

MEASUREMENTS OF ABSORPTION OF RADIO WAVES IN THE LOWER IONOSPHE- RE AND RELATED STUDIES

PROPOSAL LAFE-4/63

SUBMITTED TO THE
OFFICE OF AEROSPACE RESEARCH
THROUGH L. A. O. A. R.

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Espaciais

Laboratório de Física Espacial
São José dos Campos
SÃO PAULO—BRASIL
December 1963

C. 324-DC/63
São José dos Campos,
December, 1963

Lt. Col. Charles J. Lyness
Defense Research Office (LAOAR)
U. S. Regional Science Office
Caixa postal 699
Rio de Janeiro

Dear Col. Lyness:

With reference to your letter of 3 Dec. 1963 mentioning the letter of Dr. S. Horowitz (see enclosed copy) we would like to affirm that we are most interested in continuing to operate for AFCRL the 30 Mc/s riometer at our station in São José dos Campos under a one dollar per year contract. We desire to retain the riometer (ARI serial N^o 157) and Esterline Angus recorder (serial number 142627) presently with us as government furnished equipment. In order to operate it we would need only 50 rolls of recording paper per year and possibly a few spare transistors.

We also would like to expand the riometer measurements in order to be able to obtain electron density profiles of the D region. For such an experiment we are presently submitting to you the proposal which follows.

Sincerely yours



Fernando de Mendonça, PhD
Scientific Director

FM/bdr

CRUP/S. Horowitz/3137

Cosmic Noise Data Collection

U. S. Regional Science Office for Latin America
Department of Defense
Air Force Element (LAOAR)
U. S. Embassy, Rio de Janeiro
APO 676, New York, N. Y.

The Brazilian Space Agency has been operating a 30 MC riometer for AFCRL under a sub-contract from Stanford Research Institute. Since the SRI contract will not be extended, it is requested that your organization investigate the possibility of continuing the riometer data collection program. The data is of interest to AFCRL and CNAE and a one dollar per year contract is proposed. The operation in Brazil is under the supervision of Dr. Fernando de Mendonca located at the Comissao Nacional de Atividades Espaciais, S. Jose dos Campos, S. P., Brazil.

SAMUEL HOROWITZ
Ionospheric Properties Branch
Upper Atmospheric Physics Laboratory

cc: Dr. Fernando de Mendonca

PROPOSAL OF SCIENTIFIC RESEARCH

TO BE SUBMITTED TO THE

U. S. AIR FORCE OFFICE OF SCIENTIFIC RESEARCH

THROUGH THE

LATIN AMERICAN OFFICE OF AEROSPACE RESEARCH

BY

COMISSÃO NACIONAL DE ATIVIDADES ESPACIAIS

SÃO JOSÉ DOS CAMPOS (SP)

BRASIL

PROPOSAL OF SCIENTIFIC RESEARCH
AIR FORCE OFFICE OF SCIENTIFIC RESEARCH
LATIN AMERICAN OFFICE OF AEROSPACE RESEARCH

Submitted by the prospective grantee institution:

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

1. - Title of proposed research:

MEASUREMENTS OF ABSORPTION OF RADIO WAVES IN
THE LOWER IONOSPHERE AND RELATED STUDIES.

2. - Absorption measurements with a riometer:

Since March 16, 1963 a 3. Mc/s riometer (relative ionospheric opacity meter) has been in operation at CNAE's laboratory in São José dos Campos. The primary purposes of this experiment are the measurements of the non-deviative absorption of waves in the lower ionosphere, its correlation with solar phenomena and the bremsstrahlung radiation from high energy particles trapped in the earth's magnetic field close to the South Atlantic anomaly.

The riometer consists of a high gain receiver capable of switching automatically between an antenna and a noise diode. The absorption is measured by comparing the signal actually received with the signal received in the same system, at the same sidereal time under conditions of zero absorption. This method of measurement of absorption is called "Cosmic Noise Method". The riometer so far operating at this site, at the frequency of 30 Mc, has been providing continuous measurements on the D-region absorption. Also absorption correlation with solar flares and magnetic disturbances can be detected. This riometer has been provided to us by the Air Force Cambridge Research Laboratory (Mr. S. Horowitz) through the Stanford Research Institute (Stanford, California, U.S.A.) (Dr. Rolf B. Dyce). We are cooperating with the mentioned research groups by providing them with data from our station.

3. - Description of the research to be undertaken:

Ionospheric absorption is one of the important controlling factors in the propagation of radio waves via the ionosphere. By absorption measurements one can also establish some of the parameters consi

dered in the formation of the ionized regions above the earth. Ionospheric disturbances related to magnetic storms and solar events can considerably reduce the conditions for the propagation of radio waves, by increasing the absorption in the ionosphere. So, from the standpoint of communications it is of great interest to study the variations of ionospheric absorptions. Our plan of enlarging the studies on the lower ionosphere, through this proposal, consists of setting up a few more riometers at São José dos Campos operating in different frequencies, in order to obtain electron density profiles of the D-region. This can be done by simultaneous measurement of absorption in different frequencies during ionospheric disturbances. By assuming a model of electron collision frequency with height, it is possible to calculate a distribution of electrons responsible for the recorded absorption.

