Use of the MACC-III Regional Ensemble as boundary conditions for *air*TEXT, London's street-scale air quality forecasting service

Amy Stidworthy

MACC-III User Workshop

11th May 2015

UNICEF, Rome, Italy

CERC

Cambridge Environmental Research Consultants

Environmental Software and Services

Overview of presentation

CERC: Who we are and what we do

*air*TEXT – the free air quality forecasting service for Greater London

Using MACC Regional Ensemble Air Quality Forecasts as boundary conditions for *air*TEXT

Concluding remarks

What is CERC?

CERC

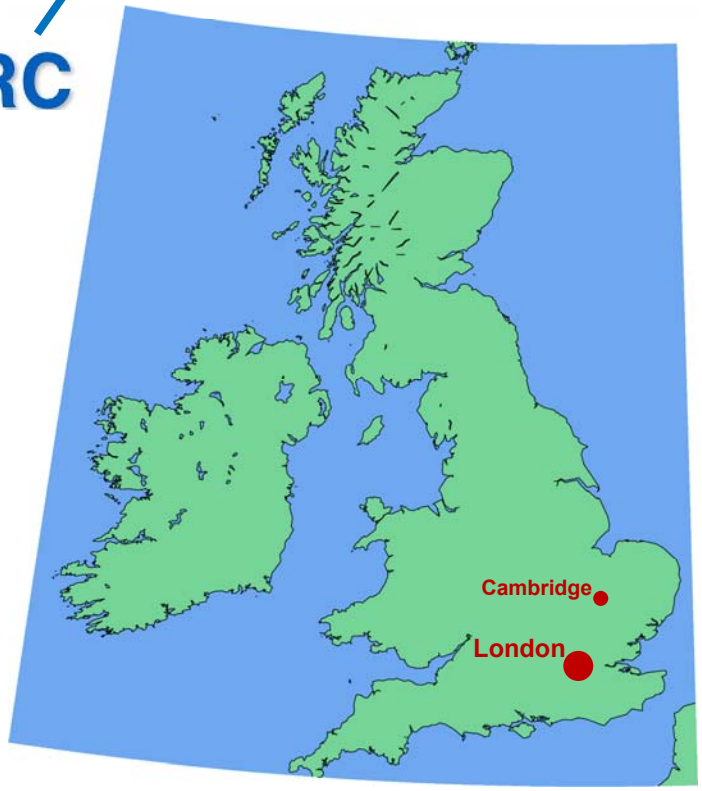
Cambridge Environmental Research Consultants (CERC) Ltd – private company founded in 1985

We carry out software design and development, consultancy, training and research in all aspects of local air quality

3 directors, 26 staff (11 Software Developers, 8 Air Quality Consultants, 7 Admin/IT Support Staff)

Offices in Cambridge (UK) and Beijing (China)

Hundreds of CERC software users all over the World



CERC Software

 ADMS 5	• Models dispersion of industrial emissions for permit applications and environmental impact assessments
 ADMS-Urban	• Comprehensive street-scale modelling system for managing urban air quality for planning and air quality assessments.
 ADMS-Roads	• Simplified version of ADMS-Urban for modelling road traffic and some industrial sources
 ADMS-Airport	• Extension of ADMS-Urban for managing air quality at airports
 EMIT	• Emissions inventory database software for toxic emissions and greenhouse gases
 FLOWSTAR	• Model of flow over complex terrain
 ADMSSTAR	• Advanced software for modelling short-term accidental releases
 ADMS-Screen	• Simple single source screening model for industrial emissions
 GASTAR	• Dense gas dispersion model
 Run Manager	• Software for distributing CERC model runs across networks

