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Quarterly Report

HIGH ALTITUDE RADIATION MEASUREMENTS

1 July 1968 - 30 September 1968

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Abstract

This report summarizes project activity during the period 1 July, 1968 to 30 September 1968.

The extensive testing necessary for the coming balloon flight of the IRIS interferometers and the Filter Wedge Spectrometer is described. Progress in measurements of self-broadened and foreign-gas broadened spectra in the 15 μm CO_2 absorption band is noted.

I. Introduction

This is the 23rd Quarterly Progress Report on Contract No. NASr-54(03), covering the period 1 July 1968 to 30 September 1968. The project effort during this time was divided among the following tasks

1. Preparations for the next balloon flight
2. Laboratory measurements of CO_2 transmission
3. Report Writing

All available effort was applied to the balloon flight operations, since after an extremely long delay and many postponements, the T. I. IRIS interferometer was finally made available for the balloon flight operation.

Reporting on the balloon operations is somewhat limited for the time 1 July - 14 September, since the period of environmental tests 14-31 September has already been reported in the 24th quarterly Progress Report #05863-24-P, which was written and published before this report. Additional comments made in this report supplement the information already presented.

II. Preparations for Balloon Flight

A. Highlights of the Preparations (by Gunar Liepins)

July 1 - 3	Calibration of thermisters for T. I. IRIS blackbodies.
July 5 - 8	Tests of balloon gondola with all equipment except T. I. IRIS.
July 9 -10	Modifications to heater for T. I. IRIS warm blackbody.
July 11-Aug. 9.	Acceptance Tests of T. I. IRIS at Dallas.
Aug. 10-11	Installation and test of T. I. IRIS on balloon gondola.
Aug. 12-17	Tests of balloon gondola with all equipment including Winzen balloon flight control equipment.
Aug. 19-21	Miscellaneous bench and gondola tests of Filter Wedge and T. I. IRIS instruments.
Aug. 24	T. I. IRIS Calibration started - detector fails during tests - T. I. IRIS returned to Dallas.
Aug. 26	Filter Wedge returned to Goddard Space Flight Center.
Aug. 26-27	Re-calibration of vacuum chamber altitude gauge.
Aug. 28-30	Vacuum chamber tests of T. I. IRIS blackbodies

Aug. 30 T. I. IRIS Returned from Dallas.

Aug. 31-Sept. 9 Tests and calibration of T. I. IRIS and T. I. IRIS blackbodies.

Sept. 10-11 Tests of outside mirror assembly for U. M. IRIS.

Sept. 12 Gondola Test with all instruments - Cold test of T. I. IRIS.

Sept. 13 Attempt to run R. F. test - Poor results due to poor environment for R. F. tests.- Postponed until later. Tests will be conducted in the field.

Sept. 14 Report from G. E. that T. I. IRIS cold test data was unsatisfactory. - Tape recorder heads found to be in poor condition.

Sept.14-26 Environmental tests at Bendix Missile System Division (Reported on in 24th Quarterly Progress Report no. 05863-24-P.

B. Testing, Calibration and Integration of Interferometers with Balloon Gondola. (By L. W. Chaney).

1. Preliminary Testing

The thermistors supplied by the Texas Instruments Company were mounted on a large heat sink along with platinum resistance thermometers. Calibration data on the thermisters (resistance vs. temperature) was obtained and sent to T. I. so that they could prepare voltage vs. temperature data.

Gondola tests of all the instrumentation, except the IRIS-B ifm, were held July 5 and 8. It was noted during these tests that the telemetry interfered with the operation of the U. M. IRIS. The r. f. signal from the telemetry distrubed the operation of the mirror drive amplifier causing the sweep rate to change.

In all subsequent tests the antenna had to be directed away from the gondola and removed from the gondola area by several feet. It was also noted during the tests that the mechanical vibration from the filter wedge modulated the U. M. IRIS mirror drive. The problem was eliminated by an improved mounting for the filter wedge and by special care in placement of cables around the U. M. IRIS.

2. Acceptance Tests of T. I. IRIS

In accordance with our original plans this phase of the program was carried out at the T. I. plant in Dallas. The actual interfacing of our control electronics and the IRIS-B went quite smoothly although a great deal of time was needed for careful testing. A buffer amplifier for the IR signal was installed, the divider network for the neon signal was modified, and a circuit to synchronize the calibration scans was designed and installed.

The instrument was checked in an environmental chamber to simulate the balloon flight altitude. Arcing was observed in several places in the electronics. Potting compound was applied and the problem was cured.

The operation of the instrument was checked in an environmental chamber with a calibration black body. Although everything looked OK. from observing the interferograms, the spectra had serious noise spikes at selected frequencies. The period from July 27 to Aug. 8 was spent in performing many tests in attempts to locate the source of the problem.

Finally, filter capacitors in the detector circuit eliminated the problem. The conclusion was that the spikes resulted from beat frequencies between two high frequency choppers.

3. Integration with Balloon Gondola

All the flight equipment was installed on the gondola and checked out. We found that operational amplifiers were required to match the IMCC and digital signals to the telemetry. It was also determined that the Winzen equipment interfered with the operation of both interferometers. The conclusion based on experience with the telemetry antenna was that the problem could be eliminated by dropping the antenna below the package during flight. An attempt was made to lift the gondola in our garage, but the height was insufficient for a valid test. It was decided to perform a test at a later date.

During the integration tests, interferogram recordings were made on magnetic tapes and sent to G. E. for processing. G. E. reported that they were able to process the first tapes satisfactorily. However, they had difficulties with the tapes made during the calibration which followed.

The digital output data was recorded on an f. m. channel and the discriminated output was monitored. Unfortunately, this masked the fact that the f. m. carrier was larger in one case than the other. In subsequent tests and during the flight the carrier amplitude was monitored to make certain that it was large enough to be discriminated by the G. E. ground station.