It would be desirable to operate receivers in a few different frequencies, say 5⁺, 5- Mc, 10⁺, 10- Mc, 20⁺, 20- Mc, 30 Mc and 50 Mc. The selection of frequencies to operate were obtained from the work of Parthasaraty, Lerbald and Little (JGR, Vol. 68 June 15, 63) who carried similar experiment in the auroral zone. The receiver for 30 Mc is already in operation at our laboratory in São José dos Campos.

The superscripts plus and minus in the frequencies above denote the ordinary and extraordinary polarizations which in low frequencies (up to 20 Mc) can provide data as a pair of effectively independent frequencies. In this way for each of the low frequencies a single receiver could be used with an electronic switch and convenient circularly polarized antennas which would reject the unwanted mode. It would also be desirable to operate another riometer at CNAE's laboratory near the magnetic dip equator in Northeastern Brazil.

4. - Time period for which support is requested:

The requested support is desired for a length of time of 5 years. The minimum period of 2 years is required to cover the Quiet Sun Year which is going to start in December 31, 1963. Further operation is of interest to compare the measurements during the Quiet Sun Year with the results in the subsequent period of increasing solar activity.

5. - Grantee's facilities:

The Comissão Nacional de Atividades Espaciais (CNAE), which is under the Brazilian National Research Council, has established a research center near São José dos Campos (São Paulo) where the principal interests lie within the field of research in radiophysics and space science. CNAE's Radiophysics Laboratory is a new institution which so far has started the following research projects:

a) - Observation of atmospheric noise in various frequencies with U. S. National Bureau of Standards sponsorship;

b) - Observation of solar noise in various frequencies by

means of a sweep frequency receiver (with Carnegie Institution equipment);

c) - Studies on the ionospheric electron content and its variations (diurnal, transequatorial, through the Brazilian anomaly, etc) from satellites observations (NASA loaned equipment);

d) - Studies on the ionospheric absorption with a riometer (AFCRL equipment through Stanford Research Institute);

e) - VLF propagation problems.

In a near future (a few months) it is intended to enlarge the topics of research to include:

i) Ionosounding (vertical continuous scanning frequency and step-sounding);

ii) Magnetometry (protons precession and/or rubidium vapor magnetometers);

iii) Solar radioastronomy;

iv) Airglow (6300A and 5577A lines).

CNAE's laboratory in São José dos Campos has also the active cooperation of the personnel and can make use of the facilities of the near by Instituto Tecnológico de Aeronáutica, which is a government sponsored school of Engineering with undergraduate and graduate courses in electronics, mechanics and aeronautics. This school has over one hundred professors and assistants and about five hundred students.

6. - Biographic informations of the investigators:

a) Dr. FERNANDO DE MENDONÇA

Graduated from the Brazilian Air Force Academy in 1953. Studied engineering (electronics) at the Instituto Tecnológico de Aeronáutica (1954-1958) receiving the degree "Engenheiro de Eletrônica" with a "Summa cum Laude". Did postgraduate work at Stanford University from March 1959 receiving the PhD degree (December 1961), with dissertation on "Ionospheric Electron Content and Variations Measured by Doppler Shifts in Satellite Transmissions". From January through December 1962 was a Research Associate at the Radioscience Laboratory at Stanford University (California) and simultaneously represented CNAE in the United States. Since January 1963 has been the Scientific Director of CNAE. Dr. Mendonça is a member of American Geophysical Union, Institute of Electrical and Electronics Engineers, Society of the Sigma

List of publications in learned journals and reports:

1958 - "Minitrack Station Report - ITA", in coauthorship with J. A. M. Coutinho;

1960 - "Some Characteristics of the Signal Received from 1958 § 2", Dec. issue of the Proc. of the IRE; coauthors: O.K. Garriott and O.G. Villard Jr.

1961 - "Ionospheric Electron Content - Report N° 2-RsL" - Prepared under a grant from the National Aeronautics and Space Administration (PhD dissertation).

1962 - (a) - "Ionospheric Electron Content Calculated by a Hibrid Faraday-Doppler Technique"; Journal of atmospheric and Terrestrial Physics, Vol. 24, April; coauthor: O.K. Garriott.

1962 - (b) - "The Effect of the Earth's Magnetic Field on Measurement of the Doppler Shift of Satellite Radio Transmissions"; Journal of Geophysical Research, Vol. 67, May; coauthor: O.K. Garriott.