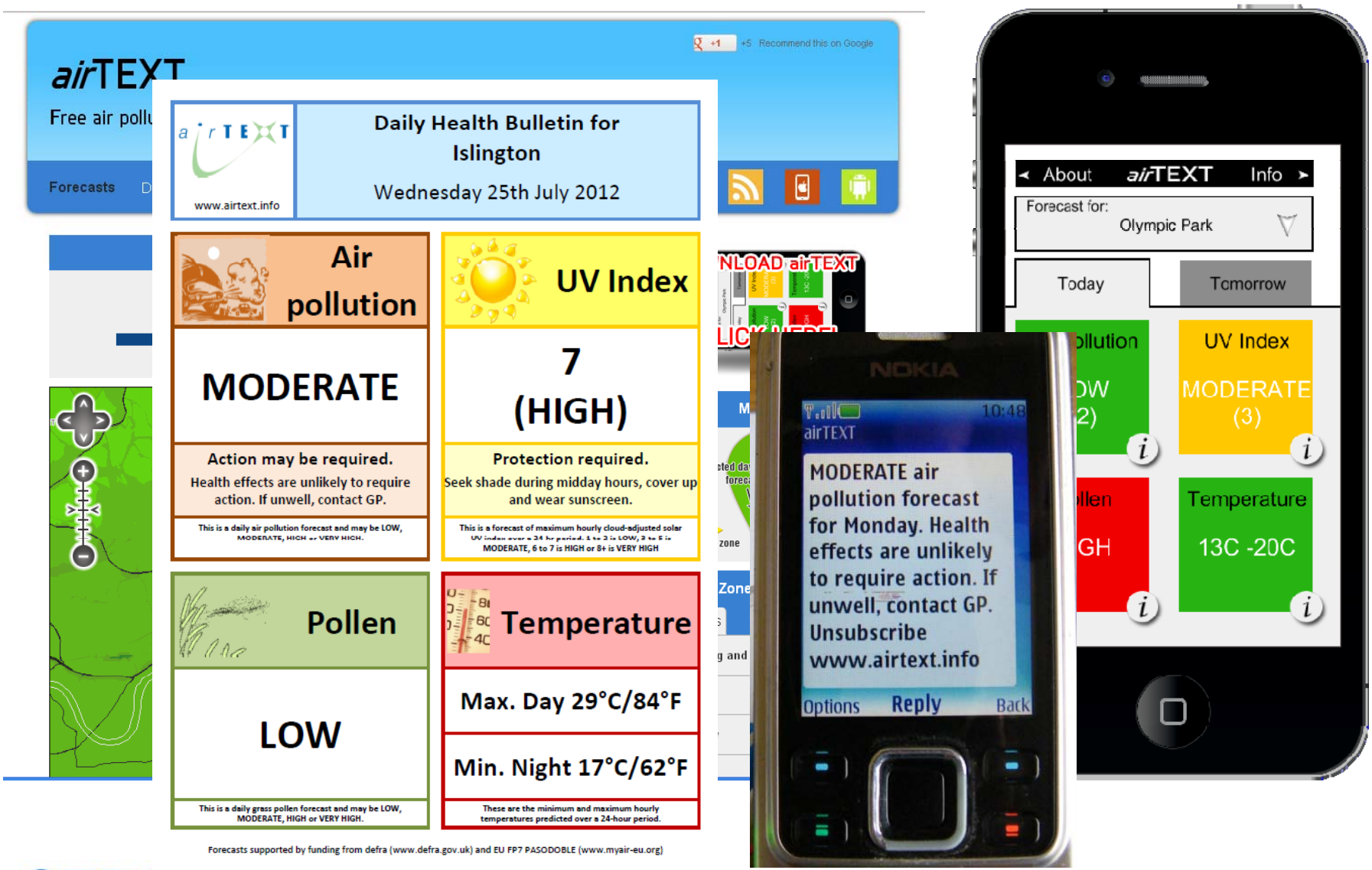
*air*TEXT

Free air pollution, UV, pollen and temperature forecasts for Greater London

Currently providing free air quality alerts to more than 10,000 subscribers

CERC

*air*TEXT products



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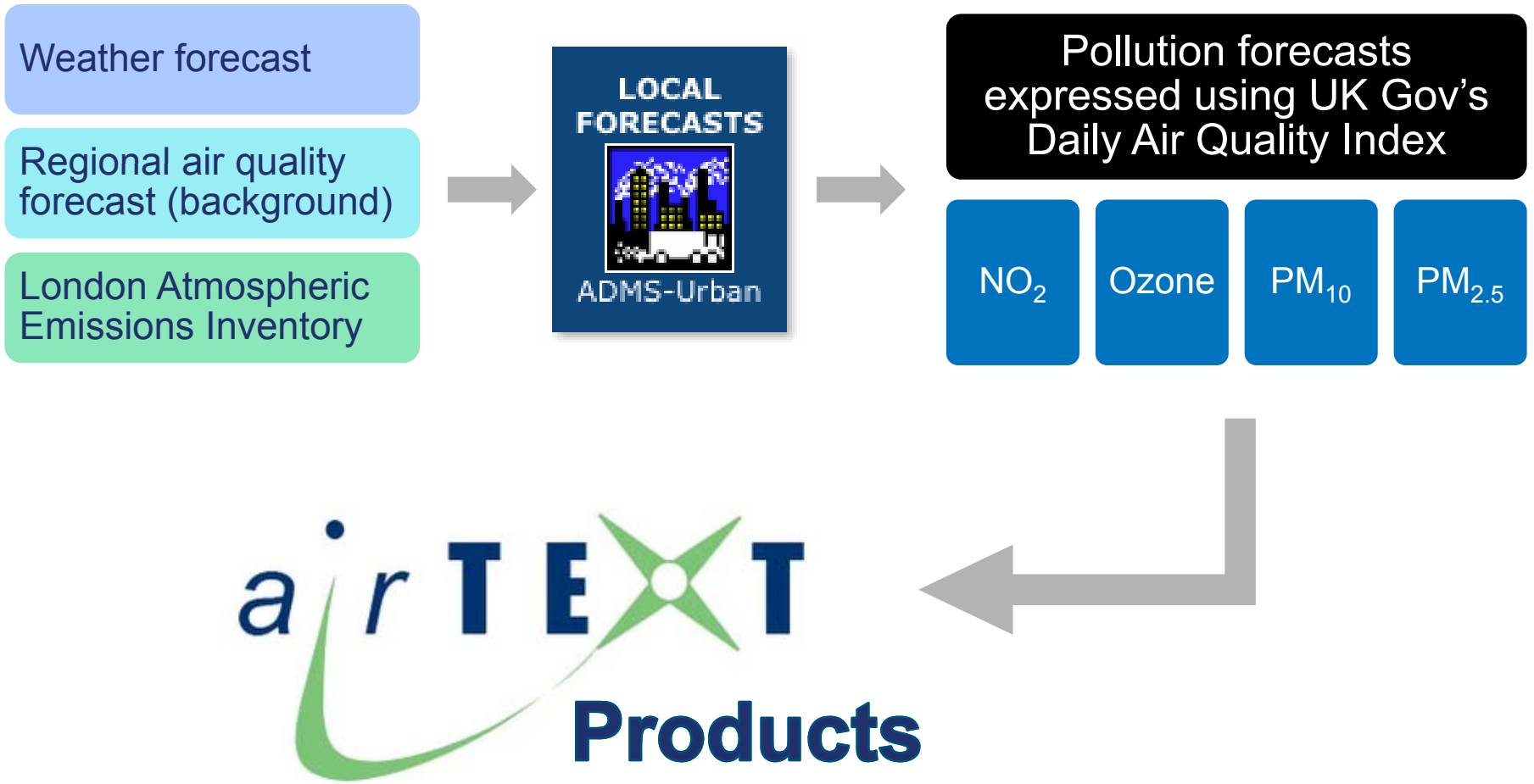
Mayor of London Air Quality Campaign: "Breathe Better Together"

CERC's *air*TEXT system



Treatment of regional forecast data in airTEXT

For each hour of the weather forecast, we interpolate regional forecast data to a point 75km upwind from a Central London receptor – idea is to remove any effect of local London sources

These data are added to contributions from local sources before the effects of NO_X chemistry are calculated

airTEXT currently uses the free Prev'air service from INERIS and partners (since 2007), which uses CHIMERE model: no complaints, great service

Migration from Prev'air to MACC Ensemble

We are migrating from Prev'air to the MACC Ensemble. Why the change?

- For airTEXT, the MACC Ensemble is the best sustainable, reliable, freely available and truly operational service that provides what we need: regional air quality forecasts over the UK
- Since the addition of $PM_{2.5}$ in 2012 and the addition of NO in 2014 (added in response to user requests) all the data we need are included
- Higher resolution (12km) compared to Prev'air (50km) ought to yield a better forecast

Why the need for a migration process? Can't we just switch now?

- Need to tread carefully – airTEXT already gives good predictions – don't want to rock the boat too much

What is the migration process?

