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Observations of Low-Latitude Red Aurora in Mexico During the 1859 Carrington Geomagnetic Storm

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Key Points:
- Observations of the Carrington Event in Mexico from seven sites
- Auroral light penetrated the cloudy skies at several locations in Mexico
- Observers reported strong oscillations in auroral intensity

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Abstract One of the most intense geomagnetic storm that has been documented in recent history occurred on 1 September 1859. This storm is known as the Carrington Event. In the morning of 1 September at around 11:15 UT, Richard Carrington and Richard Hodgson observed in England, independently and for the first time, an intense white light solar flare. About 17 hr after this solar event, there occurred the strongest geomagnetic perturbation ever recorded as well as a greatly extended red aurora, which covered unusually at low latitudes. The red auroral display on 2 September was reported in regions where this kind of phenomena is very rare, like in Cuba and Hawaii. Until now however, it was not known to scientists that the low-latitude red aurora is also registered in Mexico. At that time, Mexico was in a civil war, and there were very difficult conditions in where to establish astronomical and magnetic observatories. Nevertheless, the geomagnetic storm was observed with a maximum intensity between 7:00 and 8:00 UTC and was reported to a Mexican newspaper from five different locations (Mexico City, Querétaro, Guadalajara, Hidalgo, and Guanajuato) and registered also from at least in two additional sites (Michoacán and San Luis Potosí) in other historical documents. These records confirm that the Carrington geomagnetic storm was a global event with planetary repercussions, and that the Mexican low-latitude region is susceptible to significant effects associated with intense space weather events.

1. Introduction

The maximum of solar cycle 10 was reached in February 1860 (Clette et al., 2014). Approaching the maximum, on 28 August 1859, there was a powerful display of auroras in Europe and North America, as well as magnetic disturbances registered at several sites (Nevanlinna, 2006). These observations indicate an active phase of solar activity affecting the Earth's environment. On 1 September 1859, two British astronomers, Richard Carrington and Richard Hodgson, were performing sunspot measurements, and, independently, observed an unusual emission of white light in a large sunspot lasting about 5 min. The two astronomers reported their observations at the Royal Astronomical Society (Carrington, 1860; Hodgson, 1860). Figure 1 shows the famous sunspot drawing by R. Carrington and the two whitish regions of the flare white light signature. This was one of the earliest white solar flares observed (Carrasco & Vaquero, 2016; Hayakawa et al., 2017; Hoyt & Schatten, 1996) and presumably the strongest registered in the last 160 years (Cliver & Dietrich, 2013).

The Carrington Event is one of the most powerful space weather event that has affected the Earth in the recent history (Cliver, 2006; Giegengack, 2015). Note that the term "space weather event" involves different physical phenomena, which in some cases might be or might not be related, such as solar flare, solar energetic particle event, coronal mass ejection, geomagnetic sudden storm commencement, geomagnetic storm, and ionospheric disturbance. The Carrington solar event caused an extremely strong magnetic disturbance (Nevanlinna, 2008; Siscoe et al., 2006; Tsurutani et al., 2003), unusual extent of auroral displays (Green et al., 2006; Green & Boardsen, 2006; Kimball, 1960; Silverman, 2006), and disruptions in the telegraph systems in Europe and North America (Boteler, 2006; Muller, 2014). Green and Boardsen (2006) plotted the auroral observations, finding the equatorward boundary as ~18° in magnetic latitude (MLAT) on 2/3 September 1859. Hayakawa et al. (2016) and Moreno Cárdenas et al. (2016) surveyed historical reports from low-magnetic latitude and confirmed the auroral visibility down to 19.9° in MLAT and 23.1° in MLAT, respectively.

The Carrington Event has been reviewed and compared with other a posteriori records of intense space weather events affecting the Earth. This is a complex analysis because of the lack of information about the

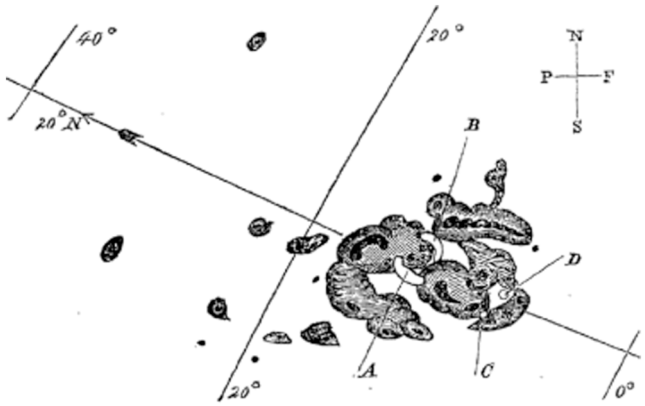

Figure 1. Sunspots drawing of the active region associated with the solar storm on 1 September 1859. (Carrington, 1860).

