

Sussex Annual Air Quality Alert Service Report 2022 Sussex Air Quality Partnership / East Sussex County Council

August 2023



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Executive Summary

Bureau Veritas UK Ltd has been commissioned by East Sussex County Council on behalf of the Sussex local authorities (who collectively form the Sussex Air Quality Partnership) to provide and manage the Air Quality Alert service for Sussex.

This report provides an overview of the Alert Service during 2022.

The Sussex Air Pollution Alert Service

Sussex has been operating an air pollution Alert service for over a decade. The Alert service was established to provide air pollution alerts direct to vulnerable people and the public to inform those people (and their carers where relevant) of air pollution episodes that may impact on their health.

2022 Alert Service

A new Sussex Alert service was started in March 2022 with air pollution forecasts provided from the Met Office. The Alert service has been in place for a number of years prior to March under contract between the Partnership and Imperial College (as previous holders of the contract). The service was enhanced from March 2022 to provide a more detailed forecasting service to over 30 locations across Sussex, a higher spatial resolution than the previous regional approach, which focused on three broad sub-regional areas. As a result of the wholesale review, the service was updated regarding GDPR compliance on data privacy, and further improvements were made on accessibility.

Service users

During 2022, the service provided alerts to over 550 users with over 9,000 air pollution alerts being issued over the period from March to December 2022. There were between 15 and 18 forecasted days when 'moderate', 'high' and 'very high' pollution levels were made in 2022, depending on the location of the subscribed Alert area in Sussex.

Air Pollution Forecasts

The air pollution forecast data, which is sourced from the Met Office, was compared to measured data from the Sussex network to ascertain the accuracy of the forecasts. The service provided Alerts to 31 locations across Sussex. Each location was provided with an individual forecast which varied from site to site. Overall, most forecasts (at 94%) were for 'low' air pollution with only 5% of forecasts provided at 'moderate' levels and 0.6% (or 1-2 forecast days) were at 'high' or 'very high' during 2022.

A comparison of two Sussex sites was undertaken to review the forecasted and measured data. Eastbourne and Brighton were selected as these sites have a full suite of measurement instruments including ozone (O_3) and particulate (PM_{10} and $PM_{2.5}$). Eastbourne data showed good correlation with forecasted Daily Air Quality Index (DAQI) 'low' and 'moderate' days. 'Good correlation was also seen at Brighton when comparing the regional Met Office forecasts with Brighton O_3 data.

The analysis of the DAQI forecasts values and measured DAQI values for Eastbourne also showed that the service was within 1 - 2 DAQI values of accuracy for over 95% of the forecasts produced. Some forecasts were issued that were higher than the measured pollutant level when compared, these are called ' false positives'. Only three 'false positive' events were identified, and these only accounted for 1% of the period's forecasts.

In summary the Sussex Alert service has been shown to reliable, and the data analysis have shown that the forecasts and measured data are well aligned. This provided the confidence that the Alert service provided a practical and reliable health protection service for subscribers and the public.



1. Sussex Air Quality Alert Service

The Sussex Air Quality Alert service was developed by the Sussex Air Quality Partnership ("Sussexair"), which is made up from the Sussex local authorities and Public Health bodies. The members of Sussex Air Quality Partnership are:

- Adur District Council
- Arun District Council
- Brighton and Hove City Council
- Chichester District Council
- Crawley Borough Council
- Eastbourne Borough Council
- East Sussex County Council
- Hastings Borough Council
- Horsham District Council
- Mid Sussex District Council
- Lewes District Council
- Rother District Council
- Wealden District Council
- West Sussex County Council
- Worthing Borough Council

Bureau Veritas provides this service on behalf of the Sussex Air Quality Partnership.

The Sussex Air Quality Alert service was established over 15 years ago to provide a Sussex-wide air pollution forecasting and alert service to support vulnerable persons such as those with respiratory and heart conditions and the public.

