AirTrack: Tracking air-quality performance: applications, implications & challenges

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Outline

- **Introduction**
  - Scope of AirTrack
  - Role of Case Studies
- **Applications**
  - London Hillingdon (M4)
  - Scunthorpe (Corus Steelworks)
- **Implications**
  - Network Optimisation
- **Challenges**
  - Meteorological Uncertainty
- **Conclusions**
  - User Engagement
  - Measures of Success

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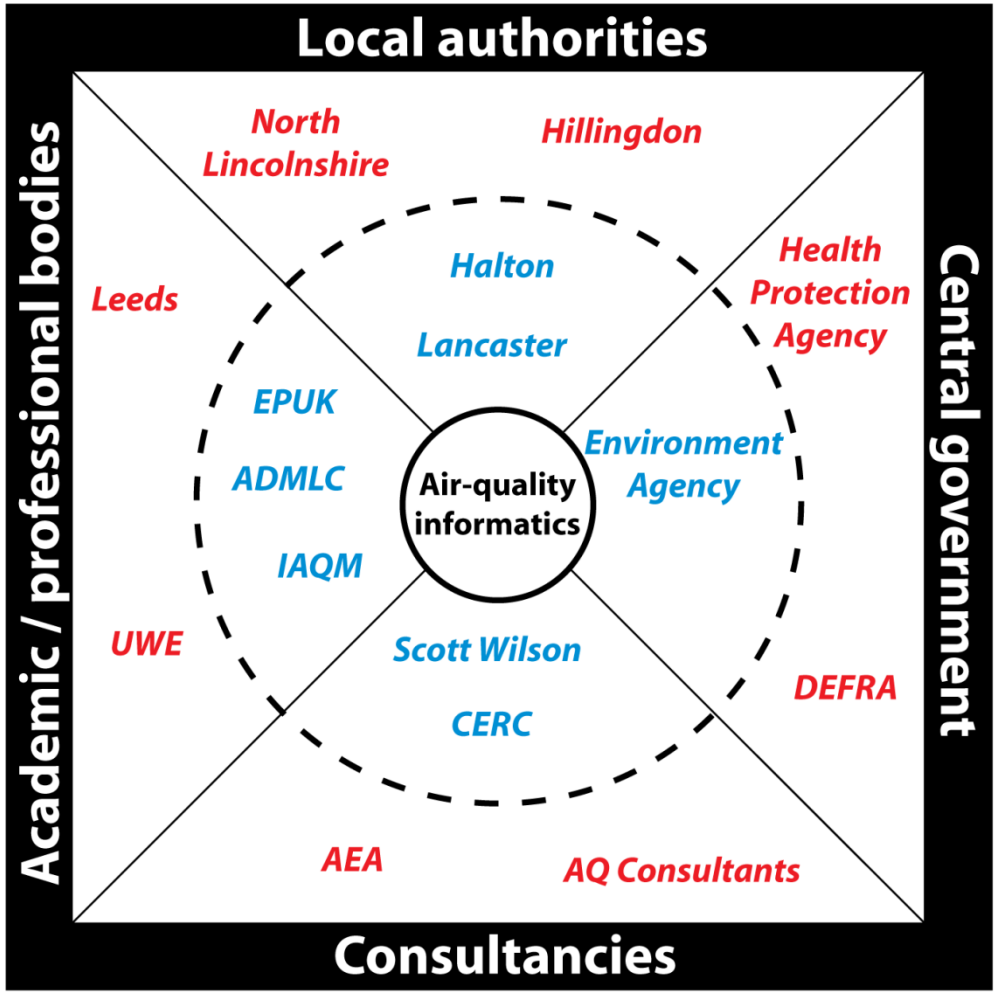
Scope of AirTrack