- Step-by-step process of validation against local monitored data: we don't necessarily need results to be **better** with the MACC Ensemble, but they do need to be **just as good**

Migration process from Prev'air to MACC Ensemble

Step 1

- Analyse MACC Ensemble performance at key rural air quality monitors around London; compare with Prev'air

Step 2

- Extract background data for ADMS-Urban from MACC Ensemble for all of 2014; re-run ADMS-Urban for all of 2014

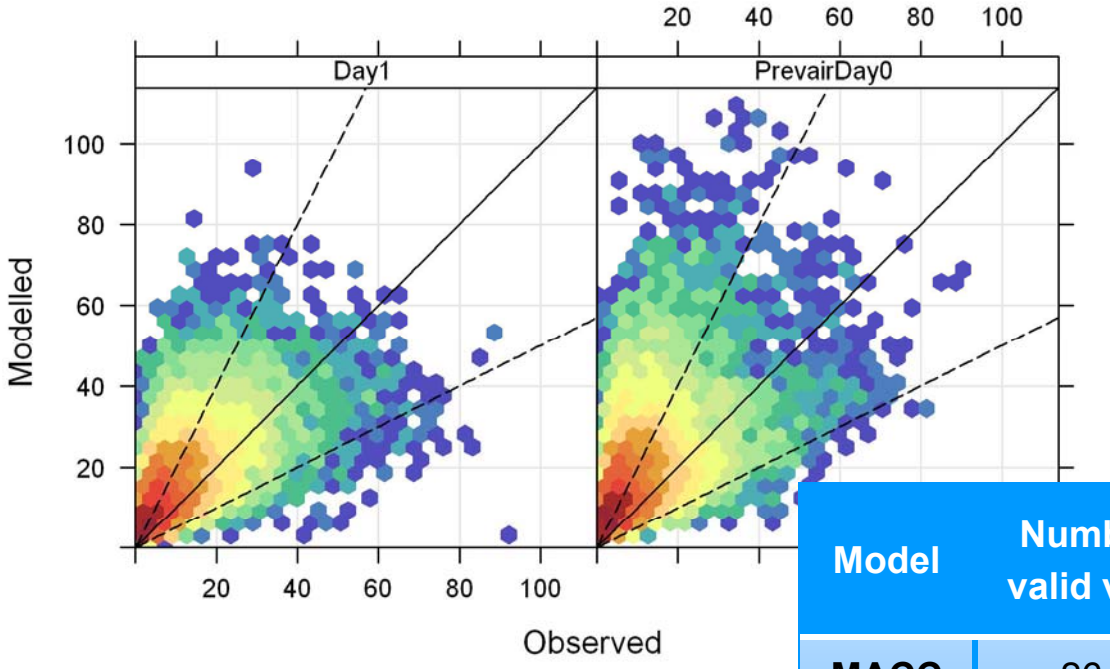
Step 3

- Compare airTEXT-Prev'air results with airTEXT-MACC results at all available monitoring sites within Greater London for all of 2014

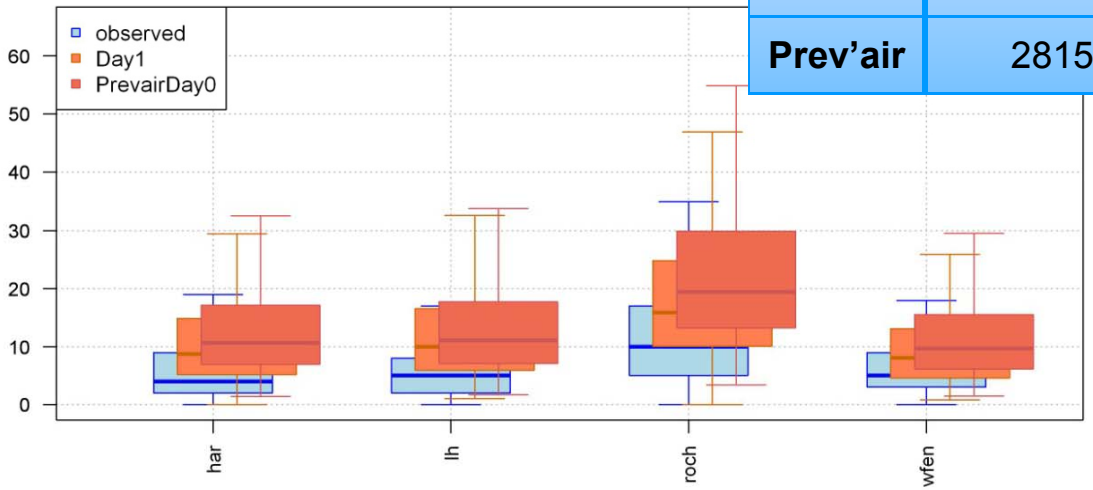
Step 4

- 'High' episodes: compare performance during key periods of 2014 and 2015 (PM10 and PM2.5)

Step 1: Comparison at rural sites – NO_2

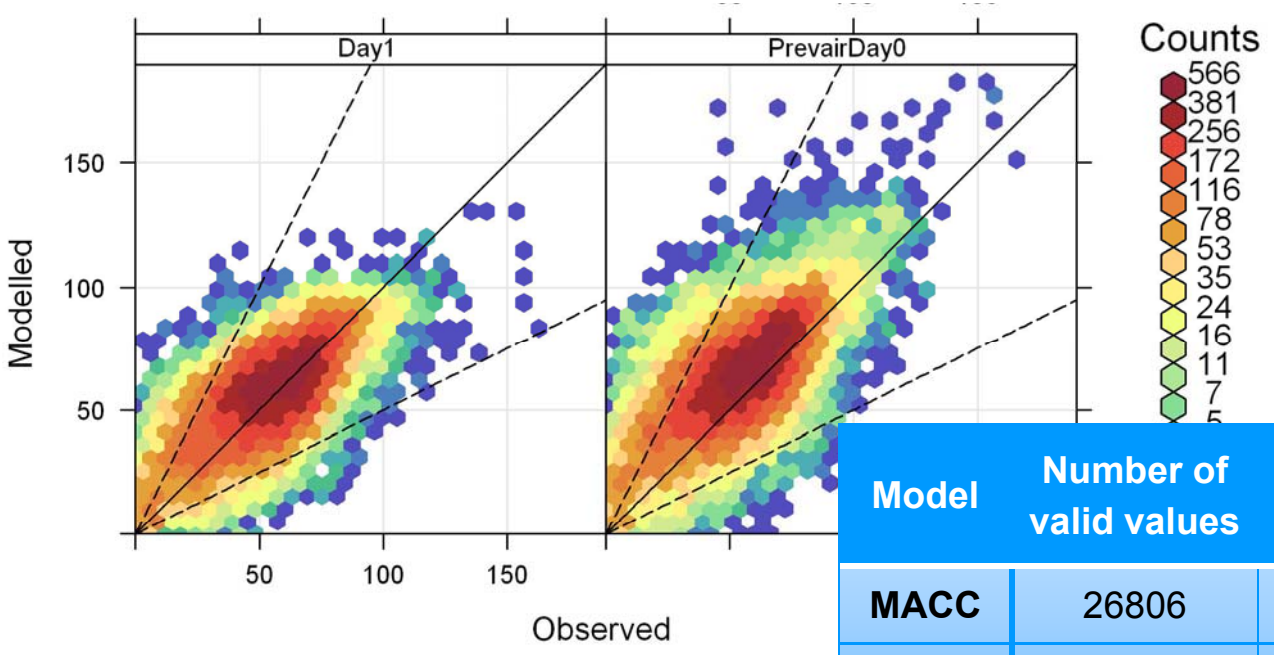


Model	Number of valid values	MB	NMSE	R	FAC2	FB
MACC	26472	4.93	0.76	0.67	0.56	0.45
Prev'air	28156	7.55	1.17	0.58	0.45	0.61

