

Researchers simulate 1770 magnetic storm using data from historical documentation

October 4 2017



The painting of the red aurora of Sept. 17 1770 in the premodern Japanese text "Seikai," which is owned by the Matsusaka City Museum of History and Traditional Crafts. A radial structure of stripes is shown, comprising small-scale rays inside the stripes. The bottom section and eastern/western edges of the stripes are somewhat darkened. The caption on the right-hand side may be translated as follows, "On 17 September 1770, at night, red vapor was active at

northern sky. The figure was as it watched at midnight." Credit: Matsusaka City, Mie Prefecture

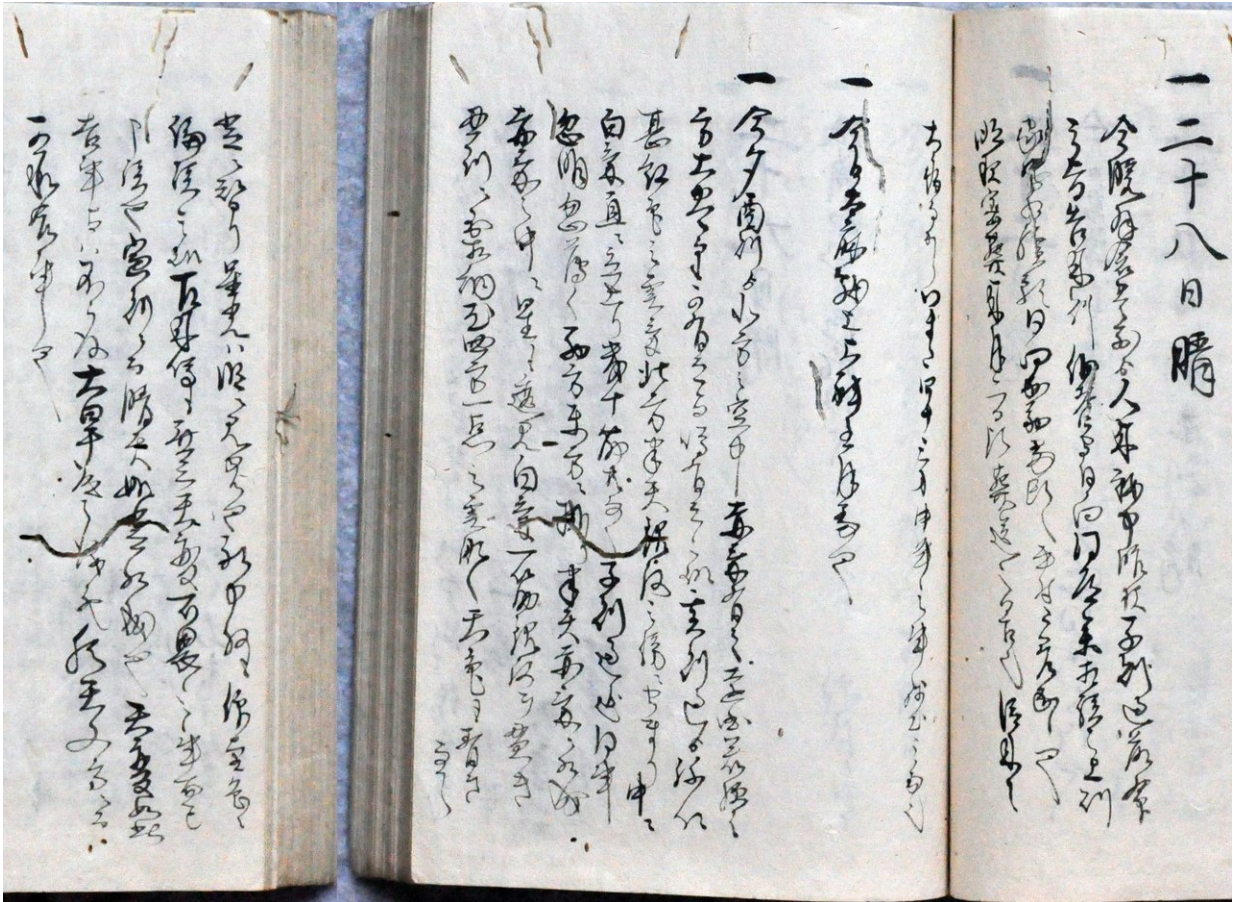
Auroras are light shows that typically occur at high latitudes such as the Arctic and Antarctic; however, they can expand toward the equator during severe magnetic storms. Past observations of such unusual auroras can therefore allow researchers to determine the frequency and severity of magnetic storms. The more information that can be gathered about historically intense magnetic storms, the greater the opportunity to mitigate disruption of power grids in a future event.

