Air Quality Forecasting in London

Gary Fuller
Environmental Research Group
King's College London

Contents

- What do we do?
- How do we do it?
- Challenges
- How well do we do it?

KING'S College LONDON Founded 1829

What do we do?

- Forecasts to subscribing London Boroughs and their nominees
- (and home counties networks if incident)
- Forecasts disseminated by email.
- Onward dissemination on Council internet sites, bulletin boards etc.

KING'S College LONDON Founded 1829

What do we do?

- Forecast each weekday / weekend
  - Next 24 hours / weekend
  - Summary of current and recent pollution
  - CO, NO_2, O_3, PM_{10}, SO_2
  - Borough / district level
  - Roadside and background
  - Local and site specific issues
  - Outlook

What do we do?

Issued at: 11:00 Friday 7th March 2003
Valid until: 12:00 Monday 10th March 2003

Current Situation

Air pollution in your area is currently ‘low’.

Forecast

Increasingly brisk south-westerly winds will ensure that air pollution in your area will remain ‘low’ throughout the weekend for the following pollutants:

Carbon monoxide
Nitrogen dioxide
Ozone
PM10 particulates
Sulphur dioxide

Current pollution levels can be found at http://www.erg.kcl.ac.uk

If you have further questions please contact airquality@erg.kcl.ac.uk.

Ben Barratt
Duty Forecaster.

What do we do?

- Issued at: 12:00 Wednesday 26th March 2003
- Valid until: 12:00 Thursday 27th March 2003
-
- Summary of Recent Conditions
-
- London continues to be affected by widespread ‘moderate’ PM10 particulates.
-
- During the last 24 hours PM10 particulate levels have shown a general rise. This morning eighteen roadside sites have measured ‘moderate’ PM10 particulates with ‘moderate’ pollution now extending to roadside sites in the southern suburbs. Six background monitoring sites in inner and east London have also measured ‘moderate’ PM10 particulates. PM10 particulate levels continue to rise slowly.
-
- ‘Very high’ PM10 particulates were measured at the Bexley 4 roadside site due additional PM10 from local sources.
-
- Yesterday afternoon ‘moderate’ ozone was measured at Kingston 1, Enfield 3 and Sevenoaks but widespread ‘moderate’ ozone was not measured in London.
-
- Several sites again measured elevated nitrogen dioxide this morning.
-
- During the last 3 hours elevated sulphur dioxide was measured at Croydon 4.
-
- The current pollution conditions are not confined to London. Our sister network in Paris has been reporting similar PM10 particulate pollution. Details of air pollution in Paris can be found at www.airparif.asso.fr
-

KING'S College LONDON Founded 1829

What do we do?

- Forecast
-
- PM10 particulate levels expected to rise slowly. It is likely (90%) that ‘Moderate’ PM10 particulates at roadside locations. There is a 30% chance that ‘moderate’ PM10 particulates will be measured at background locations.
-
- ‘Moderate’ ozone will not be as widespread as yesterday. There is a 10% chance of ‘moderate’ ozone at locations away from busy roads.
-
- Elevated sulphur dioxide may be measured due to plume grounding from industry in the East Thames corridor.
-
- Air pollution will remain ‘low’ for the following pollutants
-
- Carbon monoxide
- Nitrogen dioxide
- Sulphur dioxide
-
- Outlook
-
- Current weather conditions are likely to change on Friday and over the weekend. This should lead to an improvement in air pollution.
-
- Current pollution levels in London can be found at http://www.erg.kcl.ac.uk
-
- If you have further questions please contact airquality@erg.kcl.ac.uk.

KING'S College LONDON Founded 1829

How do we do it?

- Forecasting heavily based on network measurements.
- Started as aid to monitoring network management
  - Assess instrument performance
  - LSO activities eg TEOM filter loading
  - ESU prioritisation

How do we do it?

- Recent Pollution
  - Inner/ Outer /Rural (east /west)
  - Kerbside, Roadside, Background
  - Cycles & Trends
  - Max Readings
  - Local effects eg canyon orientation, local PM_{10}
  - PM_{10} primary & secondary
  - PM_{10} needed for exceedence
  - O_3 Gradient
  - SO_2 – Activity
  - Measurements in the home counties and near continent

How do we do it?

- Historic Pollution
  - Previous conditions that led to pollution incidents
  - Pollution behaviour at specific sites

How do we do it?

