WEATHER DATA COMMUNICATION AND UTILIZATION

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Following is a description of some of the technical work performed by the Avionics Engineering Center as a part of the Department of Electrical Engineering at Ohio University, Athens. The general title of the work is the communication of weather data and the utilization of these data in improving general aviation aircraft safety. The participants in this work have been principally Dr. Richard H. McFarland, Mr. James D. Nickum, and Mr. Daryl L. McCall. Mr. McCall served in 1981 as an intern at the Langley Research Center under a special program.

One of the basic interests in communications involving weather data is how to accomplish it efficiently. (See Figure 1.) If we are talking about weather data, in particular, we can envision great quantities of data being available and only a limited amount of capability to transfer this via radio link to an aircraft. Further, the pilot, of course, will be limited in the amount of time he has to peruse the data and excess data may actually be a detriment to safety. It is, therefore, important to be able to select appropriate information and transfer it in a very efficient manner. Earlier research indicated that the radio communications technique is the only practical means of accomplishing this. Two options appear to be available in the radio spectrum. One is to use an aeronautical radio communication channel designated by the FCC, or use a navigation channel with subcarriers imposed on it. The VOR, in particular, is a good candidate, and use of low-frequency beacons offers some possibility especially for non-line-of-sight transmission, perhaps to ground-based users for flight planning purposes. The use of subcarriers, vertical intervals on the television channels and portions of the FM band are not acceptable to the Federal Communications Commission. The possibility of obtaining some of the military channel authorizations for use for civil purposes also seems to be out of the question based on information obtained during this investigation.

Approaching the problem of providing efficient transfer, considerations such as development of coding schemes to reduce the redundancy of the information being transmitted are important. For example, providing line packing, which means that the amount of information transmitted for each line is reduced by having knowledge that certain pixels are repeated, goes a long way in saving time in transmitting a weather radar picture.

The information to be transferred can be broken into two categories. One is graphics information which includes such items as weather radar reflectivity patterns, severe weather maps, icing, synoptic weather patterns, possibly satellite pictures, sferics information, and information contained in the National Weather Service AFOS System. (See Figures 2 and 3.) The other is text items such as sequences, forecasts, altimeter settings, pilot reports, and NOTAMs. These are easily transmitted through data links and when properly screened provide excellent information for the pilot.

One of the concerns that we as researchers should have concerning the use of uplink data is how it will and can be used. An important means for determining this will be through simulation. Accordingly, Ohio University has produced some weather radar sequences on magnetic tapes which are being put into form to be applicable with the NASA Cyber computer. The intent will be to place weather information, assuming it to be derived from an uplink, in front of the pilot in the simulator and allow him to proceed to manipulate his aircraft in performing deviations and other maneuvers to avoid the serious weather threats. The safety of the flight can be examined by the observer pilot and determination will be made of how well the pilot can handle the information and in what form it can best be handled.

As a part of the display work, it is necessary to place the aircraft in the weather picture, so to speak, and to move the weather picture consistent with the heading and course of the airplane. In other words, in a good simulation the pilot may very well imagine himself to be flying behind an airborne weather radar but with greater synoptic coverage. The challenge at the present has been to place the aircraft in the weather picture and rotate and translate the weather picture according to heading and speed of the aircraft. This work is in progress at the present time. Figures 4, 5 and 6 show the equipment that has been used by Ohio University for demonstrating some of the rudimentary aspects in developing the algorithms for translating and rotating the weather picture. The weather data has been obtained by courtesy of the National Weather Service, Columbus, Ohio. Results are shown in Figures 7 and 8.

Additional hardware is shown in Figure 9 which allows for the transfer of the sferics information obtained from a Ryan Stormscope over a radio link to an aircraft type receiver. Although this demonstration has not been performed with an aircraft in flight, it has been completely simulated using the transmitter and receiver terminals connected only by the radio link. If requested by NASA, this uplink can be implemented in flight over an aeronautical radio communications channel which has been authorized by the Federal Communications Commission.

This work involving the radio uplink for the sferics information and the preparation of the weather information for inclusion in the NASA simulation has been accomplished under NASA Grant NAG-1-124.

The bibliography relevant to this weather uplink study that is dedicated to developing better capabilities of interfacing the pilot to available information and equipment in the aircraft is documented in the following publications.

