BOUNDARY DUST MONITORING SURVEY REPORT

ENVIRONMENTAL PERMIT EPR/TP3639BH/V009

CELSA MANUFACTURING (UK) LIMITED, TREMORFA WORKS, SEAWALL ROAD, CARDIFF.

ECL Ref: ECL.053.01.02/BDM
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Table of Contents

List of Tables

List of Figures

List of Terms / Acronyms used in this Report

CML	**Celsa Manufacturing (UK) Limited**
DMP	**Dust Management Plan**
EAC	**Effective Area Coverage**
ECL	**Environmental Compliance Limited**
Met	**Meteorological**
TGN	**Technical Guidance Note**
The Site	**Tremorfa Works, Seawall Road, Cardiff**

1. INTRODUCTION

1.1. Overview

1.1.1. This Boundary Dust Monitoring Survey Report has been prepared on behalf of Celsa Manufacturing (UK) Limited ("CML"), Tremorfa Works, Seawall Road, Cardiff ("the Site"), by Environmental Compliance Limited ("ECL") and in relation to their activities comprising of:

- scrap metal processing;
- scrap yard activity;
- operation of an asphalt plant; and
- slag processing, crushing and screening plant.

1.1.2. The document reports the results of boundary dust monitoring in partial fulfilment of the requirements of Improvement Condition 6 of the Variation Permit, reference EPR/TP3639BH/V009, issued as a result of a Variation Application submitted by CML.

1.1.3. A Dust Management Plan ("DMP") was prepared by CML to reduce fugitive dust emissions on the Site, providing mitigation measures to minimise the generation of dust in addition to improving dust control measures. A copy of the '*Rover Way Dust Management Plan*' is provided in Appendix I of this document.

1.1.4. The activities listed in Section 1.1.1. have their own dust management plans, detailing the sources of dust generation. These sources are as follows:

- loading of materials to storage piles, which can be continuous or batch operations;
- equipment and equipment traffic;
- crushing and screening;
- vehicle movements in and out of site;
- wind erosion of stockpiles; and
- load out of materials for shipment, or for return to the process stream, which can be batch or continuous drop operations.

1.1.5. The Site is surrounded by various receptors deemed sensitive to significant dust deposition generated from the site activities. The receptors have been identified and are detailed as:

- Travellers' site (north-east and beyond the adjacent Western Power Distribution Sub-station);
- Welsh Water compound (north-east and adjacent to Travellers' site closer to the Installation site);
- Pengam Green residential area (north);
- Willows High School (northwest);
- Tremorfa residential area (west-northwest); and
- Severn Estuary (east).

1.1.6. The DMP proposes a range of control measures to be implemented minimising and preventing dust generation. These include:

- appropriate locations of storage stockpiles;
- maintaining good levels of housekeeping;
- regular use of Road Sweepers;
- ensuring buildings remain enclosed and undertake activities within enclosed buildings where possible;
- use of enclosed vehicles, skips and containers;
- use of a water bowser for damping down in dry conditions;
- minimising the height of stockpiles and flattening the tops to prevent wind-whipping;
- regular visual monitoring and inspections; and
- site management inspections and audits.

1.1.7. The DMP also details the proposal for the Ambient Air Monitoring survey. The design and rational for the survey are detailed in Section 2. below.

2. DUST MONITORING

2.1. Document Review

2.1.1. Prior to formulating a survey strategy, a review of the existing controls and guidance for dust monitoring was undertaken. This involved a review of the following documents:

- Installation Permit (Ref: EPR/TP3639BH/V009);
- Technical Guidance Note ("TGN") M8 (Monitoring) – Monitoring Ambient Air (Environment Agency, Version 2, May 2011); and
- Technical Guidance Note M17 (Monitoring) – Monitoring Particulate Matter in Ambient Air around Waste Facilities (Natural Resources Wales, Version 4, October 2014).

2.1.2. The Permit was varied in 2019 and as stated in improvement condition 6, included a requirement to undertake a boundary dust monitoring survey to ascertain whether dust mitigation measures implemented were effective in controlling and minimising fugitive dust emissions emanating from the site.

2.1.3. Technical Guidance Note M8 discusses the various aspects of ambient air quality monitoring highlighting consideration for the purpose of monitoring, the need for a monitoring strategy, and the objectives of the monitoring. Specific considerations should be given to:

- species to be monitored;
- sampling time and duration;
- sampling method;
- supplementary data collection;
- sampling location; and
- data handling and data analysis.

2.1.4. The objective of the monitoring survey will be to ascertain whether dust mitigation and control measures are effective at minimising the fugitive release of dust across the Site boundary. The species to be monitored is dust and the proposed duration of monitoring is over a six month period. Ideally, the sampling period would cover three 'summer' months and three 'winter' months, however, restrictions arising from the COVID-19 pandemic resulted in a delayed start to the survey.

2.1.5. Technical Guidance Notes M8 and M17 were used to determine that the use of Frisbee Gauges and sticky strips would be the most suitable method for assessing fugitive transboundary dust emissions. Reference was also made to the Stockholm Environmental Institute protocol for Frisbee dust deposit gauges (Vallack, H.W., SEI-Y, 1995).

2.2. Survey Design

2.2.1. The Site boundary runs along Rover Way with one Site access point from the roundabout at the southwest corner of the Site, and the boundary line following a north-easterly direction to approximately 80m below the Sewall Road junction with Rover Way. There is a second access point to the Site approximately 120m southwest of the Seawall Road junction, this is a waste material transfer point linking to facilities on the opposite side of Rover Way. An indicative Site location (outlined in red) is provided in Figure 1 below.

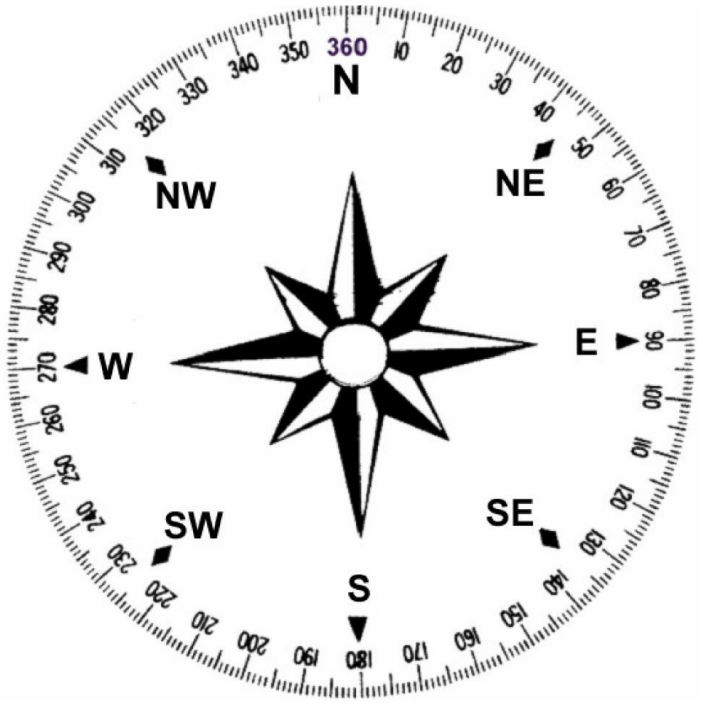
Figure 1: Indicative Site Location

2.2.2. The boundary along Rover Way is largely bordered by vegetation with openings along the access point at the northern end and more sparse vegetation along the southerly and north easterly boundaries.

2.2.3. Processing of materials is undertaken in designated areas of the Site and these areas are accessed via haul routes. Stockpiling of materials (either awaiting processing or having been processed) cover large areas of the Site.

2.2.4. The key sensitive receptors have been identified as located north easterly to north westerly of the Site. With due regard to the TGNs and taking consideration of the location of sensitive receptors in relation to the Site, it was considered that monitoring locations would be best placed to the northeast and southwest of the Rover Way boundary. This would mean wind directions from the north (360^{o}) clockwise through to southwest (approximately 230^{o}) would be 'captured' by the monitoring positions. Wind directions from southwest through to north would be from off-site directions and downwind of the key sensitive receptors. Figure 2 below illustrates the wind directions described above.

Figure 2: Wind Direction Plot (Degrees)



2.2.5. The proposed locations identified are shown in Figure 3 below, as supplied by CML.

Figure 3: Proposed Monitoring Locations

2.2.6. A Site visit was undertaken to set up the Frisbee Gauges on 15th October 2020. The location at the north was deemed unsuitable as it was lying within several inches of mud with no means to secure the Frisbee Gauge in place. The location was also visible from the road which may attract interest and entice people on to the Site creating a security and health and safety risk. The next closest location was adjacent to a stockpile of material that was due to be processed with a mobile crushing plant, effectively placing the gauge next to a dust source, this was not deemed suitable.

2.2.7. The next closest location was adjacent to the northeast boundary alongside the Western Power Substation Site. This was deemed far enough from the stockpile and haul route around the Haith Plant. It was also in line of sight of the north-western boundary enabling winds from the southwest direction to travel the length of the Site before reaching the Frisbee Gauge.

2.2.8. The proposed location at the southwest of the Site was also deemed inappropriate. It was located close to the main Site entrance where vehicle dust would be generated but not necessarily prone to leaving Site. Further, access to service the Frisbee Gauge at this location would require crossing the main access route. Site activities would also restrict access to the Frisbee Gauge.

2.2.9. An alternative location was identified on the edge of the staff car park area at sufficient distance from the office/canteen and boundary vegetation. Although considered unlikely that dust would break through the vegetation at this point, the location should identify if dust emissions were being transferred to this point.

2.2.10. The two alternative monitoring locations are illustrated in Figure 4 below.

Figure 4: Alternative Monitoring Locations

2.3. Survey Locations

2.3.1. The northeast monitoring location (Location 1) is illustrated below in Figures 5-7 This monitoring location is situated close to the Haith Plant and alongside the Western Power Sub-Station Site boundary.

Figure 5: Monitoring Location 1 - Looking South-East

Figure 6: Monitoring Location 1 - Looking East

Figure 7: Monitoring Location 1 – Looking North East

2.3.2. The southwest monitoring location (Location 2) is illustrated in Figures 8- 10 below. This is situated close to the Site's main entrance and in the vicinity of the weighbridge.

Figure 8: Monitoring Location 2 – Looking South East

Figure 9: Monitoring Location 2 – Looking West

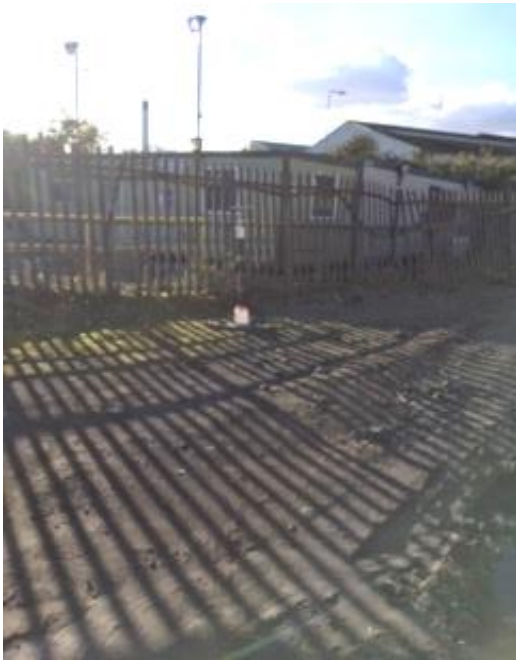


Figure 10: Monitoring Location 2 – Looking North West

2.3.3. The Frisbee Gauges were set up on the afternoon of Thursday 15th October 2020. The equipment consisted of a tripod for mounting the Frisbee which would utilise a foam collection pad, a 5 litre water bottle for the collection of rainwater and particulate washed through the foam pad, and the use of sticky strips for directional analysis of wind-blown particulate matter. This is as illustrated in Figures 5-10 above.

2.3.4. Sampling was planned to be undertaken monthly for a period of 6 months and gather data for assessing effective area coverage ("EAC") as a percentage per day for each monthly monitoring period, along with rate of deposition reported as mg/m^2/day.

3. MONITORING RESULTS

3.1. Dust Deposition Rates

3.1.1 Monitoring was planned for a six-month period, however, sampling was extended to cover an eight-month period due to a sample receipt issue along with a damaged sample problem.

3.1.1. Tables 1 and 2 below summarise the results of the dust deposition calculated from the rainwater collected in the sample bottle and the dust deposited within the Frisbee Gauge over the period of exposure.

Table 1: Location 1 (Haith Plant)

Period	Sample Reference	Total Solids (mg)	Sample volume (litres)	Rate of Dust Deposition (mg/m^2/day)
Oct-Nov	ECL/20/6151	80.5	4.46	62.14
Nov-Dec	ECL/20/6789	171.0	5.05	140.79
Dec-Jan	ECL/21/0267	165.0	5.10	135.85
Jan-Feb	ECL/21/0806	33.3	5.10	27.40
Feb-Mar	ECL/21/1555	36.4	3.60	32.10
Mar-Apr	ECL/21/2146	118.0	0.43	94.00
Apr-May	ECL/21/2922	195.0	5.26	161.00
May-Jun	ECL/21/3681	41.6	1.50	31.10

Table 2: Location 2 (Weighbridge)

Period	Sample Reference	Total Solids (mg)	Sample volume (litres)	Rate of Dust Deposition (mg/m^2/day)
Oct-Nov	ECL/20/6150	16.8	5.00	12.97
Nov-Dec	ECL/20/6788	300.0	4.52	**247.00**
Dec-Jan	ECL/21/0266	104	5.00	85.63
Jan-Feb	ECL/21/0805	86.5	5.10	71.20
Feb-Mar	ECL/21/1554	29.1	3.60	25.70
Mar-Apr	ECL/21/2145	55.6	0.49	44.30
Apr-May	ECL/21/2921	123.0	5.12	101.00
May-Jun	ECL/21/3680	426.0	1.62	**319.00**

3.1.2. Reference has been made to TGN M17 which suggests that the rate of deposition of dust should be below 200mg/m^2/day so as not to cause nuisance. Only two of the above detailed results were above this guidance limit, as shown in **bold** in Table 2. Unfortunately, the directional sticky strips for the period November – December were not received at the laboratory for this period, presumed lost in transit. Therefore, the direction in which the dust was travelling is unknown. The directional sticky pads were available for the period May – June.

3.2. Sticky Strip Soiling Rates

3.2.1. The sticky strip deposition soiling rates for the Haith Plant monitoring location (Location 1) are detailed in Figure 11-15 below. These are copied from the i2 Analytical Laboratory Reports for the survey periods where results were available. For the period November to December 2020, it is thought that the sticky strip samples were lost in transit. For the period December to January there was no report received from the laboratory for directional analysis for the Haith Plant, and the period February to March 2021, the sticky strip sample for the Haith Plant location was damaged and could not be analysed. The Laboratory Reports for all samples are detailed in Appendix II.

Figure 11: Oct-Nov Sticky Strip Results (Haith Plant)

Gauge Ref: ECL/20/6151

Sticky Pad Data

Date On	15.10.2020	Date Off	16.11.2020	Days = 32
Clean =	94			

X Axis mm	Meter	Angle deg	EAC%/day	Comment
20	89	337	0.16	
40	87	314	0.22	
60	92	291	0.06	
80	89	269	0.16	
100	87	246	0.22	
120	88	223	0.19	
140	85	200	0.28	
160	86	177	0.25	
180	68	154	0.81	
200	67	131	0.84	
220	74	109	0.63	
240	66	86	0.88	
260	73	63	0.66	
280	80	40	0.44	
300	87	17	0.22	

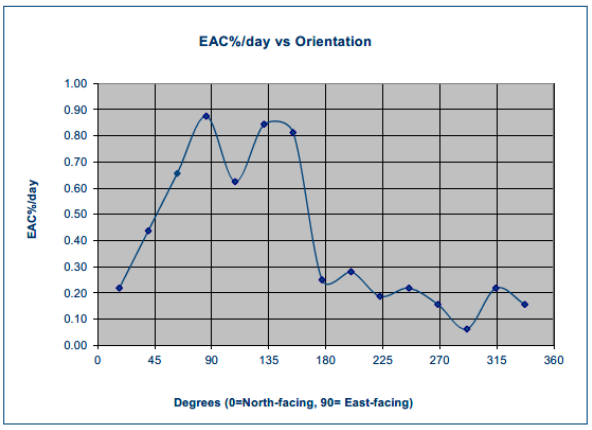


Figure 12: Jan-Feb Sticky Strip Results (Haith Plant)

Gauge Ref: 185649

Sticky Pad Data

Date On	15.01.2021	Date Off	15.02.2021	Days = 31
Clean =	98			

X Axis mm	Meter	Angle deg	EAC%/day	Comment
20	98	337	0.00	
40	95	314	0.10	
60	94	291	0.13	
80	92	269	0.19	
100	91	246	0.23	
120	90	223	0.26	
140	87	200	0.35	
160	78	177	0.65	
180	80	154	0.58	
200	76	131	0.71	
220	72	109	0.84	
240	76	86	0.71	
260	78	63	0.65	
280	84	40	0.45	
300	76	17	0.71	

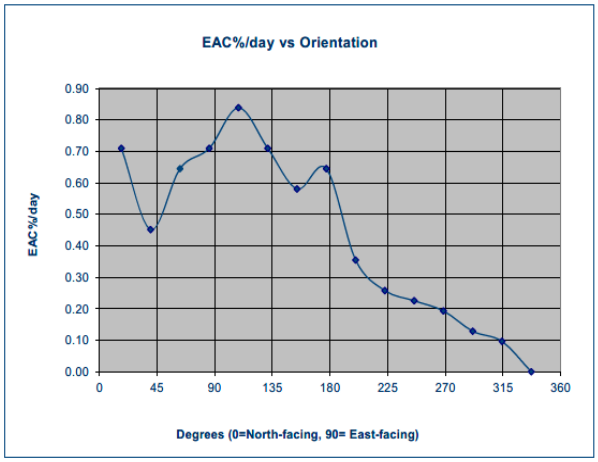


Figure 13: Mar-Apr Sticky Strip Results (Haith Plant)

Gauge Ref: ECL/21/2146

Sticky Pad Data

Date On	15/03/2021	Date Off	15/04/2021	Days =	31
Clean =	105				

X Axis mm	Meter	Angle deg	EAC%/day	Comment
20	95	337	0.32	
40	101	314	0.13	
60	103	291	0.06	
80	104	269	0.03	
100	102	246	0.10	
120	105	223	0.00	
140	98	200	0.23	
160	97	177	0.26	
180	93	154	0.39	
200	100	131	0.16	
220	101	109	0.13	
240	105	86	0.00	
260	102	63	0.10	
280	101	40	0.13	
300	95	17	0.32	

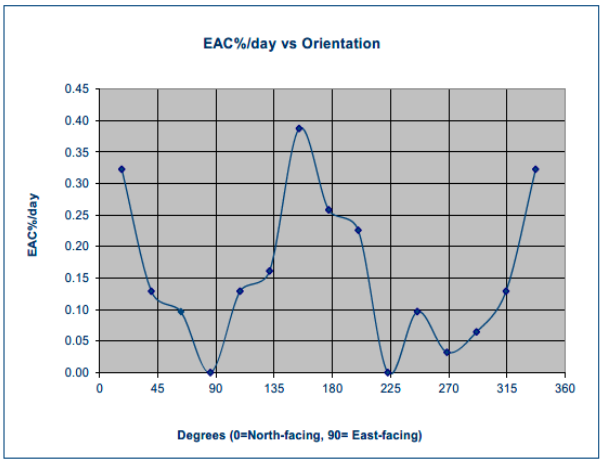


Figure 14: Apr-May Sticky Strip Results (Haith Plant)

Gauge Ref: ecl/21/2922

Sticky Pad Data

Date On	19/04/2021	Date Off	19/05/2021	Days =	30
Clean =	92				

X Axis mm	Meter	Angle deg	EAC%/day	Comment
20	87	337	0.17	
40	89	314	0.10	
60	90	291	0.07	
80	88	269	0.13	
100	85	246	0.23	
120	81	223	0.37	
140	80	200	0.40	
160	83	177	0.30	
180	88	154	0.13	
200	90	131	0.07	
220	92	109	0.00	
240	92	86	0.00	
260	91	63	0.03	
280	90	40	0.07	
300	87	17	0.17	

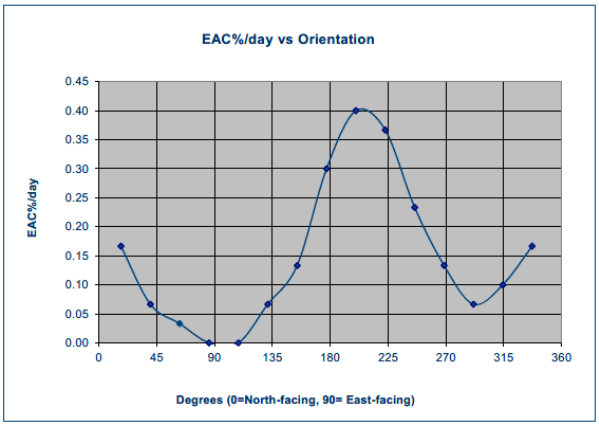


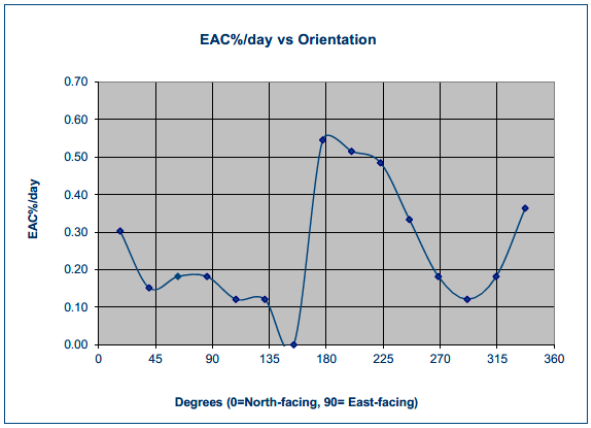
Figure 15 May-Jun Sticky Strip Results (Haith Plant)

Gauge Ref: ECL/21/3681

Sticky Pad Data

Date On	15/05/2021	Date Off	17/06/2021	Days =	33
Clean =	92				

X Axis mm	Meter	Angle deg	EAC%/day	Comment
20	80	337	0.36	
40	86	314	0.18	
60	88	291	0.12	
80	86	269	0.18	
100	81	246	0.33	
120	76	223	0.48	
140	75	200	0.52	
160	74	177	0.55	
180	92	154	0.00	
200	88	131	0.12	
220	88	109	0.12	
240	86	86	0.18	
260	86	63	0.18	
280	87	40	0.15	
300	82	17	0.30	



3.2.2. The sticky strip deposition soiling rates for the Weighbridge monitoring location (Location 2) are detailed in Figure 16 to 22 below. These are copied from the i2 Analytical Laboratory Reports for the survey periods where results were available. For the period November to December 2020, it is thought that the sticky strip samples were lost in transit and therefore, no directional results exist for this period.

Figure 16: Oct-Nov Sticky Strip Results (Weighbridge)

Gauge Ref: ECL/20/6150

Sticky Pad Data

Date On	15.10.2020	Date Off	16.11.2020	Days =	32
Clean =	91				

X Axis mm	Meter	Angle deg	EAC%/day	Comment
20	86	337	0.16	
40	88	314	0.09	
60	86	291	0.16	
80	88	269	0.09	
100	86	246	0.16	
120	86	223	0.16	
140	86	200	0.16	
160	74	177	0.53	
180	72	154	0.59	
200	67	131	0.75	
220	73	109	0.56	
240	82	86	0.28	
260	87	63	0.13	
280	87	40	0.13	
300	91	17	0.00	

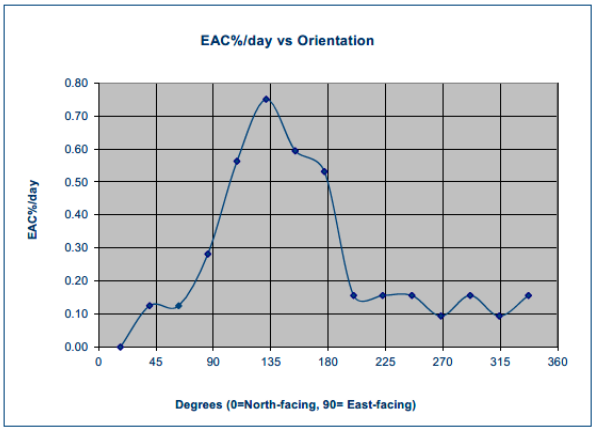


Figure 17: Dec-Jan Sticky Strip Results (Weighbridge)

Gauge Ref: ECL/21/0266

Sticky Pad Data

Date On	16.12.2020	Date Off	15.01.2021	Days =	31
Clean =	94				

X Axis mm	Meter	Angle deg	EAC%/day	Comment
20	94	337	0.00	
40	93	314	0.03	
60	94	291	0.00	
80	92	269	0.06	
100	92	246	0.06	
120	90	223	0.13	
140	85	200	0.29	
160	78	177	0.52	
180	66	154	0.90	
200	65	131	0.94	
220	77	109	0.55	
240	85	86	0.29	
260	90	63	0.13	
280	92	40	0.06	
300	95	17	-0.03	

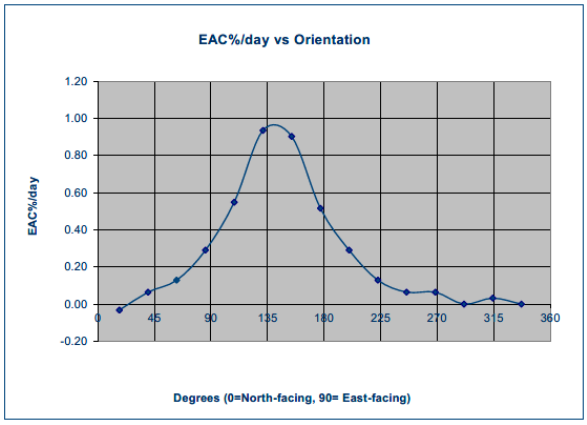


Figure 18: Jan-Feb Sticky Strip Results (Weighbridge)

Gauge Ref: 185650

Sticky Pad Data

Date On	15.01.2021	Date Off	15.02.2021	Days =	31
Clean =	88				

X Axis mm	Meter	Angle deg	EAC%/day	Comment
20	84	337	0.13	
40	84	314	0.13	
60	85	291	0.10	
80	88	269	0.00	
100	87	246	0.03	
120	83	223	0.16	
140	80	200	0.26	
160	56	177	1.03	
180	33	154	1.77	
200	32	131	1.81	
220	42	109	1.48	
240	62	86	0.84	
260	74	63	0.45	
280	65	40	0.74	
300	80	17	0.26	

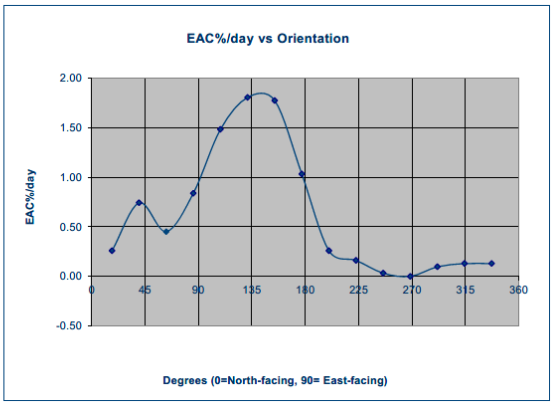


Figure 19: Feb-Mar Sticky Strip Results (Weighbridge)

Gauge Ref: ECL/21/1554

Sticky Pad Data

Date On	15/02/2021	Date Off	15/03/2021	Days =	28
Clean =	90				

X Axis mm	Meter	Angle deg	EAC%/day	Comment
20	90	337	0.00	
40	90	314	0.00	
60	88	291	0.07	
80	88	269	0.07	
100	85	246	0.18	
120	85	223	0.18	
140	86	200	0.14	
160	88	177	0.07	
180	89	154	0.04	
200	88	131	0.07	
220	87	109	0.11	
240	88	86	0.07	
260	89	63	0.04	
280	89	40	0.04	
300	89	17	0.04	

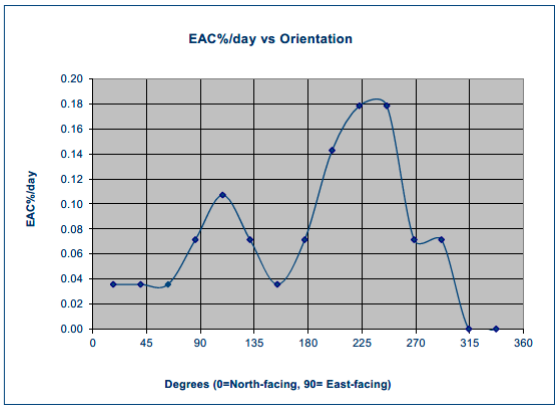


Figure 20: Mar-Apr Sticky Strip Results (Weighbridge)

Gauge Ref: ECL/21/2145

Sticky Pad Data

Date On	15/03/2021	Date Off	15/04/2021	Days =	31
Clean =	92				

X Axis mm	Meter	Angle deg	EAC%/day	Comment
20	92	337	0.00	
40	87	314	0.16	
60	87	291	0.16	
80	89	269	0.10	
100	87	246	0.16	
120	84	223	0.26	
140	83	200	0.29	
160	56	177	1.16	
180	38	154	1.74	
200	36	131	1.81	
220	58	109	1.10	
240	61	86	1.00	
260	82	63	0.32	
280	72	40	0.65	
300	62	17	0.97	

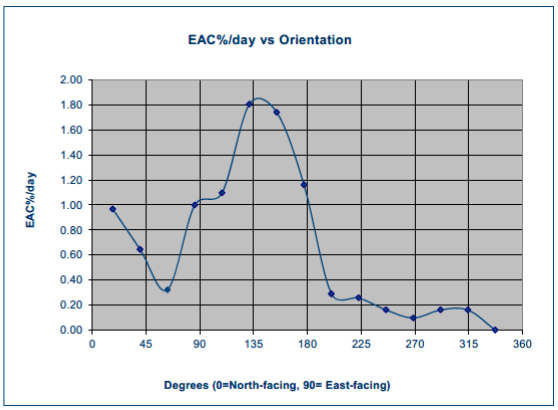


Figure 21: Apr-May Sticky Strip Results (Weighbridge)

Gauge Ref: ecl/21/2921

Sticky Pad Data

Date On	19/04/2021	Date Off	19/05/2021	Days =	30
Clean =	84				

X Axis mm	Meter	Angle deg	EAC%/day	Comment
20	81	337	0.10	
40	82	314	0.07	
60	82	291	0.07	
80	82	269	0.07	
100	82	246	0.07	
120	81	223	0.10	
140	84	200	0.00	
160	72	177	0.40	
180	48	154	1.20	
200	38	131	1.53	
220	45	109	1.30	
240	62	86	0.73	
260	79	63	0.17	
280	83	40	0.03	
300	82	17	0.07	

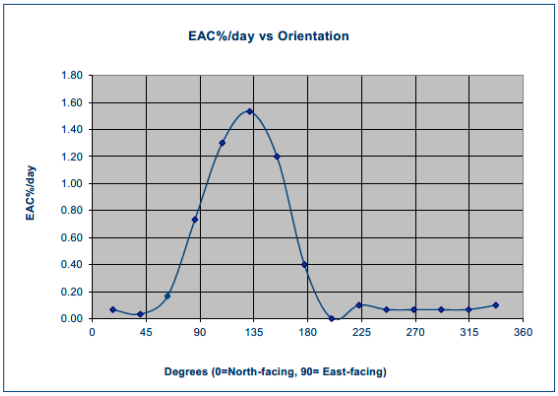


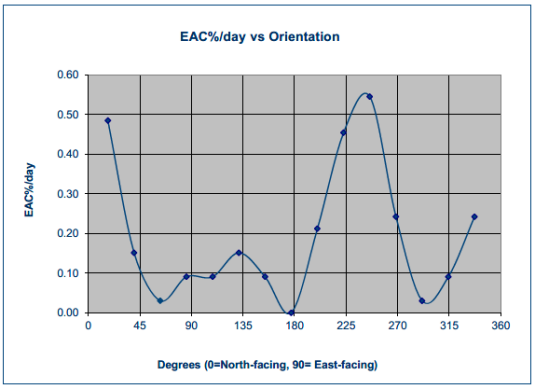
Figure 22: May-Jun Sticky Strip Results (Weighbridge)

Gauge Ref: ECL/21/3680

Sticky Pad Data

Date On	15/05/2021	Date Off	17/06/2021	Days =	33
Clean =	88				

X Axis mm	Meter	Angle deg	EAC%/day	Comment
20	80	337	0.24	
40	85	314	0.09	
60	87	291	0.03	
80	80	269	0.24	
100	70	246	0.55	
120	73	223	0.45	
140	81	200	0.21	
160	88	177	0.00	
180	85	154	0.09	
200	83	131	0.15	
220	85	109	0.09	
240	85	86	0.09	
260	87	63	0.03	
280	83	40	0.15	
300	72	17	0.48	



3.2.3. For the Haith Plant monitoring location, none of the effective area coverage results were above the 2.0% probable complaint guidance limit specified in TGN M17. Similarly, none of the results for the Weighbridge monitoring location were above the 2.0% limit either. There were however, in both the January-February and March-April periods results up to 1.81% EAC. These were from a south easterly direction which is the Site entrance and temporary storage area just east of the Site entrance.

