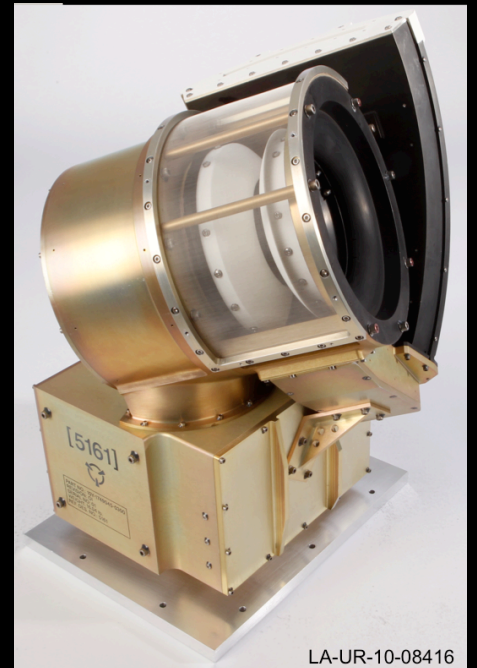
Co-I on HOPE, H⁺, He⁺, O⁺, e⁻

NASA HQ: HTIDS,
Early Career,
Rockets, SET

Rocket scientist in pursuit
of thermal electrons




Los Alamos National Lab projects:
Van Allen Probes,
geosynchronous orbit plasma,
and instrument calibration



cit·i·zen sci·ence *noun*

A form of collaboration where members of the public participate in scientific research to meet real world goals.




AIR DATES

ABOUT THE SERIES WATCH THE EPISODES CITSCI CALENDAR

JOIN A PROJECT NEWSLETTER #CrowdCloudLIVE


SOCIAL MEDIA

✓




EPISODE
1

Even Big Data Starts Small




EPISODE
2

Citizens + Scientists



EPISODE
3

Viral vs. Virus



EPISODE
4

Citizens4Earth

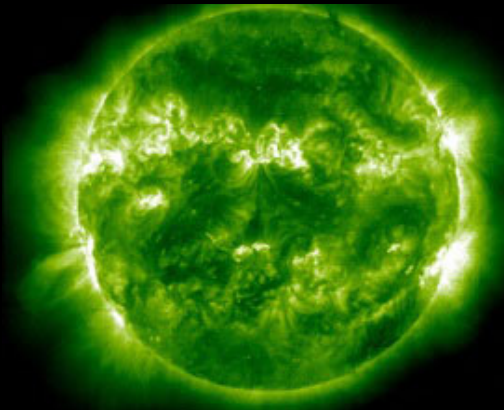
Timely science enhancement, optional but becoming crucial



Solar minimum



2005



Solar maximum



2013

First solar maximum with social media, nowcast (hr ish alerts)

Citizen science is about falling in love with the world more.

Sharman Russell, author of Diary of a Citizen Scientist



Crowdsourcing [] information may be a secondary source of data, but it is a primary source of public engagement.

Michael Fienen,
Social Water project

- Organized research in which members of the public engage in the processes of scientific investigations
 - Asking questions, collecting data, and/or interpreting results
- Works on a massive scale & generates high quality data
 - Leading to reliable, valid scientific outcomes & unexpected innovations

Plasma Physics via Twitter

Plasma Physics via Twitter



Corinne

@AuroraNorthWI

Following

Garden [#aurora](#) Northern WI 11:36pmCST
[@TamithaSkov](#) [@TweetAurora](#)
[@NorthLightAlert](#) [@Aurora_Alerts](#)
[@AngelBrise67](#) [@qtrocub](#) [@CountryViewFoto](#)



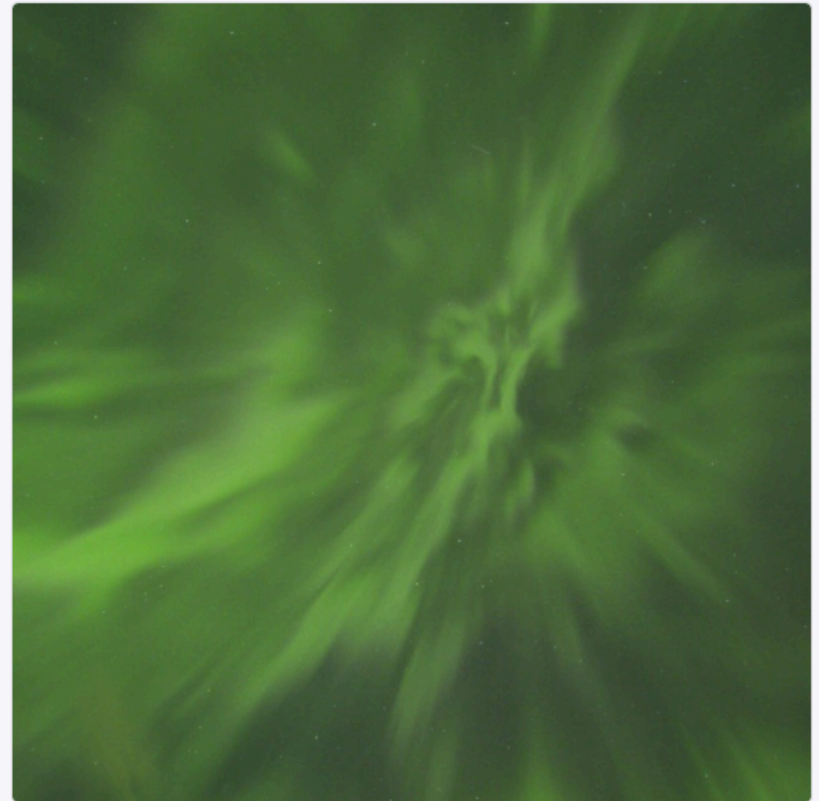
11:58 PM - 12 Sep 2017

16 Retweets 41 Likes



Dar - in Iceland! @dartanner · 4h

Pulsating [#Aurora](#) last night at Reykjavik [#iceland](#) [#teamtanner](#) [@treetanner](#)
[@TamithaSkov](#) [@NorthLightAlert](#) [@weathernetwork](#) [@ScottWx_TWN](#)



Derick Wilson, Angel Brise', Kayla and 7 others

10

21



54



Recent East Coast ampoule test rocket



Follow NASA Wallops Ustream
@tweetaurora

ARTIFICIAL AURORA

NASA Sounding Rocket Launch
from Wallops will release artificial
clouds to better understand the
ionosphere and aurora!



