A FURTHER NOTE ON THE CONTRIBUTION OF FOG DRIP TO STREAMFLOW

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A RECENT note in *Weather* (Gurnell 1976) has presented a fascinating study of a little-investigated process, namely the generation of streamflow by fog and associated precipitation. The present note is an attempt to investigate this process further and to suggest an additional mechanism by which the observed streamflow pattern may have been produced.

The markedly diurnal pattern evident in the streamflow record shown by Gurnell (her Fig. 3) is not as apparent in the pattern of fog, mist and haze occurrence (Fig. 1). It is therefore suggested that vegetation intercepting

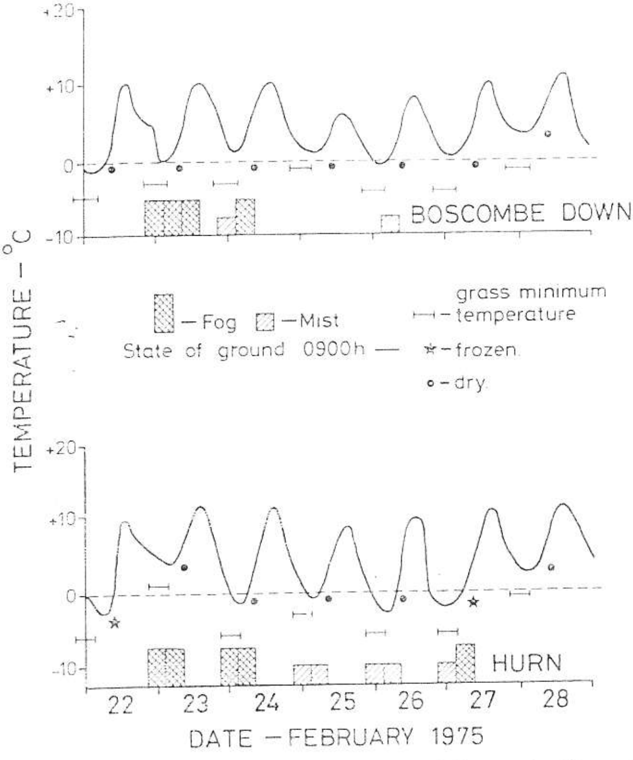

Fig. 1. Temperature and weather records of Hurn and Boscombe Down climatological stations, 22–28 February 1975

water from fog is only partially responsible for the observed streamflow pattern. To support this suggestion Table 1 relates the intensity of fog conditions to the amount of discharge above baseflow. By a consideration of the records of Hurn and Boscombe Down (Fig. 1; Gurnell's Table 1) the days concerned have been categorised in approximate order of fog intensity, with particular attention being paid to the 0600 hr record, which is considered to be the most appropriate in examination of streamflow peaks occurring

Table 1. Records related to weather conditions at 0600 hr at Hurn and Boscombe Down climatological stations

Date Feb 1975	Present weather	Past weather	Precipitation (mm)	Fog intensity*	Discharge above baseflow†
[illegible]	clear/haze	—	0·0 or trace	5	1
[illegible]	fog	f/if/th	trace	1	5
[illegible]	fog	f/if/th	0·0	2	7
25	mist/haze	—	0·0	6	3
26	mist	—	0·0	4	6
27	fog/haze	f/if/th or none	0·0	3	4
28	haze	—	0·0	7	2

* Ranked from 1 (greatest fog) to 7 (least fog)
† Ranked from 1 (largest) to 7 (smallest)

1200 hr in a small basin with nearly saturated contributing areas and low lag times. When the rank values indicating the intensity of fog are related to the magnitude of discharge above baseflow (Table 1) it can be suggested that fog alone provides an inadequate explanation for the variations in discharge, the two variables having a Spearman rank correlation coefficient of −0·714, which allows rejection of a null hypothesis of no correlation, and is negative whereas a positive correlation would have been expected according to the direct interception hypothesis.

An alternative interpretation of the runoff generation processes involved may be gained by a consideration of the temperatures during the period (Fig. 1). The diurnal fluctuations of streamflow are mirrored by a strong diurnal fluctuation of temperature, with sub-zero ground temperatures at night. It is therefore suggested that at least part of the runoff peaks described by Gurnell as being due to direct fog interception by vegetation may be in fact due to the day-time melting of ice in two forms.

