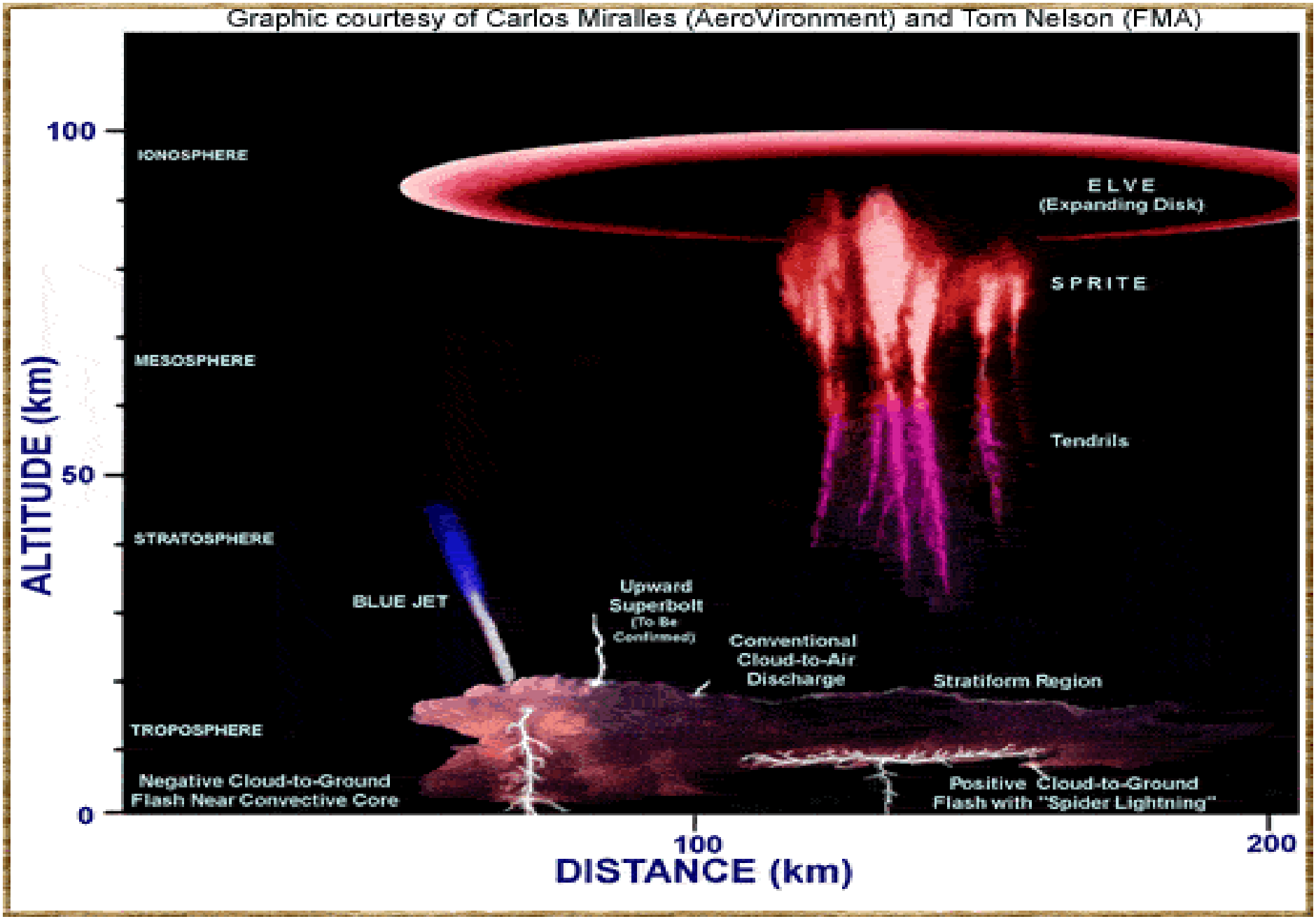