McFarland, Richard H., "Midterm Report of an Investigation of Methods for Efficient Transfer of Weather Information to the Pilot", OU/AEC/EER 53-1, Avionics Engineering Center, Ohio University, prepared for NASA Langley Research Center, July 1981.

McFarland, Richard H., "A Delineation of Critical Weather Factors Concerning General Aviation", OU/AEC/EER 53-3, Avionics Engineering

Center, Ohio University, Athens, Ohio, prepared for NASA Langley Research Center, November 1981.

Fischer, Joseph P., "An Investigation of Techniques for Coding and Transmitting Weather and Flight Related Information to an Aircraft", Avionics Engineering Center, Ohio University, Athens, Ohio, Interim Report OU/AEC/EER 53-4, prepared for NASA Langley Research Center, December 1981.

McFarland, Richard H., "Precipitation Area Detection Data", TM W-1, Avionics Engineering Center, Ohio University, prepared for NASA Langley Research Center, March 1982.

McFarland, Richard H., "Efficient Transfer of Weather Information to the Pilot in Flight", NASA Contract NAG-1-124, NASA Contractor Report 165889, Avionics Engineering Center, Ohio University, Athens, Ohio, April 1982.

Lilley, Robert W., "Creation and Demonstration of a Weather-Radar Simulation Data Base", TM W-2, Avionics Engineering Center, Ohio University, Athens, Ohio, prepared for NASA Langley Research Center, May 1982.

McCall, Daryl L., "A Ground-to-Air Sferics Telemetry System", TM W-3, Avionics Engineering Center, Ohio University, Athens, Ohio, prepared for NASA Langley Research Center, August 1982.

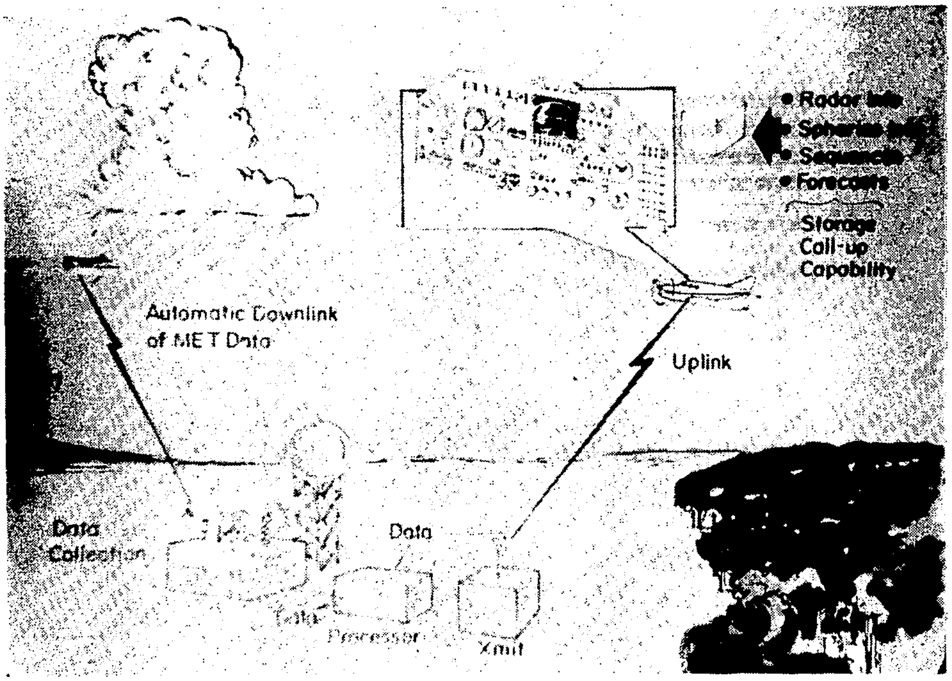
Automatic Downlink
of MET Data
Uplink
Forecasts
Storage
Call-up
Capability
Data
Data
Xmit

