Sporadic-E layer and meteorological activity

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Abstract
Observations of Es layer performed at the ionospheric observatory of Rome from 1982 to 1989 have been used to investigate a possible correlation with cold front passages. Such a correlation may exist because of the AGW excited by tropospheric activity at cold front passages. A relationship with thunderclouds electrostatic field is also marginally considered. The treatment of data shows that the distributions of the frequencies of reflection at cold front passages present only small differences compared to normal days, both for the f and for the l type; therefore, a correlation between Es layer and meteorological activity cannot be affirmed.

Key words *sporadic-E layer – acoustic-gravity waves – meteorology*

1. Introduction

It is largely accepted that the sporadic-E layer is caused by transport of ionisation in wind shear conditions, due to the activity of acoustic-gravity waves (AGW). The first theoretical work on this subject was produced more than 30 years ago (Whitehead, 1961) and several experimental confirmations now exist (see, for example van Eyken *et al.*, 1982).

Many mechanisms have been suggested as sources of AGW: each is thought to be able to trigger different periods and wavelength oscillations. For example, the auroral zone is considered the source of large period oscillations (Chimonas and Hines, 1970), while the solar terminator is the source of medium period ones (Beer, 1973; Kato *et al.*, 1977). Meteorological activity is also thought as one of the possible sources of AGW observed in the ionosphere. For this reason, a correlation is expected between the sporadic-E layer and the meteorological activity. It has been found that the phenomena of sporadic E ionisation, cold fronts, and microbarometric activity are related in the geographic area of Brisbane, Australia (Shresta, 1971). The aim of the present work was to study such relationship with respect to the Mediterranean Sea area.

Meteorological effects on the ionosphere have been noted for a long-time; for example Fr. Gherzi in 1950 noted that the height of the ionospheric layers decreases in advance of the arriving of a hurricane, so he suggested the possibility of using such an experience for weather forecasts. Nowadays much literature on the link between ionosphere and troposphere is available; this link is due to several mechanisms (for a review see Kazimirovsky, 1985). Among these mechanisms we are dealing mainly with the propagation in the ionosphere of AGW of meteorological origin, but other kinds of interactions could exist. For the subject we are studying it is important to remember that the influence of thundercloud electrostatic fields on the ionosphere has been suggested too (see, for example Hegai *et al.*, 1990). In this work this kind of relationship is also marginally examined.

2. Data analysis

The data of the period 1982-1989 from the vertical sounding of the ionospheric observatory of Rome (41.8 N, 12.5 E) have been analysed. The frequencies of reflection and the height of occurrence of the sporadic-E layer have been examined. Attention has been focused on the f and l type.

The range of the frequencies of reflection considered is from 0.9 to 10.8 MHz and was divided into 32 equal intervals. The range of altitude from 72 to 144 km was chosen and was divided into 12 equal intervals.

The days in which cold fronts were passing on Central Italy were selected from the observations of meteorological maps. The distributions of the frequency of reflection and of height of occurrence were found for these days. The days between the passage of two cold fronts were then selected. The distributions of the frequencies of reflection and of heights of occurrence were also found for these days. If no correlation exists, it is easy to understand that these distributions are similar. The comparisons between the distributions are reported in the figs. 1 to 4.

3. Discussion

The results of the treatment of data do not show evidence of interactions between meteorological activity and sporadic-E layer. In fact, from the observation of the figs. 1 to 4 we note that the distributions of the heights and frequencies of reflections do not present substantial variations due to meteorological activity.

As we said, the interaction between tropospheric phenomena and sporadic-E layer is considered an effect of the gravity waves of tropospheric origin. This result, in which no correlation is evident, seems to be in contrast with that found by Shrestha in 1971. We assume that the geographic areas play an important role. In fact, it is possible that the gravity waves of tropospheric origin are broken by non-linear phenomena or are absorbed at the level of inversion of the zonal wind. These mechanisms are effective according to the wind shear that is geographically dependent (Lindzen, 1981, 1990).