previous events compared with the ones detected after the beginning of the Space Age and the in situ measurements. Cliver and Svalgaard (2004) pointed out that although the Carrington Event would be one of the greatest space weather disturbances affecting the Earth in the last 160 years for all the signatures (magnetic crochet amplitude, solar energetic proton fluence, Sun-Earth disturbance travel time, geomagnetic storm intensity, and low-latitude auroral extension), this does not necessarily mean that the Carrington Event is the most intense one, in this interval, in all the categories. The space weather event that occurred about 160 years ago had close peers or superiors in some signatures. In particular, for two categories where the Carrington Event "reaches" the top, Cliver and Dietrich (2013) estimated that the flare soft X-ray peak intensity class was about X45 (±5) (compared with the X35 [±5] for the 4 November 2003 flare). In addition, it had a magnetic storm index with an estimated minimum Dst of about −900 (+50, −150) nT, compared with the estimated −825 to −900 nT for the great geomagnetic storm of May 1921 (Cliver & Dietrich, 2013) .

2. Observations of the 1859 Aurora in Mexico

While the great auroral display was visible down to the Caribbean Coasts during the Carrington storm on 1/2 September 1859, there have been no reported eyewitness auroral records from the territory of Mexico (Green & Boardsen, 2006; Kimball, 1960). This is presumably because Mexico was under civil war (Cosío Villegas & Potash, 2000), and systematic astronomical observations were suspended during the interval of 1858–1861. In the War of Reform (Guerra de Reforma), the liberals and conservatives were fighting for the power to define the type of government and the role that the Catholic Church would have in the structure of the country. The nation was divided: in Mexico City, Miguel Miramón governed for the conservative party, and in the state of Guanajuato, Benito Juárez governed for the liberal party. The unstable political situation produced very difficult conditions for performing scientific studies and for maintaining academic institutions, in particular at the Mining College founded in 1792 (Ramos-Lara & Saldaña, 2000).

The records of the auroral observations of the September 1859 in Mexico have been almost forgotten since they were published mostly in the conservative La Sociedad newspaper (1855–1867) (see the Appendix A for a full transcript of the reports). Note that the liberals won the civil war, and this might explain why the conservative newspapers had been "almost forgotten." In the La Sociedad newspapers at that time, the aurora was reported at least in five different sites: Mexico City, Mineral de Zimapán (today the state of Hidalgo), Querétaro, Guadalajara, and Guanajuato (La Sociedad Newspaper, 1859a, 1859b, 1859c, 1859d, 1859e). The aurora was also reported in San Luis Potosí and San José de Gracia, Michoacán in other historical documents (Cabrera, 1872; González y González, 2004). The latitude of the region covering the sites is around 29° in MLAT (Vázquez et al., 2006; Table 1).

In the night of 2 September 1859, the Moon was in first quarter. September is within the rainy season in Mexico, and the sky is usually cloudy. The newspaper reports mention that it was cloudy that night at several locations, and the phenomenon began about 1 hr before midnight (05:00 UT). In the early hours of that night, the Director of the Mining College, Joaquín Velázquez de León, and his students observed an aurora borealis for the first time. Velázquez de León sent a note to *"La Sociedad"* newspaper in which he described what