- Forecast Met.
- Episode conditions & timing

  - Wind speed, direction, temperature, cloud cover, sunshine, fog, rain, back trajectories, change air mass

  - AM Rush Hour
  - Mid Afternoon (mainly summer)
  - PM Rush hour

How do we do it?

- Recent Meteorology
  - 60 + sites with met. measurements
  - Questionable accuracy but still useful
  - Compare to recent pollution measurements
  - Looking at the sky (!)

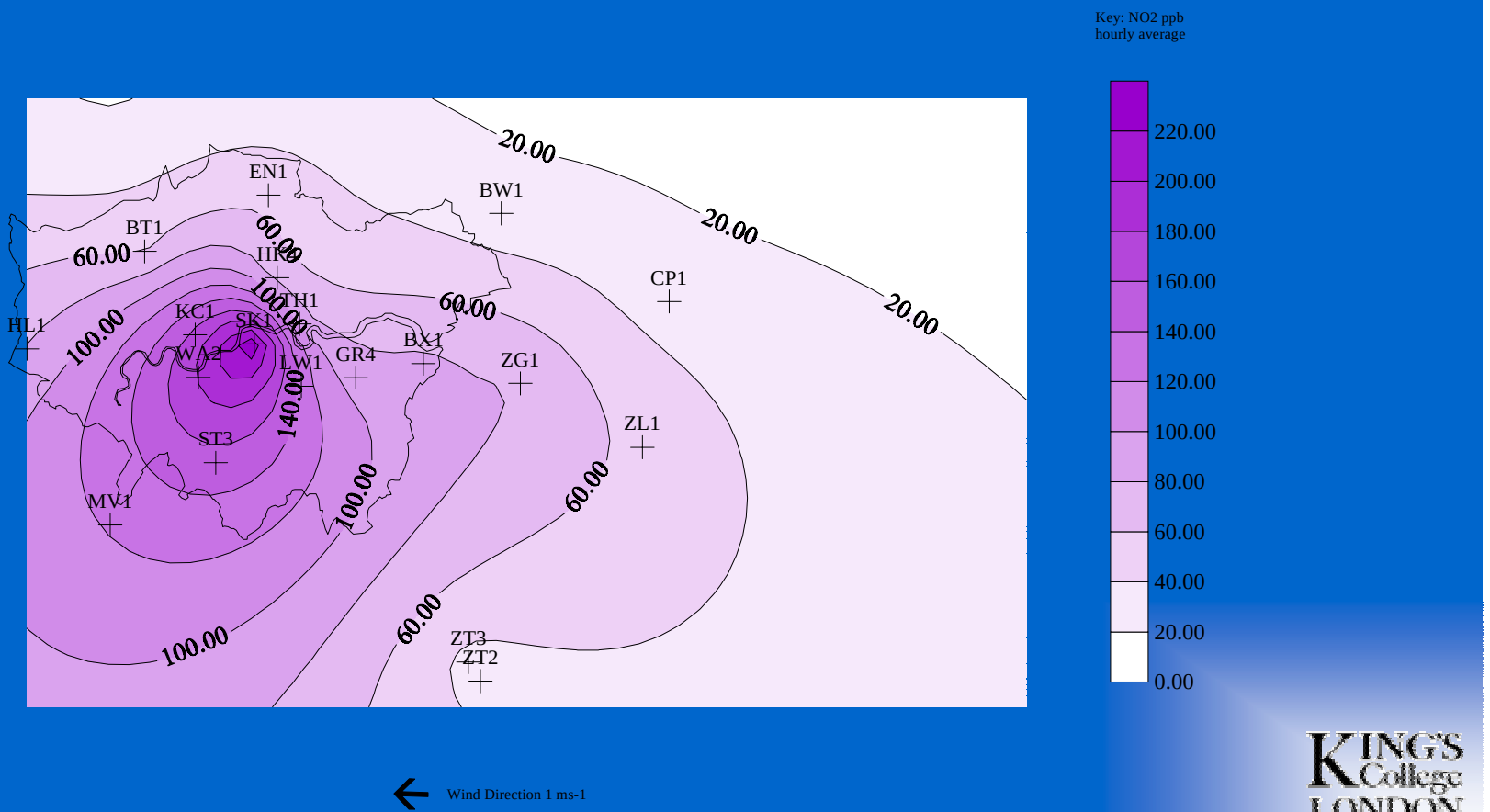
Forecasting Challenges

- Early start to O_3 season (rolling 8h >50 ppb)
  - 23rd March 2003 (earliest in 10 years LAQN)
  - 30th March 2002
- Spring peak in background O_3
- Winter 'moderate' O_3
  - Isolated overnight hourly means >50 ppb
  - 1-5 days per winter
  - Fresh 'clean' air
  - O_3 response factors?