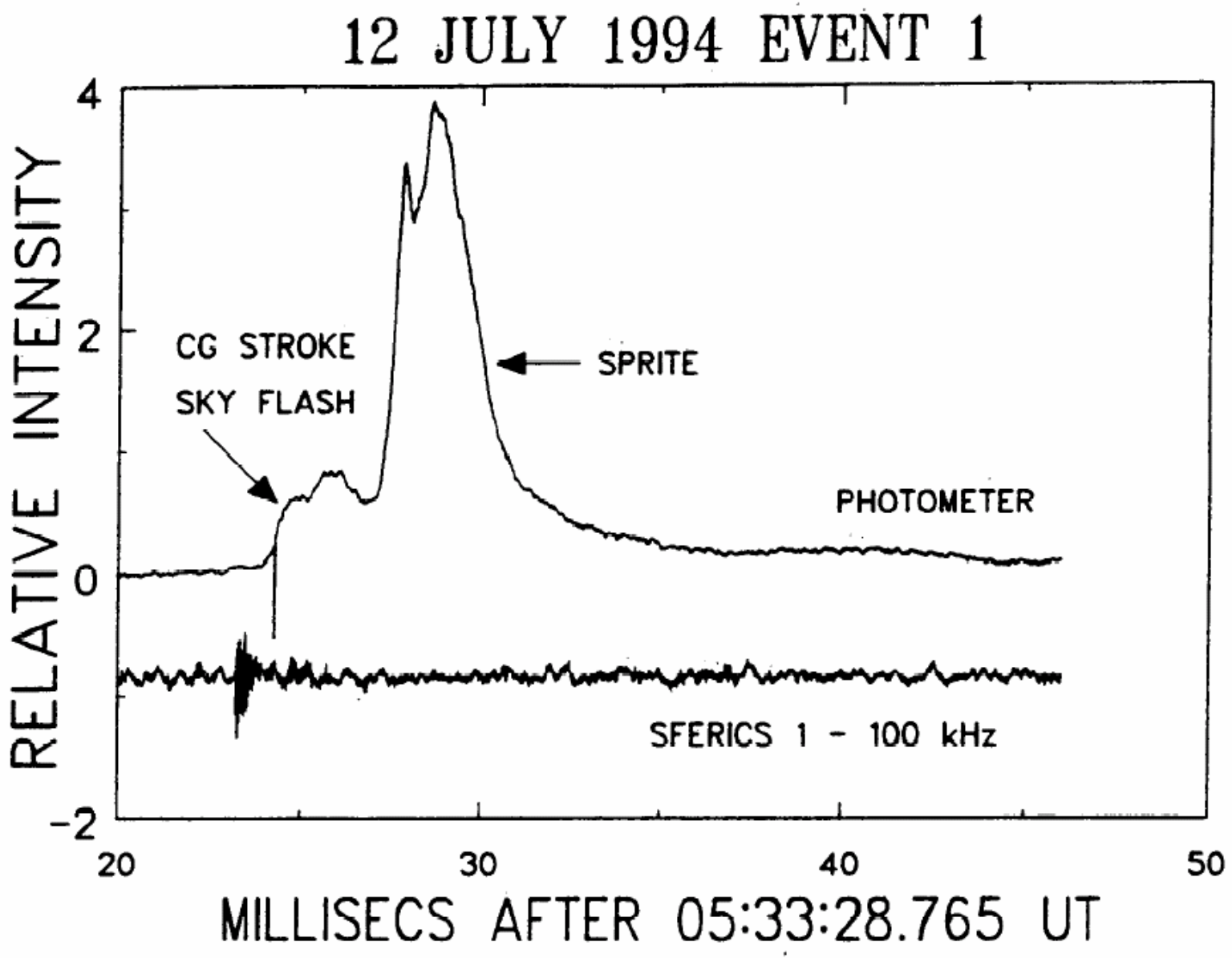
Intro to TLEs

