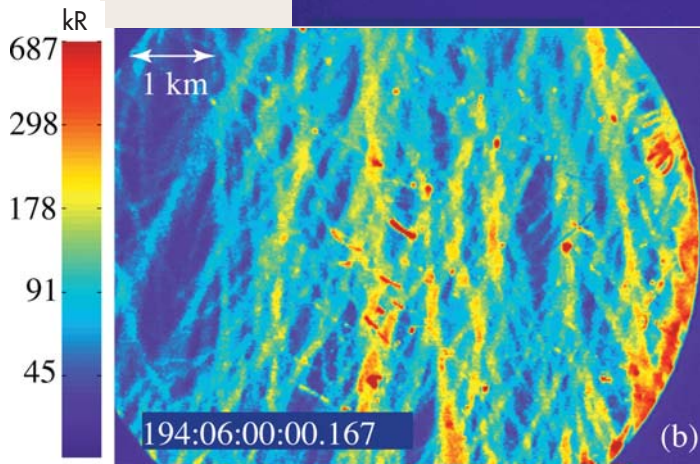
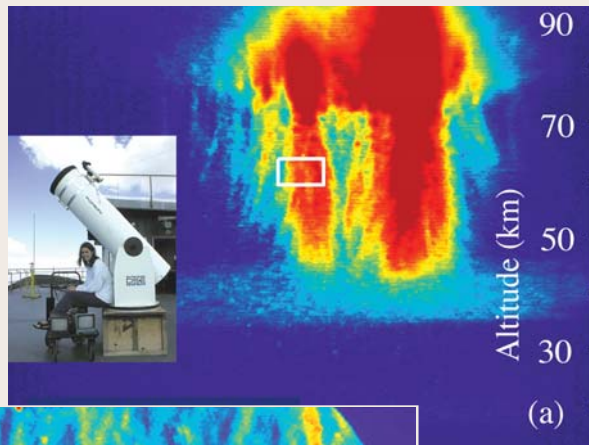


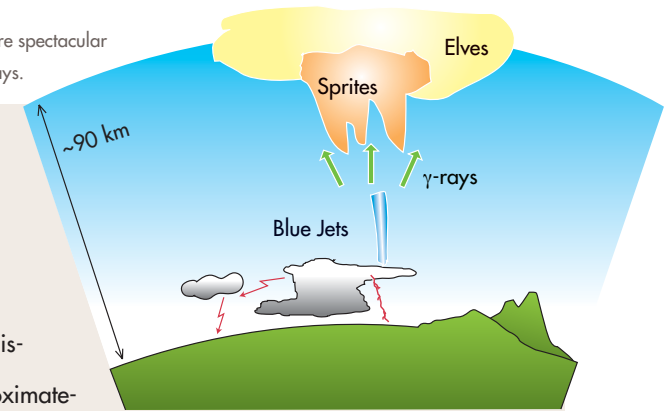
# UPWARD LIGHTNING

## SEEKING THE ELUSIVE SPRITES AND ELVES

Telescopic imaging of sprites. Top: The 16-inch wide Dobsonian telescope was used together with a wide-field-of-view camera mounted on its top. The wide field of view image shows a large, apparently amorphous, sprite in the shape of an "angel" observed on July 13, 1998. The field-of-view of the telescope is indicated as a white rectangle in the middle. Bottom: The telescopic field of view shows hundreds of streamers.



Lightning-ionosphere interactions – some of the more spectacular phenomena include sprites, elves, blue jets, and  $\gamma$ -rays.



On average, about 100 lightning discharges occur every second in approximately 2000 thunderstorms that are active globally

at any given time. While the average person has likely witnessed these “ground-to-cloud” discharges, airline pilots had reported seeing “upward lightning” for some time. It wasn’t until the 1990s that these phenomena were finally documented and studied. Scientists have now shown that lightning discharges at cloud altitudes (<10 km) affect the high-altitude (>40 km) upper atmosphere, producing the bright flashes of “sprites” and “elves.” Sprites are large, luminous discharges in the altitude range of about 40 km to 90 km that are produced by the heating of electrons for a few to tens of milliseconds—much less than the blink of an eye—following intense lightning flashes. Elves are optical flashes that last for a much shorter (<1 ms) time than sprites, and are typically limited to 80 to 95 km altitudes with much larger (up to 600 km) lateral extent; elves are produced by the heating, ionization, and optical emissions due to the electromagnetic pulses radiated by both positive and negative lightning discharges. These newly discovered phenomena indicate strong electrical coupling between upper atmospheric regions, the global significance of which must now be evaluated so that existing models of upper atmospheric dynamics can be properly modified.

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