Figure 1

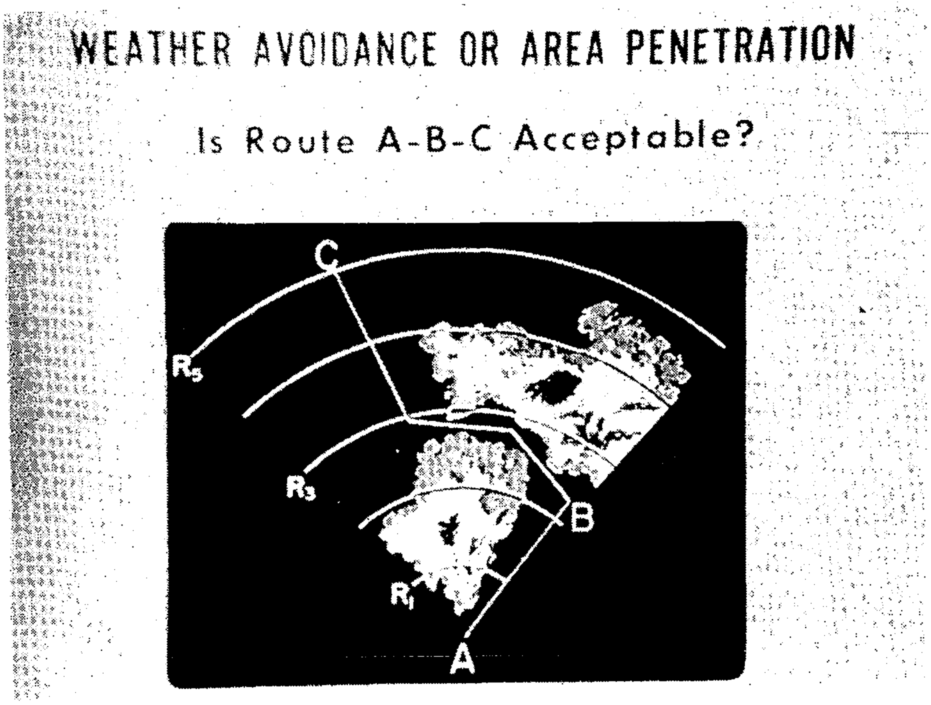

Figure 2

Navigation, Route, Weather,
Spherics Information Superimposed

