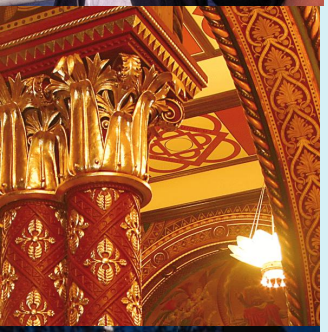

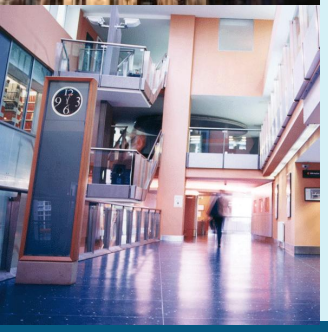

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The new Daily Air Quality Index Predicting public exposure

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The new DAQI

Why change the index?

The old index was unchanged for ~12 years and health evidence moved on during this time

Legislation moved on too causing a mismatch between index and EU LV and AQS.

- Low air pollution all year and EU LV exceeded.

Responsive and changing index more suited for near-real time information systems.

The new index

Dropped CO but introduced $PM_{2.5}$

Aligns with WHO short-term guidelines (COMEAP recommended tightening the O_3) and EU LV.

Improved health information to susceptible individuals and the general population.

The new index

Band	Index	Ozone	Nitrogen Dioxide	Sulphur Dioxide	$PM_{2.5}$ Particles	PM_{10} Particles
		Running 8 hourly mean	hourly mean	15 minute mean	24 hour mean	24 hour mean
		μgm^{-3}	μgm^{-3}	μgm^{-3}	μgm^{-3}	μgm^{-3}
LOW						
	1	0-33	0-66	0-88	0-11	0-16
	2	34-65	67-133	89-176	12-23	17-33
	3	66-99	134-199	177-265	24-34	34-49
MODERATE						
	4	100-120	200-267	266-354	35-41	50-58
	5	121-140	268-334	355-442	42-46	59-66
	6	141-159	335-399	443-531	47-52	67-74
HIGH						
	7	160-187	400-467	532-708	53-58	75-83
	8	188-213	468-534	709-886	59-64	84-91
	9	214-239	535-599	887-1063	65-69	92-99
VERY HIGH						
	10	240 or more	600 or more	1064 or more	70 or more	100 or more

Short-term exposure predictions within the index (triggers)