- NERC Knowledge Exchange (KE) project April 2009 – March 2012 - Lancaster, EA, Hertfordshire
- Initial workshop with user community (October 2009)
- Development and application of ‘smarter’ techniques for AQ analysis – 6 Case Studies
- Regular dissemination at meetings & conferences plus dedicated project website (2009 - 2012)
- Final workshop with user community (2012)

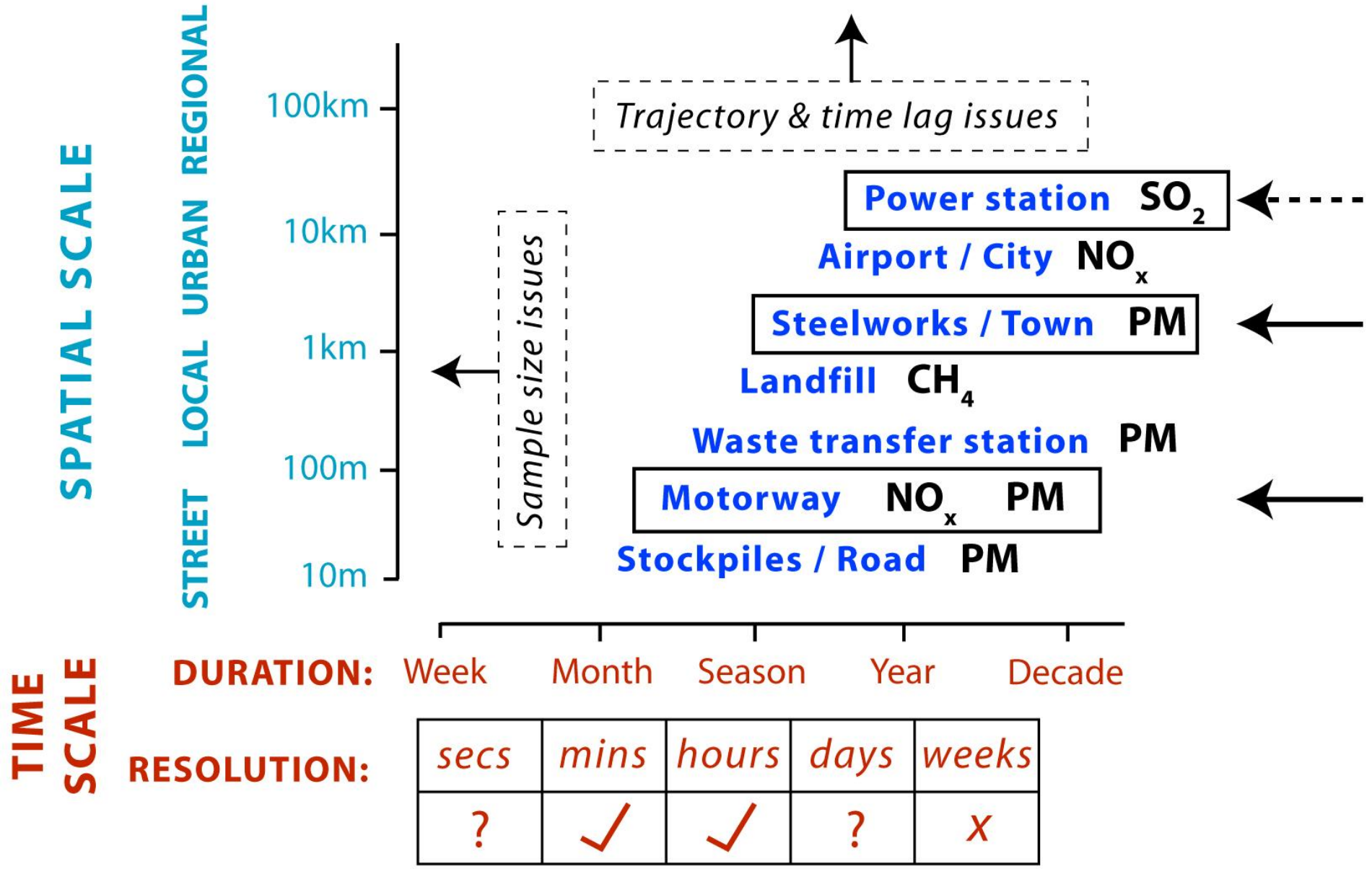
Knowledge Exchange

- Engagement with users – our approach:
- Share real-world case studies:
  - Existing portable and representative cases
  - New investigations
  - Partnerships with field teams
  - More informed air-quality management decisions
- Disseminate through:
  - Existing user-group networks
  - A dedicated website