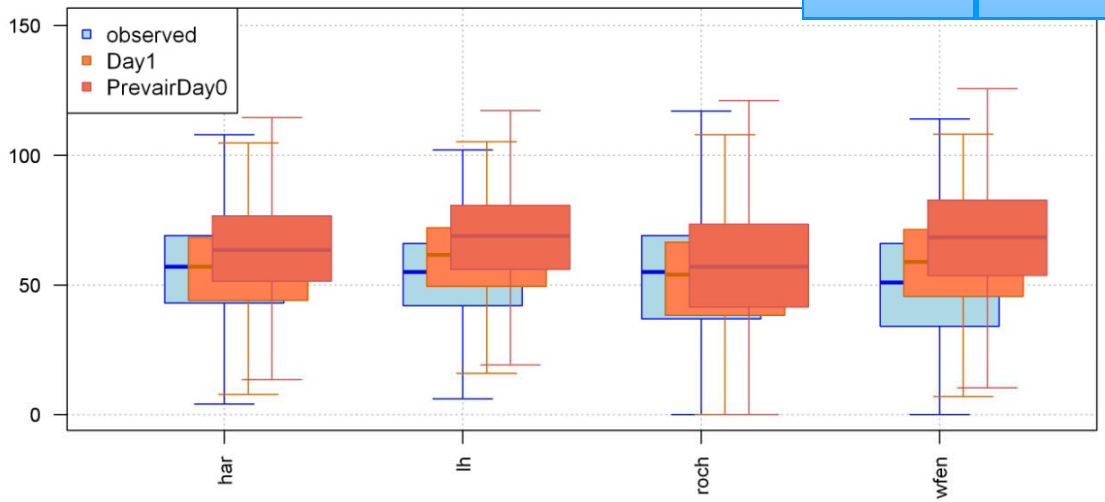


'Day1' = MACC Ensemble

Step 1: Comparison at rural sites – O_3



Model	Number of valid values	MB	NMSE	R	FAC2	FB
MACC	26806	3.54	0.09	0.71	0.91	0.07
Prev'air	28447	10.62	0.12	0.69	0.88	0.18



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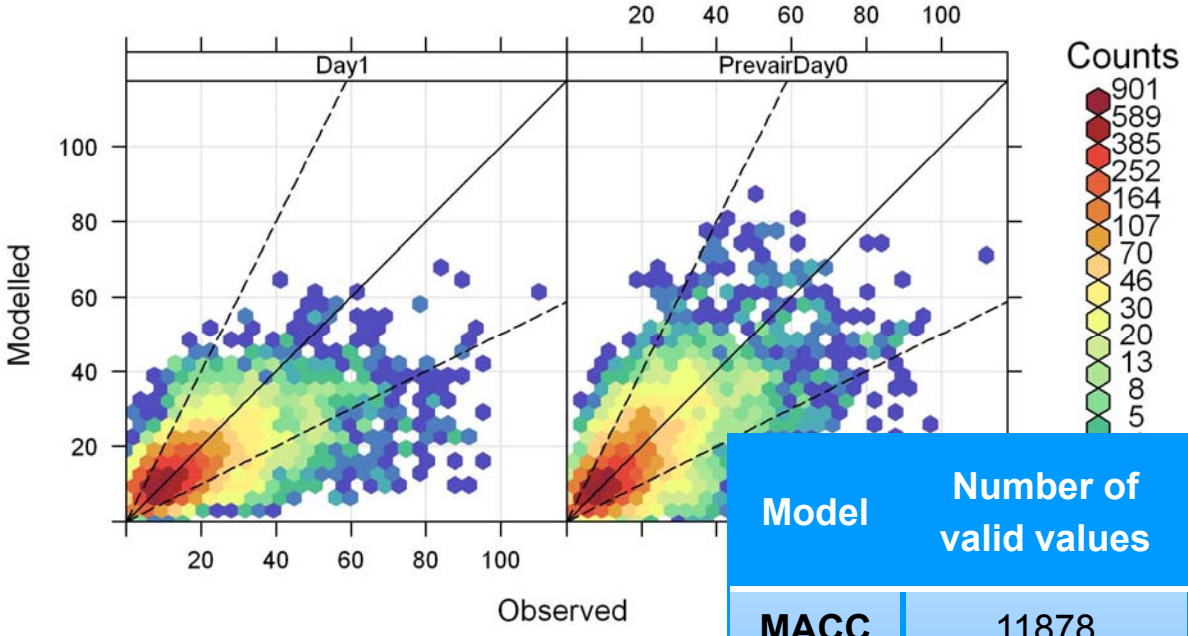
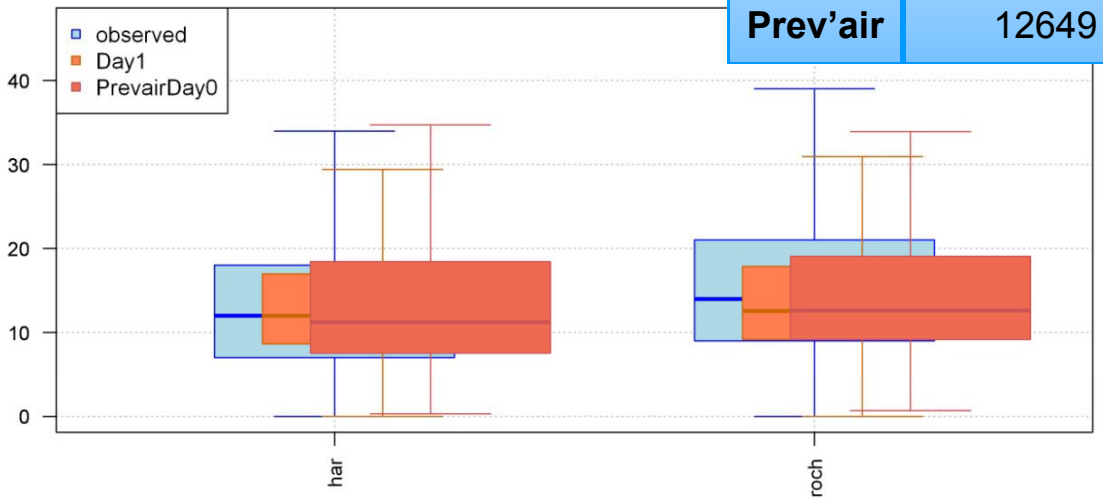
Step 1: Comparison at rural sites – PM_{10}