4. RESULTS DISCUSSION

4.1. Rate of Deposition

4.1.1. There was a variable rate of deposition throughout the monitoring period, and between the two monitoring locations on Site. Additionally, there were significant weather events which took place during the survey.

4.1.2. Generally, the Haith Plant location appears to be subject to lower dust deposition levels however, the average for both locations is reasonably close. The average rate of dust deposition over the monitoring periods at each location were 85.6mg at the Haith Plant and 113.4mg at the Weighbridge area.

4.1.3. Wind directions from the southeast to east southeast resulted in higher EAC results for both locations. This may relate to access routes not far from the monitoring locations and the routes located generally southeast of the monitoring locations. However, the highest deposition rate was recorded from a south westerly direction at the Weighbridge location.

4.2. Directional Characteristics

4.2.1. The key aspects of the directional analysis for the Haith Plant location are summarised in Table 3 below. This provides details on the highest EAC results and from which direction they were associated with in both degrees and compass directions, along with the potential source area contribution.

Table 3: Haith Plant Directional Dust Summary

Period	Direction (degrees)	Direction (compass)	Notable EAC range (%)	Area contribution
Oct-Nov	63 - 154	ENE - ESE	0.63 – 0.88	Storage area to east of location.
Jan-Feb	17 - 177	NNE - S	0.45 – 0.84	Stockpiles and haul road to east of location.
Mar-Apr	337 - 17	NNW - NNE	0.32	From off-site.
	154	SSE	0.39	Haul road along Haith Plant.
Apr-May	200	SSW	0.40	Haul road along Haith Plant.
May-Jun	177 - 223	S - SW	0.55 – 0.48	Haul road along Haith Plant and processing area near northern Site entrance.

4.2.2. Each of the ‘notable’ events during the monitoring survey at the Haith Plant location resulted in an EAC of below 1%. The period mid-March to mid-May were all below 0.5%.

4.2.3. Table 4 below details the key aspects of directional analysis for the Weighbridge location providing the similar information as Table 3.

Table 4: Weighbridge Directional Dust Summary

Period	Direction (degrees)	Direction (compass)	Notable EAC range (%)	Area contribution
Oct-Nov	109 - 177	ESE - S	0.53 – 0.75	Main entrance and car park area.
Dec-Jan	109 - 177	ESE - S	0.52 – 0.94	Main entrance and car park area.
Jan-Feb	40 - 154	NE - SE	0.45 – 1.81	Processing area and temporary storage area.
Feb-Mar	200 - 246	SSW - WSW	0.14 – 0.18	Car park, Tides Field Road, off-site.
Mar-Apr	40 - 177	NE - S	0.32 – 1.81	Processing area, temporary storage area, haul road, main entrance, and car park.
Apr-May	86 - 177	E - S	0.40 – 1.53	Temporary storage area, main entrance, and car park.
May-Jun	223 - 246	SW	0.45 – 0.55	Car park, Tides Field Road, off-site.

4.2.4. The EAC results for the Weighbridge location are generally higher than for the Haith Plant location. This is likely associated with the greater level of activity undertaken in closer proximity to the monitoring location. Each monitoring period had results exceeding 0.50% EAC except for the February to March period, which was the second driest period of the survey.

4.2.5. Three of the periods exceeded 1.5% EAC, however, no results exceeded the 2.0% EAC guidance limit which would probably be cause for complaints.

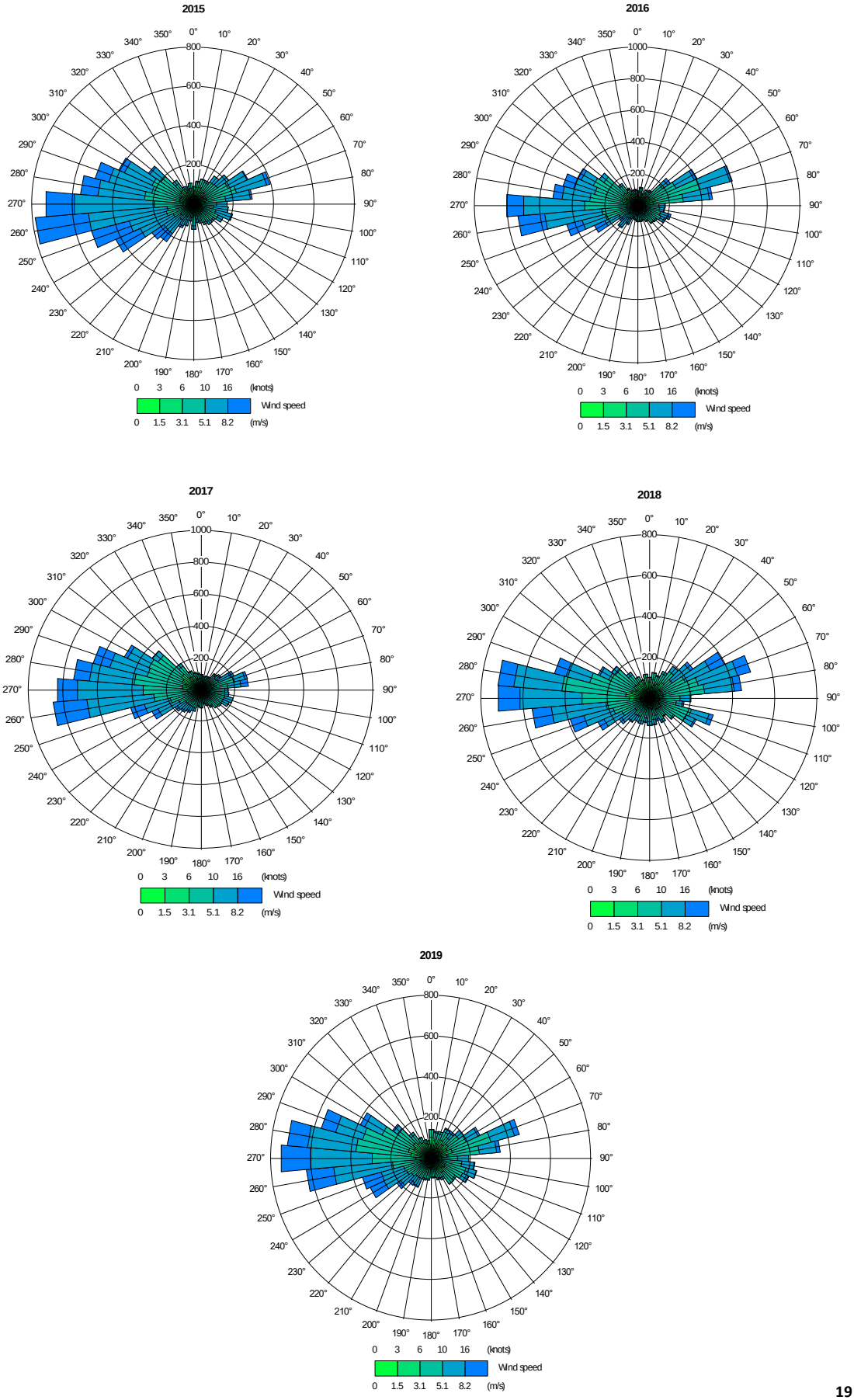
4.2.6. The highest deposition rate of 319 mg/m^2/day at the Weighbridge location was one of the lower EAC range of results. The direction also suggests that deposition was back on the Site rather than off-site.

4.2.7. Many of the higher EAC results are associated with wind directions that would result in deposition back on the Site. However, the extreme weather events may have influenced these outcomes.

4.3. Weather Review

4.3.1. The general prevailing wind direction for the area, not necessarily the Site, is westerly, as illustrated by the wind rose plots in Figure 23 below. These are for the Meteorological ("Met") Office Weather Station location of St Athan. The CML Site is located approximately 20km east northeast of St Athan, and in close proximity to the coastline on the southeast fringes of Cardiff. This is likely to have an effect on the prevailing wind direction for the Site.

Figure 23: Wind Rose Plots 2015 - 2019



4.3.2. The weather during the survey period was variable with a number of notable events, some of which have been described as 'Extreme Weather Events' by the Met Office.

4.3.3. To date, five separate case reports have been issued by the Met Office (Kendon, M., Met Office, 2020 – 2021) on different and distinct weather events that occurred within the survey period. The five individual case reports are detailed in Appendix III as reported on the Met Office website. It is not considered appropriate to summarise the reports individually or reproduce certain aspects of them. The relevance and significance of these events is difficult to ascertain without on-site weather data for the survey period.

4.3.4. However, taking in to account the relatively short duration of the survey period, five reported events are considered unusual. These events are detailed as:

- Storm Aiden (31st October 2020);
- Storm Bella (26th - 27th December 2020);
- Storm Christoph (18th - 20th January 2021);
- Storm Darcy (7th - 13th February 2021); and
- warm weather event (March to early April 2021).

4.3.5. Storm Aiden resulted in wet and windy weather from late October to early November. Storm Bella arrived over the Christmas period with high winds and heavy rainfall. This caused flooding and fallen trees. Storm Christoph brought more wind and rain in the middle of January with one of the wettest three-day periods on record. These very wet periods are reflected in the rainwater volumes detailed in Tables 1 and 2 in Section 3.1. above.

4.3.6. Storm Darcy brought very cold easterly winds and snowfall to the country in early February. This was followed by a very warm period through March to early April. Again, the very low rainfall figures in Tables 1 and 2 above illustrate this clearly.

4.4. Results Review

4.4.1. As mentioned in Section 4.3.3. above, it is difficult to determine what influence the weather events had on the monitoring survey. Whilst there were elevated wind speeds, these were associated with heavy rainfall meaning it was less likely that dust would be airborne in any significant quantity. Likewise, the elevated temperatures were likely to be associated with lower wind speeds and therefore, less dust due to wind whipping.

4.4.2. Despite the five weather events, the results illustrate that over the eight months of the survey period, there were only two results that exceeded to 200 mg/m^2/day guidance limit, one of which was known to be from a direction that would lead to dust deposition back on site, and there were no results that exceeded the 2% EAC guidance limit.

4.4.3. The results therefore suggest that the Site is not generating fugitive dust emissions to a level that are likely to be cause for complaint at the sensitive receptor sites identified.

References:

Kendon, M., (2020 & 2021) Met Office National Climate Information Centre, Case studies of past severe weather events [Online] Accessed June 2021. Available at: https://www.metoffice.gov.uk/weather/learn-about/past-uk-weather-events#y2020

Vallack, H.W., (1995), Stockholm Environmental Institute at York: Protocol for using the dry Frisbee (with foam inset) dust deposit gauge [Biology Department, University of York].

Wind Rose in degrees diagram, Google Images, [Online] Accessed May 2021. Available at: https://uni.edu/storm/Wind%20Direction%20slide.pdf

Appendix I
Rover Way Dust Management Plan (ECP53)

1. INTRODUCTION

This document provides the overarching dust management plan written in accordance with current guidance in relation to the activities on Rover Way. For dust management plans relating to individual activities see section 8 'Documentation'.

The plan identifies potential sources of dust emissions and the associated potential impacts, and the measures to reduce dust and particulate emissions. The aim is:

- to develop a robust dust management strategy
- minimise dust generation and emissions from the site; and
- ensure off-site impacts (to nearby receptors) are minimised

2. SITE OPERATION SCOPE

The operations at the site include:

- Scrap Processing Centre (Permit ref TP3639BH, Activity A11) – Integrated scrap metal recycling centre undertaking storage of waste pending the recycling/reclamation of metals and metal compounds within a standalone processing centre at the northern end of the Rover Way site.

- Scrap Yard (Permit ref TP3639BH, Activity A12) – Processing scrap metal using a mobile shear. Includes the storage of incoming scrap metal and storage of processed scrap metal.

- Asphalt Plant (Permit ref TP3639BH, Activity A3) – processed EAF slag is mixed with filler, bitumen and reclaimed asphalt pavement (RAP) according to the required specification.

- Slag Processing and Crushing & Screening Plant (Permit ref TP3639BH, Activity A2)– Slag collection and transfer from the activity A1 (Permit ref TP3639BH) to waste operation. Treatment of slag via weathering, crushing, screening, drop balling and lancing.

3. SOURCES OF DUST

The potential sources of dust associated with each activity are discussed in the individual dust management plans. These include:

- Loading materials onto storage piles (batch or continuous drop operations)
- Equipment & equipment traffic
- Crushing & screening
- Vehicles movements in & out of site
- Wind erosion of piles

- Load out of materials for shipment or for return to the process stream (batch or continuous drop operations)

4. SITE SETTING AND RECEPTORS

A map of the principal receptors and prevailing wind direction for each activity can be found in the individual dust management plans. The principal receptors to the site are:

- Travellers' site north (beyond the Western power Distribution 33kV/132 kV substation)
- Welsh Water compound adjacent to Travellers' site
- Pengam Green residential area north
- Willows High School north
- Tremorfa residential area north
- Severn Estuary East

5. CONTROL MEASURES

This section provides a summary of the dust control measures that will be undertaken on-site to mitigate dust emissions from the identified sources. Corrective actions that'll be undertaken to prevent or minimise dust emissions are in line with current guidance.

- Location of storage piles
- Good housekeeping
- Use of road sweepers
- Enclosure in buildings
- Use of enclosed vehicles, skips & containers
- Use of water-filled bowsers
- Minimise stockpile height

Control measures specific to each activity are outlined on the respective dust management plans.

6. MONITORING

6.1 Visual monitoring

To ensure that the dust control measures are effective, Celsa will ensure visual dust monitoring is in place. The following monitoring activities are regularly undertaken to ensure continuous improvement:

- site inspections by the site manager;
- site audits conducted by the company's management; and

- site audits and inspections by Natural Resources Wales

All site personnel will be responsible for reporting any dust problems immediately to the site manager or deputy.

The site manager will ensure that regular weekly inspections are made of the site and its perimeter to identify any sources of significant dust and to establish whether any dust is likely to impact upon receptors.

6.2 Ambient air monitoring

Frisbee gauges and directional sticky pads will be installed at two locations along the site boundary for a period of 6 months, one downwind and upwind of the permitted activities. Should the daily total measured value exceed 200mg m $^{-2}$, investigative action will be taken to determine the cause of the issue, and determine measures needed to prevent this reoccurring in future. The data from the monitors will be analysed at an external accredited laboratory, with the results reviewed on a monthly basis. At the end of the 6-month period, the requirement for further monitoring will be evaluated.

Figure 1 *– Ambient air monitor locations*

7. EMERGENCY PLAN & COMPLAINTS

This section considers the potential for accidents (or incidents) that could result in unacceptable short-term dust impacts. If the situation is an emergency, then mitigation measures will be immediately implemented and the technically competent manager will consider:

- limiting the hours of operation; or
- immediately suspending the site operations

If any dust complaints are received then the complaints procedure as set out in EMS procedure CP/B033 (EHS Communication – Internal and External) would be followed and the incident investigated and if found to be real, appropriate mitigation measures would be adopted. The incident would be formally reported to Natural Resources Wales.

8. DOCUMENTATION

EMS Procedure Ref	Procedure Title	Permit Activities Included
ECP53	Rover Way Dust Management Plan	• **Activity A2** • **Activity A3** • **Activity A11** • **Activity A12**
ECP47	Scrap Processing Centre Dust Management Plan	• **Activity A11**
ECP52	Cardiff Scrap Yard Dust Management Plan	• **Activity A12**
ECP12	Fugitive Emissions Management Procedure	• **Activity A2**
Harsco Dust Management Plan, Asphalt Plant (V2)	N/A	• **Activity A2** • **Activity A3**
Harsco Environmental Statement Chapter 9: Air Quality (Land south of Rover Way)	N/A	• **Activity A2** • **Activity A3**

9. REVIEW

Dust control measures will be reviewed through internal audits. The audits will review:

- weekly records of inspection;
- spot checks on the higher risk sources of dust; and
- checks to ensure that any corrective or preventative have been resolved in an efficient and timely manner
- ensure effectiveness of procedures referenced in section 8 of this document

THIS CONCLUDES THE DUST MANAGEMENT PLAN

Appendix II
Laboratory Reports

Directional Dust Analysis Report

Job No: 20-42849 Sample No: 1692416

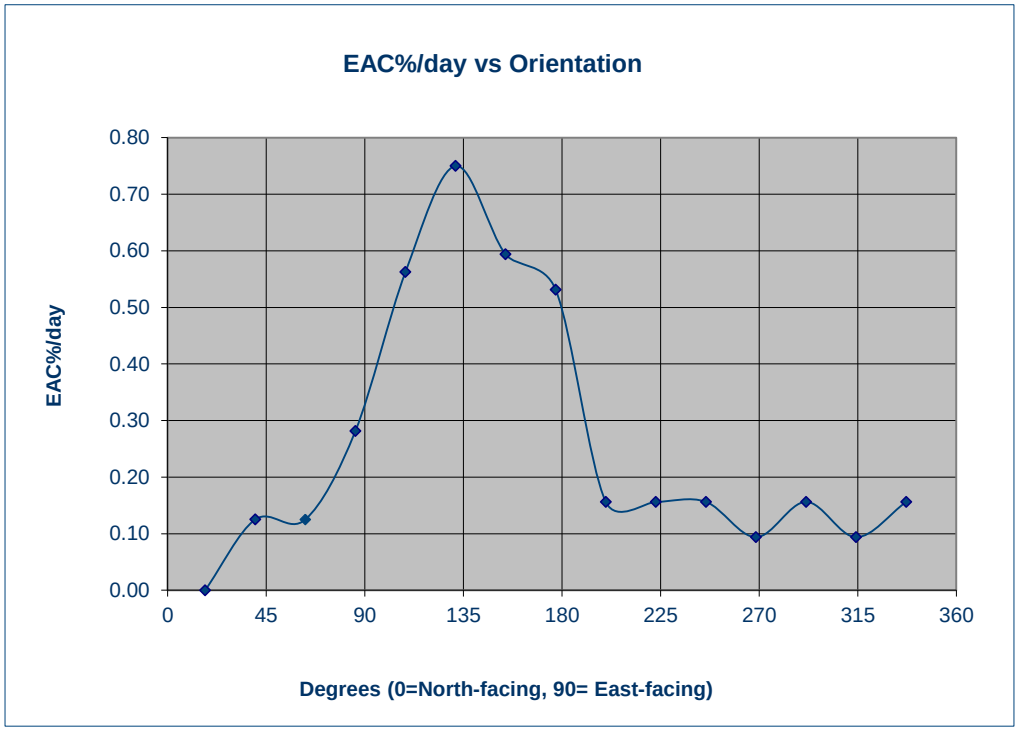
Client: ENVCOMP Site Reference: P4515

Gauge Ref: ECL/20/6150

Sticky Pad Data

Date On	15.10.2020	Date Off	16.11.2020	Days =	32
Clean =	91				

X Axis mm	Meter	Angle deg	EAC%/day	Comment
20	86	337	0.16	
40	88	314	0.09	
60	86	291	0.16	
80	88	269	0.09	
100	86	246	0.16	
120	86	223	0.16	
140	86	200	0.16	
160	74	177	0.53	
180	72	154	0.59	
200	67	131	0.75	
220	73	109	0.56	
240	82	86	0.28	
260	87	63	0.13	
280	87	40	0.13	
300	91	17	0.00	



Note: Cells coloured green are inputs. The rest are either constants or calculated values.
The calculation is based on taking readings at 20mm intervals along the sticky pad.

i2 Analytical Ltd.
7 Woodshots Meadow,
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Directional Dust Analysis Report

Job No: 20-42849 Sample No: 1692417

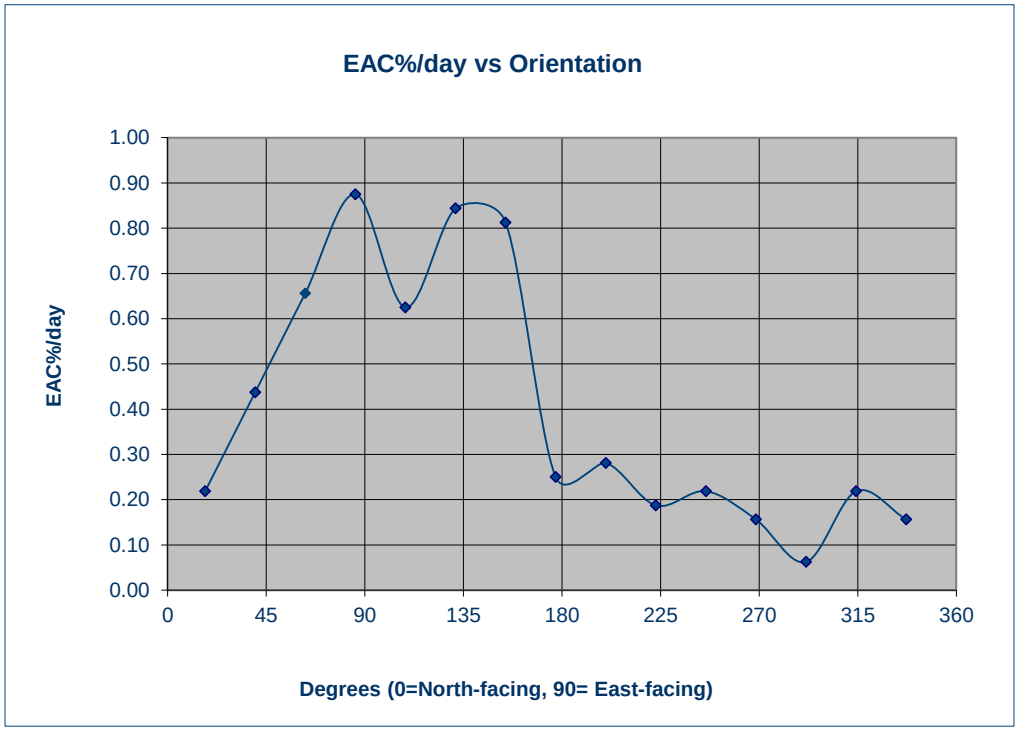
Client: ENVCOMP Site Reference: P4515

Gauge Ref: ECL/20/6151

Sticky Pad Data

Date On	15.10.2020	Date Off	16.11.2020	Days =	32
Clean =	94				

X Axis mm	Meter	Angle deg	EAC%/day	Comment
20	89	337	0.16	
40	87	314	0.22	
60	92	291	0.06	
80	89	269	0.16	
100	87	246	0.22	
120	88	223	0.19	
140	85	200	0.28	
160	86	177	0.25	
180	68	154	0.81	
200	67	131	0.84	
220	74	109	0.63	
240	66	86	0.88	
260	73	63	0.66	
280	80	40	0.44	
300	87	17	0.22	



Note: Cells coloured green are inputs. The rest are either constants or calculated values.
The calculation is based on taking readings at 20mm intervals along the sticky pad.

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Directional Dust Analysis Report

Job No: 21-52180 Sample No: 1743324

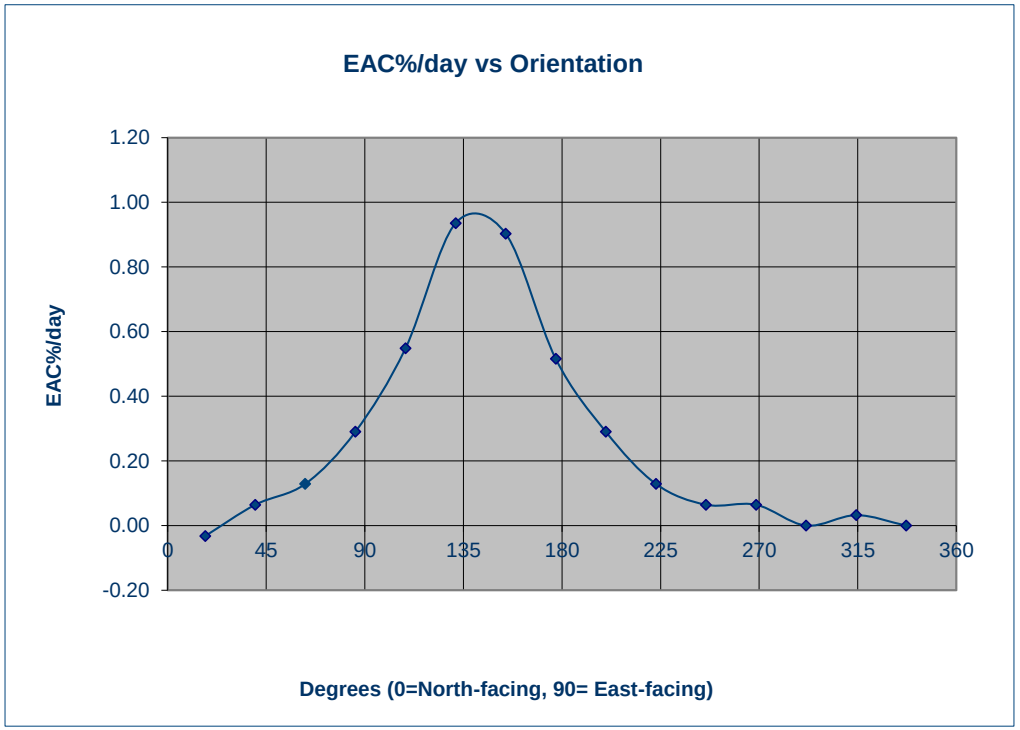
Client: ENVCOMP Site Reference: P4515

Gauge Ref: ECL/21/0266

Sticky Pad Data

Date On	16.12.2020	Date Off	15.01.2021	Days =	31
Clean =	94				

X Axis mm	Meter	Angle deg	EAC%/day	Comment
20	94	337	0.00	
40	93	314	0.03	
60	94	291	0.00	
80	92	269	0.06	
100	92	246	0.06	
120	90	223	0.13	
140	85	200	0.29	
160	78	177	0.52	
180	66	154	0.90	
200	65	131	0.94	
220	77	109	0.55	
240	85	86	0.29	
260	90	63	0.13	
280	92	40	0.06	
300	95	17	-0.03	



Note: Cells coloured green are inputs. The rest are either constants or calculated values.
The calculation is based on taking readings at 20mm intervals along the sticky pad.

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Directional Dust Analysis Report

Job No: 21-57941 Sample No: 185649 ECL/21/0805

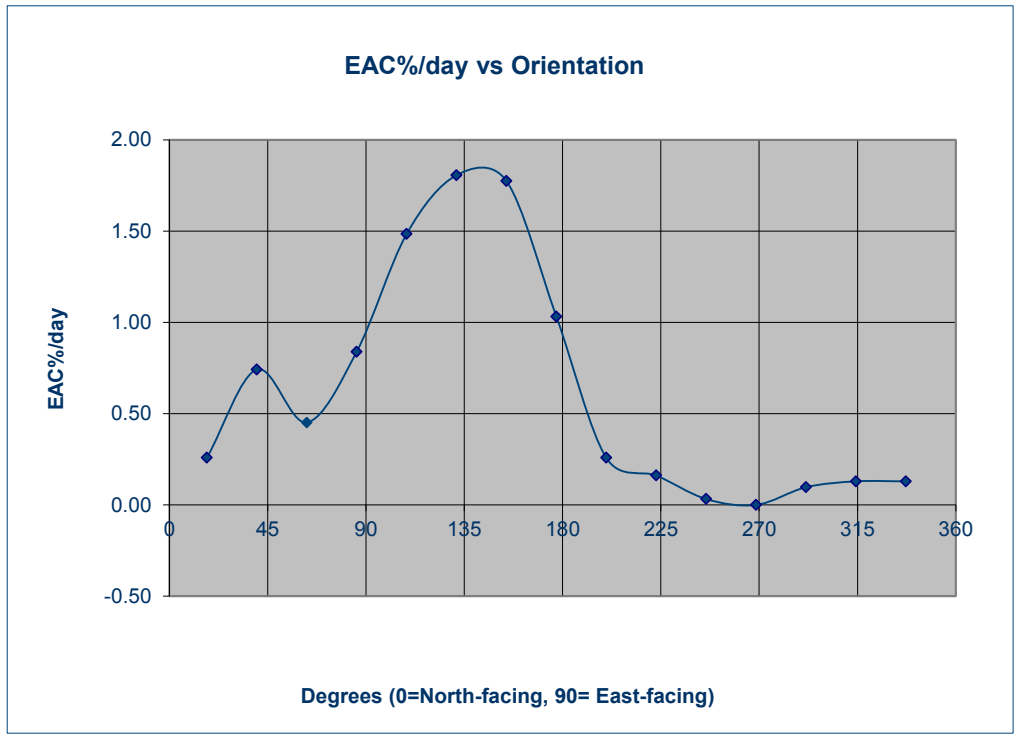
Client: I2ANALITYC Site Reference:

Gauge Ref: 185650

Sticky Pad Data

Date On	15.01.2021	Date Off	15.02.2021	Days =	31
Clean =	88				

X Axis mm	Meter	Angle deg	EAC%/day	Comment
20	84	337	0.13	
40	84	314	0.13	
60	85	291	0.10	
80	88	269	0.00	
100	87	246	0.03	
120	83	223	0.16	
140	80	200	0.26	
160	56	177	1.03	
180	33	154	1.77	
200	32	131	1.81	
220	42	109	1.48	
240	62	86	0.84	
260	74	63	0.45	
280	65	40	0.74	
300	80	17	0.26	



Note: Cells coloured green are inputs. The rest are either constants or calculated values.
The calculation is based on taking readings at 20mm intervals along the sticky pad.

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Directional Dust Analysis Report

Job No: 21-57941 Sample No: 185650 ECL/21/0806

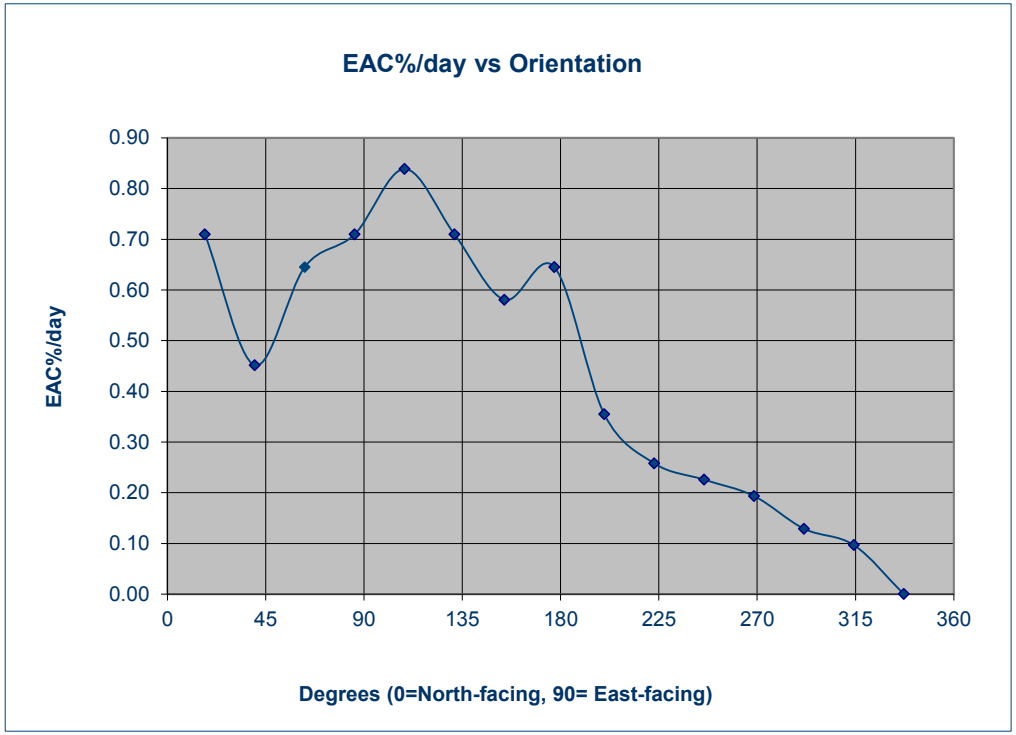
Client: I2ANALITYC Site Reference:

Gauge Ref: 185649

Sticky Pad Data

Date On	15.01.2021	Date Off	15.02.2021	Days =	31
Clean =	98				

X Axis mm	Meter	Angle deg	EAC%/day	Comment
20	98	337	0.00	
40	95	314	0.10	
60	94	291	0.13	
80	92	269	0.19	
100	91	246	0.23	
120	90	223	0.26	
140	87	200	0.35	
160	78	177	0.65	
180	80	154	0.58	
200	76	131	0.71	
220	72	109	0.84	
240	76	86	0.71	
260	78	63	0.65	
280	84	40	0.45	
300	76	17	0.71	



Note: Cells coloured green are inputs. The rest are either constants or calculated values.
The calculation is based on taking readings at 20mm intervals along the sticky pad.

