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Title: A Pointable, Helicopter-Based Remote Sensing Data Acquisition System for Collecting Bidirectional Reflectance Data

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Since 1983, researchers at the Goddard Space Flight Center and the University of Maryland have worked with engineers at the Wallops Flight Facility (WFF) to develop and refine a helicopter-based remote sensing data acquisition system. During this period of time, our evolving helicopter-borne remote sensing system has been utilized extensively to support field measurements programs such as studies of forest decline damage associated with atmospheric deposition, FIFE'87 & '89, and Goddard's current Forest Ecosystems Dynamics project. However, the level of refinement in this system reached a new plateau in 1990 as the result of significant improvements in the way the instrument package is mounted on the helicopter and in the way the data from the instruments are captured and stored.

In the new configuration, the sensor payload is mounted externally on a hinged pallet located on the starboard side of the WFF Bell Iroquois UH-1B (HUEY) helicopter[1] (see schematic, Fig. 1). This pallet is attached to the aircraft by utilizing existing ordinance mounting lugs which are located strategically near the center-of-gravity of the aircraft. Attached to this pallet is a two degree-of-freedom gimbal device which permits the sensor payload to be rotated 360° and pointed up to 60° off-nadir. The hinge in the pallet permits the sensor payload to be tilted up (using an actuator) for take-off and landing, and leveled again once in flight. This was necessitated by the need to lower the sensor payload below the helicopters' landing skids to insure that the FOV of the instruments would not be obstructed by the skids when the gimbal was positioned 60° off-nadir while pointing underneath the helicopter.

The sensor payload includes a set of bore-sighted instruments consisting of a Barnes Modular Multiband Radiometer (MMR) (1° field-of-view, FOV), a Spectron Engineering

[1] NOTE: An identical pallet can be (and has been) mounted on the port side of the aircraft to provide counterbalance and/or accommodate additional sensors.

(SE) 590 spectroradiometer (1° FOV), an Everest infrared temperature sensor (2° FOV), and a Sony CCD video camera with 10x zoom lens. Controller units for this equipment, as well as for the pallet and gimbal, are mounted within a three-bay instrumentation rack located inside the cabin of the helicopter. The centerpiece of the support instrumentation is a 20 MHz 80386 personal computer (PC) equipped with a 100 MB hard disk and a 16 bit, 16 channel differential input A/D converter board. This PC configuration permits simultaneous, high speed acquisition and storage of digital data from all of the instruments in the sensor payload. Thus, we are able to acquire more measurements in much less hover time over each target, and we avoid a significant amount of flight down-time which was required in the past to dump the MMR dataloggers.

This new payload and PC-based controller arrangement were thoroughly tested during a Multisensor Aircraft Campaign (MAC) which was conducted in mid-July and early September, 1990 at International Papers' Northern Experimental Forest (NEF), located approximately 56 km north of Bangor, Maine. The MAC was initiated to support the Forest Ecosystem Dynamics (FED) project, a major research activity within the Biospheric Sciences Branch at NASA's Goddard Space Flight Center (see abstract and poster re: 1990 Forest Ecosystem Dynamics Multisensor Aircraft Campaign).

Although there are some minor adjustments which remain to be made in this pointable, helicopter-based data acquisition system, excellent data were collected in 1990. Figure 2 illustrates the collection of bidirectional reflectance data with the pointable instrument mount, while Figure 3 illustrates the significant differences in target reflectance that one can expect as a function of sensor view angle. The capability to acquire bidirectional reflectance data permits us to closely simulate the type of radiance data acquired currently by GSFC's Advanced Solid-state Array Spectroradiometer (ASAS), as well as that which is to be acquired by several Earth Observing System (EOS) instruments. Thus, with this latest configuration, we feel that we have developed a truly unique, reliable capability to acquire multi look-angle data sets of specific targets. Furthermore, we feel that this type of data will be extremely useful to the remote sensing science community in validating the bidirectional reflectance distribution functions (BRDF) for numerous earth surface features.