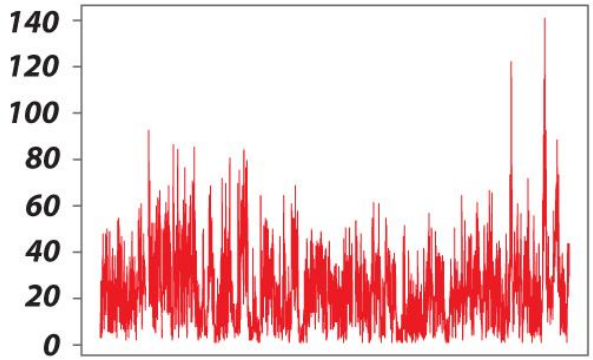
http://airtrack.lancs.ac.uk

Scales and Pollutants: Case Studies

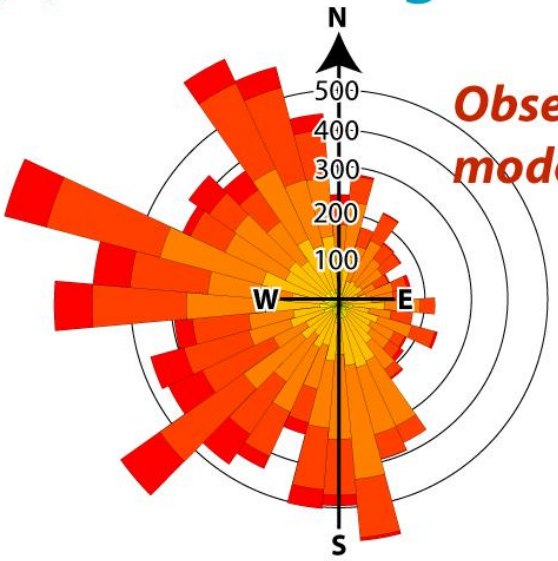


Case Studies: Essential Ingredients

(1) Pollution time-series



(2) Meteorological data



Observed and/or modelled (NWP)