Historical documents are becoming much more accessible for research as newly discovered records surface from private collections around the world. Researchers at Tokyo's National Institute of Japanese Literature (NIJL) and National Institute for Polar Research (NIPR) examined a detailed painting from a Japanese manuscript *Seikai* ("Understanding Comets") with associated commentary describing a red [aurora](#) occurring over Kyoto on 17 September 1770. They also investigated detailed descriptions of the event from a newly discovered diary of the Higashi-Hakura family of Kyoto.

"The enthusiasm and dedication of amateur astronomers in the past provides us an exciting opportunity," Kiyomi Iwahashi of NIJL says. "The diary was written by a kokugakusha [scholar of ancient Japanese culture], and provides a sophisticated description of the red aurora, including a description of the position of the aurora relative to the Milky Way."

Using astrometric calculations of the elevations of the Milky Way as it would have been viewed from Kyoto on 17 September 1770, the researchers were able to calculate the geometry of the red aurora and

check the results against the details from the *Seikai* painting and the diary. The description of the aurora according to the historical documents allowed the researchers to estimate the strength of the magnetic storm that caused the September 1770 aurora.



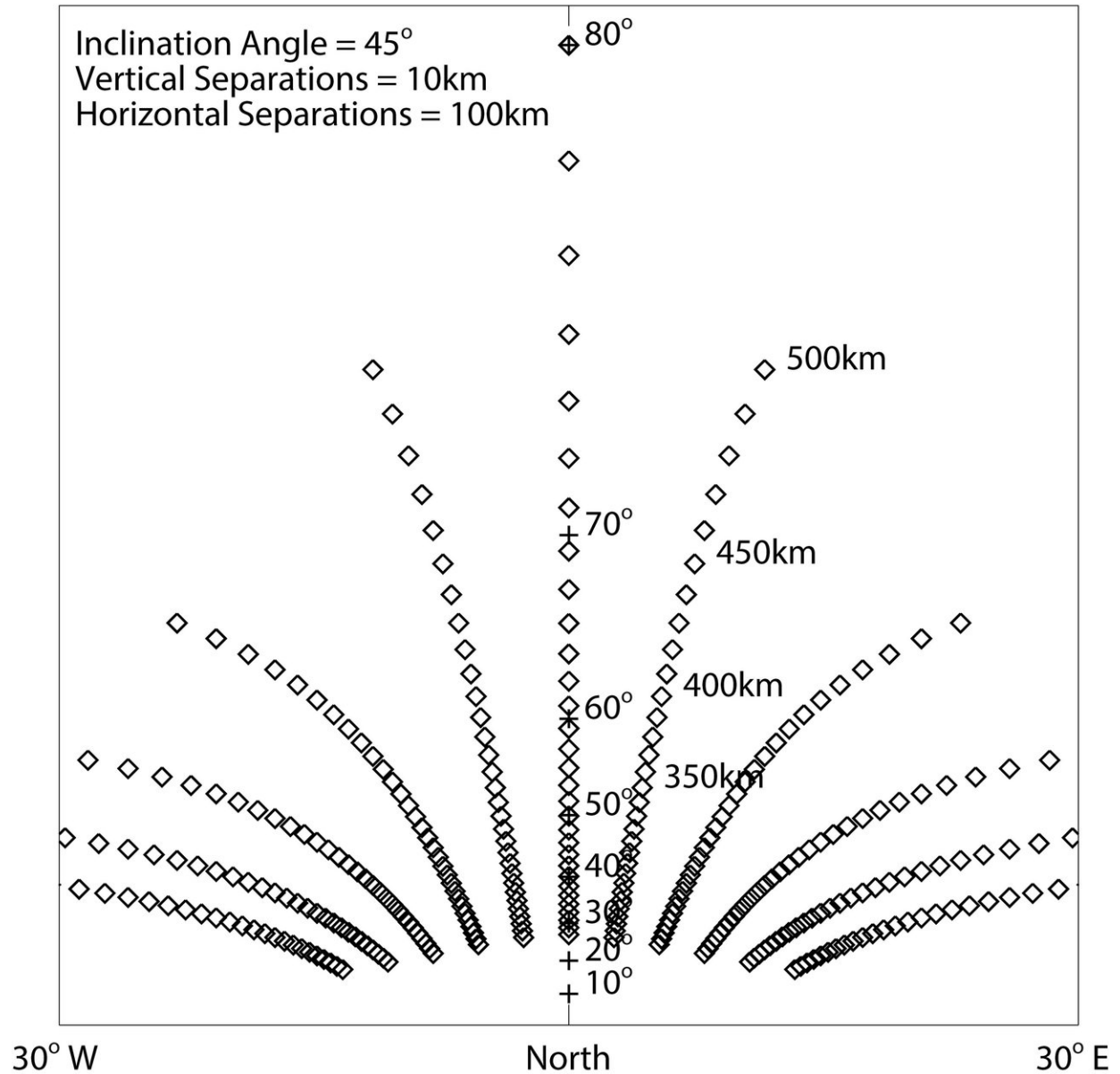
The diary of the Higashi-Hakura family (page 86a-b, call number B2-164), which is owned by the Azumamaro Jinja in Kyoto. The appearance of the zenith aurora over Kyoto on Sept. 17 1770, is described in detail with references to the position of the Milky Way. Credit: Azumamaro Jinja

"The magnetic storm on 17 September 1770 was comparable with or