- The service provides pollution alerts direct to subscribers for "FREE" via different delivery methods such as text/SMS, email, or telephone message to landlines.
- The Alerts are sent to subscribers 24 to 48 hours prior to an episode of elevated air pollution.
- Subscribers can select either the general area alerts for East or West Sussex or to specific areas more representative of where they live or work.
- Subscribers can cancel the service at any time.

Further details on the service and live pollution forecasts are shown on the homepage https://sussex-air.net/

1.1 How the Alert Service works

Air quality is measured for a variety of pollutants and can have a variety of effects on different people in society. The UK Air Quality Banding system is used to inform the public about the levels of pollution that they may be exposed to and are based on health advice approved by the Committee on Medical Effects of Air Pollution Episodes (COMEAP).

The system uses an index divided into four bands to provide more detail about air pollution levels in a simple way; these bandings range from Low, Moderate, High to Very High. The overall air pollution index is calculated from the highest index value of five pollutants: nitrogen dioxide, sulphur dioxide, ozone, carbon monoxide and particles < $10\mu m$ (PM₁₀). The bandings, pollutant concentrations and periods of exposure are provided in Appendix A.

Using the national UK Met Office air pollution service we check and send out air pollution alerts only when pollution levels are likely to affect people's health. Forecasts of air quality are generated daily and cover a 5-day period and are available 365 days of the year.



Alerts are only sent if:

- air quality is forecast to be "Moderate" or above on the day of the forecast; or
- on any of the other 4 days within the 5-day forecast period.

Alerts are sent;

- in the morning and sent by mid-day each day; and
- cover a 5-day period.

Subscribers will be sent the alert if:

- there is an alert for an area they are subscribed to is "Moderate" or above; and
- an alert is forecast for the present day or one day over the following 4 days.

We will not resend alerts if:

• the air pollution levels stay the same or goes back down to "Low".

We will only send alerts if:

• the level changes to "High" or "Very High" in that period.



2. 2022 Air Quality Alert Service

2.1 New service in 2022

The new Sussex Alert service was operational from March of 2022; however, the service was updated in October 2022 with a new service and all users invited to re-register. The service was enhanced to provide more localised air quality forecasts instead of the general "West" and "East Sussex" and "Brighton only" forecasts and alerts. There are now 32 different areas across Sussex that have specific forecasts.

2.2 Service users in 2022

The service users reported here are those that have been subscribed since the 5th October 2022. Table 2-1 shows the subscribers and delivery method type for the service since October 2022.

The service user numbers are provided for each month and a summary provided in the final quarter of 2022 (Q4). The total number of subscribers can vary from month to month, with some leaving as well as new people subscribing. The total at the end of the year includes all those who stayed with the service plus new recruits and leavers, hence the difference in the totals.

Service type	Oct	Nov	Dec	Q4 Total	Total
Email	150	99	21	270	307
Text/SMS	129	90	13	232	246
Voice message	3	2	0	5	5
				Total	558

Table 2-1: Alert Subscribers 2022

The alert service is delivered mainly by email (307 users) and text/SMS (246 users) services, these account for 55% and 44% of the users respectively. The remaining 10% of users still prefer to receive alerts via land-line telephone voice messages.

Table 2-2 shows the number of alerts sent via the three main service distribution routes. The number of alerts sent are relative the number of service users, the areas they have selected and the number of 'moderate' or above forecasts produced in a month.

During October and November Sussex-air requested invitations be sent out to all previously subscribed users as the service had been upgraded and users need to re-subscribe to ensure the service was GDPR compliant. There were no Alerts sent in this period, hence all the Alert messages were re-subscription messages, see table 3-1 for alerts sent in 2022.

Table 2-2: Alerts sent (October to December 2022)

Service type	Oct	Nov	Dec	Total
Email	706	611	0	1311
Text/SMS	1007	1001	0	2008
Voice message	174	174	0	348

The data does not show the web-browser statistics in 2022. This will be provided in future reports to track mobile web-browser users.



3. Air Quality forecasts and alerts

Air quality forecasts are produced daily, as described in section 1, with alerts are only issued when above the "moderate" DAQI level.

There are 31 area forecasts produced daily, which can vary slightly dependent on conditions, locations and other model forecast factors the Met Office determines. The locations of the forecast locations are shown below in Figure 3-1 and listed in Appendix B.