The next rocket launch
attempt will be this Sunday,
June 18th 9:05-9:20pm EST



Who can see it?

This image shows what locations
are within the viewing area.

More info: @nasa_wallops <http://bit.ly/AArocket>



Tweet what you see: include your **city**
& **state** & the words "**artificial aurora**"
or report directly with the app!



Get it here!



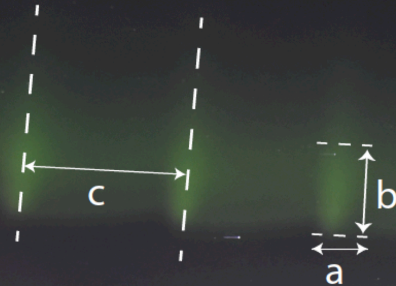
www.aurorasaurus.org

Youtube video, Chris Becke

Soft sensor signals of opportunity - Beads on Twitter

Citizen Science Image of Unusual Auroral Beads

Ray Width (a) ~ 5 km
Ray Length (b) ~ 15 km
Bead Separation (c) ~ 20 km
Total Arc Size ~ 500 km
Dst = -128 nT



2015:12:21 05:01:58 UT

Taken from Saskatoon
Moon was in the sky
Exposure time: 2.5s
Lasted ~ 4 minutes

52° 5' 10" N, 106° 26' 2" W
2015:12:21 05:01:58 UT

Image credit Alan Duffy



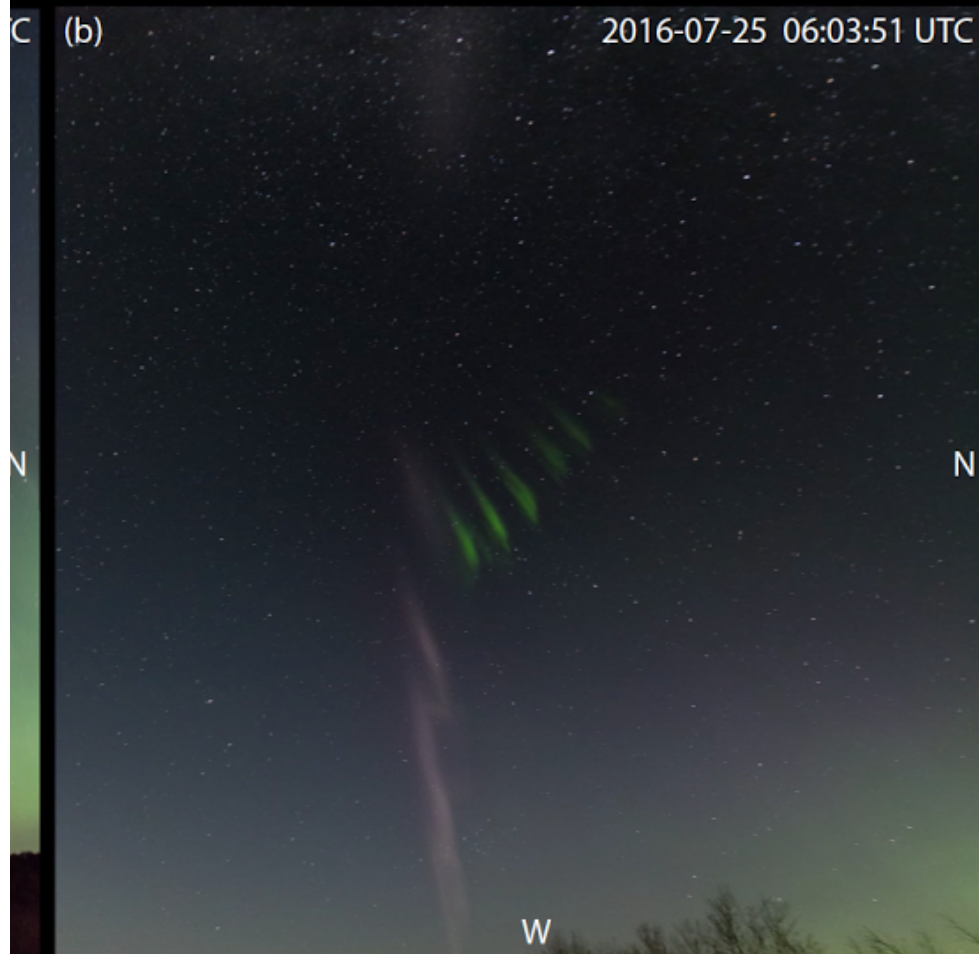
SCIENCE

That Ghostly, Glowing Light Above Canada? It's Just Steve

- Timelapse photos with color DSLR at lower than usual latitudes
 - Different viewpoint
- “Proton arc” that is not a proton arc → STEVE
- Traditional science may be missing something
 - Complementary to citizen science observations, filtered by wavelength, precise time, timelapse, fisheye view

