ΑΝΑΚΟΙΝΩΣΕΙΣ ΜΗ ΜΕΛΩΝ

ΜΕΤΕΩΡΟΛΟΓΙΑ.— **The Cyprus - Crete transhorizon radio - link,** *by Michael Anastasiadis and Olympia Lainiotou**. Ἀνεκοινώθη ὑπὸ τοῦ Ἀκαδημαϊκοῦ κ. Ἠλ. Μαριολοπούλου.

Two years ago the Greek Telecommunication Authority tested a new scatter tropospheric radio link between the island of Crete and the island of Cyprus in the SE part of the Mediterranean sea. The entirely over sea path, is 540 km long and tested frequencies were in the 800 Mhz and the 900 Mhz bands (fig. 1).

The statistical analysis of the field strength recordings, usually refers to long periods of time. However during these long time periods many propagation mechanisms may interfere. These mechanisms are caused by many different factors. The fact that laws with an appreciable deviation from the normal distribution Rayleigh law are quite frequent, is an indication that the propagation mechanism consists of an interference between random and coherent phenomena.

The statistical analysis of recordings with amplitude fluctuations must refer to static phenomena i. e to statistical laws which are independent of the considered time period. It is known however by long experience, that fluctuations may be considered «static» only when the analysis refers to recordings obtained during periods of time of the order of a few minutes.

It would then be of importance to restrict the analysis on recording obtained in as short as possible time periods.

In this way it is possible to isolate the physical phenomena responsible for the differences which appear in propagation mechanisms.

Special technique is applied for this short period recordings. The time constant of the instrument must be less than one second and the unrolling of the recording paper must be fast or very fast.

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* ΜΙΧΑΗΛ ΑΝΑΣΤΑΣΙΑΔΟΥ καὶ ΟΛΥΜΠΙΑΣ ΛΑΪΝΙΩΤΟΥ, Ἐπίδρασις τῶν μετεωρολογικῶν παραγόντων ἐπὶ τῆς ἐντάσεως τοῦ ἠλεκτρομαγνητικοῦ πεδίου κατὰ τὴν πέραν τοῦ ὁρίζοντος σύνδεσιν Κρήτης - Κύπρου.

A short period fast recordings may present greater or smaller slope in the signal strength versus time diagram, than the slope observed from longtime periods recordings.

Consequently comparison of these slopes can reveal the physical phenomena corresponding to different propagation mechanisms. Exami-