- TLE: Transient Luminous Events
- See ISS video: http://www.esa.int/esaCP/SEM4HV4Y3EE_index_1.html
- Sprites, Jets, Elves, Halos …
- Current Experiments: RHESSI, Fermi TGFs


Graphic courtesy of Carlos Miralles (AeroVironment) and Tom Nelson (FMA)
100
50
0
ALTITUDE (km)
IONOSPHERE
MESOSPHERE
STRATOSPHERE
TROPOSPHERE
ELVE
(Expanding Disk)
SPRITE
Tendrils
BLUE JET
Upward
Superbolt
(To Be
Confirmed)
Conventional
Cloud-to-Air
Discharge
Stratiform Region
Negative Cloud-to-Ground
Flash Near Convective Core
Positive Cloud-to-Ground
Flash with "Spider Lightning"
100
200
DISTANCE (km)

Winckler, et al



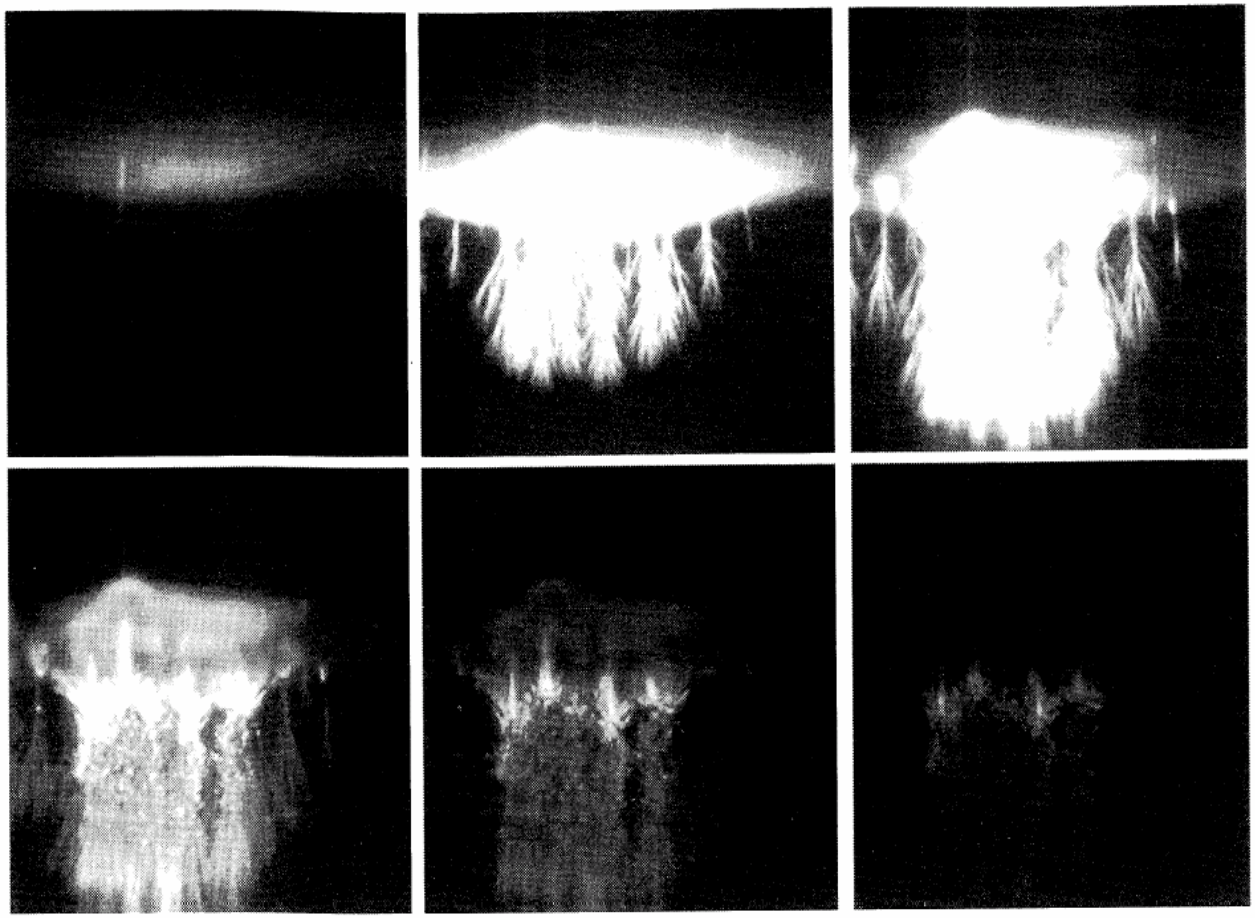


Figure 1. 6 high-speed images, each 1 ms apart, of a large sprite 06:15:07.67 UT on 18 August 1999. The examp illustrates some of the typical sprite features: The large horizontal, fairly featureless structure prominent in the two fi images is the sprite halo. It often precedes the sprite event. The sprite then develops from an altitude near that of the ha with tendrils going down and branches going up. In this example most of the activity is in the tendrils.