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Directional Dust Analysis Report

Job No: 21-63268 Sample No: 196421 / 1806788

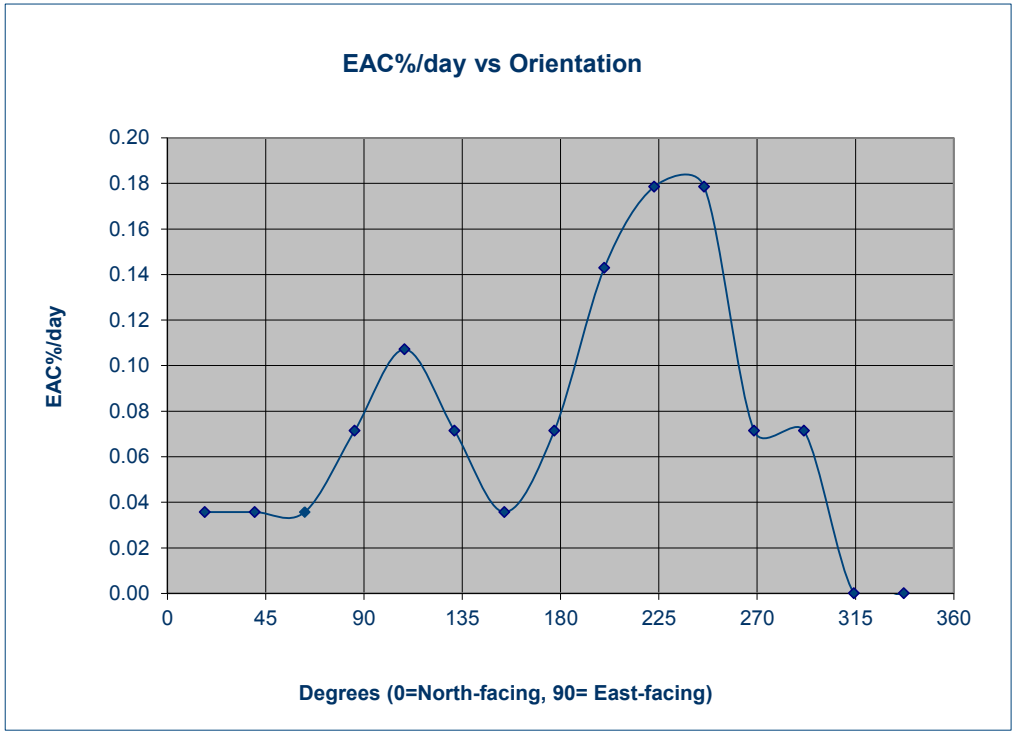
Client: ECL Site Reference: P4515

Gauge Ref: ECL/21/1554

Sticky Pad Data

Date On	15/02/2021	Date Off	15/03/2021	Days =	28
Clean =	90				

X Axis mm	Meter	Angle deg	EAC%/day	Comment
20	90	337	0.00	
40	90	314	0.00	
60	88	291	0.07	
80	88	269	0.07	
100	85	246	0.18	
120	85	223	0.18	
140	86	200	0.14	
160	88	177	0.07	
180	89	154	0.04	
200	88	131	0.07	
220	87	109	0.11	
240	88	86	0.07	
260	89	63	0.04	
280	89	40	0.04	
300	89	17	0.04	



Note: Cells coloured green are inputs. The rest are either constants or calculated values.
The calculation is based on taking readings at 20mm intervals along the sticky pad.

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Directional Dust Analysis Report

Job No: 1735 / 21-69459 Sample No: 208440 / 1841080

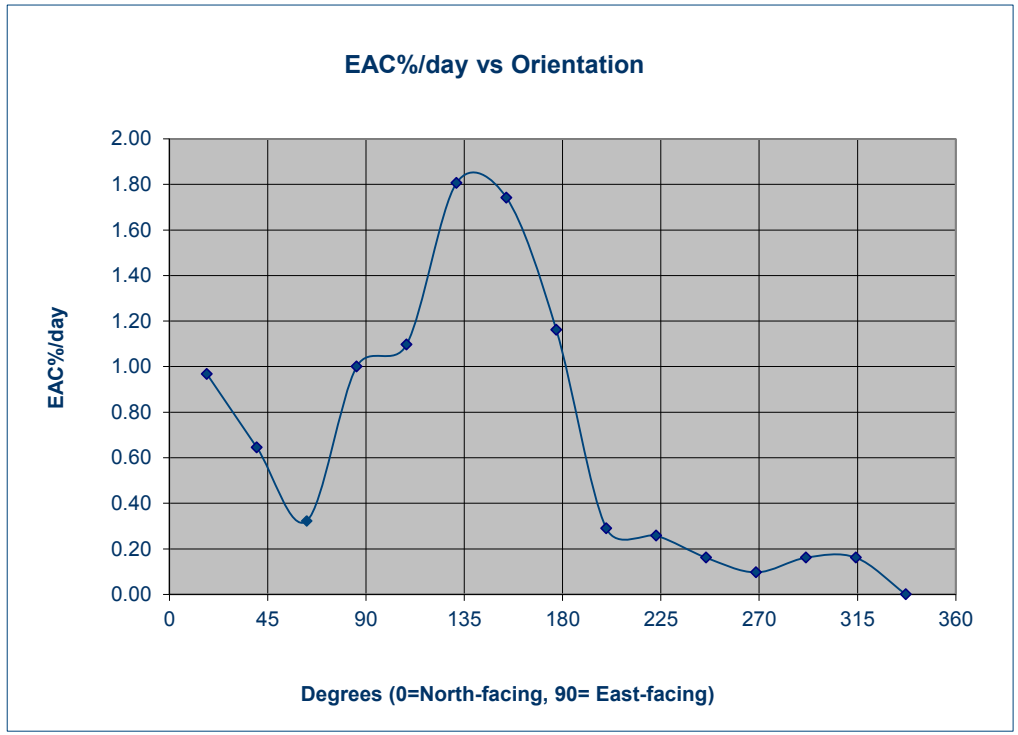
Client: ECL Site Reference: P4515

Gauge Ref: ECL/21/2145

Sticky Pad Data

Date On	15/03/2021	Date Off	15/04/2021	Days =	31
Clean =	92				

X Axis mm	Meter	Angle deg	EAC%/day	Comment
20	92	337	0.00	
40	87	314	0.16	
60	87	291	0.16	
80	89	269	0.10	
100	87	246	0.16	
120	84	223	0.26	
140	83	200	0.29	
160	56	177	1.16	
180	38	154	1.74	
200	36	131	1.81	
220	58	109	1.10	
240	61	86	1.00	
260	82	63	0.32	
280	72	40	0.65	
300	62	17	0.97	



Note: Cells coloured green are inputs. The rest are either constants or calculated values.
The calculation is based on taking readings at 20mm intervals along the sticky pad.

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Directional Dust Analysis Report

Job No: 1735 / 21-69459 Sample No: 208441 / 1841081

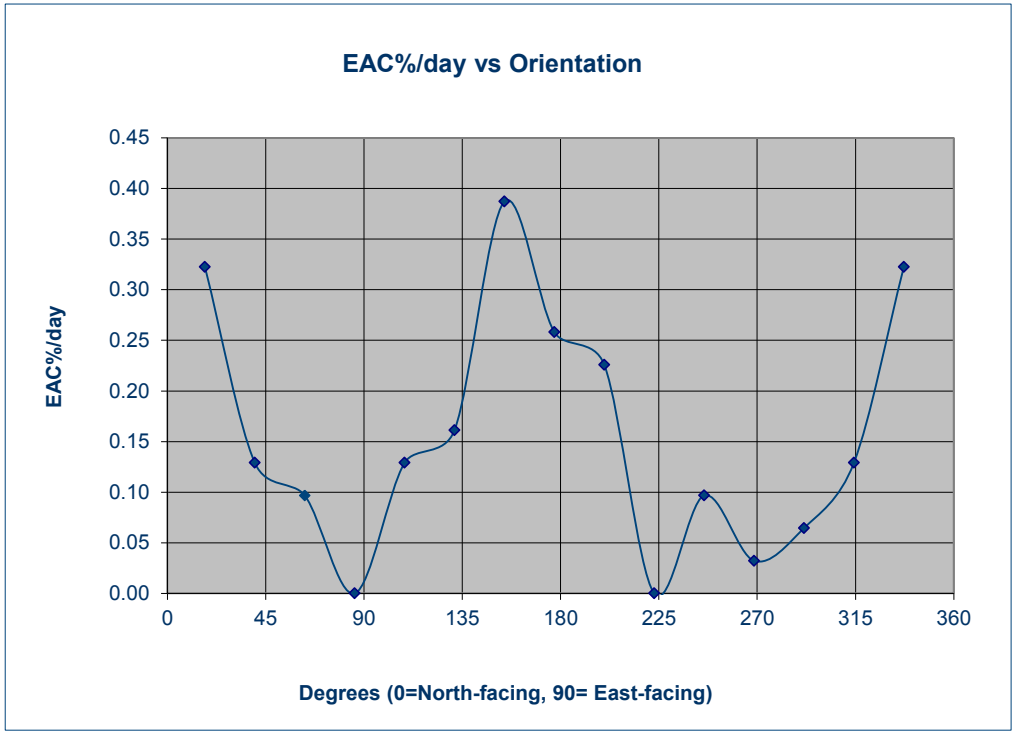
Client: ECL Site Reference: P4515

Gauge Ref: ECL/21/2146

Sticky Pad Data

Date On	15/03/2021	Date Off	15/04/2021	Days =	31
Clean =	105				

X Axis mm	Meter	Angle deg	EAC%/day	Comment
20	95	337	0.32	
40	101	314	0.13	
60	103	291	0.06	
80	104	269	0.03	
100	102	246	0.10	
120	105	223	0.00	
140	98	200	0.23	
160	97	177	0.26	
180	93	154	0.39	
200	100	131	0.16	
220	101	109	0.13	
240	105	86	0.00	
260	102	63	0.10	
280	101	40	0.13	
300	95	17	0.32	



Note: Cells coloured green are inputs. The rest are either constants or calculated values.
The calculation is based on taking readings at 20mm intervals along the sticky pad.

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Directional Dust Analysis Report

Job No: 21-75946 Sample No: 220532

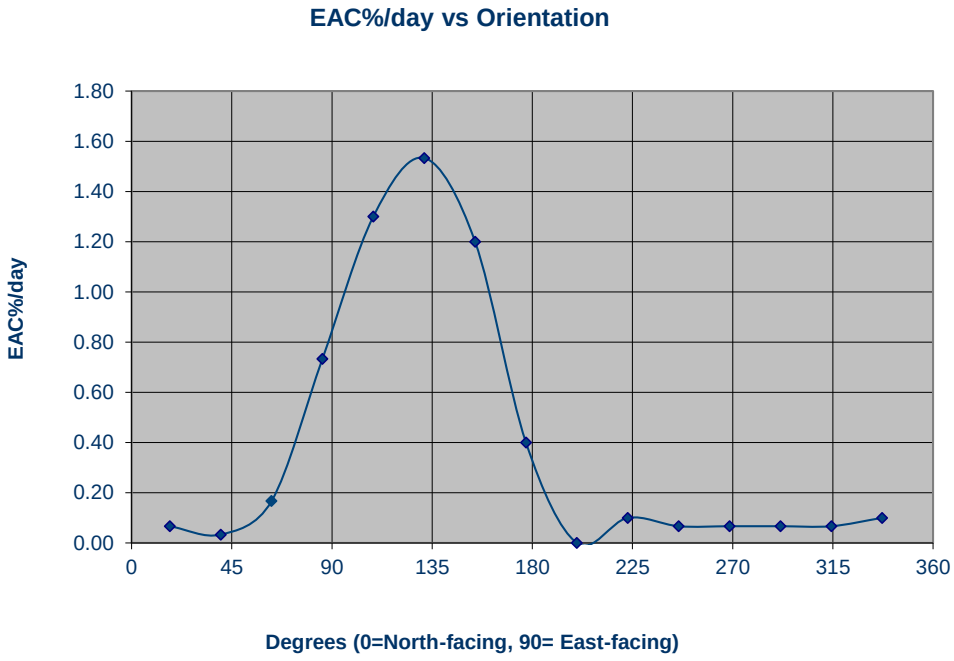
Client: ECL Site Reference: P4515

Gauge Ref: ecl/21/2921

Sticky Pad Data

Date On	19/04/2021	Date Off	19/05/2021	Days =	30
Clean =	84				

X Axis mm	Meter	Angle deg	EAC%/day	Comment
20	81	337	0.10	
40	82	314	0.07	
60	82	291	0.07	
80	82	269	0.07	
100	82	246	0.07	
120	81	223	0.10	
140	84	200	0.00	
160	72	177	0.40	
180	48	154	1.20	
200	38	131	1.53	
220	45	109	1.30	
240	62	86	0.73	
260	79	63	0.17	
280	83	40	0.03	
300	82	17	0.07	



Note: Cells coloured green are inputs. The rest are either constants or calculated values.
The calculation is based on taking readings at 20mm intervals along the sticky pad.

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Directional Dust Analysis Report

Job No: 21-75946 Sample No: 220523

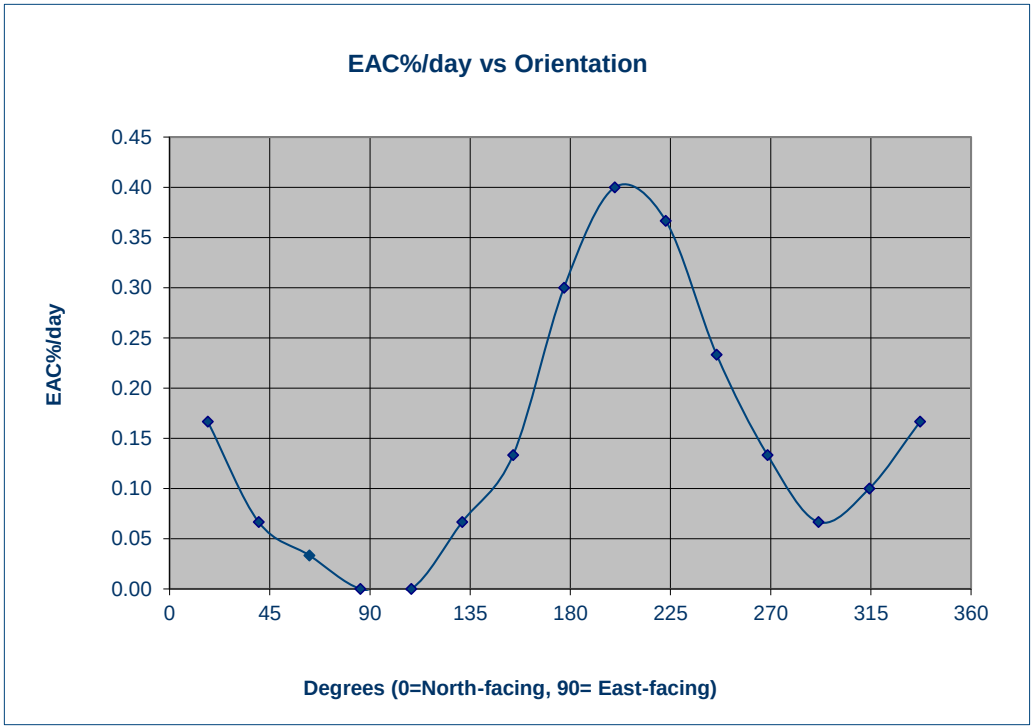
Client: ECL Site Reference: P4515

Gauge Ref: ecl/21/2922

Sticky Pad Data

Date On	19/04/2021	Date Off	19/05/2021	Days =	30
Clean =	92				

X Axis mm	Meter	Angle deg	EAC%/day	Comment
20	87	337	0.17	
40	89	314	0.10	
60	90	291	0.07	
80	88	269	0.13	
100	85	246	0.23	
120	81	223	0.37	
140	80	200	0.40	
160	83	177	0.30	
180	88	154	0.13	
200	90	131	0.07	
220	92	109	0.00	
240	92	86	0.00	
260	91	63	0.03	
280	90	40	0.07	
300	87	17	0.17	



Note: Cells coloured green are inputs. The rest are either constants or calculated values.
The calculation is based on taking readings at 20mm intervals along the sticky pad.

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Directional Dust Analysis Report

Job No: 2035 / 21-83195 Sample No: 235131/ 1915949

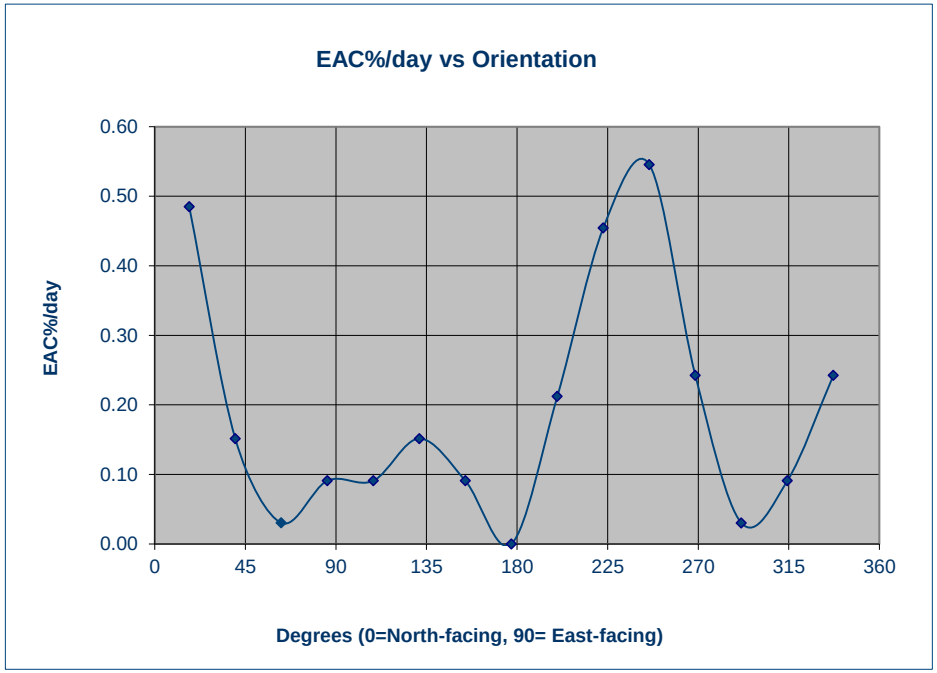
Client: ECL Site Reference: P4515

Gauge Ref: ECL/21/3680

Sticky Pad Data

Date On	15/05/2021	Date Off	17/06/2021	Days =	33
Clean =	88				

X Axis mm	Meter	Angle deg	EAC%/day	Comment
20	80	337	0.24	
40	85	314	0.09	
60	87	291	0.03	
80	80	269	0.24	
100	70	246	0.55	
120	73	223	0.45	
140	81	200	0.21	
160	88	177	0.00	
180	85	154	0.09	
200	83	131	0.15	
220	85	109	0.09	
240	85	86	0.09	
260	87	63	0.03	
280	83	40	0.15	
300	72	17	0.48	



Note: Cells coloured green are inputs. The rest are either constants or calculated values.
The calculation is based on taking readings at 20mm intervals along the sticky pad.

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Directional Dust Analysis Report

Job No: 2035 / 21-83195 Sample No: 235132/ 1915950

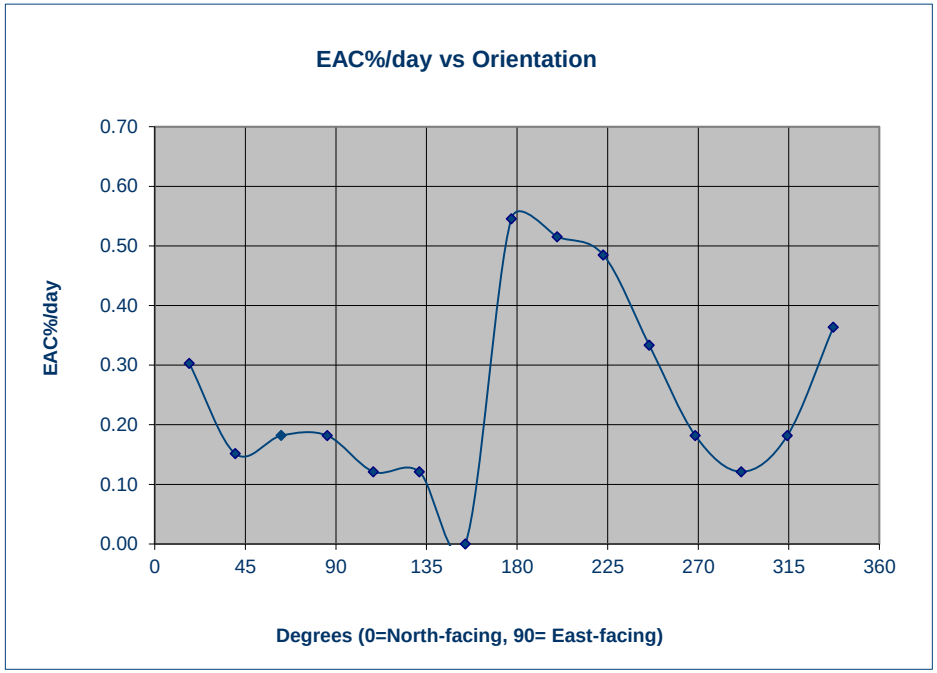
Client: ECL Site Reference: P4515

Gauge Ref: ECL/21/3681

Sticky Pad Data

Date On	15/05/2021	Date Off	17/06/2021	Days =	33
Clean =	92				

X Axis mm	Meter	Angle deg	EAC%/day	Comment
20	80	337	0.36	
40	86	314	0.18	
60	88	291	0.12	
80	86	269	0.18	
100	81	246	0.33	
120	76	223	0.48	
140	75	200	0.52	
160	74	177	0.55	
180	92	154	0.00	
200	88	131	0.12	
220	88	109	0.12	
240	86	86	0.18	
260	86	63	0.18	
280	87	40	0.15	
300	82	17	0.30	



Note: Cells coloured green are inputs. The rest are either constants or calculated values.
The calculation is based on taking readings at 20mm intervals along the sticky pad.

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Analytical Report Number : 20-42846

Project / Site name:	P4515	**Samples received on:**	24/11/2020
Your job number:	P4515	**Samples instructed on/ Analysis started on:**	24/11/2020
Your order number:	C1731	**Analysis completed by:**	27/11/2020
Report Issue Number:	1	**Report issued on:**	27/11/2020
Samples Analysed:	2 water samples		

Signed: A. Czerwińska

Agnieszka Czerwińska
Technical Reviewer (Reporting Team)
For & on behalf of i2 Analytical Ltd.

Standard Geotechnical, Asbestos and Chemical Testing Laboratory located at: ul. Pionierów 39, 41 -711 Ruda Śląska, Poland.

Accredited tests are defined within the report, opinions and interpretations expressed herein are outside the scope of accreditation.

Standard sample disposal times, unless otherwise agreed with the laboratory, are :

soils	- 4 weeks from reporting
leachates	- 2 weeks from reporting
waters	- 2 weeks from reporting
asbestos	- 6 months from reporting

Excel copies of reports are only valid when accompanied by this PDF certificate.

Any assessments of compliance with specifications are based on actual analytical results with no contribution from uncertainty of measurement.
Application of uncertainty of measurement would provide a range within which the true result lies.
An estimate of measurement uncertainty can be provided on request.

Analytical Report Number: 20-42846
Project / Site name: P4515

Your Order No: C1731

Lab Sample Number				1692412	1692413
Sample Reference				ECL/20/6150	ECL/20/6151
Sample Number				None Supplied	None Supplied
Depth (m)				None Supplied	None Supplied
Date Sampled				16/11/2020	16/11/2020
Time Taken				None Supplied	None Supplied
Analytical Parameter (Water Analysis)	**Units**	**Limit of detection**	**Accreditation Status**		
General Inorganics					
Total Solids (weight)	mg	10	NONE	16.8	80.5
Total Solids (volume)	l	0.001	NONE	5	4.46
Rate of Dust Deposition	mg/m2/day	N/A	NONE	12.97	62.14

U/S = Unsuitable Sample I/S = Insufficient Sample

Analytical Report Number : 20-42846
Project / Site name: P4515

Water matrix abbreviations: Surface Water (SW) Potable Water (PW) Ground Water (GW)

Analytical Test Name	Analytical Method Description	Analytical Method Reference	Method number	Wet / Dry Analysis	Accreditation Status
Rate of Dust Deposition (Stockholm Protocol)	Calculation of the rate of dust deposition per day - based on gravimetric analysis of the dust and calculation according to the Stockholm Environment Institute.	Protocol for using the dry Frisbee (with foam insert) dust deposit gauge - calculation of dust deposition rate.	L004-UK	W	NONE
Total Solids	Determined gravimetrically following filtration.	In-house method	L004-PL	W	NONE

For method numbers ending in 'UK' analysis have been carried out in our laboratory in the United Kingdom.
For method numbers ending in 'PL' analysis have been carried out in our laboratory in Poland.
Soil analytical results are expressed on a dry weight basis. Where analysis is carried out on as-received the results obtained are multiplied by a moisture correction factor that is determined gravimetrically using the moisture content which is carried out at a maximum of 30oC.

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Analytical Report Number : 21-52072

Project / Site name:	P4515	**Samples received on:**	21/01/2021
Your job number:	P4515	**Samples instructed on/ Analysis started on:**	21/01/2021
Your order number:	C1917	**Analysis completed by:**	29/01/2021
Report Issue Number:	1	**Report issued on:**	29/01/2021
Samples Analysed:	2 water samples		

Signed:

Joanna Wawrzeczko
Technical Reviewer (Reporting Team)
For & on behalf of i2 Analytical Ltd.

Standard Geotechnical, Asbestos and Chemical Testing Laboratory located at: ul. Pionierów 39, 41 -711 Ruda Śląska, Poland.

Accredited tests are defined within the report, opinions and interpretations expressed herein are outside the scope of accreditation.

Standard sample disposal times, unless otherwise agreed with the laboratory, are :

soils	- 4 weeks from reporting
leachates	- 2 weeks from reporting
waters	- 2 weeks from reporting
asbestos	- 6 months from reporting

Excel copies of reports are only valid when accompanied by this PDF certificate.

Any assessments of compliance with specifications are based on actual analytical results with no contribution from uncertainty of measurement.
Application of uncertainty of measurement would provide a range within which the true result lies.
An estimate of measurement uncertainty can be provided on request.

Analytical Report Number: 21-52072
Project / Site name: P4515

Your Order No: C1917

Lab Sample Number				1742695	1742696
Sample Reference				ECL/21/0266	ECL/21/0267
Sample Number				None Supplied	None Supplied
Depth (m)				None Supplied	None Supplied
Date Sampled				16/01/2021	16/01/2021
Time Taken				None Supplied	None Supplied
Analytical Parameter (Water Analysis)	**Units**	**Limit of detection**	**Accreditation Status**		
General Inorganics					
Total Solids (weight)	mg	10	NONE	104	165
Total Solids (volume)	l	0.001	NONE	5	5.1
Rate of Dust Deposition	mg/m2/day	N/A	NONE	85.63	135.85

U/S = Unsuitable Sample I/S = Insufficient Sample

Analytical Report Number : 21-52072
Project / Site name: P4515

Water matrix abbreviations: Surface Water (SW) Potable Water (PW) Ground Water (GW)

Analytical Test Name	Analytical Method Description	Analytical Method Reference	Method number	Wet / Dry Analysis	Accreditation Status
Rate of Dust Deposition (Stockholm Protocol)	Calculation of the rate of dust deposition per day - based on gravimetric analysis of the dust and calculation according to the Stockholm Environment Institute.	Protocol for using the dry Frisbee (with foam insert) dust deposit gauge - calculation of dust deposition rate.	L004-UK	W	NONE
Total Solids	Determined gravimetrically following filtration.	In-house method	L004-PL	W	NONE

For method numbers ending in 'UK' analysis have been carried out in our laboratory in the United Kingdom.
For method numbers ending in 'PL' analysis have been carried out in our laboratory in Poland.
Soil analytical results are expressed on a dry weight basis. Where analysis is carried out on as-received the results obtained are multiplied by a moisture correction factor that is determined gravimetrically using the moisture content which is carried out at a maximum of 30oC.