3.1 Sussex Alert analysis 2022

The following analysis looks at the issued alerts from the Met Office for the regional service and latterly compared to the Sussex alert service.

The Sussex alert service from the Met Office provides forecasts to 31 different locations across the region. As the service was only in operation since March 2022, a complete review of the number of alerts issued versus the local Sussex monitoring sites is limited.

The full list of DAQI days for all 31 sites is provided in Appendix B and Table B-1 sets out the number of days that were categorised as 'low', 'moderate', 'high' and 'very high' at the alert area locations. These data demonstrate the variance in the numbers of DAQI days across different locations.

The full set of 31 sites data identifies that most days were 'low' air pollution days over this period accounting for on average 289 out of 307 days (94%). There were on average 15 days across the region that were forecasted as 'moderate' air pollution days, which accounted for 5% of days during this period. On average there was only 1 day (0.3%) in each location where 'high' days of pollution were being forecast. Similarly, there was only 1 day (0.3%) in each location where 'very high' pollution days were forecast.



	Low	Moderate	High	Very High
Alert location	(1-3)	(4-6)	(7-9)	(10)
Brighton	292	12	1	1
Chichester	286	18	1	1
Eastbourne	290	13	2	1
East Grinstead	290	14	1	1
Hastings	286	17	2	1
Haywards Heath	291	13	1	1
Horsham	289	15	1	1
Worthing	288	16	1	1
Average	289	15	1	1
Percentage of period	94%	5%	0.5%	0.5%

Table 3-1: Number of forecast DAQI days in 2022 (March to December) at selected sites.

A more detailed distribution of forecasts is provided below for Eastbourne to demonstrate the spread of alerts over the period of the service in 2022.

	Low	Moderate	High	Very High
Month	(1-3)	(4-6)	(7-9)	(10)
March	28	1	2	0
April	30	0	0	0
Мау	31	0	0	0
June	28	2	0	0
July	28	3	0	0
August	23	7	0	1
September	30	0	0	0
October	31	0	0	0
November	30	0	0	0
December	31	0	0	0
Total	290	13	2	1

Table 3-2: Number of forecast DAQI days in 2022 (March to December)

The following figure 3-1 presents the timeline of DAQI forecast days across Sussex from March to December 2022. This shows the profile of forecast days over the period for the eight selected sites. A peak period of 'high' and 'very high' DAQI forecasts were at the end of March and middle to late August, which will be analysed further in the following sub-sections.





Figure 3-2: DAQI forecast days across Sussex (March to December 2022).

3.2 2022 DAQI forecasts and measured data inter-comparison

There are two main pollutants of interest; ozone (O_3) and particulate matter (PM₁₀ and PM_{2.5}). O₃ is the pollutant that most commonly exceeds the 'moderate' threshold in Sussex as it is higher in rural and background locations and is influenced by long range transport from the nearby continent. O₃ exceedances tend to occur more in the warmer periods such as spring and summer. Particulate matter exceeds the 'moderate' threshold less frequently and this tends to occur during still, settled weather conditions which lead to poor dispersal. It is also influenced by long range transport from the continent which adds to local emissions. Particulate exceedances tend to occur more in the colder more settled periods such as in the winter.

Two sites in the Sussex Air Quality Network were selected for the inter-comparison of the DAQI forecasts and measured data, namely Eastbourne Devonshire Park (EB1) and AURN Brighton Preston Park (BH0). These sites were selected as these are the only locations where DAQI Forecast Alerts were available, and where the key pollutants of interest were monitored i.e., O_3 , particulates and NO_2 during 2022.

Eastbourne Devonshire Park inter-comparison

Eastbourne Devonshire Park (EB1) was selected for inter-comparison of DAQI forecasts and measured data as this location monitored O_3 as well as NO_2 and PM_{10} during 2022. Table 3-3 shows the number of days measured at the DAQI levels for Eastbourne Devonshire Park.

