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St. Patrick's Day: a success for citizen science.

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The recent St. Patrick's Day geomagnetic storm provided a rare chance for the public to witness a dazzling auroral display, even from mid-latitudes. An unprecedented number of citizen scientists reported their sightings to Aurorasaurus, offering an exciting opportunity for future scientific study.

The geomagnetic storm of 17 to 19 March 2015, colloquially known as the St. Patrick's Day storm, is the largest storm of solar cycle 24 to date. Owing to a fortuitous combination of an earthward directed, southward orientated, CME and a high speed stream, the solar wind buffeted the earth's magnetic field creating a once in a decade event.

At its peak, the storm registered as "severe" (G4) on the NOAA storm scale (Poppe 2000). Geomagnetic indices reached their highest levels in many years with a maximum real-time Kp index of 8 and a minimum real-time Dst index of -228nT. All of which meant a high chance of auroral visibility even at mid-latitudes (evidenced by photographs such as Figure 1).

Shown in Figure 2 are the preliminary real-time values of the Kp (Bartels et al. 1939) and Dst (Sugiura 1964) indices, provided by NOAA's Space Weather Prediction Center and the World Data Center for Geomagnetism, respectively.

The CME arrived slightly earlier than expected, with arrival estimates averaging at around 12:00UTC and actual arrival occurring at 04:05UTC. The arrival time originally looked somewhat unfortunate for aurora hunters in Europe and North America, as daylight would soon be approaching. Aurora hunters in New Zealand and Australia, however, were in luck. Indeed, aurora sightings in New Zealand first starting appearing on Twitter by early morning (UTC).

Fortunately, strongly disturbed geomagnetic conditions continued throughout the day and, as darkness approached, Twitter was abuzz with talk of auroras. Aurora sightings were reported throughout Europe including from countries such as Germany, Poland and Romania, where sightings are a rarity. Conditions remained strong, though not quite as elevated as earlier, well into 18 March, allowing auroral sightings from the northern-mid US, including Ohio, Pennsylvania and Virginia.

Throughout the storm, the public reported sightings of the aurora on various platforms. Reports were made on social media (e.g. Twitter, Facebook, Instagram) and via the citizen science project Aurorasaurus (MacDonald et al. 2014).

Aurorasaurus (www.aurorasaurus.org) is aimed at both collecting observations of the aurora generated by the interested public, or "citizen scientists", and improving the public's understanding of the aurora and space weather in general. Visitors to the site are able to report observations of the aurora (both positive and negative) and provide details such as auroral activity, color and height in the sky along with a photo. The site also combs Twitter for tweets that are likely to be aurora sightings and visitors are encouraged to verify these. All of these citizen science data are shown on a Google map (see Figure 3) alongside an estimated auroral oval - based on the empirical model of Roble and Ridley (1987).

During the peak of the storm, Aurorasaurus saw a 50 percent increase in the number registered members. This is a staggering increase to achieve in just one day for a site that has been live since October 2014. Such an increase demonstrates that the public are clearly interested in the aurora, are wanting to share their sightings with others, and are keen to receive alerts of when an aurora might be visible near them.

Over 170 auroral sightings were reported by Aurorasaurus users during the St. Patrick's Day storm – which accounts for nearly a quarter of all observations received thus far. Additionally, Aurorasaurus users verified over 420 tweets as being auroral sightings. These sightings spanned the globe, encompassing several different countries and continents, as shown in Figure 4.

By combining multiple auroral sightings in the same region, Aurorasaurus is able to produce alerts of when an aurora might be seen near one of its registered members (Lalone 2015). During this storm, Aurorasaurus sent over 300 alerts to its users (both via email and Twitter). The power of citizen science observations in aiding event notification was clearly demonstrated.

The citizen science observations are useful not just for alerting other users of nearby aurora. They can also be used in a scientific method to improve our understanding of the aurora and our ability to predict when, and from where, they will be visible. This is especially true for oval models that have been relatively scantly tested during extreme auroral events, owing to the rarity of such events.

Whilst detailed investigation is on-going as to the accuracy of the auroral sightings and their utilization in improving auroral models, early results suggest that model developers may benefit from exploiting the Aurorasaurus dataset (and citizen science data in general). During the St. Patrick's Day storm, significant differences were noted between the locations of the modeled auroral ovals of Newell et. al (2010) and Roble and Ridley (1987). Aurorasaurus can offer ground-truth observations to help address such discrepancies and, perhaps, lead to further improvements of these models.

It is clear that this geomagnetic storm provided an extraordinary chance of seeing the aurora for those outside of the usual auroral ovals and that many people took advantage of such disturbed conditions. Although auroral viewing was hampered by local weather conditions in some cases, citizen scientists reported their aurora observations in unprecedented levels.

These observations are already showing promise in improving our future modelling abilities and are sure to offer some exciting insights in subsequent analyses. Overall, this storm proved to be a great success for citizen science!