The first of these is ice accreted on to vegetation and the ground during night in the ice-fog and frost conditions, and may therefore be considered as a form of interception; the second is interstitial ice in the areas adjoining the stream channels, which prevents part of the direct streamflow generation until day-time temperatures rise sufficiently to melt this ice. The state of the ground at 0900 hr and the grass minimum temperatures for the two climatological stations (Fig. 1) indicate that such ice is likely to have been present to some extent, with the day-time rise of temperature being responsible for its melting as well as for fog clearance.

An estimate of the intensity of night-time freezing and day-time melting may be gained by use of the daily temperature range, averaged for Hurn and Boscombe Down. This index has been related to discharge above baseflow figures given by Gurnell (her Table 2), after correction of discharges for the small but important, effects of the precipitation recorded in the area (Table 2). If assumptions are made that a trace is regarded as being equivalent to 0·1 mm of rainfall, and that the average rainfall of the contributing areas of the catchment during the drizzle recorded at Boscombe Down on 25 February was responsible for 1·0 mm of the maximum recorded weekly total of 1·15 mm, then the adjusted discharge figures shown in Table 2 may be produced by calculation from figures in Gurnell's Table 3. These adjusted discharges, when correlated with the index of fog intensity, produce a non-significant correlation coefficient, of −0·29. However, when the ranks of the adjusted discharges are correlated with the daily temperature range (Table 3)

TABLE 2. Adjustment of discharge figures

Date: Feb 1975	0600 hr rainfall and 1200 hr past weather		Discharge produced (litres)	Adjusted discharge (litres)
	Hurn	Boscombe Down		
22	—	Trace	370	52 030
23	Trace	Trace	370	38 580
24	—	—	—	20 200
25	—	Drizzle	37 000	11 100
26	—	—	—	28 850
27	—	—	—	40 400
28	—	—	—	52 200

TABLE 3. Correlation of daily temperature range with adjusted discharge

Date: Feb 1975	Daily temperature range* (deg C)	Rank	Rank of adjusted discharge	Differences in rank (squared)
22	12·5	2·5	2	0·25
23	10	6	4	4
24	12	4	6	4
25	8	7	7	0
26	11·5	5	5	0
27	12·5	2·5	3	0·25
28	14·5	1	1	0

* Average of Hurn and Boscombe Down

it can be seen that a close relationship exists, and a Spearman rank correlation coefficient of +0·85 is produced, with a correction for tied values being employed. This value is different from zero at a level of significance greater than 0·05. Furthermore, examination of Table 3 suggests that the correlation between the temperature range and the observed discharge above baseflow was lowest on 23 and 24 February when Fig. 1 and Table 1 suggest that the direct fog interception process of Gurnell should be at its maximum, thereby upsetting the overall freezing/thawing–discharge relationship.

It is therefore suggested that the direct interception process suggested by Gurnell may be better considered as a series of related processes involving interception, night-time ice accretion and freezing, and day-time thawing, and that this more accurately explains the discharge peaks produced than does the hypothesis of simple interception. The uncertainty surrounding the interpretation of this data illustrates the lack of knowledge of this type of process and the value of such instrumental observations as have been presented by Dr Gurnell.

REFERENCE

GURNELL, A. M. 1976 A note on the contribution of fog drip to streamflow. *Weather*, **31**, pp. 121–126

CORRECTION

In the article 'The smoke plume associated with an intense local fire', *Weather*, **32**, 1977, pp. 18–25, the date of the fire was incorrect. The fire occurred on 25 June 1973, *not* 1975.

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Cover photograph supplied by R. L. Holle

Large cumulonimbus north-east of the South Catalina mountains near Tucson, Arizona, USA on the evening of 23 October 1974

The Editor welcomes contributions and correspondence on all aspects of weather and meteorology, but the responsibility for opinions expressed in articles and correspondence lies in every instance with their respective authors. All material submitted for publication should be typed double-spaced, on one side of the paper only and with wide margins. Brevity and lucidity are encouraged. Potential authors may find the article by D. E. Pedgley entitled 'Writing for *Weather*' (in *Weather*, **27**, pp. 294–299) of some value. For guidance in setting out tables, references, etc., authors should consult *Preparation of papers for the Quarterly Journal*, copies of which may be obtained from the Editor. Authors are entitled to 10 free copies of the issue containing their published article.

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