Evaporation Memo. No.23a

Estimation of 7-day average values of wind speed at 2 metres (above ground) representative of 40 X 40 km. squares of terrain.

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Abstract. A numerical example of the system proposed in Evaporation Memo.No.20a is set out with brief explanatory notes. The system is suitable for operation by a computer.

1. 7-day averages of reported wind speeds for 1-7 Aug 1971 were obtained from stations whose data are available in the Daily Weather Report. For Kew and Ross-on-Wye reports were available for 06,12 and 18 hrs GMT; for all other stations midnight reports were also available. These reported speeds were read from anemometers and "corrected" (for effective height) to give estimates of speeds at 10 metres above ground. These reported speeds are shown as V_{10} on the Working Sheet (Fig 1)

2. We require V_s, the theoretical 7-day average speed which would have been obtained at each station if the measurements had been made at 10 metres above smooth, level, open country with few trees. To obtain station estimates of V_s we must use the "uncorrected" speeds and measures of the roughness of the observing sites.

3. Many large areas of Britain are not represented by anemometer/anemograph measurements and we need a field of 7-day average wind speed, related to that at 2m., covering the whole country. This is obtained by linear interpolation between radar-wind station average speeds at 06 and 18 hrs GMT at 900 metres, Fig.2.

A worked example of the above method for calculating V_2' is shown. The isotachs in Fig.1 are drawn on the basis of very few wind speed averages, far more would be available in practice.

Details of the calculations are as follows:-

(1) Obtain 7-day average wind speed V_h at anemometer effective height h for each station. (See Note)

(2) Adjust V_h to V_s by the use of a power law formula including a roughness exponent a and an empirical roughness divisor q.

$$V_s = 1/q \ (V_h) \ (10/h)^a$$

(3) Produce a field of V_s (Fig.1)

(4) Store a value of V_s for each square (centre) (Fig 3.1)

(5) Obtain 7-day average 900 m wind speed (V_{900}) at each upper wind station.

(6) Produce a field of V_{900} (Fig.2)

(7) Store a value of V_{900} for each square centre (Fig 3.2)

(8) Multiply each V_{900} value by the corresponding value of $\frac{}{V_s/V_{900}}$ (Fig 3.3) to get V_s' (Fig 3.4)

(9) Calculate $\frac{1}{2}(V_s + V_s')$ for each point (Fig 3.5)

(10) The formula in (2) relates V_s and V_h, putting $h = 2$ we have

$V_s = 1/q(V_2)(5)^a$ or $V_2 = qV_s/5^a$

So we evaluate $\frac{1}{x}(V_s + V_s')q/5^a$ using values of a, and q appropriate to the average roughness index for the square (Figs 3.6 and 3.7)

Note: The routine corrections applied to winds measured at non-standard heights are removed as follows:

Effective height	Change	
10 to 13 m	none	to obtain V_h from V_r
14 to 22 m	X 10/9	
23 to 42 m	X 5/4	
43 to 93 m	X10/7	