CERTIFICATE OF ANALYSIS

MULTI-SAMPLE REPORT REFERENCE	REGISTERED DATE	RECEIVED DATE	ANALYSIS STARTED	ANALYSIS COMPLETE
2021-04-43-11:43:24	22/02/2021	22/02/2021	22/02/2021	04/03/2021

LABORATORY
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CUSTOMER
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Pontypridd
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PO NUMBER	C1917	CLIENT SITE	P4515
END DATE SAMPLED	15/01/2021	CLIENT CODE	P4515
DATE SAMPLED (DD/MM/YY)	16/12/2020		

Matrix: Water

			i2 Sample Number	185647	185648
			Sample Type	W	W
			Sample Reference	ECL/21/0805	ECL/21/0806
Determinand	Technique	LOD	Accreditation		
Rate of Dust Deposition	T487	0.0 mg/m2/day	None	71.2	27.4
Total Solids (mass)	T487	10.0 mg	None	86.5	33.3
Total Solids (volume)	T487	0.001 l	None	5.100	5.100

Matrix: Sticky Pad

			i2 Sample Number	185649	185650
			Sample Type	SP	SP
			Sample Reference	ECL/21/0805	ECL/21/0806
Determinand	Technique	LOD	Accreditation		
Directional Dust	T488	0.0	None	Saved In Online Documentation	Saved In Online Documentation

Technical Reviewer	Role
Mrs Jeanette Abbott	Customer Service Manager
Mrs Kathryn Gleaves	Customer Services

Extra Testing Information

Technique Code	Technique Name	Samples
T487	L004B-Grav	185647, 185648
T488	L016-Sticky Pad Reader	185649, 185650

Testing Location	Samples
All analysis was carried out at i2 Analytical (Poland), i2 Analytical Limited Sp z.o.o, Oddziat w Polsce, ul.Pionierow 39, 41-711 Ruda Slaska, Poland	185647, 185648, 185649, 185650

The results reported relate to samples received in the laboratory and may not be representative of a whole batch.
Tests covered by this certificate were conducted in accordance with i2 Analytical's SOPs.
Note: All assessments of compliance with specifications are based on actual analytical results with no contribution from uncertainty of measurement. Application of uncertainty of measurement would provide a range within which the true result lies. An estimate of measurement of uncertainty can be provided on request.
This is a simplified test report

Results in black are positive/detected results. Results in gray are below the LOD or have not been found.
LOD = Limit of Determination. This is the lowest reportable limit of the test.

i2 Analytical Limited.
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0972 49

CERTIFICATE OF ANALYSIS

MULTI-SAMPLE REPORT REFERENCE	REGISTERED DATE	RECEIVED DATE	ANALYSIS STARTED	ANALYSIS COMPLETE
2021-31-18-08:18:00	18/03/2021	18/03/2021	18/03/2021	31/03/2021

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PO NUMBER	C1917	CLIENT SITE	P4515
END DATE SAMPLED	15/03/2021	CLIENT CODE	P4515
DATE SAMPLED (DD/MM/YY)	15/02/2021		

Matrix: Water

			i2 Sample Number	196419	196420
			Sample Type	W	W
			Sample Reference	ECL/21/1554	ECL/21/1555
Determinand	**Technique**	**LOD**	**Accreditation**		
Rate of Dust Deposition	T487	0.0 mg/m2/day	None	25.7	32.1
Total Solids (mass)	T487	10.0 mg	None	29.1	36.4
Total Solids (volume)	T487	0.001 l	None	3.600	3.600

Matrix: Sticky Pad

			i2 Sample Number	196421	196422
			Sample Type	SP	SP
			Sample Reference	ECL/21/1554	ECL/21/1555
Determinand	**Technique**	**LOD**	**Accreditation**		
Directional Dust	T488	0.0	None	Unreportable [467]	Refer to Additional Report

Technical Reviewer	Role
Mrs Kathryn Gleaves	Customer Services
Mrs Jeanette Abbott	Customer Service Manager

Extra Testing Information

Technique Code	Technique Name	Samples
T487	L004B-Grav	196419, 196420
T488	L016-Sticky Pad Reader	196421, 196422

Testing Location	Samples
All analysis was carried out at i2 Analytical (Poland), i2 Analytical Limited Sp z.o.o, Oddziat w Polsce, ul.Pionierow 39, 41-711 Ruda Slaska, Poland	196419, 196420, 196421, 196422

The results reported relate to samples received in the laboratory and may not be representative of a whole batch.
Tests covered by this certificate were conducted in accordance with i2 Analytical's SOPs.
Note: All assessments of compliance with specifications are based on actual analytical results with no contribution from uncertainty of measurement. Application of uncertainty of measurement would provide a range within which the true result lies. An estimate of measurement of uncertainty can be provided on request.
This is a simplified test report

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LOD = Limit of Determination. This is the lowest reportable limit of the test.
467 - Unreportable- sample is damaged and untestable

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0972 49

CERTIFICATE OF ANALYSIS

MULTI-SAMPLE REPORT REFERENCE	REGISTERED DATE	RECEIVED DATE	ANALYSIS STARTED	ANALYSIS COMPLETE
2021-30-32-11:32:44	20/04/2021	20/04/2021	20/04/2021	30/04/2021

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PO NUMBER	C1917	CLIENT SITE	P4515
END DATE SAMPLED	15/04/2021	CLIENT CODE	P4515
DATE SAMPLED (DD/MM/YY)	15/03/2021		

Matrix: Water

			i2 Sample Number	208438	208439
			Sample Type	W	W
			Sample Reference	ECL/21/2145	ECL/21/2146
Determinand	Technique	LOD	Accreditation		
Rate of Dust Deposition	T487	0.0 mg/m2/day	None	44.3	94.0
Total Solids (mass)	T487	10.0 mg	None	55.6	118
Total Solids (volume)	T487	0.001 l	None	0.490	0.430

Matrix: Sticky Pad

			i2 Sample Number	208440	208441
			Sample Type	SP	SP
			Sample Reference	ECL/21/2145	ECL/21/2146
Determinand	Technique	LOD	Accreditation		
Directional Dust	T488	0.0	None	Saved In Online Documentation	Saved In Online Documentation

Technical Reviewer	Role
Mrs Jeanette Abbott	Customer Service Manager
Mrs Kathryn Gleaves	Customer Services

Extra Testing Information

Technique Code	Technique Name	Samples
T487	L004B-Grav	208438, 208439
T488	L016-Sticky Pad Reader	208440, 208441

Testing Location	Samples
All analysis was carried out at i2 Analytical (Poland), i2 Analytical Limited Sp z.o.o, Oddziat w Polsce, ul.Pionierow 39, 41-711 Ruda Slaska, Poland	208438, 208439, 208440, 208441

The results reported relate to samples received in the laboratory and may not be representative of a whole batch.
Tests covered by this certificate were conducted in accordance with i2 Analytical's SOPs.
Note: All assessments of compliance with specifications are based on actual analytical results with no contribution from uncertainty of measurement. Application of uncertainty of measurement would

provide a range within which the true result lies. An estimate of measurement of uncertainty can be provided on request.
This is a simplified test report

Results in black are positive/detected results. Results in gray are below the LOD or have not been found.
LOD = Limit of Determination. This is the lowest reportable limit of the test.

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CERTIFICATE OF ANALYSIS

MULTI-SAMPLE REPORT REFERENCE	REGISTERED DATE	RECEIVED DATE	ANALYSIS STARTED	ANALYSIS COMPLETE
2021-03-42-09:42:49	20/05/2021	20/05/2021	21/05/2021	02/06/2021

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PO NUMBER	C1917	DATE SAMPLED (DD/MM/YY)	19/04/2021
END DATE SAMPLED	19/05/2021	CLIENT CODE	P4515

Matrix: Water

			i2 Sample Number	220530	220531
			Sample Type	W	W
			Sample Reference	ECL/21/2921	ECL/21/2922
Determinand	Technique	LOD	Accreditation		
Rate of Dust Deposition	T487	0.0 mg/m2/day	None	101	161
Total Solids (mass)	T487	10.0 mg	None	123	195
Total Solids (volume)	T487	0.001 l	None	5.120	5.260

Matrix: Sticky Pad

			i2 Sample Number	220532	220533
			Sample Type	SP	SP
			Sample Reference	ECL/21/2921	ECL/21/2922
Determinand	Technique	LOD	Accreditation		
Directional Dust	T488	0.0	None	Refer to Additional Report	Refer to Additional Report

Technical Reviewer	Role
Mrs Kathryn Gleaves	Customer Services
Mrs Jeanette Abbott	Customer Service Manager

Extra Testing Information

Technique Code	Technique Name	Samples
T487	L004B-Grav	220530, 220531
T488	L016-Sticky Pad Reader	220532, 220533

Testing Location	Samples
All analysis was carried out at i2 Analytical (Poland), i2 Analytical Limited Sp z.o.o, Oddziat w Polsce, ul.Pionierow 39, 41-711 Ruda Slaska, Poland	220530, 220531, 220532, 220533

The results reported relate to samples received in the laboratory and may not be representative of a whole batch.
Tests covered by this certificate were conducted in accordance with i2 Analytical's SOPs.
Note: All assessments of compliance with specifications are based on actual analytical results with no contribution from uncertainty of measurement. Application of uncertainty of measurement would provide a range within which the true result lies. An estimate of measurement of uncertainty can be provided on request.
This is a simplified test report

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LOD = Limit of Determination. This is the lowest reportable limit of the test.

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0972 49

CERTIFICATE OF ANALYSIS

MULTI-SAMPLE REPORT REFERENCE	REGISTERED DATE	RECEIVED DATE	ANALYSIS STARTED	ANALYSIS COMPLETE
2021-07-42-13:42:50	25/06/2021	25/06/2021	25/06/2021	07/07/2021

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PO NUMBER	C1917	CLIENT SITE	P4515
END DATE SAMPLED	17/06/2021	CLIENT CODE	P4515
DATE SAMPLED (DD/MM/YY)	15/05/2021		

Matrix: Water

			i2 Sample Number	235129	235130
			Sample Reference	ECL/21/3680	ECL/21/3681
Determinand	Technique	LOD	Accreditation		
Rate of Dust Deposition	T487	0.0 mg/m2/day	None	319	31.1
Total Solids (mass)	T487	10.0 mg	None	426	41.6
Total Solids (volume)	T487	0.001 l	None	1.620	1.500

Matrix: Sticky Pad

				i2 Sample Number	235131	235132
				Sample Reference	ECL/21/3680	ECL/21/3681
Determinand	Technique	LOD	Accreditation			
Directional Dust	T488	0.0	None	Saved In Online Documentation	Saved In Online Documentation	

Technical Reviewer	Role
Mrs Jeanette Abbott	Customer Service Manager
Mrs Kathryn Gleaves	Customer Services

Extra Testing Information

Technique Code	Technique Name	Samples
T487	L004B-Grav	235129, 235130
T488	L016-Sticky Pad Reader	235131, 235132

Testing Location	Samples
All analysis was carried out at i2 Analytical (Poland), i2 Analytical Limited Sp z.o.o, Oddziat w Polsce, ul.Pionierow 39, 41-711 Ruda Slaska, Poland	235129, 235130, 235131, 235132

The results reported relate to samples received in the laboratory and may not be representative of a whole batch.
Tests covered by this certificate were conducted in accordance with i2 Analytical's SOPs.
Note: All assessments of compliance with specifications are based on actual analytical results with no contribution from uncertainty of measurement. Application of uncertainty of measurement would provide a range within which the true result lies. An estimate of measurement of uncertainty can be provided on request.
This is a simplified test report

Results in black are positive/detected results. Results in gray are below the LOD or have not been found.

i2 Analytical Limited.
Registered in England No.
4750390 VAT Reg. No. 821
0972 49

LOD = Limit of Determination. This is the lowest reportable limit of the test.

i2 Analytical Limited.
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0972 49

Appendix III
Extreme Weather Reports (Met Office)

Storm Aiden 31 October 2020

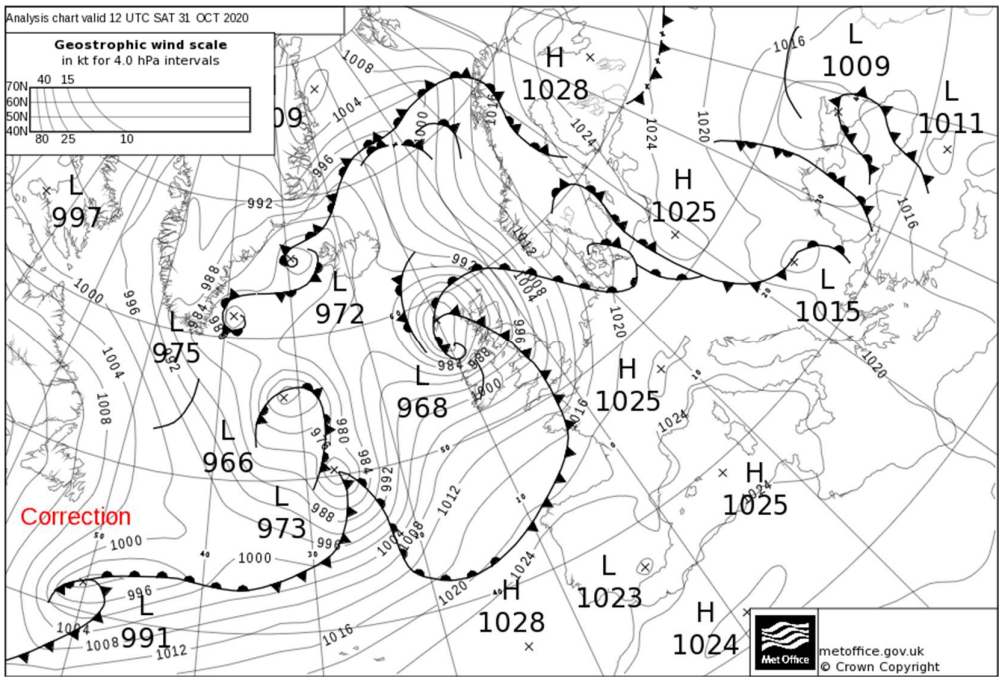
Storm Aiden[1] brought strong winds and heavy rain to the UK on 31 October 2020. The storm was part of a spell of turbulent, wet and very windy weather from late October to early November as a succession of deep Atlantic low pressure systems, associated with a powerful jet stream, crossed the UK. 50 to 100mm of rain fell across western upland parts of the UK, and winds in exposed locations gusted at over 60Kt (69mph). This was a fairly typical spell of stormy weather for the time of year.

Impacts

The strong winds and heavy rain brought travel disruption to western Scotland with many ferry services cancelled. Large waves resulted in 33 shipping containers being lost overboard from a vessel in the Pentland Firth, while a yacht capsized of the Isles of Scilly. There was localised flooding on roads in Scotland, Wales and Northern Ireland with the A83 in Argyll affected by a landslide at Rest and Be Thankful. There was some disruption to rail services, and large waves battered exposed western coastlines.

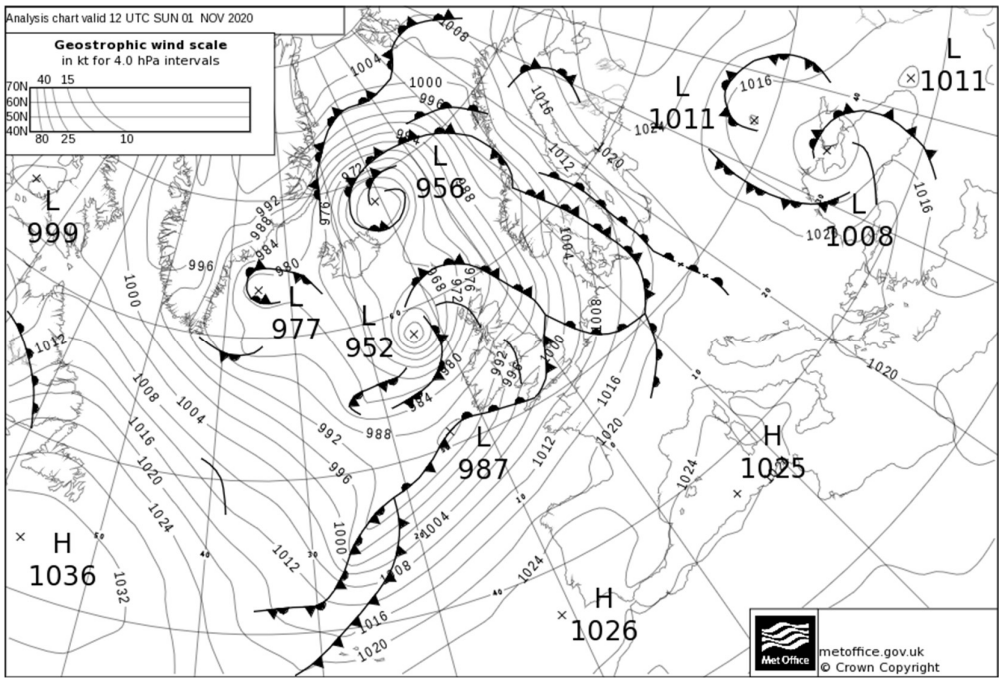
Weather data

The analysis chart at 1200 UTC 31 October 2020 shows the centre of storm Aiden to the west of Scotland.



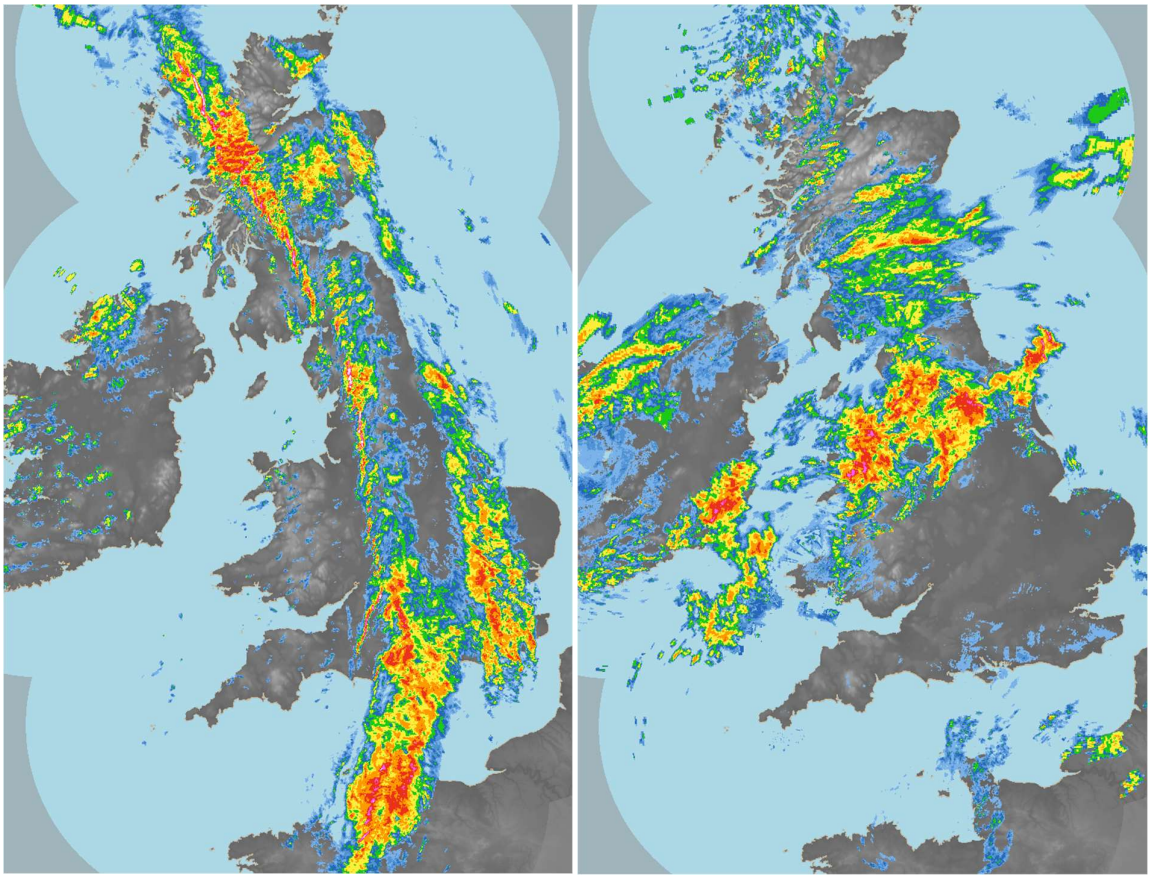
The analysis chart at 1200 UTC 1 November 2020 shows a further deep area of low pressure (containing the remnants of ex-hurricane Zeta) to the west of Scotland, with associated fronts sweeping across the UK.

[1] Storm Aiden was the first named storm of the 2020/2021 season under the Name our Storms collaboration between the Met Office, Met Eireann and KNMI.

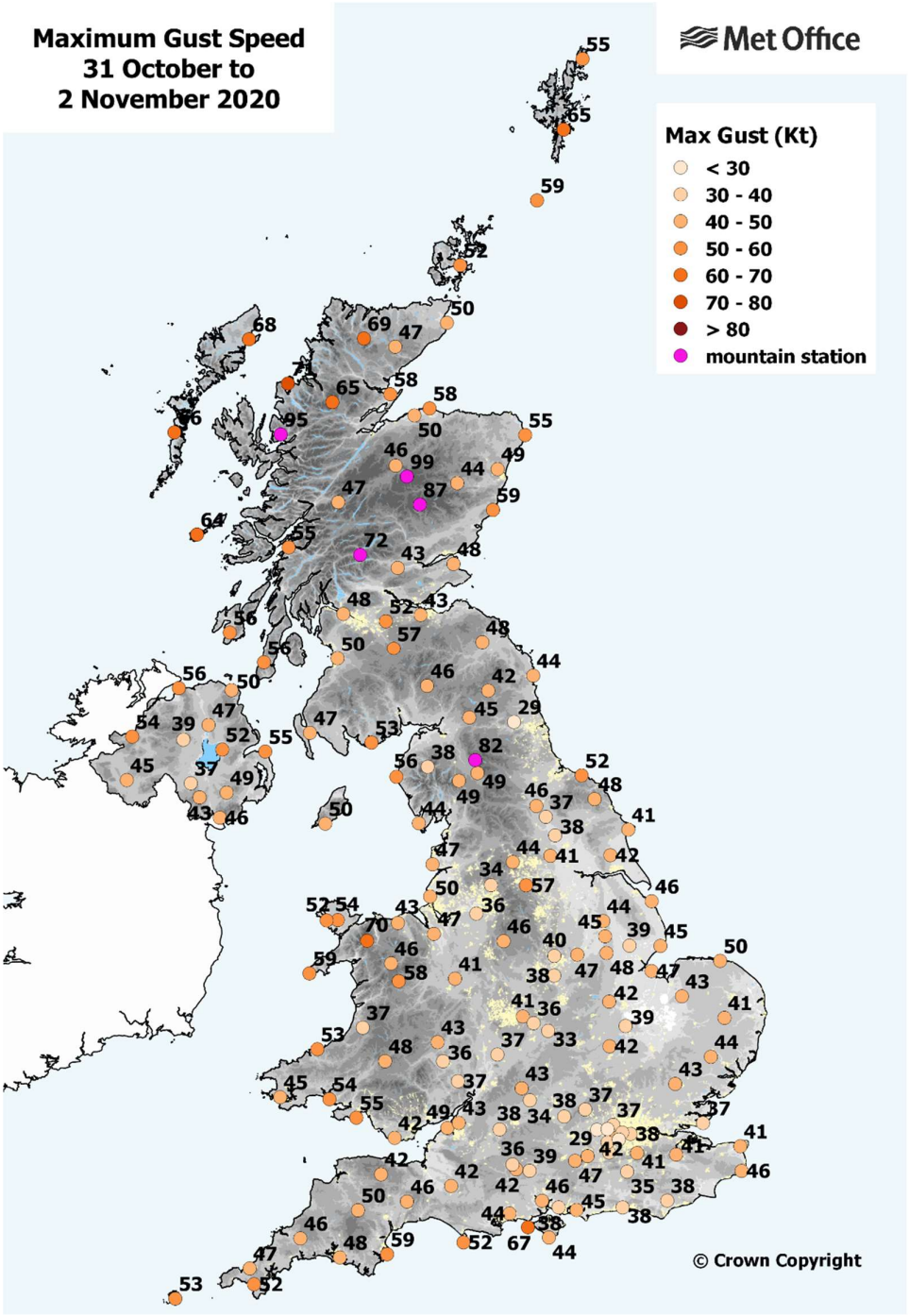


The rain-radar images below show heavy rain from storm Aiden across western Scotland, with the associated cold front sweeping across the UK, followed by further persistent heavy rainfall across parts of Wales and northern England. On 1 November, upland locations in Snowdonia, Lancashire and North Yorkshire recorded up to 100mm of rain.

1200 UTC 31 October 2020 1800 UTC 1 November 2020



The map below shows maximum gust speeds across the UK from 31 October to 2 November 2020. Wind gusts exceeded 50Kt (58mph) around the coastline of the UK, with gusts exceeding 60Kt (69mph) in exposed locations in the north and west, with 71Kt (82mph) at Aultbea, Wester Ross, 70Kt (81mph) at Capel Curig, Conwy, and several other locations in northern Scotland and the Western and Northern Isles exceeding 65Kt (75mph). Cairngorm Summit recorded a gust of 99Kt (114mph).



Author: Mike Kendon, Met Office National Climate Information Centre

Last updated 12/11/2020

Met Office

Storm Bella 26 to 27 December 2020

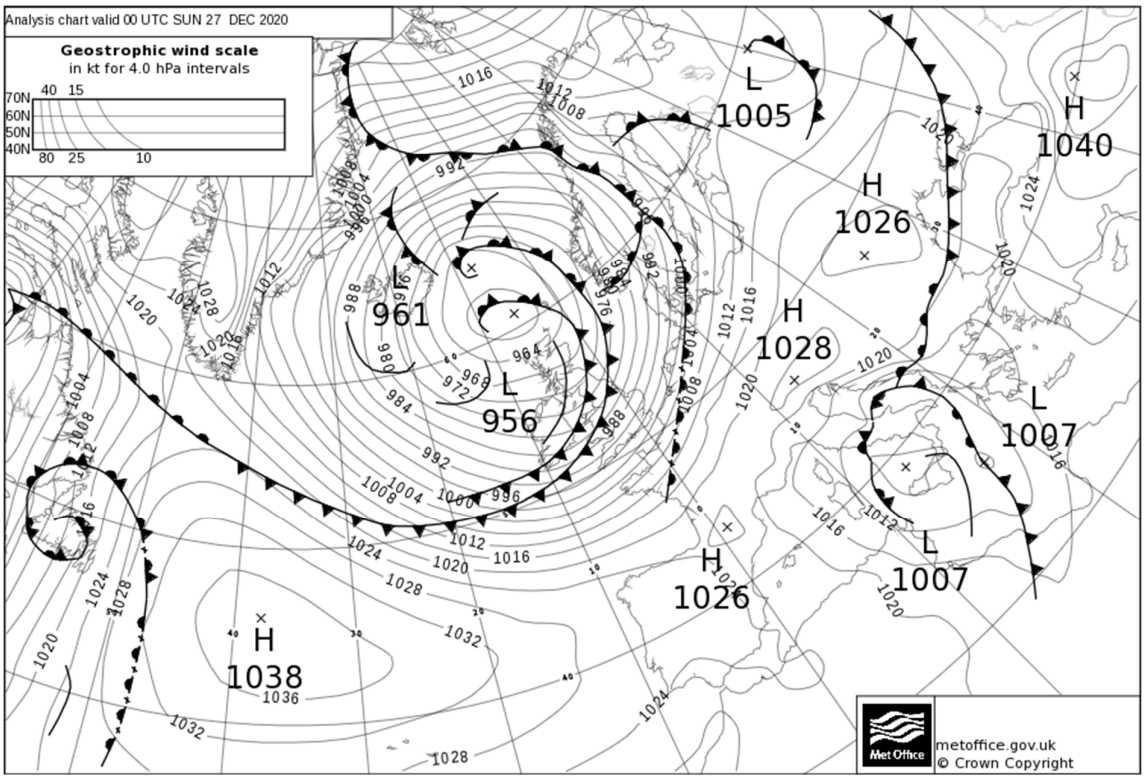
Storm Bella was the second named storm of the 2020/2021 season. Bella was a large, deep area of low pressure dominating the North Atlantic, bringing persistent heavy rain across western Scotland on 26 December, with heavy rain and very strong winds sweeping across England and Wales overnight 26 to 27 December. The strongest winds were across Wales, south-west and southern England, where this was one of the most powerful storms of the year.

Impacts

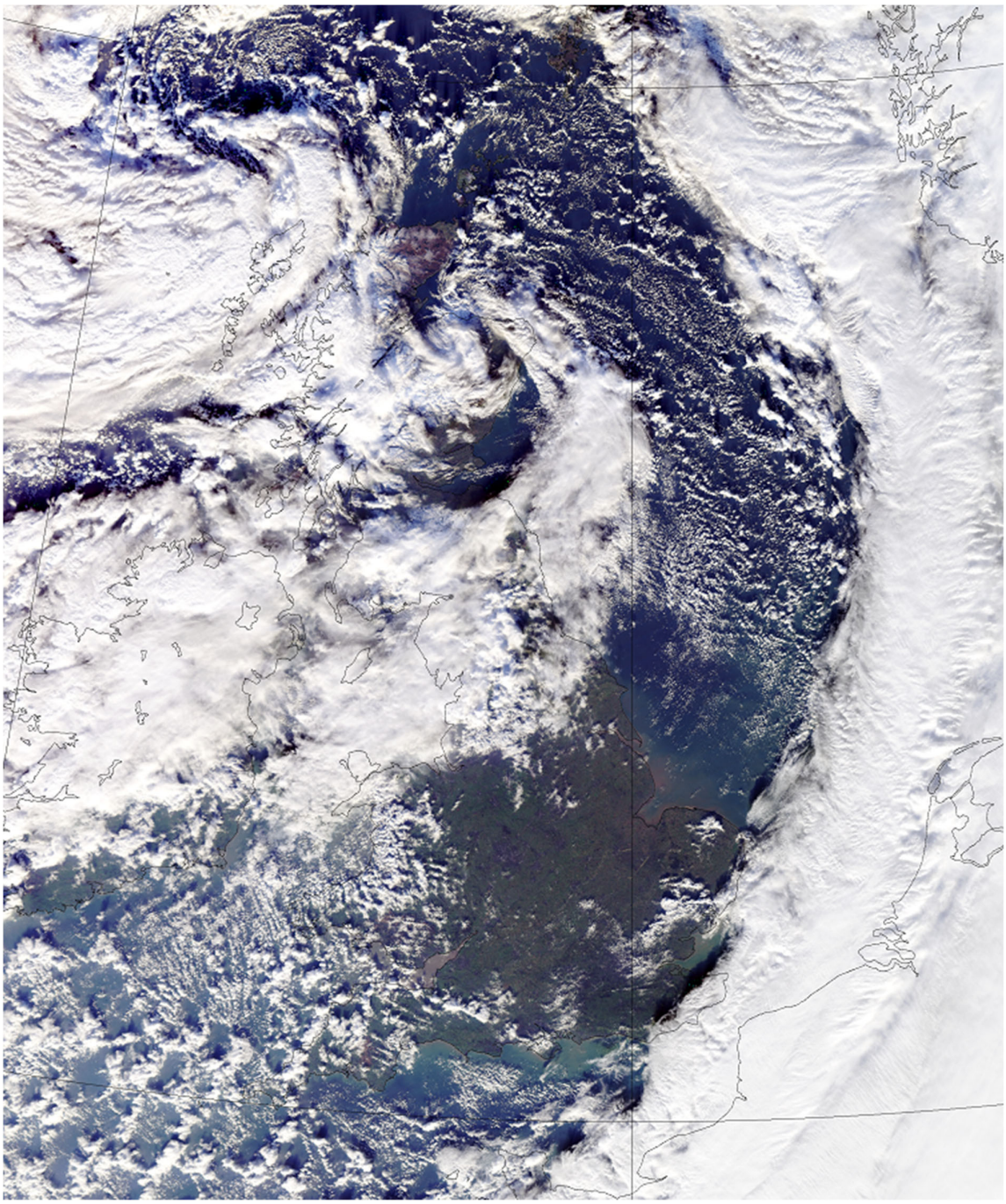
Fallen trees caused disruption to rail services in the south-west, south-east and London, while Dover to Calais ferry services were also disrupted. Large waves battered coastlines of Wales and southern England. Heavy rain from storm Bella, falling on already saturated ground, following wet and unsettled weather through much of the month resulted in localised transport disruption from flooding and a number of properties flooded in Oxfordshire, Gloucestershire, Northamptonshire and Bedfordshire. The Welsh Grand National at Chepstow was called off due to a waterlogged course.

Weather data

The analysis chart at 0000 UTC 27 December 2020 shows the centre of storm Bella to the north of Scotland with associated cold fronts sweeping across the UK.

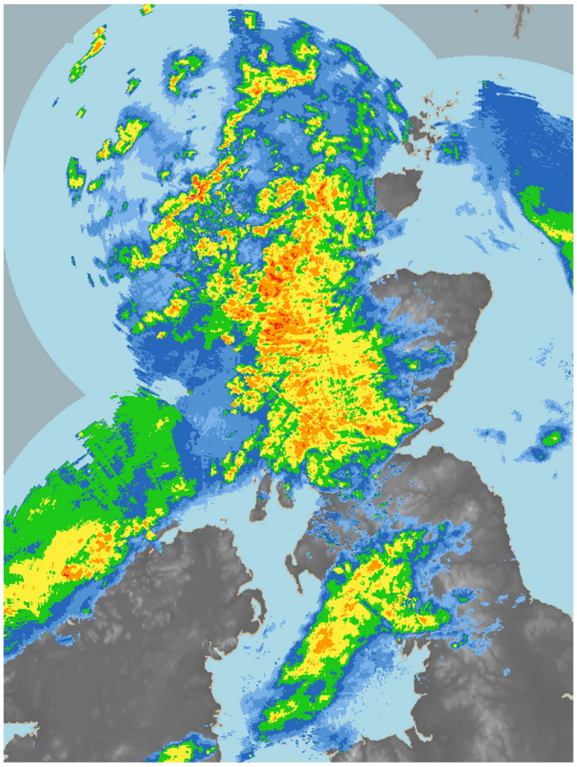


The satellite image on 27 December 2020 shows the back of the cold front clearing East Anglia and Kent with sunshine across much of the southern half of the UK, and the centre of storm Bella to the north-west of Scotland.