Table 1
Observations of the 1859 Aurora in Mexico

Location	2 September 1859 (UTC)	Latitude	Longitude	Reference
Mexico City	07:00	19.39	−99.28	La Sociedad newspaper, 3 September 1859, p.3, col. 3
Querétaro	05:40	20.61	−100.48	La Sociedad newspaper, 12 September 1859, p.2, col. 2
Guadalajara	05:00	20.67	−103.40	La Sociedad newspaper, 17 September 1859, p.2, col. 4
Hidalgo	05:00	20.50	−100.05	La Sociedad newspaper, 3 September 1859, p.3, col. 3
Guanajuato	05:30	20.87	−102.01	La Sociedad newspaper, 24 October 1859, p.1, col. 1
Michoacán	no data	19.99	−101.04	(González y González, 2004) p.15
San Luis Potosí	no data	22.11	−101.03	(Cabrera, 1872) p.369

they saw and complained that they were not able to register the magnetic variations because the money promised to complete the construction of the observatory had been suspended (La Sociedad Newspaper, 1859a). "Between 1 and 2 AM yesterday (7:00–8:00 UTC, 2 September 1859), the director and his students of the astronomy class of the Mining College witnessed an aurora borealis from his observatory: 5 min before 1 AM (7:00 UT) the fourth quadrant was occupied, from the horizon until a height of about 40 degrees, with a beautiful translucent white cloud that showed a carmine red background spreading throughout the northwest, which was divided into various groups with growing intensities."

A former student of the Mining College, Ismael Castelazo, also wrote to the newspaper *La Sociedad* from Mineral de Zimapán to report on the observations that he made that night. He noted that 15 min before 11:00 on the evening of 1 September (2 September 6:45 UTC) the sky was cloudy, but there appeared lights forming a large arc with silver rays and a red light that illuminated the entire northern region of the sky (La Sociedad newspaper, 1859d). The red light bulb seemed fixed in the magnetic pole, and greater auroral intensities were noticed in the northwesterly direction. "The red light covered the sky ascending until Orion and the Pleiades, drawing an arc parallel towards the equator. You could see rays of white light pointing to the equator."

Castelazo noticed that the bursts of the red light were lit and dull by unequal intervals, and in these changes of intensity there were oscillations in the magnetic needles. He had three different compasses, and there were oscillations in all three. He indicated that during the night of the aurora the needles were oscillating toward the west, deflecting in a range of 10° to 30°. "When the aurora borealis disappeared at 3:53 (9:53 UT), I noticed that the north index returned to its site that does not change. I did return to place the following night with the three compasses, and I collocated them in the same position as they were the night before, although their mutual attraction made them oscillate momentarily, they ended up pointing towards the magnetic north without moving again."

Although there are several reports of the observations of the red aurora in Mexico, we did not find records of failures in the telegraph network reported in La Sociedad newspapers during August–September 1859. The telegraph arrived in Mexico in 1848 promoted by Juan de la Granja, and the first telegraph line was a connection between the National Palace and the Mining College in Mexico City. From this first successful test, the telegraph grew, and by 1856, more than 50,000 messages were issued annually between Mexico City, Puebla, Veracruz, and the agricultural centers of the Bajio (Mendoza Vargas, 2013). The War of Reform, however, presumably diminished its activity in that period, and we could not find any historical record of failures to corroborate possible effects on 2 September 1859.

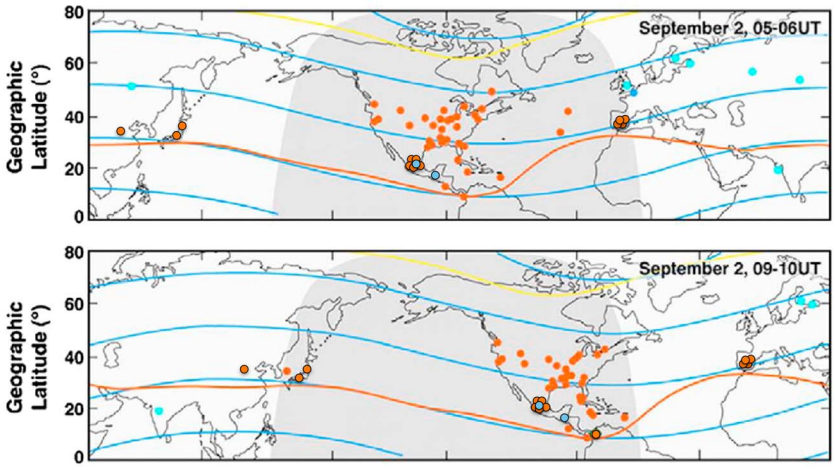

Figure 2. Geographic locations of reports of eyewitnesses auroral (orange dots) and magnetic (blue dots) observations of the great aurora on 2 September 1859. The plot indicates the night zone at the two different UTC times. Geomagnetic dipole latitude is shown as blue wavy lines with the yellow and orange lines the minimum and maximum extent of the auroral oval from Holzworth-Meng model, respectfully. The figure adapted from Green and Boardsen (2006) adds the sites in Mexico, Guatemala (Ribeiro et al., 2011), Colombia (Moreno Cárdenas et al., 2016), Spain Farrona et al. (2011), and East Asia (Hayakawa et al., 2016; https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5215858/figure/F2/).