1962 - (c) - "Ionospheric Electron Content and Variations Measured by Doppler Shift in Satellite Transmissions"; Journal of Geophysical Research, Vol. 67, June.

1962 - (d) - "Ionospheric Studies with the Differential Doppler Technique"; Tech. Report N° 3-RsL - Stanford University, June 62, and "Radio Astronomical and Satellite Studies of the Atmosphere"; edited by Jules Aarons, North-Holland Publishing Co., 1963.

1963 - (a) - "A comparison of methods used for obtaining electron content from satellite observations"; CNAE Tech. Report N° 1 and also in the Sept. 1, 1963 issue of J. G. R.; coauthor: O.K. Garriott.

1963 - (b) - "Latitudinal variation of the ionospheric electron content through the equatorial anomaly", in preparation; CNAE Tech. Report N° 3.

b) MARIA ALICE SETTE

Received a BS in Physics (1953) in the Catholic University of São Paulo, Brazil. During the period 1958-1960 was a Technical Assistant in the Engineering School (University of São Paulo) working on ionosphere research. During 1960-1962 did graduate studies in electrical engineering at Stanford University, California, U.S.A. Presently Miss Sette is a Research Assistant at CNAE with the radiophysics group.

7. - Cost estimate:

a) Personnel	Per year
F. de Mendonça (10% time)	#
M. A. Sette (100% time)	2400.00
1 student (20% time)	#
1 radio technician (20% time)	400.00
2 data reduction clerk (100% time)	#
	<u>\$ 2800.00</u>

b) Permanent equipment	
4 Riometers ARI mark II (5, 10, 20, 50 Mc/s) at \$ 3000	12000.00
4 Antennas at \$ 400	1600.00
4 Esterline-Angus recorders at \$ 300	1200.00
1 Powerline Regulator	80.00
1 Powerline Filter	50.00

1 Electronic Voltmeter HP 410C 410.00
 \$ 15340.00

c) Expendable supplies and spares:

Esterline Angus Recording paper (50 rolls per year per riometer) 200.00
 Transistor, diodes, pens etc 50.00
 Coaxial cables \neq
 \$ 250.00

d) Publication costs:

Data summaries and reports..... \neq
 Publication in periodical and reprints..... 250.00
 Scientific books 40.00
 \$ 290.00

<u>Summary of costs</u>	<u>1 year</u>	<u>5 years</u>
a - Personnel.....	2800.00	14000.00
b - Permanent equipment.....	15340.00	15340.00
c - Supplies and spares	250.00	1250.00
d - Publications	290.00	1450.00
Totals.....	<u>U.S. \$ 18680.00</u>	<u>32040.00</u>

\neq All the amounts marked with this sign will be provide by CNAE. The yearly average for the time proposed is U.S. \$ 6408.00, for AFCRL and US\$ 3000.00 for CNAE.

8. - References:

Parthasaraty, R, Lorfald, G.M. and Little, C.G., "Derivation of Electron Density Profiles in the Lower Ionosphere Using Radio Absorption Measurements at Multiple Frequencies", J.G.R., Vol. 68, 3581, June 15, 1963;

Little, C.G. and Leimbach, H., "Some Measurements of High-latitude Ionospheric Absorption Using Extra-terrestrial Radio Waves", Proceedings of IRE 46, 334, 1958;

Little, C.G. and Leimbach, H., "The Riometer - A Device for the Continuous Measurements of Ionospheric Absorption", Proceedings of IRE 47, 315-320, 1959;

Mitra, A.P. and Shain, C.A., "The Measurements of the Ionospheric Absorption Using Observations of 18.3 Mc/s Cosmic Radio Noise", J. Atmosph & Terrestrial Physics, Vol. IV, 1959, pp 204-218;

Lusignan, B.B., "Cosmic Noise Absorption Measurements at Stanford, California and Pullman (Washington)", J.G.R., Vol. 65 December 1960, pp 3896-3902;

Goldmann, S.S. and Horowitz, S., "Global Riometer Measurements", (presented in the COSPAR IV International Space Source Symposium, June 63);

Nakada, M.P., "High Energy Electrons in the Radiation Belt", J.G.R., Vol. 68 January 1, 1963, pp 47;

Ochs, G.R., Farley, D.T., Bowles, K.L. and Bandyopad-

kay, P., "Observations of Synchrotron Radio Noise at the Magnetic Equator Following the High-altitude Nuclear Explosion of July 9, 1962", J.G.R., Vol. 68 February 1, 1963, pp 701;

Dyce, R.B. and Horowitz, S. "Measurements of Synchrotron Radiation at Central Pacific Sites", J.G.R., Vol. 68 February 1, 1963, pp 713;

Peterson, A.M. and Hower, G., "Synchrotron Radiation from High Energy Electrons", J.G.R., Vol. 68 February 1, 1963, pp 723;

Holt, Olav, "Multistation Riometer Observation of Sudden Ionospheric Disturbances".