Table 3-3: Number of measured DAQI days in 2022 by pollutant (March to December)

Eastbourne (EB1)	Low (1-3)	Moderate (4-6)	High (7-9)	Very High (10)
O ₃	291	14	0	0
PM ₁₀	288	3	0	0
NO ₂	302	0	0	0

Note: Data was not available for all days in 2022 for every pollutant.

Table 3-3 shows that during 2022 the dominant pollutant used to provide the DAQI Alerts, i.e. above 'moderate', was O_3 with 14 days at 'moderate. Although there were with 3 days where PM_{10} was at 'moderate', one of those days coincided with the day where O_3 was also moderate.

Table 3-4: Number of forecasted DAQI days in 2022 for Eastbourne

Alert location	Low (1-3)	Moderate	High (7-9)	Very High (10)
Alert IOCation	(1-3)	(4-0)	(1-9)	(10)
Eastbourne	290	13	2	1

This indicates that there were a similar number of days that were forecast as low and moderate between measured and DAQI metrics, but there were three days that were forecast as high or very high from the Met Office service, for which data subsequently acquired did not align to.

To analyse the effectiveness of the forecasts we have compared the O₃ measured data (max 8-hour running average for each day) with the DAQI data for the Eastbourne.

Figure 3-2 provides the profile of DAQI forecast days for the Eastbourne area and overlays the ozone (O₃) data from the Eastbourne Devonshire Park (EB1) Air Quality Monitoring Station (AQMS). This overlay indicates that the 'moderate', 'high' and 'very high' DAQI forecasts corresponded reasonably well with measured O₃ peaks through the period (March to December 2022).





Figure 3-3: DAQI forecast days and O₃ measured data (max 8-hour running average for each day) in Eastbourne (March to December 2022).

Figure 3-3 provides the intercomparison of DAQI forecast days and daily measured O_3 concentrations (based on the max. 8-hour running mean) in Eastbourne. Measured data is converted to a DAQI value for each day and compared to the forecasted DAQI value provided by the Met Office. The following figure shows if the measured DAQI and forecasted DAQI are aligned, i.e the same or not, and provides a statistical value to show how close each day's value are during the period. This is the R-squared (R²) value which gives a value out of 1.







The intercomparison data show a strong correlation in the low and moderate DAQI forecasts and measured data, however less co-relation in the high and very high bands. Overall, statistically the R² value of 0.8488 shows strong correlation of DAQI forecasts and measured data.

The forecasts analysis shown in Table 3-5 shows that Eastbourne had 34% under-prediction of forecasts compared to the measured DAQI value, 23% over-predictions and 43% correctly provided DAQI forecasts.

Table 3-5: Number of forecasted DAQI days in 2022.

Forecast	Number	%
Under-predictions	103	34%
Over-predictions	70	23%
Aligned predictions	133	43%

Table 3-6 shows that the difference in the DAQI values where a forecast predicted a value and the measured DAQI values were not significant. Most forecasts (93%) were within 1 DAQI value, with a further 3% within 2 DAQI values for this period. The number of days where the forecast over-predicted a DAQI by more than 3 DAQI values was four days with the forecast over-predicted 'high' or very high' for three days, which equates to 3 out 306 days or 1% false positive forecasts.

Difference in forecasted and measured DAQI (DAQI value difference)	Number	%
8	1	0%
7	0	0%
6	1	0%
5	1	0%
4	0	0%
3	1	0%
2	5	2%
1	61	20%
0	133	43%
-1	93	30%
-2	4	1%
-3	5	2%
-4	1	0%
-5	0	0%

Table 3-6: Difference in the forecasted DAQI values in 2022.

A histogram showing the profile of the difference in the forecasted DAQI values in 2022.



Figure 3-5: Histogram of the difference in the forecasted DAQI values in 2022.



Figure 3-6 presents the period of 'moderate' and 'very high' DAQI forecasts and the measured O_3 at Eastbourne Devonshire Park (EB1) in more detail over the month of August. The peak period of the highest measured O_3 arose from the 12th to 16th August, which corresponded with the period of 'moderate' and 'high' DAQI forecasts, with the 'very high' forecast a day later on the 17th August.