Figure 2 adapts a diagram from Green and Boardsen (2006) incorporating the seven locations in Mexico from where the aurora was reported. The figure indicates the eyewitnesses auroral (orange dots) and magnetic (blue dots) observations on 2 September 1859. These Mexican observations of the effects of the Carrington Event complement the records in other countries (Green et al., 2006), such as Guatemala (Ribeiro et al., 2011), Colombia (Moreno Cárdenas et al., 2016), Spain (Farrona et al., 2011), Australia (Humble, 1860), and East Asia (Hayakawa et al., 2016) among others, confirming that this was a global event with planetary repercussions.

For additional context it is interesting to point out that the 1859 aurora event is not the only aurora documented in Mexico. Additionally, in the previous century (XVIII), on 14 November 1789, another aurora was observed over Mexico (Luna & Biro, 2017; Téllez-Nieto & Espinosa-Sánchez, 2009; Vázquez et al., 2006). This event in 1789 is better known to the historians because it was registered by several scientists of that time: Antonio de León y Gama, José Antonio Alzate, and José Francisco Dimas Rangel. They published a number of articles on the astronomical phenomenon in two magazines essential to the scholars of that epoch, the *Gazeta de literatura de Mexico* and the *Gazeta de Mexico*, and established a discussion that lasted almost 2 years on the characteristics of the northern lights (see Luna & Biro, 2017; Téllez-Nieto & Espinosa-Sánchez, 2009, and references therein). Besides, Vaquero et al. (2013) report a possible case of sporadic aurora in Mexico on 19 April 1843. We point out also that, to our knowledge, there are no reports in Mexico of the low-latitude red aurora registered in Asia in September 1770 (Ebihara et al., 2017; Hayakawa et al., 2017; Kataoka & Iwahashi, 2017; Nakazawa et al., 2004; Willis et al., 1996) nor for the aurora in October 1870 (Vaquero et al., 2008).

3. Conclusions

The civil war in Mexico did not prevent the registration in at least seven different sites of the red aurora on 2 September 1859, while we did not find reports for the aurora on 28 August 1859. Contemporaries wrote reports to the newspaper on the extraordinary event, showing a society interested in and amazed by this unusual natural phenomenon. There were also observations of oscillations of magnetic needles suggesting a strong magnetic disturbance, but we did not find reports of failures in the telegraph network. Unfortunately, because of the lack of financial support and the unstable political situation, there were no systematic (professional) astronomical or meteorological observatories in operation at that time (the Mexican National Astronomical Observatory was founded in 1878 (Biro, 2010), and the first magnetic observatory was installed in the National Palace in 1879). These aurora reports and magnetic observations in 1859 together with the papers of the 1789 aurora can be considered as the first space weather observations in the history of Mexico. It would take more than a century afterward to initiate the basis of the space physics studies in Mexico (Denardini et al., 2016) and eventually the creation of a space weather service (González-Esparza et al., 2017).

