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A SHORT NOTE ON ATMOSPHERIC POLLUTION AND ATMOSPHERIC ELECTRICITY

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SVMMARIVM — Auctor ostendit cur non omnia recte successerint in investigationibus de correlatione inter universam aëris pollutionem et electricae currentis densitatem inter aërem et orbem terrarum.

The purpose of this short article is to describe some experiments made at our Observatory.

The Municipal Administration of Health of the City of Montreal made, very kindly, available to us the long series of bihourly observations (Sept. 1959-1972) of the air content in SO_2 and in very small (5 mus) floating solid particles, in the atmosphere of that town [1].

We intended to find out if a recurring and well established correlation existed between the values of the air-to-earth electric current density, recorded continuously at our Observatory, and the global atmospheric pollution figures.

The recording instrument of the electric current density is similar to that one used by KASEMIR in 1955 [2]. It

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amounts to making the time constant of the collector circuit RC equal to the relaxation time of the lower atmosphere. Such are the values of R and C used by the SWISS FIRM.

One can reasonably admit that the current, through R will be rather equal to the air-earth current of the collector, "no correction being needed for the displacement current" [3].

Well aware that the convection current could falsify the data recorded of the electric current density, we accepted the theory according to which "the convection current plays only a small part" [4].

The technique used by the Municipal Department of Health of Montreal, for measuring the bihourly intensity of SO_2, is the standard one used in chemistry.

The number of very small (5 mus) of solid floating particles is obtained by means of a small aspiration pump. It gives, every minute, a quarter of an inch cubic volume of air, through a tube of one inch of diameter. This tube is conveniently connected to a special paper filter. After two hours of pumping, the filtered column of air equals a cyclindrical air column, of one inch diameter, 2000 feet long. The intensity of the blackening of the filter paper is proportional to the number of particles collected. The optic density is reported by means of an arbitrary unit called COH.

The permissible pollution values of SO_2 has been fixed to 0.10 pmm. in 24 hours and for COH to 2.0 also in 24 hours. These detailed data ,already well known and accepted elsewhere, helped us to find out, when, in the long list of daily bihourly data examined, the atmospheric pollution could be stated as "great" or "small", at the times when we were checking the current density values, recorded at our stations. We were about one and a half mile distant from the locality, where the pullution was measured. Both places are in a residential area of Montreal.

In our analysis we often found that the permissible values of SO_2 and of COH had been reached in less than 24 hours.

Such a variability of the atmospheric pollution was compared with that of the air-earth current density. As we discarded days with precipitation (rain or snow) or with high winds, we retained 800 checks out of the 1400 made. The bihourly data examined belonged to the months of April, October, November, December 1971 and January 1972.

The choice of these months was dictated by the fact that, in winter, the heating of buildings produced a great amount of pollutants. In April there should be a drastical decrease.

Of course, a full year test would have been more realistic, but we wanted, first of all, to find out if such a longer and laborious check was worthwhile.

As a matter of fact we found that the recurring and well established correlation we wanted to state, did not exist. The result was, practically, negative.

Of course our technique of considering ONLY two poltutants (SO_2 and COH should be admitted as possibly misleading. Many other kinds of pollutants are present in the atmosphere, mixed with the standard volumes of oxygen, nitrogen, argon, and especially water vapour.

At the Municipal Department of Health of Montreal analysis have been made, and are still being made, of sulphates, acids, chlorides, lead and carbonates. These results were not available and, moreover, they had been obtained, mostly, in the industrial areas of the City, too far away from our Observatory.

Can we assume that these data, unquoted by us, were, nevertheless, included in the measurement of the COH pollutants?

Even, if this supposition were accepted, we would make the following remark. The COH figures correspond to the existing conditions of visibility at the time the measurements were made. Many times, in the past, we have recalled that the turbidity of the air can be caused by different factors.

The presence of a dry haze, of a wetting mist or a real London fog (colloids and industrial pollutants) should be considered. These different atmospheric conditions affect the quality of the COH figures.

The COH data at hand were not discriminative. The fact that scattered days were showing a real correlation between the atmospheric pollution and the electric current density, seems to point out that the quality and their abundance of the pollutants should have been considered. Unhappily we had no values, for instance, of the humidity and the temperature gradients up to the "austasch" level.

Our, not very discriminative analysis, was due to be, at least, a partial failure.

All that means that we want a more realistic definition of the atmospheric pollution. There are quite different kinds of floating pollutants.

Moreover the relationship between air pollution and conductivity is very complicated also for other theoretical reasons. The mobility of the small and large ions and their relative number, especially in fonction of water vapour and of the temperature gradients, should be known: and all that at every two hours intervals.

Another important datum, which was not at hand but which is also acting, is the knowledge of the bihourly potential difference between the earth and the ionosphere. That would help to know the atmospheric columnar resistance at the times of the observations.

The fact, already quoted, that, at times, a real correlation was found, could be explained by a massive presence of an unknown special type of pollutant.

The more so that the presence of highly hygroscopic pollutants, while reducing the number of water molecules, could help to keep the fast ions mobile. There is to also a possibility "that some pollutants do attract fast ions more than

others, especially if they encounter large molecules among them, which have a strong electric dipole". (Letter from Dr. H. DOLEZALEK).

CONCLUSION — A partially negative result of a scientific research, can help to write down a more realistic programmation of the problem to be solved.

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REFERENCES

[1] MARIER, J. and BRABANT, W., *La pollution de l'air par l'anhydride sulfureux et les particules aéroportées - Rapport du Service de Santé de Montréal*, Passim (1970, 1971 and 1972).

[2] CHALMERS, J. ALAN, *Atmospheric Electricity*, Pergamon Press, London, p. 148 and 149.

[3] CHALMERS, J. ALAN, *Atmospheric Electricity*, p. 148 (1957).

[4] CHALMERS, J. ALAN, *Atmospheric Electricity*, p. 149 (1957).

NOTE - Articles, written on similar atmospheric electricity questions, by R. Mühleisen in 1959 and by A. C. Montefinale and H. M. Papee in 1965, were not at hand.