Hardman, et al, GRL, 2000

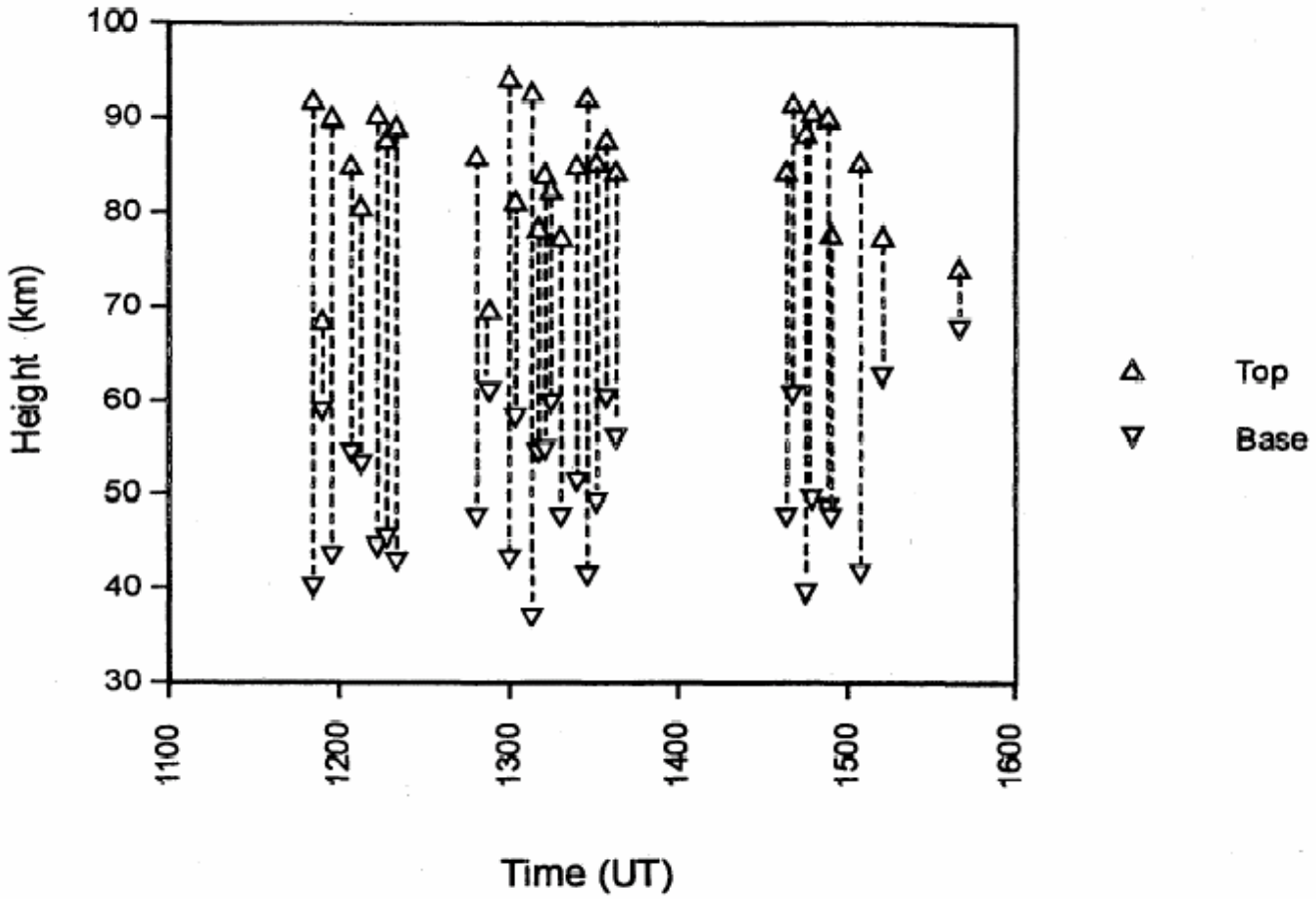
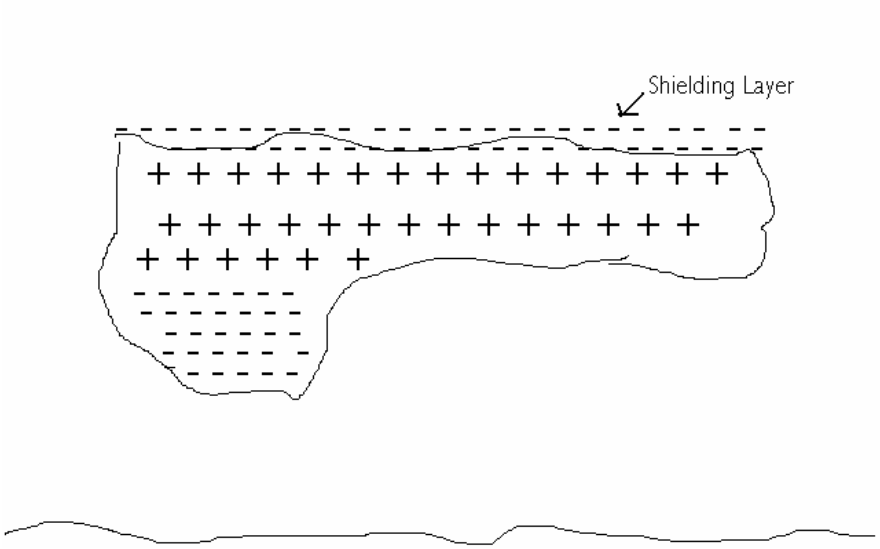
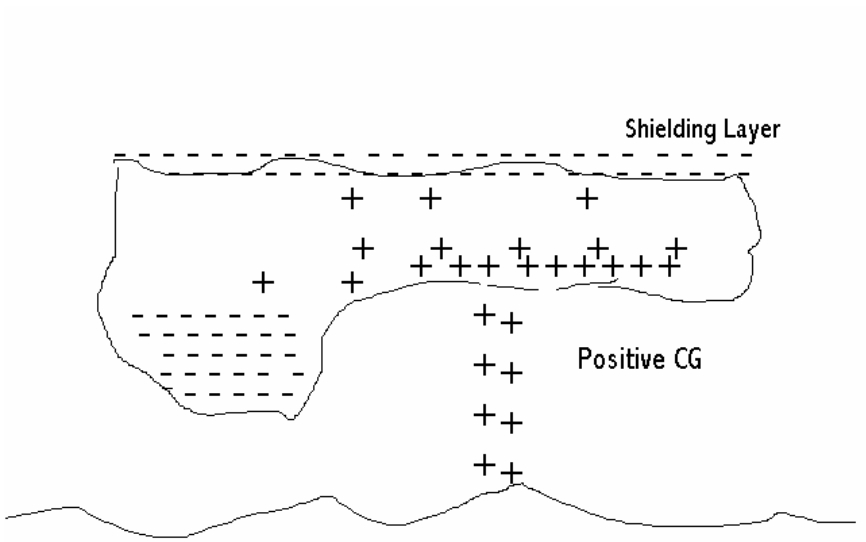


Figure 7. Heights of the lowest (base) and highest (top) visible portions of sprites observed on November 26.