It is also remarkable that the days chosen as meteorologically perturbed are the ones in which cold front passages in Central Italy were recorded. These are more or less the same days

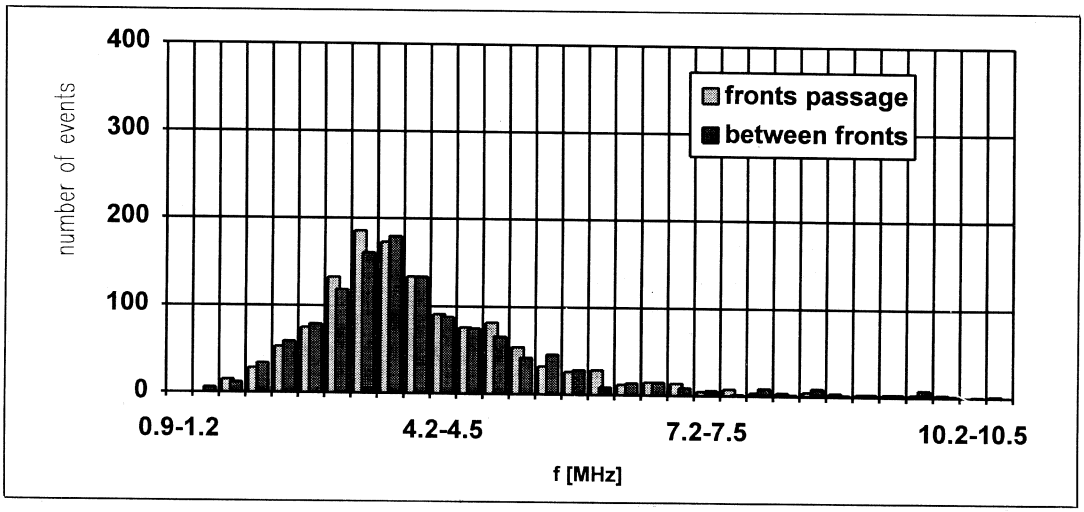

Fig. 1. Comparison between the distributions of the frequencies of reflection observed at cold front passages and between two fronts for the E sporadic layer, type l. Good agreement is found and this is interpreted as no correlation between meteorological phenomena and E sporadic ionisation.

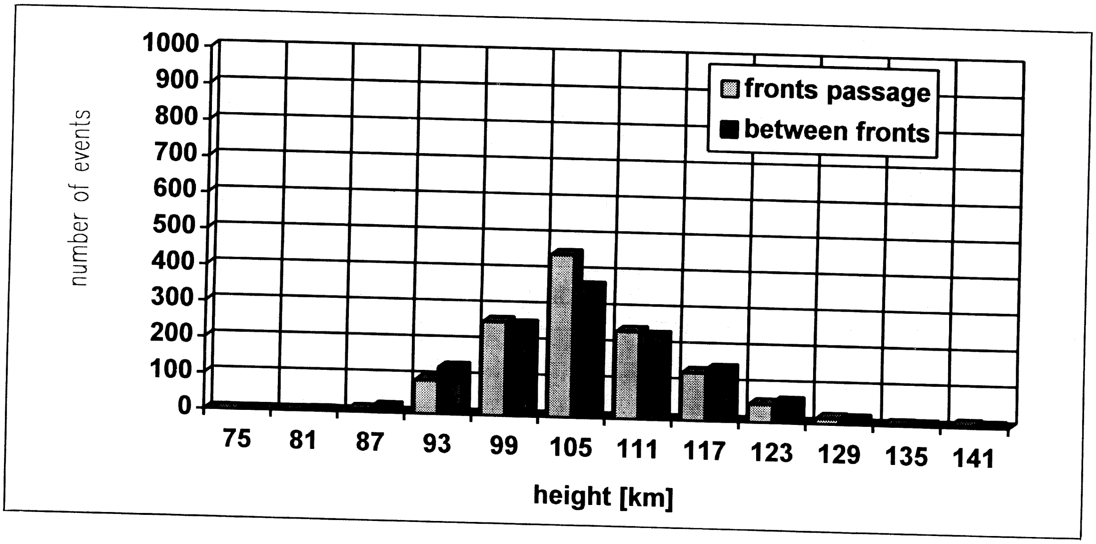

Fig. 2. Comparison between the distributions of the heights of occurrence at cold front passages and between two fronts for the E sporadic layer, type l. Good agreement is found and this is interpreted as no correlation between meteorological phenomena and E sporadic ionisation.

