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V. E. Suomi, Principal Investigator
Space Science & Engineering Center
The University of Wisconsin

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Technical Monitor : Mr. William Bandeen

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SUMMARY

This report on contract NAS5-11542 covers the period January 1 - March 31, 1971. Major reporting areas include:

1. Radio altimeter - some improvements on
2. Application of ATS data
   (i). On the B-scale wind field in the tropics.
   (ii). Wind speed and direction from ATS sun glitter information.
   (iii). Correlating ATS cloud brightness to stream flow data.
3. On the feasibility of gridding and rectifying APT satellite pictures based on geographic reference points.
4. Time domain data extraction.

CONTENTS

I. INTRODUCTION AND DISCUSSION

A. Radio Altimetry

Progress on the radio altimeter this quarter centered on: (1) improvements in locking accuracy and sensitivity; (2) improvements in air safety; and (3) a continuing investigation into the transponder potential of the altimeter. New work initiated in this quarter includes two new lightweight antenna configurations and a polarization experiment.

The radio altimeter, as described by Levanon*, is designed to lock to the peak of the returned pulse shape. For scattered reflections, this corresponds closely to the trailing edge of the transmitted pulse delayed by the altitude. For specular reflections, however, this point may vary by as much as the pulse width for a flat-topped pulse shape. Using a pulse width of about 0.4 μsec., this allows the possibility of as much as 60 meters of static altitude error. This is judged excessive and an effort has been made to correct this without decreasing the pulse width (and thereby using excessive bandwidth).

Various alternatives investigated include the use of varactor diodes in the tuning circuit and series regulation circuits in the transmitter drive and supply lines. After trying many schemes, the most effective and simplest means appears to be to place an inductor of about 2.0 μh in the transmitter power supply line. Unwanted transients introduced by this inductance can be suppressed using a diode and isolated from other circuitry using emitter followers. This method yields a minimum linear rise angle of 10° at the end of the transmitted pulse. RF sensitivity has been improved with this modification because the turn-on transients of the transmitter are suppressed with the inductance.

*N. Levanon, "Balloon-Borne Radio Altimeter", IEEE Trans, on Geoscience Electronics, GE-8, No. 1, Jan. 1970, pp 19-30.

Air safety improvements have included eliminating the tuning coil and bypass capacitors and etching them on the circuit board in the RF section of the altimeter. Board thickness has been reduced from 1/16" to 1/32" with no degradation in performance. Currently, a new model is being tested using .015" circuit board. Total electronics weight is about 40 grams and is limited primarily by component weight and wiring.

Use of the altimeter as a transponder is being investigated. It has been found that interrogation pulses of 400 MHz energy which are turned on and off (a rate of 2kHz was used in the experiment) during an interval of about 5 msec. are quite effective for using the altimeter as a transponder. Much higher interrogating frequencies are being investigated, the goal being the use of the altimeter as a transponding ranging device.

Two new antenna designs are to be investigated in a continuing effort to develop new lightweight antennas. Current lightweight antennas are constructed of balsa wood and copper foil. They weigh 40 grams and meet air safety requirements, but are too fragile for normal balloon launch conditions. The new antenna designs use flexible materials.

A complete radio altimeter has been modified to fit on a rotating platform. Power supply leads are fed through slip rings, together with data leads. During the next quarter we plan to use this altimeter to study polarization detectability. This has possible application to detecting surface wind direction over water.

B. Application of ATS Data

(i) On the B-scale wind field in the tropics

About 3,000 cloud trajectories have been measured for selected cloud clusters in the tropics for 18 days using a "close up" movie technique. An objective polygon technique has been employed to derive divergence and vorticity fields.

Preliminary analysis indicate that in 5° x 5° grid zones at least three low cloud trajectories could be always found and these trajectories compared very well with surface and low level winds. The occurence of high cloud tracers was too eratic to be used for more than ocassional comparisons except in cloud cluster outflow regions where the number of cirrus tracers were adequate to describe the outflow field. Based on these 18 day samples the low level convergence field is found to range from 10^{-6} sec^{-1} to 2.0×10^{-5} sec^{-1} for polygons in the immediate vicinity of a cloud cluster while for the high level cirrus shield it is 10^{-5} to 8×10^{-4} sec^{-1}.

Detailed analysis of the data is in progress in a Ph.D dissertation program.

(ii) On the wind stress from ATS sun glitter information

Sun glitter information on the ATS time lapse pictures have been exploited to derive surface wind speed and direction over the oceans using Cox and Munk's linear relation between the variance of the waves' slope and the wind velocity. Comparison with the actual winds from the Line Island, 1967 as well as from the BOMEX 1969 experiments reveals an excellent agreement in wind speed (accuracy < 1 m/s). The wind direction, however, agrees within ± 10°.

Detailed analysis of these data is in progress toward a Ph.D dissertation.

(iii) Correlating ATS cloud brightness to stream flow data

In continuation of the study reported under B(2) page 2 in the previous quarterly report an attempt to relate the high brightness areas to stream flow data is being made. Net result may be a relation between the bright cloud cover and discharge rate in the river basins in remote tropical land areas. Analysis continues in this area.

C. On the Feasibility of Gridding and Rectifying APT Satellite Pictures Based on Geographic Reference Points.

A technique has been developed to rectify and grid APT satellite pictures in real time based on geographic features in the picture. The product has a higher utility and is more versatile.

First an ordinary APT satellite is received and at least 3 geographic features in the picture identified. The picture coordinates and the earth coordinates of these geographic features are used to generate a new format, such as a polar stereographic map projection via a computer program. A new picture having the full resolution and dynamic range of the original is available about 35 minutes after receipt of the satellite signals. These new signals have characteristics identical to ordinary facsimile signals and could be relayed to many weather stations.

D. Time Domain Data Extraction

For 1971, heavy emphasis has been placed on fitting together the separate processes developed at SSEC for wind determination with the intent of producing an operational ATS data reduction system capable of quality and quantity outputs suited to the needs of weather models, GARP, and SMS image processing. We have new techniques of navigation and geometry correction to compensate for apparent motion of the earth caused by shifts in ATS attitude and subpoint. In the past three months we have been investigating more efficient alternatives for selecting data and determining cloud displacement without losing the geometric accuracy necessary to ensure accurate winds. For this reason an error analysis of ATS data is also underway to isolate and upgrade any weak links in the ATS data reduction chain.

The cloud displacement alternatives involve the autocorrelation principle. We have a completely computer based system which uses fast fourier transforms.

It is already so fast on our third generation computer that we are becoming I/O limited. Detection of cloud motion has been successful. The next step now underway will combine the navigation process to produce actual winds. A second autocorrelation technique we are studying uses high precision photographic negatives similar to those produced by NESS for the ATS archives. The cloud motion or parallax between successive pictures is detected electronically, using dual phase locked flying spot scanners to correlate an image detail. The intermediate photographic step degrades both geometry and radiometry but may still be sufficiently adequate, since we have obtained winds from other hard copy on an experimental basis. It will definintely be a less expensive operational route. A quantitative test to get winds using the new hardware is in the planning stage. We intend to pursue both techniques of cloud displacement since we need both high quality radiometry and access to the complete archives.

II. PROGRAM FOR NEXT REPORTING PERIOD

Studies on the determination of wind vectors from ATS time lapse information may be completed by the end of next quarter. Also, further results on the case studies on the correlation between the ATS cloud brightness and rainfall intensity in the remote tropical areas may be available. A report on the feasibility studies on Data Retrieval, Processing and Storage will be prepared.