Credit: Notanee Bourassa, Alberta Aurora Chasers

C (b) 2016-07-25 06:03:51 UTC

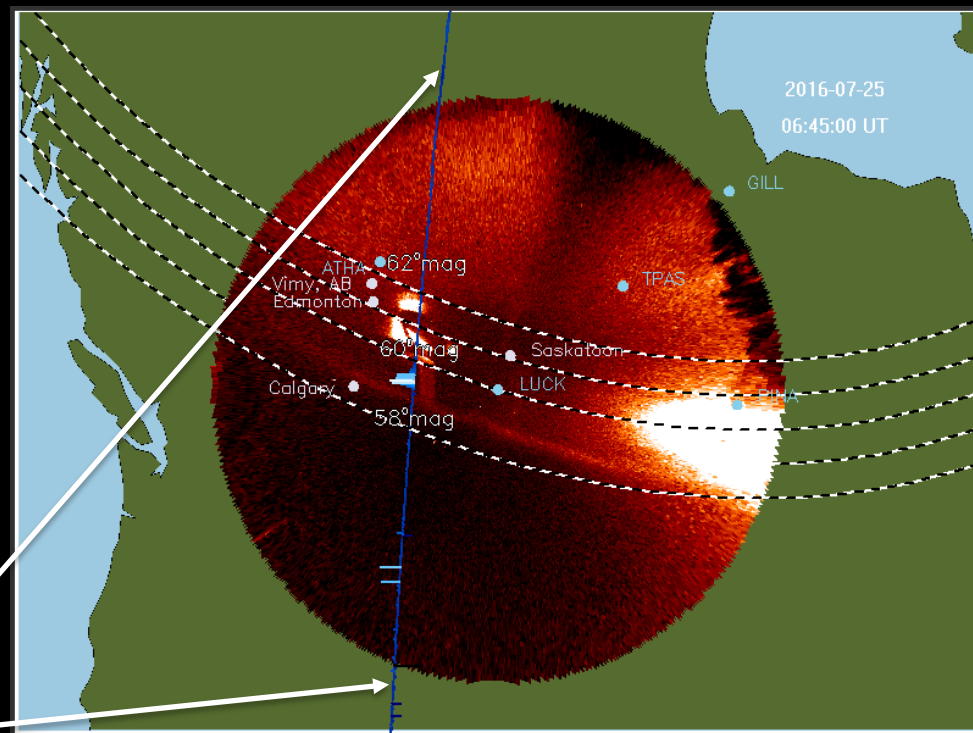


Picket fence auroral features are accompanying STEVE

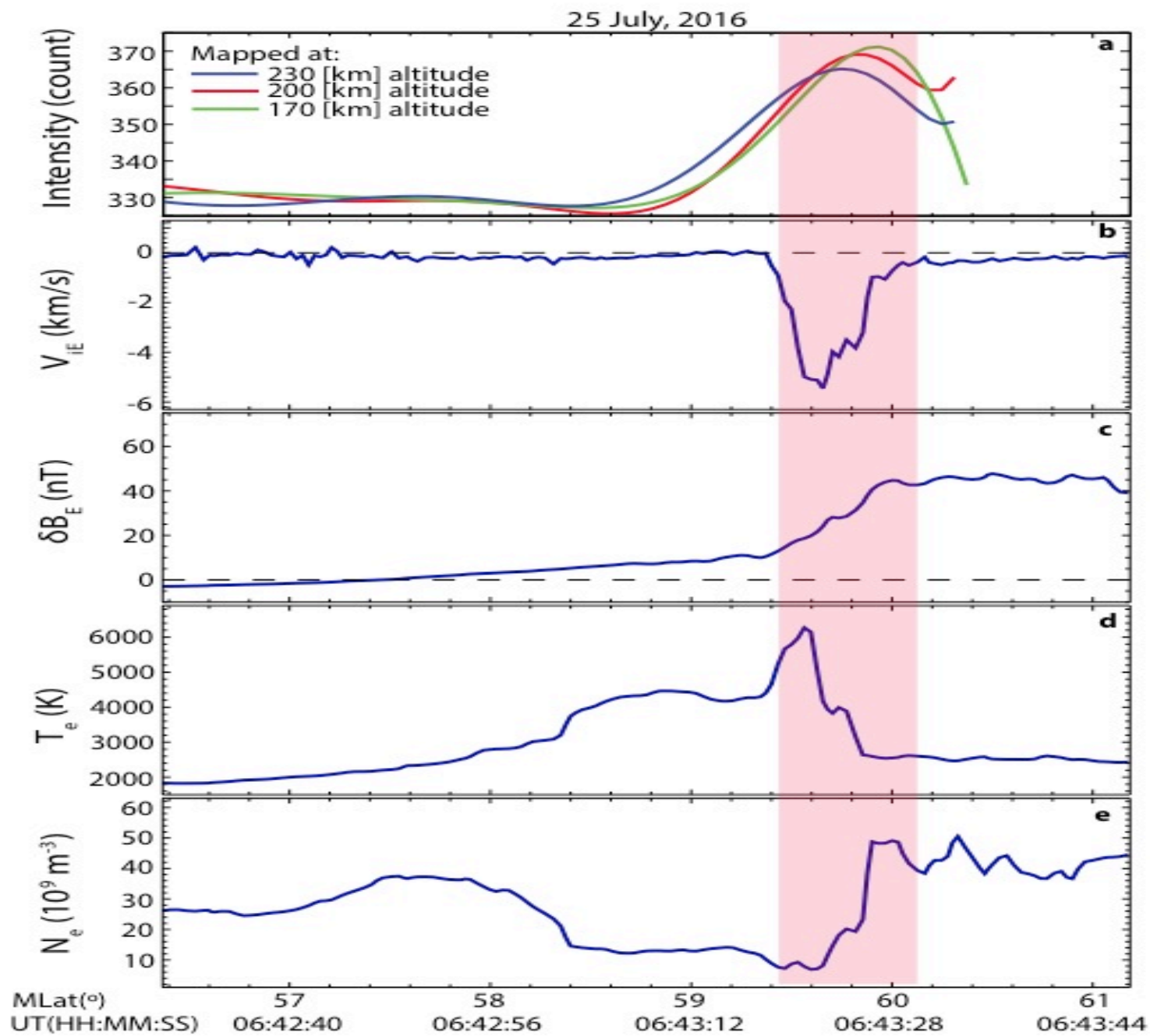
