



PRESIDÊNCIA DA REPÚBLICA
CONSELHO NACIONAL DE PESQUISAS
COMISSÃO NACIONAL DE ATIVIDADES ESPACIAIS
S. José dos Campos, S.P. - Brasil

C. 268-DC/63
São José dos Campos,
November , 1963

Lt. - Col. Charles J. Lyness
Chief, LAOAR
U. S. Embassy
Caixa postal 699
Rio de Janeiro, Brasil

Dear Col. Lyness:

The Radioscience Laboratory (RSL) of Stanford University has a contract AF 19(604)-8046 for research and studies of long distance and around-the-world radio wave propagation with the Air Force Cambridge Research Laboratories.

As you know, we at CNAE are also interested in this field of investigation. Recently RSL submitted a proposal to AF CRL for continuing research in which we were to participate by establishing and operating a receiving station (in the vicinity of the magnetic equator) with a G/A model 903 step frequency receiver.

I have been informed that Mr. Ming Wong, of AF CRL, who is the branch chief supervising the Stanford contract, has consented RSL to lend us their receiver for the proposed research if support can be found from sources external to AF CRL.

In view of the information of the last paragraph, we are submitting by the present letter to OAR through your office the same Stanford proposal in which we have modified the estimated cost breakdown to include only the funding necessary to complement CNAE's expenditure in the experiment.

FM/bdr

Sincerely yours
F. de Mendonça
Fernando de Mendonça, PhD
Scientific Director



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STUDIES OF LONG DISTANCE
AND AROUND-THE-WORLD RADIO WAVE
PROPAGATION WITH AID OF STEPPED-
-FREQUENCY SOUNDING EQUIPMENT

PROPOSAL Nº 6

SUBMITTED TO THE
OFFICE OF AEROSPACE RESEARCH
THROUGH LAOAR

NOVEMBER 1963
SÃO JOSÉ DOS CAMPOS
SÃO PAULO - BRASIL

INFORMATION SHEET

1) Name and address of prospective grantee:

COMISSÃO NACIONAL DE ATIVIDADES ESPACIAIS (CNAE)
SÃO JOSÉ DOS CAMPOS -SÃO PAULO -BRASIL

2) Title of Proposed Research:

STUDIES OF LONG DISTANCE AND AROUND-THE-WORLD
RADIO WAVE PROPAGATION WITH AID OF STEPPED-
-FREQUENCY SOUNDING EQUIPMENT

3) Desired Starting Date of Research:

January 1964

4) Time Period for which support is requested:

One year

5) Investigators:

From Stanford University: Prof. O.G. Villard, Jr., Dr. Robert B. Fenwick, Mr. Larry Roben

From CNAE : Dr. F. de Mendonça and Prof. J.L. Muzzio

6) Description of Proposed Basic Research:

See Stanford University proposal on following pages.

7) Estimated cost breakdown for the part of the research to be executed by CNAE with OAR funds:

Total - US\$ 17 500 - See details on the last page.

PROPOSAL TO
AIR FORCE CAMBRIDGE RESEARCH LABORATORY

FOR

STUDIES OF LONG-DISTANCE AND AROUND-THE-WORLD
RADIO WAVE PROPAGATION WITH THE AID OF STEPPED-FREQUENCY
SOUNDING EQUIPMENT

FOR A PERIOD OF ONE YEAR

SUBMITTED BY
RADIOSCIENCE LABORATORY
STANFORD ELECTRONICS LABORATORY
STANFORD UNIVERSITY
STANFORD, CALIFORNIA

OCTOBER 14, 1963

Studies of a round-the-world (RTW) hf radio propagation have been conducted at Stanford University since 1961 with the aim of better elucidating the mode structure in RTW and very long-distance radio paths. From this work, a theory and much information have become available concerning RTW signals, such as LOF, MUF, time delays, pulse dispersions, apparent ray paths, and so on (Refs. 1, 2, 3, and 4).

It is very desirable to obtain a further check of the theory by additional multi-frequency experiments using stepped-frequency forward-propagation ionospheric sounders operating on very long paths.

AFCRL currently has a G/A Model 903 step frequency receiver located at WSU in Pullman, Washington which could be easily modified for use on this program. This modification would enable the selection of up to 8 programs by means of a punched tape and motorized tape reader. Present programs planned by AFCRL for the WSU receiver would not be affected by the additional reception tasks, and the potential usefulness of the 903 for other research would be greatly increased. Thus, by using currently-available equipment on another AFCRL program, and for very little additional cost, the Air Force could support a worth-while scientific experiment designed to answer important questions on RTW propagation.

Specifically, the studies at Pullman would greatly increase knowledge of the spatial distribution of RTW energy in the vicinity of the transmitter. Comparison of these data with that simultaneously obtained at Stanford and at a Lubbock, Texas receiving site (sponsored under an Office of Naval Research Contract) should make possible an accurate estimate of both the average width of the azimuthal sector in which RTW propagation is possible from Stanford and the degree of focusing of the RTW signal energy. Both of these factors should vary with time and frequency, but the nature of this dependence is not presently clear. Better understanding of these points is important from the practical point of view, and would also provide important clarification or confirmation of the theory.

