Meteorological effects of the 20 March 2015 solar eclipse over the UK
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On 20 March 2015 a deep partial eclipse of the Sun, the most significant since the 11 August 1999 total solar eclipse, occurred over the UK. No comparably deep UK solar eclipse will occur until 2026 (e.g. Williams 1996, Espenak 1987). It is well known that solar eclipses cause transient meteorological effects, the most obvious of which is a drop in temperature, but – because total or major partial solar eclipses are fairly rare from any one point on the Earth's surface and many areas are not well instrumented - there are relatively few systematic studies covering a wide region. The UK has one of the densest networks of weather stations compared with many other parts of the world. This applies to both amateur and professional station networks. Therefore the 2015 event was a unique opportunity to gather and analyse meteorological data. This has already been done for the main Met Office network of Meteorological Monitoring System sites (Hanna et al. 2016, Clark 2016), so here I present the results of a similar exercise based on amateur weather stations. I compare the meteorological effects of the 2015 eclipse over the UK with the 11 August 1999 eclipse for which I carried out a previous study (Hanna 2000).

On 20 March 2015 the eclipse began over the UK at approximately 08:30 GMT, reaching maximum at about 09:30 and ending around 10:40 (all times referred to in this paper are GMT). The eclipse magnitude (the percentage of the Sun's diameter which is in eclipse) ranged from around 85% in extreme south-east England to more than 97% in parts of north-west Scotland (Fig. 1). On eclipse morning (20 March) the UK was on the eastern edge of an area of high pressure, with a couple of weather fronts embedded over northern England and Scotland. The synoptic chart (Fig. 2) suggests a cool north-westerly airflow and only light winds but with a fresher breeze over northernmost regions. Satellite pictures and ground-based observations show a great deal of cloud cover over much of the UK, with especially thick stratiform cloud hogging Southeast England during the entire period of eclipse (Fig. 3). However, there were persistently clear (white) areas over parts of central England, Wales, north-east England and south-east Scotland. It was expected that the thermal signature of the eclipse would be considerably less than the 11 August 1999 eclipse over the UK, which occurred around midday, but equally it was anticipated that some meteorological effects would still be detected (Hanna 2014).

With recent developments in computer models used to produce weather forecasts and climate-change predictions, solar eclipses are a useful opportunity as a 'controlled experiment' to gauge how the atmosphere responds when the incoming energy - which drives atmospheric circulation and all our weather systems - is temporarily reduced (Harrison & Hanna 2016). Eclipses are also of interest given the important role of solar photovoltaic (PV) and wind-turbine installations in the national and global portfolio of renewable energy sources. Changes in energy production during an eclipse, that are routinely monitored at thousands of installations in the domestic solar PV market in the UK, can be used to infer meteorological conditions for sites where solar-radiation data are lacking, as there is a relatively sparse network of solar radiometers. On the other hand, where such meteorological data are available at solar PV sites, the relation between insolation and power generation over a short (minutes' to several hours') period – when meteorological conditions are often reasonably stable - can usefully be studied. We therefore include an exploratory analysis in this paper.

Regional response of temperature to eclipse

In response to appeals put out in WEATHER magazine and to the Climatological Observers Link several months before the eclipse, observations were received from 43 sites, mainly automatic weather stations logging data every 1-10 mins (Table 1, Fig. 1). Details of instrumentation and exposure are shown in Table 1. Only screened temperature data are considered here. One point, which may be of importance, is whether the thermometer screen was actively or passively ventilated, because this can affect the response time of the thermometers to any ambient radiation and temperature changes, especially during periods of near-calm conditions, bearing in mind that winds may tend to slacken during an eclipse (e.g. Hanna 2000, Hanna et al. 2016). The default is still for passive ventilation, relying on natural airflow across the thermometer, but actively-ventilated weather stations such as the Davis Vantage Pro 2 with Fan Assisted Radiation Shield (FARS) are becoming increasingly popular: however, this may affect the results obtained (e.g. Hanna et al. 2014, 2016). In the present study only a relatively few sites (Brockham, Chineham, Doncaster Town Moor, Fleet Ancell's Farm, Little Paxton, Newark Balderton Lake, Normanby, Stratfield Mortimer, Willand and Wokingham) utilised active ventilation. A comparison of actively- and passively-ventilated thermometers at Stratfield Mortimer, which has standard Met Office-site and instrument specification, shows similar temperature drops of 0.4 and 0.3degC during the eclipse; another comparison at Willand likewise shows comparable temperature drops of 0.7 (0.6) degC for its actively- (passively-) ventilated thermometers (Table 2). Moreover, there is no clear evidence that aspirated temperature drops were overall lower than drops recorded using passively-ventilated thermometers in similar regions, although aspirated instruments tended to be concentrated in the generally cloudier Southeast England sites.