Figure 3-6: DAQI forecast days and DAQI O₃ measured data in Eastbourne (1st to 31st August 2022).

The forecasted Eastbourne DAQI values highlighted in green for 'low', orange for 'moderate' and purple for 'very high' are compared to the measured O₃ DAQI values at EB1 (blue). These showed similar values for the majority of the period when at low and moderate pollution days over the period. The exception being the peak DAQI forecast of very high '10' on the 17th August.







This data shows a strong correlation between the elevated O_3 concentrations (based on 8-hour running average data) and the DAQI forecasts. Overall, statistically the R² value of 0.7242 shows moderate correlation of DAQI forecasts and measured data, when retaining the forecasted 10 DAQI day. If this day were excluded the R² value of 0.88, therefore there was a strong correlation in the periods forecasting and measured data for 'moderate' air pollution.



Brighton Preston Park inter-comparison

The Met Office service also provides national and regional forecasts which are published each year on the UK-AIR website¹, these data provide the local statistics on the number days for each DAQI category. Figure 3-6 shows the DAQI for each day across for Brighton/Worthing/Littlehampton Agglomeration Region for the complete year of 2022 (January to December) with the measured O_3 and $PM_{2.5}$. from AURN Brighton Preston Park. This region was the only local representative location available for data analysis.



Figure 3-8: 2022 DAQI forecast and measured data for Brighton.

Within the Brighton/Worthing/Littlehampton Agglomeration Region there were 15 days above the Moderate (4-6) DAQI level during 2022.

¹ https://uk-air.defra.gov.uk/data/DAQI-regional-data



These were moderate days where all O₃ exceedance days and predominantly occurred during the mid-year spring and summer period. The maximum DAQI for PM_{2.5} for 2022 at AURN Brighton Preston Park was DAQI level 3 (low). Table 3-7 shows the number of days measured at the DAQI levels for AURN Brighton Preston Park.

Table 3-7: Number of measured DAQI days in 2022 by pollutant at AURN Brighton (January to December)

Brighton	Low (1-3)	Moderate (4-6)	High (7-9)	Very High (10)
O ₃	353	6	0	0
PM _{2.5}	342	0	0	0
NO ₂	360	0	0	0

Note: Data was not available for all days in 2022 for every pollutant.

Data from the Met Office service does not specify the pollutant type, however when overlaying the AURN Brighton Preston Park O₃ data for 2022, it is evident the DAQI moderate days were influenced by elevated concentrations of O₃.

Figure 3-9: 2022 DAQI forecast data for Brighton (January to December).







Figure 3-10: Inter-comparison of DAQI forecast days and DAQI O₃ measured data for Brighton (January to December) 2022.

The regional forecast from the Met Office showed good correlation to the measured data at AURN Brighton Preston Park. This data shows a strong correlation between the elevated O₃ concentrations (based on 8-hour running average data) and the DAQI forecasts. Overall, statistically the R² value of 0.7486 shows good correlation of DAQI forecasts and measured data. It should be noted that these DAQI forecasts were for a wider area and so is treated as a more generalised forecast that covers a wider geographical area along the coast.

The Alert forecasts produced from the Met Office service have shown to have strong correlations with measured data at Eastbourne and Brighton. The analysis of the DAQI forecasts values and measured values for Eastbourne also showed that the service was within 1 - 2 DAQI values of accuracy for over 95% of the forecasts produced. Some false positives were identified but these were only for 1% of the period's forecasts.

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3.3 Summary

In summary the Met Office forecasts have been shown to correlate well in the 'low' to 'moderate' bandings during 2022. There were few, in fact only 1- 2 'high' and only 1 'very high' forecasts during the year which makes it difficult to assess these data statistically. These high and very high forecasts did not align with measured days at Eastbourne or Brighton but did align with the previous days trend. In general, the forecasts system did follow local monitoring trends and DAQI days were well aligned to the measured 'low' and 'moderate' days which covered 99% of the period during 2022.