where V_r = reported speed

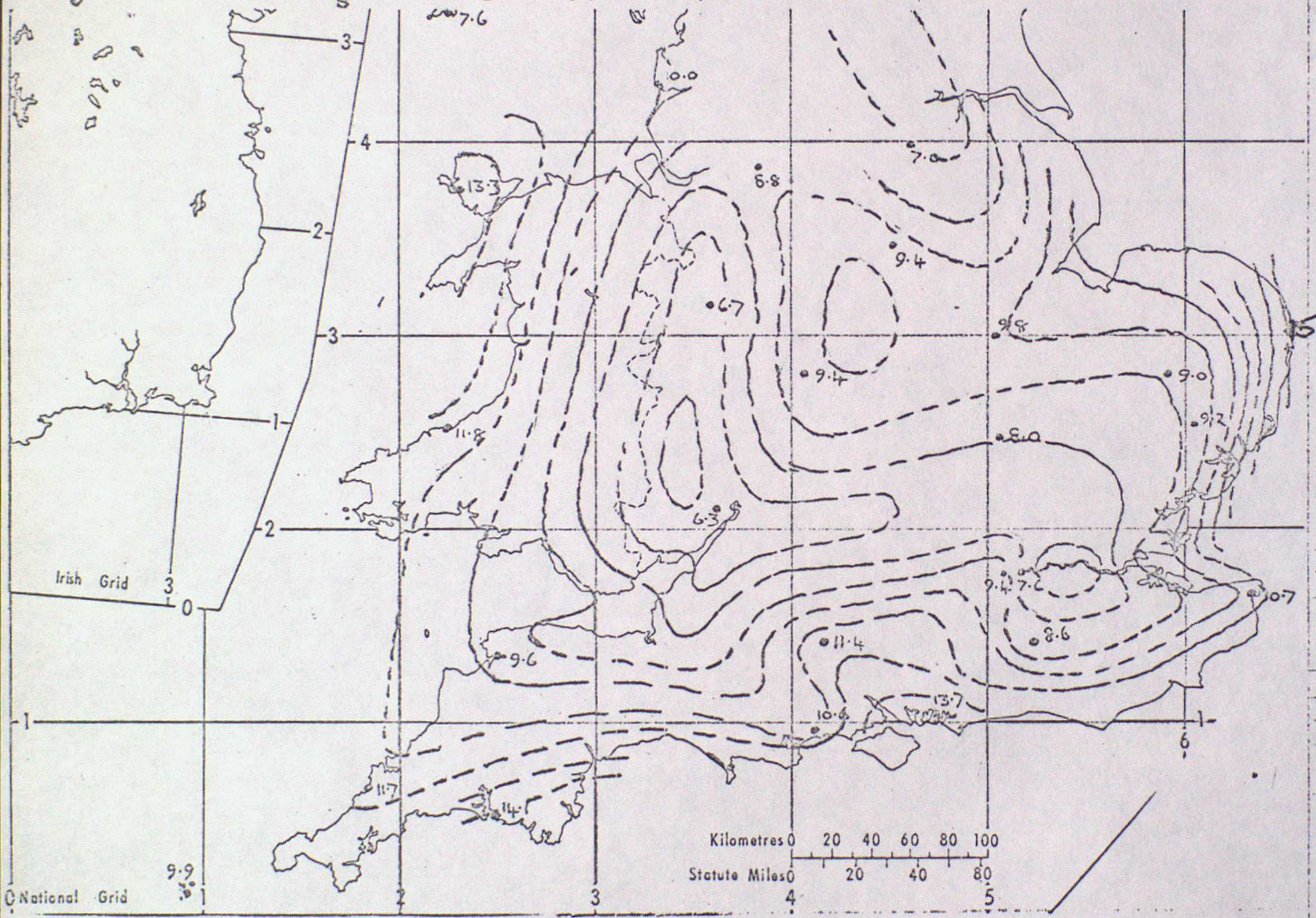
Some measured average values of V_2 for the test period compare well with the estimates. Kew 3.4, Reading 5.5, Shinfield 4.5, Faversham 7.7, Martyr Worthy 5.4 and Rothamsted 4.3 kts.

Bracknell

No23 November 1972.

No23a (revised version) May 1973.

Fig.1 . Isotachs of V_s 1 – 7 August 1971 knots.