The observed temperature drop and cloud-cover conditions at each site are shown in Table 2. Most sites had either partial or complete cloud cover during the eclipse period but a few sites (Bathgate, Calthorpe, Newark Balderton Lake, Newchapel Observatory, Pitsford Hall, Tenbury Wells, Towcester, Warstock) had mainly clear or clearing skies throughout. In addition, Minera was fairly clear and sunny until around mid-eclipse. Cloud cover was notably heavy and persistent for most sites in southern England and East Anglia, although cloud was clearing at Willand (Devon) after the first 30 mins of the eclipse. Temperature drops range from 0.1degC in cloudy Southeast England to >1.5degC at three sites: 1.6degC at Pitsford Hall (Northants.) and Minera (near Wrexham) and 1.8degC in the frost hollow of Gleann Nam Brog (Outer Hebrides) (Fig. 4). These latter were sites where skies were relatively clear or cloud was at least partly broken during the eclipse. Four other locations, Bablake (near Coventry), Normanby (near Middlesbrough), Romiley (near Stockport) and Stornoway A, recorded temperature drops of at least 1.0degC, and there was rather more cloud cover – although not complete – at these sites. There are a few exceptions where weather stations with mainly clear skies, most notably Tenbury Wells, experienced relatively modest temperature drops, here of only 0.2degC. Apart from wider meteorological factors, some of the differences in temperature drop can probably be explained by differences in exposure between sites.

The average drop of all the (43) sites is 0.55degC, and the average time taken for this temperature decline was 32.9 minutes, with the lowest temperature being reached on average at about 09:45, about 15 minutes after maximum eclipse (Fig. 5). This time delay is to be expected due to thermal lag, where the surface keeps on cooling for a while after the Sun's energy has been diminished, and it takes time for the ground and near-surface air layer to warm up again following maximum eclipse (Founda et al. 2007). Such an effect has been observed elsewhere during both this and previous eclipses (e.g. Hanna et al. 2016).

Wind-speed and air-pressure response

Fig. 6 shows average wind speed based on ten well-scattered weather stations [Bathgate, Chineham, Drumburgh, Fleet Ancell's Farm, Menstrie, Newchapel Observatory, Pitsford Hall, Smallwood Sandbach, Wimborne and Wokingham (Fig. 1)] which each had complete 1-minute wind-speed data for the 20 March. We can see a typical diurnal profile with relatively light nocturnal winds and a stronger mid-afternoon breeze. Mean wind speed initially peaks at 4.1 mph at 08:46 and then declines to 2.0 mph at 09:35, just a few minutes after mid-eclipse. By 10:06 it has picked up to 3.6 mph, and the graph shows a very obvious ~30% (>1 mph) lull during the eclipse (Fig. 6). Part of the ensuing increase in wind was due to enhanced synoptic activity with a declining high moving away west and a developing low approaching from the north (Fig. 2) but part is due to increased turbulence and convection in the lowest few tens of metres of the atmosphere (the boundary layer) following mid-eclipse. An eclipse-related drop in wind has been observed in a number of previous studies (e.g. Hanna 2000, Hanna et al. 2016).