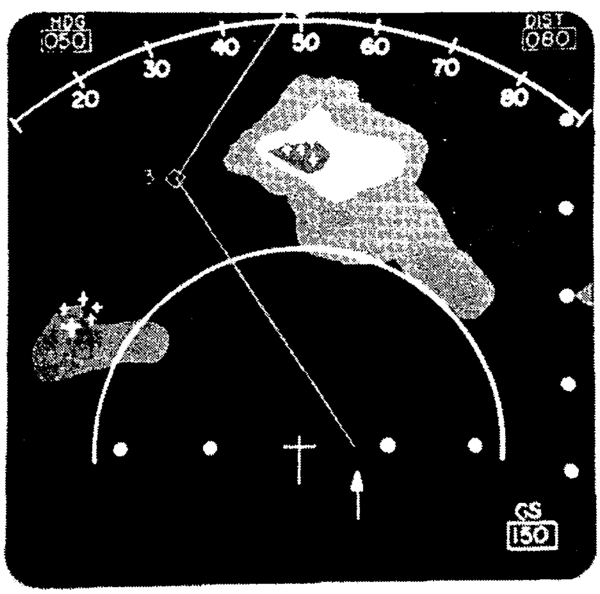

Figure 3

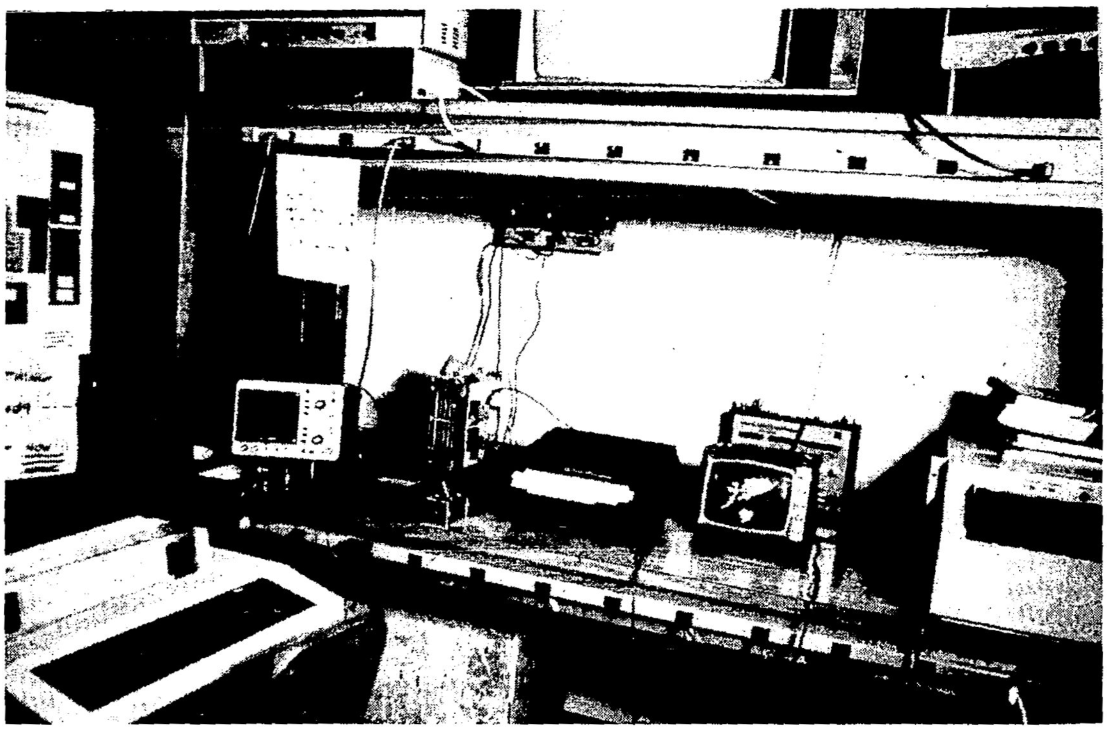