(c) 2016-07-25 06:07:20 UTC

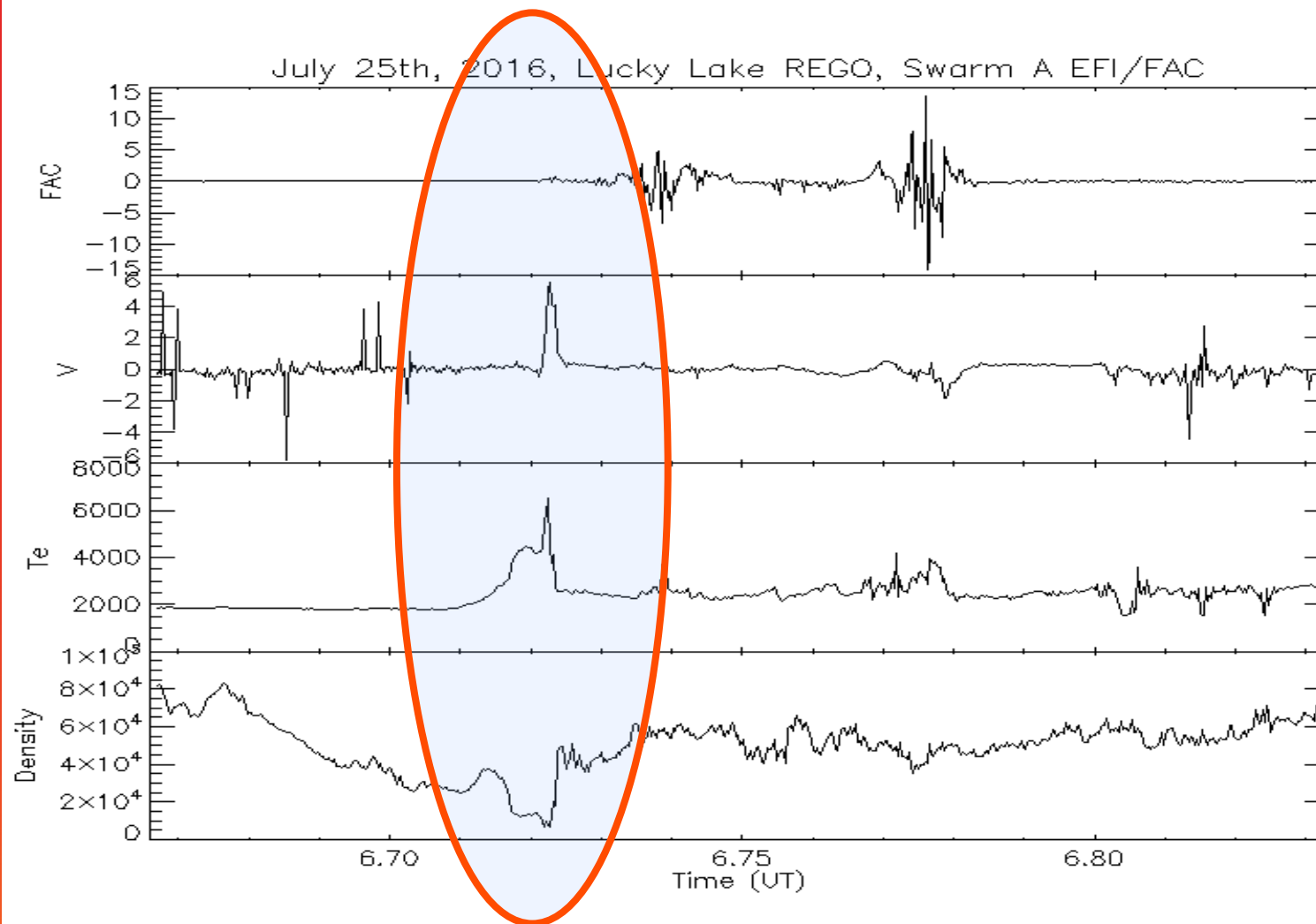
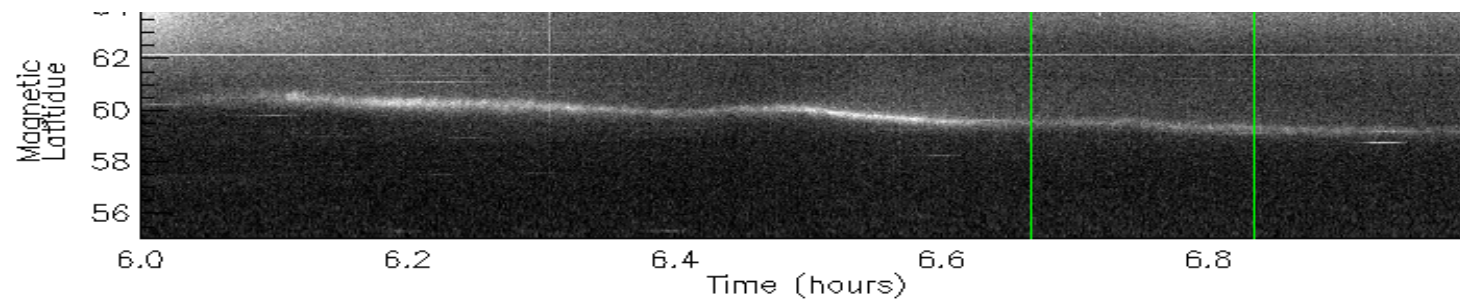


STEVE is overhead



ESA Swarm A



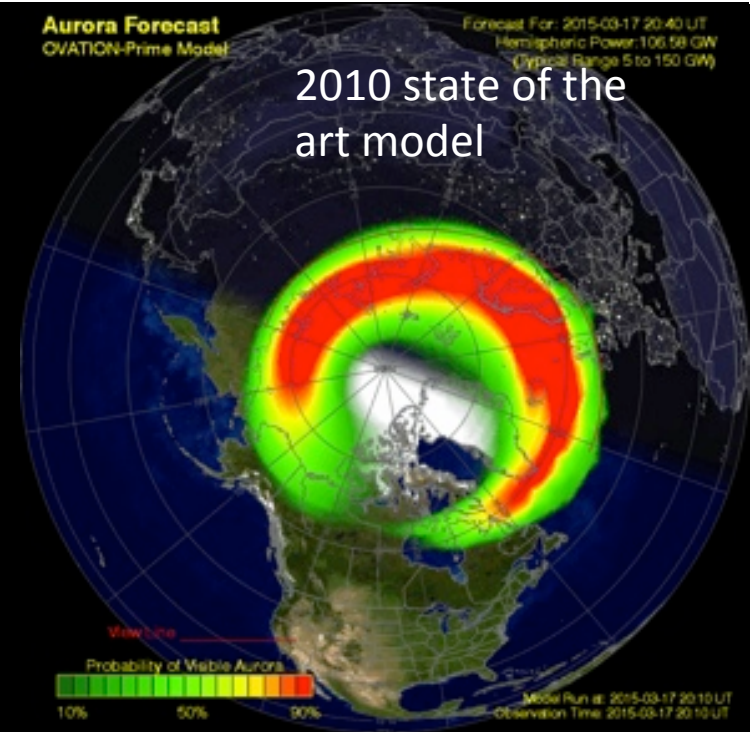


Why do we need this?