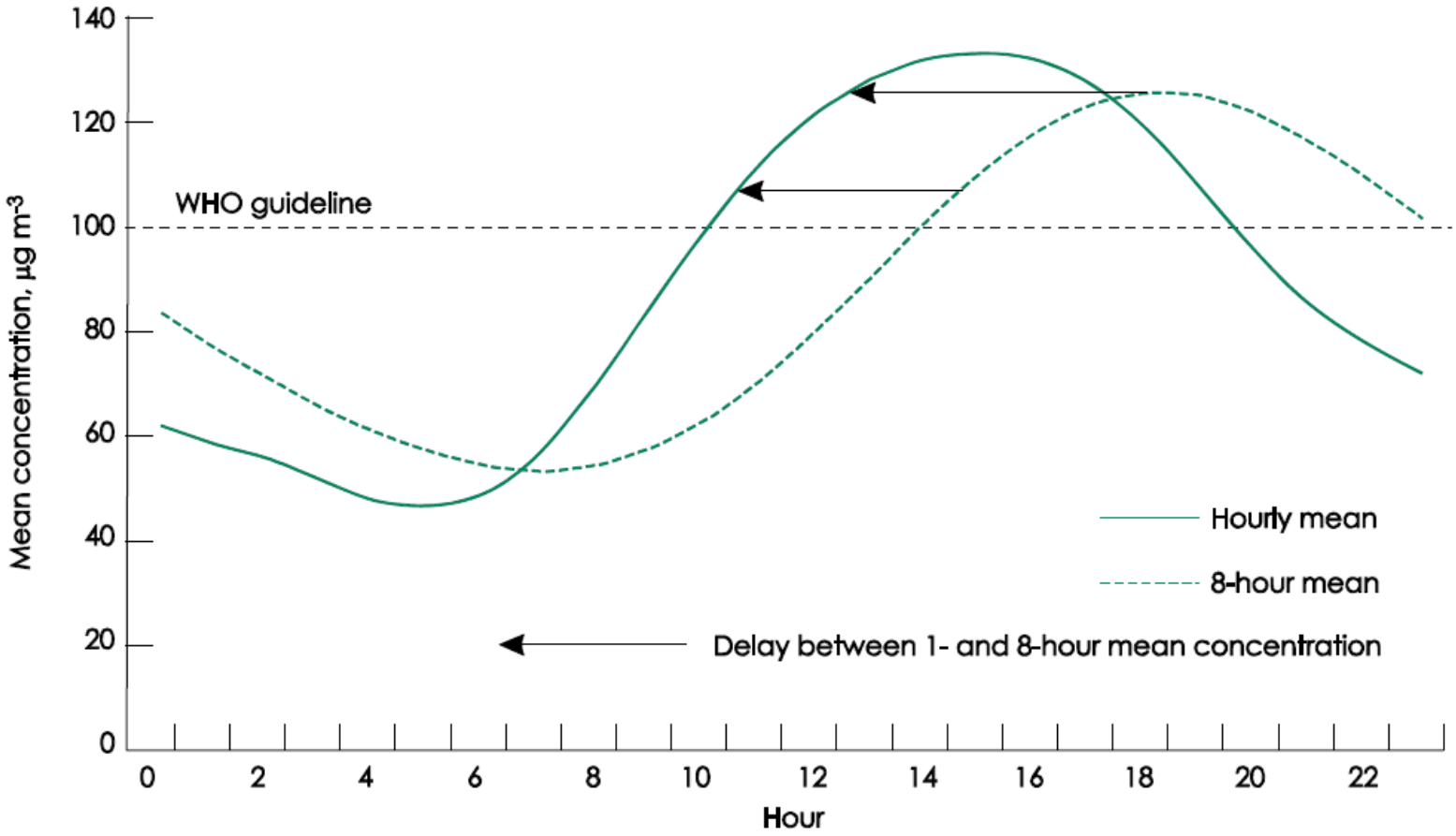
Short – term exposure predictions

Health evidence for O_3 and PM WHO Guidelines are based on long exposure periods

- 8 hours for O_3
- one day (not rolling 24h) for PM

This makes it impossible to give pollution information to the public until an episode is well established or maybe even finished.

Short – term exposure predictions



Short – term predictions

Using a flooding analogy:

- There is a risk of flooding tomorrow (forecast)

- The river has flooded (O3)
- The river flooded yesterday (PM)

This is unworkable for real-time public information and offers little to allow people to modify their behaviour as air pollution episodes develop.

Short – term exposure predictions

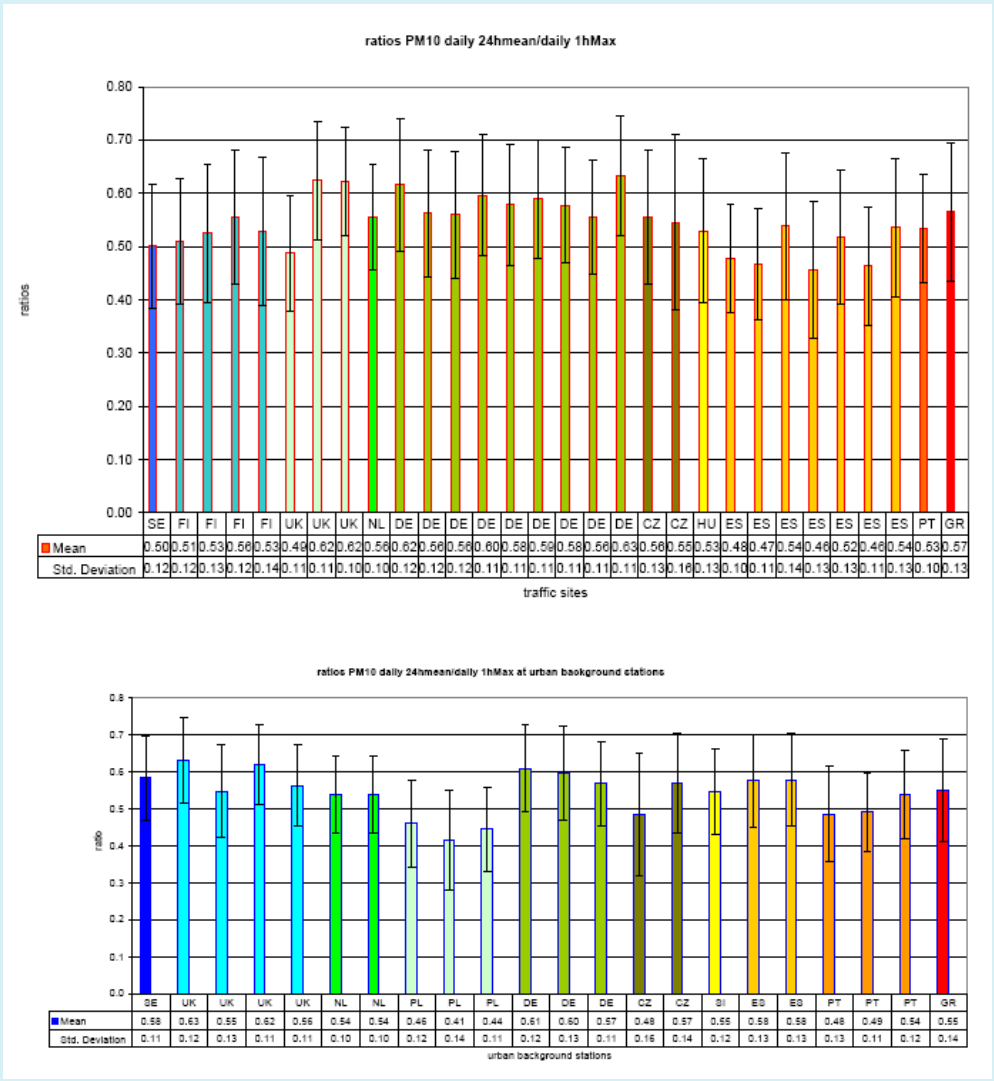
www.citeair.eu

ratio 1h : daily mean PM

Different types of episode

But maybe the peak occurs towards the end of the day?

Doesn't test how good 1h mean is as a predictor.



What's a good predictive model ?

- Would you accept a model that's right 97% ?
  - Predicting low O3 all the time gives a 97% hit rate

Predicting moderate air pollution all the time would get all of moderate days correct but would have many false alarms

Confusion matrix
(or Contingency table)

		Event observed	
		Yes	**No**
Event modelled	**Yes**	*a* (true positive)	*b* (false positive)
	No	*c* (false negative)	*d* (true negative)

2x2 Contingency table adapted from Stephenson (2000).