Station.	Eff. Ht. h m	V_F	Rough-	a	q	$\left(\frac{10}{h}\right)^a$	Vs
Boscombe Down	16	10.5	4	.23	.9	.90	11.4
Hurn	10	10.6	2	.17	1	1	10.6
Thorney Island	10	12.3	4	.23	.9	1	13.7
Manston	17	10.7	2	.17	1	.91	10.7
Gatwick	10	8.2	3	.2	.95	1	8.6
Kew	15	6.3	7	.3	.79	.89	7.6
Heathrow	10	8.9	3	.2	.95	1	9.4
Honington	13	8.3	4	.23	.9	.94	9.0
Wattisham	10	8.7	3	.2	.95	1	9.2
Gorleston	13	13.2	5	.26	.85	.93	15.0
Aberporth	11	11.2	3	.2	.95	.98	11.8
Ross-on-Wye	12	6.1	3	.2	.95	.96	6.3
Filton	9	8.1					
Rhoose	10	10.0				1	
Chivenor	10	9.1	3	.2	.95	1	9.6
Mount Batten	13	11.9	6	.28	.82	.93	14.1
St. Mawgan	13	11.2	3	.2	.95	.95	11.7
Scilly	17	9.9	2	.17	1	.91	9.9
Culdrose		9.5	2	.17	1		
Guernsey	X	12.1	X				
Elmdon	10	8.9	3	.2	.95	1	9.4
Cardington	40	7.9	3	.2	.95	.76	8.0
Wittering	10	8.3	5	.26	.85	1	9.8
Watnall	10	8.0	5	.26	.85	1	9.4
Shawbury	11	6.0	4	.23	.9	.98	6.7
Finningley	10	7.0	2	.17	1	1	7.0
Kilnsea		13.4	1	.14	1.05		
Leeming	10	6.1	4	.23	.9	1	6.8
Tynemouth		7.9	3	.2	.95		
Carlisle	9	5.5	3	.2	.95	1.02	5.8
Valley	12	13.3	2	.17	1	.97	13.3
Ringway	10	8.4	3	.2	.95	1	8.8
Squires Gate	11	10.0	2	.17	1	.98	10.0
Ronaldsway	10	7.6	2	.17	1	1	7.6
Mull of Galloway		14.1					
Eskdalemuir	10	5.7	3	.2	.95	1	6.0
Prestwick	10	5.4	3	.2	.95	1	5.7
Abbotsinch	10	5.8				1	
Leuchars	12	6.8	3	.2	.95	.96	7.1
Dyce	10	7.6	3	.2	.95	1	8.0
Lerwick	10	6.8	2	.17	1	1	6.8
Wick	10	6.1	2	.17	1	1	6.1
Sule Skerry		5.9					
Cape Wrath		3.6	4	.23	.9		
Stornoway	11	9.8	2	.17	1	.98	9.8
Benbecula	10	9.9	2	.17	1	1	9.9
Tiree	13	11.9	1	.14	1.05	.96	11.3
Aldergrove	10	7.8	4	.23	.9	1	8.7
[illegible]							