Appendix A: Transcription of Printed Documents in Old Spanish

Report of observations in Mexico City. J. Velázquez de León. "Aurora Boreal". La Sociedad newspaper, 1859-09-03, page 2, column 3, printing of J. M. Andrade and F. Escalante. *Original text in Spanish* (translation in modern English). *"Entre la una y las dos de la mañana de ayer el director y los alumnos de la clase de astronomía del Colegio Nacional de Minería presenciaron desde su observatorio el espléndido meteoro tan raro en presentarse a nuestra corta latitud, una aurora boreal, o con más propiedad, una aurora polar, ya que también en el polo austral se presenta este fenómeno. El cuarto cuadrante era ocupado desde el horizonte y a una altura como de 40 grados, 5 minutos antes de la una, de una hermosa nube blanca que parecía transparentar el color rojo extendido en todo el Noroeste, y dividiéndose después en diversos grupos y creciendo la intensidad del bello fondo, las nubes se presentaban bajo la forma de las cirrostratus a la una y 25 minutos, a cuya hora comenzaba ya a indicarse la tinta ligeramente roja hacia el horizonte del Nordeste; pero la nublazón oscura cubría todo lo demás de la bóveda celeste, invadiendo la parte más aparente del meteoro, que cubierta ya a las dos de la mañana, dejaba ver desde el zenit hacia el Oriente y el Sur, nubes de un rojo muy inferior en intensidad a las magníficas que se presentaron en el Noroeste"*. (Yesterday between 1:00 a.m. and 2:00 a.m., the director and students of the astronomy class at the Colegio Nacional de Minería witnessed a splendid atmospheric phenomenon that is rarely seen at our low latitudes: an aurora borealis, or more properly aurora polaris, since this phenomenon also occurs at the South Pole. At 5 min to 1, the northern lights occupied the fourth quadrant of the horizon at an altitude of some 40°. The witnesses reported seeing a beautiful white cloud, through which they saw the entire northwest sky reddened. It then divided into several clusters and and the beautiful background grew more intense. At 1:25, the clouds were cirrostratus, at which time a pale red color began to spread toward the northeast, but the rest of the sky was covered by cloud that moved over the brightest part of the northern lights. By 2:00 the aurora was all covered, and all that were visible were some red clouds extending from the zenith overhead toward the east and west, but their color was much less brilliant than the magnificent sight that had been visible earlier in the northwestern sky). *Report of observations in Querétaro*. Anonymous."La aurora boreal en Querétaro". La Sociedad newspaper, 1859-09-12, page 2, column 2, printing of J. M. Andrade and F. Escalante. *Original text in Spanish* (translation in modern English) "Como a las once y 40 minutos de la noche del 1 al 2 del actual comenzó a notarse hacia el Norte una claridad desusada, que poco a poco fue extendiéndose hacia el zenit, y de la misma manera hacia el Este y el Oeste del punto inicial y formando un círculo inmenso: a la una de la mañana del día 2 se extendía ya la luz rojiza hasta la constelación llamada vulgarmente las Siete cabrillas, que se veía dibujada sobre un fondo rojo, el que reflejaba sobre las paredes y torres de la ciudad, cuyas calles se presentaban harto iluminadas. Del indicado punto inicial al Norte, desprendíanse ráfagas blancas, no poco semejantes a las que se observan en el sol a su salida, de cuyas ráfagas eran las principales dos que se inclinaban una al Oriente y otra al Occidente, guardando todas una especie de oscilación que las hacía aparecer por intervalos, ora más extensas, ora más reducidas y menos visibles. Lo mismo debemos decir de la luz rojiza que se despedía del fenómeno, la cual era ya muy intensa, ya más débil y como desvanecida en la inmensa extensión del cielo que ocupaba, particularmente en la superficie exterior del arco. El brillo de las estrellas aparecía tanto más reluciente cuanto más alejadas se hallaban éstas del Norte. La noche no era extremadamente oscura, por la cercanía en que nos hallábamos del cuarto creciente de la luna. Las nubes que cubrieran el cielo en la tarde de aquel día, habían desaparecido casi completamente. El viento que corría era poco menos que insensible. El barómetro y el termómetro no presentaban variación sensible respecto del estado que habían guardado durante todo el día 1. Este fenómeno desapareció hasta estar próxima la salida del Sol del día 2." (At about 11:40 p.m. on the night of the first day of this month, an unusual light began to appear in the northern sky. It gradually spread overhead toward the zenith, and also toward the east and west, forming an immense circle. By 1:00 in the morning of the second day, the reddish light had spread toward the constellation commonly known as the Seven Goats (Pleiades). The light was seen against a background of red, which was reflected on the walls and towers of the city, illuminating the streets to a considerable degree. From the initial point where the light had appeared in the north, white streamers began to extend, not unlike those that can be observed radiating from the Sun at sunset. Of these, two main streamers stretched toward the east, and others toward the west, all of them at varying intervals, appearing now greater, now smaller, and less visible. The same must be said for the reddish light that was cast by the phenomenon, which was by turns now more intense, now weaker, and seemingly fade into the immense area of the sky that it occupied, particularly at the outer edges of the arc. The stars appeared to shine brighter the farther they were from the north. The night was not extremely dark, as the Moon was nearly in the first quarter. The clouds that had covered the sky that afternoon had almost completely disappeared. There was barely a breath of wind. Neither the barometer

nor the thermometer varied perceptibly from their readings during the entire day. The phenomenon did not disappear until night to sunrise in the morning of the second day).