- Categorical model – Yes/No
- Normally used to assess a model once its built
- We used it to assess different candidate models

The COMEAP “Triggers”

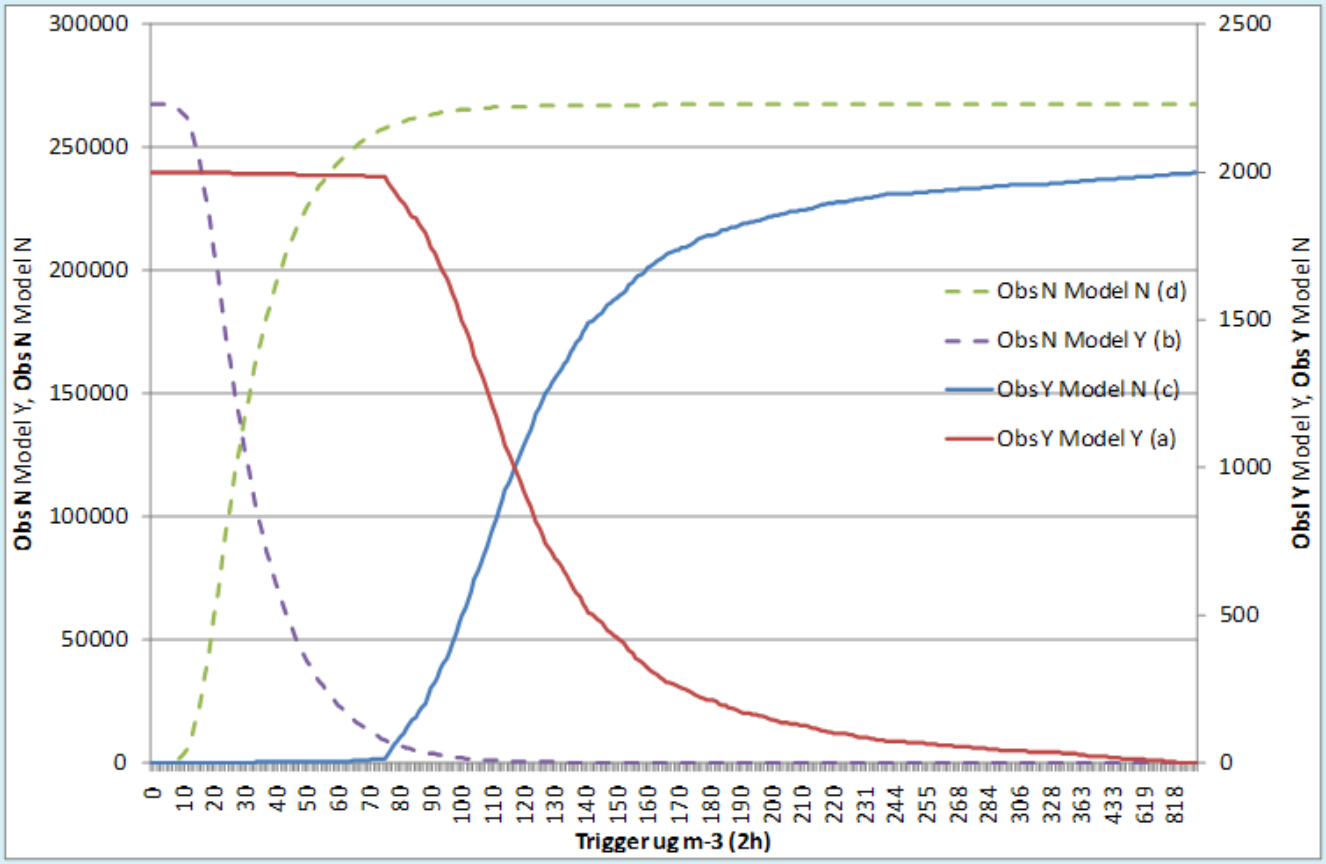
Requirements

- Easy to implement by any information provider
- Provide prediction of an event before it happened – less worried about information afterwards as concentrations fall
- Maximise true positives (hits) while minimising false alarms and false negatives (misses).

Solutions (we tried a few)

- Tests on 4.7 million O_3 measurements, 270,000 days of PM10 measurements and 27,000 days of PM2.5
- Trigger based on two consecutive hours
- Second hour bigger than the first (pollution is rising)

Confusion Matrix Output



Confusion Matrix for moderate O_3

Triggers proved very good predictors of moderate and high O_3 in the next 5/6 hours

O_3 trigger moderate (8h, 100 µg m^{-3}) or above at 104 µg m^{-3} GSS = 0.78		**Event observed**	
		Yes	**No**
Event modelled	**Yes**	33,835	2,358
	No	6,962	4,519,358

Worked well for PM10 and PM2.5 too.

