BARBADOS EXPERIMENT
SURVEY TRIP REPORT

National Center for Atmospheric Research
Boulder, Colorado

August, 1967

Barbados '68 – Observational Program

SATELLITES

ATS-C – SYNCHRONOUS (COLOR)

2 – ESSA TAPE

1 ESSA APT

1 NIMBUS – TAPE, APT, HRIR

SHIP – USC&GSS DISCOVERER

PIBAL/Radiosonde

C-L Balloons release FREQ.

~~Standard~~ oceanographic (Sea-air)

BUOYS – Two Semi-stable (Geodyne)

15 miles up & downwind (Sea-air)

ISLAND – Barbados

A1 – 3 BASELINE STATIONS – PROFILES (4-d of Wind, sp, T, hum, w (2 levels)), profiles to Several 1000 ft.

1. Accelerated Rawinsondes

2. Constant level balloon – M-33 tracked

3 – WX Radar

4. Cld Photography

AIRCRAFT –

BOOKER'S APACHE – Cld Physics, balloon release, radiometric survey – digital

NCAR Q-A – Research instrumented – Wind, T, h, cld cameras

MAIN SUPPORT REQ.

Meeting Next week – Bob, Joanne, Cecil, Gerstang (and Zaturn), Pepper, Rex, Sanborn

Cannot be to specific.

But: A Barbados immediate area needs some a/c support – MESO-scale related + sea-air measurements –

Q/A can support this phase – 2 general types of requirements.

(1) High level winds & photography

(2) Island or vicinity energy budgets.

~ Box around island at several levels at several times.

B. Synoptic scale environment for exp – inadequate.

(1) Description of systems passing vicinity – framework

(2) Modeling of systems –

(3) Quantitative energy budget studies.

3 biggest unknowns: Priority listing 1 vs 2

Attempt to make quantitative boxes or pure description.

Value of fixed track vs system chasing

INTRODUCTION

A survey trip to Barbados was made from 5 to 8 July 1967, to evaluate the island as a site for a meteorological experiment planned for July to September 1968. This tropical meteorology experiment will be conducted largely under the auspices of the Department of Meteorology of Florida State University (FSU), and will be directed by Dr. Michael Garstang of that department. NCAR has been asked to assist, through its Field Observing Facility (FOF), by providing equipment and personnel suitable to the types of observations planned.

The survey party was made up of the following members:

W. S. Lanterman, NCAR (FOF)
G. H. Saum, NCAR (FOF)
Michael Garstang, FSU
D. Brown, FSU

Transportation of the field party was by Pan American commercial flight from New York to Barbados. The island can also be reached by Pan American or British West Indies Airline flights from Miami.

During the two-day stay on Barbados, the survey party inspected existing meteorological facilities, reviewed observing sites previously selected by Dr. Garstang, and investigated various possible facilities for housing and feeding experiment participants in Barbados. Aircraft facilities and requirements were discussed with the Director of Civil Aviation and with the operators of some of the facilities on the island. A courtesy call and brief discussion with the Prime Minister served to point out our interest in the area. Dr. Garstang, who is familiar with political aspects of this new nation, has been able to make arrangements to bring in equipment and supplies tax-free.

GEOGRAPHY

The island of Barbados is now a nation, the newest member of the British Commonwealth. It is located at 13°4'N and 59°37'W, and is 166 sq mi in extent, pear-shaped in form, 21 mi long and up to 15 mi wide. The island is almost completely encircled by coral reefs. The only natural harbor is at Bridgetown, on the southwest coast. The maximum elevation of the island is 1115 ft, at Mt. Hillaby, in the north central area. The northeast slope of the island is unusually jagged and steep (even precipitous), but elsewhere the land falls in a series of terraces to coastal strips or wide, flat areas.

CLIMATE

The climate of Barbados is very pleasant. Maximum temperature seldom exceeds 86°F, and the minimum seldom falls below 65°F. Normally the dry season lasts from December to May. Easterly trades temper the effect of the tropical sun, and it is only occasionally that the weather becomes disagreeably hot and humid. Annual rainfall varies markedly from one area to another; averages range from 50 to 75 in. The island is at the southern edge of the West Indian hurricane zone, and severe hurricanes affect the island at infrequent intervals.