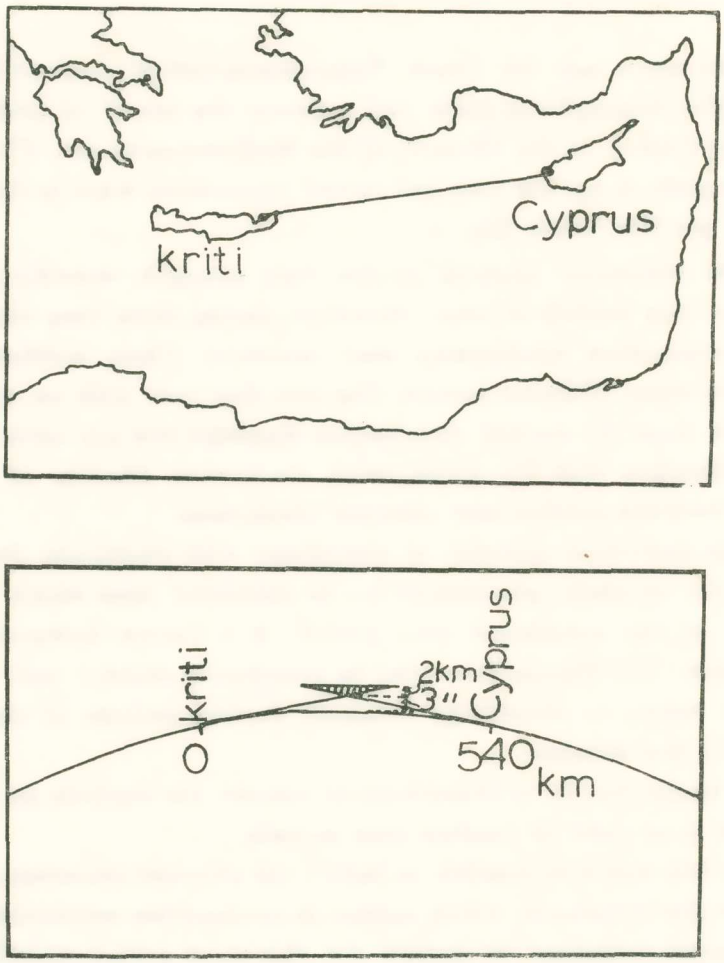

Fig. 1

nation of the normal Rayleigh slopes indicates that the physical phenomena responsible for the propagation mechanisms affect in random way the phases of the vector but not the amplitude. When amplitude and phases are not constants the distribution curve is of a greater slope and

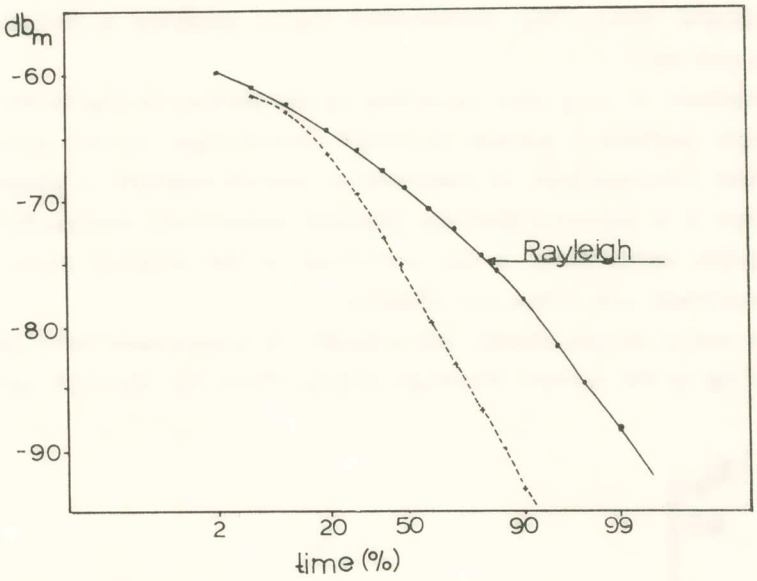
db$_m$
-60
-70
-80
-90
Rayleigh
2
20
50
90
99
time (%)

Fig. 2a

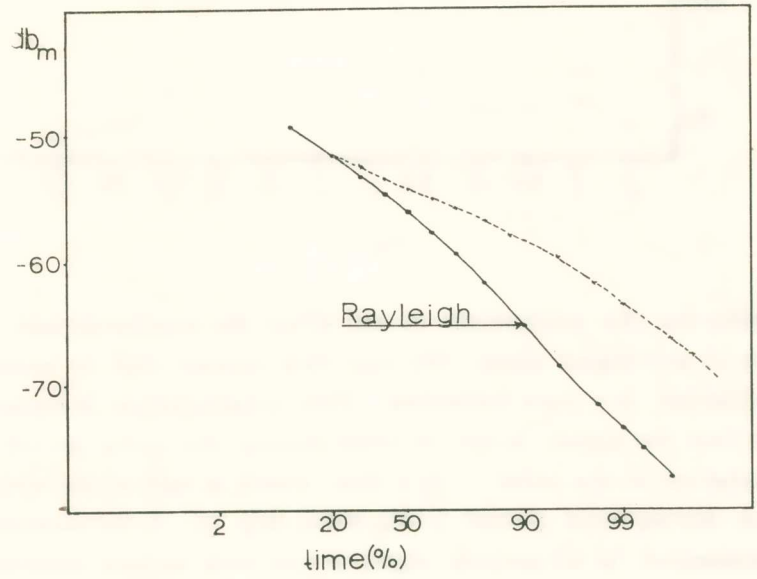
db$_m$
-50
-60
-70
Rayleigh
2
20
50
90
99
time(%)

Fig. 2b

in the contrary when vector amplitudes are constant but the phases have a privilaged value, the distribution curve presents a reduced slope (fig. 2a and 2b).

