THE NIMBUS 4 IRLS METEOROLOGICAL EXPERIMENT

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A meteorological experiment designed to provide scientists with their first direct look at the upper atmosphere in the tropical regions of the Earth is currently being conducted by the Nimbus 4 Interrogation, Recording, and Location System (IRLS). The IRLS is designed to locate and collect data from remote instrumented platforms deployed on a global scale. These capabilities are being utilized to obtain measurements of upper atmospheric parameters through the tracking of free-floating, constant level balloons flying at altitudes of 20.5 and 24.1 km (50 and 30 mb pressure, respectively). Operations commenced in May 1970, and, during the following months, a total of 26 balloons carrying specially designed Balloon Interrogation Packages (BIP's) were launched from a site established at Ascension Island in the southern hemisphere. This site was selected to enable insertion of balloons into the biennial circulations, which are the subject of study in the experiment. To date over 1500 locations have been obtained from points around the globe; the data have provided information which will be the subject of study for many years.

The IRLS concept is shown in Figure 1. The basic elements of the system include a ground acquisition and command station, the Nimbus satellite, and the remote platforms. In operation, addresses of platforms expected in view are programed into the satellite on an orbit-by-orbit basis from the central ground station. As orbital time elapses, interrogations are executed in ordered sequence. A minimum of two interrogations per platform are required for location computation, which is derived through range-range techniques. Simultaneous with ranging operations, sensory data sampled by the platform are transmitted to the satellite for storage and readout at the termination of the orbit. The IRLS was first flown as a technological experiment aboard the Nimbus 3 satellite and successfully demonstrated the feasibility of global data collection through tracking operations with air, sea, and land deployed platforms. The accomplishments of this program provided the design base of the improved Nimbus 4 system which incorporated features sufficient to enable the world-wide meteorological balloon tracking experiment to be conducted.

A major developmental effort on the Nimbus 4 program involved the design of the BIP shown in Figure 2. The BIP consists of an antenna mounted on a 1.2-m diameter ground plane, a polystyrene housing containing the electronics, and a solar array. The unit is powered by rechargeable batteries and is thermally designed to maintain an internal battery temperature near 0°C during day or night periods of operation. The entire payload weighs 4.5 kg and is suspended 30 m below the balloon. The development of a 4.5-kg BIP represented a 90 percent reduction in gross weight as compared to the platform design requirements of the Nimbus 3 system. This reduction was primarily due to a 6-dB improvement realized in the satellite receiver sensitivity which in turn yielded a corresponding reduction in platform transmitter power requirements (25 to 6.25 W).

The system improvements which led to the lighter self-contained BIP unit required for balloon applications also provided a versatile instrument suitable for other applications. For example, a BIP was reconfigured into an animal collar and utilized to perform the first satellite animal tracking experiment (April 1969). Additional applications involving lightweight buoys are currently under development for the Nimbus 4 mission.

An example of balloon tracking data obtained during the experiment is shown in Figure 3. The trajectories of two balloons flying at the 50-mb level are plotted during five revolutions of the Earth. Movements north and south of the equator, but remaining within ±10 deg, were observed on each revolution. On other flights, at both altitudes, the tendency to remain near the equator was likewise observed. This tendency is of interest to experiment meteorologists since it was expected that 10 to 15 percent of the balloons would leave the equatorial region.

A brief example of additional information contained within the data is seen by referring to the wave ridges indicated by the arrows. The ridges indicated are believed to be caused by the same wave as it progressed easterly in opposition to the direction of balloon travel. This is evidenced by the changes in longitude on successive revolutions in the upper trace, beginning with August 30, and by comparison of wave ridges seen on each balloon near the September 16 and 28 time periods. The progressive movement of the wave toward the east is at a rate of approximately 5 m/s while the balloon speed is approximately 74.4 km/hr (40 knots). A thorough analysis of all data is being performed by Dr. James Angell of NOAA and Dr. Richard Reed of the University of Washington. A paper describing their initial results will be delivered at the spring meeting of the American Geophysical Union in April 1971.