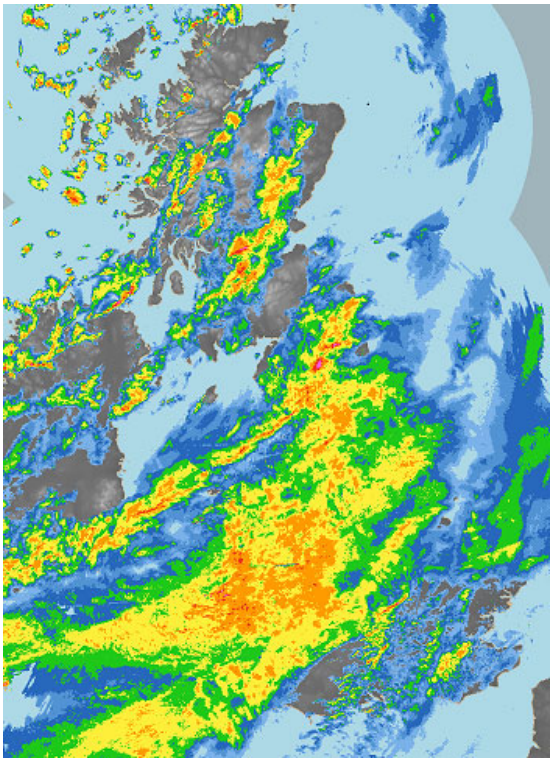


The rain-radar images below show heavy and persistent rain from storm Bella across western Scotland - falling as snow across the mountains - with heavy rain across northern and western and England and Wales overnight, clearing to leave blustery showers across Scotland and Northern Ireland.

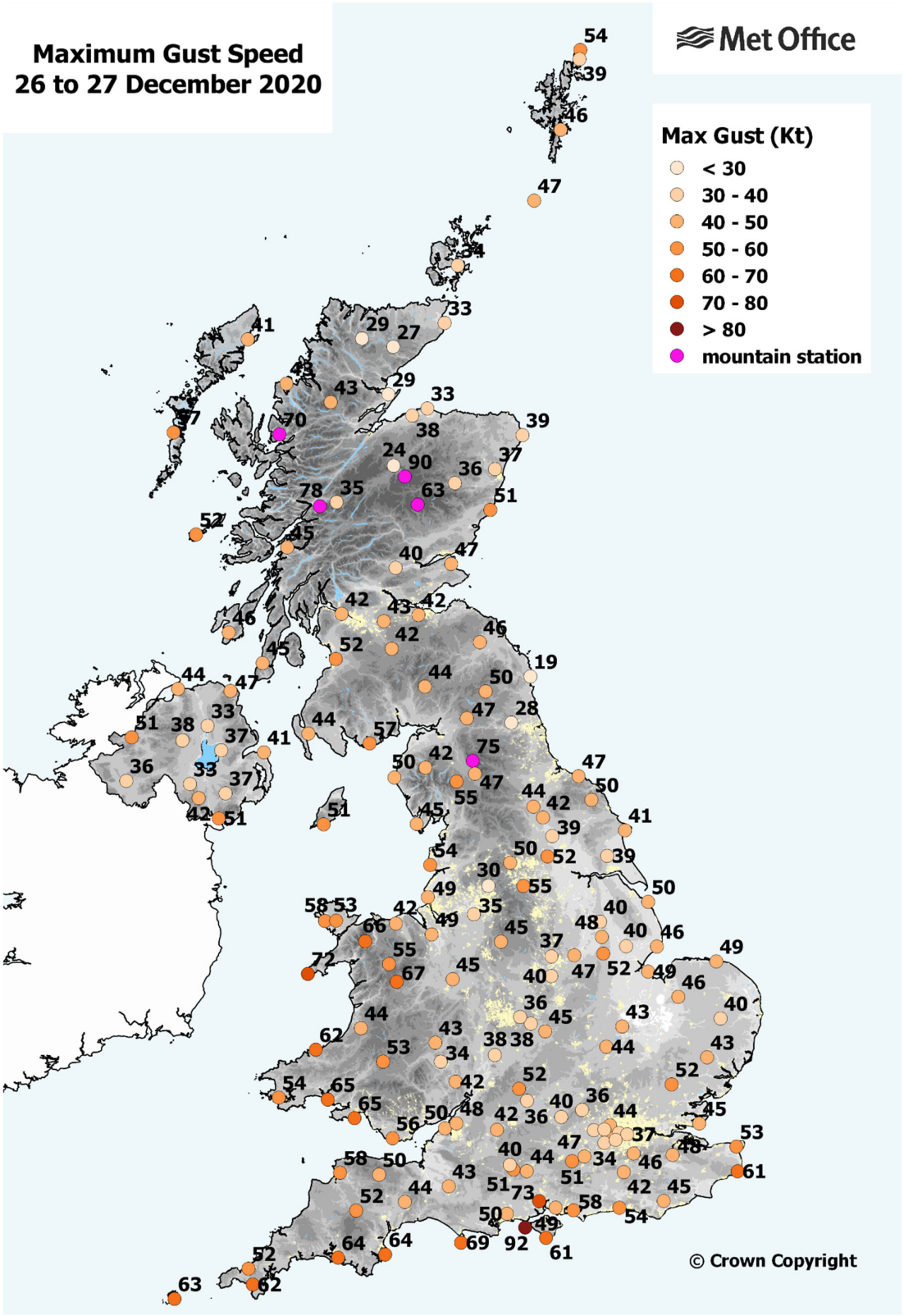
1200 UTC 26 December 2020



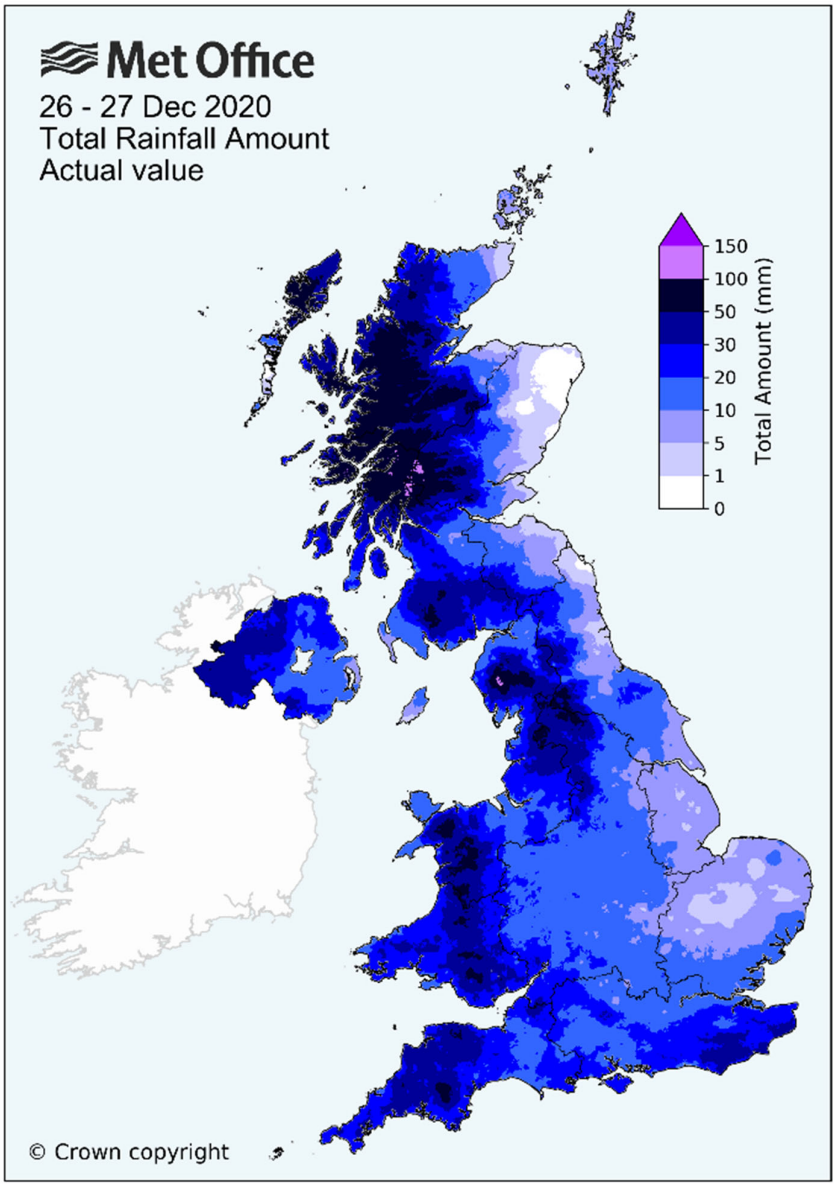
0000 UTC 27 December 2020



The map below shows maximum gust speeds across the UK from 26 to 27 December 2020. The strongest winds from storm Bella were around the coastline of Wales, south-west and southern England, where wind gusts exceeded 60Kt (69mph). Needles Old Battery (Isle of Wight) recorded 92Kt (106mph), the UK's highest wind gust since 2 November 2019 (excluding mountain stations), while Aberdaron, Llŷn Peninsula recorded 72Kt (83mph).



The map below shows daily rainfall totals from storm Bella for 26 to 27 December 2020. Over 30mm fell across parts of Kent and Sussex with 30 to 50mm falling widely across upload parts of south-west England, Wales, and northern England, and over 50mm across much of western Scotland. Two-day totals from storm Bella included 57.0mm at Capel Curig, Conwy, 64.6mm at Shap, Cumbria, 80.2mm at Tyndrum, Perthshire and 71.0mm at Achnagart (Highland). Three days prior to the arrival of storm Bella, 23 December 2020 was a particularly wet day in a swathe from Devon, south Wales, the Midlands to East Anglia, so the rain of 26 to 27 December fell on already saturated ground, exacerbating flooding problems.



Author: Mike Kendon, Met Office National Climate Information Centre

Last updated 30/12/2020

Met Office

Storm Christoph 18 to 20 January 2021

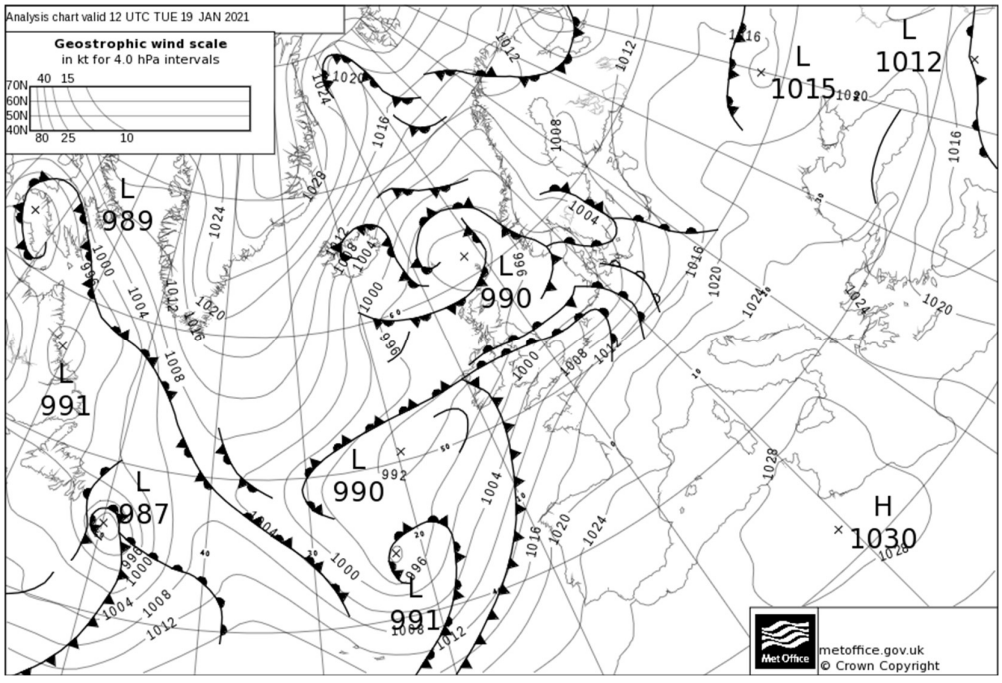
Storm Christoph brought some exceptionally wet weather to North Wales and northern England from 18 to 20 January. 100mm of rain or more fell across upland areas, and parts of Cheshire, Greater Manchester and Lancashire received around the January whole-month long-term average rainfall from this event. For north-west England and North Wales this was one of the wettest 3-day periods on record. Storm Christoph also brought some strong winds, particularly across eastern England and Scotland, and as the storm cleared eastwards, it brought some significant snowfalls with blizzard conditions across upland in the north-east.

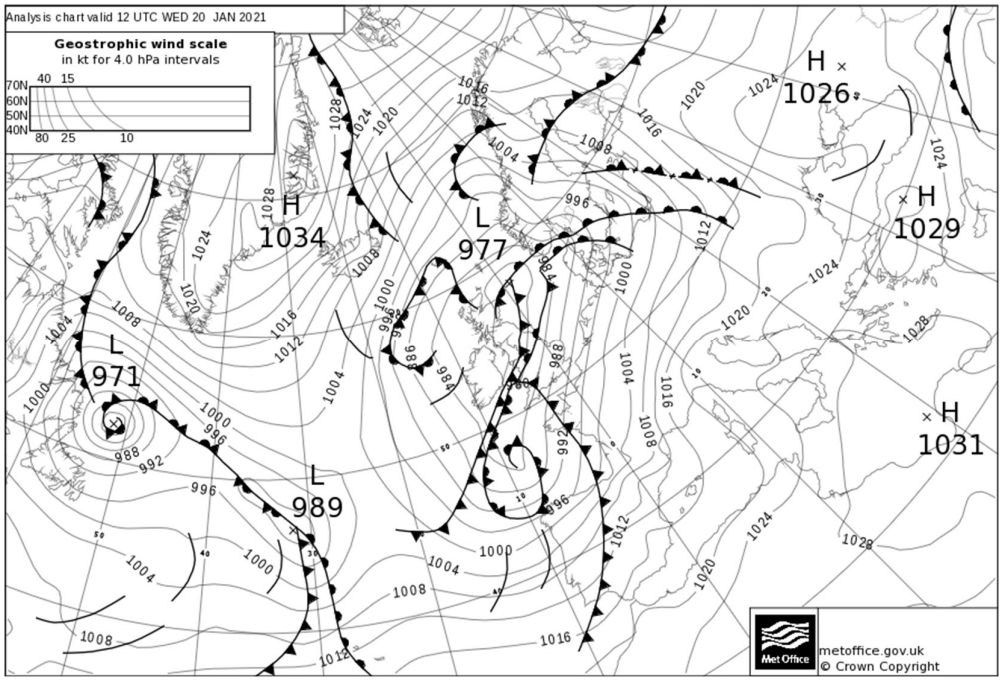
Impacts

A number of homes were flooded in Cheshire, much of Northwich town centre was under water and residents of two care homes were evacuated by dinghy. Homes were also evacuated in Warrington, Chester, Didsbury and Northenden in Manchester, Ruthin and Bangor-on-Dee in North Wales, and Maghull in Merseyside due to rising floodwater, while some properties were also flooded in South Wales. Evacuations were made more difficult by both the ongoing coronavirus pandemic and falling snow. A bridge over the River Clwyd in Denbighshire was swept away by floodwater, and the East Coast Main Line was affected by floods between York and Darlington. The snowfalls caused travel disruption, with many roads affected by snow, the A9 closed south of Inverness and the Queensferry crossing closed for a time due to the risk of falling ice. Icy conditions on the M5 near Bristol caused multiple crashes including an overturned lorry. Avalanche debris was spotted in the Pentland Hills south-west of Edinburgh.

Weather data

The analysis charts at 1200UTC 19, 20 and 21 January 2021 show storm Christoph and associated fronts moving across the UK, with the low deepening as the storm tracked north-east across the North Sea towards Norway.




Analysis chart valid 12 UTC WED 20 JAN 2021
Geostrophic wind scale
in kt for 4.0 hPa intervals
40 15
70N
60N
50N
40N
80 25 10
H 1026
H 1034
L 977
H 1029
L 971
H 1031
L 989
metoffice.gov.uk
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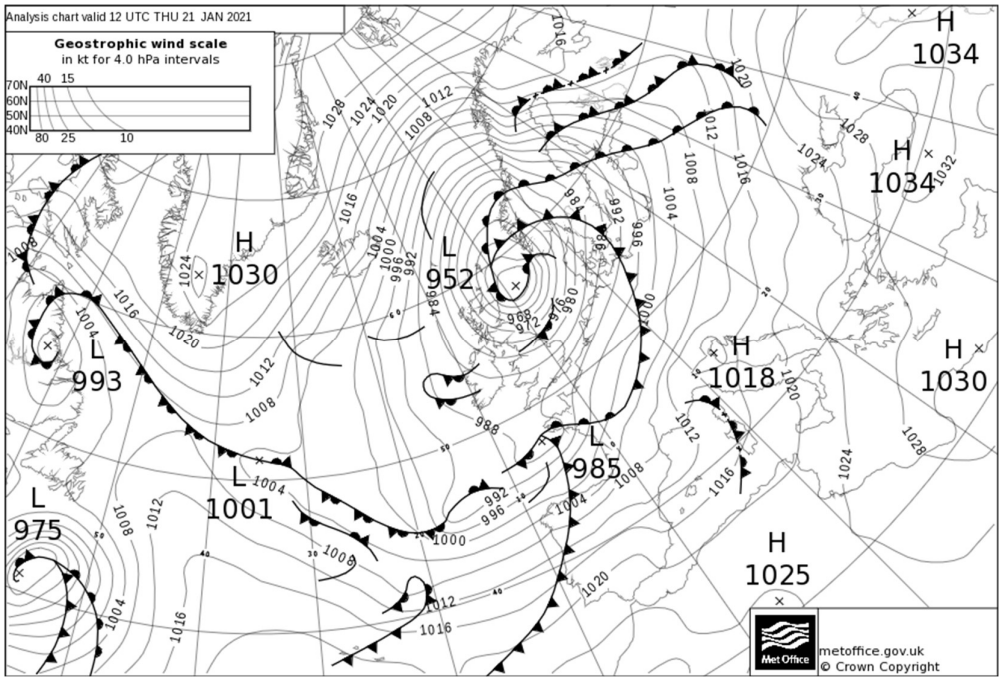
Analysis chart valid 12 UTC THU 21 JAN 2021
Geostrophic wind scale
in kt for 4.0 hPa intervals
40 15
70N
60N
50N
40N
80 25 10
H 1034
H 1034
H 1030
L 952
L 993
H 1018
H 1030
L 985
L 1001
L 975
H 1025
metoffice.gov.uk
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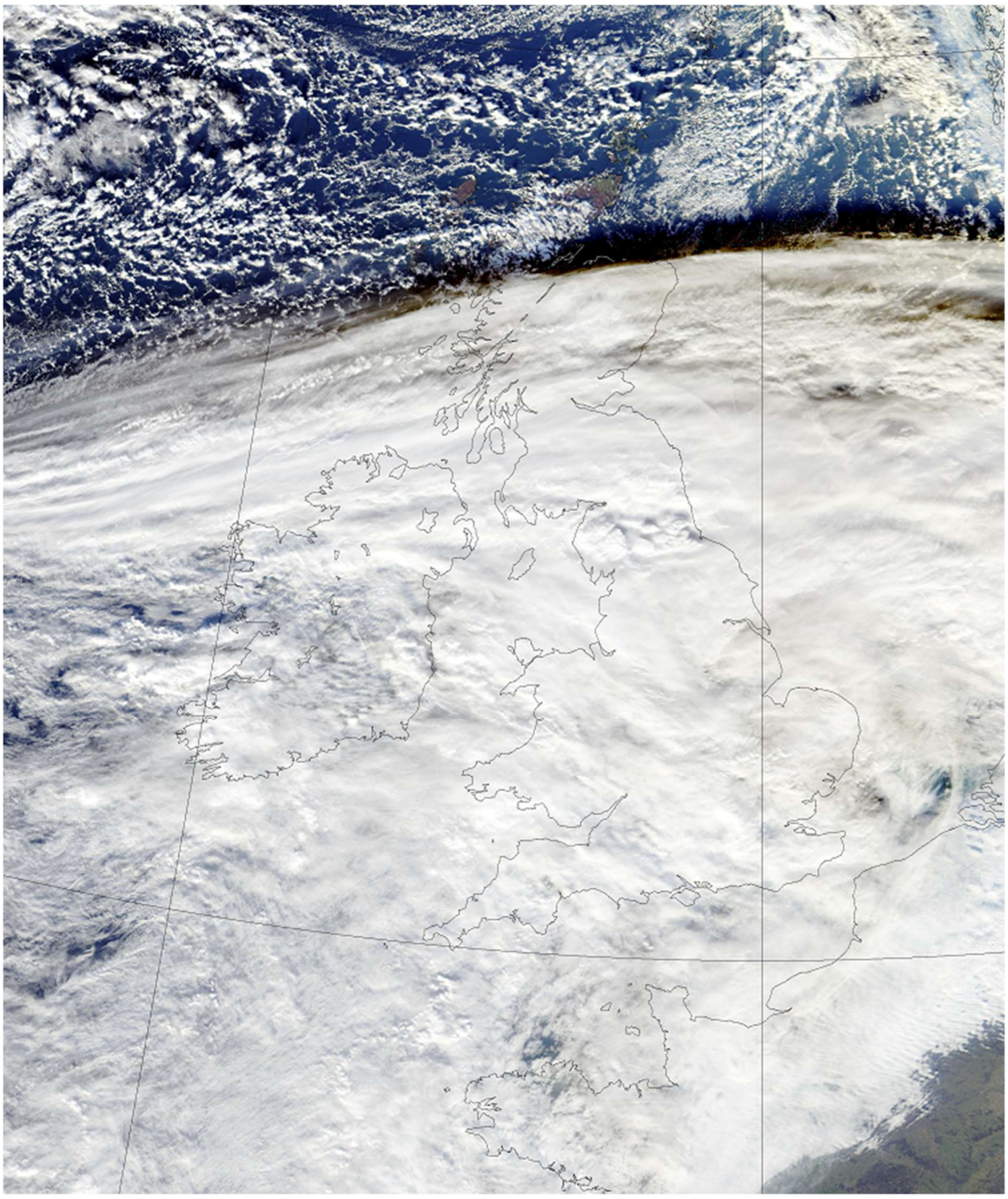
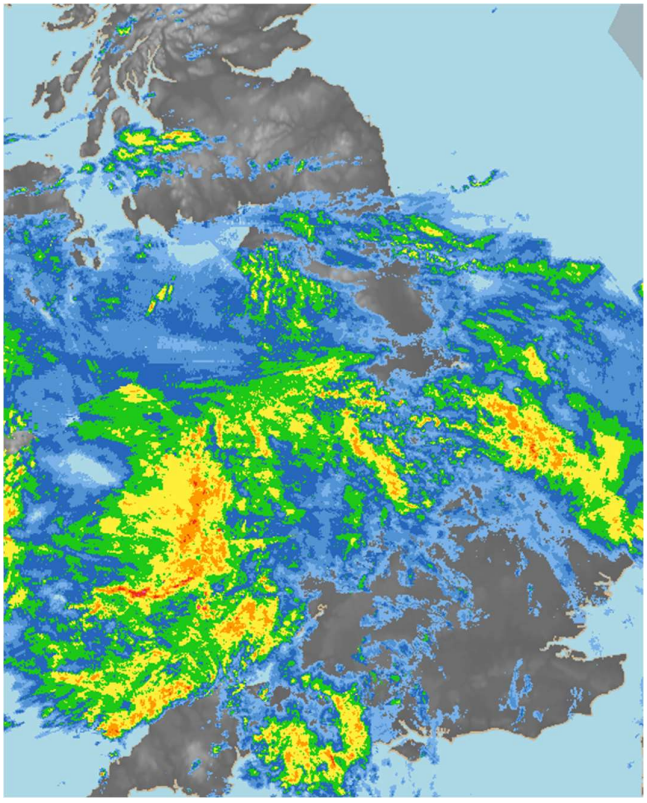
The satellite image on 19 January 2021 shows the UK almost entirely swathed in cloud – with the sole exception of the far north of Scotland – as fronts from storm Christoph moved across the UK.

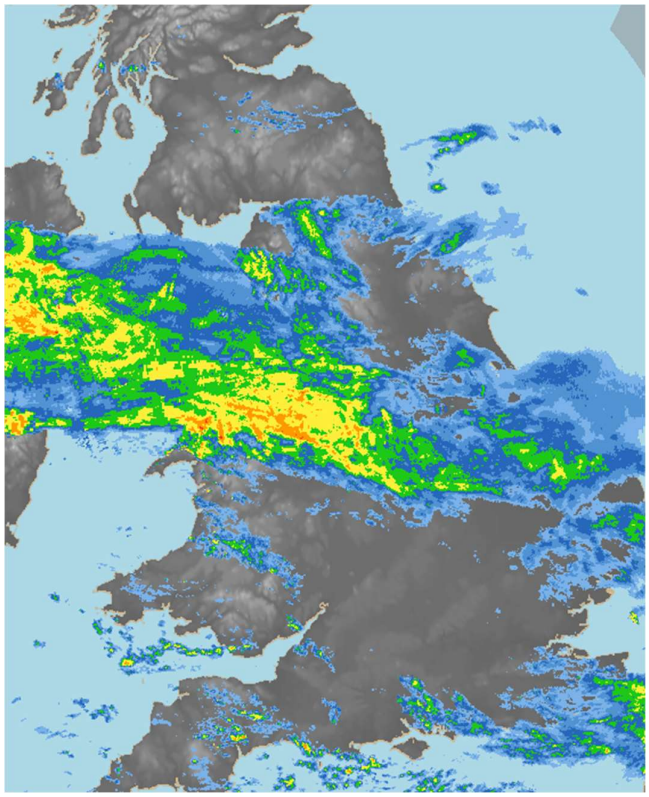


The rain-radar images below at 6 hourly intervals through 19 and 20 January 2021 show the heavy and persistent nature of the rainfall from storm Christoph, with the wettest weather focussed across upland areas of Wales and northern England through this 48-hour period.