Report of observations in Guadalajara. Anonymous."La aurora boreal". La Sociedad newspaper, 1859-09-17, page 2, column 4, printing of J. M. Andrade and F. Escalante. *Original text in Spanish* (translation in modern English). *"Se vio una aurora boreal en Guadalajara, entre las 11:00 y las 12:00 del 1 del actual, según dice el periódico El Exámen.* (An aurora borealis was seen in Guadalajara from 11:00 to 12:00 on the night of the first day of this month, reports were taken from the newspaper El Examen).

Report of observations in Zimapán (Hidalgo). I. Castelazo. "Descripción de la aurora boreal observada en el mineral de Zimapán en la noche del 1 y mañana del 2 de Septiembre de 1859". La Sociedad newspaper, 1859-09-28, page 2, columns 1-2, printing of J. M. Andrade and F. Escalante. *Original text in Spanish* (translation in modern English). "Quince minutos antes de las 11 de la noche del día 1 había, a 15 grados sobre el horizonte boreal, una nube negra y prolongada de Este a Oeste a una extensión de 30 grados a cada lado del Norte. De repente, el límite inferior de la nube se iluminó presentándose como una lis de plata en forma de arco de grande círculo, y de allí se desprendieron rayos luminosos hacia abajo como al encuentro de una luz roja que subía del horizonte boreal. La región toda del Norte se coloreó de carmín en una extensión de 75 grados a cada lado del punto Norte prolongándose más allá; pero desvanecida la luz hasta tocar los puntos de Este y Oeste. El foco de luz roja parecía fijo en el polo magnético y la mayor intensidad de la aurora se notó en el cuadrante N.O. Entre la luz roja que cubría el cielo y que había ascendido ya muy viva hasta Orión y las Pléyades trazando un arco paralelo al Ecuador que cortaría a los 70 grados al meridiano del lugar, se veían rayos de luz blanca que como ráfagas divergentes subían del horizonte boreal hacia el Ecuador, perdiéndose ya débiles en la parte desvanecida de la luz roja que ascendía casi imperceptible hasta el zenit. Tanto las ráfagas como la luz roja se encendían y opacaban por desiguales intervalos, y en estos cambios de intensidad se notaba más una pequeña oscilación que tenía de vez en cuando la aguja magnética. En las notas que hice de mi observación anoté por primer desvío 30 grados, pero sólo una vez, pues todos los demás no pasaron de 10 grados". (At 15 min before 11 on the night of the first day of the month, at 15° above the northern horizon, there was a long black cloud extending to the east and to the west 30° from north in both directions. Suddenly, the bottom edge of the cloud was illuminated, appearing as a silver lily in the shape of an arc of a great circle. From it, glowing rays extended downward as if to meet a red light that shone up from the northern horizon. The entire northern sky was colored carmine red in an arc extending 75° to each side of due north and fading toward the east and west. The middle of the red light seemed as though it were fixed in the direction of the magnetic pole, and the aurora seemed most intense in the northwest quadrant. Between the red light that covered the sky, rising brightly to Orion and the Pleiades in an arc parallel to the celestial equator and intersecting the meridian at 70°, there were rays of white light like streamers that fanned out from the northern horizon toward the celestial equator, fading at the faint edges of the red light and barely visible as they rose to the zenith. Both the streamers and the red light glowed brighter and diminished at irregular intervals, and a magnetized needle was observed to move slightly when these changes in intensity took place. In the notes I made of my observations I wrote down that the first deflection was 30°, but only once, for none of the others exceeded 10°).

Report of observations in Guanajuato. P. Septién. "La aurora boreal en Guanajuato". La Sociedad newspaper, 1859-10-24, page 1, columns 1, printing of J. M. Andrade and F. Escalante. *Original text in Spanish* (translation in modern English). *"Pío Septién de Guanajuato comunicó a la Sociedad Mexicana de Geografía y Estadística que la noche del 1 al 2 de septiembre se vio la aurora boreal en Guanajuato. Comenzó a manifestarse a las 11:30 y a la una estaba en todo su esplendor formando un arco de luz algo roja, despidiendo ráfagas e iluminando*. (In a communication to the Mexican Society of Geography and Statistics, Pío Septién of Guanajuato reported that on the night of 1–2 September, the aurora borealis was seen in Guanajuato. It began at 11:30 and by 1:00 it was visible in all its splendor forming a reddish arc of light, emitting streamers, and illuminating half the sky).