Surface air-pressure changes during the eclipse period are shown in Fig. 7 for both the same individual stations as for wind speed (except for Pitsford Hall), and for the mean profile. This graph shows a steady and increasing decline in UK surface air pressure during the 06:00-12:00 GMT period on 20 March 2015, due to the changes in pressure systems just mentioned. However, there is a striking lack of any eclipse-related air-pressure signature [e.g. the fabled 'eclipse cycle' (Aplin et al. 2016)].

Solar radiation changes and relation with solar photovoltaic energy generation

Global (total) solar radiation measurements were obtained using a Davis Vantage Pro 2 automatic weather station for every 5 mins between 06:00 and 18:00 on 20 March 2015 at the author's home weather station, located in Newark-on-Trent (Nottinghamshire) (site details in Table 1). These are compared in Fig. 8 with solar energy production logged every 15 minutes from a 4 kW-peak potential domestic solar photovoltaic (PV) installation at the same location. There is an expected very strong relationship between solar radiation and PV generation (Fig. 8b), meaning that the latter can be used as a surrogate of the former where solar-radiation measurements are lacking. However, where the two factors are measured simultaneously, as here, it can also be enlightening to explore the relation between solar radiation and PV generation. During the eclipse, between about 08:30 and 09:30, solar radiation at this site declined to 25% of its pre-eclipse peak, while PV generation fell to 18% of its maximum pre-eclipse value. The proportional reduction in PV generation could be greater for at least two possible reasons. First, it is a split (NE-/SW-facing) roof system and half the panels were in shade at the time of eclipse, so only responded to the change in diffuse solar radiation which is likely to be different from the proportional change in direct or global (total) solar radiation during the eclipse. Second, there is a non-linear conversion between sunlight and electrical energy (e.g. http://www.powerfromthesun.net/Book/chapter05/chapter05.html# 5.4.1 Flat-plate Collectors, The Curve). Obviously these results are just for one site but it would be insightful to repeat this analysis for a range of further sites where both solar-radiation and PV production data are available and for differently-oriented roof systems. Harrison & Hanna (2016) explore the effects of the eclipse on national electricity demand and generation.

Comparison with Met Office weather station data and with previous UK eclipse

In their analysis of 76 selected Met Office Meteorological Monitoring Network weather stations, Hanna et al. (2016) found an average 0.83degC temperature drop, with the minimum temperature lagging the eclipse peak by about 10 mins. This is, on average, a slightly greater temperature drop than that we report here (0.55degC), although the time lag (15 mins here) is similar. This might be because the Met Office data are for every minute whereas only a limited number of sites in the present analysis have 1-min data, with many reporting temperature only once every 5 or 10 mins: this could mean that the highest (lowest) temperature reached before (during) the eclipse is sometimes missed. Temperature drops at several Met Office sites exceeded 2degC, up to 3.8degC in the highest case, whereas the highest temperature drop we found from the present analysis (but for a smaller number of sites) was 1.8degC. On the other hand, the spatial distribution of the temperature drops in the two analyses is similar, with parts of the Midlands, Wales and Scotland (often under clearer skies) clearly having the largest drops – and Southeast England having the smallest drops - in both cases.

Mean screened surface air temperature drops during the 11 August 1999 eclipse over the UK ranged from 1.2degC in Northern and Southwest England to 2.3degC in Southeast England (regional averages), with several sites in Southeast England recording >3degC drops (Hanna 2000). That eclipse was total in Cornwall and southern Devon, with the eclipse magnitude typically about 97% in Southeast England and 90% in northern England, so astronomically was not too dissimilar to the 2015 event (with the important exception that it was total over most of Cornwall and part of Devon). However, the 1999 eclipse was a near-midday, summer event and, despite significant cloud cover over much of the UK, this resulted in a temperature response of approximately double that observed during the 2015 event. It is telling that in the zone of totality, generally thick cloud cover over Southwest England depressed the temperature drops there by a factor of two during the 1999 eclipse (Hanna 2000). This is much in line with present results.