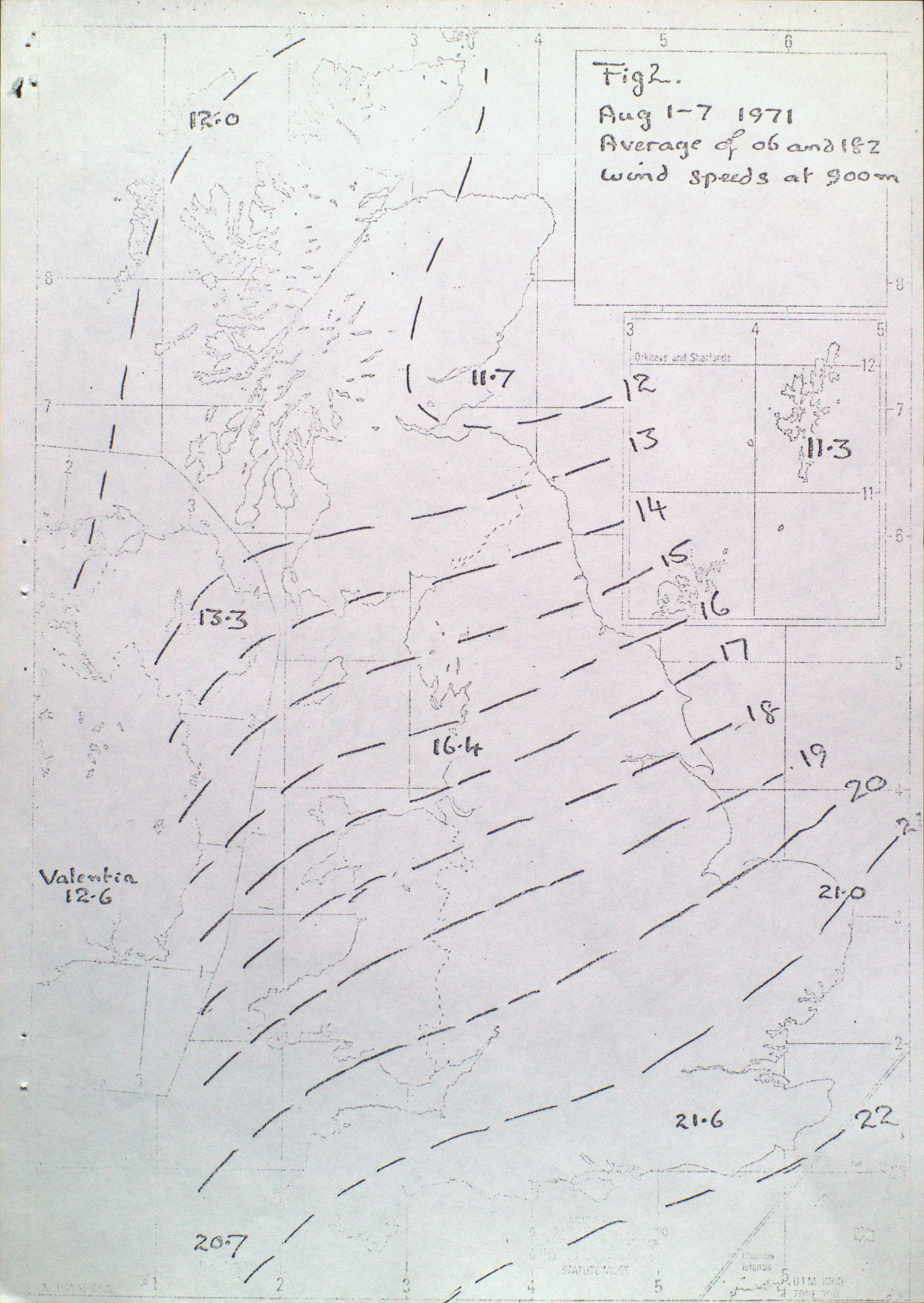
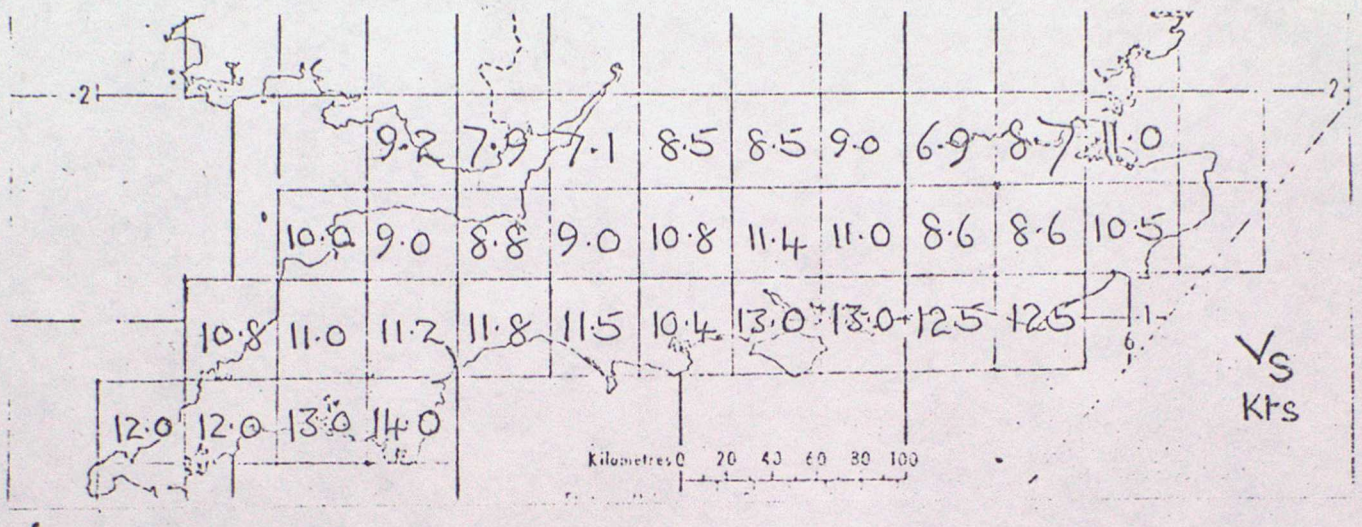