The Sussex Alert service has been shown to reliable, and the data analysis have shown that the forecasts and measured data are well aligned. This provided the confidence that the Alert service provided a practical and reliable health protection service for subscribers and the general public.



Appendices

Appendix A: Air Quality Bandings

Table A -1– UK Air Quality Bandings

Band	Index	Ozone	Nitrogen Dioxide	Sulphur Dioxid e	PM2.5 Particles	PM10 Particles
		Running 8 hourly mean	Hourly mean	15 minute mean	24 hour mean	24 hour mean
		µg m-3	µg m-3	µg m-3	µg m-3	µg m-3
Low						
	1	0-33	0-67	0-88	0-11	0-16
	2	34-66	68-134	89-177	12-23	17-33
	3	67-100	135-200	178-266	24-35	34-50
Moderat	e					
	4	101-120	201-267	267-354	36-41	51-58
	5	121-140	268-334	355-443	42-47	59-66
	6	141-160	335-400	444-532	48-53	67-75
High						
	7	161-187	401-467	533-710	54-58	76-83
	8	188-213	468-534	711-887	59-64	84-91
	9	214-240	535-600	888-1064	65-70	92-100
Very High						
	10	241 or more	601 or more	1065 or more	71 or more	101 or more



Appendix B: Number of forecast DAQI days in 2022

Table B -1– Number	r of forecast	DAQI davs i	n 2022

Alextleastics	Low	Moderate	High	Very High
	(1-3) 288	(4- 6) 16	(7-9)	(10)
Dettle	200	14	1	4
Battle	290	14	1	1
Bexnill	291	12	2	1
Billingsnurst	289	15	1	1
Bognor Regis	286	18	1	1
Burgess Hill	291	13	1	1
Brighton	292	12	1	1
Chichester	286	18	1	1
Crowborough	289	15	1	1
	290	13	2	1
East Grinstead	290	14	1	1
Goodwood	284	20	1	1
Hailsham	289	15	1	1
Hastings	286	17	2	1
Haywards Heath	291	13	1	1
Heathfield	290	14	1	1
Horsham	289	15	1	1
Hove	292	12	1	1
Littlehampton	287	17	1	1
Newhaven	291	13	1	1
Petworth	287	17	1	1
Portslade by Sea	292	12	1	1
Rye	289	14	2	1
Seaford	291	13	1	1
Selsey	290	14	1	1
Shoreham	291	13	1	1
Steyning	288	16	1	1
Storrington	288	16	1	1
Uckfield	290	14	1	1
Worthing	288	16	1	1
Average	289	15	1	1



Table B -1– Percentage of forecast DAQI days in 2022

	Low	Moderate	High	Very High
Alert location	(1-3)	(4-6)	(7-9)	(10)
Arundei	94%	5%	0%	0%
Battle	94%	5%	0%	0%
Bexhill	95%	4%	1%	0%
Billingshurst	94%	5%	0%	0%
Bognor Regis	93%	6%	0%	0%
Burgess Hil	95%	4%	0%	0%
Brighton	95%	4%	0%	0%
Chichester	93%	6%	0%	0%
Crowborough	94%	5%	0%	0%
Eastbourne	94%	4%	1%	0%
East Grinstead	94%	5%	0%	0%
Goodwood	93%	7%	0%	0%
Hailsham	94%	5%	0%	0%
Hastings	93%	6%	1%	0%
Haywards Heath	95%	4%	0%	0%
Heathfield	94%	5%	0%	0%
Horsham	94%	5%	0%	0%
Hove	95%	4%	0%	0%
Littlehampton	93%	6%	0%	0%
Newhaven	95%	4%	0%	0%
Petworth	93%	6%	0%	0%
Portslade by Sea	95%	4%	0%	0%
Rye	94%	5%	1%	0%
Seaford	95%	4%	0%	0%
Selsey	94%	5%	0%	0%
Shoreham	95%	4%	0%	0%
Steyning	94%	5%	0%	0%
Storrington	94%	5%	0%	0%
Uckfield	94%	5%	0%	0%
Worthing	94%	5%	0%	0%
Average	94%	5%	0%	0%