disturbances visible on the surface of the sun, including spots and faculae to be recorded on a diagram of the sun's surface and transmitted to the Meteorological Office for the purpose of comparing them with the observations of solar radiation received from the Smithsonian Solar Observatory at Calama, Chile.

The observations at first consisted chiefly of a record of sun-spots, and although the time is short the relation seems so apparent as to be worthy of record. The records have been arranged in three series, two of which are practically independent of each other and the third partly so.

The first series was derived from seven groups of sun-spots by taking the day of their first appearance on the east edge of the sun three days before and five days after, and obtaining the average values observed of solar radiation on these days in calories per square centimetre.

The second series was derived from six groups of sun-spots by taking out the mean solar radiation on the last day of visibility and for five days preceding and three days following.

The third series was derived from seven series of spots by taking the mean solar values on the days the spots crossed the solar meridian and for eight days preceding and eight days following.

The results are shown in the following table:

Mean Radiation Values for Different Positions of Sun-spots.

(1)	Days before.	East edge.			First seen.	Days after.												
		2	1	0		1	2	3	4	5	6							
	Radiation	40	24	45	55	52	48	37	47	39								
(2)	Days before.				Meridian.	Last seen.	West edge.	Days after.										
		6	5	4				3	2	1	0	1	2					
	Radiation	46	45	35	30	48	50	54	40	38								
(3)	Days before.									Meridian.	Days after.							
		8	7	6	5	4	3	2	1		0	1	2	3	4	5	6	7
		42	38	40	49	41	48	33	46	44	45	35	47	40	49	46	40	38

The mean solar radiation value is formed by adding 1.900 to the values given in the table.

As the spots are rarely seen exactly on the edge of the sun, the day on which they are first seen is numbered 1, and the day before is numbered 0; also, when last seen the day is numbered 1, and the day after 0.

The mean solar values during the interval covered by the observations is 1.943, so that on the day when the spots were first seen the radiation averaged 0.012 calorie above normal, and when last seen 0.007 calorie above, or in the mean about $\frac{1}{2}$ per cent. of the solar radiation.

There was one day common to the two series when spots were visible on both edges of the sun at the ends of a diameter passing through the sun's centre, or, in other words, on a great circle about 180° apart. On this day the solar radiation value was 1.969, or more than 1 per cent. above normal.

The grouping around the central passage of the spots does not bring out the relation so distinctly, although higher values are found five days before and five days after the passage across the meridian, the lowest values being found two days before and two days after the central position. If one takes the mean of the five days about the centre, including two days before and two days after the central passage, a value of 1.941 is obtained, which is slightly below the normal value, as if some absorption of heat resulted from the central passage of the spots.

These results have an interest in connection with the fact that Dr. Abbot found a decrease in the contrast of brightness between the edge and centre of the sun coinciding with short-period increase of solar radiation (Smithsonian Miscellaneous Collections, vol. lxi., No. 5). Both these results can, I think, be

explained in the same way. It is well known that solar faculae and solar eruptions surround regions where spots are numerous.

These eruptions when seen near the edge of the sun tend to decrease solar contrast and to increase the total solar radiation. On the other hand, when they are near the centre of the sun they are seen directly above the hotter gases from which radiation is coming vertically through the sun's atmosphere, and hence is not greatly absorbed.

The cooler gases within the spots may even absorb more of this radiation than is made up for by the increased radiation of the faculae in the outer atmosphere.

The results, if confirmed by more extended observations, will also have an important meteorological bearing. Numerous investigators like Loomis, Veeder, Arctowski, and Huntington have found evidences of increased solar influences on the earth's atmosphere when the solar spots were near the edge of the sun. E. Huntington especially has made an extensive investigation of the position of the solar spots as related to the storminess in the North Atlantic, and has found that the most marked effects are shown when the spots are near the edge of the sun, and hence when there is probably increased solar radiation (Monthly Weather Review, U.S.A. Weather Bureau, March-June, 1918).

H. H. CLAYTON.

Buenos Aires, November 6.

Odours Caused by Attrition.

THE unpleasant odour which attends the attrition of pebbles, etc., appears to have been noticed at a much earlier date than any mentioned by previous correspondents. Robert Boyle ("The Efficacy of Languid Motion," Works, edited by Boulton, 1699, vol. i., p. 234) remarks: "And that it may further appear, that a peculiar Modification of Motion, may contribute to the various Effects produced by it, I shall observe, That those Stones which *Italian Glassmen* make use of [quartz?], afford Sparks of Fire by Collision; but if moderately rubb'd together, they emit *faetid* Exhalations; from whence probably proceed those offensive Steams, emitted by Glass; and what is more remarkable, and to our purpose is, tho' Glass when Red-hot emits no such *Effluvia*; yet if two pieces be dextrously rubb'd together, they will send forth Steams copious enough and *faetid*."

It seems to me that there are at least two suggestions not brought forward by previous correspondents in NATURE contained in Boyle's observations, both of which might well be followed up experimentally. The implicit explanation of the cause of smell is also of some interest.

J. R. PARTINGTON.

Lostock Gralam, Cheshire.

The Energy of Cyclones.

I SHALL be glad if you will allow me to refer briefly to the objection Mr. W. H. Dines raises to my theory of cyclones (NATURE, December 23, p. 534). Mr. Dines remarks that if "cyclones are caused by an access of warmth in the stratosphere . . . the troposphere ought to bulge upwards over the cyclone, whereas, in fact, it bulges downwards." My view is that where the stratosphere is warmest it must be thickest, and the troposphere must be thin. As the warmest portions of the stratosphere are at cyclonic centres, the lower boundary of the stratosphere must bulge downwards over such areas and the troposphere be correspondingly thin. I assume that the heat of the stratosphere passes downwards so rapidly that the slowly rising air cannot maintain the troposphere at its normal thickness.

R. M. DEELEY.

Tintagil, Kew Gardens Road, Kew, Surrey,
December 24.