The observed drop in wind speed during the eclipse is greater than the ~10% reduction in wind speed measured at the (average of) 63 Met Office Meteorological Monitoring System (MMS) weather stations (Hanna et al. 2016). This may be due to the non-standard/more-sheltered nature of some of the sites used in this study, which could amplify any wider wind-speed reduction. However, Hanna et al. (2016) noted a fair degree of disparity between different weather stations in terms of the wind-speed change during the eclipse, with 15/63 MMS sites showing an *increase* in wind speed. Our lack of a surface air-pressure signal is also in accordance with the results of Hanna et al. (2016). Harrison & Hanna (2016) conclude that any small circulation changes arising from eclipses are restricted to the near-surface boundary layer rather than more vertically-extensive 'eclipse cyclone' originally envisaged.

Summary

UK weather conditions were not wholly co-operative on 20 March 2015, as there was a great deal of cloud cover across large parts of the country, but substantial parts of central England and smaller portions of northeast England and southeast Scotland were at least partly clear. Winds were generally light due to a dominating area of high pressure, albeit quite a cloudy high - especially in the Southeast. There was also a relatively cold (and fairly cloudy) northwest airflow across much of the UK. Nevertheless, analysis of several dozen amateur weather stations reported here confirms previous reports of a discernible temperature reduction during the eclipse – although the eclipse-related cooling was severely muted in the cloudy Southeast regions. Also, available high-frequency wind-speed data show a significant slackening of wind during the eclipse period, although there was no discernible signature on air-pressure changes. Only a relatively small number of weather stations (10/43) used active ventilation systems to aspirate their thermometers, which might be expected to reduce the eclipse signature under sunny/clear, near-calm conditions, but most of the active systems were in Southeast England where conditions were generally overcast.

The observed eclipse-induced cooling ranged from 0.1-0.4degC in the cloudier South of England to locally ≥1.5degC in parts of the Midlands, Northeast England and Scotland. These are likely to be underestimates in many cases because of the early-morning timing of the eclipse, which occurred at a time of day when temperatures are often rising strongly. The spatial distribution of the UK temperature response observed here is very similar to that based on a more extensive network of Met Office monitoring weather stations. However, the magnitude of the temperature response was in both cases approximately half of that recorded during the 11 August 1999 eclipse over the UK.

There are still relatively few eclipse meteorology studies based on extensive networks of weather stations, and those that are available are necessarily based on a relatively limited range of meteorological conditions. Therefore any further such studies are valuable to add to the global database and for helping to refine computer-model simulations. As well as being useful for engaging the amateur meteorology community and wider public, this kind of study can also help shed light on the relation between micrometeorological influences, such as topography and land-surface type, and wider synoptic meteorology. The 2015 eclipse enabled us to take advantage of recent developments in meteorological monitoring equipment used by amateurs, such as the widespread use of the Davis VP2 and other automatic weather stations, and also allows a broader perspective arising from the recent widespread uptake of domestic renewable energy (solar PV) generation. I hope to be able to report on the meteorological effects of the 12 August 2026 solar eclipse (magnitude 91-96% over the UK), which in contrast to the previous two major UK eclipses mentioned here will be a late-afternoon (~1700-1900 GMT) eclipse, in a future issue of WEATHER!

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Table 1. Summary of weather stations, sites and exposures used in this study