4. Environmental Testing and Calibration of the T. I. IRIS Interferometer

The original purpose of the environmental tests was to perform a complete calibration of the instrument. The warm blackbody and the cold blackbody were to be used to develop a calibration function to be applied to the "scene" data. The "scene" data in this case would be a standard blackbody. The black body curves so obtained would be compared with theoretical calibration curves.

During our first calibration attempts a transistor failed. A replacement was sent from T. I. and the instrument was repaired. Following this on August 24 we were halfway through a calibration run when the detector failed. The instrument was returned to T. I. for repair and returned to us on September 1, 1968.

As a result of the detector breakdown an investigation was made to determine if the chamber could have been pumped to a lower pressure than indicated. A careful check found that the chamber was pumped to 3.0 mm of Hg, rather than 4.0 as expected. However, T. I. visually examined the detector and concluded that the failure was not due to arcing, but to deterioration of the varnish on the detector.

Finally on September 5, we obtained a complete calibration run. The data was sent to G. E. for processing, but only a small portion could be reduced. Unfortunately, calibrations could not be applied directly to the data. The programs for this were only available at GSFC. However, based on the spectra that were available and scaling the relative spectra, we decided that the instrument was probably working satisfactorily. More data was sent to G. E. before the flight. Data was sent from both the Bendix tests and the complete checkout at Casper. The results from the tests gave a qualitative indication of the instrument performance, but no quantitative calibrations were ever made.

The remainder of the period was spent in correcting problems in the cold blackbody control circuit.

The U. M. external mirror drive was checked in the chamber. In the first test a gear was stripped. This was replaced and afterwards the unit performed successfully.

After the chamber checks the instrumentation was again installed on the gondola and the complete system checked in the lab.

5. Environmental Tests of the Balloon Gondola

Three complete tests of the gondola package were carried out in the environmental chamber at the Bendix plant in Mishawaka, Ind.

The tests uncovered problems with both of the blackbody controls. The germanium output transistors locked in the "ON" position due to overheating. This was a result of not driving the transistors hard enough into saturation. The problem was solved by changing to silicon transistors and also supplying a higher and more reliable drive voltage from silver cells rather than mercury batteries.

There was also a problem in adjusting the flow of liquid N_2. We thought that the problem could be solved by placing more insulation around the blackbody and very carefully adjusting the flow rate. However, during the balloon flight the flow was too low and the cold blackbody did not stay at the control temperature. In any future flights the liquid N_2 flow conditions should be carefully worked out early in the program. Our underestimation of the difficulty of controlling the temperature of the cold blackbody proved quite costly in both time expended and the final results.

Another problem which developed was that the IR detector in the UM IRIS failed during two of the tests. One of the detectors failed by arcing and the other developed high noise. The latter was restored to normal by baking in an oven. However, we decided to use the detector which was flown in the 1966 flight and came from an entirely different hatch. Also during later tests at Bendix we provided our own pressure monitor to ensure ourselves that the chamber was not pumped to too low a pressure.

C. Testing of the Filter Wedge Spectrometer

The gondola test run on 8 July indicated that its signal was much noisier than observed previously. The signal itself seemed to be of a quite different character than observed previously.

Vibration noise due to the filter wedge chopper motor seemed to be unusually great. Even though the interferometers did not seem to be disturbed too much, it was decided to shock mount the unit.

In a test run on 19 July, unbalanced detector bias voltages were noted. New Mercury batteries were installed.

On 22 & 23 July, intermittant short circuits occurred between the filter wedge bias supply batteries and ground. Irratic operation of the instrument was observed even when it was removed from the gondola and tested on the bench and therefore, it was returned to Goddard Space Flight Center for repair.

It was returned from GSFC on 26 August, and although the gain of the telemetry system had to be readjusted for new signal levels, operation was satisfactory from that time on.

D. Miscellaneous Items

On 27 July, all 4 Maurer cameras were shock mounted. Tests run on 29 July, using the U. M. IRIS operation as indicated showed that vibration noise levels on the gondola were adequately low.

On 1 August, the modification and charging of ozonesondes was started. Eight units were prepared and packed with the necessary accessories.

III. Medium Resolution Measurements of Spectra of Self-Broadened and Foreign Gas-Broadened CO_2 (by Henry Reichle)

During this period the band averaged broadening factors (relative to Nitrogen) were found for Argon, Helium and Oxygen in the 15 μ m region. These factors were determined at pathlengths of 8.75 and 1000 cm and CO_2 partial pressures of 100 torr at L = .875, 30 and 100 torr at L=100 cm. The factors were found to be similarly dependent on pressure and optical mass. The average values were as follows:

$S_A = 0.78$

$S_{He} = 0.80$

$S_{O_2} = 0.85$

where $S_i = P_{N_2} \frac{"}{"} P_i$ for equal values of the integral of A $d\nu$

These results compare relatively well with the work of others in the 4.3 μm band except for S_{He} which is somewhat higher than that determined by Burch et al, at Ohio State University.

During the next period it is planned that wavelength dependence foreign gas broadening coefficients will be determined for Nitrogen, Oxygen, Helium and Argon.

IV. Report Writing

No reports were written or distributed during this work period. A paper was presented by W. Kuhn at the Third Aeronomy Conference, Meteorological and Chemical Factors in D-Region Aeronomy, at the University of Illinois, September 23-26, 1968. Professor Kuhn's paper was entitled "Radiative Transfer in the Mesosphere."

V. Future Work

It is anticipated that during the next quarter, environmental tests of the balloon gondola will be completed and that the balloon flight will have been carried out.

Work on other tasks will then be resumed and processing and analysis of the balloon flight data will begin.