The Quasi-Electrostatic Field Model

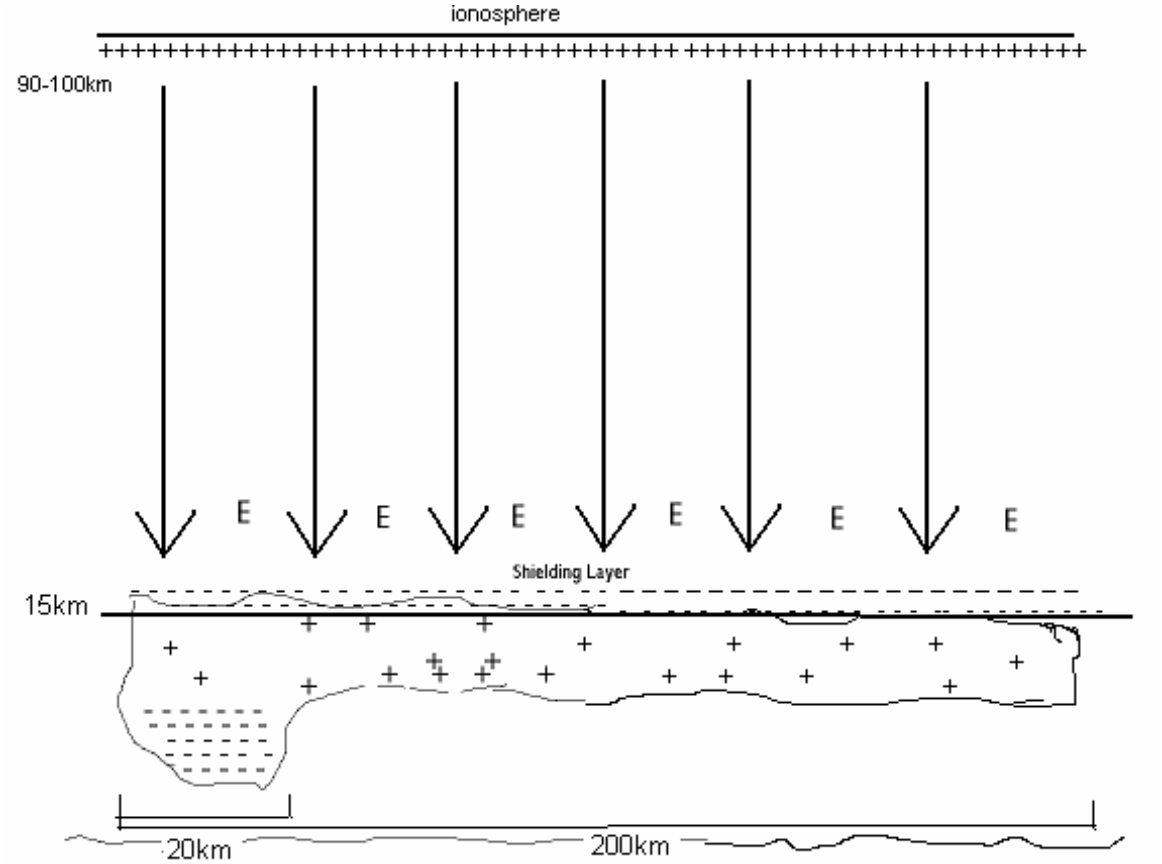


1. The cloud charges up before the lightning discharge inducing a negative shielding layer



2. The positive CG removes positive charge but the negative shielding layer remains over a much longer time scale

The Quasi-Electrostatic Field



3. The negative shielding layer remains after the discharge causing polarization in the atmosphere and a quasi-static E-field. This can me likened to a giant parallel plate capacitor as shown above. This strong E-field causes electrical breakdown producing sprites.