Short – term exposure predictions

Back to the flooding analogy:

We can now say:

- There is a risk of flooding tomorrow (forecast)
- *River levels are rising fast and we expect a flood in a few hours / today.*
- *Then later we can confirm…*
- The river has flooded (O3)
- The river flooded yesterday (PM)

Implementation and trigger performance

Implementation

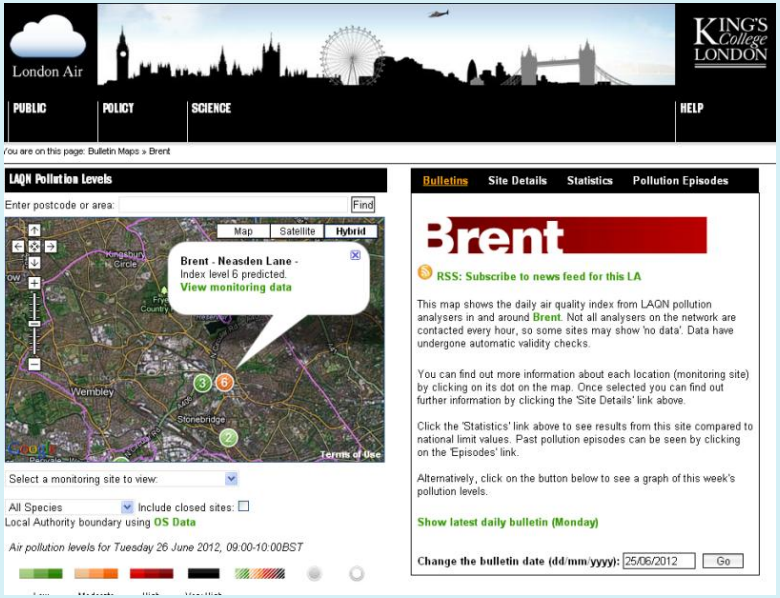
Just after midnight on 1st Jan 2012 we started an update covering:

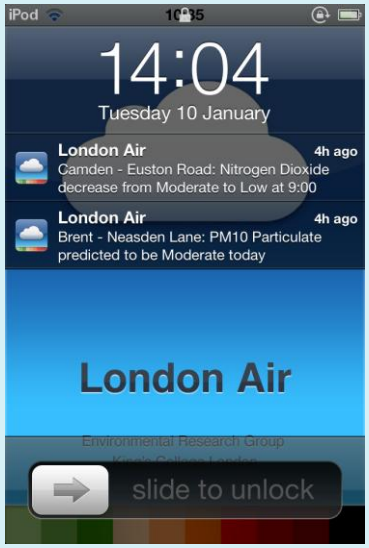
- LondonAir web pages
- LondonAir mobile phone web pages
- iPhone app
- Android app
- Chrome extension
- RSS feeds
- Facebook and Twitter
- New film about the index funded by Defra AQ grant via City of London

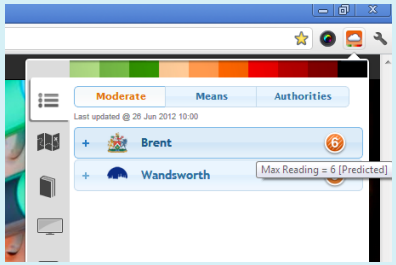
Implementation

Hatched icons to indicate predicted index levels.