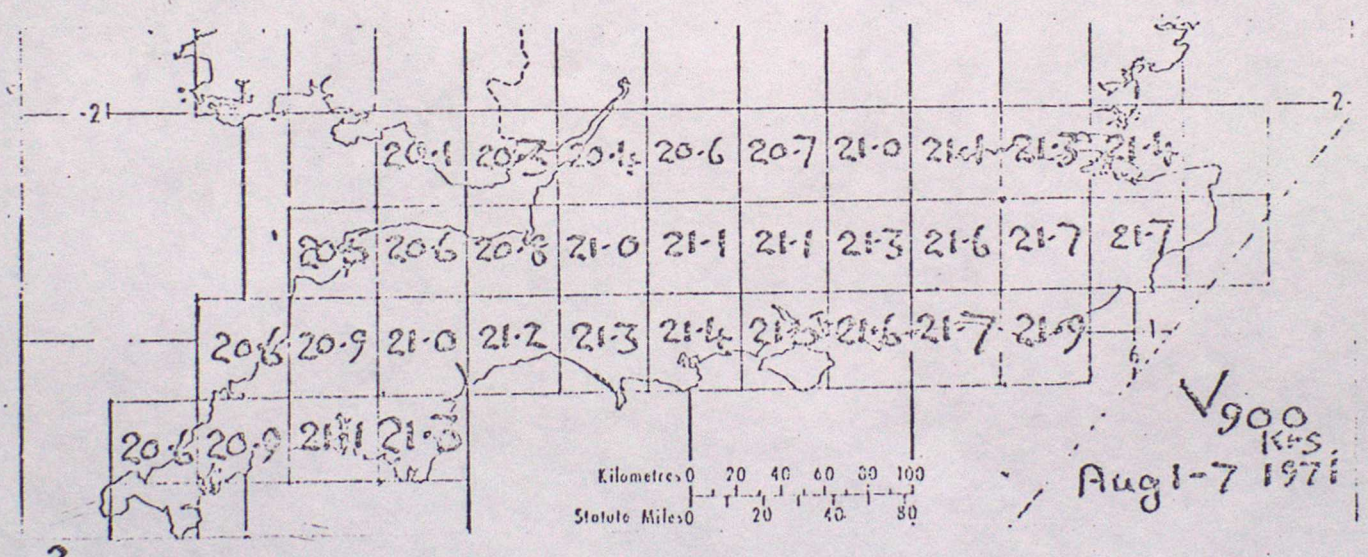
Fig 2.
Aug 1-7 1971
Average of 06 and 18Z
wind speeds at 900m
12·0
11·7
12
13
14
15
16
17
18
19
20
21
22
13·3
16·4
Valentia
12·6
21·0
21·6
20·7
Orkneys and Shetlands
11·3

Figs. 3 (1-7)

An example of the method of processing V_s and V_{900} to produce estimates of V_2.
Grid-square values of V_s and V_{900} were obtained from the isotachs of Fig. (a) and (b).



