1 Nowcast evaluation 16th September 2010

1.1 Background

Nowcast is an operational visualisation tool to produce maps of air pollution concentrations in London based on a combination of dispersion modelling and near real-time measurements. Nowcast uses modelled annual mean concentrations of air pollution (Kelly et al 2010) to represent the spatial variation in concentrations between monitoring sites. To produce each nowcast near-real time measurements from each monitoring site are compared to the annual mean concentration at that site to produce a scaling factor. The nowcast is generated using measurements from all non-industrial monitoring sites in London. The scaling factor is then applied to the modelled maps of annual mean concentrations to produce the hourly nowcast map.

1.2 Evaluation

The model was evaluated according to the metrics recommended for the evaluation of air quality models for defra (Derwent at al 2010).

The model was evaluated in two modes; retrospective and operational. The nowcast was compared to measurements at 15 randomly selected monitoring sites, plus Marylebone Road.

Retrospective evaluation

Retrospective evaluation compared measured concentrations to hourly nowcast results over two years from June 2008 and the end of May 2010. The test included 268,000 comparisons for PM_{10} and 197,000 for NO_2. The results of the nowcast evaluation in retrospective mode are shown in Table 1. It is clear that the nowcast performs better for PM_{10} than NO_2 for all metrics. This is expected due to the nature of the pollutants modelled; the nowcast predicts a 24 hour mean concentration for PM_{10}, which is less susceptible to short-term variation exhibited by the hourly mean NO_2 concentration. Further, PM_{10} in London includes a large regional component that is common across all monitoring sites making the nowcast simpler. There is a basis in both models with the nowcast tending to under predict measured concentrations. This is due to two factors; 1) the 20m resolution of the model means that it cannot reflect high concentrations within a few metres of roads and may underestimate kerbside concentrations and 2) part of the nowcast calculation is based on median rather than mean concentrations to avoid undue influence from extraneous high or low measurements. The normalised mean bias for NO_2 and PM_{10} is within the defra recommended bounds of ± 20% and the FAC2 (fraction of predictions within a factor of 0.5 to 2) is well above the recommended 50%.

	Measured Mean µg m^{-3}	**Modelled Mean µg m^{-3}**	**Mean error µg m^{-3}**	**Standard deviation µg m^{-3}**	**Normalised mean bias %**	**Normalised mean gross error %**	**FAC2 %**
PM_{10}	25	23	2	7	9	19	99
NO_2	56	52	5	30	8	34	85

Table 1 Nowcast evaluation Jan 2009 to May 2010 run in retrospective mode.

The overall results shown in Table 1 do not however give a complete view of the nowcast performance. Table 2 shows nowcast performance at each of the 16 PM_{10} monitoring sites in the evaluation. The FAC2 is greater than 50% at all sites meeting the defra criteria. The normalised mean bias is inside the defra recommended range of ± 20% at 13 sites. At three sites close to roads (highlighted in grey) normalised mean bias is outside the range of ± 20%. At these sites the 20m model resolution cannot fully represent peak concentrations within a few metres of traffic sources.

Site	Measured Mean µg m^{-3}	Modelled Mean µg m^{-3}	Mean error µg m^{-3}	Standard deviation µg m^{-3}	Normalised mean bias %	Normalised mean gross error %	FAC2 %
BL0 (B)	19	19	0	4	1	15	100
BN1(K)	23	25	-2	3	-8	11	100
BT1(B)	18	17	0	3	2	9	100
CD3(R)	30	26	4	5	13	16	100
GR4(B)	24	19	5	4	19	20	100
HG1(R)	22	19	3	4	14	16	99
HR1(B)	17	17	0	2	-2	9	100
HS5(R)	32	21	11	15	34	35	89
IS2(R)	27	25	3	4	10	15	100
KC1(B)	21	19	2	2	10	11	100
KC2(R)	28	26	1	4	4	12	100
LH2(B)	23	20	3	4	14	16	100
MY1(K)	36	44	-8	13	-21	33	96
ST4(K)	25	17	8	4	31	31	97
TH1(B)	22	19	3	3	13	14	100
TH4(R)	34	29	5	7	14	18	99

Table 2 Nowcast evaluation Jan 2009 to May 2010 run in retrospective mode for 16 PM_{10} sites. Letters following the site code denote the site type, (K) = kerbside, (R) = roadside and (B) = background or suburban.