Location (name, county)	**Latitude (°N)**	**Longitude (°E)**	**Elevation (m.a.s.l.)**	**Thermometer type/model**	**Screen type (if not AWS)**	**Ventilation (P = passive; A = aspirated)**	**Station grade/exposure**	**Temperature measurement frequency**
Appledore Station, Kent,	51.03	0.81	2	Davis Vantage Pro 2 (VP2) automatic weather station (AWS)		P	COL C1; very open site.	10 min
Bablake School, Coundon, nr. Coventry	52.41	-1.52	118	Campbell Scientific AWS		P	School playing fields – open site with Met Office MMS	2 min
Bathgate, West Lothian	55.91	-3.64	167	Davis VP+ AWS		P		1 min
Brockham, Surrey	51.22	-0.30	45	Davis VP2 AWS with FARS		A	COL C2	10 min
Calthorpe, Norfolk	52.83	1.23	36	Tinytag Plus 2 TGP-4020 thermistor	Stevenson	P	COL A; exposed meadow	1 min
Carlton-in-Cleveland, North Yorks.	54.42	-1.23	103	Tinytag Plus 2 TGP-4505 thermistor	Stevenson	P	COL B; fairly sheltered back garden.	1 min
Carlton-in-Coverdale, North Yorks.	54.26	-1.90	278	Davis Vantage Vue AWS		P	COL A; semi-exposed hillslope site.	10 min
Chedburgh, Suffolk	52.19	0.67	75	Davis VP2 AWS		P	COL C2	10 min
Chineham, Hants.	51.29	-1.06	86	Davis VP2		A	Very sheltered	1 min

				AWS, FARS			garden	
Chippenham, Wilts	51.27	-2.06	61	Davis VP6320		P	COL C2; quite sheltered garden.	10 min
Chudleigh, Devon	50.6	-3.6	67	Davis VP2		P	Relatively sheltered sloping garden	5 min
Colchester NE2, Essex	51.89	0.93	36	Davis VP		P	COL B; partially-sheltered site.	1 min
Crowthorne 2, Berks.	51.36	-0.81	80	MINI temperature logger	Stevenson screen	P	COL C2; moderately dense housing; well-wooded area.	10 min
Doncaster, Town Moor, South Yorks.	53.52	-1.12	10	Davis VP2 AWS, FARS		A	COL C2; sheltered suburban back garden.	5 min
Drumburgh, Cumbria	54.92	-3.18	7	Davis VP2		P	COL A	1 min
Farnborough, Hants.	51.31	-0.78	66	Davis Vantage Vue		P	COL C; partly sheltered garden.	5 min
Fleet, Ancell's Farm, Hants.	51.31	-0.76	65	Davis VP2, FARS		A	COL C2	1 min
Gleann Nam Brog, Lewis Castle, Stornoway, Outer Hebrides	58.21	-6.40	~25-30	Conrad Electronics DL-120TH logger	small screen	P	Middle of open glen/frost-hollow; mixed grass and moorland.	1 min
Hepworth,	52.33	0.91	46	Davis Vantage		P	COL C2;	5 min

Suffolk				Vue AWS			sheltered.	
High Bradfield, South Yorks.	53.43	-1.58	393	Delta T thermistor logger	Small plastic Stevenson screen	P	Very open/exposed site. Run by Department of Geography, University of Sheffield; also Met Office anemometer.	5 min
Horsham, West Sussex	51.06	-0.32	37	Campbell Scientific AWS		P	COL B; urban back garden.	1 min
Lapford, Devon	50.85	-3.82	150	Traditional dry thermometer	Stevenson screen	P	COL A; good exposure; rural; undulating terrain.	Various down to 1 min during eclipse
Little Paxton, Cambs.	52.36	0.33	17	Davis VP2		A	Village-centre ungraded COL site near church	5 min
Menstrie, Clackmannanshire	56.15	-3.86	19	Davis VP2		P	Sheltered garden	1 min
Minera, Wrexham	53.05	-3.09	250	Maplin + Kilmalog Pro 30.3039.IT		P	Sheltered (COL 1) village site	1 + 5 min
Newark Balderton Lake, Notts.	53.06	-0.80	15	Davis VP2 FARS		A	Sheltered back garden	5 min
Newchapel Observatory, North Staffordshire	53.08	-2.21	219	Davis Vantage Vue		P	Standard exposure; medium/ suburban development	1 min