METEOROLOGICAL FACILITIES

The locations of the following sites are indicated on the attached map.

SEAWELL AIRPORT

a) GMD-1B operated by Barbados government

b) M-33 now at this site will be moved to radar site R1 or R2, and operated by FSU and NCAR

c) APT operated by Barbados government

ATMOSPHERIC SCIENCE INSTITUTE of the University of the West Indies

This will be used as a site for GMD and other equipment. Housing may also be available at this site.

TOWER SITES, selected by Garstang

a) Sites 1-11, 26-ft towers.

b) Sites T1-T3, 52-ft towers. Tethered balloons will be located at these sites also.

RADAR SITES R1 OR R2

Both these sites are located on hills, with good horizons. Pictures taken from site R1 are available. Current plans are to use site R1, near Cottage.

LOGISTICS (GENERAL)

POWER

Power (110-v, 50-cycle, single phase) is locally available at some sites. Three generators are available to Dr. Garstang at present. These are gasoline-driven and are not believed to be capable of running continously with only a single standby.

VEHICLES

One U.S. military vehicle (5-ton, 6 x 6) is available. It has been in sea water and the body is badly rusted. Jeeps may be available from a McGill University project, but firm commitment has not been made. Trucks and passenger vehicles are available for hire from local sources.

HOUSING

Hotels and apartments will be available during the period of the planned experiment. The Atmospheric Science Institute is expected to have rooms for five to eight men, but meals would not be available there unless a maid could be hired. Personnel could drive about five miles

to the nearest inn. There are three inns about five miles north of the Seawell airport: Crane Hotel, Mrs. Foster's Hotel, and Stonehaven. Although meals could be obtained at these hotels, the hours would in all likelihood be pretty rigid and might not always fit in with research requirements. Apartments are located in many different sections; rates are reasonable, but groups occupying them would either have to have maids or do their own cooking. A typical upper-middle-class hotel would cost about $12-15 U.S. per day per person, including three meals. For the extended period of this experiment, a lower rate could be expected.

AIRCRAFT LOGISTICS

SEAWELL AIRPORT FACILITIES

a) Gas (100-130) and oil are available at the airport. Hopefully, tax can be remitted.

b) Maintenance may be available to supplement Clyde Hudson or your mechanic. Spares can be obtained rapidly, on short notice, from San Juan, Puerto Rico.

c) Working space *probably* will be available from Aero Services Barbados, Ltd., Christchurch, Barbados. The manager, Mr. R. J. Forster, will write us concerning facilities available through this company.

d) Power (110-v, 50-cycle, single phase) is available at the airport.

ALTERNATE AIRPORTS

a) St. Vincent -- 90 mi
b) St. Lucia -- 120 mi
c) Grenada -- 250 mi
d) Tobago -- 200 mi
e) Trinidad -- 250 mi

DETAILED NAVIGATIONAL AID FACILITY CHARTS

a) USAF, Caribbean and South America, L-3, L-4.

b) AERAD Flight Guide NAT/5
Int. Aeradio, Ltd., Hayes Road, Southall, Middlesex, England.

c) Jeppesen, just as good as above.

ACCOMMODATIONS

Since Garstang will go over problems with us late in August or early in September, we will discuss airport accommodations more fully later.

AIRPORT USE

The Civil Aviation Authority on Barbados (Mr. T. E. Wente, Director) is most helpful. Mr. Wente will shift approach patterns if necessary, will make parking space available, and will waive landing fees.

COMMUNICATIONS AND ELECTRONICS

On 6 July 1967 a meeting was held at the Government Electrical Inspector's Department in Bridgetown, Barbados. Those present were:

W. Percy Cooper, Electrical Inspector for Barbados
Michael Garstang, FSU
D. Brown, technician, FSU
W. S. Lanterman, NCAR
G. H. Saum, NCAR

The Barbados Experiment was outlined to Mr. Cooper, whose department is in charge of radio communications licensing and regulation for the new government of Barbados. Mr. Cooper was extremely cooperative and stated that permission would be granted to operate VHF-FM communications sufficient to fulfill program objectives. It was decided that the frequencies of 151.760 and 151.840 MHz would be most suitable for use on Barbados. NCAR will provide the following communications equipment, tuned to these frequencies, including antennas sufficient to satisfy the communications requirement:

- Fixed transceivers at each of three 52-ft tower sites:
  T1 (Coles) -- cardioid pattern for all-island coverage

T2 (Cottage) -- omni directional pattern

T3 (Husbands) -- cardioid pattern

- One mobile transceiver for the Bedford (Red) van
- Two walkie-talkies

Equipment should be capable of two-channel operation if possible. All other supporting activities or organizations which have compatible communications equipment for the Barbados study program are requested to use 151.760 MHz as primary frequency.