1



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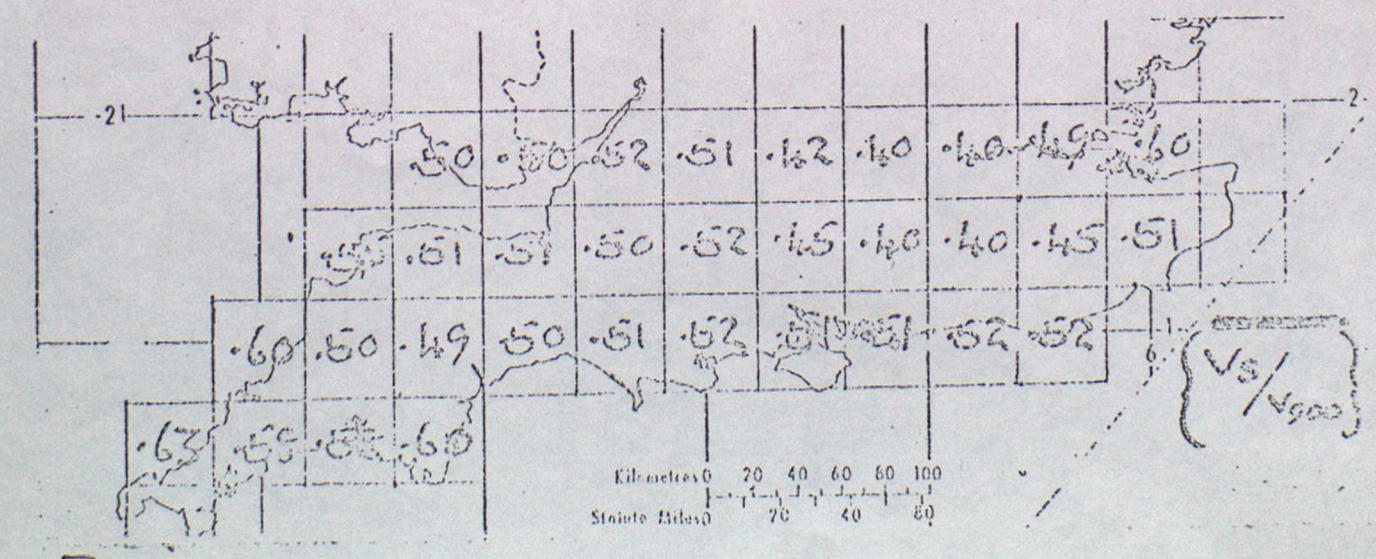