Forecasting Challenges

- ‘Sub – regional’ variations

Figure 1:
NO2 Pollution Incident over London 31 October 1997 10:00 hours



KING'S College LONDON Founded 1829

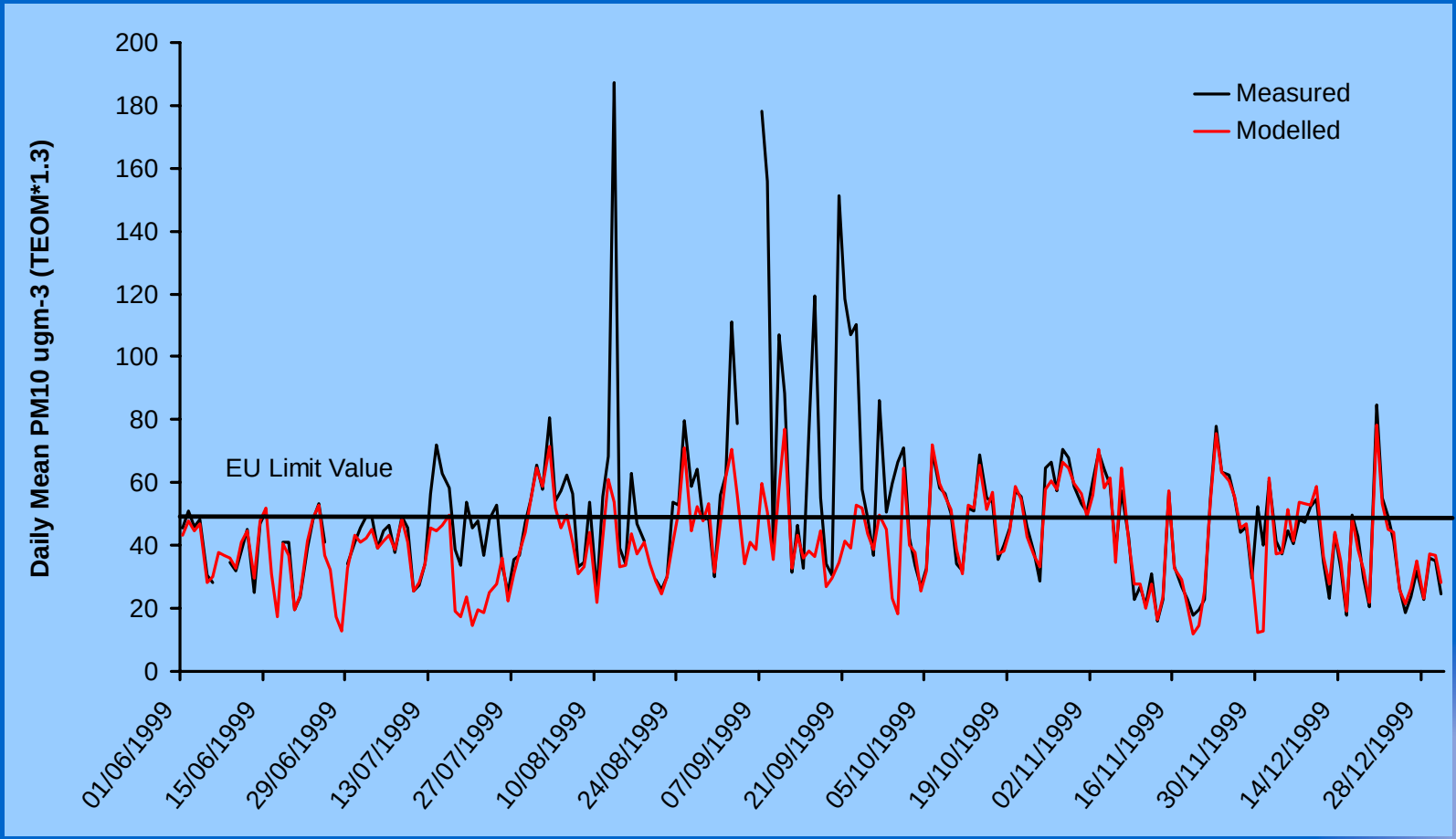
Forecasting Challenges

- ‘Sub – regional’ variations

KING'S College LONDON Founded 1829

Forecasting Challenges

- Local PM_{10} (Fuller *et al* 2002 Atmos Env 36/9 1431-1441)