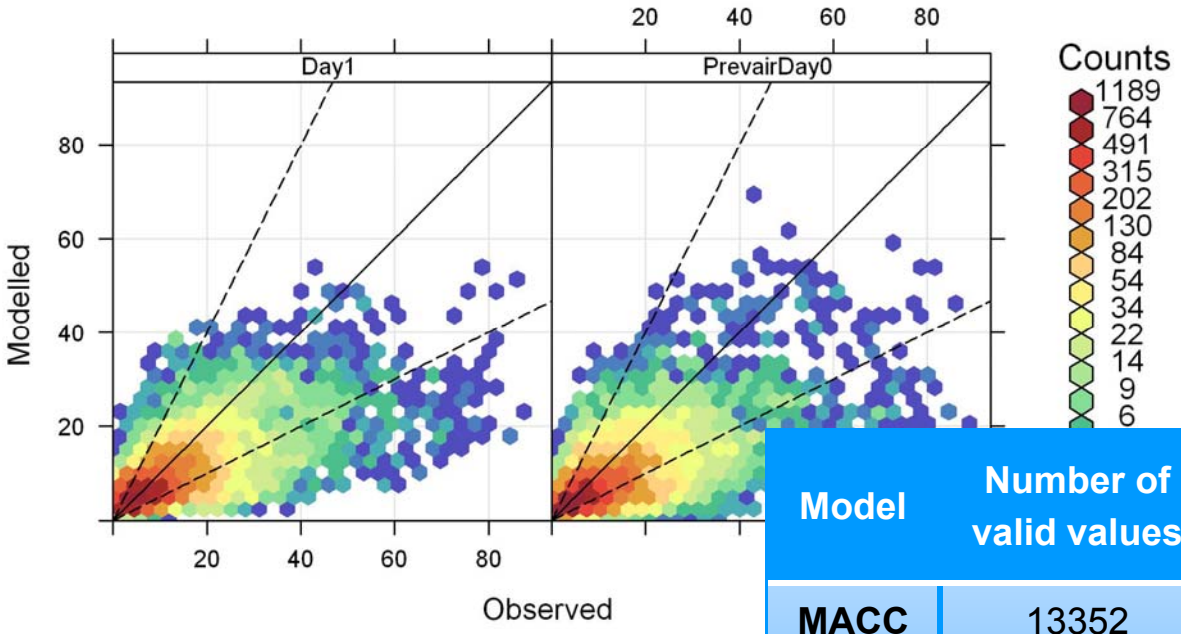


Model	Number of valid values	MB	NMSE	R	FAC2	FB
MACC	11878	-1.84	0.42	0.62	0.79	-0.12
Prev'air	12649	-1.03	0.36	0.67	0.79	-0.07

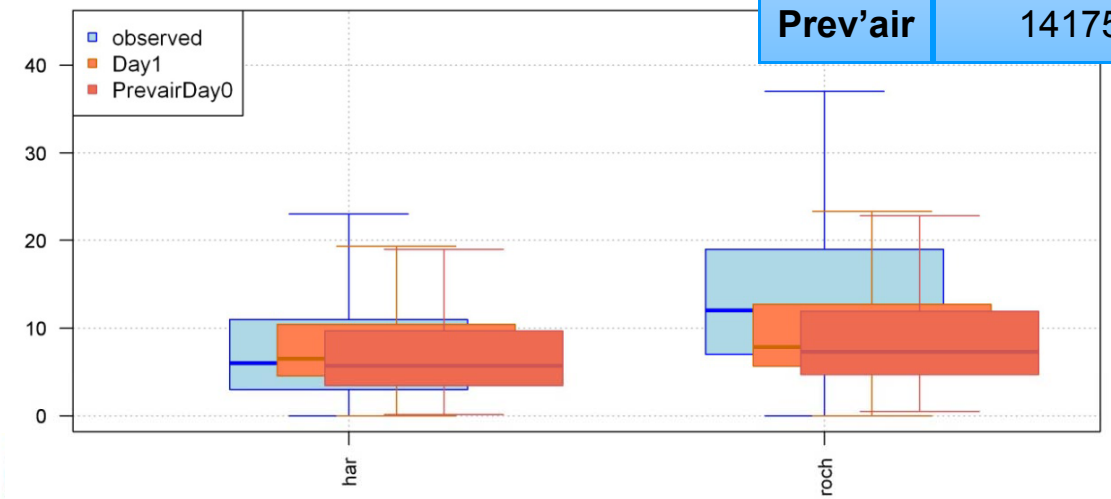


'Day1' = MACC Ensemble

Step 1: Comparison at rural sites – $PM_{2.5}$



Model	Number of valid values	MB	NMSE	R	FAC2	FB
MACC	13352	-2.44	0.67	0.68	0.70	-0.23
Prev'air	14175	-3.41	0.80	0.65	0.66	-0.33



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Step 4: Compare *air*TEXT 2014 results at all London sites

DAQI Statistics:

- NO_2: Daily maximum
- O_3: 8-hour rolling average
- PM_{10}: Daily mean
- $PM_{2.5}$: Daily mean

airTEXT-Prevair: Prev'air adjusted

airTEXT-MACC: No adjustments

Pollutant	Model	Number of valid values	MB	NMSE	R	FAC2	FB
NO_2	airTEXT_Prevair	23571	-2.1	0.30	0.55	0.85	-0.02
	airTEXT_MACC	23571	-9.8	0.32	0.56	0.84	-0.12
O_3	airTEXT_Prevair	181204	13.9	0.31	0.72	0.67	0.35
	airTEXT_MACC	181204	7.3	0.23	0.73	0.72	0.20
PM_{10}	airTEXT_Prevair	20328	0.6	0.14	0.71	0.95	0.02
	airTEXT_MACC	20328	-5.8	0.27	0.67	0.89	-0.27
$PM_{2.5}$	airTEXT_Prevair	7451	0.6	0.20	0.72	0.93	0.04
	airTEXT_MACC	7451	-3.7	0.34	0.73	0.88	-0.28