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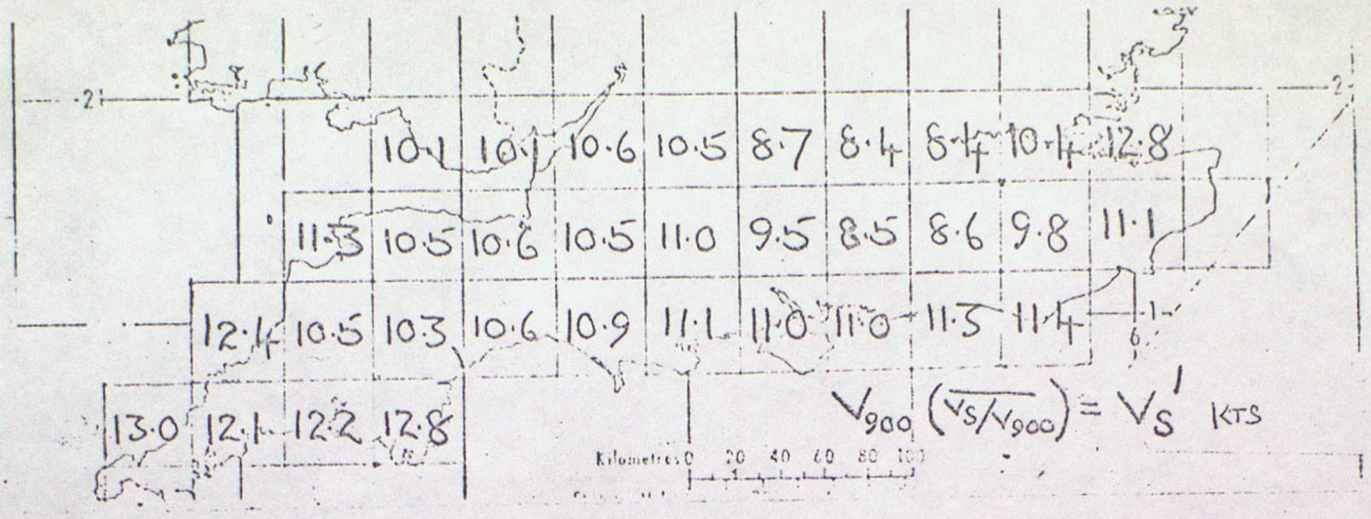
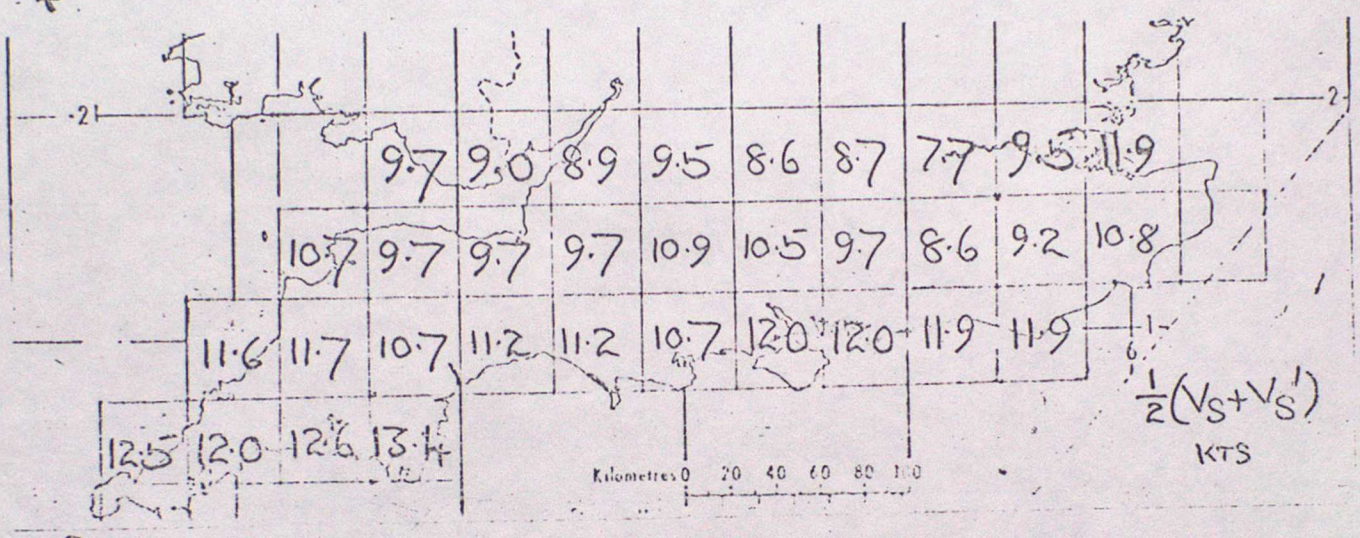
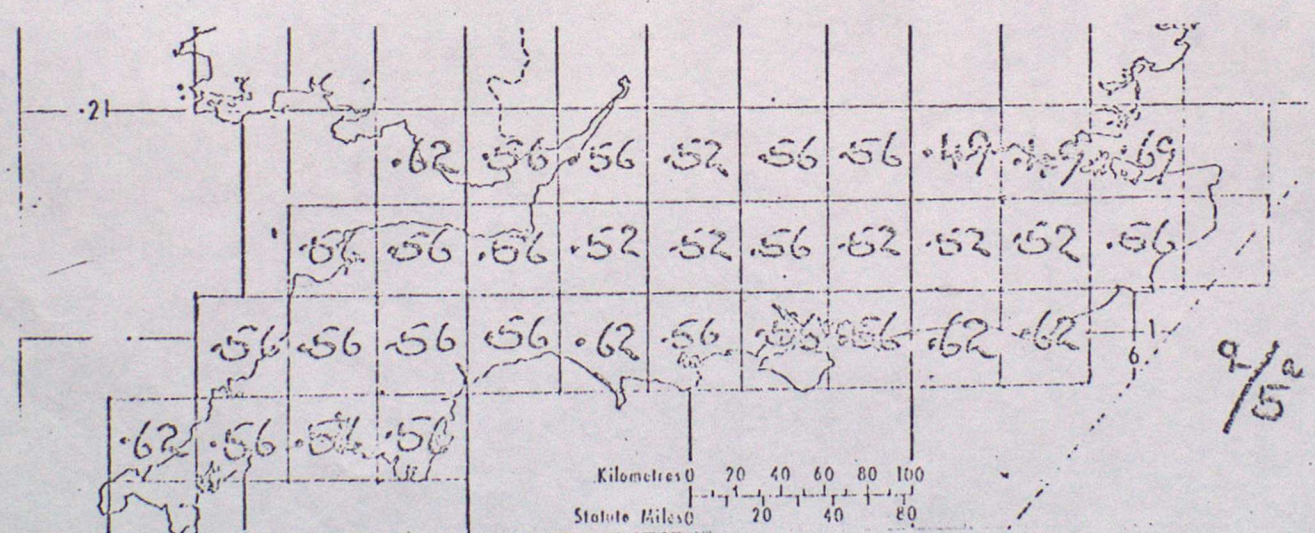