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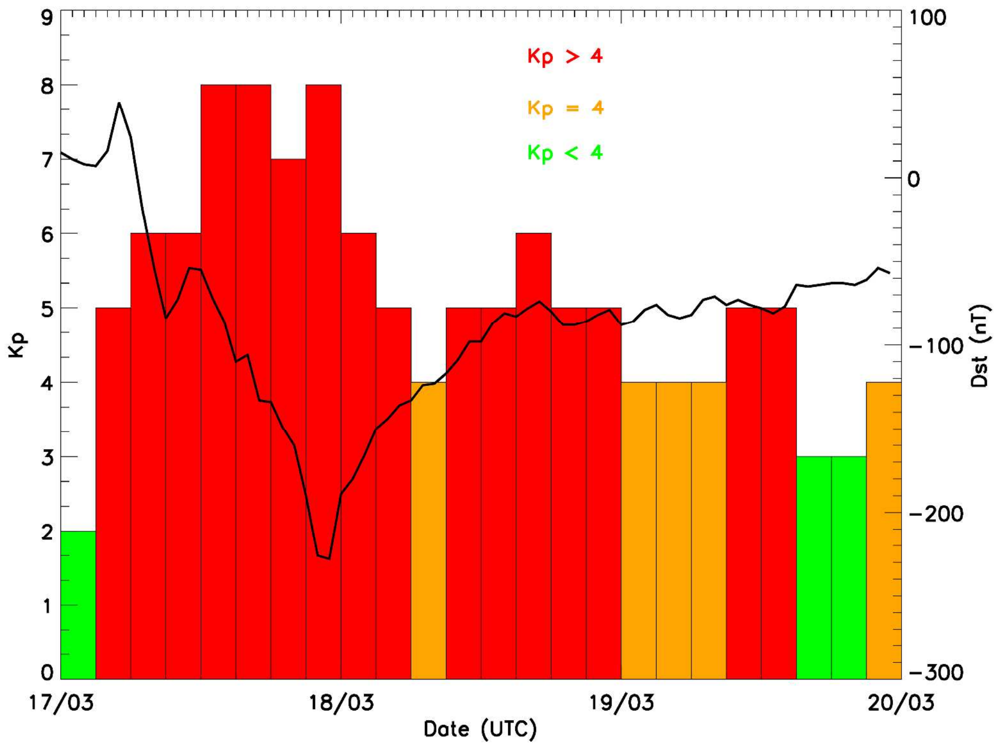
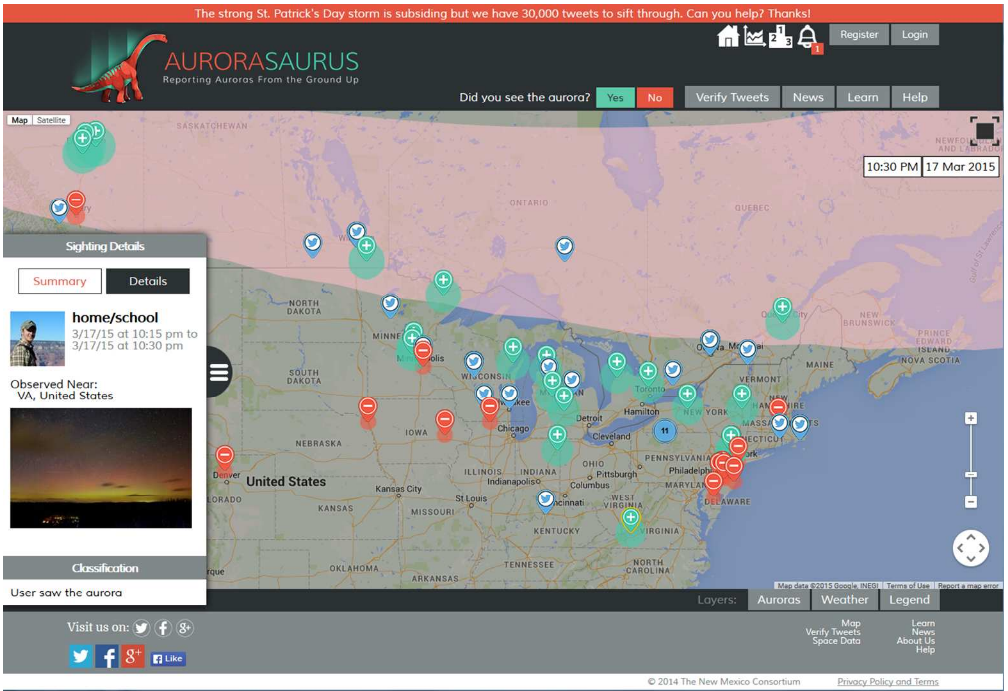
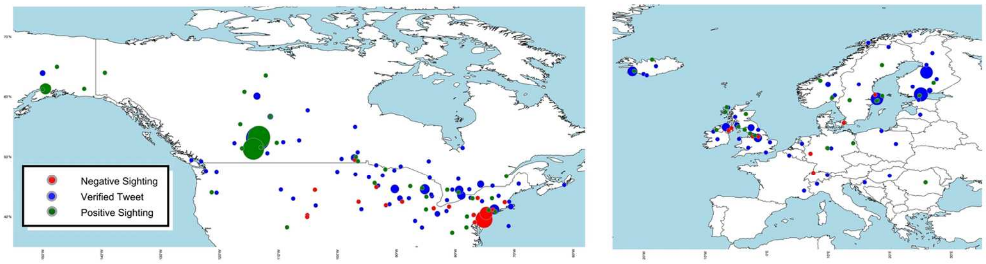
An aurora photo taken by an Aurorasaurus user near Berlin, Germany.
254x168mm (72 x 72 DPI)



Real-time Kp and Dst values for the storm period.



A screenshot of the Aurorasaurus map, showing a positive sighting from as far south as southern Virginia (time is UTC-4). Positive sightings are represented by green '+' symbols, negative sightings by red '-' symbols and verified tweets by the blue Twitter icon (blue bird).



Locations of sightings reported by Aurorasaurus users and of verified Twitter sightings. Red circles indicate the location of a negative sighting (no aurora), green circles indicate a positive sighting and blue circles indicate a verified Twitter sighting. The size of each circle represents the density of sightings in a given area.
135x36mm (300 x 300 DPI)