In winter, best RTW propagation takes place generally on east-west paths. At this time of year, RTW propagation from Stanford to Pullman, which is nearly north of Stanford, would not be expected, and reception data taken at Pullman would indicate the degree to which RTW energy is focused. During summer, RTW propagation should be expected on the Stanford-Pullman path during the sunset period. At this time, comparison of the received frequency band at Pullman with that at Stanford, as a function of time, would provide valuable information on propagating azimuthal width and on ground energy distribution.

The addition of the Pullman site to the RTW experiment is thus very desirable due to the location of Pullman - to the north of Stanford. The implementation of the experiment described at this site is not possible under the existing ONR contract, owing to lack of funds.

In addition to the Pullman experiment, it is proposed that transmissions from Stanford be received on both "long" and "short" paths to Brazil, as well as at Stanford by means of RTW propagation. The location of eastern Brazil, east of Stanford, is particularly favorable for such an experiment. This would be accomplished by furnishing the existing AFCRL G/A 903 receiver, currently at Stanford, to the Comissão Nacional de Atividades Espaciais.

The choice of the CNAE site near Natal, Brazil was suggested by Dr. Fernando de Mendonça. Dr. de Mendonça obtained his Ph. D. from Stanford University in 1961 and remained at the University for a year of post doctoral research. In his present position, Dr. de Mendonça is the director of the ionospheric research section of CNAE (the Brazilian counterpart of NASA). He has expressed a keen desire to conduct research experiments of the type described in this proposal in Brazil, and we feel that he and his staff would be most competent in this task. The projected costs for doing this research appear to be quite reasonable since CNAE assumes the cost of housing, power, and shipping of the equipment from the Brazilian Embassy in Washington, D. C., by carrier airplane. This procedure eliminates the customs problem one normally encounters in dealings with foreign nations. Stanford would supply the equipment, spare parts, film, shipping to Washington, D. C., and the salary of one full-time engineer (\$ 400/month).

Through comparison of long and short path reception at Brazil with the RTW propagation at Stanford in the direction of Brazil, a further, and very valuable, test would be made of the existence, locations, and importance of ionosphere-to-ionosphere modes (Ref. 4) in long distance hf propagation. Such an experiment, involving long and short path propagation, as well as RTW propagation on a given path and on a stepped - frequency basis, should provide much new information concerning very long-distance propagation characteristics and is particularly attractive at this time due to the opportunity provided to perform the work with relative ease and at comparatively low cost. Summarizing, it appears extremely desirable to conduct research in Brazil with CNAE from scientific, political, and economic standpoints.

The existence of the 903 receiver in Brazil would enable further studies of transequatorial hf propagation to take place. (The long path between Stanford and northern Brazil would be transequatorial; the short path would not.) This data would be available to AFCRL for transequatorial propagation studies involving their other G/A sounders now located in Puerto Rico and Uruguay. It should be pointed out that the site in Brazil (somewhere in the vicinity of Natal) would lie nearly on the Stanford-Puerto Rico great circle.

Almost all of the equipment required to perform the above outlined experiments is presently available. The purchase of additional equipment involves only two antennas and a suitable film recording system for Brazil.

Data reduction on the RTW program will be conducted at Stanford. Supplementary computer ray tracings will be performed to validate the RTW propagation modes.

Stanford will also perform ray tracings for AFCRL on their trans-equatorial propagation paths and continue to serve as consultants to their program involving step-frequency ionospheric soundings.

References.

1. R. B. Fenwick and O. G. Villard, Jr., Round-the-world high-frequency propagation, TR 71, Radioscience Lab., Stanford Univ., Stanford, Calif., Contract Nonr 225(64), April 1963.
2. R. B. Fenwick and O. G. Villard, Jr., The effect of magnetic storms on around-the-world high-frequency propagation, Journal of Geophysical Research, 68, 4683-4688, August 1963.
3. R. B. Fenwick and O. G. Villard, Jr., Measurements of the frequency dependence of round-the-world, HF pulse time delays and dispersions, Proc. IEEE, 51, 1240-1241, September 1963.
4. R. B. Fenwick and O. G. Villard, Jr., A test of the reality and practical importance of ionosphere-ionosphere reflections in long-distance HF propagation, TR 76, Radioscience Lab., Stanford Univ., Stanford, Calif., Contract Nonr 225(64), May 1963.

- C N A E -

ESTIMATED COST BREAKDOWN

For a Period of One Year

I. Direct Salaries		
Scientific Personnel	#	
Technical Personnel (12 man months at \$ 400)	4 800.	
Secretarial Service	#	4 800.
II. Capital Equipment		
Granger Associate Model 541 A Camera System	4 500.	
Hy-Gain Log Periodic Antenna 13-30 Mc	1 200.	
Housing and installations	#	5 700.
III. Expendable Supplies		
Film	500.	
Spare Parts	3 000.	3 500.
IV. Miscellaneous		
Reports	500.	
Power	#	
Communications	#	
Travel (two trips USA-Brazil)	3 000.	
Freight	#	3 500.
Total		US\$17 500.

CNAE will fund the items marked with # which are estimated to be US\$ 15 000.00. This cost breakdown does not include the price of the AFCRL G/A 903 receiver, currently at Stanford and to be furnish to CNAE.