WEEKLY ANTHROPOGENIC PHENOMENA IN THE F2 LAYER OF THE IONOSPHERE

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A statistical analysis of the behavior of the characteristic frequency $f_0F_2$ during the seven days of the week in 1987 is performed. Italian data from a station in Rome situated in an industrial center and from a station in Gibilmana, which is located in a rural area, are used. Since industrial activity in European countries decreases rapidly during weekends, the behavior of the density of the F2 layer shows weekly periodicity. By expansion of this quantity in a Fourier series it is found that the intensity of the second harmonic with period $T = 12$ h increases at the end of the work week. Moreover, the correlation coefficient between pairs of successive days increases monotonically during the week. Since this correlation coefficient is directly connected with the phase shift of the harmonics from one day to the next, it can be concluded that industry influences systematically the behavior of the ionospheric density over industrial centers. Conceivably, this effect is due to local random heating of the ionosphere by anthropogenic infrasound waves.

1. INTRODUCTION

In some papers [1–5], the authors consider the ionospheric effects produced by powerful anthropogenic sources, such as explosions, launchings, power lines, etc. It is found that the ionosphere is subject to strong modification in almost all known large-scale events, including earthquakes, meteorological disturbances, and intense perturbations on the terrestrial surface and in the lower atmosphere due to human activities (e.g., wars) [6–8]. However, the weaker perturbing factors, such as everyday industrial activities for example, have not been detected there. In the present paper, we attempt to detect such effects in a developed industrial center.

Since the intensity of industrial production in the European countries decreases considerably during weekends, it can be surmised that the behavior of the atmosphere over a large industrial center is different for working days and for weekends. It seems interesting to detect such effects through a statistical analysis of ionospheric parameters. Among the wide variety of parameters characterizing the atmosphere, it seems reasonable, first of all, to choose the characteristic frequency of the F2 layer of the ionosphere, $f_0F_2$.

For the analysis, we used Italian data from a vertical sounding (VS) station in Rome and from a station in Gibilmana in 1987. Those data were presented in the form of standard values of $f_0F_2$ at 1-h intervals. The station in Rome is situated in an industrial area where most of the local enterprises are active five days a week, thus making it possible to examine a seven-day cycle. The station at Gibilmana is located in a rural area 400 km from the city of Rome. Thus, the objective of this work is to reveal the effect of human industrial activities on the ionization density of the F2 layer.

2. EXPERIMENTAL RESULTS

1. For the detection of technogenic effects, we performed a statistical analysis of the behavior of $f_0F_2$ during the seven days of the week. The problem of detecting weekly periodic effects proved to be rather difficult, since it was impossible to visualize the difference between the averaged diurnal behavior of $f_0F_2$
on different days of the week. Figure 1 shows the averaged hourly variation in the diurnal behavior of $f_0 F_2$ during one year for both stations.

The attempt to extract the effect by diurnal averaging of $f_0 F_2$ during one year was also unsuccessful, although it was found that the frequency $f_0 F_2$ tends to rise during week ends.

Figure 2 shows the characteristic frequency $f_0 F_2$ averaged diurnally for successive days of the week (vertical axis); the week begins with Monday (the first day) and ends with Sunday (the seventh day) (horizontal axis). For the sake of convenience, we normalized the data to the average yearly frequency $f_0 F_2$. It is seen from the diagrams that the average value of $f_0 F_2$ increases during the week, but the statistical data are insufficient to draw conclusions with confidence on the influence of industrial activities on the density of the $F_2$ layer.