Problems with the models, as shown by Cummer & Stanley:

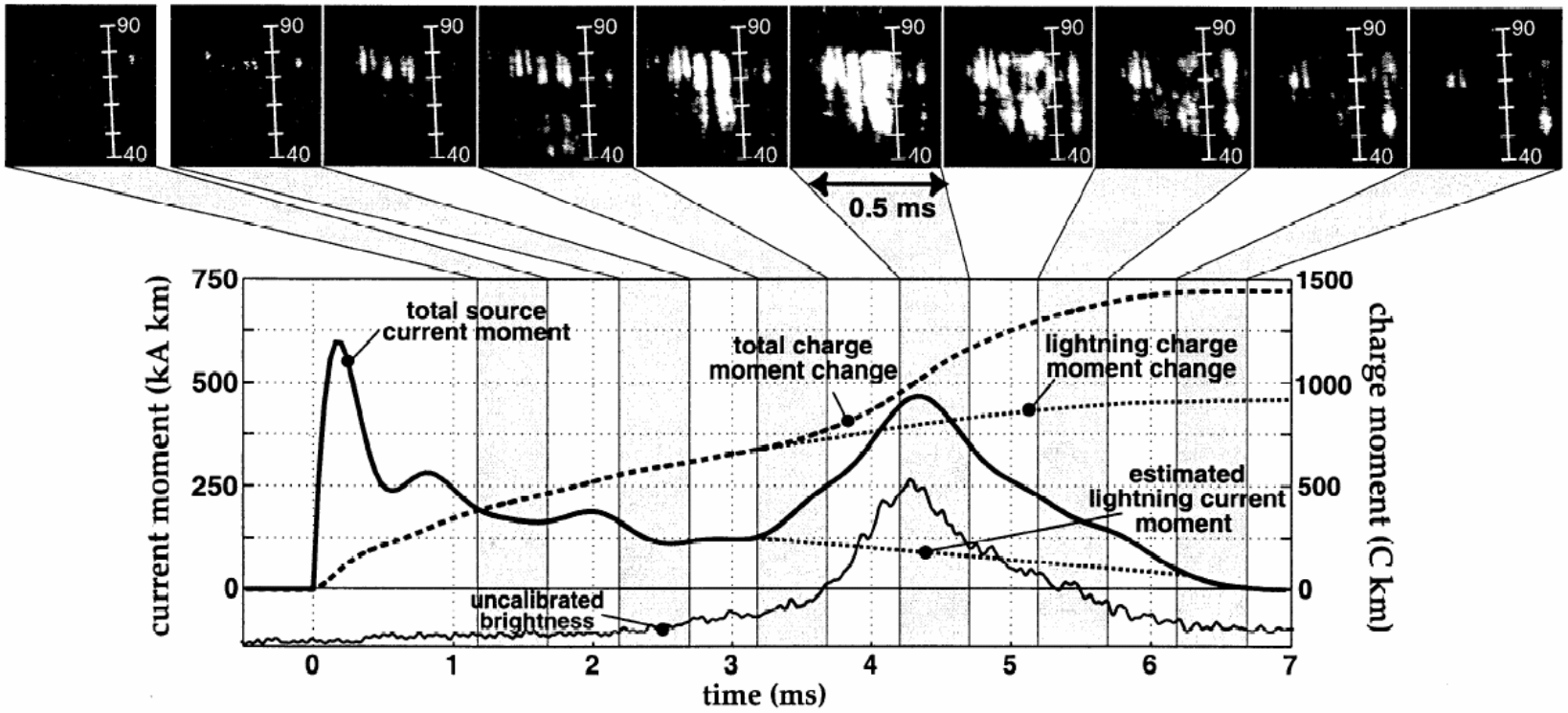


Figure 1. Time-aligned high speed video images, photometer-observed brightness, lightning and sprite current moment waveform, and cumulative charge moment change from a sprite cluster on 6 Oct 1997, 04:45:59.10691 UT. The contrast of the first two images is enhanced to highlight the optical emissions.

Cummer and Stanley, GRL, 99

The data (previous slide) show that vertical charge moment changes of 800 – 1100 CKm in 2 – 4 ms are associated with sustained emissions at altitudes as low as 50 km. This is a factor of 2 to 10 times smaller than the vertical lightning charge moment changes required to produce runaway and conventional breakdown at 50 km, respectively.