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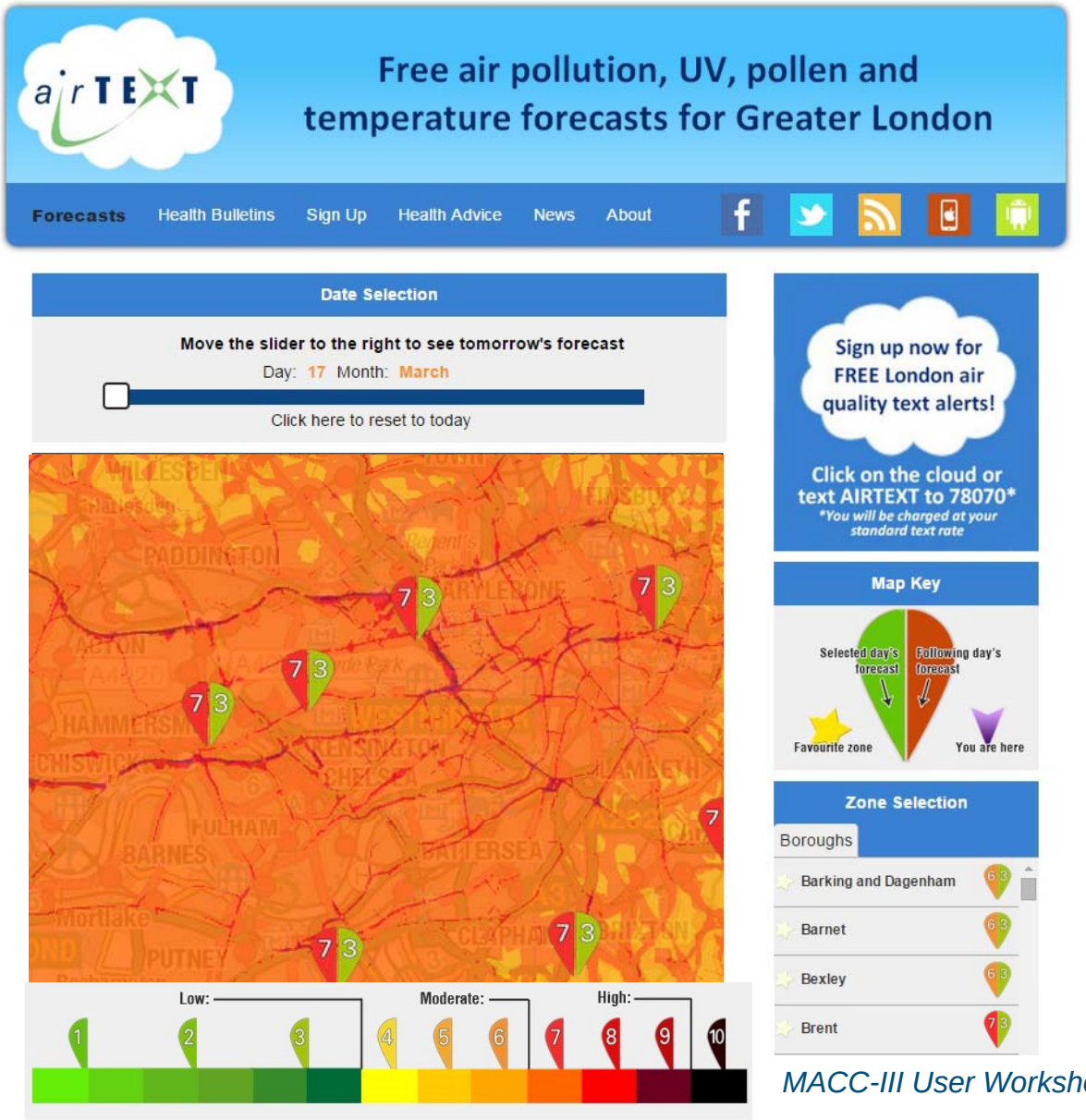
High Pollution Episodes



Early April 2014: PM_{10} and $PM_{2.5}$

The Telegraph

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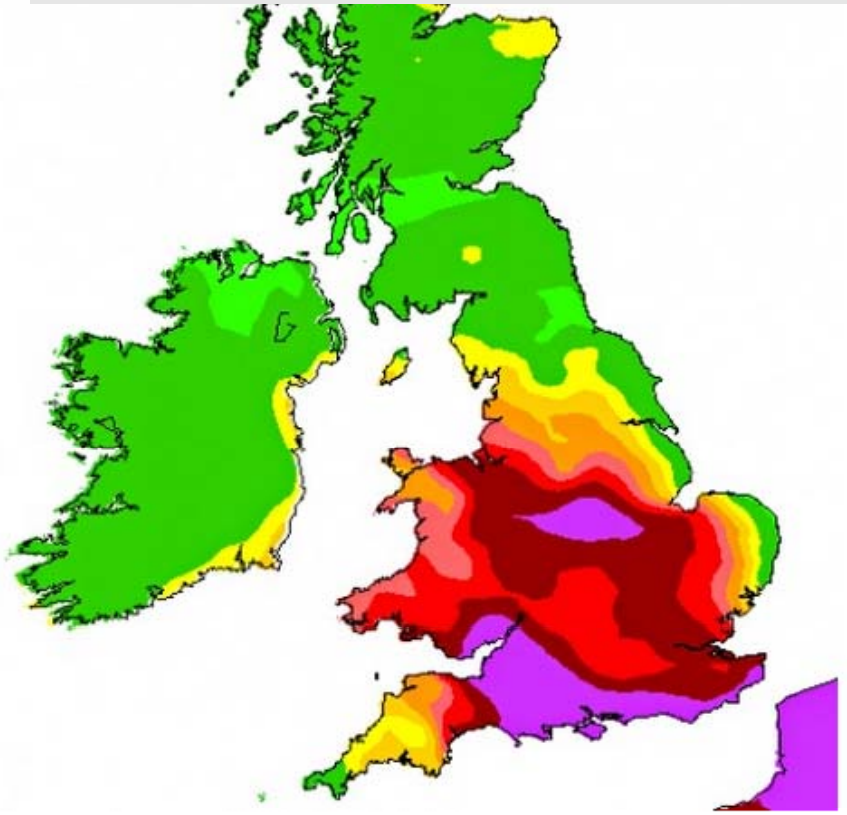
Saharan dust prompts 'very high' air pollution threatening sick and elderly

Anyone suffering from sore eyes or throat is advised to cut back on physical exertion while those with heart and lung problems are warned to take extra care

0 0 0 0 0 Email

David Cameron's car was covered in a light coating of red dust on Monday morning Photo: Steve Back

UK Gov air quality forecast for 2nd April 2014, produced by the Met Office.