Analysis of long time recording in all periods of the Crete - Cyprus radio-link indicate a normal Rayleigh distribution. In cold period however short time analysis of distribution curves indicate a greater slope. Therefore it is assumed that the physical phenomena responsible for the propagation mechanism is the scattering of the incident wave, because both amplitude and phase are affected.

In warm period, slopes are reduced in comparison with those corresponding to the normal Rayleigh slopes. Then the physical phenomena

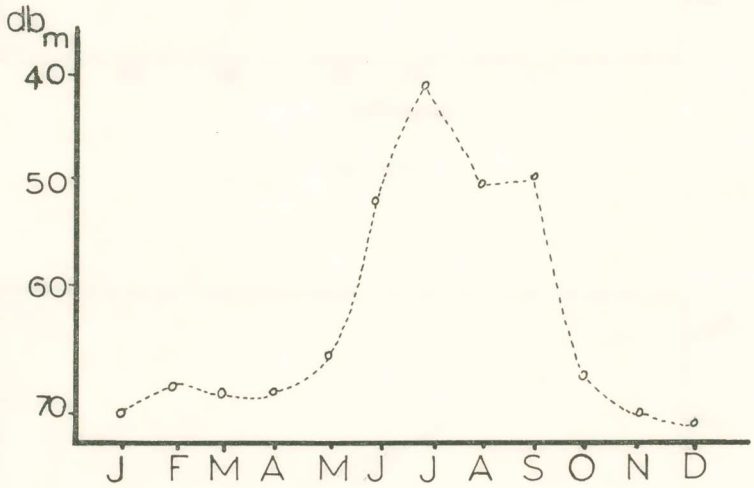

Fig. 3

responsible for this mechanism do not affect the amplitude and the vectors, are of privilaged phase. We may then assume that in warm period the mechanism is a pure reflection. This assummption is supported by the fact that the signal levels in Crete during the warm period present an attenuation of the order — 37.2 dbm which is half of the attenuation observed during cold period (— 64 dbm) (fig. 3). A correlation of the above measured in all periods signal levels with surface meteorological data will be almost completely unsuccesful. It is then obvious that in transhorizon links there are others than surface meteorological parame-

ters to be correlated with signal levels. The geometry rays of each transhorizon link indicate that following the climatology of each region earth profile and consequently the air volume, where rays issued from the transmitter and arriving to the receiver, reached by their meeting point, is different in altitude.

Refractivity gradient dN/dh computed from available meteorological data, in this SE part of the Mediterranean sea, indicates a value of the order of 40 in the cold period and almost the double, of the order of 90, in warm period. That indicate a path geometry of the meeting point of transmitted and received rays located in cold period in an altitude of 8.5 km and in warm period in an altitude of 3 km. The simplest way to check if it is really the air volume located in the above, following the periods altitude, responsible for a definite transhorizon propagation mechanism is to correlate the measured field strenght with one of the meteorological parameters characteristic of air masses located in high altitude. Such a characteristic parameter is for instance the variations of isobaric surfaces.

Table I shows correlation coefficients between field strengh variations and variation of isobaric surfaces for different altitudes during the cold period. We can see that the highest coefficient corresponds to the isobaric surface between 300 and 500 mb namely to air masses located around 8 km altitude. Table II shows correlation coefficient for the warm period. Air volume responsible for this transhorizon propagation mechanism is now located in altitude of 700 mb namely 3 km. Both altitudes indicated by the geometry in cold and warm period, are computed on the basis of measured refractivity indices during the above periods for this SE part of the Mediterranean.