Figure 4

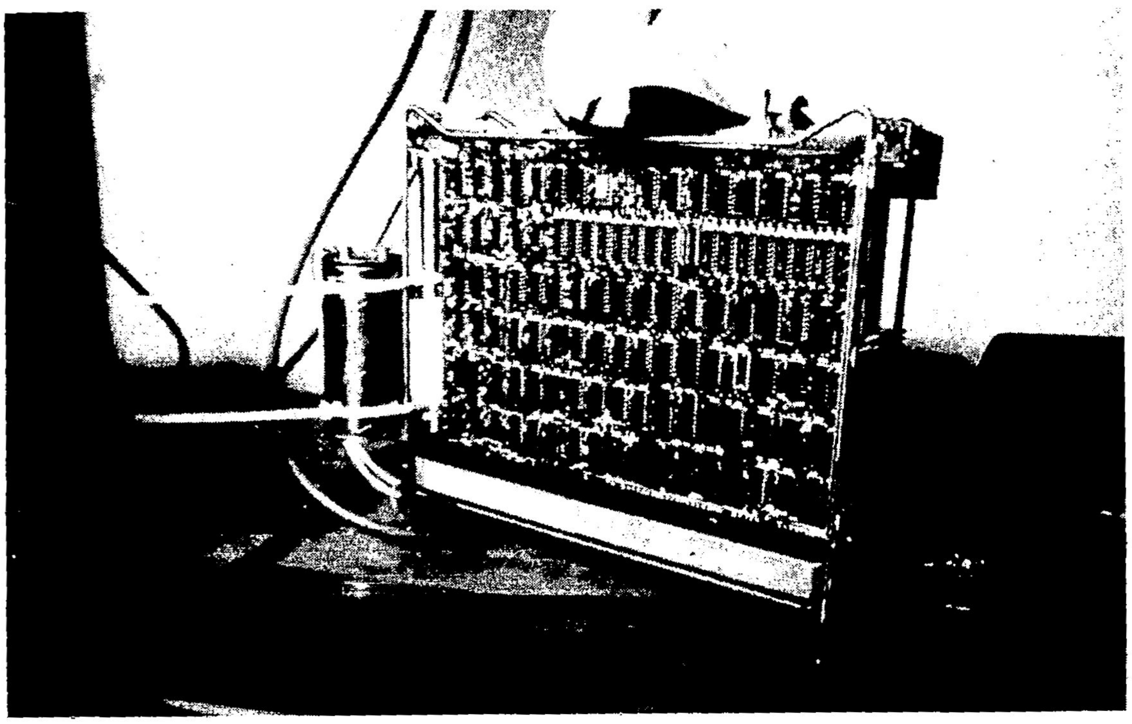

Figure 5

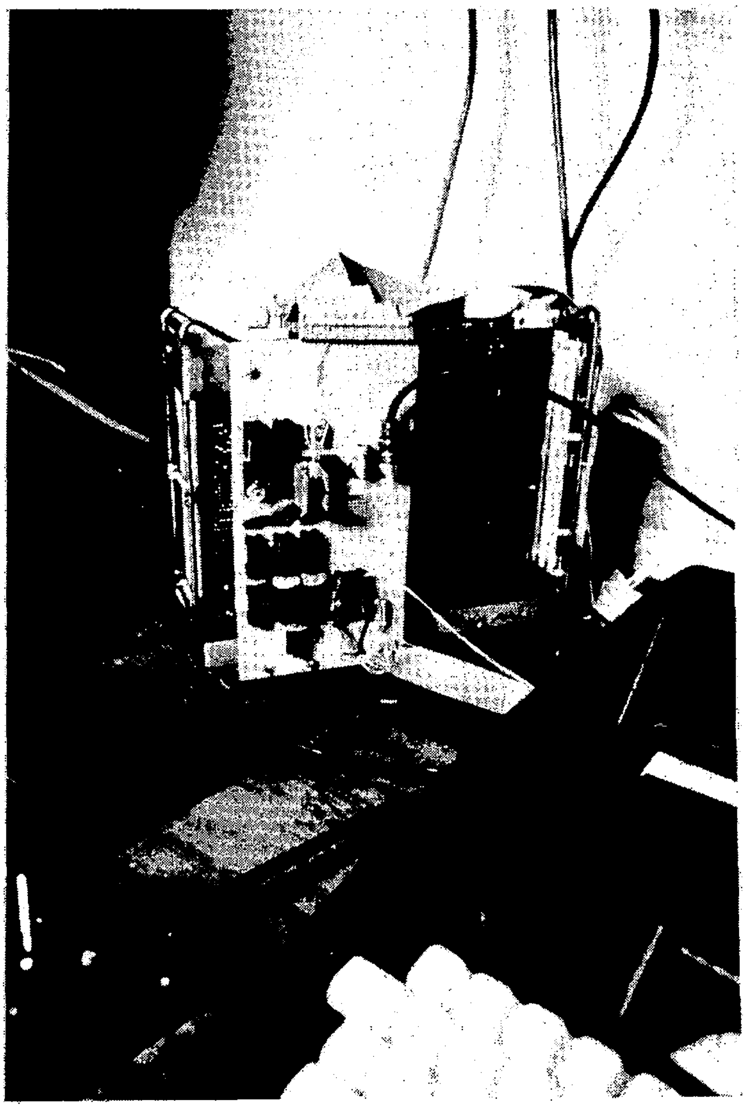

Figure 6