slightly larger than the September 1859 magnetic storm that occurred under the influence of the Carrington solar flare. The 1859 storm was the largest magnetic storm on record in which technological effects were widely observed," says Ryuhō Kataoka of NIPR. "It was lucky for us that the 1770 storm predated our reliance on electricity."

So how likely are such magnetic storms? "We are currently within a period of decreasing solar activity, which may spell the end for severe magnetic storms in the near future," Kataoka says. "However, we actually witnessed an extremely fast coronal mass ejection only several days ago [10 September 2017], which might be powerful enough to cause extreme storms. Fortunately, it just missed the Earth."

Regardless of the specific likelihood of another perfect magnetic [storm](#), interdisciplinary historical and scientific collaborations are invaluable in providing important physical details that could help us to understand the greatest [magnetic storms](#) in history and prepare for any potential future event.



The geometry of the auroral appearance as seen from Kyoto on Sept. 17 1770, is calculated for its reconstruction. Diamonds show the positions of the red aurora tangentially mapped to the flat plane of the 60 by 80 field-of-view, plotted every 100 km in east-west direction and every 10 km in vertical direction. The main body of the emissions is assumed to be in the range of 200 km to 500 km, with an inclination angle of 45 along the local magnetic field. Elevation angles are shown by angle markings on the vertical axis with plus signs. Credit: Kataoka R and Iwahashi K, Space Weather, 2017

More information: Ryuho Kataoka et al, Inclined zenith aurora over Kyoto on 17 September 1770: Graphical evidence of extreme magnetic storm, *Space Weather* (2017). [DOI: 10.1002/2017SW001690](https://doi.org/10.1002/2017SW001690)

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