(3) Policy pressure

Compliance with EU standards

Management interventions

Strategic planning decisions

Exceedances of NAQS

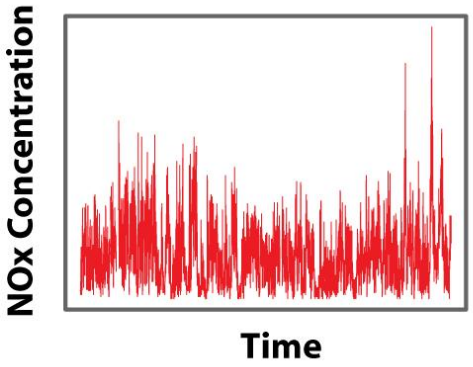
(4) Supporting information

e.g. annual average traffic counts

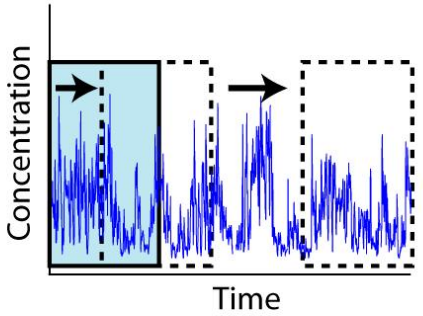
power station fuel management

Sequence of Analyses: Conditional Tracking

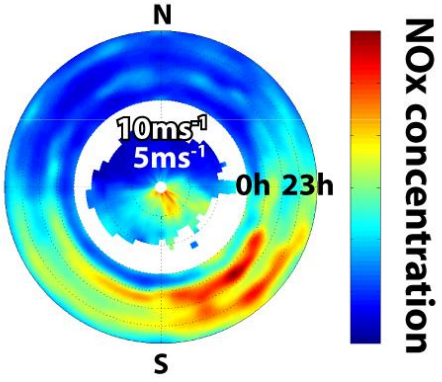
STEP 1
Collate data



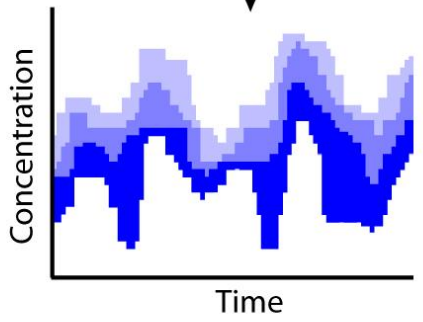
Simple exceedance statistics



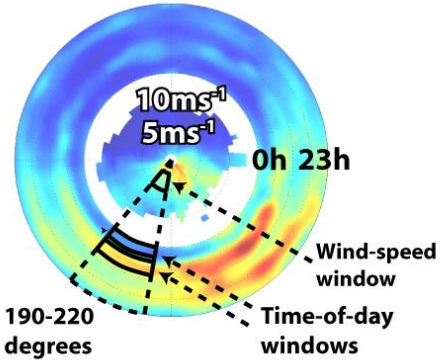
STEP 2
Visualise data



STEP 4