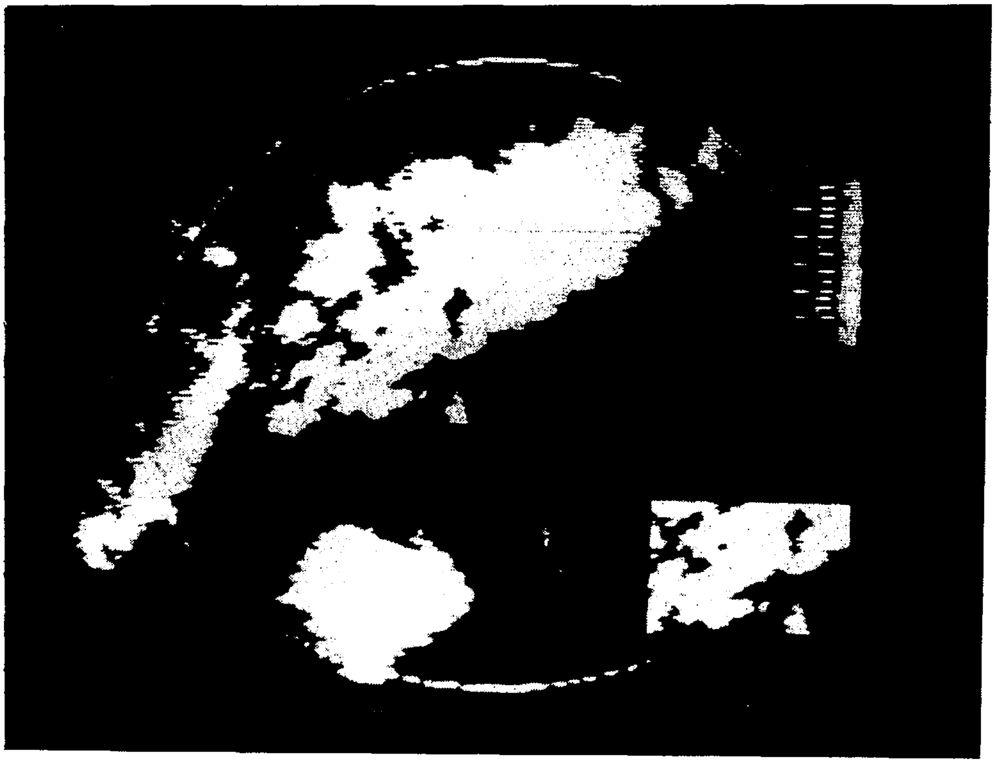

Figure 7

Figure 8

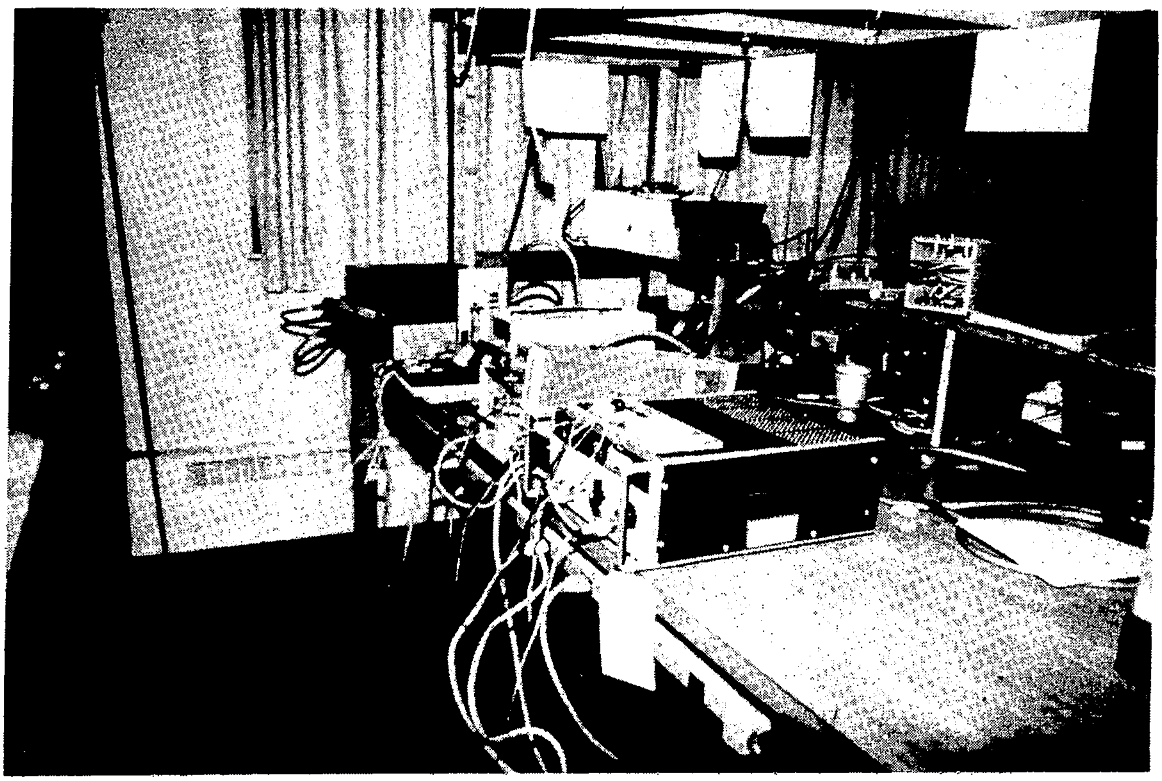

Figure 9