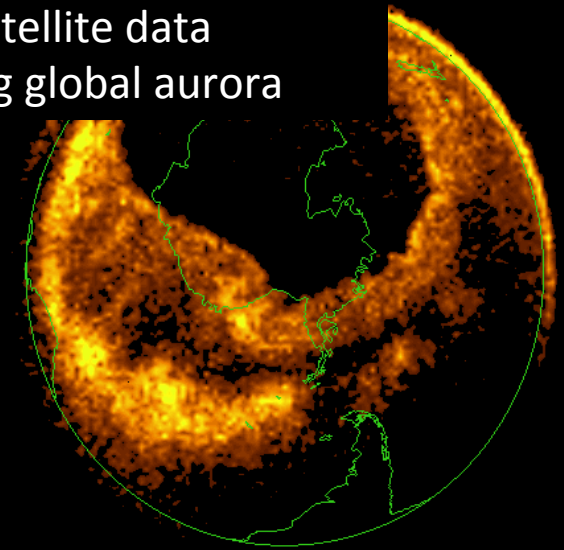
- Science gaps
 - The evolution of aurora during large storms never fully characterized
 - Aurora are universal acceleration processes and our monitors are very sparse

Space Weather has billion \$\$ impact potential:

GPS, ground induced current, spacecraft charging



1989 satellite data showing global aurora



A perfect storm of public participation


- ✓ Is there a well-posed problem?
 - ✓ When and where is the aurora (in real-time)? A huge problem, with coarse models, and the tricky science communication.
- ✓ Is there a public with cognitive surplus and interest?
 - ✓ Vastly distributed aurora enthusiasts
- ✓ Can the public participate? (Where, when, how)
 - ✓ Contribute observations via apps, website, and Twitter (@tweetaurora)
- ✓ Can public participation yield scientifically valuable results?
 - ✓ Yes, with data quality controls, new data can improve knowledge
- ✓ Are there resources for building tools and coordinating?
 - ✓ NSF INSPIRE award and NASA CAN support, professional development team, postdocs, and outreach coordinators
- ✓ Is there a spark?
 - ✓ Turning tweets into knowledge... across many fields scientifically useful and searchable.

Did you see the aurora?

Yes

No

Sighting Details




BertoBluFyre

@BertoBluFyre

3/8/15 at 12:29 am

Current view of the #NorthernLights patiently awaiting next substorm #Ottawa <http://t.co/NpOXNUd6ig>




Sighting Verification

Tweet confirmed to be a positive sighting

Sighting Details

Summary


Details



home/school

3/17/15 at 10:15 pm to 3/17/15 at 10:30 pm

Observed Near:
VA, United States



Colors Seen:
Green, Red

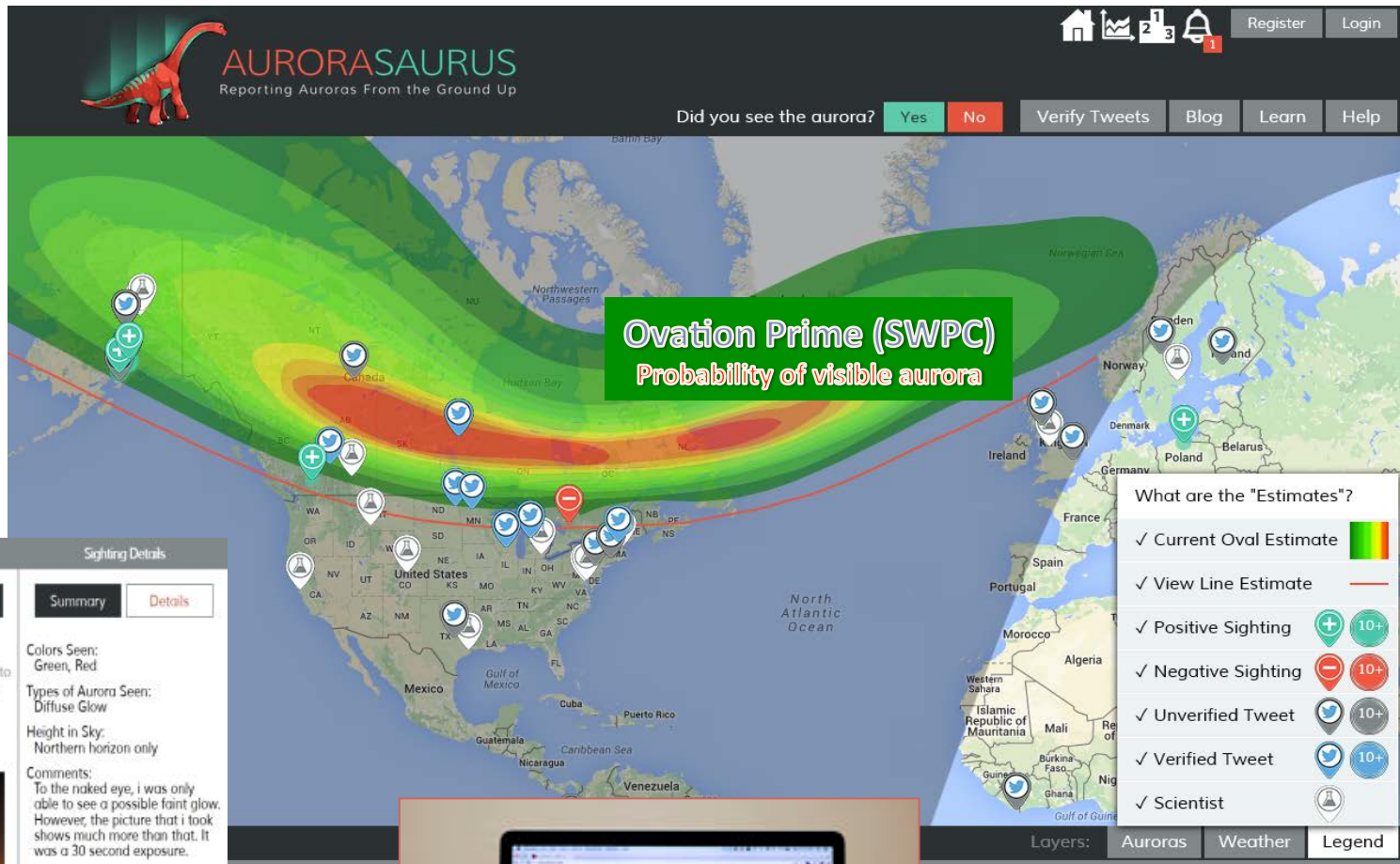
Types of Aurora Seen:
Diffuse Glow

Height in Sky:
Northern horizon only

Comments:
To the naked eye, I was only able to see a possible faint glow. However, the picture that I took shows much more than that. It was a 30 second exposure.