Supported by text phrasing





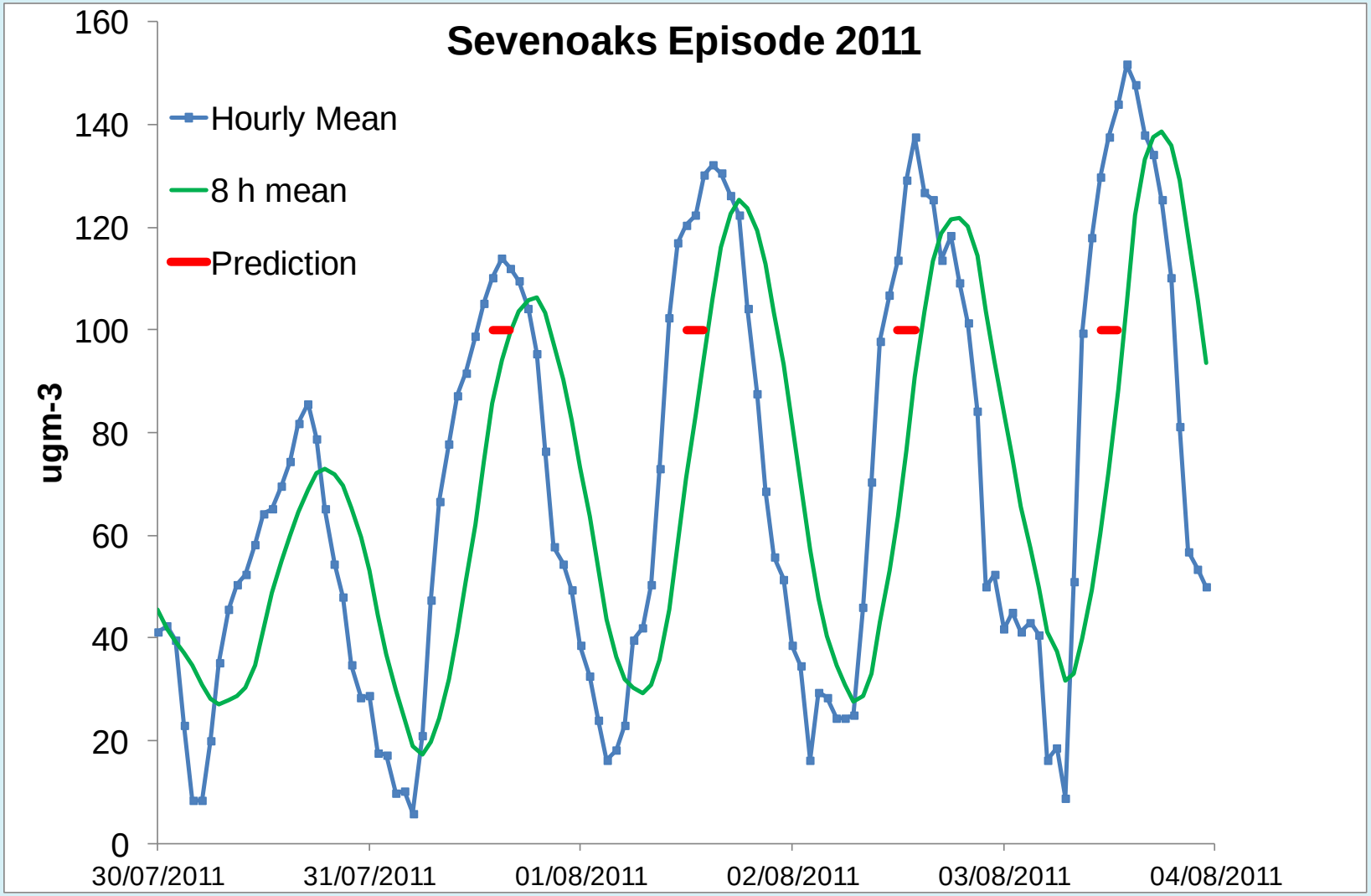


Trigger performance

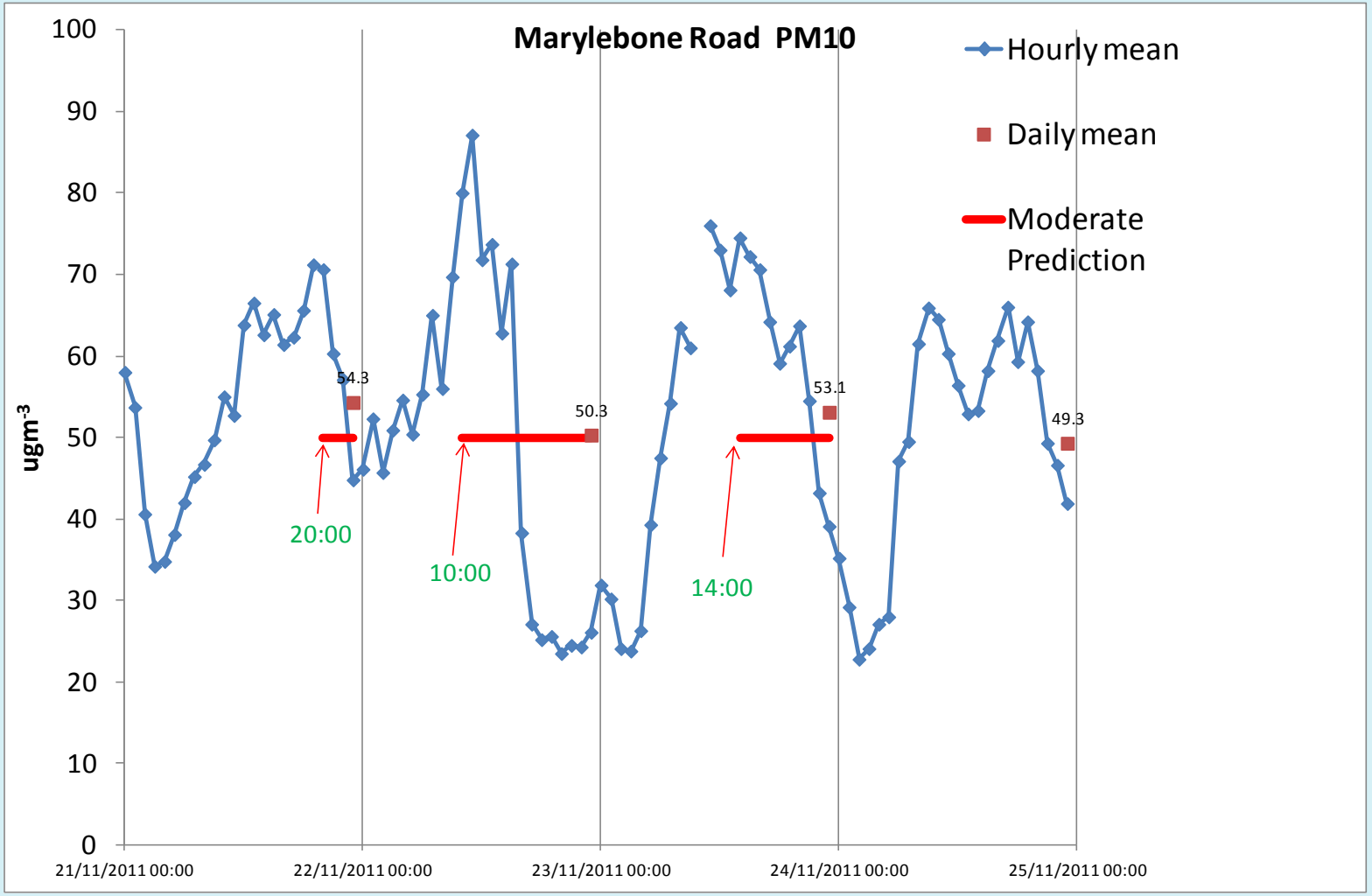
Triggers were originally derived by looking a overall performance across large datasets over many years.