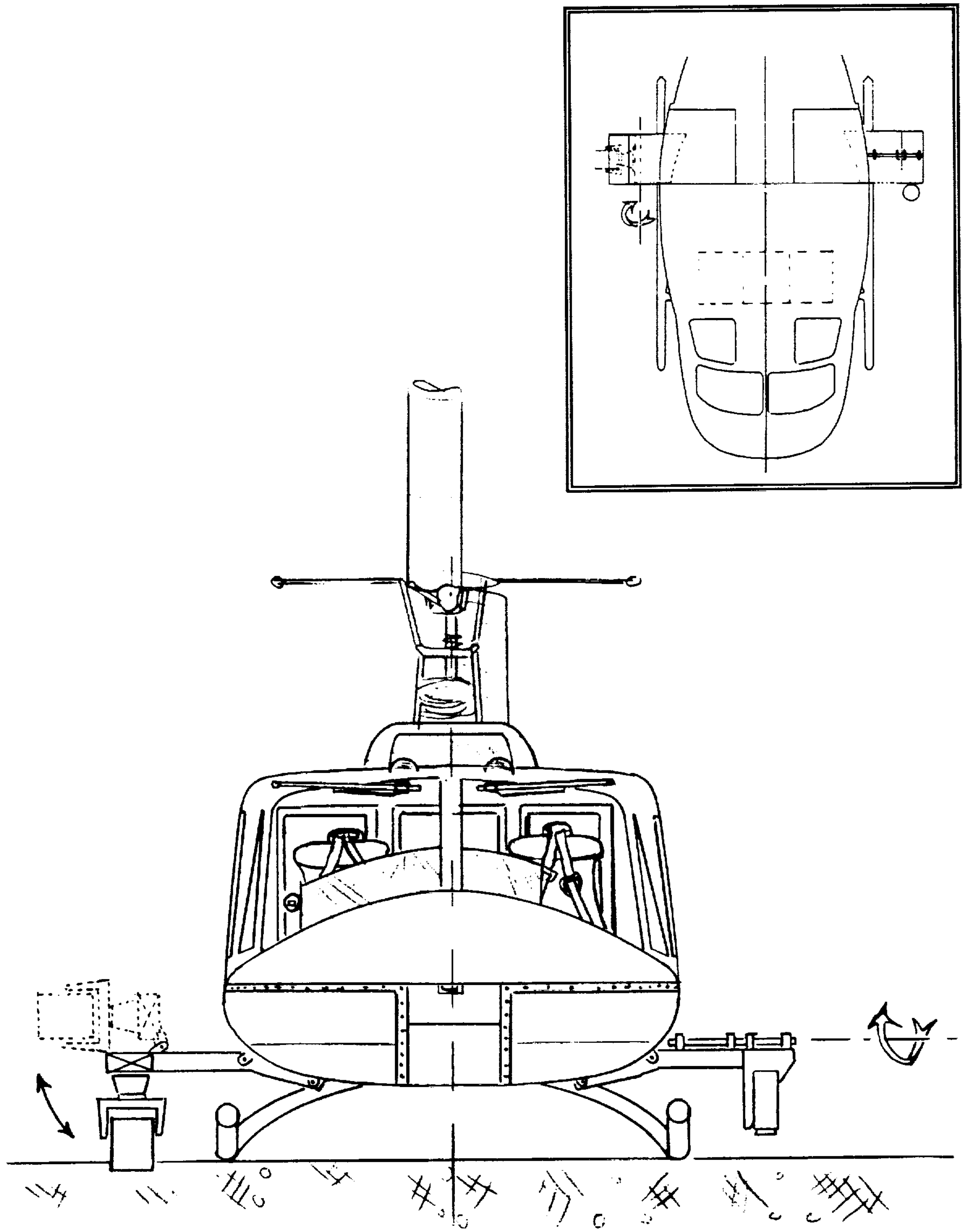

Figure 1. Frontal view schematic of a UH-1B helicopter showing the location of instrument pallets on the starboard and port sides of the aircraft. The insert (top, right) illustrates the location of the pallets on the fuselage near the center-of-gravity of the aircraft.

