New eyes from space yield a spectrum of results

Weighing nearly three tons, a diverse collection of instruments carried into orbit last month by the space shuttle was in a sense designed for studies of rock types and landforms on the ground, chlorophyll in the oceans, lightning and pollution in the atmosphere and sunflowers in space. More precisely, however, it was designed to study the *studies*, as scientists sought to evaluate new techniques and technologies (from individual sensors to the shuttle itself) in preparation for more comprehensive missions in the future (SN: 5/9/81, p. 292).

Data from the package, called OSTA-1 for NASA's Office of Space and Terrestrial Applications, have been in the researchers' hands for only a few weeks. Even an early look, however, is sufficient to indicate that results from the wide-ranging experiments run the gamut from near-total success to near-total failure.

The shuttle flight, its second, was ended after only 54 of its planned 124 hours because of a malfunctioning fuel cell (SN: 11/21/81, p. 324). The OSTA-1 projects suffered to varying degrees from the shortened mission, but hardest hit was the Heflex Bioengineering Test (HBT), a plan to determine the optimum amount of soil moisture that should be included with a group of dwarf sunflower seeds in a future study of their growth patterns under weightless conditions. The seeds germinated and sprouted, as expected from past spaceborne studies, but the test was to find out the effect of moisture differences after four or five days — impossible to measure in a flight lasting barely two. The data were to aid preparations for a more detailed experiment scheduled for the 1983 first flight of the European Spacelab research module (aboard the shuttle), and the University of Pennsylvania's Allan H. Brown hopes that there will be time and room aboard an earlier shuttle run to repeat the preliminary test. For example, he says, it is uncertain whether water "migrates" through soil in different ways under weightlessness. Also, the test chamber was exposed to unexpectedly large temperature swings in its compartment in the shuttle's mid-deck area, and these, Brown notes, must be understood before more elaborate biological studies are conducted.

A plan to make Night/day Observations of Storms and Lightning (NOSL) with a hand-held movie camera also suffered from the flight's forced brevity, which required astronauts Richard Truly and Joe Engle to pack more tasks into their already busy schedule. This was added to the unpredictability of lightning occurrences, and to the constraint that filming was to be done only when it did not interfere with other crew activities. The result was three minutes of storm footage, showing no visible lightning bolts at all (a single optical pulse was recorded on magnetic tape), although Bernard Vonnegut of the State University of New York at Albany notes that stereo techniques are making it possible to study the storms in three dimensions from individual movie frames.

Far more successful was the Shuttle Imaging Radar (SIR-A), sent along to make high-resolution images of different types of surface terrain. Despite the shortened mission, the device provided virtually the entire planned amount of coverage and the full intended range of landforms (SN: 11/28/81, p. 341), with only some of the specific target areas changed. The resolution, says Charles Elachi of Jet Propulsion Laboratory, reached the experiment's theoretical limit of 36 meters.

An "Ocean-Color Experiment" (OCE), testing a sensor to map chlorophyll concentrations as an indicator of phytoplankton possibly representing productive fishing grounds, yielded 118 of 120 planned minutes of data, 78 of them free of obstructing clouds (which could have been a factor even in a full-length mission). The shuttle's altered flight plan meant that some of the data had to be taken when it would be degraded by unfavorably low sun angles, but Hongsuk Kim of the NASA Goddard Space Flight Center reports that about 20 to 30 usable minutes remain. Coverage includes the Mediterranean, the mid-Pacific Ocean, and waters south of Cuba.

The Shuttle Multispectral Infrared Radiometer (SMIRR) was included to see whether the Landsat satellites' poor ability to discriminate among different rock types from orbit could be improved by observing over a wider range of wavelengths. The Landsats covered bands from 0.5 to 1.1 microns (Landsat D, scheduled for a 1982 launch, will add a 1.6-micron channel), but SMIRR included, for example, a 2.15-to-2.24-micron region that encompasses the spectral absorption characteristics of hydroxyl ions, such as would be found in clays or other hydrated minerals. Clays in sedimentary rocks are important in geologic mapping for petroleum deposits, and can hint at the presence of buried metal deposits such as copper, gold and silver. Clay absorption features indeed show up in the SMIRR data, and in fact, says Alexander Goetz of JPL, "the variety of spectra exceeded our expectations." The researchers' plan is essentially to look at the spectra, predict what they represent and then visit the sites to check. The instrument scanned along about 80,000 km of the earth's surface, of which some 25,000 will probably be analyzed. Cloud cover ruined some hoped-for data over the western United States, and the delayed launch and shortened flight cost coverage of Australia, southern Africa and South America, but useful data were obtained over some parts of Africa and the United States, as well as Asia, the Middle East, Europe and Mexico.

Users of data from future Landsat-type satellites could benefit from the Feature Identification and Location Experiment (FILE), which rode the shuttle to study a way of bringing some order to the mountains of data that such satellites provide. Two TV cameras photographed the earth at red and near-infrared wavelengths, while another device used the brightness ratio between the two bands to determine how much of each image consisted of liquid water, bare ground, vegetation, or snow and ice. The idea was that this discrimination would be used by the system to limit the number of scenes recorded of each dominant surface type. In a working satellite, the ability to make such distinctions automatically would allow the possibility, for example, of transmitting only images of selected vegetation, omitting unwanted subjects such as desert or ocean. FILE suffered from the low sun angles (which change the surface reflectivities) caused by the late launch, as well as a tape recorder problem, but Roger Schappell of Martin Marietta Aerospace says that the one frame studied so far indicates that the spectral discrimination plan worked, and that the experiment's sun sensor successfully confined operations to the day side of the earth. A four-channel version, FILE-2, capable of making more types of discriminations, will be tried in airborne tests early next year.

The first global maps of carbon monoxide distribution in the atmosphere were the goal of an experiment for Measurement of Air Pollution from Satellites (MAPS). Despite the truncated misson, says Henry Reichle Jr., of the NASA Langley Research Center in Virginia, "adequate viewing coverage" was obtained for about 90 percent of the earth between 37.5° north and south latitudes. Data from the instrument (a gas-filter correlation radiometer) are now being processed and combined with the necessary meteorological data to produce the CO maps, which will then be compared with "ground truth" measurements from air samples collected by aircraft that underflew the shuttle's path at various altitudes during selected orbits. An early look, however, has already resolved a key technical concern, that of the instrument's thermal stability, which apparently held up even despite unexpectedly large temperature variations in the shuttle's cargo bay.

Besides the experimental data themselves, the OSTA-1 project provided the first chance to try conducting a complex, multidisciplinary exercise aboard the shuttle. *—J. Eberhart*