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LITE MISSION OPERATIONS AND EXPERIMENT PLAN OVERVIEW

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The Lidar In-Space Technology Experiment (LITE) is a backscatter lidar developed by NASA Langley Research Center to fly on the Space Shuttle. The instrument is built around a three-wavelength Nd:YAG laser (1064 nm, 532 nm, and 355 nm) and a 1 meter telescope. The system has been designed to study a wide range of cloud and atmospheric aerosol phenomena from the surface of the Earth to an altitude of 40 km. The instrument has successfully completed a ground-test phase and is presently at Kennedy Spaceflight Center awaiting integration into the space shuttle Discovery for a 9-day mission in September 1994. The objective of the LITE program is to better understand the engineering processes required for space lidar and to test lidar remote sensing techniques from orbit. To this end, a comprehensive program of scientific investigations will be conducted during the upcoming mission.

MISSION OPERATIONS

The instrument is controlled by a central processor and several distributed processors. Over 200 commands are available to configure, control, and monitor the status of the instrument. A variable aperture stop and movable interference filters can be used to optimize the signal-to-noise ratio during day or night portions of the orbits. PMT voltages, amplifier gains, and DC offsets may also be varied to optimize acquisition of the lidar return signals, which have a dynamic range of 6 orders of magnitude from the surface return pulse to an altitude of 40 km. The instrument can be reconfigured within in a few seconds. The instrument will accept commands to be executed when received, or the commands can be time-tagged to execute at some future time. The instrument can be commanded either from the ground at Mission Control in Houston or, to a more limited extent, by the crew on board the shuttle. In addition the instrument has the capability to automatically reconfigure itself from night to day or day to night configurations, as required, as the terminator is crossed.

SCIENCE INVESTIGATIONS

Although LITE is primarily a technology experiment, a science team has been formed to ensure that maximum benefit is gained from the experiment. The science team has participated in formulating the mission objectives and experiment plan for the instrument. The atmospheric parameters to be measured by LITE are shown in Table 1. Stratospheric measurements are made at 532 nm and 355 nm only. A wide variety of phenomena which occur on regional scales will be studied. Representative examples include the organization of cloud in the western Pacific warm pool, marine stratus decks off the coasts of California and Peru, plumes from biomass fires in South America and Africa, and the transport of desert dust from the Sahara.

In addition to regional studies, global surveys will be performed. LITE will provide a unique and complementary dataset on the global distribution of clouds and aerosols which will complement that provided by current orbital sensors. With the ability to detect and locate even subvisible cirrus, LITE will provide new insights into the global distribution and structure of cirrus. By providing accurate statistics on cloud heights, LITE can provide guidance in the development of realistic retrieval models on which to base the analysis of routine satellite observations. LITE will also provide the first global measurements of the height of the planetary boundary layer (PBL), improving our abilities to model the coupling between the atmosphere and the earth's surface.

Details on specific investigations planned are given in McCormick, et al.(1993).

Troposphere	Clouds
aerosol backscatter cross-section	height
aerosol scattering ratio	fractional cloud cover
PBL height	reflectance/albedo
PBL optical depth	optical depth

Stratosphere
density and temperature profiles to 40 km
aerosol backscatter cross-section
aerosol scattering ratio

Table 1. Primary parameters measured by LITE.

EXPERIMENT PLAN

LITE is scheduled for STS-64, on board space shuttle Discovery. Although LITE is the primary payload on STS-64, there are a number of secondary payloads which must also be accomodated in the total mission profile. Figure 1 shows the mission timeline for STS-64. LITE operations are concentrated in 10 'datatakes' of 4.5 to 5 hours (shown as wide gray bars), and several 'snapshots' lasting 15 to 30 minutes (narrow gray bars). Activities of some of the other payloads are denoted by hatching. An additional LITE datatake will be performed on orbits 123-125 if excess power is available near the end of the mission. This set of datatakes and snapshots corresponds to the groundtracks shown in Figure 2. Each datatake covers roughly 3 orbits and was located in the timeline to accomodate either correlative measurement activities or study of a specific regional phenomenon. Two surface sites in the southwest US, at Edwards Air Force Base (EAFB), California and White Sands, New Mexico (WSNM) have been characterized and will be used to determine the system constant of the 1064 nm channel (Reagan and Zielinskie, 1991). A certain amount of additional surface data will be taken at low gain to allow quantitative measurements of the strength and variation of the surface return signal. Surface return data will be taken over the ocean and over a variety of land surface types. Some of the surface return data will be taken at angles up to 30° off nadir to investigate the angular dependence of the surface return.