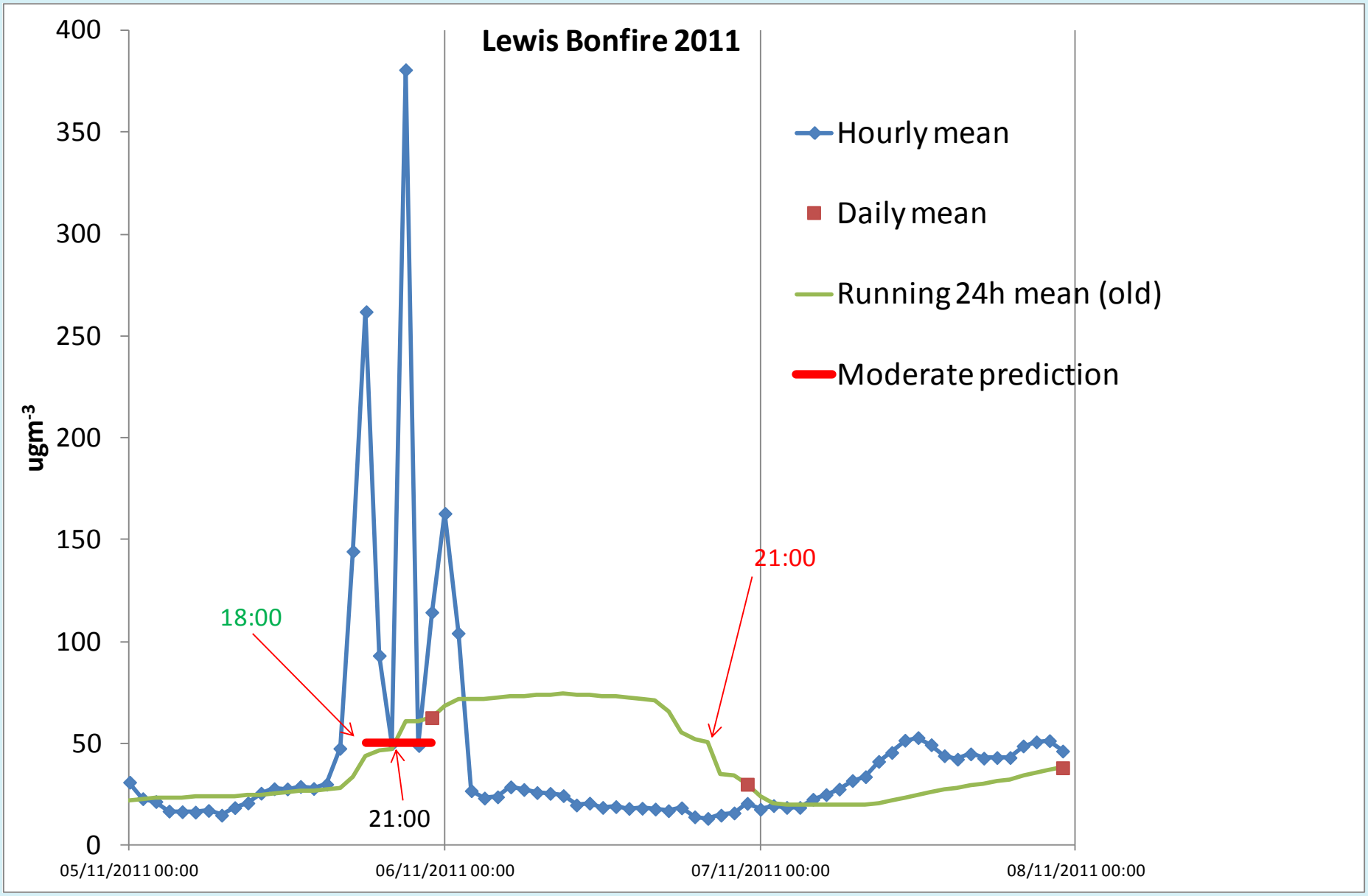
Decided to look in detail at performance and single sites during pollution episodes using measurements that post dated the original assessment.