Calculate percentiles in moving-window

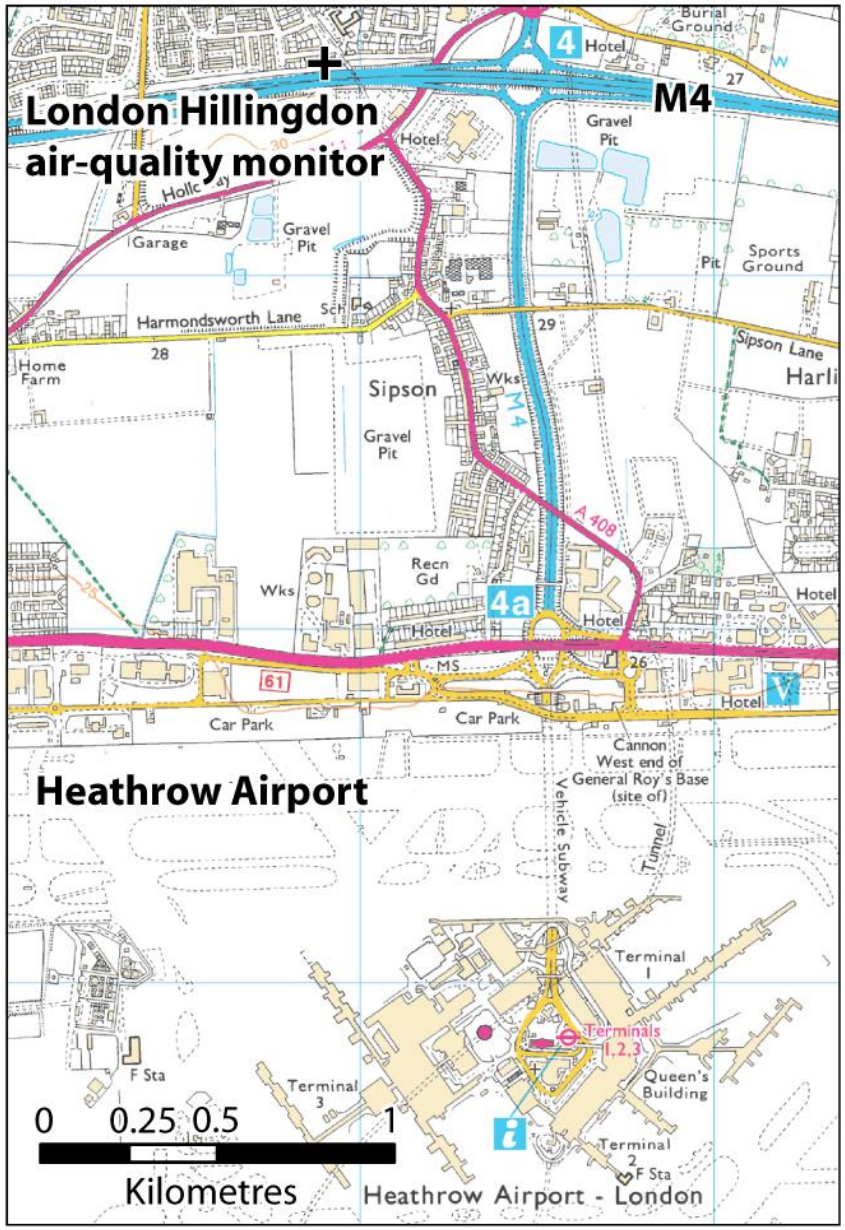


STEP 3
Define conditions



STEP 5 ***Interpret trends***

Case Study 1: M4 traffic



NO_x and NO_2 near the M4 motorway, London Hillingdon

Annual mean objective for NO_2 ($40\mu gm^{-3}$) exceeded in:

2006 ($50\mu gm^{-3}$)

2007 ($45\mu gm^{-3}$)

2008 ($51\mu gm^{-3}$)

Implications for compliance and airport expansion

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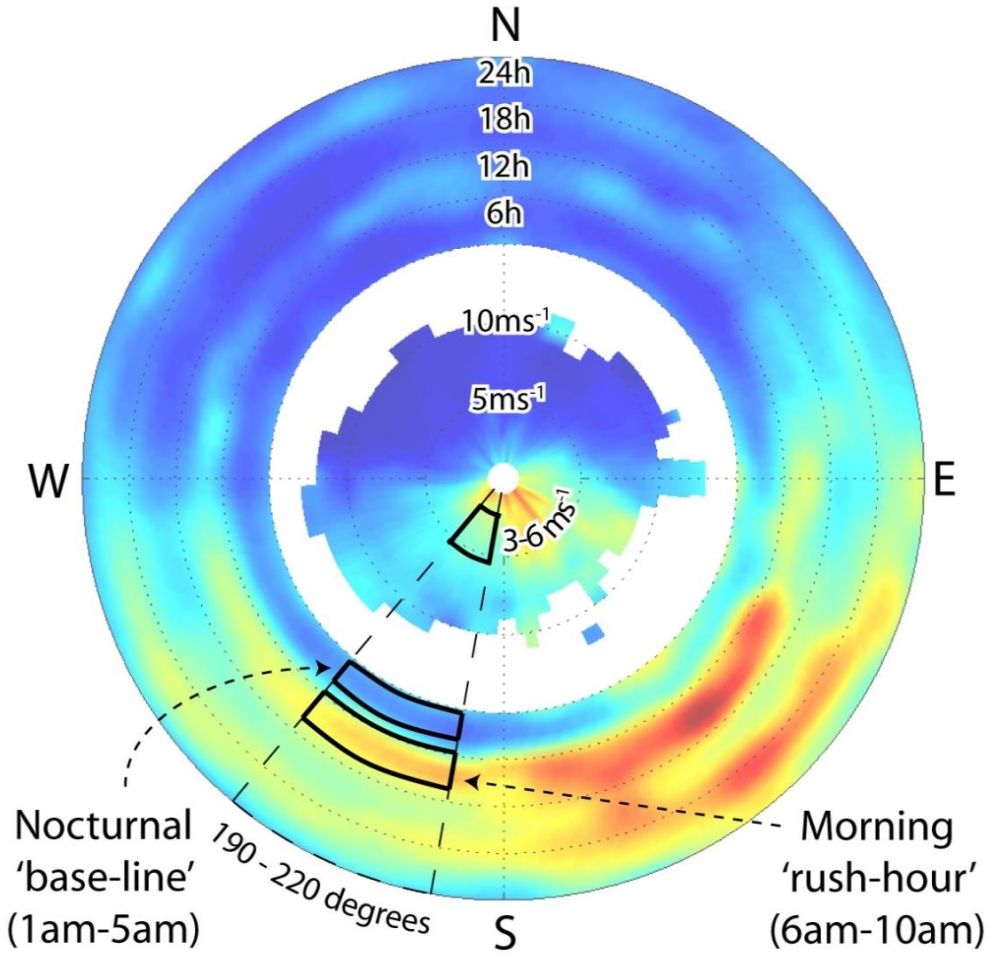
Case Study 1: M4 traffic: London Hillingdon NO_2