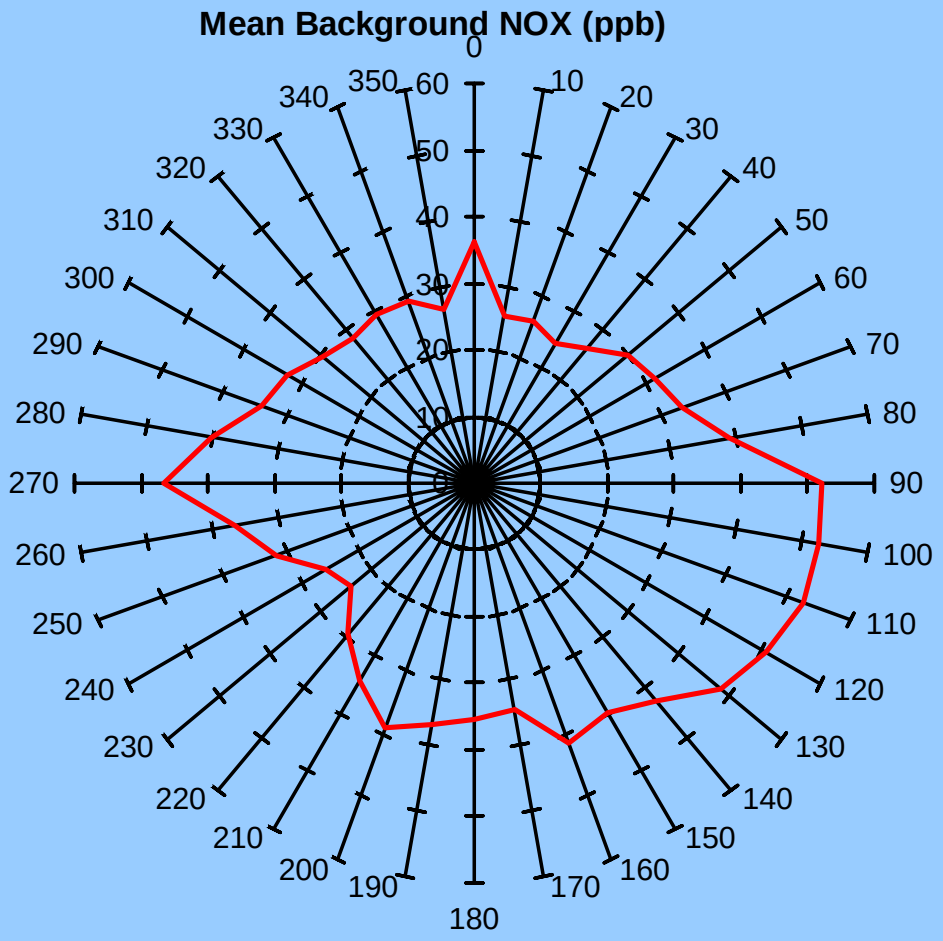


KING'S College LONDON Founded 1829

Forecasting Challenges

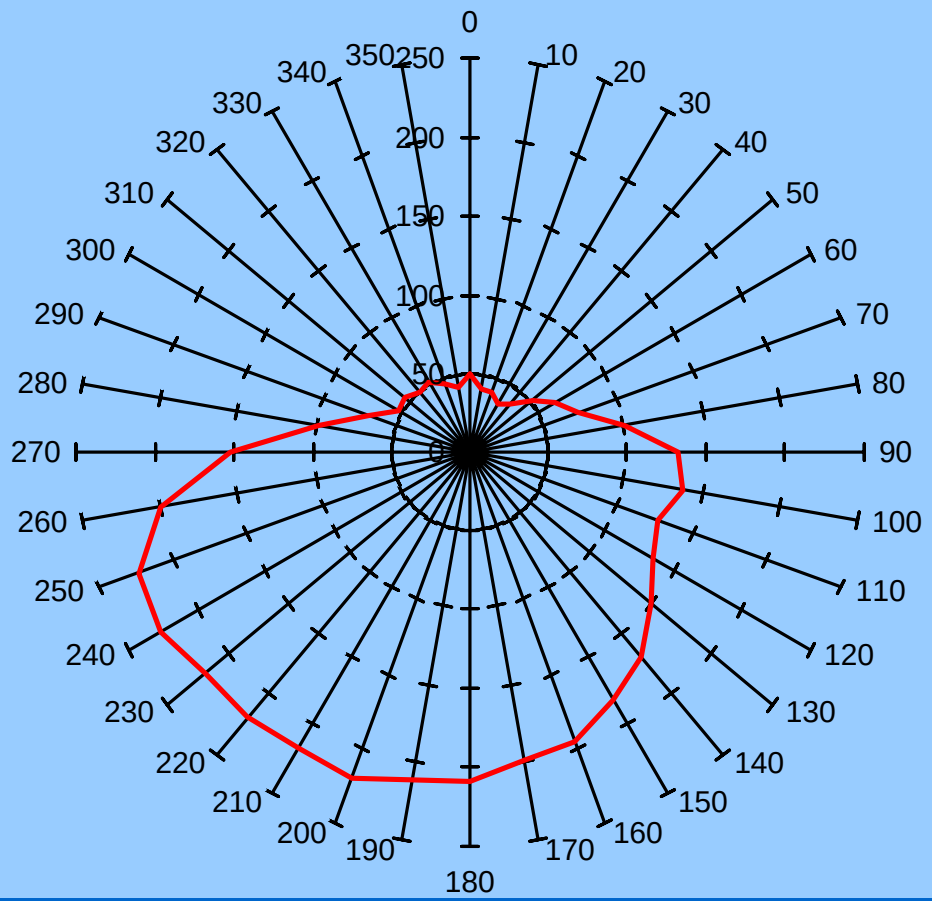
- ‘Canyon’ effects…..

