

Results From the MEIDEX Sprite Campaign on Board the Space Shuttle Columbia

C. Price¹, Y. Yair², P. Israelevich¹, E. Greenberg¹, Z. Levin¹, J.H. Joseph¹, G. Satori³,
J. Bór³, H. Fukunishi⁴, M. Sato^{4,5}, M. Moalem⁶, A. Devir¹, I. Mayo¹, B. Ziv³

¹ *Department of Geophysics and Planetary Science, Tel Aviv University, Israel*

² *Department of Life and Natural Sciences, Open University of Israel, Israel*

³ *Geodetic and Geophysical Research Institute, Hungarian Academy of Sciences, Sopron, Hungary*

⁴ *Department of Geophysics, Tohoku University, Sendai, Japan*

⁵ *Now at RIKEN (The Institute of Physical and Chemical Research), Wako, Japan*

⁵ *Space Branch, Israeli Air Force, Tel Aviv, Israel*

Abstract. In January 2003, sprites and ELVES were observed by the astronauts on board the space shuttle Columbia flight STS-107, during the Mediterranean Israeli Dust Experiment (MEIDEX). This was the first time such calibrated measurements have been obtained from space. During the STS-107 mission less than 10 hours of sprite observations were allocated to the MEIDEX team, with 7.5 hours of data down-linked during the flight, and therefore not lost in the tragic end of the Columbia flight. A total of 14 sprites and ELVES were observed during the allocated time windows. The MEIDEX images clearly distinguished between two types of ELVES: the classic, donut-shaped ELVES, and the thin, arch-shaped ELVES with no hole. The second type was attributed to IC flashes, a fact confirmed by the latest images from the ISUAL sensor on board the ROCSAT-2 satellite. During the space shuttle flight, ELF electromagnetic data at four ground stations (Israel, Hungary, Japan and Antarctica) were collected to geo-locate and determine the parameters of the parent lightning that triggered the TLEs. From our analysis, ELF transients were detected for 5 of 7 ELVES at all ground stations with accurate geo-location of these events. However, *none* of the sprites were associated with ELF transients. This is contrary to the present theories of TLE formation, and may require some new thinking into the mechanisms that produce sprites and ELVES. Since ELF transients in the earth-ionosphere cavity are primarily generated by cloud-to-ground (CG) lightning, is it possible that the sprites observed by the astronauts were produced by intracloud lightning? Is it possible that if CG discharges did produce the sprites, they were too weak to produce ELF transients at any of the four stations? It is generally believed that sprites are triggered by the most intense CG discharges. We estimate that if this is the case, the discharges had charge moments less than 100 Ckm. However, the lack of ELF signals for these events implies there may be many more sprites out there than previously believed, caused by weaker, more frequent CGs. In addition to the well-known forms of TLEs, the MEIDEX data showed a unique observation of what was termed "Transient Ionospheric Glow Emission in Red" (TIGER). This flash was delayed 0.23 seconds from a preceding visual lightning flash which was horizontally displaced > 1000 km from it, far exceeding all known lightning-TLE spatial and temporal relations.