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Hemispherical transport of volcanic dust inferred from diffuse radiation measurements

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ABSTRACT. Volcanic dust has been used in the past as a tracer of atmospheric motions. The volcanic dust resulting from the eruption of Mt. Agung, Bali (8° S, 115°E) in March 1963 produced some spectacular effects in the southern hemisphere as seen from the radiation observations made at Aspendale (38° S, 145°E). The diffuse radiation measurements made at Poona, however, do not show such effects to any appreciable extent. It is, therefore, concluded that the transport from the southern to the northern hemisphere of stratospheric dust is of a much smaller magnitude than the transport within the southern hemisphere itself.

After the eruption of Mt. Agung, Bali (8°S, 115°E) on 17 March 1963, observations of effects of the resulting volcanic dust have been reported from a number of places in the southern hemisphere. Among these are some very striking effects observed by Dyer and Hicks with the radiation data of Aspendale (38°S, 145°E). They found that in July—August 1963, the diffuse radiation values at Aspendale were nearly twice the normal values for these two months and that the diffuse radiation continued to be markedly above normal in 1964 and, to a lesser extent, even in 1965. The appearance of vivid sunsets over southern Australia during the winters of 1963 and 1964 and their re-appearance, although with reduced intensity during the 1965 winter have also been observed. These and similar other observations have a bearing on the problem of atmospheric transport on a global scale. It has been estimated that in the lower stratosphere, the volcanic dust moved towards the South Pole at such a rate that the effects were detected after about six weeks in the middle latitudes and that it took four to six months for the maximum concentration to appear. Such observations show that volcanic dust can be used as a tracer of atmospheric motions.

It was, therefore, thought worthwhile to investigate whether the diffuse radiation data of Poona ($18\frac{1}{2}$°N, 74°E) for the same period give any evidence of the spread of volcanic dust from the southern hemisphere across the equator.

The data used were those collected with Moll-Gorczynski solarimeters, one exposed to global radiation and the other with a shading ring which, by cutting off direct radiation enables the diffuse radiation component to be measured separately. Days on which the sky was clear of clouds between 11 A.M. and 1 P.M. were selected and the maximum diffuse radiation was thus noted. It is evident that on such days, the diffuse radiation recorded is due to factors other than clouds. Diffuse radiation data are available for Poona on a systematic basis from 1959. During the monsoon months, June to September, there were no days without clouds within one hour of noon. The data for the years 1959 to 1962 were used to compute the 'normals' of diffuse radiation for purposes of comparison with the later data. The normals of diffuse radiation thus computed and the actuals for Aspendale and Poona expressed as percentages of the normal during the years 1963, 1964 and 1965 (as far as available) are given in Tables 1 and 2 for comparison. For Poona, the monthly values have been given whereas for Aspendale bi-monthly values, which were readily available, have been given. The data are also shown diagrammatically in Fig. 1. The abscissa gives the months and years and the ordinate $D/\bar{D}$, where $\bar{D}$ is the normal diffuse radiation. The curve pertaining to Aspendale has been taken from the paper of Dyer and Hicks, to be published.

The very remarkable increase in diffuse radiation at Aspendale from May 1963 to the end of 1963, with a value nearly twice the normal in July—August 1963, and the continuing high values in 1964 and to some extent in 1965 may be compared with those at Poona. Poona shows an increase of 33 per cent in November 1963 and 26 per cent in March 1964. The increase during the period between November 1963 and March 1964 is, however, only 5—11 per cent. The maximum increase noticed after March 1964 is 21 per cent in November 1965.

It would appear from these data that while the effect of the volcanic dust has been very spectacular at Aspendale, in the southern hemisphere, it is less spectacular at Poona in the northern hemisphere. It would thus seem that the transport from the