Classification

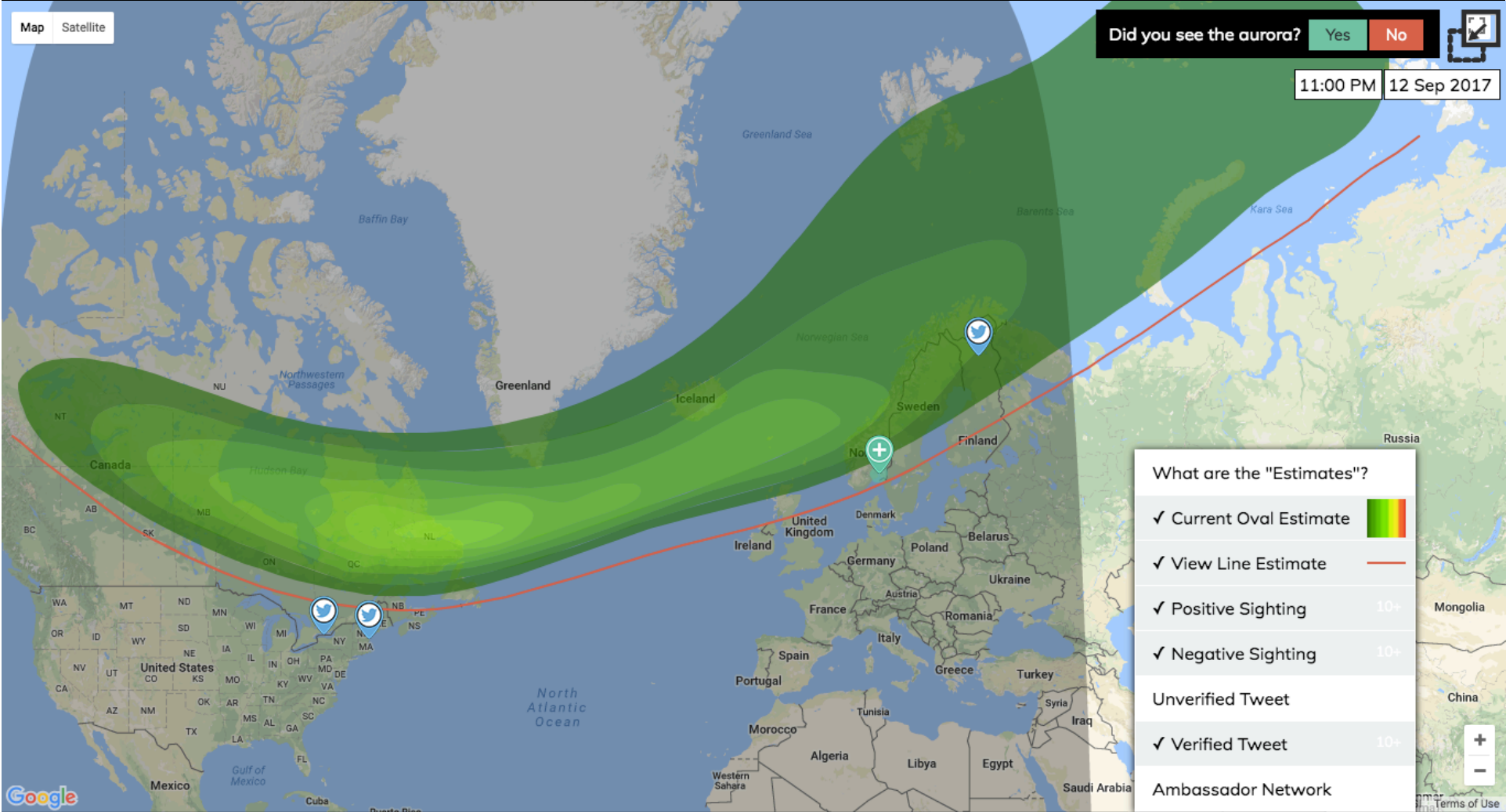
User saw the aurora



Map Satellite

Did you see the aurora? ☒ Yes ☐ No

11:00 PM 12 Sep 2017



What are the "Estimates"?

- ✓ Current Oval Estimate
- ✓ View Line Estimate
- ✓ Positive Sighting 10+
- ✓ Negative Sighting 10+
- Unverified Tweet
- ✓ Verified Tweet 10+
- Ambassador Network

Layers: Auroras Weather Legend

Surprise!
STEVE aurora
viral success
& 10+ papers
(bit.ly/Aurorasaurus-papers)

THE 'AURORASAURUS' MAPS THIS YEAR'S SPECTACULAR AURORAS

WIRED



Science Friday  @scifri

10h

Auroras are like glitter bombs of charged particles, says @spaceyliz.
scifri.me/p11

"I think imagining plasma as something more familiar, like a glitter bomb, can help scientists communicate some of the main processes."