- Conditional window defined by:
- a) time-of-day (*outer plot*)
  - (nocturnal 'base-line' 1-5am)
  - (morning 'rush-hour' 6-10am)
- b) Wind direction
  - (190-220 degrees)
- c) Wind speed (*inner plot*)
  - (3-6 ms^{-1})

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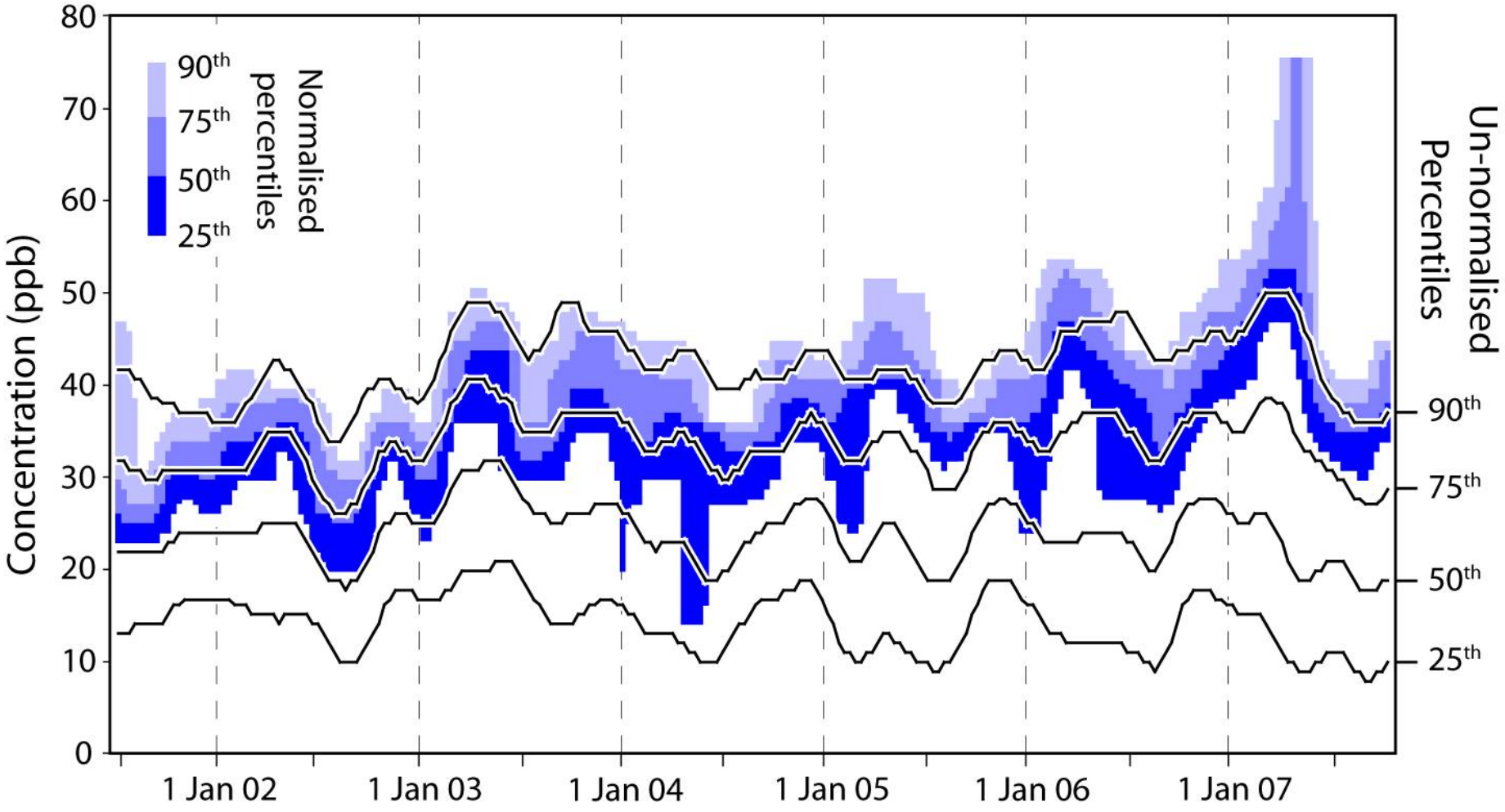
NO_2: Normalised Percentiles (2002-07)