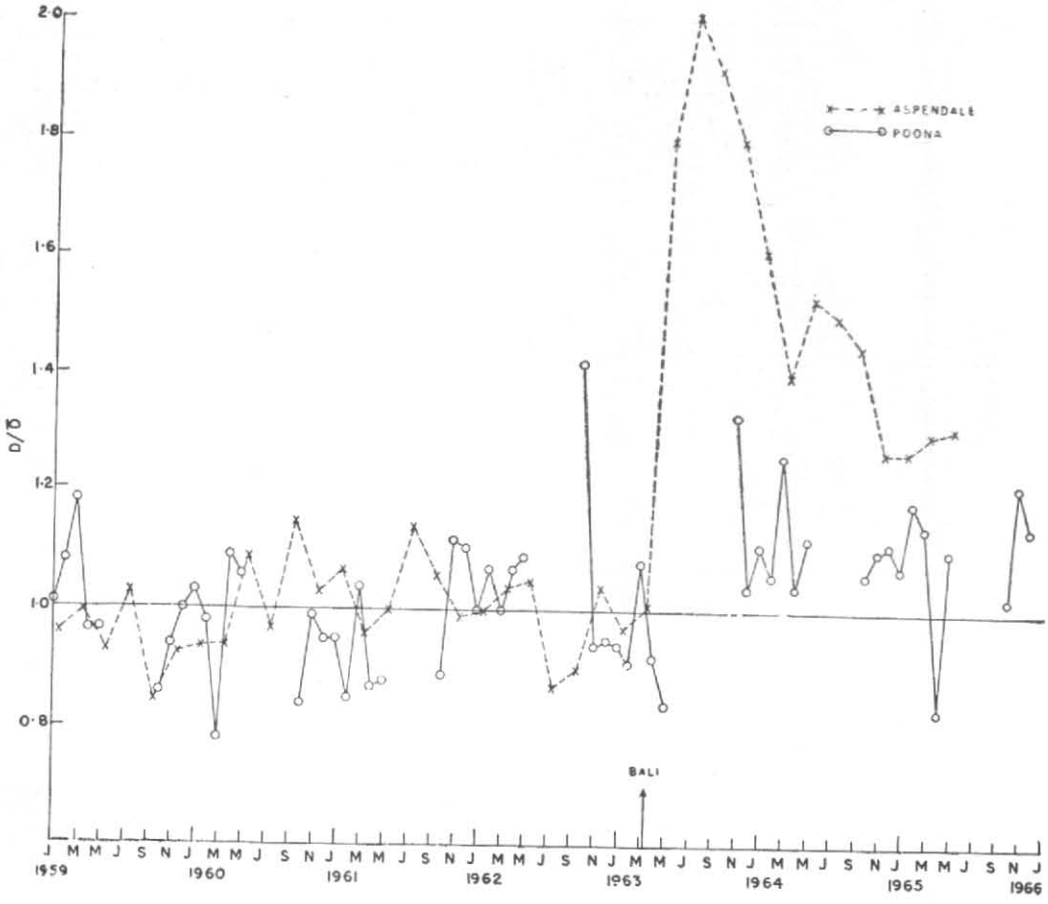
2·0
1·8
1·6
1·4
1·2
1·0
0·8
D/D
ASPENDALE
POONA
BALI
J M M J S N J M M J S N J M M J S N J M M J S N J M M J S N J M M J S N J M M J S N J
1959
1960
1961
1962
1963
1964
1965
1966

Fig. 1

TABLE 1

ASPENDALE

Diffuse radiation on clear (cloudless) days about noon

	Jan–Feb	Mar–Apr	May–Jun	Jul–Aug	Sep–Oct	Nov–Dec
			(mw cm^{-2})			
Normal (1959-1962)	10·5	8·5	7·5	7·5	8·5	10·2
Departures (+)			(mw cm^{-2})			
1963		0·4	6·0	7·6	7·8	8·2
1964	6·4	3·4	4·0	3·8	3·8	2·8
1965	2·8	2·6	2·3			
			Actual as percentage of normal			
1963		105	180	201	102	180
1964	161	140	153	150	145	127
1965	127	130	131			

TABLE 2

POONA

Diffuse radiation on clear (cloudless) days about noon

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
					(mw cm^{-2})							
Normal (1959-1962)	9·7	10·5	13·1	16·5	16·3		No cloudless days			10·5	8·2	8·2
Departures					(mw cm^{-2})							
1963			+1·0	—1·4	—2·6		No cloudless days				+2·7	+0·4
1964	+1·1	+0·6	+2·4	+0·6	+2·1		No cloudless days			+0·7	+0·8	+1·0
1965	+0·7	+1·9	+1·9	−2·9	+1·6		No cloudless days			+0·2	+1·7	+1·1
					Actual as percentage of normal							
1963			108	92	84		No cloudless days				133	104
1964	111	106	126	104	112		No cloudless days			106	110	111
1965	107	118	114	83	110		No cloudless days			102	121	113

southern to the northern hemisphere of stratospheric dust is of a much smaller magnitude than the transport within the hemisphere itself.

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