Forecasting Challenges



KING'S College LONDON Founded 1829

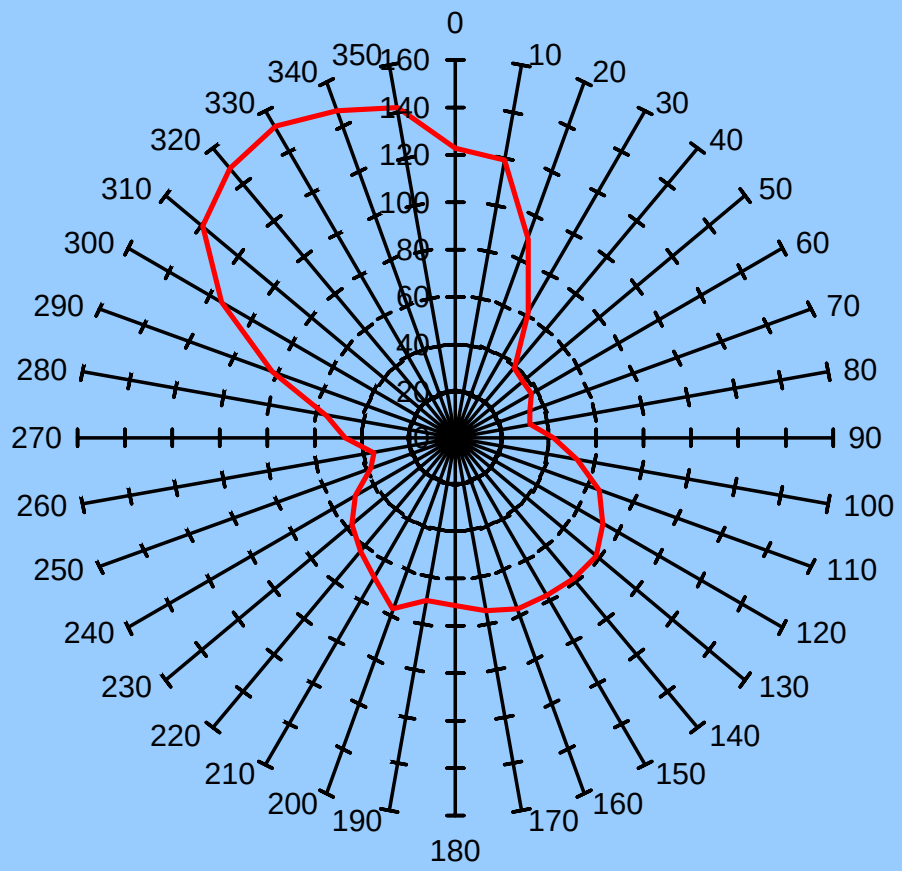
Forecasting Challenges



NB Variation in NO_2 approx 26ppb

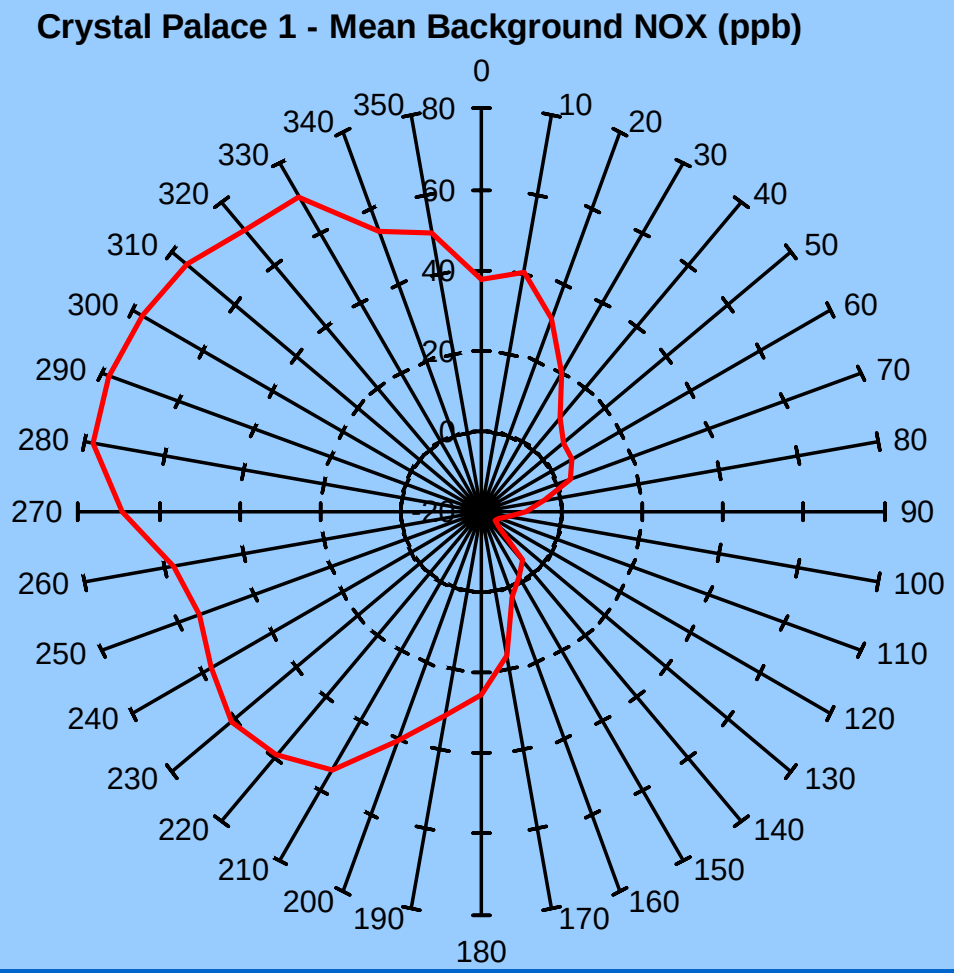
KINGS College LONDON Founded 1829

Forecasting Challenges



KING'S College LONDON Founded 1829

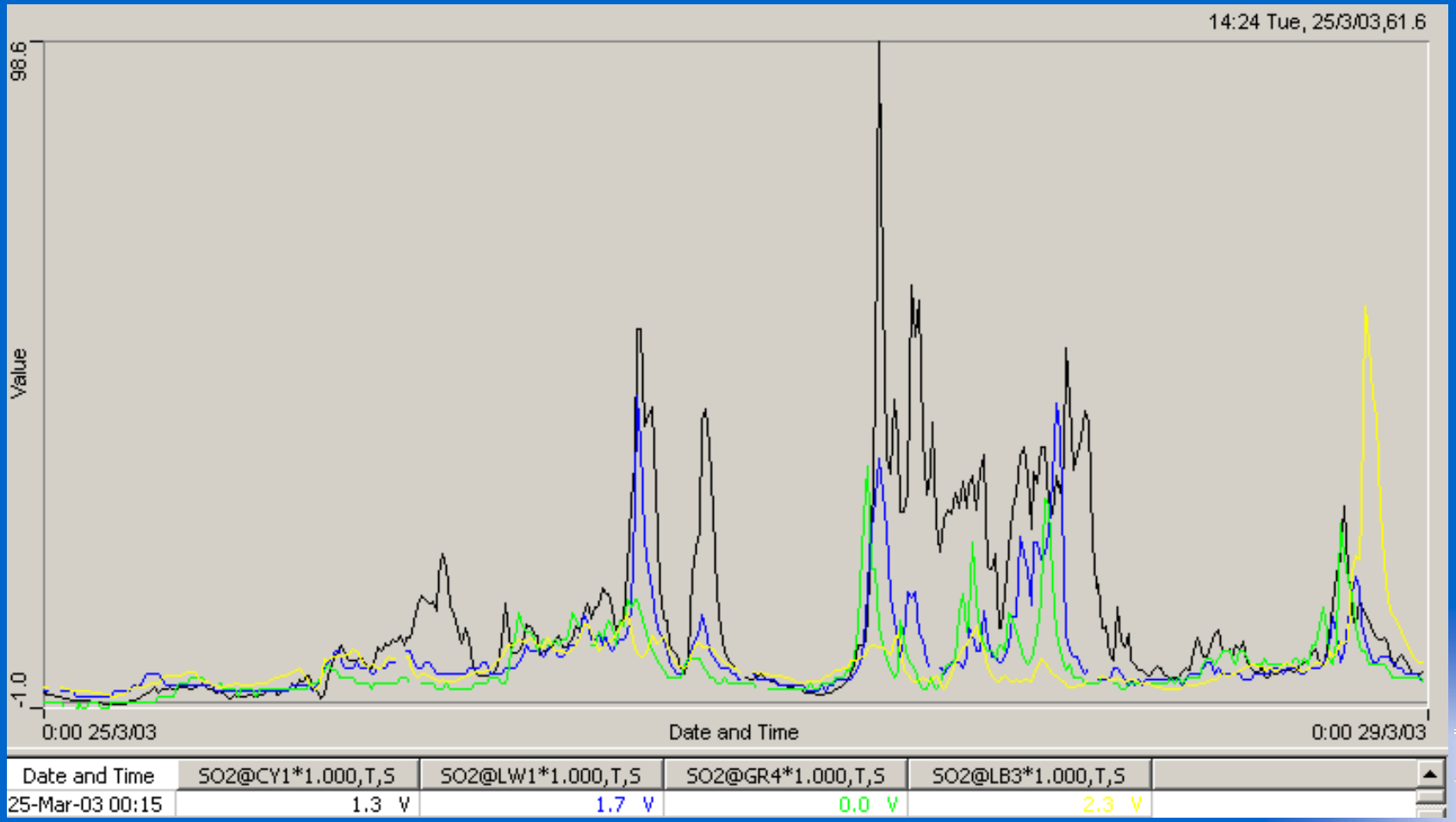
