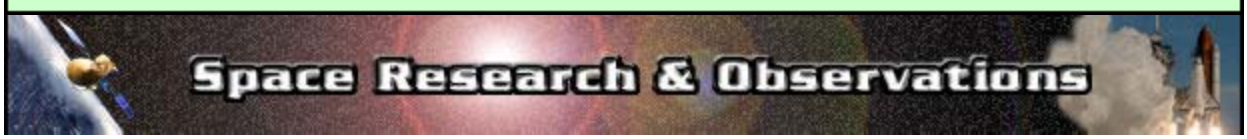

Space Shuttle Lightning Experiments

Background

Lightning has been observed from space since the early 1960s using both optical and radio frequency sensors. More than a dozen satellites have flown instruments that have recorded signals from lightning. The detection of lightning from some of these satellites was an unanticipated bonus, while for others it was a primary research objective. Lightning observations have been made by cosmonauts and astronauts dating back to 1963. Astronauts have occasionally reported discharges having horizontal extents of many hundreds of kilometers and simultaneous lightning events occurring between widely separated storms.

Early Space Shuttle Lightning Experiments

The Space Shuttle has been used as a platform for lightning studies from the beginning of the shuttle program, ever since the Night time and daytime Optical Survey of Lightning (NOSL) experiment was flown onboard shuttle missions STS-2, STS-4, and STS-6. This experiment, in turn, developed from cooperative airborne research efforts between NASA's Marshall Space Flight Center, the State University of New York at Albany, and the New Mexico Institute of Mining and Technology at Socorro. The purpose of these experiments was to learn more about atmospheric electricity and its relationship to severe storms and their development. They were conducted using NASA Ames U-2 high altitude aircraft equipped with special instrument pallets in the bottom of the aircraft to gather both optical and electrical signatures from the lightning. A CCD TV line scan camera with a diffraction grating filter also provided crude spectral information.

In the late 1980s (after the Challenger accident of 1986), a new shuttle lightning program began. The purpose of this experiment, called the Mesoscale Lightning Experiment, was to observe lightning directly under the shuttle as it would be seen by unmanned orbiting satellites. The data obtained from these shuttle flights directly provided design criteria data for modern and future spaced based sensors (such as OTD, LIS, and LMS).

Observations of Lightning in the Stratosphere

An examination and analysis of video images of lightning, captured by the payload bay TV cameras of the space shuttle, provided a variety of examples of lightning in the stratosphere

above thunderstorms. These images were obtained on several recent shuttle flights while conducting the mesoscale lightning experiment (MLE). The images of stratospheric lightning illustrate the variety of filamentary and broad vertical discharges in the stratosphere that may accompany a lightning flash. A typical event is imaged as a single or multiple filament extending 30 to 40 km above a thunderstorm that is illuminated by a series of lightning strokes. Examples are found in temperate and tropical areas, over the oceans and the land. Shuttle images and animations can be found in Space Shuttle Observations of Lightning - Mesoscale Lightning Experiment.

Reference

Observations of Lightning in the stratosphere, Boeck, W. L., O. H. Vaughan, R. Blakeslee, B. Vonnegut, M. Brook, and J. McKune, Journal of Geophysical Research, 100, 1465-1475, 1995. Abstract, Paper

The Role of the Space Shuttle Videotapes in the Discovery of Sprites, Jets and ELVES

The sequence of video tape observations of the upper atmospheric optical flashes called sprites, jets, starters, and ELVES are described in the successive phases of search, discovery, confirmation, and exploration for the years before 1993. Although there were credible eyewitness accounts from ground observers and pilots, these reports did not inspire a systematic search for hard evidence of such phenomena. The science community would instead wait for serendipitous observations to move the leading edge of this science forward. The phenomenon, now known as a sprite, was first accidentally documented on ground based videotape recordings on the night of July 6, 1989. Video observations from the space shuttle acquired from 1989 through 1991 provided 17 additional examples to confirm the existence of the sprites phenomenon. Successful video observations from a mountain ridge by Lyons, starting July 7, 1993, and night time aircraft video observations by Sentman and Wescott on July 8, 1993, established the basic science of the sprite phenomena by acquiring and analyzing data based on hundreds of new events. The 1994 Sprites campaign and the video titled "Red Sprites and Blue Jets" popularized the name sprite and provided a vocabulary of terms to describe the visual attributes. Prior to this video, investigators used a variety of vague descriptive words to describe the individual events. Also, during the 1994 campaign, Wescott and coworkers obtained the first quantitative measurements of jets and provided the name "blue jets". A third phenomenon was discovered in a video from the STS-41 mission (October 1990) in the lower ionosphere directly above an active thunderstorm. It consisted of a large horizontal brightening several hundred kilometers across at the altitude of the airglow layer. In 1995, Lyons and associates confirmed the existence of this type of very brief brightening which they named Emissions of Light and Very Low Frequency Perturbations From Electromagnetic Pulse Sources (ELVES). Because sprites, jets, and ELVES have appeared for millennia, their discovery was inevitable.

Reference

The Role of the Space Shuttle Videotapes in the Discovery of Sprites, Jets and ELVES, Boeck, W. L., O. H. Vaughan,Jr., R. Blakeslee, B. Vonnegut, and M. Brook, Submitted to the Journal of Atmosphere Trrestrial

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