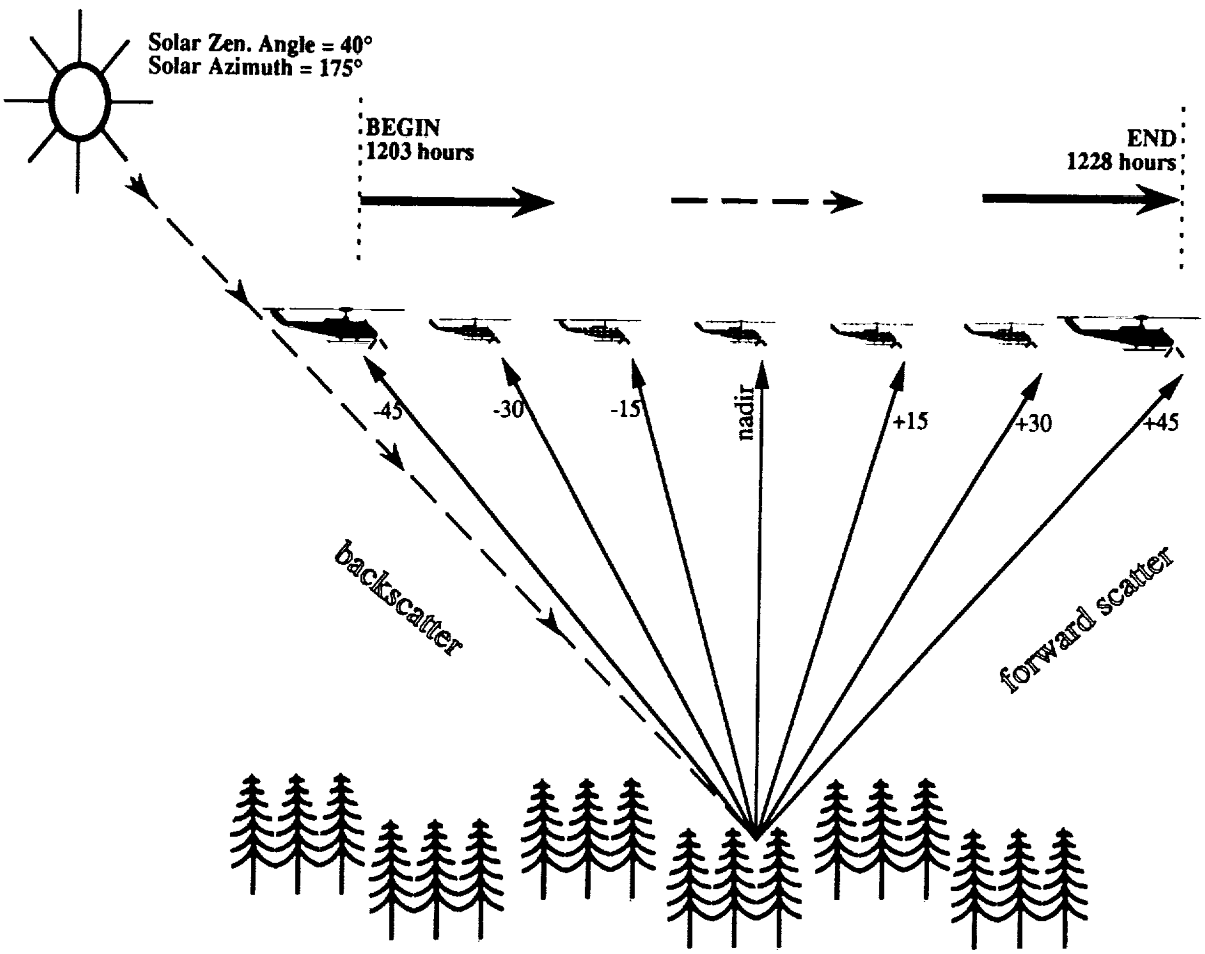

Figure 2. Cartoon drawing illustrating the collection of bidirectional reflectance data made possible with the pointable instrument mount. It should be noted that the azimuth orientation of the sensor payload can be adjusted independent of the helicopter azimuthal orientation, which is typically into the prevailing wind.

