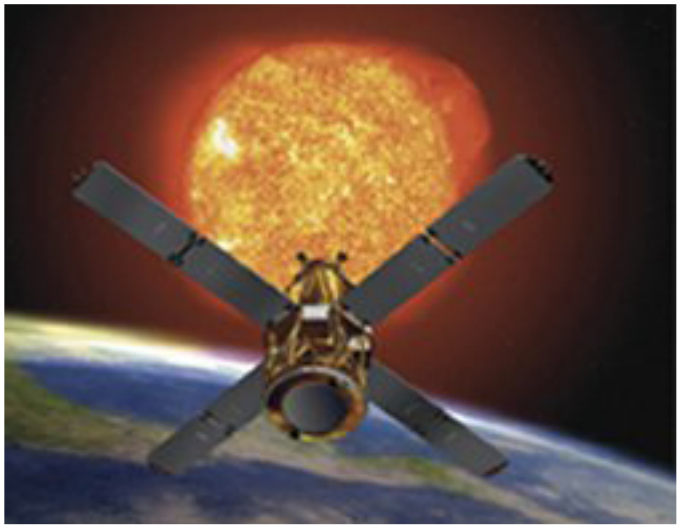
SCIENCE NEWS Online
THE WEEKLY NEWSMAGAZINE OF SCIENCE
Week of Feb. 19, 2005; Vol. 167, No. 8 , p. 115

Sky High: Gamma-ray bursts are common in Earth's upper atmosphere

Sid Perkins

Enigmatic bursts of high-energy gamma rays produced in Earth's atmosphere are surprisingly strong and frequent, satellite data suggest.

In the early 1990s, Earth-orbiting sensors originally designed to monitor sporadic flares of gamma rays from exotic sources such as black holes and neutron stars also detected the high-energy photons coming from a more mundane source—Earth's atmosphere. These terrestrial gamma-ray flashes (TGFs) were seen once every few weeks and lasted around a millisecond, says physicist David M. Smith of the University of California, Santa Cruz.



STARING AT THE SUN. A satellite designed to observe solar flares also detects high-energy photons produced by exotic phenomena in Earth's atmosphere. Artist's depiction shows the satellite orbiting Earth.
NASA

Now, Smith and his colleagues have analyzed portions of data gathered by another gamma ray–detecting satellite, which was launched in 2002 to study high-energy emissions of solar flares. The craft's sensors detected 86 TGFs over a span of 6 months. In 60 of those TGFs, the energy of at least one gamma-ray photon exceeded 10 million electron-volts (MeV), about 300 times the energy of an X-ray photon in a typical medical scan. In nine instances, a photon's energy surpassed 20 MeV.

Such high-energy photons are typically the result of bremsstrahlung, a process that takes its name from the German words for "braking radiation." When a high-speed electron slams into a much heavier atom, the kinetic energy shed during the electron's sudden deceleration is cast off in a photon, says Smith. The higher-energy gamma rays observed during the recently detected TGFs probably were produced by the deceleration of electrons traveling about 99.99 percent of the speed of light, he notes. He and his coworkers describe their findings in the Feb.

18 *Science*.

Scientists don't fully understand the origins of TGFs, but flashes seem to be associated with lightning. The multimillion-volt electric fields generated between strong thunderstorms and higher layers of the atmosphere probably propel stray electrons upward at nearly the speed of light, says Umran Inan, a physicist at Stanford University. When one such electron smashes into an atom in the atmosphere, it can knock loose several other electrons, starting a chain reaction that slows only when the cascade of electrons reaches altitudes where atoms are few and far between.

According to some models of the phenomenon, most of a TGF's gamma rays spew upward in a beam no more than 100 kilometers wide. Smith and his colleagues estimate that if that's the case, given the satellite's detection rate, TGFs may occur high in Earth's atmosphere at least 5,000 times each day.

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From Science News, Vol. 167, No. 8, Feb. 19, 2005, p. 115.