It is necessary to verify the accuracy of the measurements made by the instrument and to make quantitative performance assessments. The science team has designed and is leading a comprehensive, worldwide correlative measurements program to assist in measurement validation. This effort employs ground-based, airborne, and space-based sensors. The timeline shows underflights (indicated by diamonds) by NASA P3 and Electra aircraft, and a Convair 580 aircraft operated by the Canadian Atmospheric Environment Service. These aircraft carry upward- and downward-looking lidars, visible and infrared radiometers, and in situ sensors which will be used to validate measurements of clouds and aerosols. The P3 and Electra each carry lidars capable of both tropospheric and stratospheric aerosol measurements. They will be based out of Puerto Rico, Barbados, and Ascension Island in the south Atlantic during the mission. The Convair 580 will be based in southern California.

Details of the mission operations concept and experiment plan will be presented.

REFERENCES

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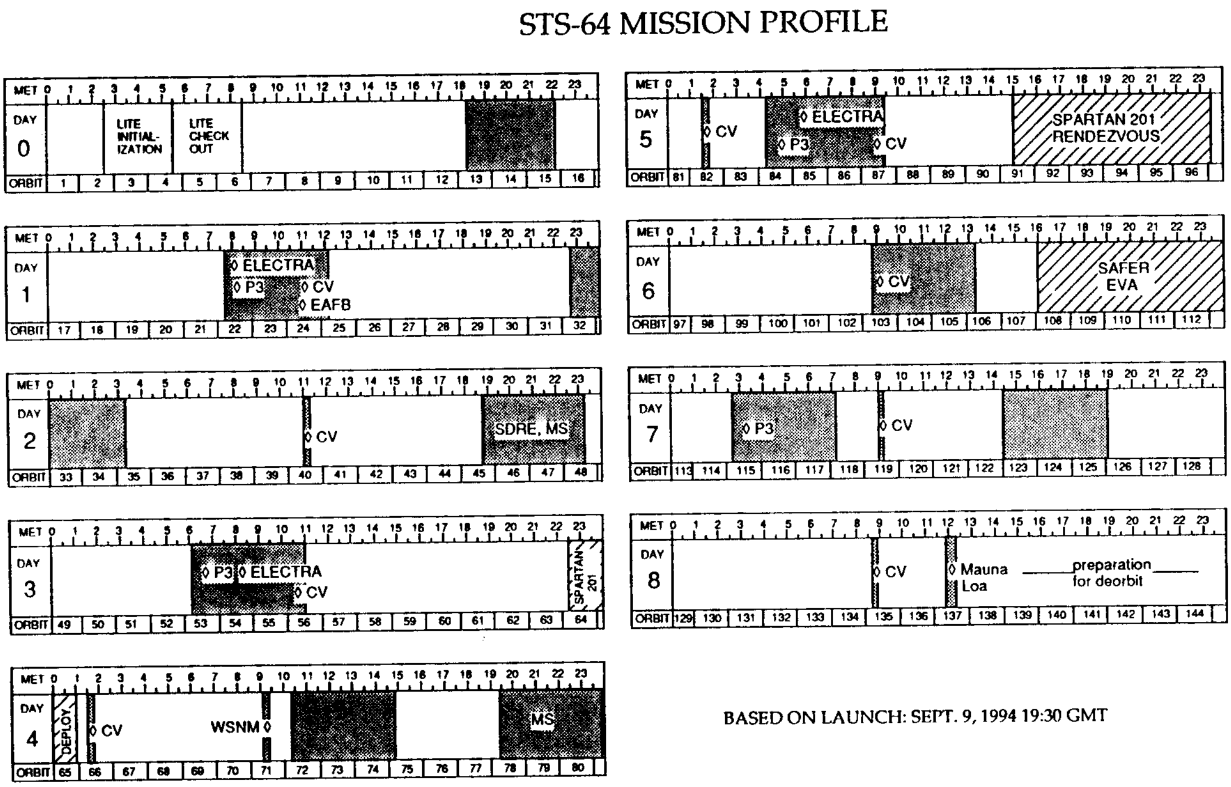