NCAR feels that the following additional communications equipment should be included in the Barbados Experiment, and that a general communications operations plan should be issued (apparently no such plan exists now):

- One mobile transceiver for use on the boat which services offshore buoys.
- One mobile transceiver for use in an additional vehicle which services the 26-ft towers. (The source of the vehicle is as yet undetermined.)

For general information, some other communications topics discussed at the meeting are listed below:

- S & X band radars at (probably) the Cottage site.
- Radar-tracked transponders (up to three, simultaneous) which will transmit on 403 MHz.
- Three telemetry transmitters near 400 MHz, which will be used to gather meteorological data from tethered balloons. The contractor for these is Weather Science Inc., Norman, Oklahoma.
- Data will be transmitted from anchored buoys on 34.98 MHz, and a C-W, on/off carrier on 2.398 MHz, which will be used for radio direction finding if the radar is unable to distinguish the buoy from sea clutter. The buoy contractor is Geodyne, in Massachusetts.
- Citizens' band walkie-talkies will be available on channels 4 and 5 or 5 and 6.

HF-SSB links to the mainland were not discussed. At present, only British subjects can obtain amateur radio operator licenses. This may change when the next session of the Barbados Parliament meets, as a reciprocal agreement with the U.S. is being considered.

RADAR DATA-ACQUISITION SYSTEM

NCAR will provide the data system which will accept radar target information (slant range, azimuth, and elevation) plus transponder transmissions of temperature and humidity. Exact format, dynamic range, and accuracy requirements were not discussed. The data-conversion system should be capable of converting each channel of analog data into computer-compatible tape at least three times per second, with an accuracy which is at least as good as the original radar. The contractor for the radar transponder receiver and associated meteorological data-demodulators is Weather Science Inc. (WSI), of Norman, Oklahoma. They will provide the interface to NCAR's data system, which amounts to two channels of 0-10 v positive unbalanced with a load impedance of more than 10 K ohms requested. The calibration curves for the transducers will be furnished by WSI. This information was provided by Mr. Robert Cook during our 11 July visit to WSI.

GMD DATA-ACQUISITION SYSTEM

In addition to the radar data system, NCAR will provide a second data-acquisition system which will accept the output of a GMD-1B and convert temperature, humidity, reference, and antenna azimuth and elevation angles into digital form at the rate of about one channel every second, and with accuracy comparable to that of the original GMD. (The 1/20-degree accuracy indicated by the GMD manual was mentioned in the discussion, and it was remarked that shaft angle converter prices increase rapidly when the accuracy requirement increases only modestly. Garstang felt that it was important not to reduce accuracy in the Experiment. It was brought out that it may not be possible to convert meteorological data into digital format unambiguously with the present types

of radiosondes. Manual entry or operation was mentioned as an alternative; this seemed acceptable to Garstang. He also suggested we talk to Larry Davis of Penn State, who has told him that this activity is now commonplace.

TRANSPORTATION

Present plans call for use of the U.S. Coast and Geodetic Survey Ship *Discoverer* to move scientific and support equipment to Barbados. Equipment to be moved is listed in the Appendix, and amounts to about 110,000 lb or 9000 cu ft.

PARTICIPATION

Present plans call for about 30 participants in the Barbados Experiment, including FSU faculty members and graduate students. Prof. La Seur (FSU) will be scientific coordinator. Col. Bob Peterson (USAF, ret.), who recently joined the FSU staff, will coordinate logistics and maintain some of the instrumentation.

On completion of the FSU experiment in 1968, ESSA may continue the same type of research, but on a much larger scale, in 1969. In discussion with the Prime Minister of Barbados, Garstang indicated that if the Barbados Experiment is successful, TROMEX may be based on Barbados instead of in the Marshall Islands.