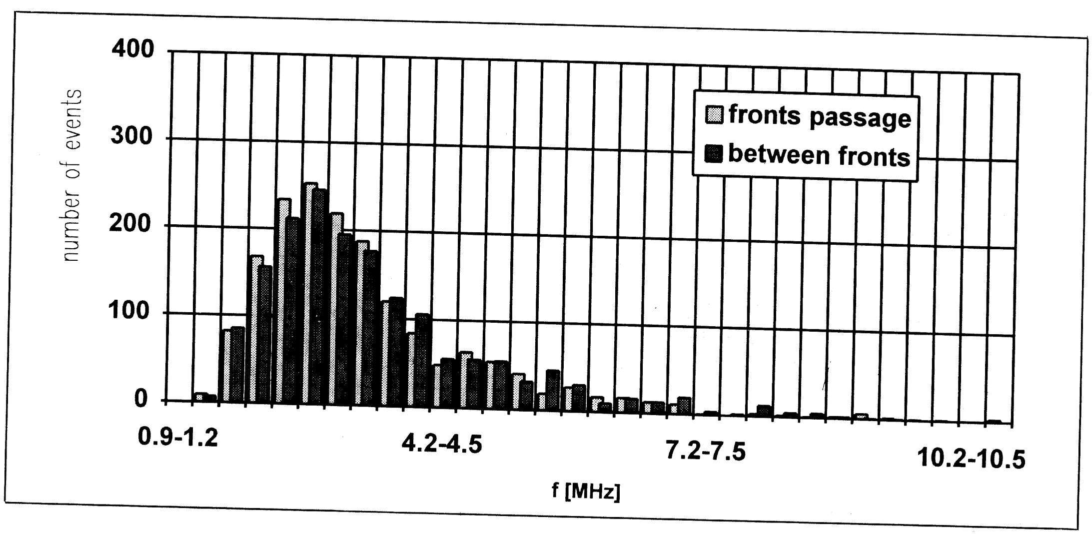

Fig. 3. Comparison between the distributions of the frequency of reflection at cold front passages and between two fronts for the E sporadic layer, type f. Good agreement is found and this is interpreted as no correlation between meteorological phenomena and E sporadic ionisation.

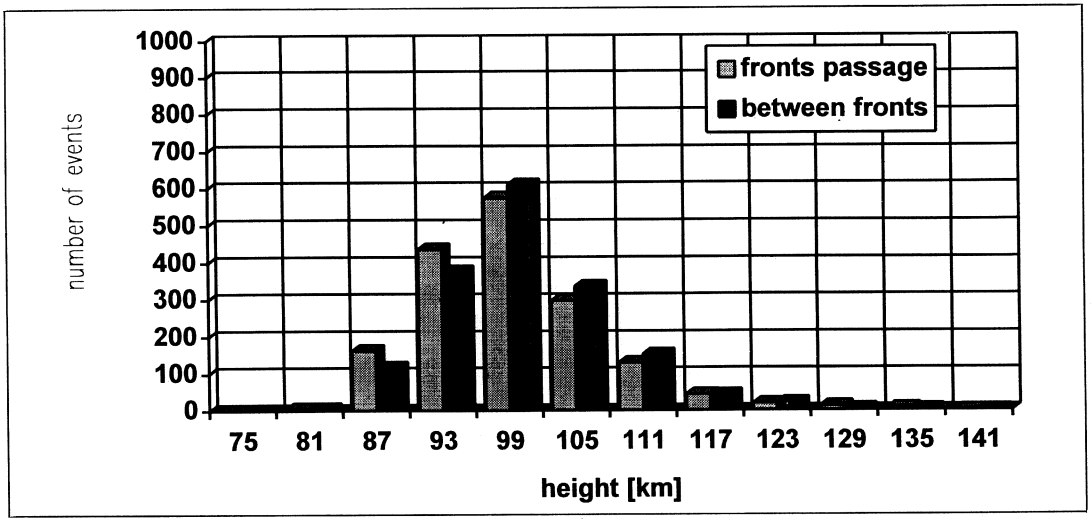

Fig. 4. Comparison between the distributions of the heights of occurrence at cold front passages and between two fronts for the E sporadic layer, type l. Good agreement is found and this is interpreted as no correlation between meteorological phenomena and E sporadic ionisation.

in which thundercloud activity was observed. So, this kind of treatment of data also seems to exclude the possibility of the influence of the thundercloud electrostatic field on the sporadic-E layer. However, this interpretation is affected by the fact that the meteorologically perturbed days are not exactly the same ones in which thundercloud activity exists, therefore a more specific statistic would be needed.

Acknowledgements

The author would like to thank E. S. Kazimirovsky for helpful comments and suggestions.

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(received April 11, 1994;
accepted January 19, 1995)