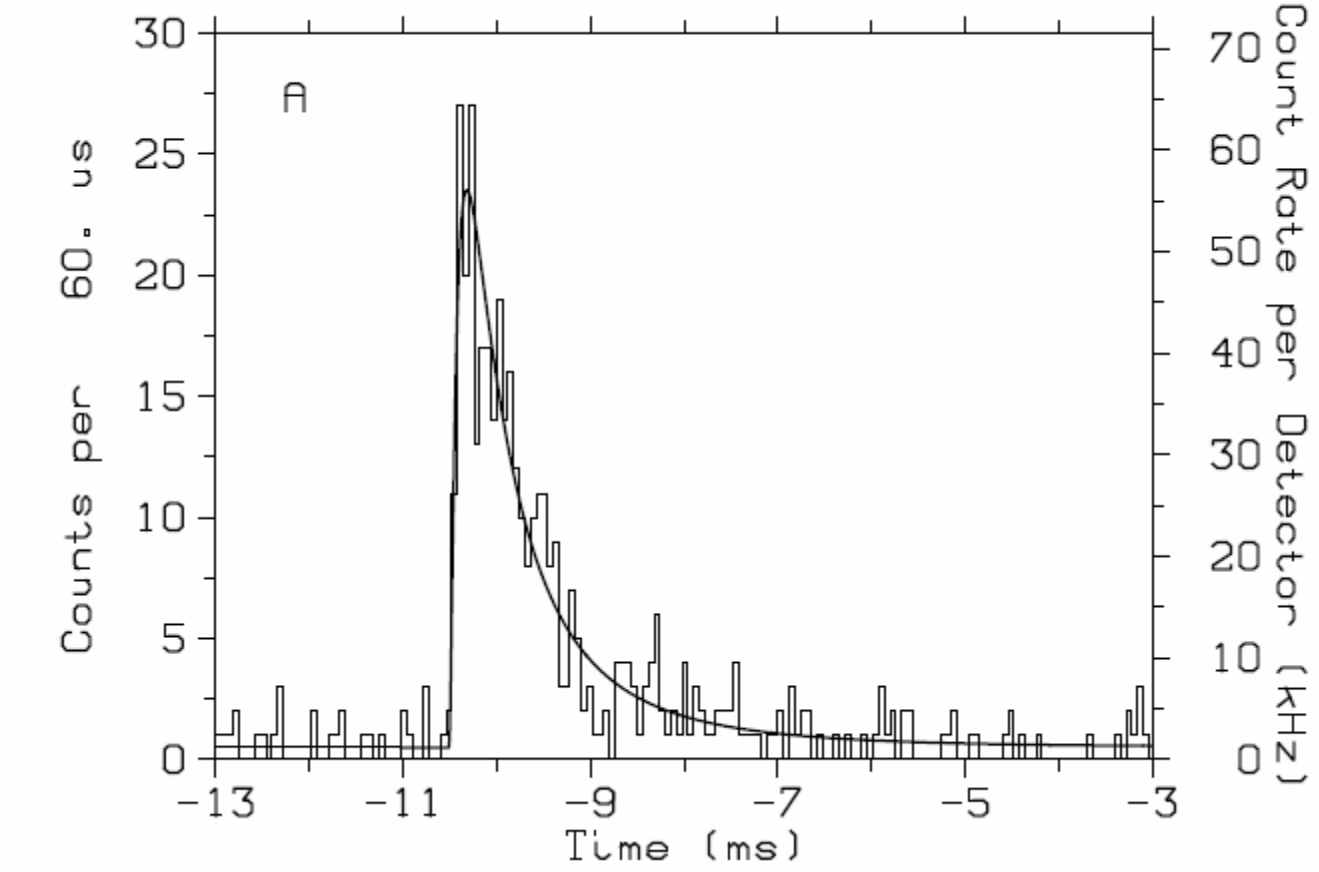
These observations are consistent with the generation of significant mesospheric electric fields by horizontal currents in some sprites, but we cannot rule out other processes as the explanation for the observations

(Cummer et al, 1999)

TGFs (Terrestrial Gamma Flashes)

- TGF examples
- Antimatter In lightning

http://www.sciencenews.org/view/generic/id/49288/title/Signature_of_antimatter_detected_in_lightning



Fermi satellite, looking for gamma ray bursts, finds extremely intense bursts from the Earth. WWLLN shows they are associated with Lightning