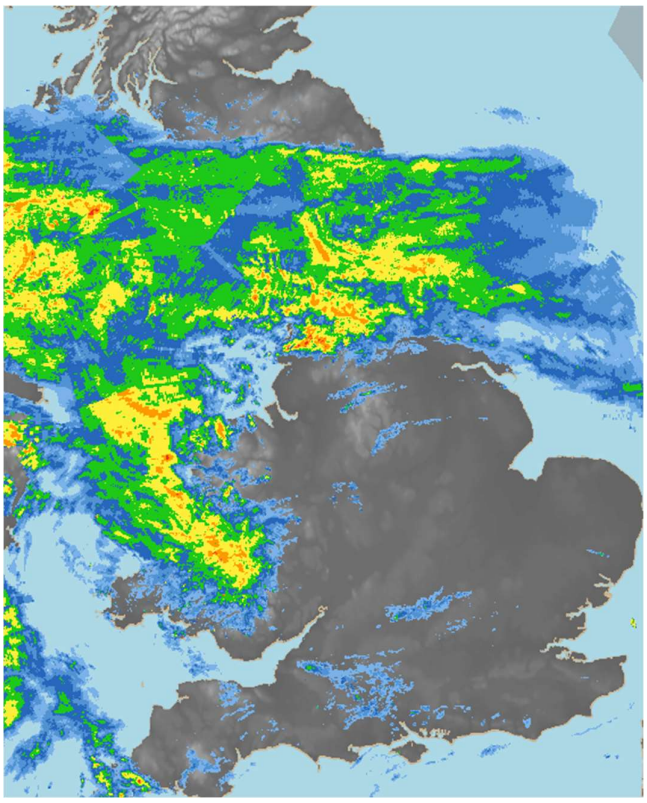
0000 UTC 19 January 2021



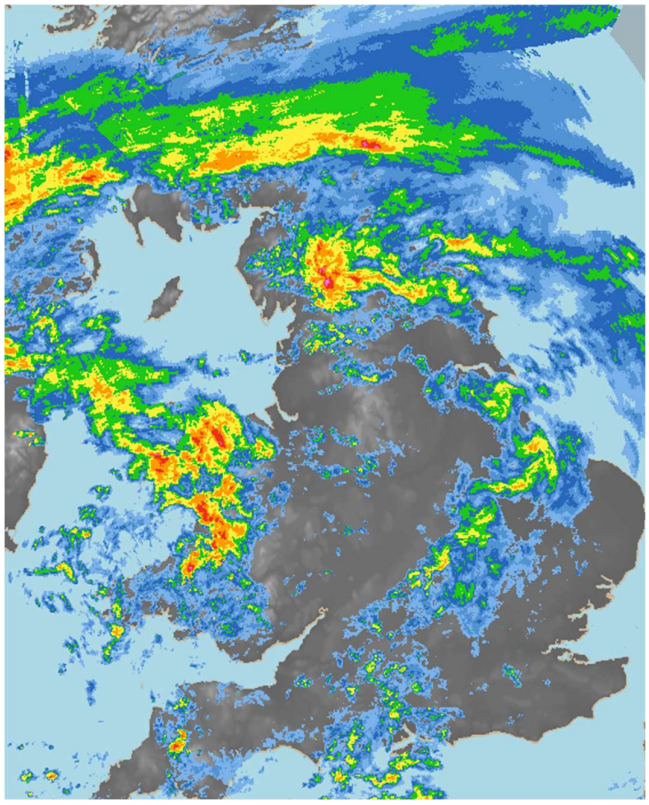
0600 UTC 19 January 2021



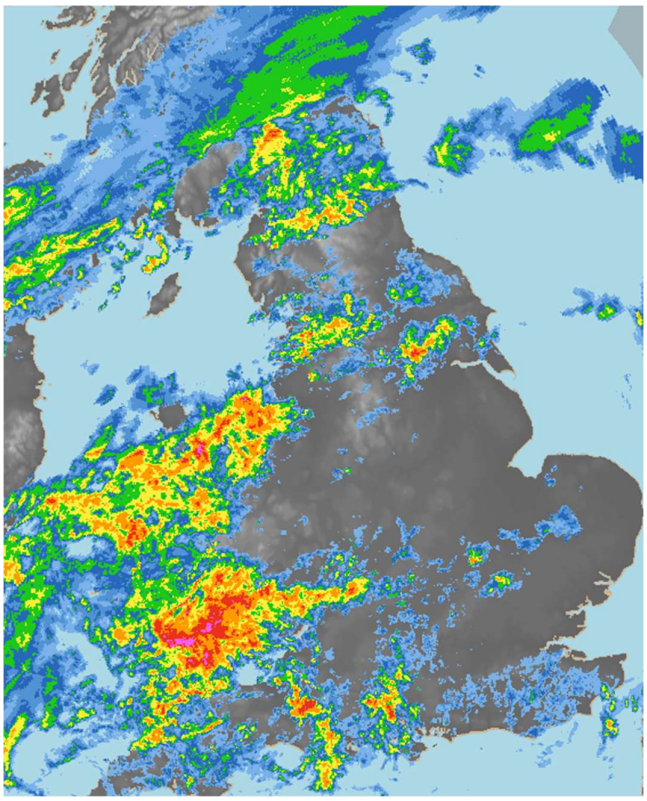
1200UTC 19 January 2021



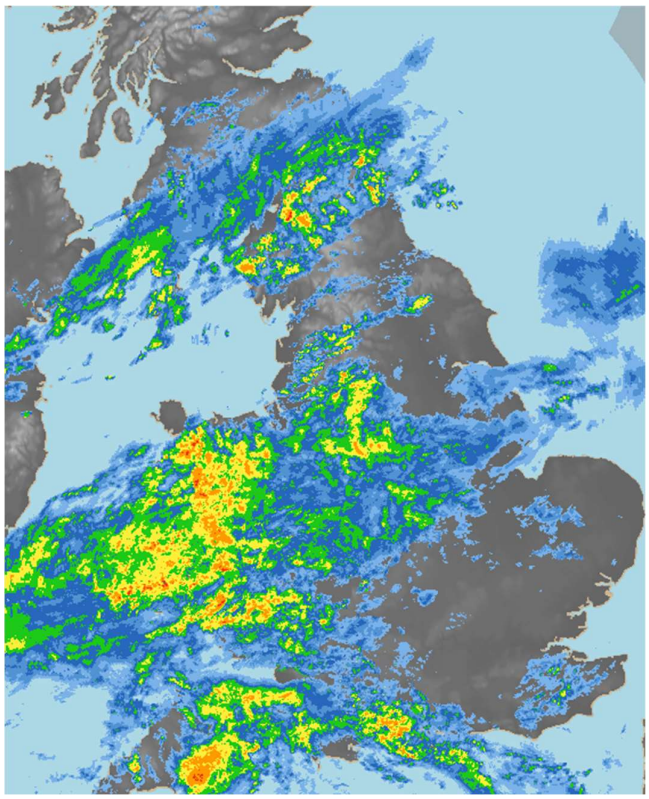
1800UTC 19 January 2021



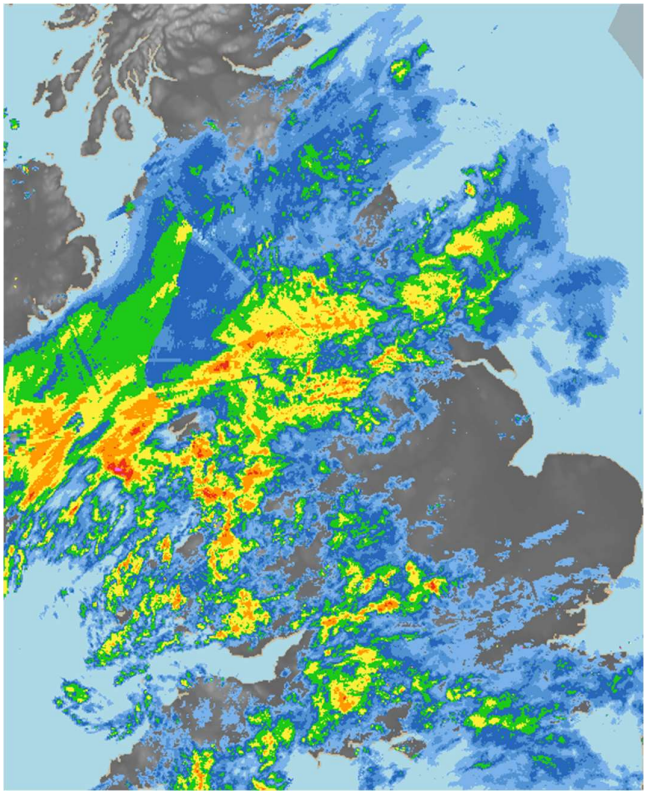
0000UTC 20 January 2021



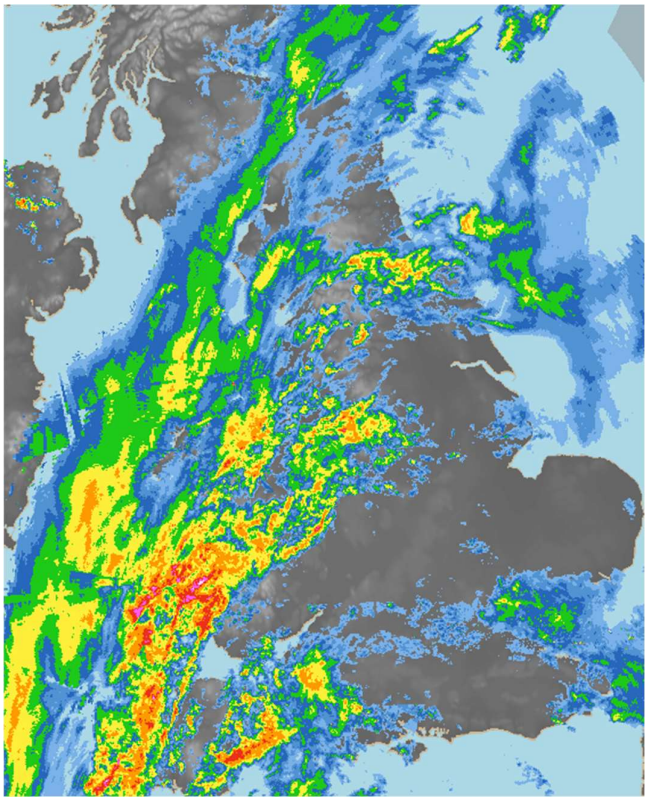
0600UTC 20 January 2021



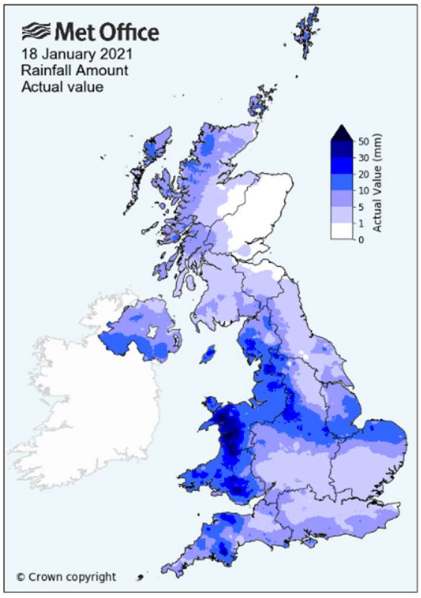
1200UTC 20 January 2021

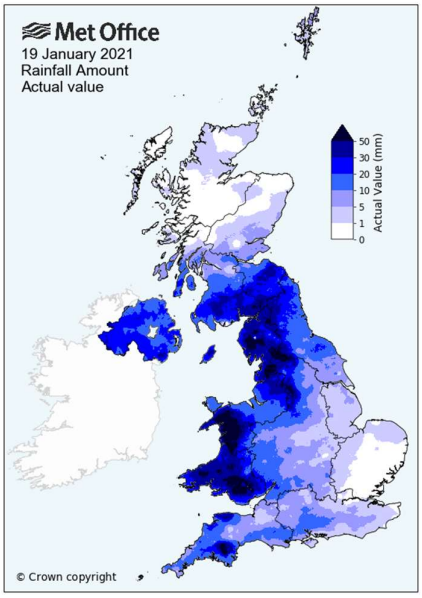


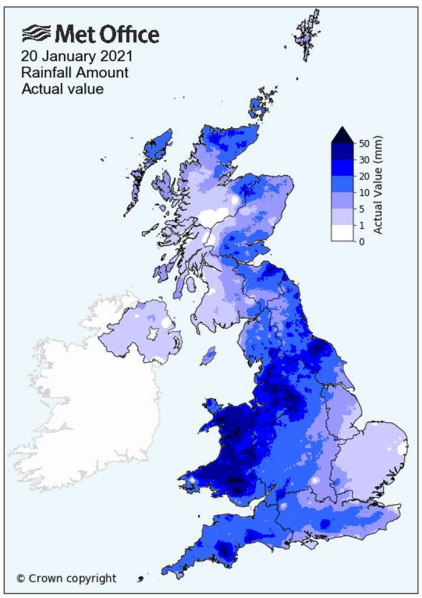
1800UTC 20 January 2021



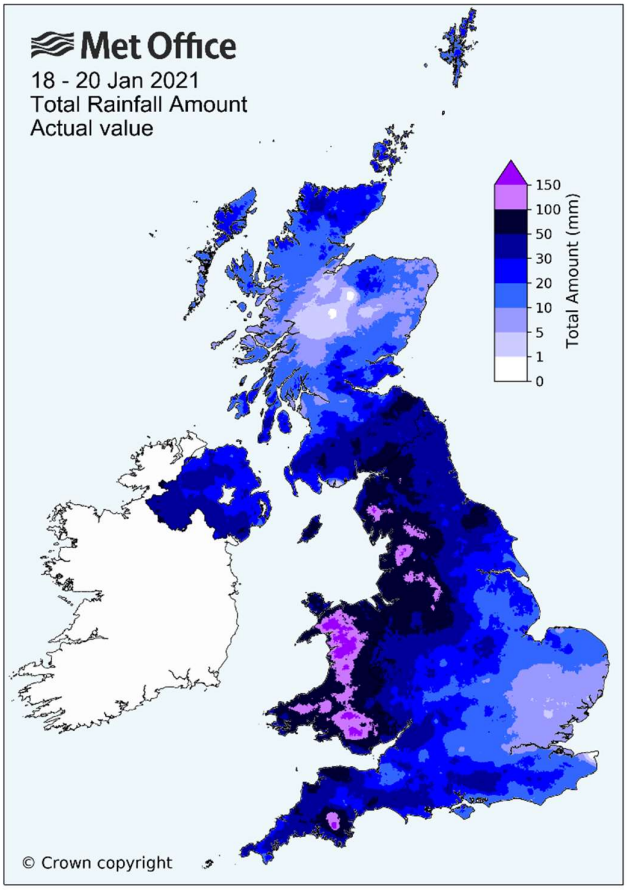
The maps below show rainfall totals for the three rain-days 18 to 20 January 2021 (0900-0900 UTC)

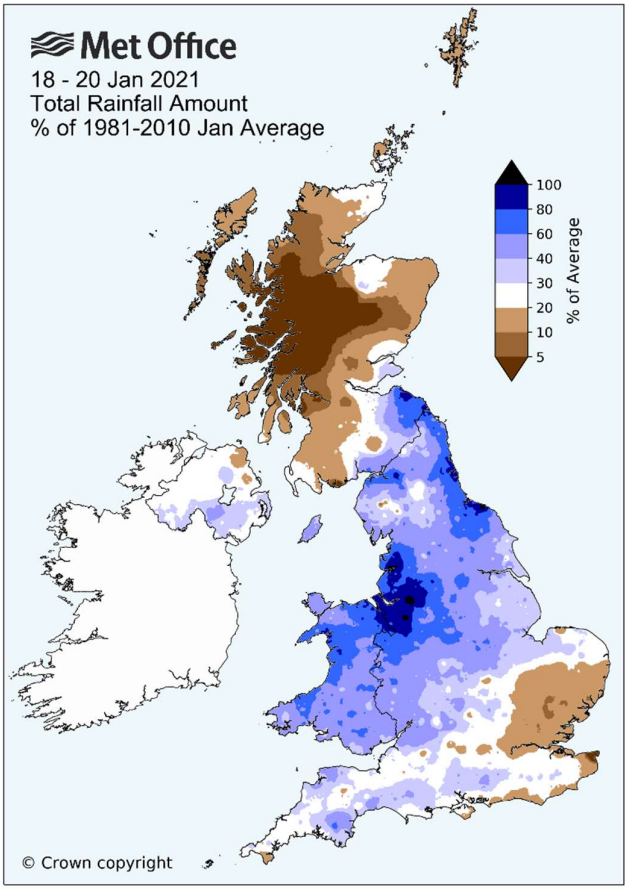




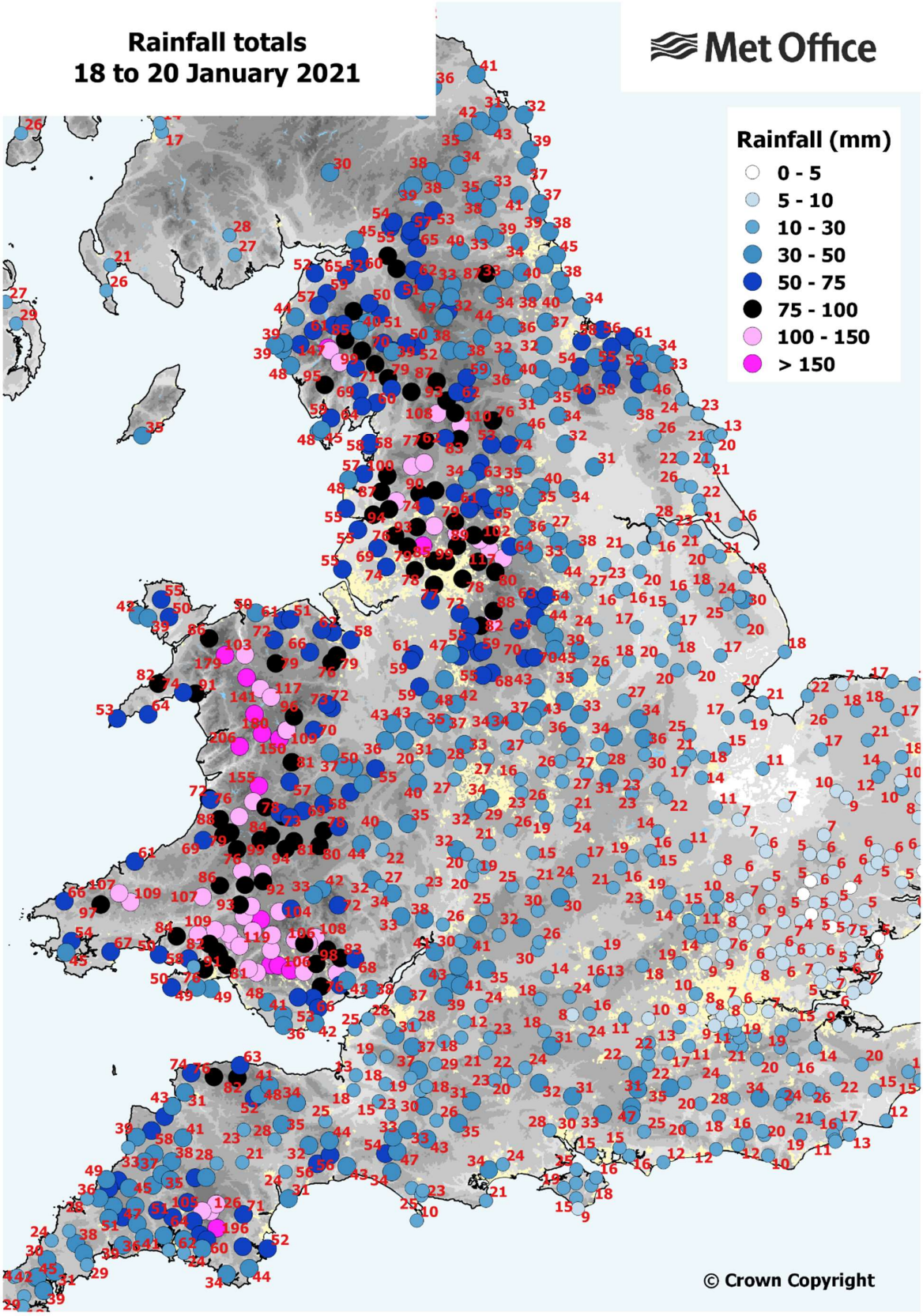


The maps below show rainfall totals from 0900UTC 18 January to 0900UTC 21 January 2021. 50 to 100mm of rain fell widely across Wales and north-west England, with over 100mm across upland areas of Wales, south-west England, the Lake District and the Pennines, and locally 150 to 200mm across the higher ground. Half of the January full-month average rain fell widely across Wales and northern England, with the whole-month average falling across parts of Cheshire, Greater Manchester, Lancashire and parts of north-east England and East Lothian.





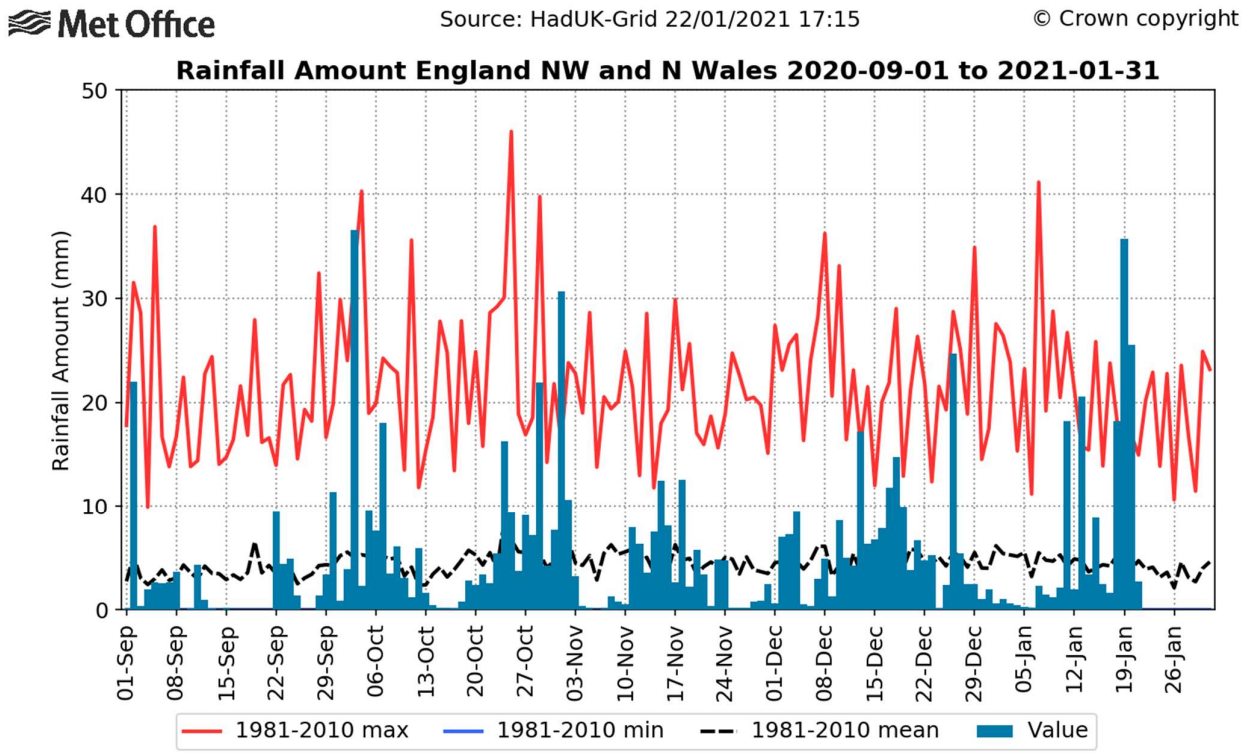
The map below shows rainfall totals recorded by the network across England and Wales from 18 to 20 January 2021 (0900UTC 18th to 0900UTC 21st).



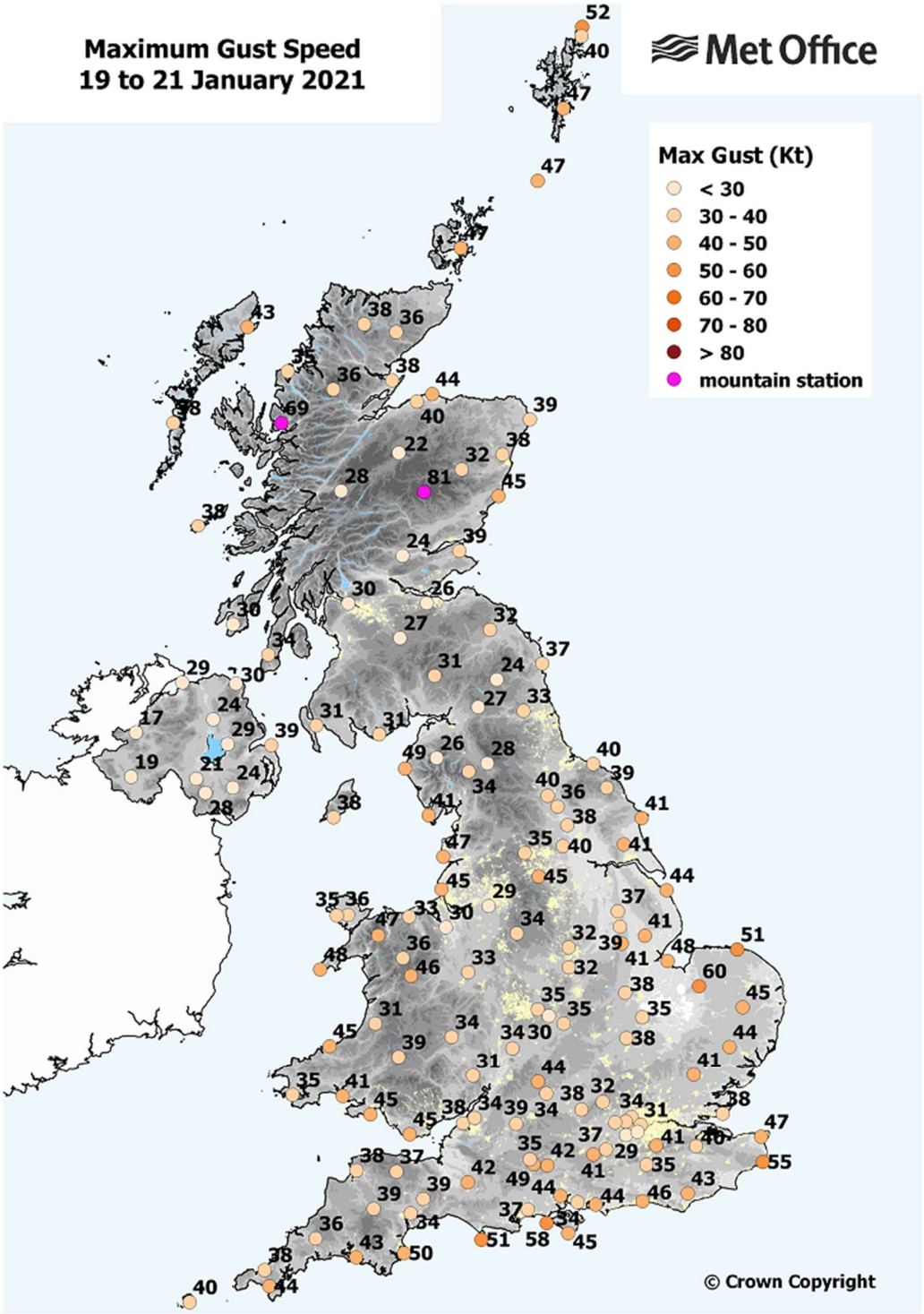
The table below lists rainfall totals at selected stations from storm Christoph.

Station	Rainfall total 18 to 20 January (mm)	January 1981-2010 long-term average (mm)	% of average
Derwent Bridge, County Durham	86.6	75.3	115
Worleston S Wks, Cheshire	61.2	54.2	113
Preston Moor Park, Lancashire	94.4	93.4	101
Sale, Carrington Lane, Greater Manchester	76.6	77.2	99
Audlem, Mere Farm, Cheshire	59.1	60.1	98
Nantwich, Reaseheath Hall, Cheshire	59.2	61.9	96
Hawarden Airport, Clywyd	57.8	60.0	96
Denton Resr, Greater Manchester	78.2	82.8	94
Prestbury S Wks, Cheshire	71.9	77.4	93
Myerscough, Lancashire	87.0	96.8	90
Rochdale, Greater Manchester	98.6	112.2	88
Ruthin, Clywd	65.6	75.1	87
Westerdale, North Yorkshire	66.4	77.1	86

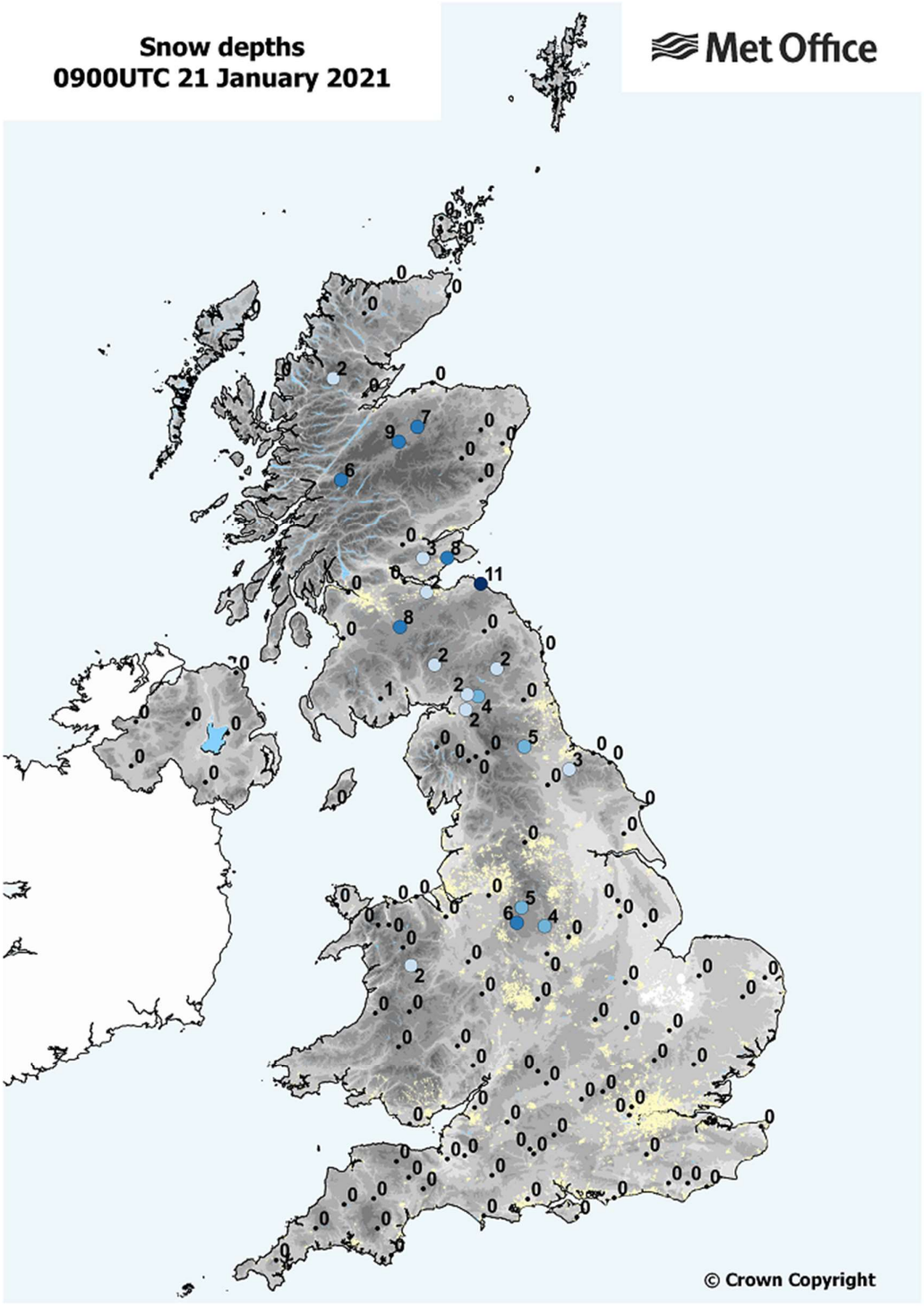
The chart below shows area-average daily rainfall totals across north-west England and North Wales from September 2020 to January 2021. This region experienced three consecutive very wet days from 18 to 20 January with area-average rainfall totals of 18.2mm, 35.7mm and 25.5mm – overall 79.4mm making this provisionally the wettest 3-day period on record for this region in a series from 1891 – marginally wetter than 3 to 5 December 2015 (78.2mm) – the latter including the record-breaking rainfall from storm Desmond.



The map below shows maximum gust speeds across the UK from 19 to 21 January 2021. Storm Christoph was named for the potential impacts from the heavy rainfall and flooding, but nevertheless there were some strong winds, particularly across eastern England with Marham (Norfolk) recording a gust of 60Kt (69mph) overnight 20th to 21st as the low moved east across the UK.



As the low moved into the sea, it intensified, drawing a cold northerly airflow to north-eastern parts of the UK bringing snow across upland areas of north-east England and eastern Scotland on 21 January, with strong winds leading to blizzard conditions at times over high ground. The map below shows snow depths at 0900UTC on 21 January 2021. Depths included 11cm at Dunbar, East Lothian, 8cm at Baintown, Fife and 5cm at Copley, County Durham and Buxton, Derbyshire. While lying snow is of course not unusual in mid-winter, it nevertheless contributed to the ongoing weather-related impacts from storm Christoph.



Author: Mike Kendon, Met Office National Climate Information Centre

Last updated 24/01/2021

Met Office

Severe winter weather and storm Darcy, February 2021

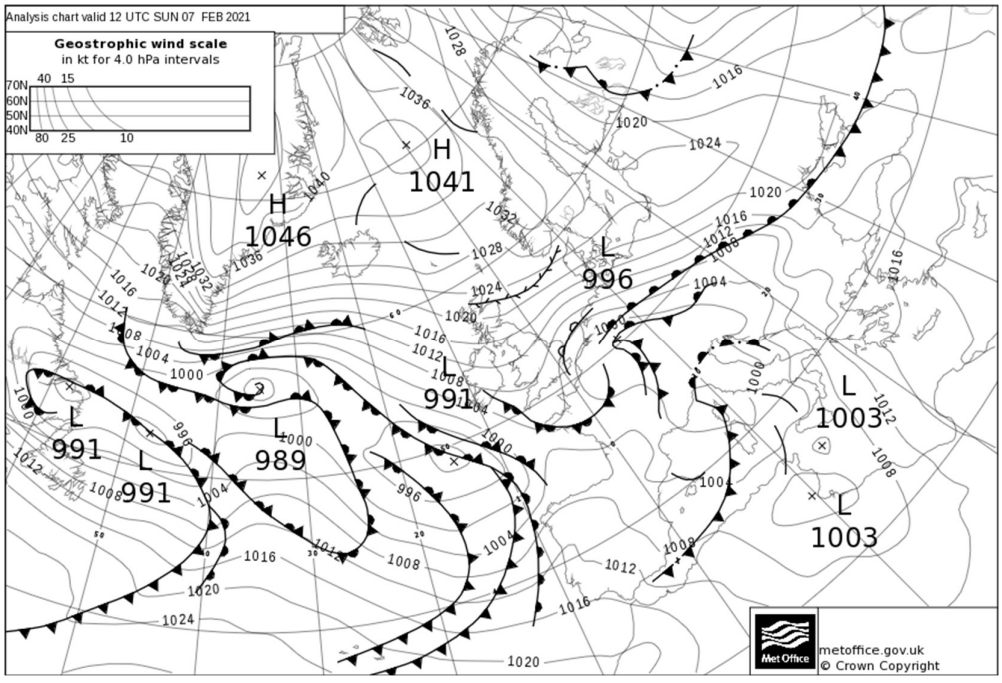
The UK experienced a week of severe winter weather from 7 to 13 February, with easterly winds drawing a bitterly cold airflow from eastern Europe. Storm Darcy brought some strong winds and heavy snow to parts of south-east England on 7th, while persistent snow showers resulted in significant accumulations across eastern England and Scotland. Daytime temperatures struggled to rise above freezing, and, combined with the wind, resulted in severe wind-chill, particularly on the exposed east coast. Much of eastern Scotland experienced deep lying snow with depths in some places of 20 to 30cm or more. 11th/12th February was a bitterly cold night with temperatures of -10 to -15°C across eastern Scotland, and three stations falling below -20°C. At Braemar, -23.0°C made this the UK's lowest temperature since December 1995.

Impacts

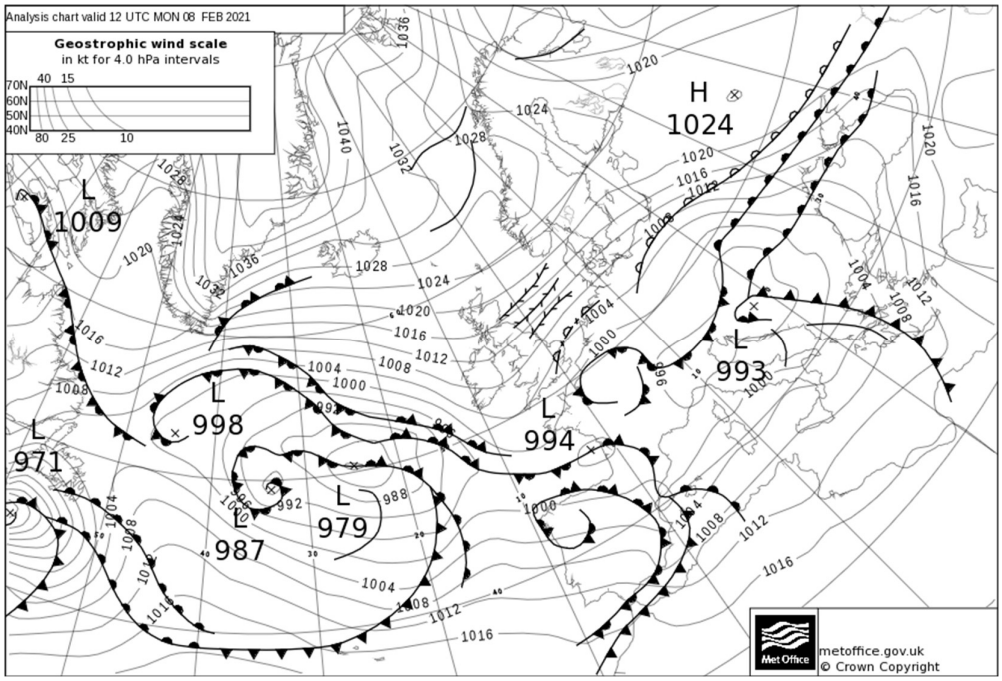
Snow and ice caused widespread travel disruption, with roads closed across many eastern coastal counties; Kent and Essex were particularly affected by deep snow. Hazardous conditions made driving conditions difficult with several accidents. There were also train cancellations. A number of schools had to close across the south-east and Lincolnshire and several Covid vaccination centres were also shut. A kitesurfer died on a beach in Suffolk. Scotland was also affected by deep lying snow, with transport disruption and school closures, and the harbour at Nairn was frozen over. There was deep lying snow across Scotland's mountains, with large accumulations and severe drifting. The Stevenson screen at the weather station at Cairngorm Chairlift (663masl) was buried in snow, and an extreme avalanche risk was reported in the Pentland Hills south of Edinburgh. Several impressive igloos were built by members of the public.