Table 3 shows the nowcast performance at 12 NO_2 sites. Although the FAC2 is greater than 50% at all sites meeting the defra criteria. The normalised mean bias is inside the recommended range of ± 20% at nine of the twelve sites. It was outside the range of ± 20% at two sites close to roads (highlighted in grey) where the 20m model resolution cannot fully represent peak concentrations within a few metres of traffic sources. The normalised mean bias was also outside ± 20% at one background site.

Site	Measured Mean µg m^{-3}	Modelled Mean µg m^{-3}	Mean error µg m^{-3}	Standard deviation µg m^{-3}	Normalised mean bias %	Normalised mean gross error %	FAC2 %
BN1(K)	68	61	7	24	11	29	91
BT1(B)	32	31	1	12	3	30	86
CD3(R)	84	65	18	25	22	30	86
EA1(B)	40	41	-1	11	-3	21	97
EA2(R)	58	53	5	22	9	26	94
GR4(B)	24	30	-6	10	-23	38	73
HR1(B)	26	29	-3	11	-10	34	82
HS5(R)	59	48	11	19	19	28	90
IS2(R)	59	62	-2	20	-4	28	92
MY1(K)	107	116	-9	62	-9	48	72
ST4(K)	76	42	34	42	44	50	63
TH1(B)	37	37	1	10	2	19	99

Table 3 Nowcast evaluation Jan 2009 to May 2010 run in retrospective mode for 12 NO_2 sites. Letters following the site code denote the site type, (K) = kerbside, (R) = roadside and (B) = background or suburban.

Operational evaluation

Evaluating the model using past measured data is not a representative test of the model. The measured data used to generate each retrospective nowcast have been subject to validation and ratification that remove the effects of equipment faults and problems with calibration. In operational mode the nowcast would use measurement data gathered in near real-time. Although this is subject to extensive automatic validation the quality of these measurements is of course inferior to the fully validated and ratified measurements used in the retrospective evaluation. Additionally, measurements from some monitoring sites are only collected twice daily and these will not be available for the near real-time nowcast. For the operational evaluation the nowcast was run each hour from 25th August to 15th September 2010 using all London non-industrial monitoring sites in London using as measurements as they were collected in near-real time. The near-real-time nowcast were then evaluated against the same monitoring sites as those in the retrospective evaluation, subject to operational availability. Results from this real-time evaluation, shown in Table 4 show a similar overall performance to the evaluation in retrospective mode with the model achieving the performance criteria for normalised mean bias and FAC2 recommended by defra.

	Measured Mean µg m^{-3}	Modelled Mean µg m^{-3}	Mean error µg m^{-3}	Standard deviation µg m^{-3}	Normalised mean bias %	Normalised mean gross error %	FAC2 %
PM_{10}	21	20	1	5	3	16	100
NO_2	49	41	8	32	17	42	75

Table 4 Nowcast evaluation 25th August 2010 to 15th September 2010 run hourly in operational mode.

1.3 References

Derwent R., Fraser A., Abbott J., Jenkin J., Willis P., Murrells T., 2010. Evaluating the Performance of Air Quality Models - www.airquality.co.uk/reports/cat05/1006241607_100608_MIP_Final_Version.pdf.

Kelly F., Anderson R., Armstrong B., Atkinson R., Barratt B., Beevers S., Derwent D., Green D., Mudway I. and Wilkinson P. 2010. An assessment of the impact of the Congestion Charging Scheme on Air Quality in London, Report prepared for the Health Effects Institute (in press).

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