

HALOS: A SOLUTION TO THE SPRITE POLARITY PARADOX

EARLE WILLIAMS 1, József Bór 2, Cheng-Ling Kuo 3,5, Gabriella Sători 2, Robert Boldi 4, A. B. Chen 3, 6, Eric Downes 1, R.R. Hsu 3, 6, 7, Walter A. Lyons 8, M. M. F. Saba 9, and H.T. Su 3, 7

1. Parsons Laboratory, Massachusetts Institute of Technology, Cambridge, USA
2. Geodetic and Geophysical Research Institute, HAS, Sopron, Hungary
3. Department of Physics, National Cheng Kung University, Tainan, Taiwan
4. University of Alabama, Huntsville, USA
5. Institute of Space Science, National Central University, National Cheng Kung University, Tainan, Taiwan
6. Institute of Space, Astrophysical and Plasma Sciences, National Cheng Kung University, Tainan, Taiwan
7. Earth Dynamic System Research Center, National Cheng Kung University, Tainan, Taiwan
8. FMA Research, Inc., Fort Collins, Colorado, USA
9. National Institute for Space Research, São José dos Campos, Brazil

C.T.R. Wilson's explanation for sprite initiation in the mesosphere by lightning in the troposphere is independent of the polarity of the parent lightning. Yet in thousands of published ground-based observations of sprites, only three have been clearly associated with ground flashes with negative polarity. This finding is however inconsistent with ELF measurements of charge moments, showing that typically 10% of supercritical values are negative in polarity. ISUAL satellite measurements in the Earth's limb have exposed a population of halos that is a substantially larger fraction of total TLEs (sprites+halos) than in the earlier ground-based measurements. ELF measurements from Nagycenk, Hungary for more than one hundreds ISUAL-identified halos show a predominant negative polarity in the parent lightning with a range of charge moments from 300-1200 C-km. Halo brightness measured by ISUAL is positively correlated with the vertical charge moment, consistent with theoretical predictions based on impact excitation of nitrogen for halo production. The polarity asymmetry in TLE production by positive and negative ground flashes appears to resolve the original sprite polarity paradox. The physical reasons for the differences in positive and negative flashes deserve further clarification.

halo, brightness, charge moment

Earle Williams, Parsons Laboratory, Massachusetts Institute of Technology, Cambridge, Massachusetts, USA, earlew@ll.mit.edu