Trigger performance O_3 at Sevenoaks

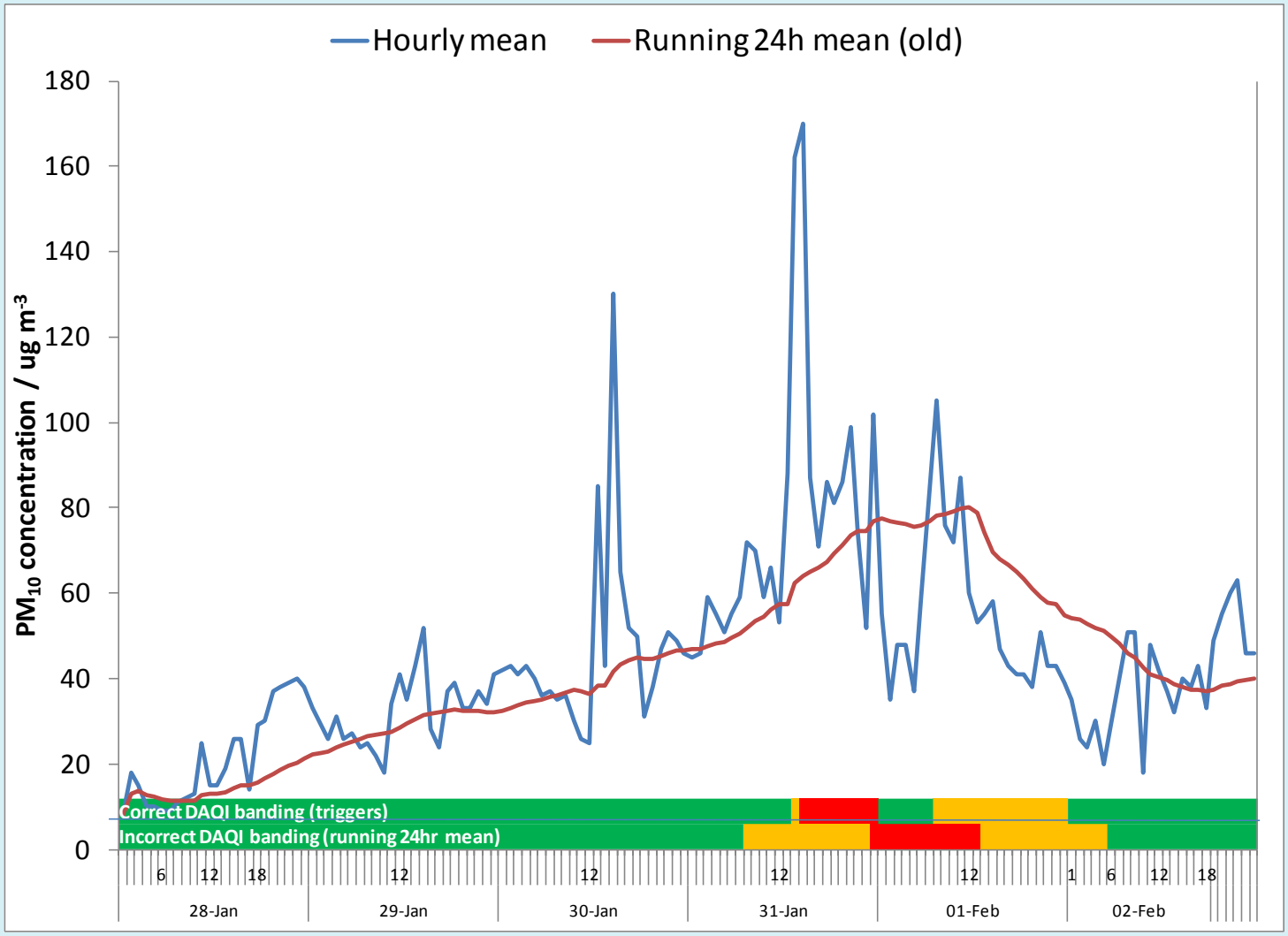


Trigger performance – PM10 at Marylebone Rd

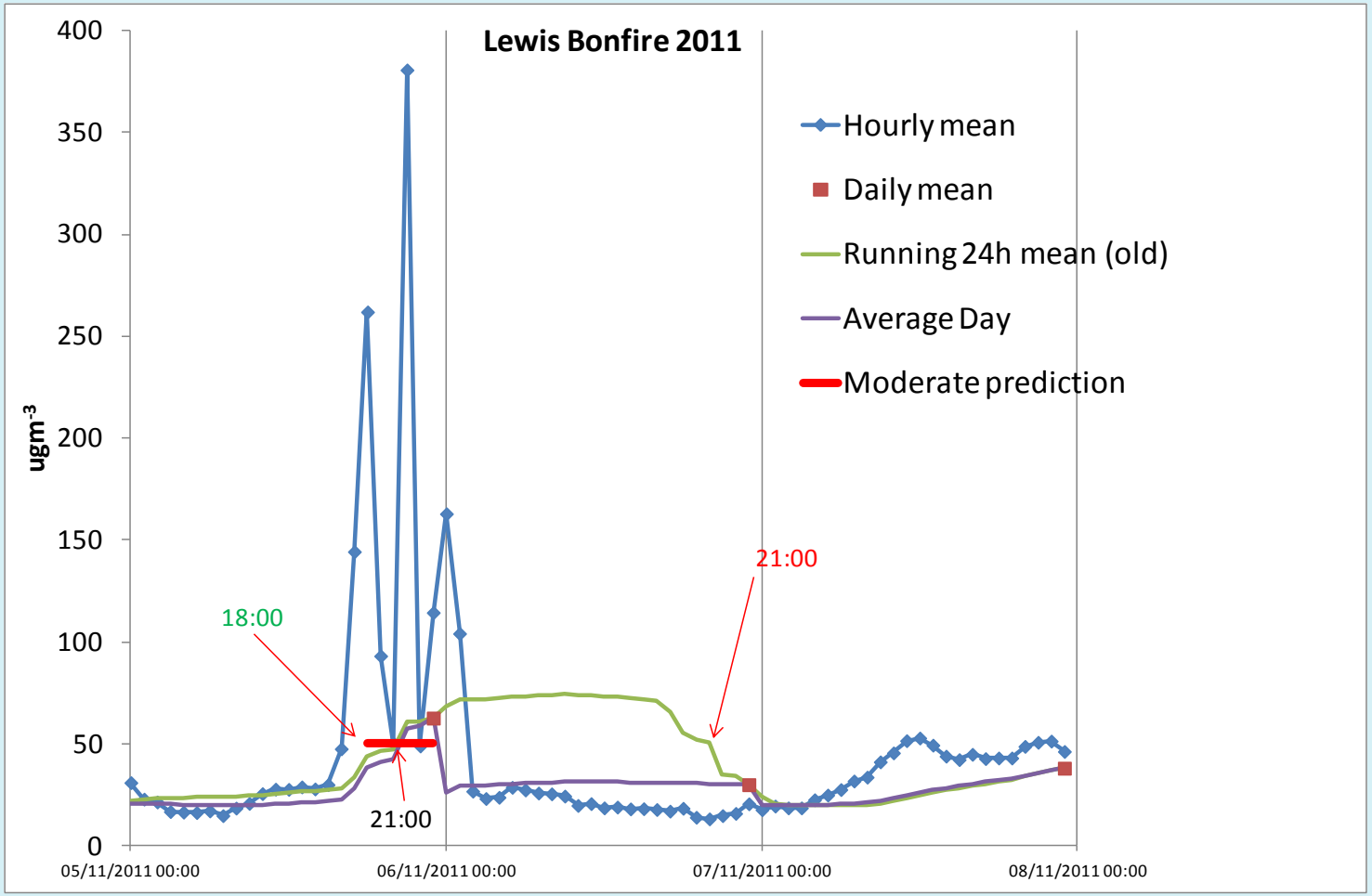



Lewis Bonfire 2011
400
350
300
250
200
150
100
50
0
ugm-3
Hourly mean
Daily mean
Running 24h mean (old)
Moderate prediction
18:00
21:00
21:00
05/11/2011 00:00
06/11/2011 00:00
07/11/2011 00:00
08/11/2011 00:00

