

**Passage I**

Transient luminous events (TLEs) are brief flashes of light that appear above large thunderstorm clouds. A TLE is produced by a positive cloud-to-ground (+CG) lightning stroke. However, not every +CG lightning stroke is followed by a TLE. Figure 1 shows the typical shape, width, and altitudes of 3 types of TLEs—red sprites, blue jets, and elves. Table 1 shows the typical duration (in milliseconds, msec) and brightness (in kiloRayleighs, kR) of each type of TLE. Figure 2 shows the number of +CG lightning strokes of a given peak electrical current (in kiloamperes, kA) from 6 thunderstorms and the percent of those +CG lightning strokes that produced a TLE.

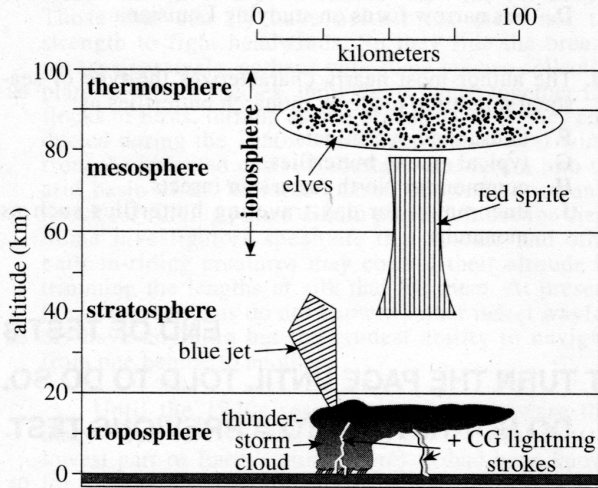


Figure 1

Type of TLE	Duration (msec)	Average brightness (kR)
Red sprite	10–100	10
Blue jet	100–300	800
Elves	< 1	1,000

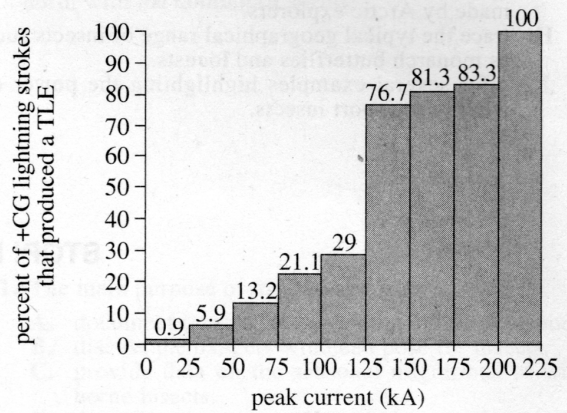
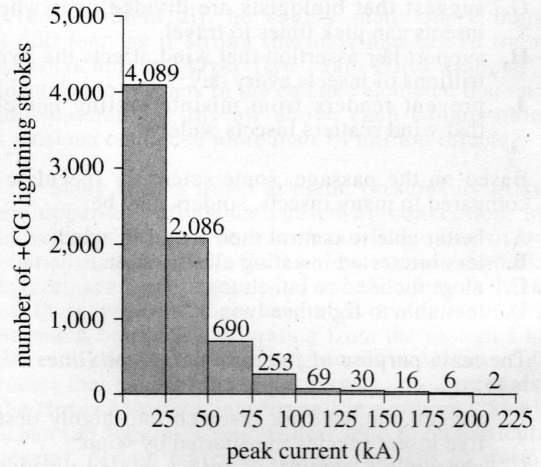


Figure 2

Figure 1 adapted from W. Lyons, R. J. Vavrek, and R. Holle, "Mysterious Flashes: Red Sprites–Blue Jets–Elves." ©2000 by the National Earth Science Teachers Association.

Figure 2 adapted from W. Lyons et al., "Characteristics of Thunderstorms and Lightning Flashes Which Produce Mesospheric Transient Luminous Events." ©1999 by the National Aeronautics and Space Administration.

1. Figure 1 defines the ionosphere as a region of the atmosphere that overlaps which of the following atmospheric layers?

- I. Mesosphere
- II. Stratosphere
- III. Troposphere

- A. II only
- B. III only
- C. I and II only
- D. II and III only

2. A flash was observed above a large thunderstorm cloud. The flash had a duration of 100 msec and an altitude between 50 km and 80 km. Based on Figure 1 and Table 1, that flash was most likely which of the following?

- F. A red sprite
- G. A blue jet
- H. Elves
- J. A +CG lightning stroke

3. According to Figure 2, the percent of +CG lightning strokes that produced a TLE more than doubled between which of the following 2 peak current ranges?

- A. Between 75–100 kA and 100–125 kA
- B. Between 100–125 kA and 125–150 kA
- C. Between 125–150 kA and 150–175 kA
- D. Between 175–200 kA and 200–225 kA

4. According to Figure 2, the probability that a TLE will follow a +CG lightning stroke is highest for which of the following ranges of peak currents?

- F. 25 kA to 50 kA
- G. 75 kA to 100 kA
- H. 125 kA to 150 kA
- J. 175 kA to 200 kA

5. Based on Figure 2, TLEs were produced by approximately what fraction of +CG lightning strokes with peak currents between 75 kA and 100 kA ?

- A.  $\frac{1}{2}$
- B.  $\frac{1}{3}$
- C.  $\frac{1}{4}$
- D.  $\frac{1}{5}$