Newton Abbot, Devon	50.52	-3.59	13	Lacrosse AWS (calibrated)	Small standard screen	P	COL BB-A25-	1 & 5 min
Newton Hall, Durham	54.8	-1.6	77	Davis VP2		P	Fairly sheltered garden	10 min
Normanby (near Middlesbrough)	54.55	-1.17	30	Gemini Tinytag logger with flying lead probe	Davis VP FARS screen	A	COL C1; suburban garden	30 sec & 5 min
Pateley Bridge 2, North Yorks.	54.09	-1.76	150	Mindset temperature probe	Standard thermometer screen	P	COL A	<1 min
Pitsford Hall, Northampton	52.30	-0.89	117	Instromet AWS		P	COL C1	1 min
Radcliffe, Greater Manchester	53.55	-2.34	85	Davis VP2		P	COL CC-A15-; semi-sheltered back garden	5 min
Romiley, Stockport, Greater Manchester	53.42	-2.08	116	Davis VV		P	School playground; well-exposed.	1 min
Smallwood Sandbach, Cheshire	53.16	-2.33	79	Vaisala HMP45 temperature probe	Standard plastic Stevenson screen	P	AAAA47-	1 min
Stornoway A	58.21	-6.38	27	Data Harvest-Easylog platinum resistance thermometer	Large Stevenson screen	P	Large garden	10 sec
Stornoway B	58.21	-6.38	27	Conrad Electronics DL-120 TH	Same	P	Large garden	30 sec

				data logger				
Stratfield Mortimer*-+ ++, Berks.	51.373	-1.042	60	Calibrated platinum resistance	Standard Metspec Met office pattern + RM Young aspirated screen	A & P	Class A (Met Office standard)	1 min from 6-12z on 20 Mar, otherwise 5 min
Tenbury Wells, Worcs.	52.30	-2.62	90	Davis VP2		P	COL C2; fairly sheltered rural site.	1 min
Towcester, Northants.	52.53	-0.90	105	Klimalogg pro temperature logger	Homemade Stevenson screen	P	Over grass in small back garden neat town edge	5 min
Warstock, Birmingham	52.40	-1.87	151	Novalynx 210-201 sensor & 195-704-A logger	Standard wooden Stevenson screen	P	Very sheltered (COL 0); CC-B03-	5 min
Willand, Devon	50.88	-3.37	79	Tinytag (calibrated) and Davis VP2 FARS	Stevenson screen & Davis screen	P (Tinytag) & A (Davis)	Semi-sheltered back garden	1 min (Tinytag) & 10 min (Davis)
Wimborne, Dorset	50.78	-1.97	45	Davis VP2		P	Sheltered garden	1 min
Wokingham, Berks.	51.42	-0.87	45	Campbell Sci HMP45 probe		A	Level grass area within school grounds	1 min

Table 2. Highest and lowest temperatures with their times (UTC), temperature drop and time taken, and cloud cover conditions during the eclipse period on 20 March 2015

