

Development of sprite streamers and preceding halos and elves observed in NHK Cosmic Shore Campaign

Y. Takahashi¹, Y. Sanmiya¹, M. Sato¹, T. Kudo¹, N. Kobayashi¹, T. Yamada¹, Y. Shima¹,
NHK Cosmic Shore Project², H. C. Stenbaek-Nielsen³,
M. G. McHarg⁴, T. Kanmae³, R. Haaland³, Y. Yair⁵, W. Lyons⁶, S. A. Cummer⁷

¹*Department of CosmoSciences, Hokkaido University, Japan*

²*NHK, Japan Broadcasting Corporation, Tokyo, Japan*

³*Geophysical Institute, University of Alaska Fairbanks, Alaska, U.S.A.*

⁴*US Airforce Academy, Colorado, U.S.A.*

⁵*Department of Life and Natural Sciences, The Open University of Israel, Israel*

⁶*FMA Research, Fort Collins, Colorado, U.S.A.*

⁷*Electrical and Computer Engineering Department, Duke University, North Carolina, U.S.A.*

In the TLEs observation campaign supported by NHK special TV program “Cosmic Shore” was conducted both in summer in US and in winter in Japan. High-speed and color EM-CCD cameras onboard chartered jet airplane(s) captured temporally and spatially resolved images. In the summer campaign stereo imaging was succeeded for more than 10 TLE events. Based on the detail analysis of such dataset, we may investigate the development of fine streamers for the first time. The captured events show inhomogenous structures in halo before being accompanied by streamers. This result would be an important hint in considering the generation mechanism of streamers. In the winter campaign, an elves event shows wavy structures inside the luminous region that could be made by atmospheric gravity waves.

1. NHK Cosmic Shore Campaign

In the period of June 27 - July 10, 2011, a combined aircraft and ground-based campaign, in support of NHK Cosmic Shore project, was carried with two jet airplanes under collaboration between NHK, Japan Broadcasting Corporation, and universities. On 8 nights out of 16 standing-by, the jets took off from the airport near Denver, Colorado, and an airborne high speed camera captured over 60 TLE events at a frame rate of 8000-10,000 /sec. Also in the period of November 28 – December 4, 2010, a wintertime campaign is conducted. On 2 nights we got some very fine high-speed and/or EM-CCD color images of elves and sprites.

2. Relationship between halo/elves and streamers

The relationship between diffuse glows such as elves and sprite halos, and subsequent discrete structure of sprite streamers is considered to have a key to solve the generation mechanism of streamers. However, it's not easy to image at high frame rate both the diffuse and discrete structures simultaneously, since it requires high sensitivity, high spatial resolution and high signal-to-noise ratio. To capture the real spatial structure of TLEs without influence of atmospheric absorption, aircraft would

be one of the best solutions. The aircraft can approach thunderstorm up to a few hundred km or less to image TLEs with high spatial resolution and can carry heavy high-speed cameras with huge size data memories.

3. Latest results of the campaign

Here we introduce the latest analysis of a very complicated time development of sprite streamers and its relationship to the structures of preceding halos and elves. In most cases the halo and elves seem to show inhomogenous structures before being accompanied by streamers, which suggests a mechanism to cause the large variation of sprite features. Also the wavy structure found in the elves may reflect the electron density in the bottom region of the ionosphere.