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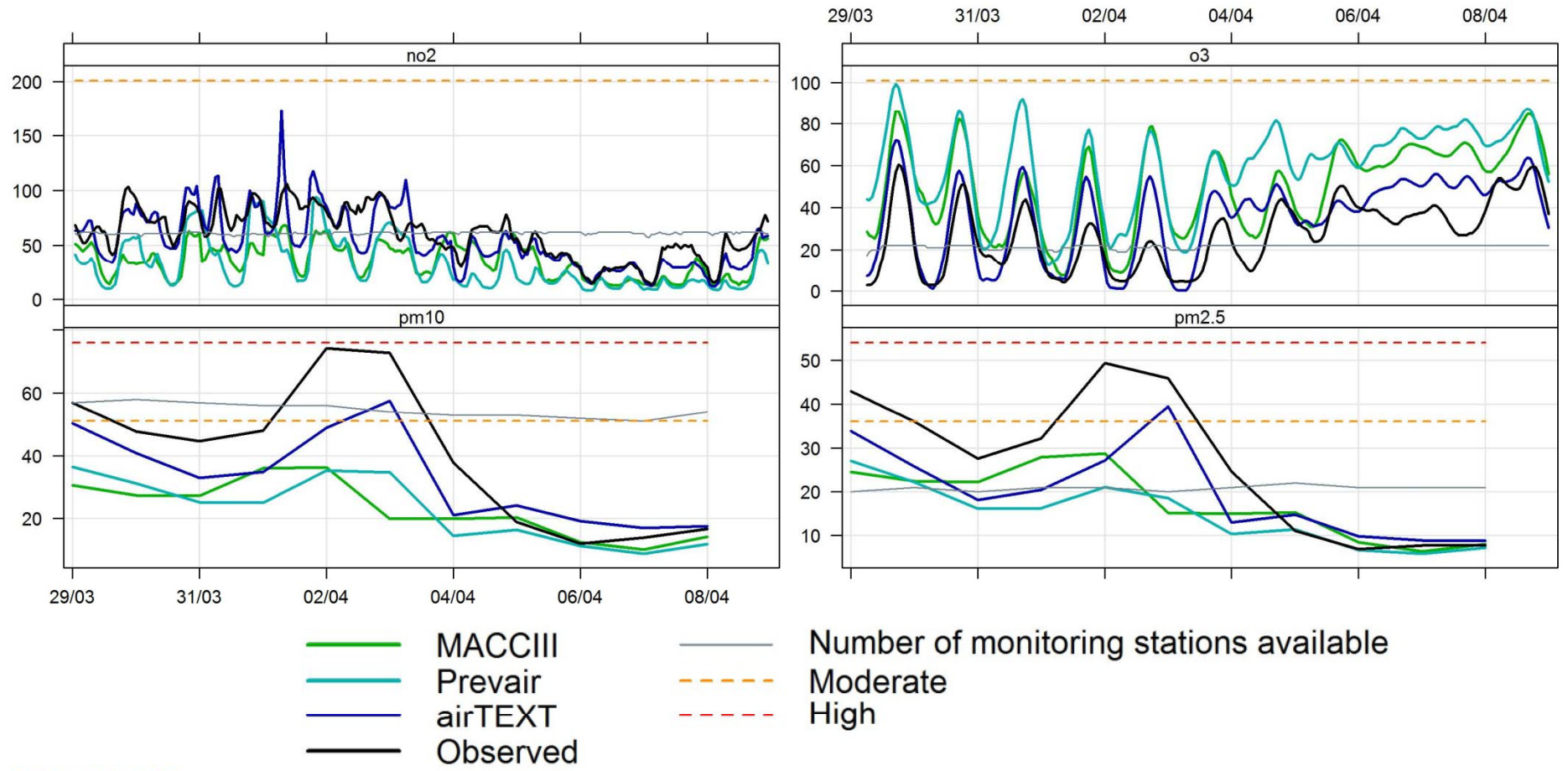
Early April 2014: Comparison with observations

Average concentration across all available London monitoring stations

DAQI Statistics: NO_2: Daily maximum, O_3: 8-hour rolling average, PM_{10} and $PM_{2.5}$: Daily mean