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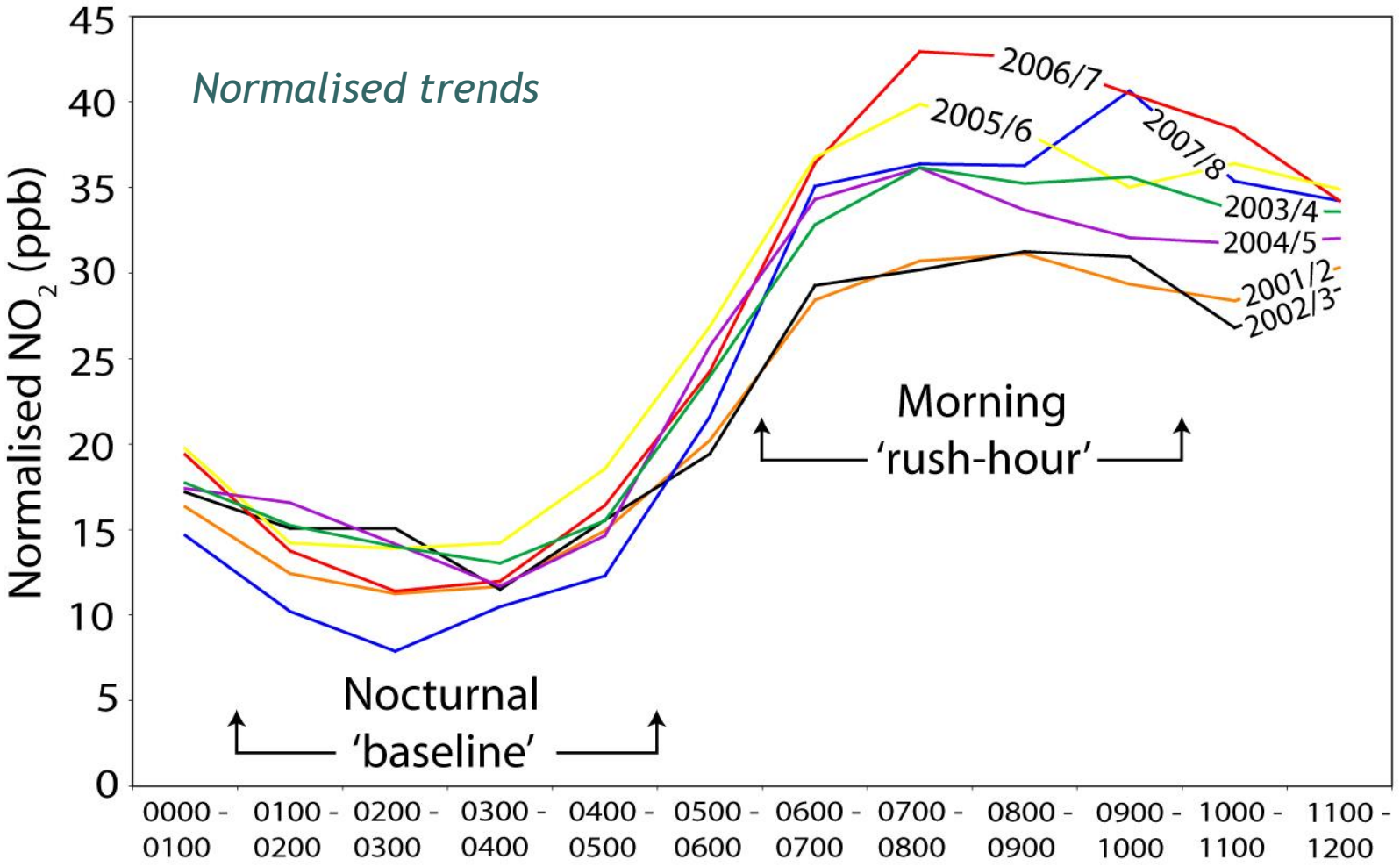
NO_2: Night-time & Morning Rush-hour Trends (2002-07)