—Liz MacDonald

NASA PLASMA PHYSICIST AND FOUNDER OF AURORASAURUS

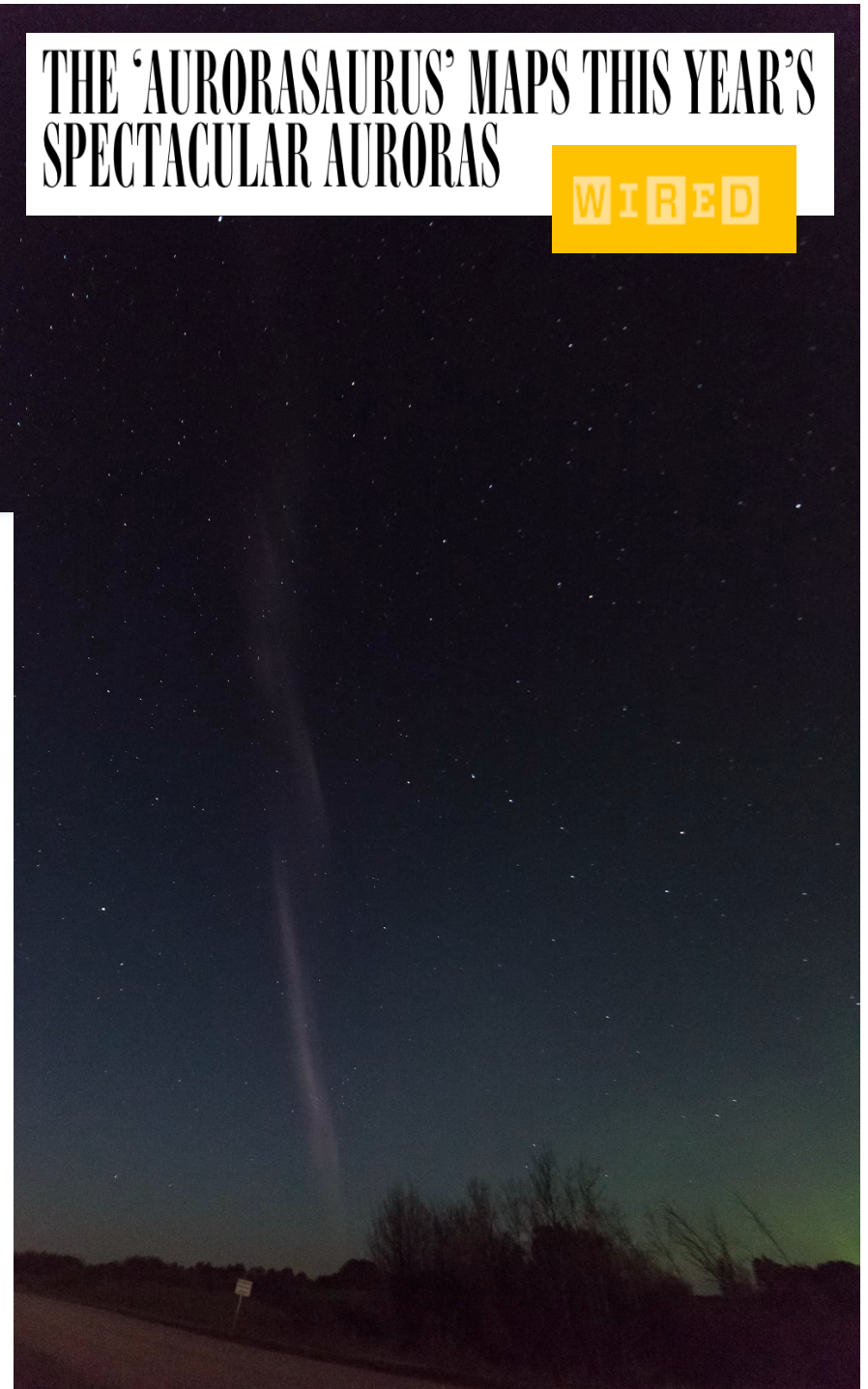
SCI
FRI



16



37



Aurorasaurus Space Science Results

- Rich data is plentiful and can be attained through this platform
- Integrated data is actionable to improve alerts for visibility of the aurora

Citation:

Case, N. A., E. A. MacDonald, M. Heavner, A. H. Tapia, and N. Lalone (2015), Mapping auroral activity with Twitter, *Geophys. Res. Lett.*, 42, 3668–3676, doi:10.1002/2015GL063709.

- 1 Use of solar wind power as a concept to help explain
- 2 auroral strength to the non-specialist

N. A. Case^{1,2}, E. A. MacDonald^{1,2} and H. K. Connor^{2,3}

SPACE WEATHER, VOL. ???, XXXX, DOI:10.1002/,

- 1 Using citizen science observations to define the
- 2 equatorial extent of the visible aurora

N. A. Case^{1,2}, E. A. MacDonald^{1,2} and R. Viereck³

Aurorasaurus and the St Patrick's Day storm

Nathan A Case, Elizabeth A MacDonald and Kasha G Patel examine the spectacular response of citizen scientists to a once-in-a-decade geomagnetic storm.



A&G • June 2015 • Vol. 56 • www.astrongeo.com

 **AGU PUBLICATIONS**

Space Weather

RESEARCH ARTICLE

10.1002/2015SW001214

Key Points:

- Citizen science project collecting aurora observations

Aurorasaurus: A citizen science platform for viewing and reporting the aurora

E. A. MacDonald^{1,2}, N. A. Case^{1,2}, J. H. Clayton³, M. K. Hall³, M. Heavner^{1,4}, N. Lalone⁵, K. G. Patel^{1,2}, and A. Tapia⁵



- 1 A real-time hybrid aurora alert system: cc
- 2 citizen science observations with an aurora
- 3 model

N. A. Case,^{1,2} D. Kingman,¹ and E. A. MacDonald^{1,2}

Determining the Accuracy of Crowdsourced Tweet Verification for Auroral Research

Human Computation (2015) xx:xx:xx
© 2015, Case et al. CC-BY-3.0
ISSN: 2330-8001, DOI: 10.15346/xx

Where could we go?

- Continued evolution of Aurorasaurus with new technology, open innovation, and interdisciplinary development
 - Data assimilation approach. Applications to conductance.
 - Citizen science being used operationally, globally
 - A version for other phenomena... sprites, NLC's
 - Integrated image analysis citizen science
 - Integrated to weather apps, other sensors
 - Integrated satellite tracking
 - Integrated community/social platform



Images By Stan

@ImagesByStan

Following



Tonights cloudy moon lit sky and [#Aurora](#).
[@TweetAurora](#) [@TamithaSkov](#) [@coryedelCTV](#)
[@RobWilliamsCTV](#)



12:19 AM - 13 Sep 2017

4 Retweets 10 Likes



1

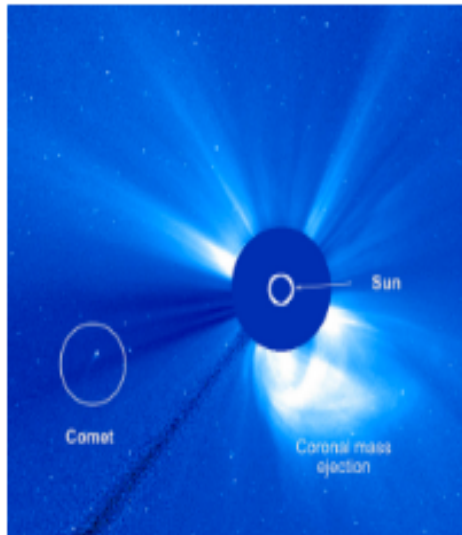


4



10

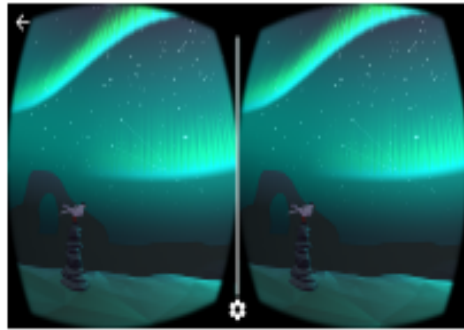




Space Weather at our Doorstep: How Can We Detect it?