Forecasting Challenges



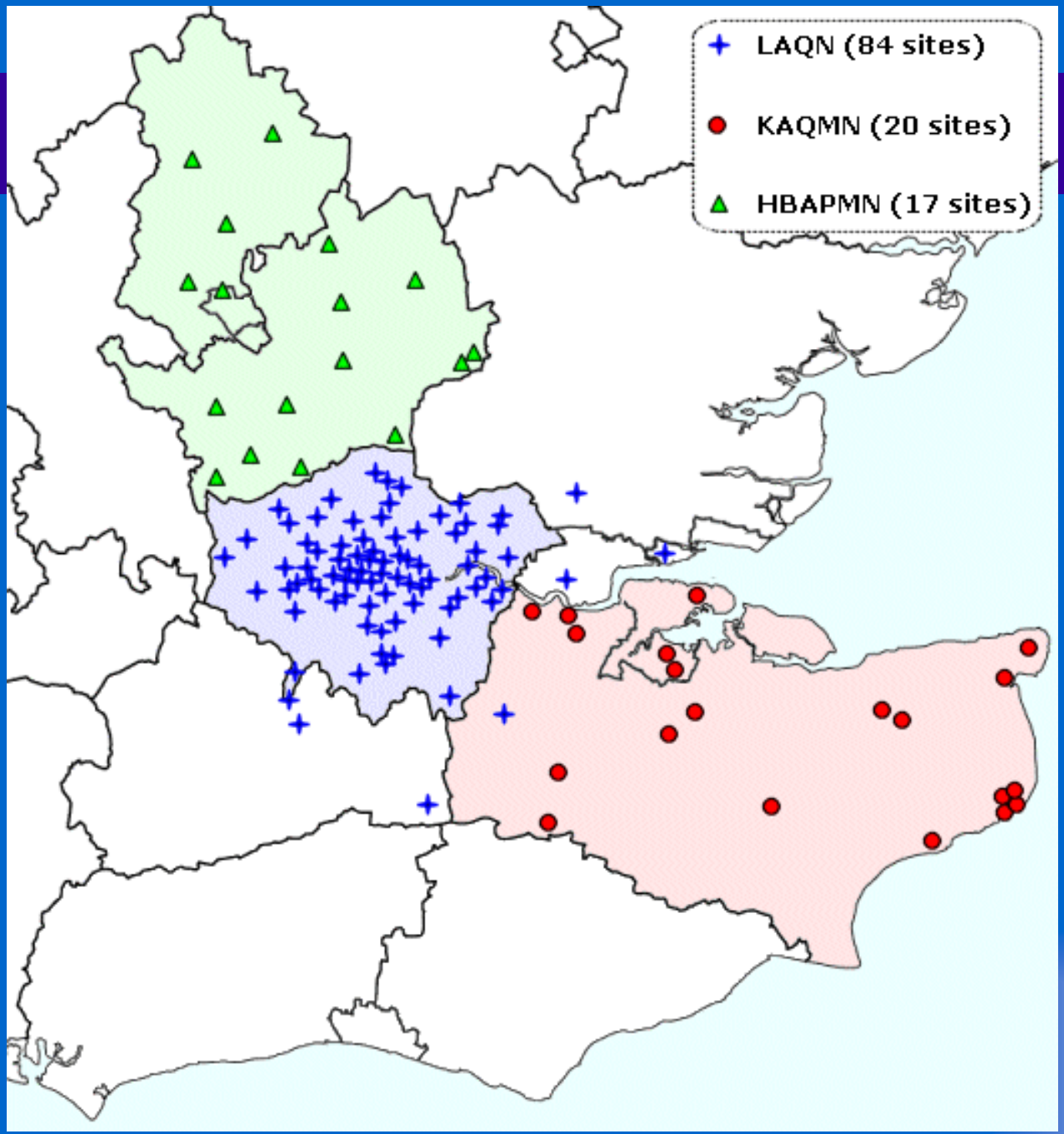
KING'S College LONDON Founded 1829

Forecasting Challenges

- SO_2 activity



Date and Time	SO2@CY1*1.000,T,S	SO2@LW1*1.000,T,S	SO2@GR4*1.000,T,S	SO2@LB3*1.000,T,S
25-Mar-03 00:15	1.3 V	1.7 V	0.0 V	2.3 V



KING'S College LONDON
Founded 1829

Forecasting Challenges

- Varying emissions
  - Christmas shopping eg at KC3 (Knightsbridge)
  - Traffic diversions

Accuracy

- Accuracy of probability estimates 1997 – 'moderate'+
  - PM_{10} predict <50% actual 19%
  - PM_{10} predict >50% actual 47%
  - O_3 predict <50% actual 26%
  - O_3 predict >50% actual 80%
  - SO_2 predict ~5%-10% actual 3%
  - NO_2 predict 3, events 0
- Measured and Predicted

Accuracy

- Jan 2001 to Jul 2002
  - 70% of days moderate and above correctly predicted. (60/85)
  - Main errors
    - Early start to O_3 season in 2002 (30th March!)
    - Fog bound weekend in Oct 2001
    - Single site events

Summary

- ERG Forecasts
- Methodology strongly based on network measurements
- Challenges
- Accuracy