# FOWLE ON ATMOSPHERIC OZONE: ITS RELATION TO SOME SOLAR AND TERRESTRIAL PHENOMENA [1]

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This paper gives the results of a research for which a preliminary report was made a year ago, and published in the Journal of Terrestrial Magnetism and Atmospheric Electricity, **33**: 151, 1928. For his observational data he used the solar spectro-bolograms obtained by the Astrophysical Observatory, Smithsonian Institution, at its observing stations at Harqua Hala, Ariz., Montezuma, Chile, Table Mountain, Calif., and Mount Brukkaros, Africa. Bolograms for about 1,000 days were utilized. On many days as many as six bolograms were obtained at an observing station, a number quite sufficient to determine atmospheric transparency at any desired wave length within the limits at which measurements were made.

The region of the spectrum selected for the study was that covered by the Chappuis band, in the yellow and red, between $0.450\mu$ and $0.650\mu$. While not visible to the eye even under the most favorable circumstances, Fowle concludes that for the amount of ozone present in the atmosphere this band is a more sensitive indicator of changes in atmospheric ozone than the long-wave portion of the Hartley band, in the ultra-violet (wave-length under $0.310\mu$).

Fowle's determinations and conclusions differ from those given by Dobson in several respects. We quote his summary in full as follows:

SUMMARY

The amount of energy absorbed from the incoming solar radiation by the yellow ozone band has been used to measure the variations in the amount of atmospheric ozone during the years from 1921 to 1928. These observations have been made in both the Northern and the Southern Hemispheres.

The resulting values show a distinct yearly march in both hemispheres. In the Northern Hemisphere the maxima of this march occur between April and May, the minima between August and November; in the Southern Hemisphere the maxima occur between August and September, the minima between April and May. In other words in both hemispheres the maxima occur in the spring, the minima in the autumn.

In the Northern Hemisphere a marked relationship exists between the ozone and the Wolfer sun-spot numbers. The range in the monthly mean values for the ozone numbers is great and between $20\times10^{-4}$ and $100\times10^{-4}$ calories absorbed per cm.[2] per minute from the incoming solar energy.

In the Southern Hemisphere no such marked relationship is noted, although one may be masked by the small range and corresponding inaccuracy in the values. The range is only from $20\times10^{-4}$ to $50\times10^{-4}$ calories.

It is suggested—and such a suggestion is strengthened by magnetic data—that we are dealing with two layers of ozone. The first is due to ultra-violet light coming from the sun and hence existing over all the stations. The second is assumed to be due to positively electrified particles emitted from definitely disturbed areas of the sun. This second effect reasonably shows a strong correlation with the Wolfer sun-spot numbers. Probably because these positive particles are deflected towards the earth's north pole this layer of ozone is found over the Northern Hemisphere stations only. At sun-spot minimum it is negligible so far as the present measurements indicate.

All the results of the present paper are based on monthly and yearly means. A consideration of the daily values would be another story. The plot published in the preliminary paper was based on daily values for only two years at Table Mountain. The short study then made of the daily values would indicate that what may be said of the connection between many magnetic values and solar disturbances may be said of ozone; that although with monthly and yearly averages, solar spottedness, for example, goes hand in hand with the amount of ozone, yet a day of many spots may pass with no increase of ozone and vice versa.

Our thanks are due to both Dobson and Fowle for their careful work in this difficult field of research. When we appreciate the difficulties attending the measurements they are making it is not surprising that their results and conclusions are not in complete accord. Both, however, have contributed materially toward the final solution of a question of great interest and importance to meteorologists.

[1] Fowle, Frederick E. Smith. Misc. Coll., 81: No. 11. 1929.

# SEVERE WINTER IN EUROPE, 1928–29

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The stormy conditions, so prevalent during November (see Bulletin Amer. Met'l Soc. for December, 1928, pp. 206–207) over northwestern Europe, continued for the most part during December, culminating in a severe storm in the last week of the month, centered over the eastern North Atlantic and Scandinavia. Westerly gales caused by this disturbance brought high tides and floods along the Belgian lowlands, inundating districts that were just emerging from the floods of the previous month. Germany experienced the most severe fog in recent years, and Russia [U. S. S. R.] reported serious floods along the Neva from the melting snows. No particularly low temperatures were reported.

Conditions changed decidedly with the advent of 1929. By January 4 pressure had increased to 1040 mb. (30.71 in.) over central Europe, and an area of low pressure remained stationary over the Mediterranean.[1] This pressure distribution brought cold northerly winds to France and heavy falls of snow even to the Mediterranean coast, Marseilles reporting a fall of 6 inches. In Italy heavy rains caused floods. From then until the middle of the month pressure tended to remain high over Europe. At times there was a curious northwest-southeast trend to the area of high pressure, with one center in the vicinity of Iceland and the other over Poland. The tendency for the pressure to remain high over Iceland was one of the remarkable characteristics of January, 1929, for only once before, in 1846, has pressure averaged as high over Iceland as in the month under discussion.[2] About the 13th of the month a very severe storm, center 980 mb. (28.94 in.), appeared over Russia, and westerly gales and warmer weather prevailed. Toward the end of the month, while a low-pressure area of extraordinary depth (948 mb., under 28.00 in.) and extent developed and remained over the northwestern Atlantic (see Bulletin Amer. Met'l Soc. for January, 1929, pp. 52–53), pressure began to increase to the north and northeast of Europe, one HIGH, 1045 mb., (30.86 in.) being centered in the vicinity of Spitzbergen, and the other, 1056 mb. (31.18 in.) over eastern Russia.

[1] Information from daily "Chart of Weather in the Northern Hemisphere." Air Ministry (British) Meteorological Office, London.

[2] Cf. Dr. C. E. P. Brooks, in the Meteorological Magazine for February, 1929.