

Into the Ionosphere: Real-Time Aurora Mapping Through Citizen Science

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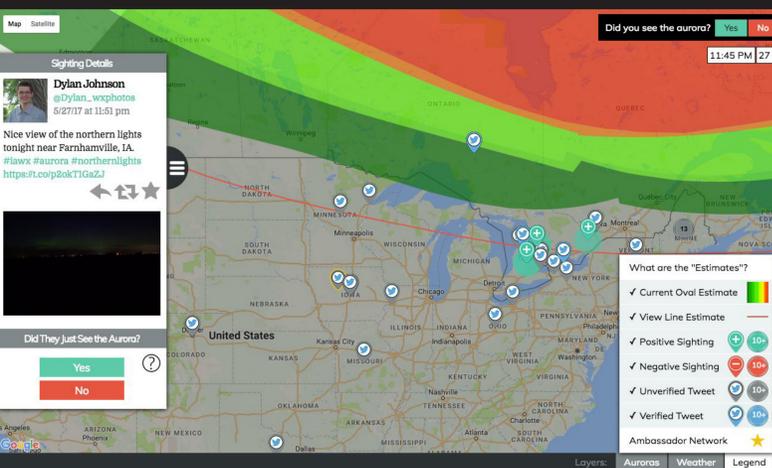


Image capture of the Aurorasaurus website, 2017

Aurorasaurus Is...

- The first and only citizen science project that **maps aurora sightings**, providing real-time validation, alerting registered users, and enhancing scientists' ability to image large solar storms.
- A hybrid, assimilative platform reliant on **crowdsourcing and community science reports** through our website, free apps, and Twitter. Verification of tweets is also crowdsourced.



STEVE by citizen scientist Catalin Tapardel

Data-Driven Discoveries

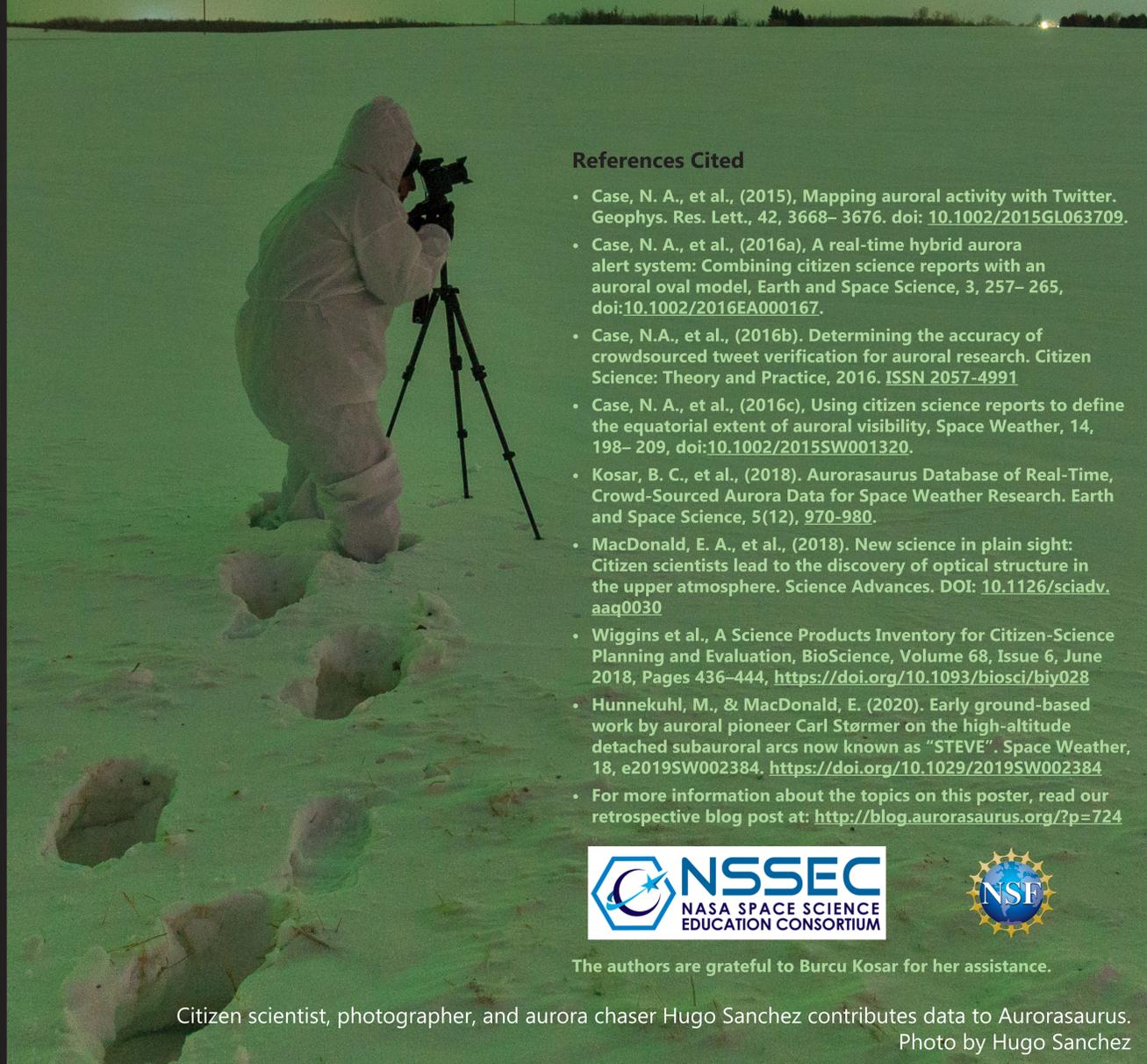
- Social media can provide accurate, detailed, real-time indications of space weather events (Case et al, 2015.)
- Combining citizen science reports with a traditional solar wind-driven auroral precipitation model enables greater spatial resolution of auroral visibility and the ability to generate localized alerts (Case et al., 2016a).
- Utilizing crowdsourced verification of real-time aurora sightings is successful (Case et al., 2016b).
- A structure recognized by citizen scientists but unidentified by science is associated with subauroral ion drift (SAID) and is now known as Strong Thermal Emission Velocity Enhancement, or STEVE (MacDonald et al., 2018).
- **Datasets are made publicly available** to encourage further discoveries (Kosar et al., 2018).