10·1 10·1 10·6 10·5 8·7 8·4 8·4 10·1 12·8
11·3 10·5 10·6 10·5 11·0 9·5 8·5 8·6 9·8 11·1
12·4 10·5 10·3 10·6 10·9 11·1 11·0 11·0 11·5 11·4
13·0 12·1 12·2 12·8
$V_{900}\left(\frac{V_S}{V_{900}}\right) = V_S'$ KTS
Kilometres 0 20 40 60 80 100

4


9·7 9·0 8·9 9·5 8·6 8·7 7·7 9·5 11·9
10·7 9·7 9·7 9·7 10·9 10·5 9·7 8·6 9·2 10·8
11·6 11·7 10·7 11·2 11·2 10·7 12·0 12·0 11·9 11·9
12·5 12·0 12·6 13·4
$\frac{1}{2}(V_S+V_S')$ KTS
Kilometres 0 20 40 60 80 100

5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·62 ·56 ·56 ·52 ·52 ·56 ·62 ·52 ·52 ·56
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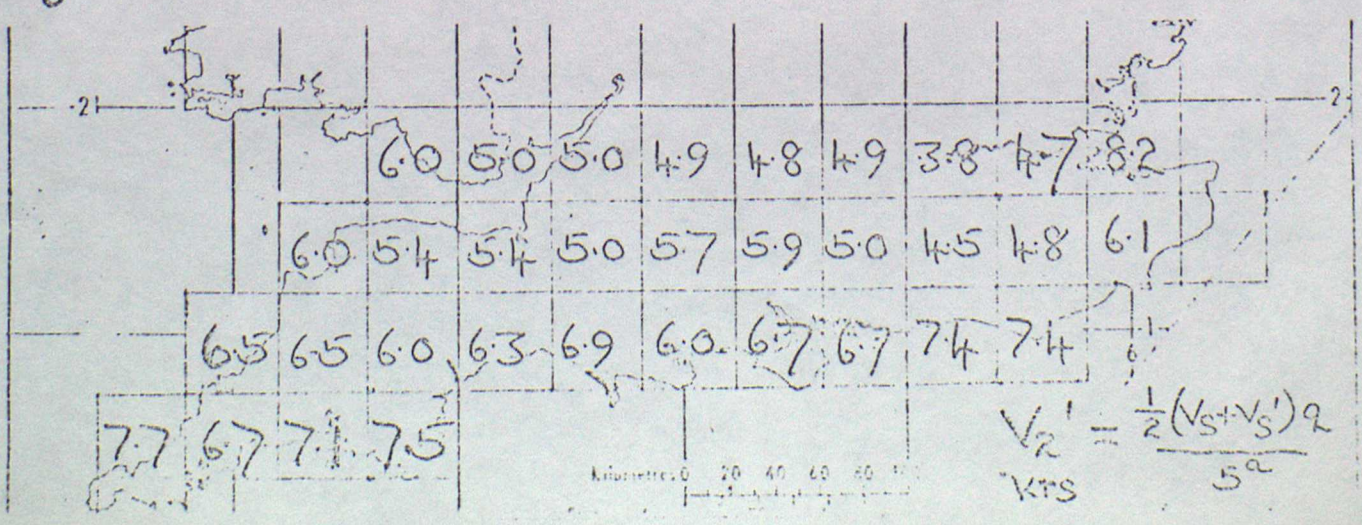
·62 ·56 ·56 ·56
Kilometres 0 20 40 60 80 100
Statute Miles 0 20 40 60

$\frac{9}{5^a}$

6


6·0 5·0 5·0 4·9 4·8 4·9 3·8 4·7 5·2
6·0 5·4 5·4 5·0 5·7 5·9 5·0 4·5 4·8 6·1
6·5 6·5 6·0 6·3 6·9 6·0 6·7 6·7 7·4 7·4
7·7 6·7 7·1 7·5
$V_2' = \frac{\frac{1}{2}(V_S+V_S')2}{5^a}$ KTS