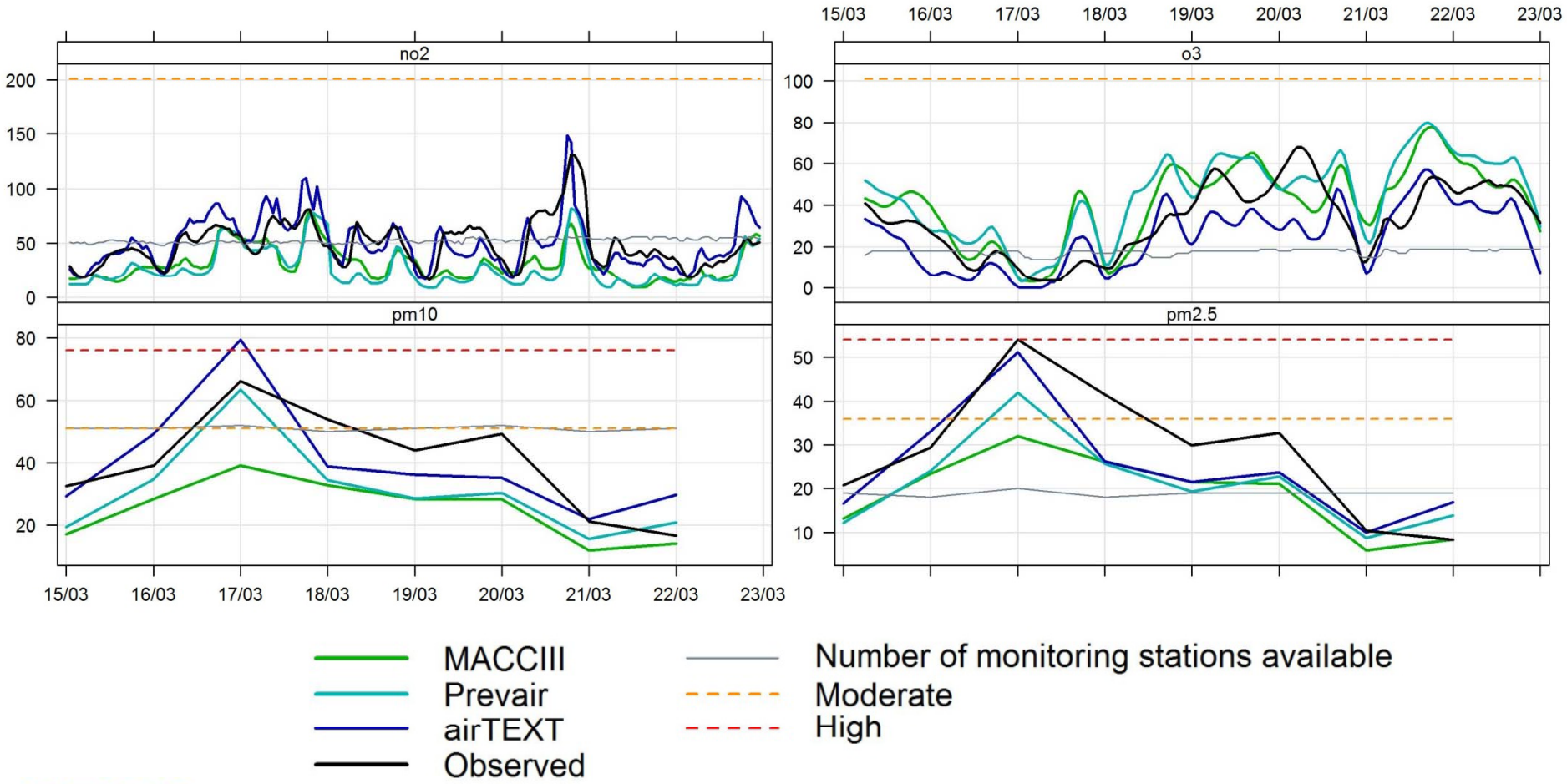


CERC

Mid March 2015: Comparison with observations

Average concentration across all available London monitoring stations

DAQI Statistics: NO_2: Daily maximum, O_3: 8-hour rolling average, PM_{10} and $PM_{2.5}$: Daily mean



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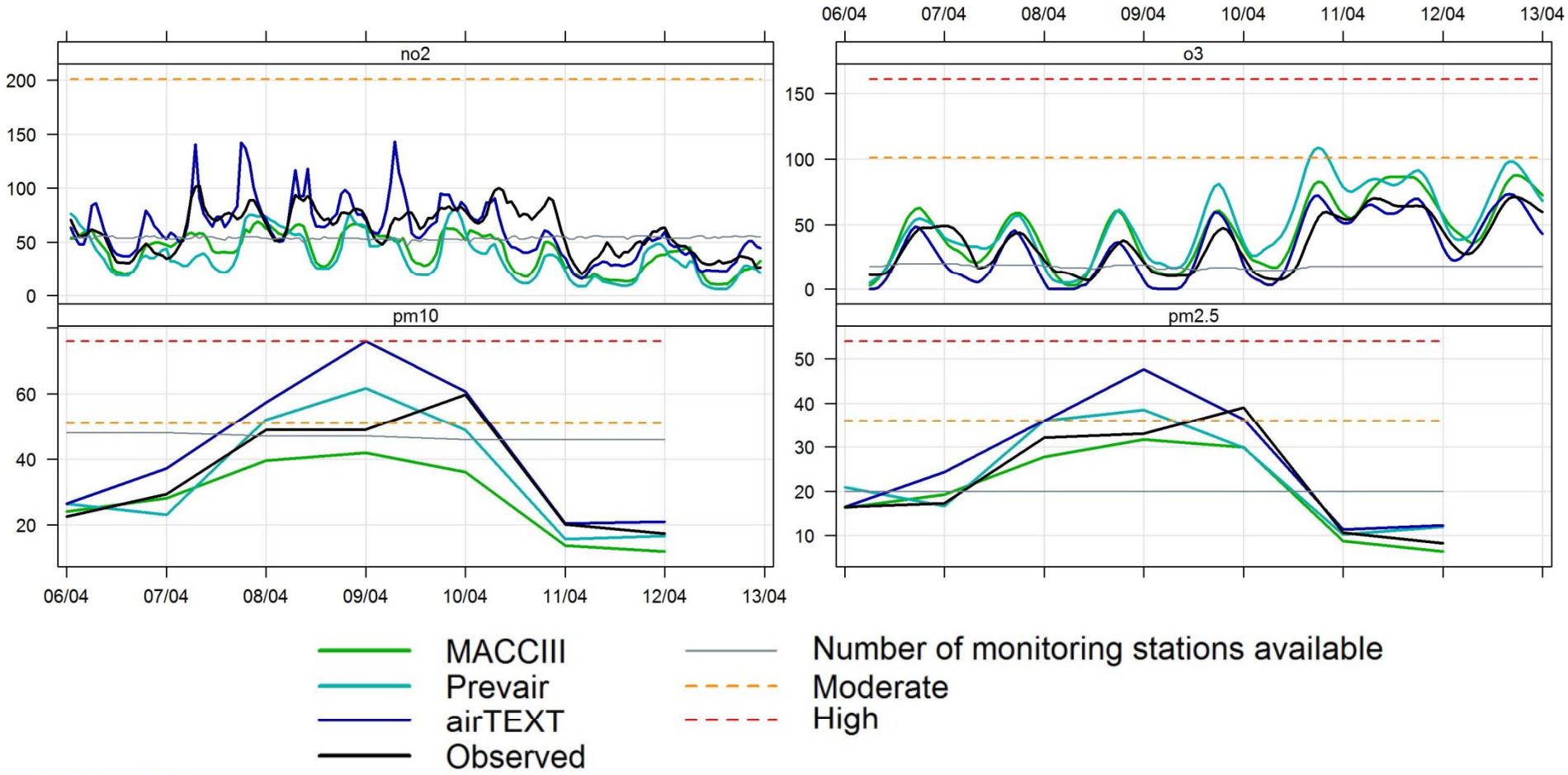

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Remaining steps before moving to operations

Calculate adjustment factors to apply to MACC Ensemble data at extraction stage

Run forecast with MACC Ensemble in operational system for monitoring sites only in parallel to standard system for 3-4 weeks

Finally, switch operational *air*TEXT system over to use MACC Ensemble

Concluding remarks

- MACC Ensemble has proved reliable – no issues since May 2014
- For all pollutants except PM_{10}, MACC Ensemble performs better at rural sites around London than Prev'air in 2014
- airTEXT re-runs for 2014 with MACC Ensemble are at least as good as with Prev'air
- Episode analysis shows that airTEXT-MACC is likely to be as good at predicting High PM episodes as airTEXT-Prevair.
- Episode analysis also demonstrates that a regional air quality forecast on its own is not enough to capture high pollution episodes in an urban area like London – a local air quality forecasting system like *air*TEXT is needed

Thank you for your attention