AURORASAURUS

Reporting Auroras From the Ground Up

Citizen Scientists Map Auroras in Real Time, Make Discoveries, and Improve Alerts



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- For more information about the topics on this poster, read our retrospective blog post at: <http://blog.aurorasaurus.org/?p=724>



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Citizen scientist, photographer, and aurora chaser Hugo Sanchez contributes data to Aurorasaurus. Photo by Hugo Sanchez

Category	Science Product	Aurorasaurus
Communication	Blogs (Y/N)	57 Aurorasaurus blog posts + 7 NASA features
Communication	Newsletters (Y/N)	11 newsletters, 2016-17, and distributed 10k-12k brochures
Communication	Presentations (Y/N)	35+
Communication	Videos (Y/N)	Aurorasaurus YouTube: 16 videos, 5 playlists
Communication	Website (Y/N)	Aurorasaurus website
Data	APIs (Y/N)	Our own API and we use the Twitter search API
Data	Data packages (#)	76 downloadable files on Zenodo
Data	Metadata (Y/N)	Description is in Kosar et al. 2018
Data	Requests (# requests, transfer volume)	5,929 unique downloads on Zenodo, totaling 111.7 GB
Data	Specimens/samples (#)	More than 7,000 reports: plus tweets, photos and observation numbers in AWS database
Data	Visualizations (Y/N)	Aurorasaurus map, graphs as figures in publications
Management	Decision support (Y/N)	No, but citizen science stakeholders use the map and data to make their own decisions.
Management	Forecasting/models (Y/N)	Increasing accuracy of OVATION Prime aurora forecasting model
Management	Regulatory action (Y/N)	No
Written	Dissertations, theses (#)	One thesis: Formalizing Citizen Science: Creating a New Paradigm in Space Weather Policy, by Michael Cook
Written	Grants awarded (#, \$)	7 grants
Written	Reports (#)	2 white papers: <i>Astronomy Decadal</i> , NSF annual grant report 2017
Written	Scholarly publications (#)	21+ publications

Category	Data Practice	Aurorasaurus
Findable	Data available from project website (Y/N)	No. Data is visible in real-time but not downloadable
Findable	Data available from repositories or registries (Y/N)	Yes
Accessible	Downloadable data file(s) available (Y/N)	Yes, from Zenodo
Accessible	Tools for data exploration (Y/N)	Map display of data. Queryable to past dates. Not offline software exploration
Accessible	Data licensing specified (Y/N)	Yes: Creative Commons Attribution Non Commercial 4.0 International
Accessible	Metadata available (Y/N)	Some metadata displayed on map
Accessible	API documentation (Y/N)	Not sure
Interoperable	Data recorded in standard formats for discipline (Y/N)	No, standard format not yet established
Reusable	Uniqueness of data (describe)	Accurate real-time aurora prediction does not exist. Aurorasaurus collects real-time ground-based aurora data
Reusable	Time scale of data (# yrs)	5 years
Reusable	Spatial scale of data (describe)	Inhabited areas of Earth that experience auroras—geographic boundary changes depending on space weather and other conditions
Reusable	How much data (# data points, describe)	9,519 raw observations in 2015-16, but the program has been in place since 2014
Reusable	Errors documented (Y/N)	Tweet validation process in place
Reusable	Quality assurance or quality control documented (Y/N)	Yes, in report (Kosar et al, 2018)
Reusable	Changes documented (Y/N)	GitHub on software; version control
Reusable	Questionable data flagged (Y/N)	No
Reusable	Software or platform development (Y/N)	Open-source platform could be adapted for other projects, none to date

Top: Science Products. Bottom: Data Practices. Credit: Aurorasaurus

Evaluation and Innovation

- Aurorasaurus is collaborating with field leaders to synthesize interdisciplinary evaluation frameworks for citizen science.
- We applied the quantitative “A Science Products Inventory for Citizen-Science Planning and Evaluation” (Wiggins et al, 2018) to Aurorasaurus (see chart above) and integrated qualitative metrics
- We posit that citizen science project evaluation should benefit citizen scientists as stakeholders



Hearts in the Ice are overwintering in Svalbard doing “extreme citizen science,” including for Aurorasaurus. Credit: Hearts in the Ice

Join us!

- Aurorasaurus builds partnerships with local enthusiast groups that benefit the aurora science and citizen science communities. Join our Ambassador group to help build a broader community of practice.
- Visit aurorasaurus.org or **download our app** from iTunes or the Play Store (coming soon!) to make reports
- Follow our e-newsletter, Twitter [@TweetAurora](https://twitter.com/TweetAurora), and Facebook, or contribute a blog post
- Questions? Email aurorasaurus.info@gmail.com