Typical example of the truthfulness of the above method is signal analysis in some particular cases. In warm period for instance weather conditions producing characteristic steady signal levels, are followed sometimes by conditions very similar to those existing in cold period. Signal levels of days with steady values when correlated with isobaric surfaces of 700 mb (earth profile corresponding to the warm period) presents a correlation coefficient equal to 0.72, while with 500 mb the coefficient is only 0.44 (coefficient needed for significance 10 % 0.72). In the contrary for days with strong variations the correlation for 500 mb is

TABLE I

Isobaric in mb

Months	700	500	300
September	0.27	0.69	0.73
October	0.48	0 67	0.69
November	0.58	0.69	0.71
December	0.32	0.65	0.69

TABLE II

Isobaric in mb

Months	500	700	850
June	0.11	0.68	0.03
July	0.44	0.72	0.19
August	0.21	0.48	0.01

equal to 0,73 and for 700 mb is only 0.39 (coefficient needed for significance 10 % 0.62). The above typical examples may be repeated for a large number of cases with the same succesful results. They are completely consistant also with similar results observed in the Cairo - Ierapetra radio link (3). We may then conclude that transhorizon propagation conditions are the same in the E-W direction as well as in the N-E the S-E part of the Mediterranean sea.

A knowledgment:

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ΠΕΡΙΛΗΨΙΣ

Ἡ ἐπίδρασις τῶν μετεωρολογικῶν παραγόντων ἐπὶ τὴν ἔντασιν ραδιοηλεκτρικοῦ σήματος προερχομένου, εἴτε κατ' ἀπ' εὐθείας σύνδεσιν μεταξὺ πομποῦ καὶ δέκτου (ὀπτικὴ ἐπαφή) εἴτε κατὰ συνδέσεις πέραν τοῦ ὁρίζοντος, εἶναι ἀποφασιστική, ἔχει δὲ μελετηθῆ ἀπὸ μακροῦ καὶ εἰς πλείστας ἀνὰ τὸν Κόσμον περιοχάς. Τὰ ἀποτελέσματα τῶν ραδιομετεωρολογικῶν αὐτῶν παρατηρήσεων, δὲν ἔχουν μόνον θεωρητικὸν ἐνδιαφέρον ἀλλὰ καὶ ἀμέσους ἐπιπτώσεις ἐπὶ τοῦ ποσοστοῦ ἐκμεταλλεύσεως ραδιοηλεκτρικῆς τινὸς συνδέσεως.

Παρ' ἡμῖν αἱ σχετικαὶ μελέται ἤρχισαν μᾶλλον ἐνωρίς, ἀπὸ τοῦ 1958, ἀκολούθως δὲ καὶ κατὰ διεθνῆ συνεργασίαν, μὲ Ἰταλικὴν ἐρευνητικὴν ὁμάδα ἐμελετήθησαν καὶ αἱ συνθῆκαι συνδέσεως ὑπὲρ τὸν ὁρίζοντα εἰς τὸ στενὸν τοῦ Ottranto.

Τὰ ἀποτελέσματα συστηματικῶν μετρήσεων, γενομένων κατὰ τὴν σύνδεσιν Ο.Τ.Ε. μεταξὺ Κρήτης καὶ Κύπρου δύνανται νὰ θεωρηθοῦν συμπληροῦντα τὴν κατὰ τὴν διεύθυνσιν Α-Δ προγενεστέραν μελέτην ἤτοι μεταξὺ Καΐρου καὶ Ἱεραπέτρας Κρήτης.