SUMMARY OF NCAR SUPPORT

Based upon the information contained in the "Request to the NCAR Field Observing Facility for Support for the 1968 Barbados Experiment," and the Field Observing Facility's evaluation of that request, NCAR has formally committed the following to the Barbados Experiment:

1. Loan of a data-acquisition system for use on an M-33 tracking radar. This system will provide X, Y, and Z coordinates unambiguously defining the position of a tracked target, and the temperature and humidity information transmitted from that target, in computer-compatible digital form.

2. Loan of a data-acquisition system for use on a GMD-1B. This system will provide conversion of temperature, humidity, reference, and azimuth and elevation antenna shaft angles into computer-compatible digital form.
3. Loan of an 8-channel analog tape recorder (P.I. 6100).
4. Loan of eight MRI Mechanical Weather Stations with raingage attachments.
5. Crew to man the M-33: one operator and one technician for the duration of the field program.
6. Two technicians, also for the duration of the field program, to service instrumented towers and/or buoys provided by Geodyne, Inc. These technicians will attend a training program at Geodyne in May 1968, prior to the field operations.
7. One radar and one GMD-1B for field trials at Boulder in August 1967. The field trials will demonstrate the application of the NCAR data-acquisition equipment, and will consist of approximately ten single transponder flights, five triple transponder flights, and thirty radiosonde flights. Helium will be provided by NCAR.

The following items were requested subsequent to the formal commitment of equipment listed above, and will also be furnished by the FOF:

1. Loan of three base and two mobile VHF-FM communications transceivers, tuned to 151.760 (primary) and/or 151.840 MHz (secondary, in case sets are two-channel type).
2. Spare components for the M-33 radars at present on Barbados, in accordance with a list recently furnished.

On the basis of the survey trip, it appears that additional support and assistance from NCAR would be desirable to insure the success of the field program. It is therefore recommended that additional support be offered, as follows:

1. That NCAR make arrangements with the Air National Guard for transportation of equipment and supplies.

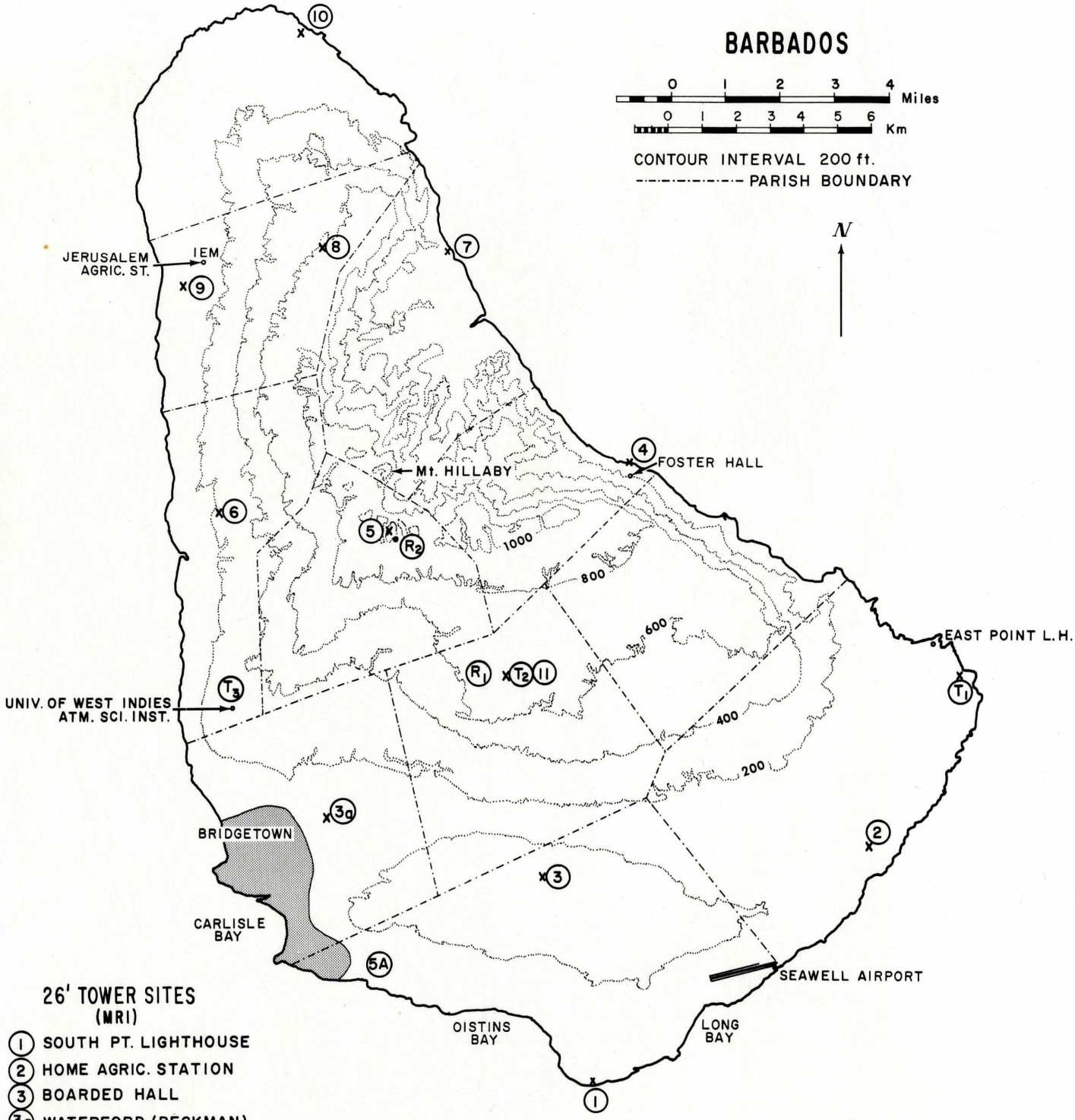
2. That additional personnel be made available to (a) assist in the operation and maintenance of the data-acquisition systems furnished by NCAR; (b) install communications equipment and assist in maintenance of the MRI weather stations; and (c) coordinate the efforts of NCAR personnel and assist in logistics and technical problems.