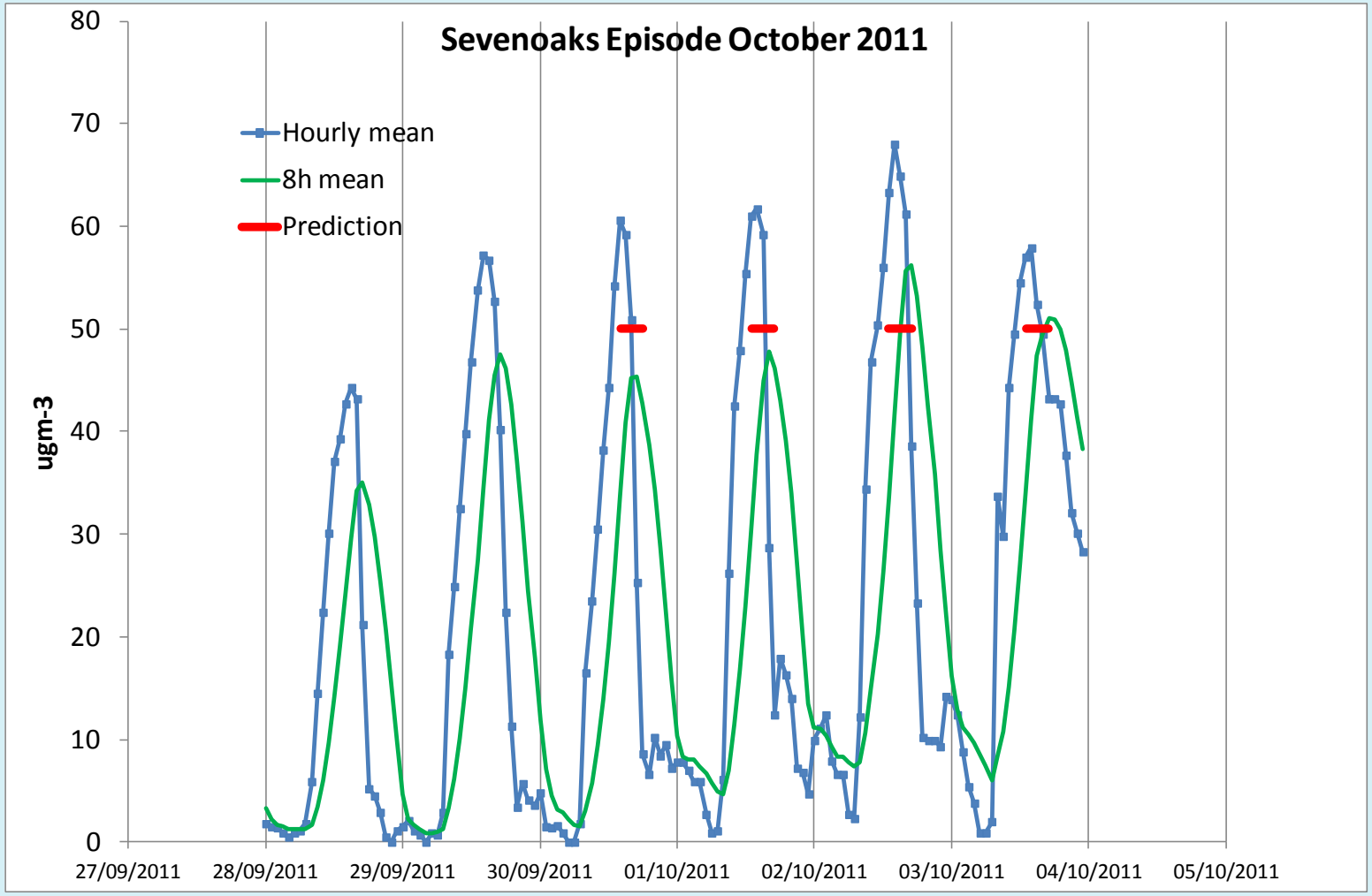
Trigger performance – PM10 at Leeds Headingley



Trigger performance – PM10 at Lewes



Trigger performance - O_3 at Sevenoaks



Summary

The new DAQI provides information consistent with WHO and EU LV.

The update drops CO and introduces PM2.5.

Includes improved health advise directed at susceptible people.

Summary

Innovative predictive ‘triggers’ provide early warning of pollution incidents so that people can take action to reduce the effects of air pollution on their health.

Roll out of the full DAQI (including triggers) across all information providers will greatly enhance public information (only used fully by King’s at the moment)

Can greater awareness of pollution episodes be an effective route to engage the public in managing air pollution?

Thanks

To Timothy Baker for the measurement processing behind the predictive triggers and much clear thinking.

Timothy Baker, Robert Hepburn, Andrew Grieve (and friends) and Ben Barratt for their hard work to implement the DAQI

The members of COMEAP sub committee on AQ standards

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