Weather data

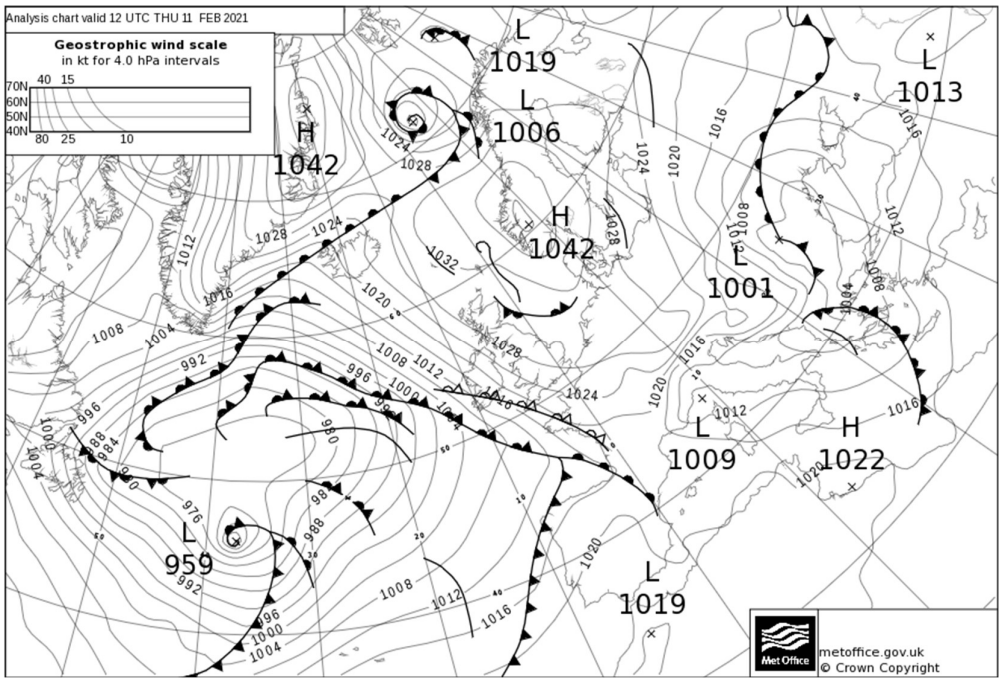
The analysis chart at 1200 UTC 7 February 2021 shows an area of low pressure (storm Darcy) located across the Netherlands bringing heavy snow and strong winds to south-east England.



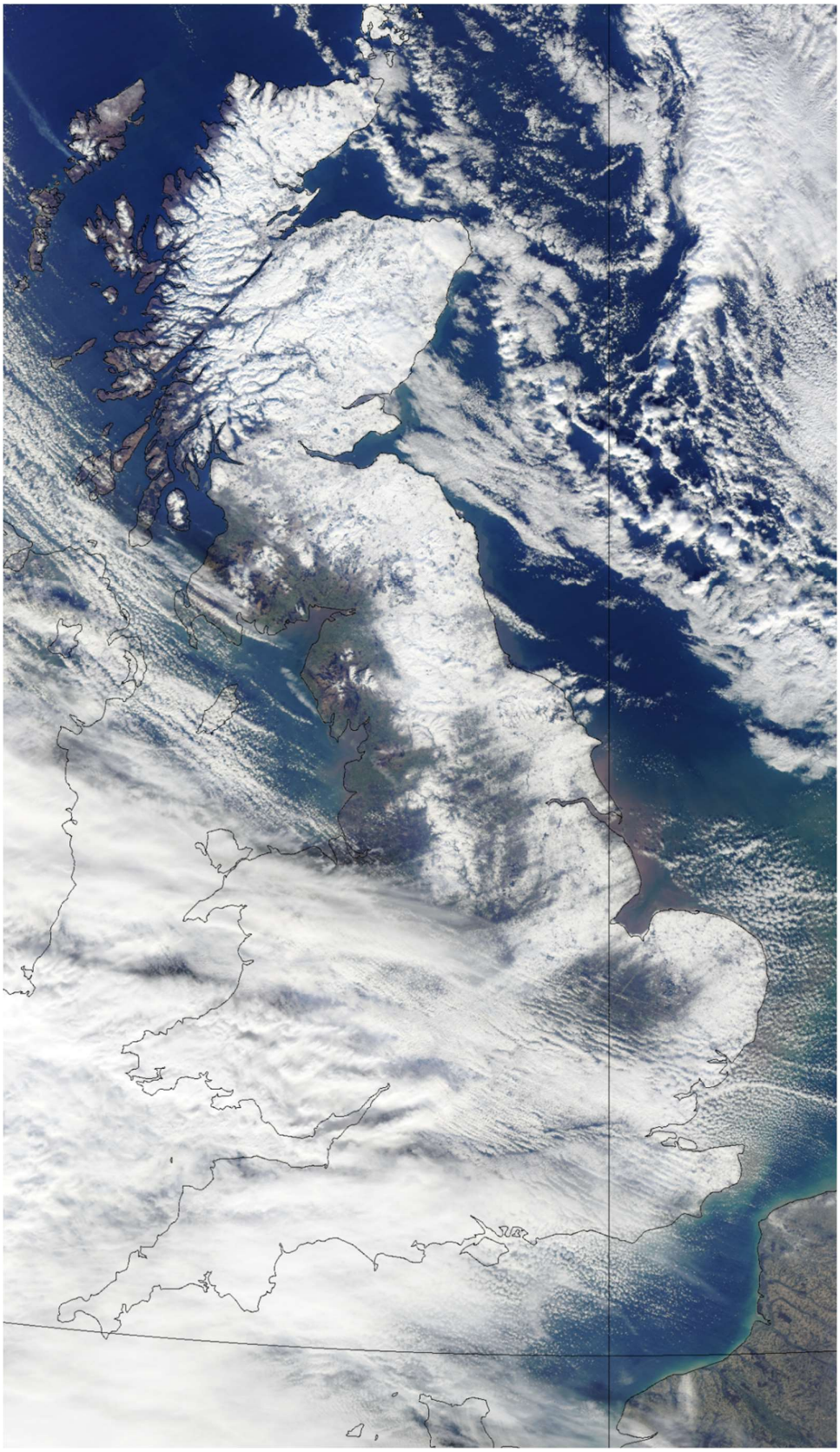
The analysis chart at 1200 UTC 8 February 2021 shows the UK in a bitterly cold easterly airstream with a persistent feed of snow showers off the North Sea affecting the east coast.



The analysis chart at 1200 UTC 11 February 2021 shows high pressure over Scandinavia extending to cover much of the UK, while frontal systems start pushing into the far south-west.

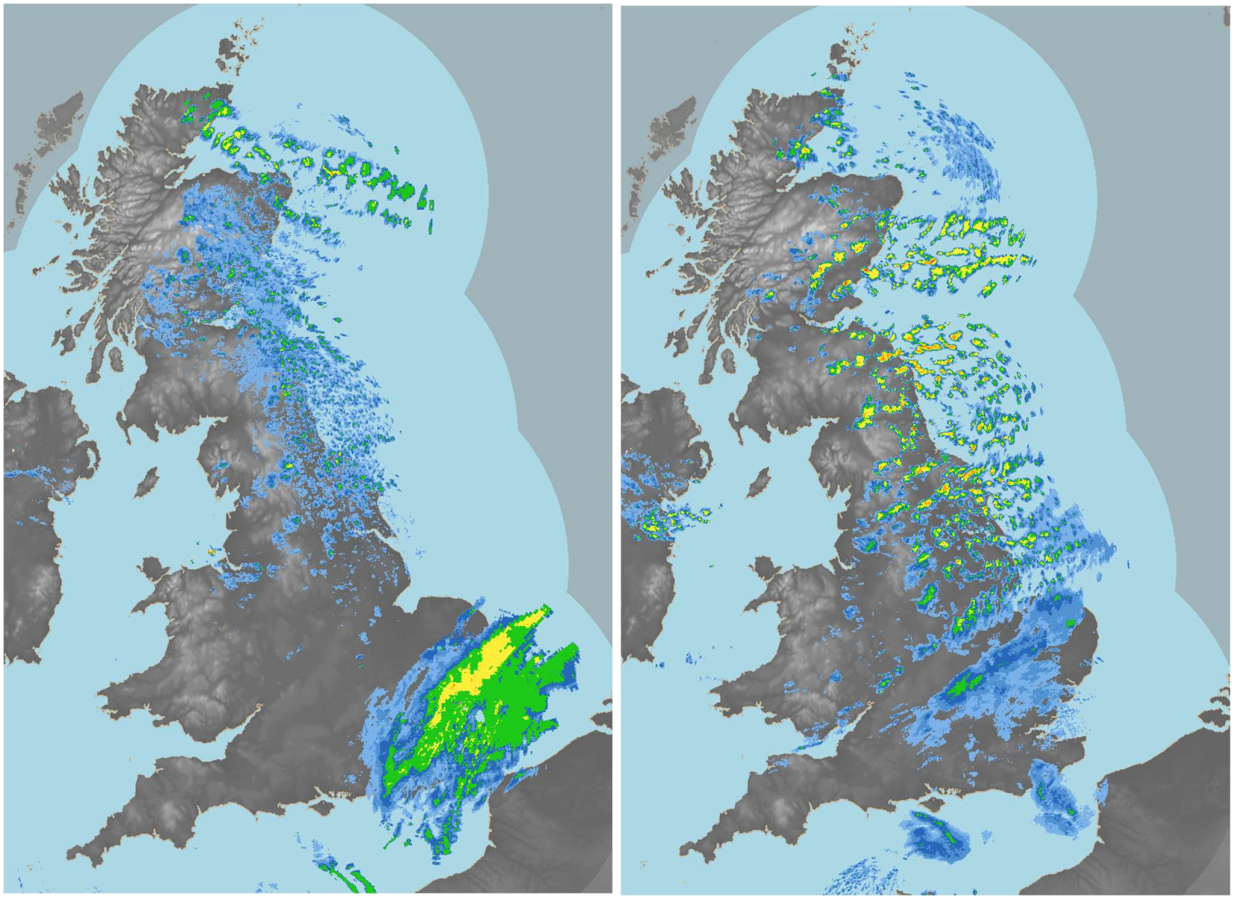


The satellite image on 11 February 2021 shows lying snow from Kent to Caithness, extending from the coast and inland across the east Midlands, Pennines and much of Scotland. Bands of snow from lines of showers in the easterly airflow can clearly be seen across Lincolnshire and Yorkshire. 11th/12th was the coldest night of the spell, with temperatures falling below -20°C in Scotland – this occurred due to a combination of clear skies, lying snow and light winds. Image copyright Met Office / NOAA / NASA.

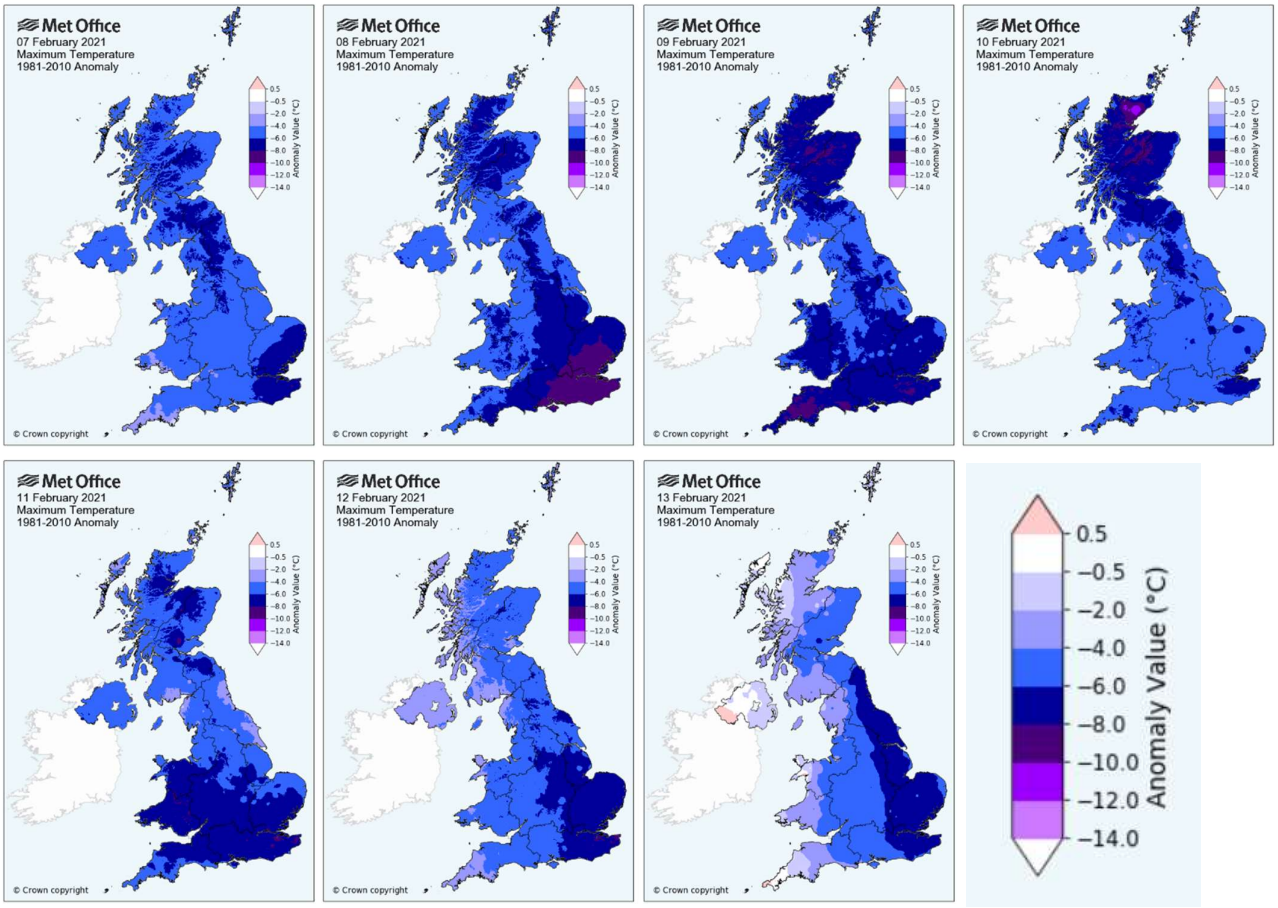


The satellite image on 11 February 2021 shows lying snow around the coastlines of the southern North Sea. Image copyright Met Office / NOAA / NASA.

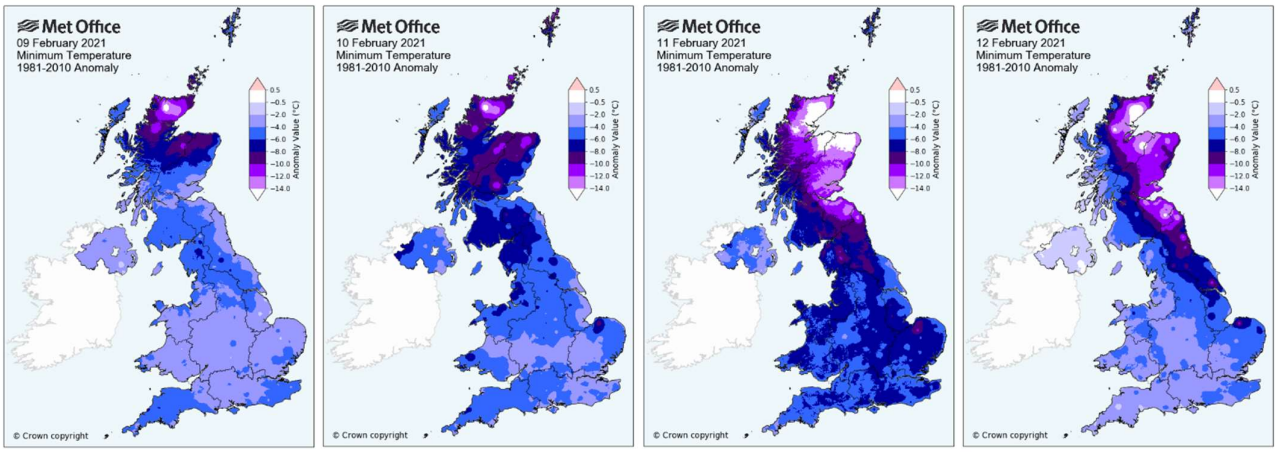
The rain-radar images at 1200 UTC 7th and 1200 UTC 8th February show heavy snow affecting south-east England, with a feed of snow showers running in off the North Sea.



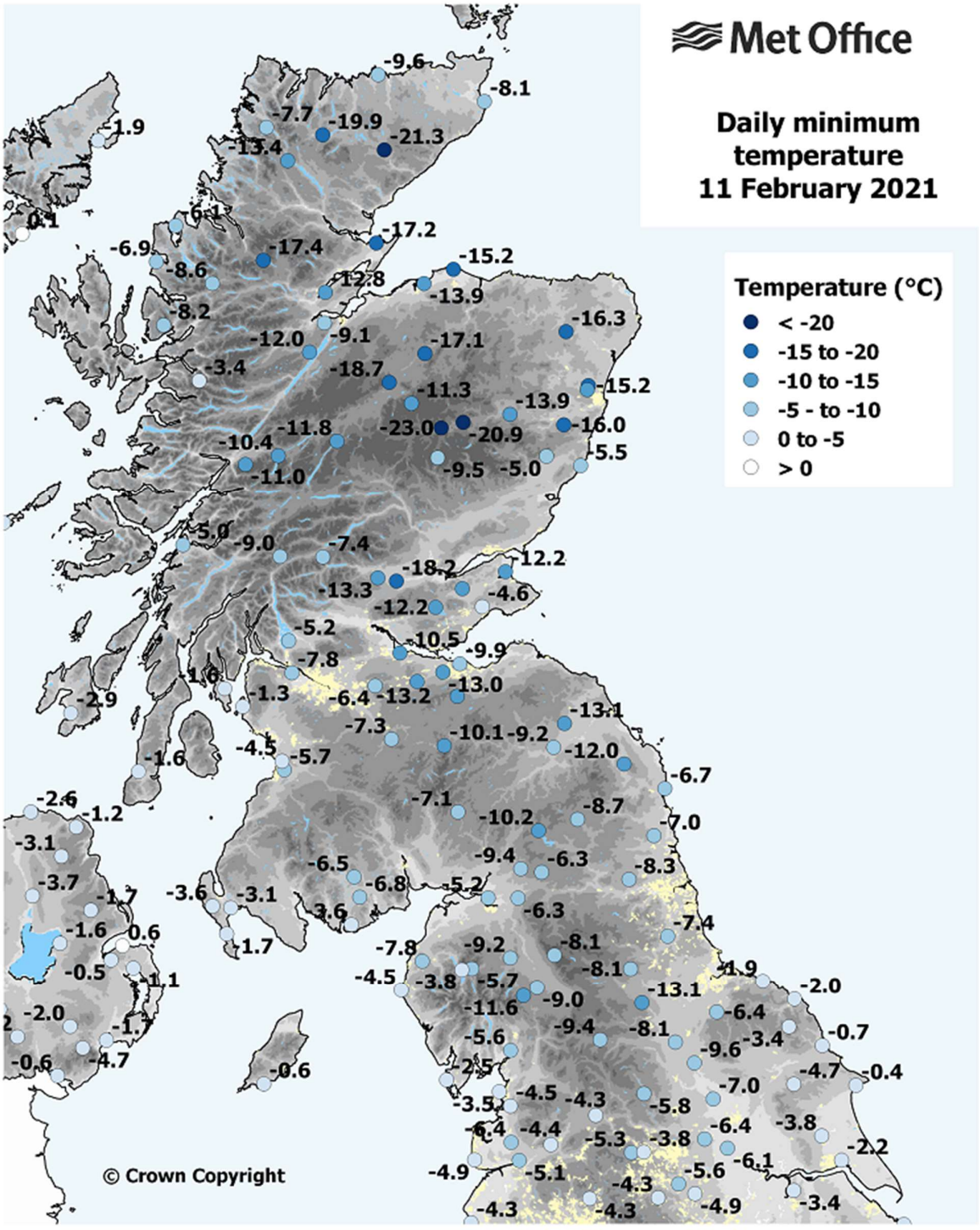
The maps below show daily maximum temperature anomalies from 7 to 13 February 2021. Temperatures were well below average throughout the UK for the week, reaching only 1 or 2°C widely. With lying snow and a strong easterly wind, 8th February was particularly cold across the south-east where temperatures remained below freezing all day – with daily maximum temperatures of -1.5°C at Rothamsted, Hertfordshire and -2.4°C at Wych Cross, East Sussex – 8 to 10°C below average for the time of year. Even central London remained below freezing with a daily maximum of -0.1°C at St James's Park.



The maps below show daily minimum temperatures from 9 to 12 February 2021. The coldest night was 11th/12th February. Temperatures fell below -5°C across most of the UK and -10 to -15°C or lower across north-east Scotland – around 14°C below average for the time of year. Only a few coastal fringes in the west and south escaped a frost. Daily minimum temperatures are observed from 0900 to 0900 UTC and since the lowest temperatures occurred around 0900 UTC, this accounted for the very low temperatures on both 11th and 12th.



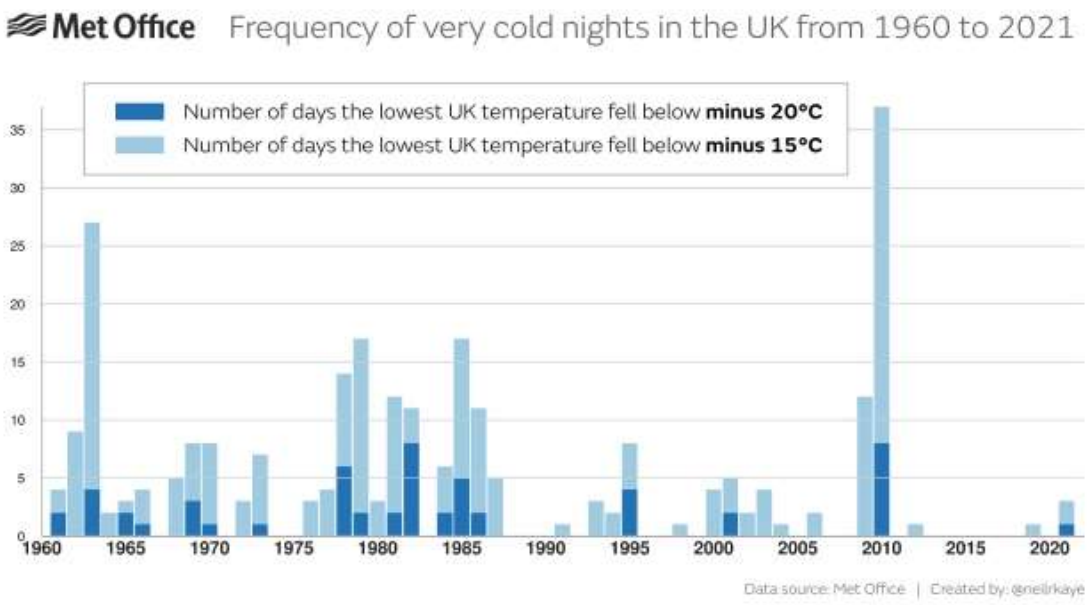
The map below shows daily minimum temperatures across Scotland and north-east England on 11 February 2021. Minima were widely -5 to 10°C across northern England, while it was an exceptionally cold night across eastern Scotland. The provisional daily area-average minimum temperature for eastern Scotland was -12.3°C making this the coldest night here since 3rd December 2010 (-13.5°C). Three stations fell below -20°C: -20.9°C at Balmoral and -23.0°C at Braemar (both Aberdeenshire) and -21.3°C at Kinbrace, Sutherland. Temperatures fell well below -10°C even on the coast, with -17.2°C at Tain Range, Cromarty, -15.2°C at Lossiemouth, Moray, -15.2°C at Dyce, Aberdeen, -12.2°C at Leuchars, Fife and -13.0°C at Edinburgh, Gogarbank. Several stations in this area recorded their coldest February night since 1978 and at Lossiemouth it was the coldest February night in a 69-year record.



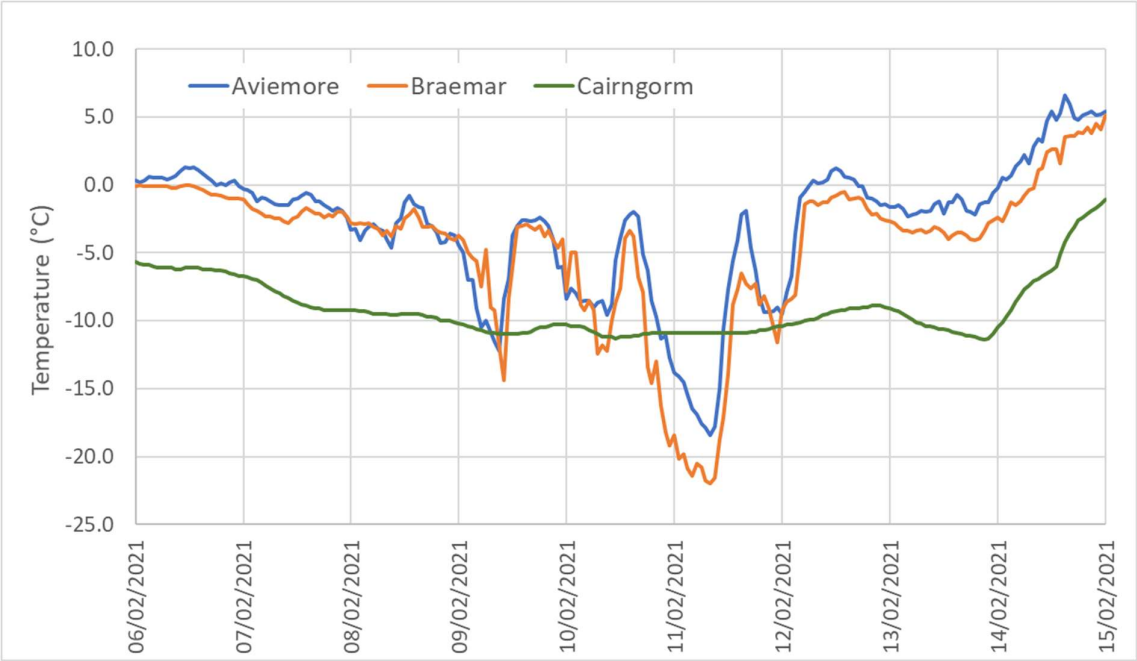
The lowest temperature of the spell, -23.0°C at Braemar, was the UK's lowest temperature since -27.2°C at Altnaharra, Sutherland on 30 December 1995 (the UK's equal-lowest temperature on record). Ravensworth (North Yorkshire) recorded a minimum of -15.3°C on 12th (this occurring after 0900 UTC on 11th) – making this England's lowest temperature since 11 February 2012.

Temperatures below -20°C are comparatively unusual in the UK, having last occurred in 2010, 2001 and 1995, while in recent years -15°C has also been unusual. The figure below counts the number of days by year from 1961 with at least one station recording -15°C and -20°C or lower. In both cases there were generally more days in the years from 1961 to the mid-1980s compared to the second half of the series. In 1982 there were over 50 observations of -20°C across England and Scotland in a bitterly cold spell between 7th and 15th January, while in 1995 there were over 30 observations of -20°C across Scotland from 28th to 30th December. In 2010 there were several spells of severe winter weather with -20°C recorded in both January and December and -15°C recorded on 37 separate days in January, February, March, November and December.

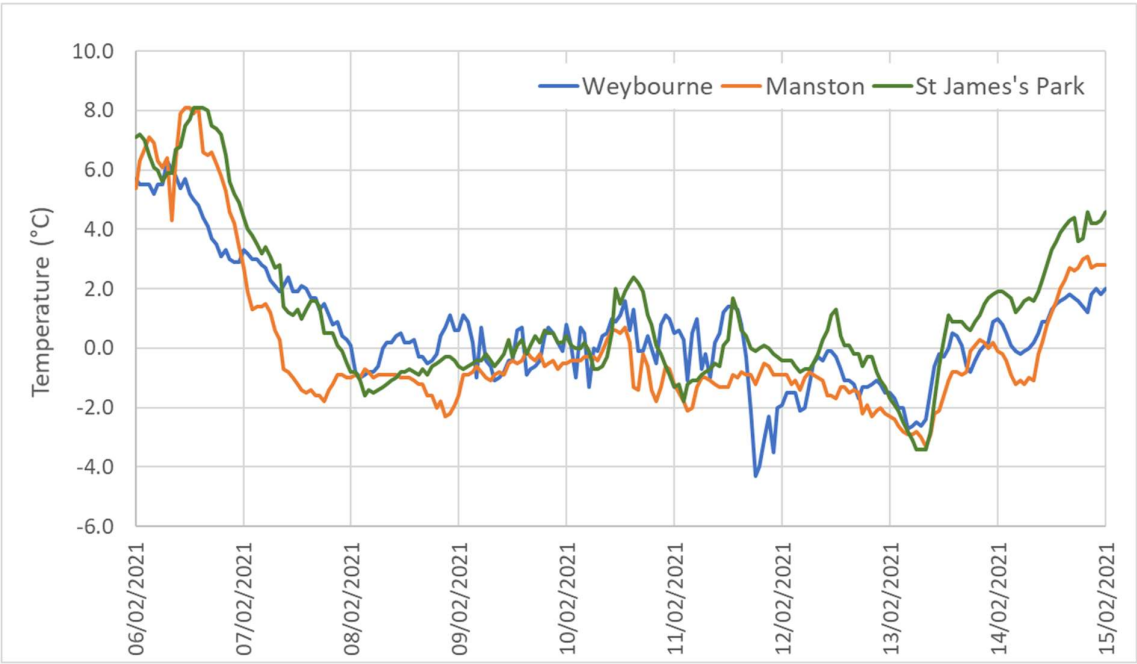
More than 30 stations across the UK recorded minimum temperatures below -10°C on 11 February 2021, making this the most widespread severe frost since February 2012.



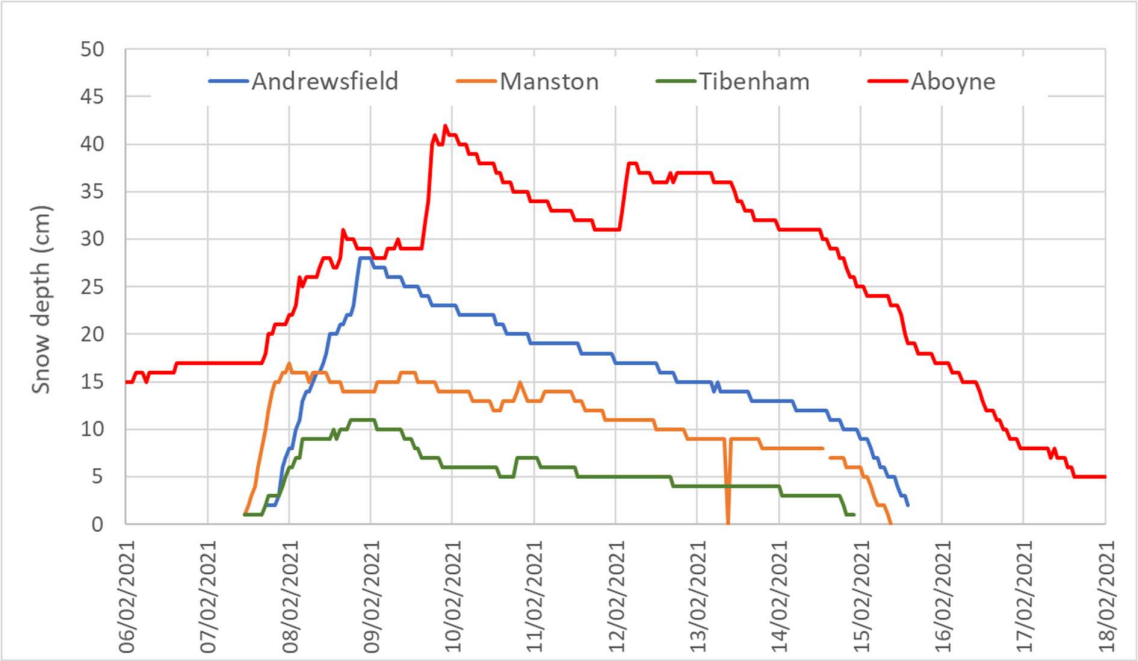
The figure below shows hourly air temperature at Aviemore (Inverness-shire), Braemar (Aberdeenshire) and Cairngorm summit (1237masl) through the spell. Temperatures at Braemar fell below -10°C for four consecutive nights, with the coldest night 11th/12th falling below -20°C, and daytime temperatures remaining well below freezing. By contrast the air temperature at Cairngorm summit remained relatively steady at around -10°C.