3. That the FOF supply one or two standby generators to help insure continuous generator operation. On the basis of past experience, FOF does not believe that gasoline-driven generators can be expected to run continuously with only a single standby.

4. That the FOF provide an adequate store of running spares for the GMD-1B rawinsonde equipment, or assign one GMD to the program. This recommendation results from FOF's previous experience with GMD-1B rawinsonde equipment.

APPENDIX

	Weight (lb)	Volume (cu ft)
Buoys (3)	25,770	1,867
T. Balloons (3)	870	31.5
S. P. Balloons	570	62
Tetroons	300	48
Radar (M-33)	8,784	752.5
Rawinsonde	1,600	280
Generators	1,600	232.5
Cameras	40	9
Towers: (3) Fixed (52')	6,525	1,797
(1) Mobile (52')	1,260	227
(11) Fixed (26')	2,200	352
Communications	340	6
Wind Tunnel	4,050	516
Portable Lab	10,000	1,088
Expendable Supplies	24,400	1,050
Vehicles: (4) Jeeps and (4) Trailers	15,600	435
Radiation Instr. (3) Cases	600	12
Drague (winch)	2,000	27
Misc.: (a) Power tools	170	9
(b) Hand tools	200	9
(c) Household items	1,000	100
(d) Test equipment	1,000	36
(e) Med. supplies	200	12
TOTAL	109,279	8,958.5
	(54.6 tons)	



26' TOWER SITES (MRI)

1. SOUTH PT. LIGHTHOUSE
2. HOME AGRIC. STATION
3. BOARDED HALL
3a. WATERFORD (BECKMAN)
4. BATHSHEBA
5. LION CASTLE
5A. ROCKLEY (WATKINS)
6. LANCASTER
7. MORGAN LEWIS
8. WELCH TOWER PLTN.
9. COLERIDGE PARRY SCHOOL
10. NORTH PT. SURF RESORT
11. COTTAGE

52' TOWER SITES

- T_1 COLES (RAGGED PT.) (COM F_2)
- T_2 COTTAGE (COM M_1)
- T_3 HUSBANDS (COM F_3)

RADAR SITES

- SITE R_1 COTTAGE } COM$_F$
- SITE R_2 LION CASTLE } COM$_F$

COM M_2 REMAINS MOBILE