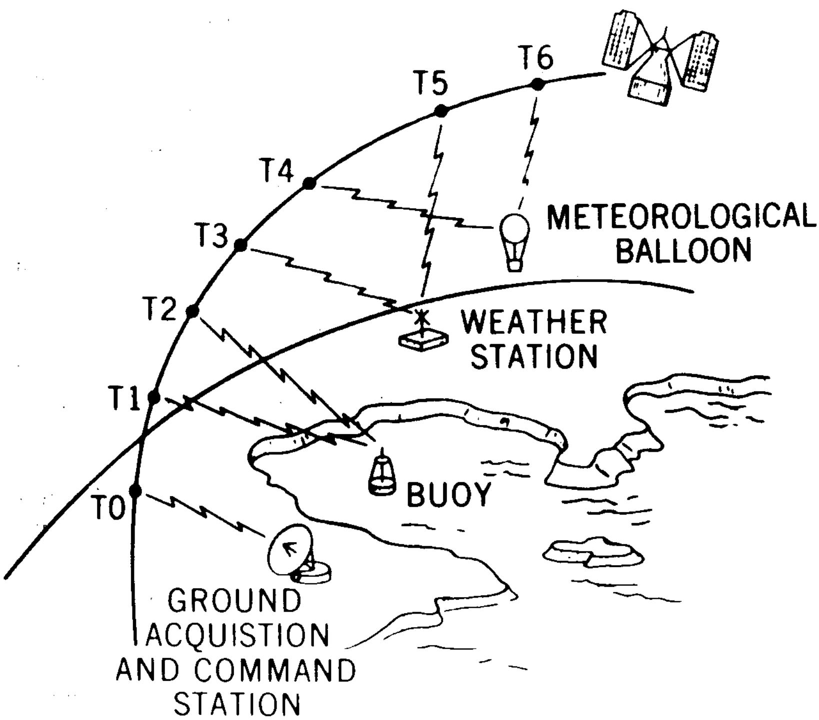

Figure 1–Interrogation, recording, and location system (IRLS).

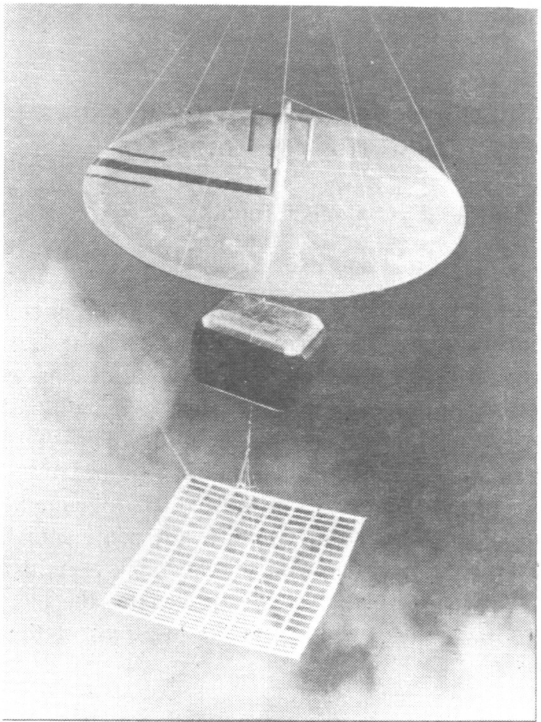

Figure 2–Balloon interrogation package.

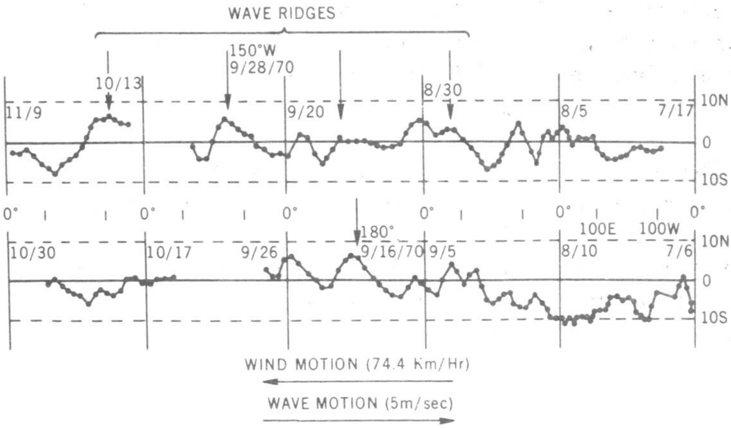

Figure 3–Nimbus 4 IRLS 50-mb balloon trajectories.