Report of observations in Michoacán. Luis González y González (2004), Pueblo en vilo, page 15, Fondo de Cultura Económica, México. *Original text in Spanish* (translation in modern English) "Mientras los franceses desembarcaban en Veracrúz, los rancheros de la hacienda sólo hablaban de fraccionamiento y de la aurora boreal. Para este millar y medio de mexicanos que vivían al margen de la vida del país y muy adentro de la naturaleza, una aurora boreal importaba más que cien intervenciones forasteras. En el otoño de 1789 había habido otra, y lo sabían los vecinos, aunque ninguno la hubiera visto. Esta de 1861, comparada con lo que se decía de aquella, no fue menos maravillosa y tremebunda. Se vio en las madrugadas, al final del año, hacia el norte. Distaba

mucho de ser la luz sonrosada que precede inmediatamente a la salida del sol. Las danzantes luminiscencias vistas en el cielo se asemejaban a la lumbre emanada de lugares con tesoros ocultos, pero su enormidad infundía zozobra. Era como si se hubieran juntado a bailar todos los fuegos. Aquello parecía un combate en el que san Miguel y sus ángeles arrojaban rayos, centellas y bolas de lumbre, contra el ejército de los demonios."

(Luis González y González, the eminent historian who wrote the book "Pueblo en vilo" on the history of San José de Gracia, Michoacán', stated that one of the events that made a great impression on the collective memory of the town was the aurora borealis. It must be noted that González y González situated the event in 1861; nevertheless, there is no record of it in newspapers of that year. Even so, an error of only 2 years is surprising. On page 15 of his book he writes "While the French were disembarking in Veracruz, the ranchers on the estates spoke of nothing but the division of landholdings and of the aurora borealis. For the fifteen hundred Mexicans living close to nature far from the center of the country's affairs, an aurora borealis mattered more to them than a hundred foreign interventions. In the autumn of 1789 there had been another one, and the residents knew about it, although none of them had seen it. The 1861 aurora, compared with what was said of the previous one, was no less wonderful and awesome. It was seen in the early morning, at the close of the year, towards the north. It was very different from the rosy light of dawn that is seen just before sunrise. The display of dancing luminescences seen in the sky resembled flames shooting from such places as guard hidden treasures, but its vastness was overwhelming. It was as if all the fires had joined to dance together. It seemed as though it were a battle in which St. Michael and all his angels were casting rays of lightning and balls of fire at an army of demons.")

Report of observations in San Luis Potosí. Cabrera, F (1872). "Aurora Boreal. Informe presentado a la Junta Auxiliar de San Luis Potosí". Boletín de la Sociedad de Geografía y Estadística, Segunda Época, vol IV, p.369. *Original text in Spanish* (translation in modern English) "Al volver de una visita, el domingo 4 de Febrero, poco antes de las seis de la tarde, me llamó la atención una luz muy intensa que se veía en el horizonte, por el rumbo Norte. Observé con cuidado y noté que no era la crepuscular ni la zodiacal y que su color, así como las ráfagas en forma de abanico que se veían en aquel momento eran parecidas a la de la hermosa aurora boreal que en Septiembre de 1859 había observado por primera vez en mi vida, y sobre la cual escribí una teoría electro-química que mereció la aprobación de don Ignacio Ramírez (actual presidente de nuestra sociedad en México) a quien tuve entonces la honra de presentarla porque se encontraba accidentalmente en esta capital (San Luis Potosí)"

(Returning from a visit on Sunday, 4 February, shortly before 6:00 in the afternoon, my attention was drawn by an intense light that was visible along the northern horizon. I observed carefully and was able to determine that it was neither the twilight nor the zodiacal light. Its color and the fan-shaped bursts also visible at the time were similar to the beautiful aurora borealis that I had observed for the first time in my life in September 1859, and on which I had written an electro-chemical theory that earned the approval of Don Ignacio Ramírez [current president of our society in Mexico] to whom I then had the honor of presenting my theory, as he happened to be here in the capital city [San Luis Potosí]).

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