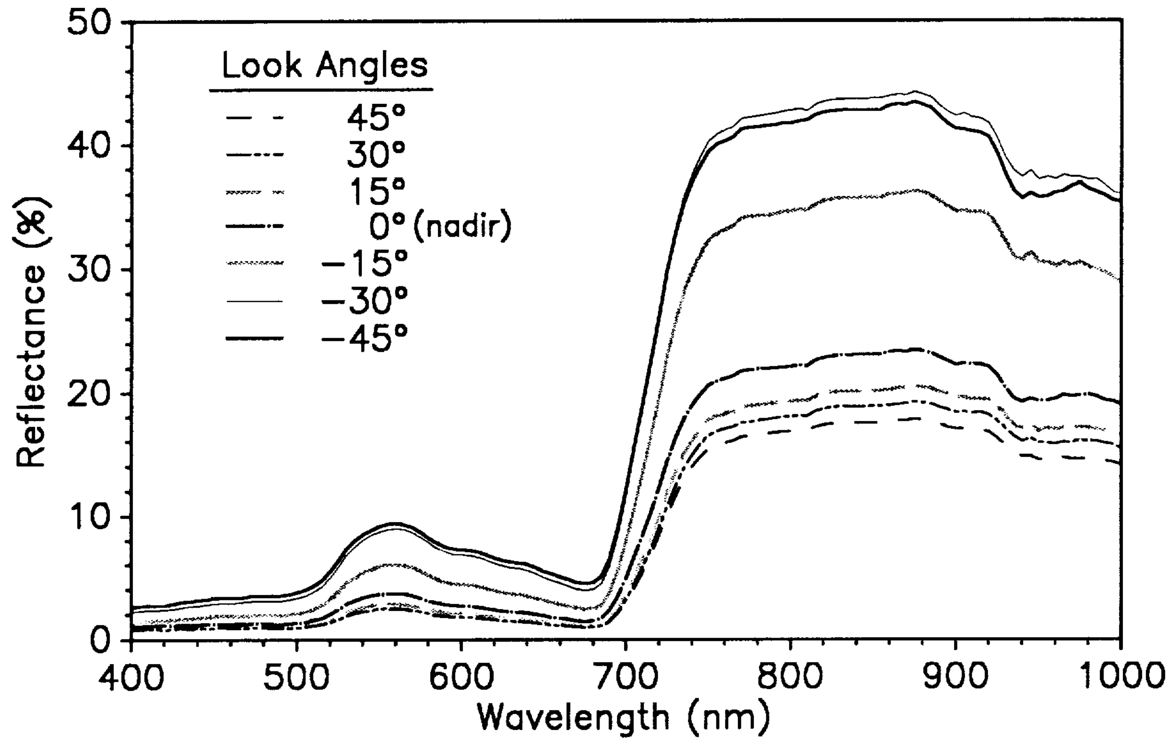

Figure 3. Graph illustrating the significant changes in the magnitude of reflectance for a hemlock/mixed hardwood forest stand as a function of sensor look angle. In this case, data were taken parallel to the principal plane of solar illumination. The magnitude of reflectance is much greater in the backscatter direction (i.e., -45° to -15°), than at nadir (0°) or in the forward scatter direction. Each curve represents the mean of ~ 50 scans at that particular look angle; data were acquired with an SE-590 spectroradiometer.