Location (name, county)	High temp, time	Low temp, time	Drop, time taken	Cloud cover conditions
Appledore Station	5.8, 0830-0900	5.4, 0940	0.4, ~40min	Cloudy.
Bablake School	7.4, 0922	6.4, 0950	1.0, 28min	Partial clearance during eclipse.
Bathgate	8.6, 0852-0916 & 0928-31	8.4, 0942-1004.	0.2, 11min	Sunny periods/ few clouds.
Brockham	5.3, 0920	5.2, 0930-1000	0.1, ~10min	Cloudy.
Calthorpe	4.90, 0851	4.15, 0942	0.75, 51min	Thick Sc before eclipse, began to thin ~0845 with gaps revealing eclipse and big holes by eclipse peak (0930).
Carlton-in-Cleveland	9.7, 0910	8.5, 0952	1.2, 42min	7 oktas CM7, mainly thickish Ac, some As/Ns – thin enough to see eclipse at times, breaking apex WNW ~1030, ~5-6 oktas by 1100.
Carlton-in-Coverdale	8.5, 0920	8.0, 0950	0.5, ~30min	5 oktas cloud at 0900.
Chedburgh	4.4, 0912	4.0, 0952	0.4, ~40min	Overcast until 1030 when Sun started to emerge.
Chineham	4.7, 0857-09:29	4.6, 0930-1012	0.1, 1min	N/A
Chippenham	5.9, 0910	5.5, 0950	0.4, ~40min	Cloudy but fairly thin cover; cloud cleared about midday.
Chudleigh	6.0, 0905 & 10	5.7, 0945 & 50	0.3, 35min	Thick frontal stratiform cloud at at least two levels – just enough thinning for <5 min ~0955 to get brief view of eclipse.
Colchester NE2	5.1, 0855-0922	4.8, 0957-8	0.3, 35min	Overcast throughout eclipse period. Cloud began to thin at 1130.
Crowthorne 2	4.3, 0653-0953	4.2, 1003-1033	0.1, ~10min	Overcast until 1130.
Doncaster, Town Moor	7.9, 0925 & 30	7.8, 0935-50	0.1, 5min	Sheet of light, high Sc obscured Sun during eclipse, clearing from NW. Sun fleetingly visible through thin areas of cloud.
Drumburgh	8.1, 0826-0900	7.5, 0947-0951	0.6, 47min	6 oktas; eclipse visible through cloud.
Farnborough	4.5, 0910 & 15	4.3, 0945 & 0950-1010	0.2, ~30min	Overcast. St.
Fleet, Ancell's	5.1, 0904-6	4.8, 0942-1021	0.3, 36min	Completely overcast throughout event.

Farm				
Gleann Nam Brog	8.6, 0848-50	6.8, 0952	1.8, 62min	5-7 oktas Sc for first half of eclipse; 7-8 oktas Sc thereafter.
Hepworth	4.7, 0850	4.2, 0930-55	0.5, ~40min	7 oktas St with possible Ac above.
High Bradfield	7.5, 0819	6.7, 0939	0.8, ~80min	N/A
Horsham	4.90, 0909	4.77, 0952-0955	0.13, 43min	Overcast until early p.m.
Lapford	1.1, 0905	0.8, 0929-40	0.3, 24min	Fog throughout most of eclipse period; thinned slightly during 0927-1005 (200-300-m visibility).
Little Paxton	4.7, 0925 & 30	4.4, 0950 & 55	0.3, ~20min	Complete cloud cover to 0920 then veil of thinner cloud allowed glimpses of eclipse. Cloud cover diminished after max. eclipse.
Menstrie	9.9, 0911-0923	9.2, 0950-1007	0.7, 27min	N/A
Minera	7.3, 0852	5.7, 0934-7 & 41	1.6, 42min	1 okta cloud at 0800. Sunny until 0935 then cloudy with little Sun. Hard to see Sun after max. eclipse.
Newark Balderton Lake	6.6, 0900	6.3, 0955 & 1000	0.3, ~55min	Mainly clear/sunny.
Newchapel Observatory	6.4, 0842-0909	5.8, 0937-52	0.6, 28min	<4 oktas cloud during eclipse but increasing in second half. Lowering cloud interrupted view in last 10-15 mins.
Newton Abbot	6.3, 0850-0920	6.0, 0940-5	0.3, ~20min	First half of eclipse visible only through St & Sc, with increasing cloud obscuring eclipse altogether from its maximum.
Newton Hall	9.9, 0910	9.3, 0950 & 1000	0.6, ~40min	Mainly cloudy with Sc and only a very few glimpses of Sun.
Normanby	10.5, 0959	9.0 1039-40 & 49	1.5, 40min	No bright/sunny intervals recorded by electronic sensor between 0904 & 1108.
Pateley Bridge 2	6.7, 0931-9	6.5, 0955	0.2, 16min	7 oktas Sc cloud cover, just thin enough for eclipse to show through at times.
Pitsford Hall	6.0, 0855	4.4, 0934	1.6, 39min	Decrease in cloud to almost clear sky at 0934, with Ci, Cs & Sc to south, but notable increase in Cc just before max eclipse.
Radcliffe	7.4, 0905-30	7.3, 0935-55	0.1, 5min	7 oktas Sc at 1000 m at 0900.
Romiley	7.8, 0908-10	6.8, 0940-55	1.0, 30min	Cloud cover changed from ‘mostly’ to ‘complete’ at about 1030.
Smallwood	6.4, 0903-4	5.5, 0948-51	0.9, 44min	5 oktas cloud cover at 0900. Sun’s disc was partially obscured