Ἡ ἰσχύουσα τεχνικὴ προβλέπει ὅπως χαράσσωνται καμπύλαι τοῦ ποσοστοῦ χρόνου κατὰ τὴν διάρκειαν τοῦ ὁποίου ἡ μετρουμένη ἔντασις πεδίου διατηρεῖ μετρηθεῖσαν τινὰ τιμήν. Αἱ καμπύλαι αὗται ἀναφερόμεναι εἰς πεδίον δημιουργούμενον ἀπὸ ἄθροισμα ἀνυσμάτων, ἴσου περίπου πλάτους, ποικίλης ὅμως φάσεως, ὁδηγοῦν εἰς τὴν λεγομένην κατὰ Rayleigh κατανομὴν ἥτις ὁδηγεῖ εἰς καμπύλας γνωστῆς ἐξελίξεως, ἀρκεῖ ὁ ἀποτιμώμενος χρόνος μετρήσεως ἐντάσεων πεδίου νὰ εἶναι σημαντικός. Οἱ Ἀναστασιάδης - Παρασκευόπουλος ἀναλύοντες ἐγγραφήματα πεδίου παλαιότερον, ὑπέδειξαν ὅτι, ἂν ἡ ἀποτίμησις τῆς κατανομῆς ἐπιβραχυνθῆ, τότε προκύπτουν καμπύλαι Rayleigh μεγαλυτέρας κλίσεως τῆς κανονικῆς. Ἀπέδωσαν δὲ τὸν ἐλάχιστον ἐκεῖνον χρόνον ἀπὸ τοῦ ὁποίου ἀρχίζουν αἱ καμπύλαι νὰ παρουσιάζουν μεγαλυτέραν κλίσιν, ὡς ὁρίζοντα τὴν χρονικὴν ἐκείνην περίοδον

κατὰ τὴν ὁποίαν εἶναι δυνατὸν ἡ ἀέριος μᾶζα, ἡ παρεμβαλλομένη μεταξὺ πομποῦ καὶ δέκτου, νὰ διατηρῆται σύμφωνος πρὸς ἑαυτήν. Ἡ στατιστικὴ αὐτὴ ἀνάλυσις ἀπεδείχθη ὀρθὴ εἰς πάσας τὰς μελετηθείσας περιπτώσεις ὀπτικῆς ἐπαφῆς. Σκέψεις διατυπούμεναι κατ' ἐπέκτασιν τῶν ἀνωτέρω, ἐφαρμόζονται καὶ εἰς τὴν περίπτωσιν μιᾶς πέραν τοῦ ὁρίζοντος συνδέσεως, ἐπιτρέπουσαι ἐκ τῆς χαράξεως τῶν καμπύλων κατανομῆς καὶ ἐκ τῆς ἑκάστοτε κλίσεως αὐτῶν, νὰ ἀναχθῆ τις εἰς τοὺς μηχανισμοὺς οἵτινες κατὰ πᾶσαν ἔνδειξιν εἶναι ὑπόλογοι μιᾶς πέραν τοῦ ὁρίζοντος συνδέσεως.

Ἡ ἀνωτέρω θεωρητικὴ τοποθέτησις τῆς πέραν τοῦ ὁρίζοντος συνδέσεως, ἐδικαιώθη εἰς τρεῖς τουλάχιστον περιπτώσεις:

α) Κέρκυρα - Martina Franca.

β) Κάϊρον - Ἱεράπετρα.

γ) Ἤδη δὲ καὶ εἰς τὴν σήμερον ἀνακοινουμένην σύνδεσιν Κρήτης - Κύπρου.

Ἡ σύνδεσις αὕτη, πραγματοποιηθεῖσα διὰ λογαριασμὸν τοῦ Ο.Τ.Ε. ὑπὸ τῆς Ἑταιρείας Marconi, ὡδήγησεν εἰς πλοῦτον ἐγγραφημάτων ἐντάσεως πεδίου, τόσον ἐν Κρήτῃ ὅσον καὶ ἐν Κύπρῳ. Κατ' αὐτὴν ἀπεδείχθη ὅτι μετεωρολογικοὶ παράγοντες ἐπιφανείας ἐδάφους, οὐδεμίαν συσχέτισιν δύνανται νὰ ἔχουν καὶ μόνον αἱ μεταβολαὶ τῶν ἰσοβαρῶν ἐπιφανειῶν, αἵτινες ὑπολογίζονται κατὰ τὰς ἑκάστοτε περιόδους τοῦ ἔτους καὶ ὅπου εὑρίσκονται οἱ ὑπόλογοι ἑκάστου μηχανισμοῦ ὄγκοι ἀέρος, πρέπει νὰ λαβμάνωνται ὑπ' ὄψιν.