Posted on *July 29, 2016*

Identifying Space Weather Phenomena Space weather is a complex field of study and can be a difficult term to define. According to NOAA's Space Weather Prediction Center (SWPC), space weather is described as the variations in the space environment between the sun and Earth. Other planets have space weather, too. In fact, we have been[...]



Check out Virtual Reality Aurora!

Posted on *November 1, 2016*

Aurora only occur in particular areas of the world and are highly unpredictable which are some of the reasons why many people feel fortunate to see them at all. And, for the majority of known human history, you could only experience the beauty and mystique

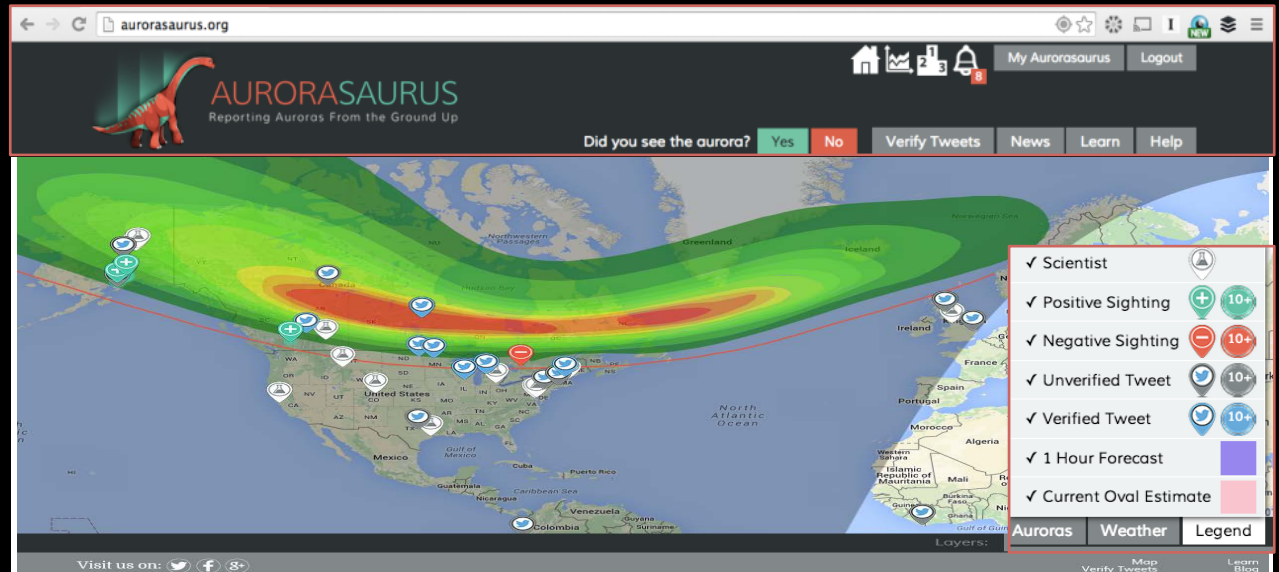
Aurorasaurus Tracks St. Patrick's Day storm on Social Media

Posted on *March 19, 2015*

By Nathan Case and Karina Patel An Aurorasaurus user submitted this photo of the aurora in Germany along with a report. On Tuesday, March 17, 2015, as people adorned themselves with green clothing and infused their livers with green beer, Earth was experiencing the biggest geomagnetic storm of the last decade—leading to beautiful,



Aurorasaurus.org
Apple iOS & Android apps



New global, real-time data sources from citizen scientists and tweets Alerts of auroral visibility for the public

In 2 years, our database has more than **5000** users, more than **2700** reports, and votes on more than **290,000** tweets.

Selected Papers (of >10 submitted so far)

MacDonald, E. A., et al., **Aurorasaurus: A citizen science platform for viewing and reporting the aurora**, Space Weather, doi: 10.1002/2015SW001214, 2015.

Case, N. A., et al., **Mapping Auroral Activity with Twitter**, Geophys. Res. Lett., 42, doi:10.1002/2015GL063709, 2015.

Case, N. A., et al., **Aurorasaurus and the St Patrick's Day storm**, Astronomy & Geophysics, 56 (3), 2015.

Case, N. A., E. A. MacDonald, and R. Viereck (2016), **Using citizen science reports to define the equatorial extent of auroral visibility**, Space Weather, 14, doi:10.1002/2015SW001320.

Tapia, A.; Lalone, Nicolas; (2014) **Crowdsourcing Rare Events: Using Beauty to Draw Participants into Science and Early Warning Systems**, 11th International Conference on Information Systems for Crisis Response and Management (ISCRAM). May 18-21, 2014



**Citizen Scientist Images
March, 2016**



A new, open innovation, geospatial, crowdsourcing, open source platform and public-private partnership...

Join us! @tweetaurora

POC: Elizabeth MacDonald, e.a.macdonald@nasa.gov



Calling Citizen Scientists Everywhere!

**Help NASA track the aurora at
Aurorasaurus.org**

**Partner and
collaborate
with us!**

Join the conversation with
[@tweetaurora](https://twitter.com/tweetaurora) and download
the iOS, Android apps

aurorasaurus.info@gmail.com,
fb.com/aurorasaurus.org



AURORASAURUS

Backup

NASA mission provides recognition and exposure

- Unique manmade signature.
- Exploring the unknown.
- Craft bobbing in the turbulent magnetospheric seas, phoning home.
- Scientific process
- We ask how far away was our craft, magnetically?