Sandbach				through quite thin stratocumulus throughout the eclipse.
Stornoway A	7.97, 0848	7.0, 0945-54	1.0, 57min	5-7 oktas Sc for first half of eclipse; 7-8 oktas Sc thereafter.
Stornoway B	8.1, 0854-0900	7.4, 0952-1005	0.7, 52min	Ditto.
Stratfield Mortimer	4.6°C, 0841 (aspirated); 4.6, 0855-0910 (passive)	4.2°C at 0927-44 (aspirated); 4.3, 0929-57 (passive)	0.4degC, 46 min (aspirated); 0.3, 19 min (passive)	8/8 low St throughout eclipse.
Tenbury Wells	4.2, 0920-0932	4.0, 0945-0951	0.2, 13min	Some Ac in E of sky from dawn to 0850, then completely clear to 1200.
Towcester	5.6, 0855-0920	5.3, 0950-1000	0.3, ~30min	Sun's outline visible through cloud at ~0825. Cloud then progressively thinned and broke during eclipse.
Warstock	6.25, 0915 & 20	6.0, 0940	0.25, ~20min	Patchy Ac during eclipse.
Willand	5.8, 0850 (aspirated); 5.5, 0855 (passive)	5.1, 0940 (aspirated); 4.9, 0936-8 (passive)	0.7, 50min (aspirated); 0.6, 41min (passive)	Eclipse partially obscured by cloud for first 30 minutes, after which sky cleared.
Wimborne	5.5, 0903-5 & 0906-7	5.2, 0945-6, 0950, 0953-7 & 0959.	0.3, 38min	N/A
Wokingham	4.7, 0851 & 0854-8	4.3, 0930-53	0.4, 32min	8 oktas St at 0900, Overcast & hazy in morning. First cloud breaks ~1200.

Figure captions

Fig. 1. Map of British Isles, indicating eclipse magnitude (green lines) and UK weather stations used in this study. Red (blue) dots denote sites with passively- (actively-) ventilated thermometers.

Fig. 2. Synoptic chart for 06:00 GMT on 20 March 2015, based on Met Office analysis (redrawn). Obtained from http://www.willandweather.org.uk/mycharts.php and original chart is Met Office Crown Copyright.

Fig. 3. Time sequence of multispectral infrared satellite (MSG-3 SEVIRI) pictures of UK region obtained by the Department of Geography, University of Sheffield's satellite receiver for 09:30 to 10:15 UTC on 20 March 2015, during the eclipse period. Composite image is courtesy of Dr. Rob Bryant, University of Sheffield.

Fig. 4. Temperature drops during the eclipse period for the sites detailed in Table 1 & Fig. 1.

Fig. 5. Near-surface air-temperature profiles for selected sites with 1-minute data on 20 March 2015. The thick black line depicts the (mean) average of the individual sites. The C1, GE and C4 thin black dashed vertical lines respectively mark the start of eclipse, mid-eclipse (maximum obscuration) and the end of eclipse.

Fig. 6. Mean wind speed profile for 20 March 2015 for ten selected sites with 1-min data.

Fig. 7. Mean surface air pressure profile for 20 March 2015 for nine selected sites with 1-min data, with the (mean) average pressure profile shown by the thick black line.

Fig. 8. Global solar radiation and solar photovoltaic energy production measured at Newark Balderton Lake Climatological Observers Link station on 20 March 2015. (a) shows the time profiles of both parameters, and (b) shows a strong statistical relation between solar radiation and energy production. The latter is measured using SolarEdge monitoring software.