Figure 1. STS-64 mission timeline.

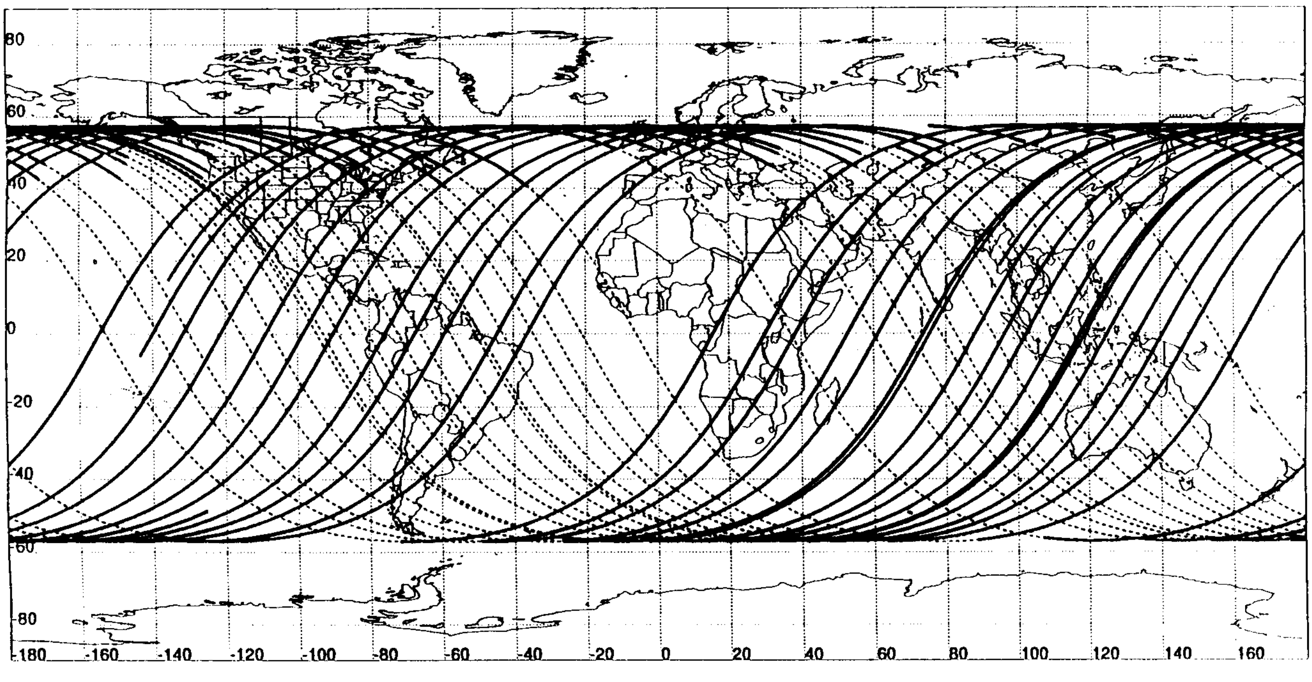

Figure 2. Shuttle ground tracks during LITE datatakes. Solid lines indicate orbit segments in daylight; dashed lines, nighttime. Lighting based on September 9, 1930 GMT launch. Location of terminator refers to shuttle lighting.