The figure below shows hourly air temperature at Weybourne (Norfolk), Manston (Kent) and St James's Park (London). Note the different y-axis scale. In contrast to Scotland, temperatures across south-east England remained generally close to 0°C, with the easterly wind tending to mostly suppress the diurnal temperature variation. There were particularly strong easterly winds at the start of the spell, especially on exposed eastern coasts, with Weybourne recording a maximum gust of 48Kt (55mph) on the 7th. Winds inland gusted widely at around 20 to 30Kt (23 to 35mph) resulting in severe wind-chill and drifting of lying snow.



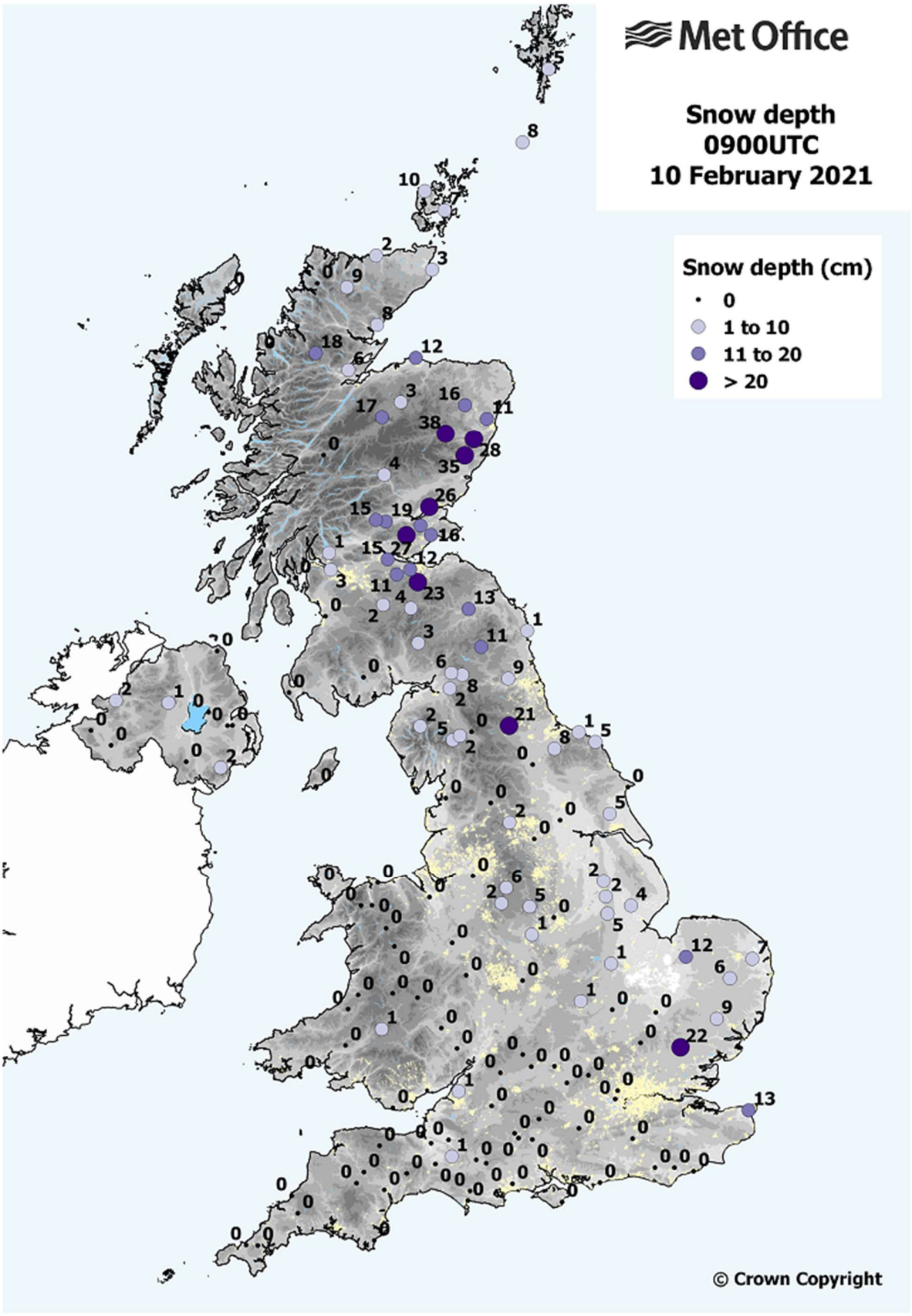
The figure below shows hourly snow depths at three stations across the south-east: Manston (Kent), Andrewsfield (Essex) and Tibenham (Norfolk), and also Aboyne (Aberdeenshire). 10 to 20cm fell at these locations in the south-east on 7th and 8th, with this lying largely un-melted until the 15th. At Aboyne, persistent snow showers led to a much greater depth of snow, exceeding 30cm from 8th to 15th, with a maximum depth of 42cm.



The figure below shows snow depths on 10 February 2021. Parts of Kent and East Anglia recorded depths of 15 to 20cm or more from the heavy snow of 7 February, but snow depths up the east coast were more typically 5 to 10cm. The deepest lying snow was across Scotland around Edinburgh, Fife, Angus, Kincardineshire and Aberdeenshire with depths of 20 to 30cm or more, including 38cm at Aboyne, Aberdeenshire, 35cm at Fettercairn, Kincardineshire, 26cm at Mylnefield, Angus and 23cm at Penicuik, Mid-Lothian. There was also deep lying snow parts of across the north Pennines with 21cm at Copley, County Durham. However, most central and western parts of the UK sheltered from the east remained snow free.

This was the UK's most severe spell of wintry weather since the 'Beast from the East' event of late February to early March 2018. Although minimum temperatures fell lower during February 2021, daily maximum temperatures were generally lower during the 2018 event with 'ice-days' (the temperature remaining below 0°C all day) more widespread – particularly on 28 February and 1 March 2018. In 2018 the snow was also generally much more widespread and deeper, with significant depths across Wales, central southern and south-west England. There was also a brief spell of widespread snow and low temperatures which caused disruption in late January / early February 2019.

7th to 13th February 2021 was a notable spell of severe wintery weather – particularly in comparison to several very mild winters in the last few decades, but would not be considered exceptional compared to long-term climate records, less severe than 2018 and very much less severe than the exceptional freezing weather of December 2010.



Author: Mike Kendon, Met Office National Climate Information Centre

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Met Office

Extremes of temperature, March and April 2021

The UK experienced a brief spell of unusual warmth at the end of March with temperatures across England and Wales widely reaching 20 to 22°C. 24.5°C was recorded at Kew Gardens, Greater London on 30th March, only the third day on record with a UK March temperature exceeding 24°C. Many long-running stations recorded their warmest March day on record, while Scotland recorded its equal-highest March daily minimum temperature.

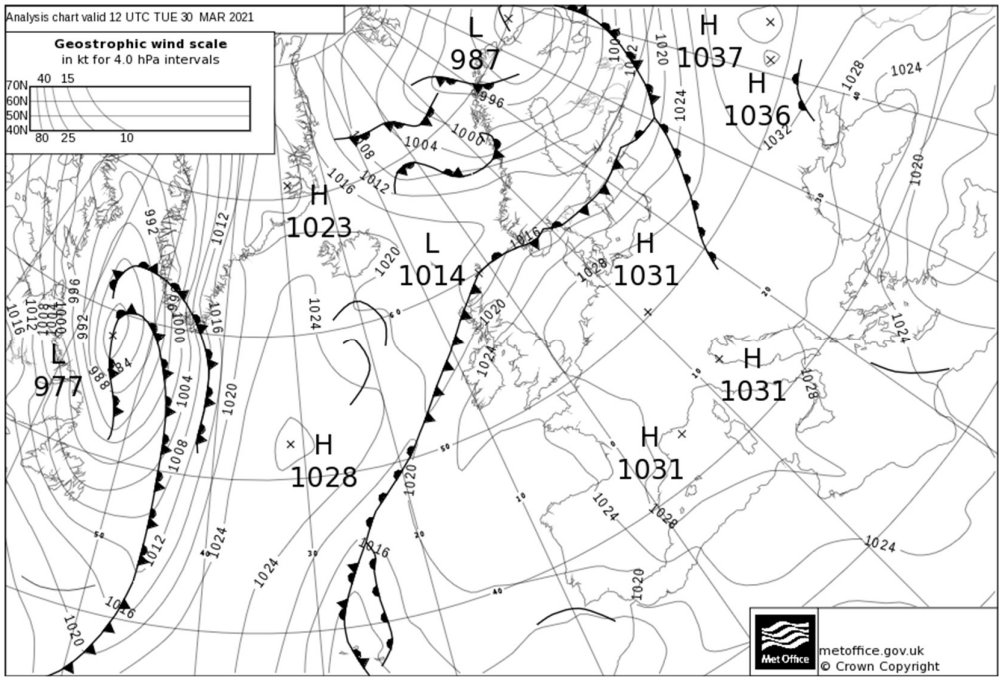
The warmth of late March was followed by a cold plunge in early April as a brisk northerly airstream brought a cold Arctic Maritime airmass across the UK, accompanied by wintry showers. Daily maximum temperatures were 6 or 7°C across much of the UK (in places a fall of 15°C in the space of a week) and only 2 or 3°C across northern Scotland. A strong northerly wind also brought significant windchill to exposed coastal areas. There were some widespread hard frosts with temperatures falling below -5°C and several stations recording their lowest April temperature for over 40 years. There was also lying snow across much of northern Scotland, with snow depths of several cm as far south as the Peak Districts and some snow reported across parts of southern England.

Impacts

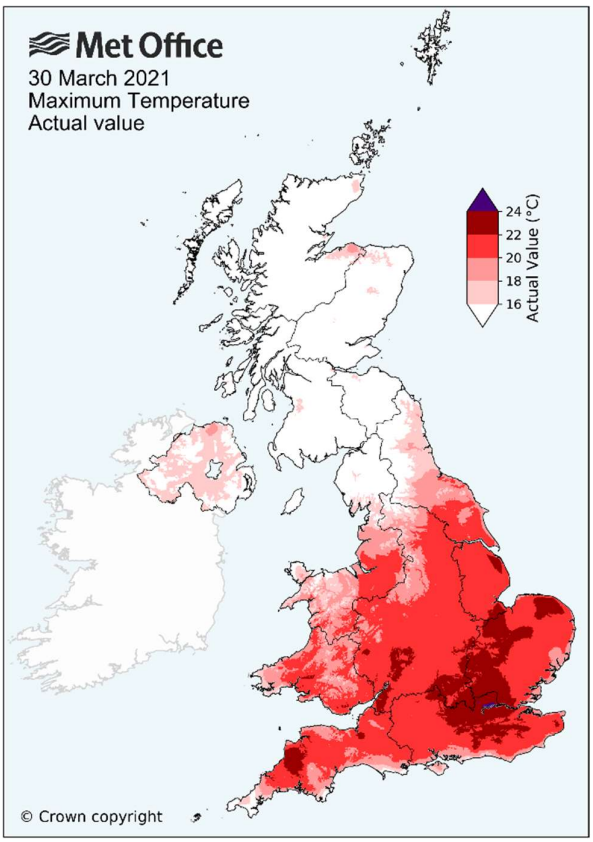
The warmth and sunshine coincided with the government ending its ‘stay at home’ guidance across England. Many people gathered in parks and beaches where there were reminders to people to maintain social distancing due to the ongoing coronavirus pandemic. Lying snow caused some disruption to motorists in early April in parts of North Yorkshire and Teeside and there was also some travel disruption from the wintry weather across Scotland including ferry cancellations.

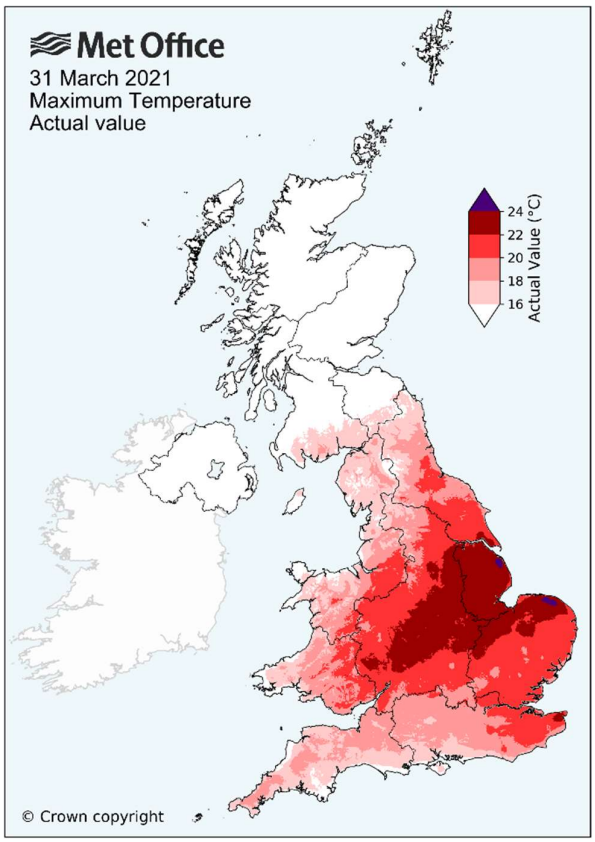
Weather data

The analysis chart at 1200UTC 30 March 2021 shows the UK in a light southerly airflow from the near continent accompanied by clear skies and warm sunshine.



The maps below show daily maximum temperatures on 30 and 31 March 2021. 20°C was exceeded widely across England and Wales with 22°C reached across some areas – approximately 12°C above the 1981-2010 long-term average for March. The highest temperature was 24.5°C at Kew Gardens (Greater London) on the 30th. This was only the third day in March in UK climate station records where a temperature of 24°C has been reached in the UK. The previous dates were 29 March 1965 and 29 March 1968 – with the March record of 25.6°C set at Mepal, Cambridgeshire on 29 March 1968.



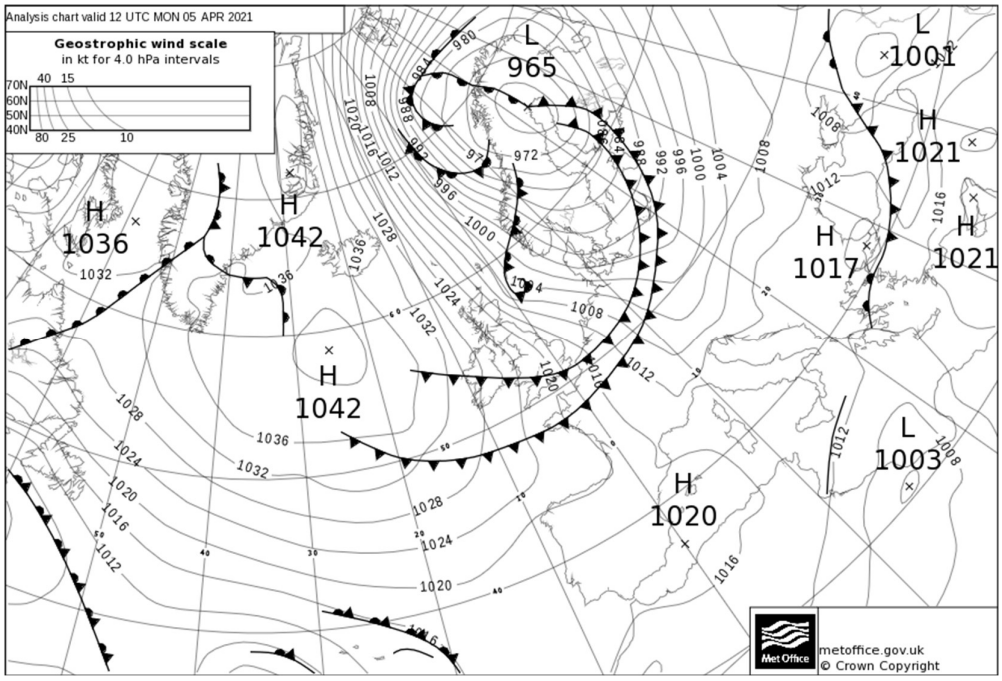


The table below lists long-running stations which recorded their highest March temperature on record (including several with 100+ year record lengths). Many other stations with 50+ year records also recorded their highest March temperature.

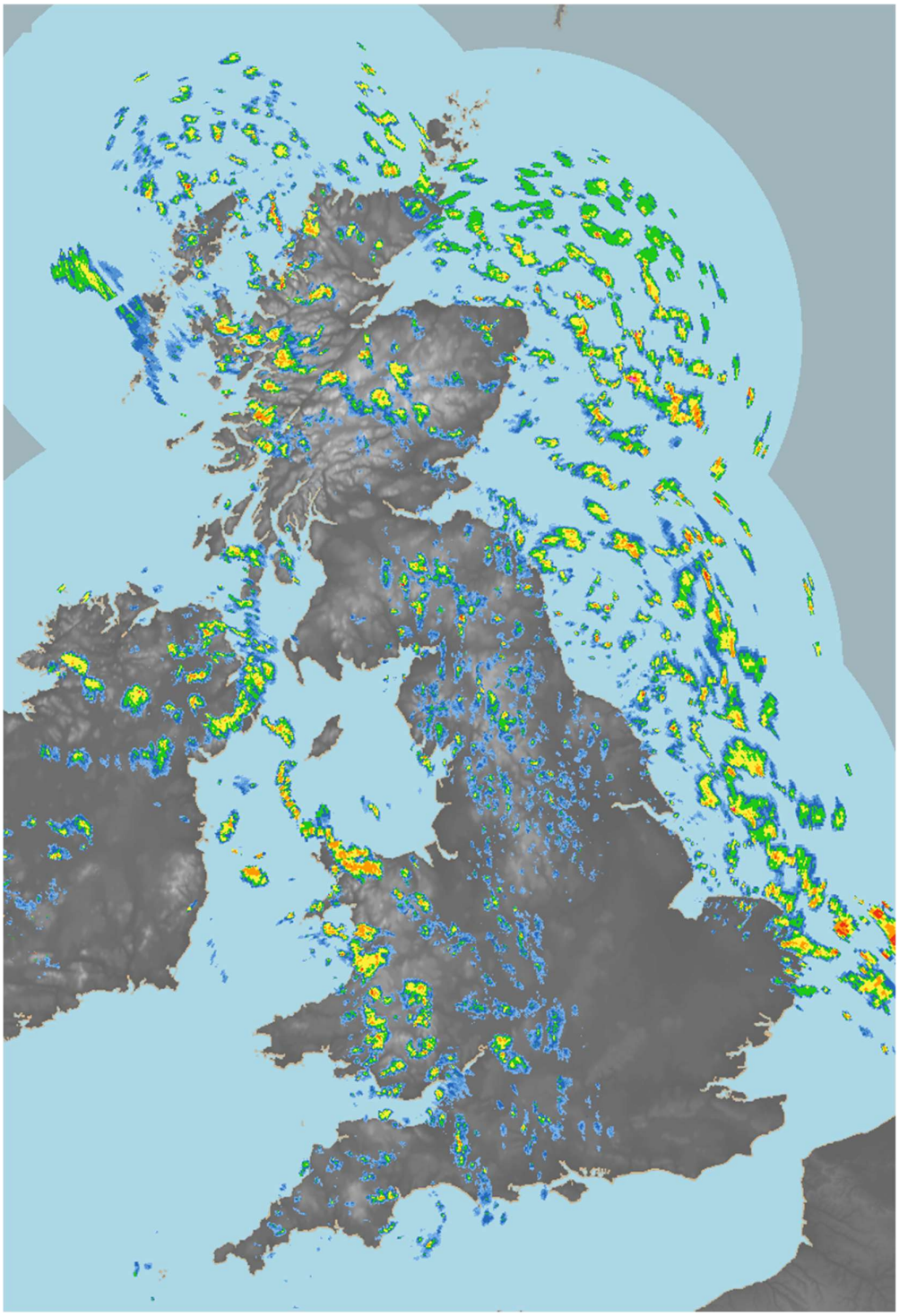
Station	Daily maxtemp (°C)	Date	Previous record (°C)	Previous date	Record length (years)
Oxford	22.6°C	30th	22.2°C	29-03-1965	168
Wisley, Surrey	23.5°C	30th	22.8°C	29-03-1965	107
Rothamsted, Hertfordshire	22.3°C	30th	22.2°C	29-03-1968	107
Cranwell, Lincolnshire	23.2°C	31st	22.2°C	28-03-1965	105
Bude, Cornwall	23.4°C	30th	21.1°C	28-03-1968	93
Sutton Bonington, Nottinghamshire	22.9°C	31st	22.7°C	13-03-2008	92

Daily minimum temperatures also remained unusually high – above 10°C – across Northern Ireland and parts of Scotland on 30th March. Kinloss, Moray recorded a daily minimum temperature of 12.7°C – Scotland's equal-highest March daily minimum temperature on record (shared with Benmore, Argyll on 9 March 1948).

After the warmth at the end of March, the UK experienced a plunge of bitterly cold arctic air in a strong northerly airstream in early April, accompanied by wintry showers and lying snow across high ground – falling to lower levels across northern Scotland. The analysis chart below at 1200UTC 5 April 2021 shows cold fronts sweeping south across the UK.

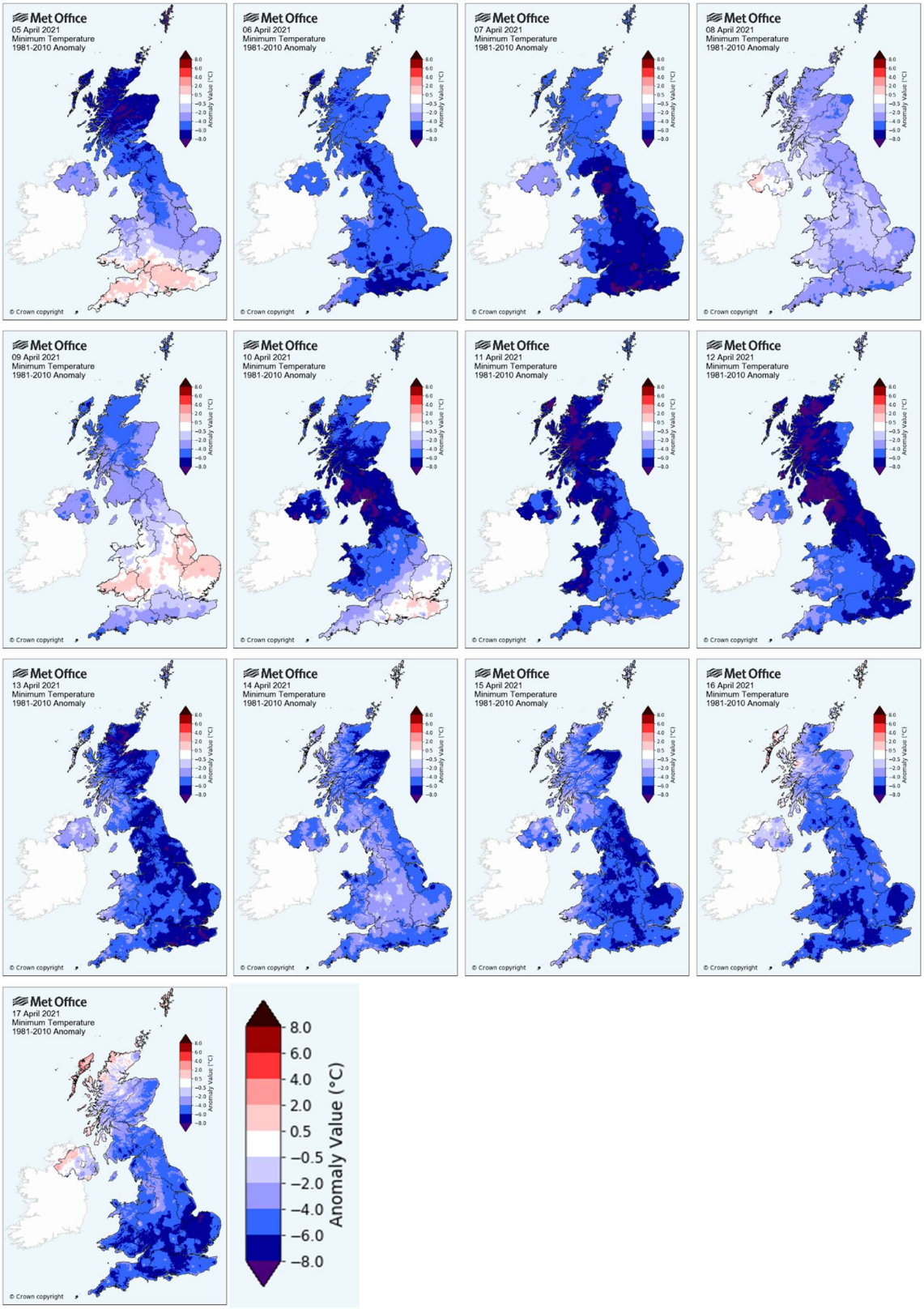


On 5 April lying snow depths included 5cm at Lerwick, Shetland, 7cm at Kirkwall, Orkney, 5cm at Oyne, Aberdeenshire and Loch Glascarnoch, Highland, while on 11 April there was 4cm at Buxton, Derbyshire and 3cm at Leek, Thorncliffe, Staffordshire. The rain-radar image below at 1200UTC on 6 April 2021 shows wintry showers in a northerly airflow affecting Scotland, Northern Ireland, North Sea and Irish Sea coasts, with a run of showers through the North Channel affecting North Wales.

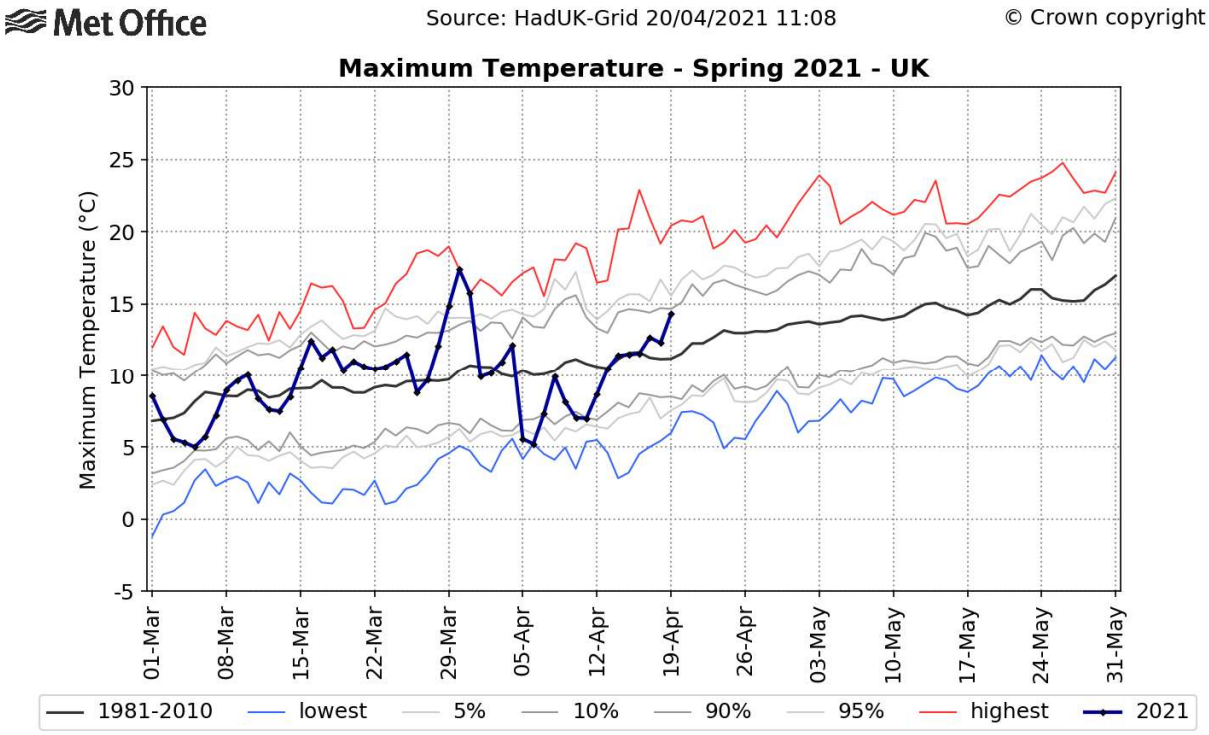


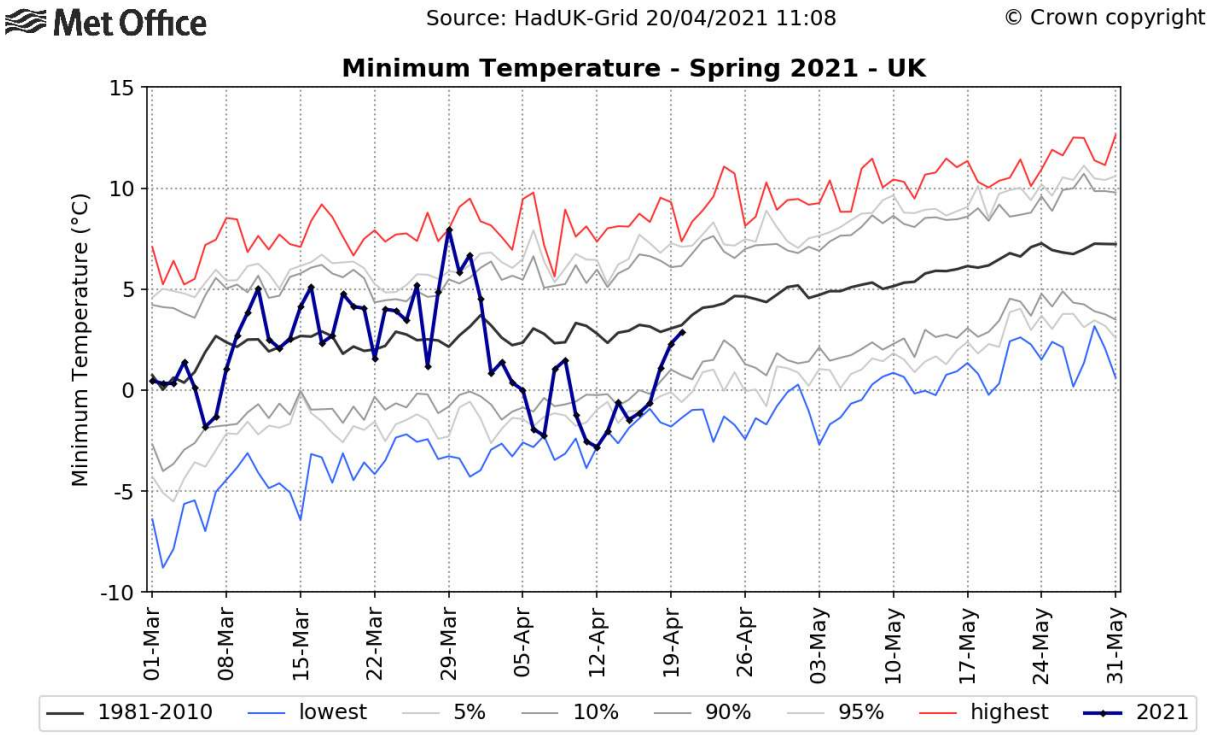
On 5 April, Lerwick, Shetland recorded a daily maximum temperature of 1.1°C, and a daily minimum of -5.2°C, the lowest April daily maximum and minimum temperatures at this station for over 50 years. The low temperatures and snow were accompanied by a northerly wind gusting at over 50Kt (58mph) leading to severe wind-chill. Several other stations recorded their lowest April temperatures for over 40 years.

The maps below show daily minimum temperatures from 5 to 17 April 2021 relative to the 1981-2010 April long-term average – a run of notably cold April nights with widespread hard frosts at times and temperatures locally more than 8°C below average for the time of year.



The time-series below shows UK area-average daily maximum and minimum temperatures for spring 2021, illustrating the contrast between the unusually high temperatures for the time of year in late March followed by unusually low temperatures in early April – a fall of almost 10°C in the UK area-average daily values in the space of a only a week.





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Met Office