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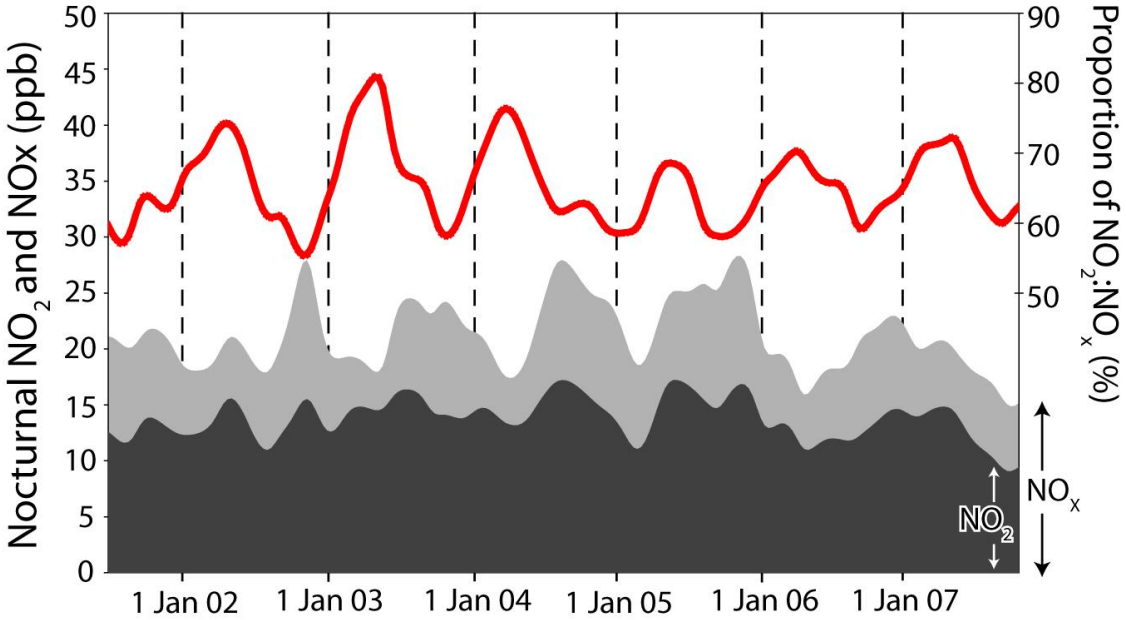
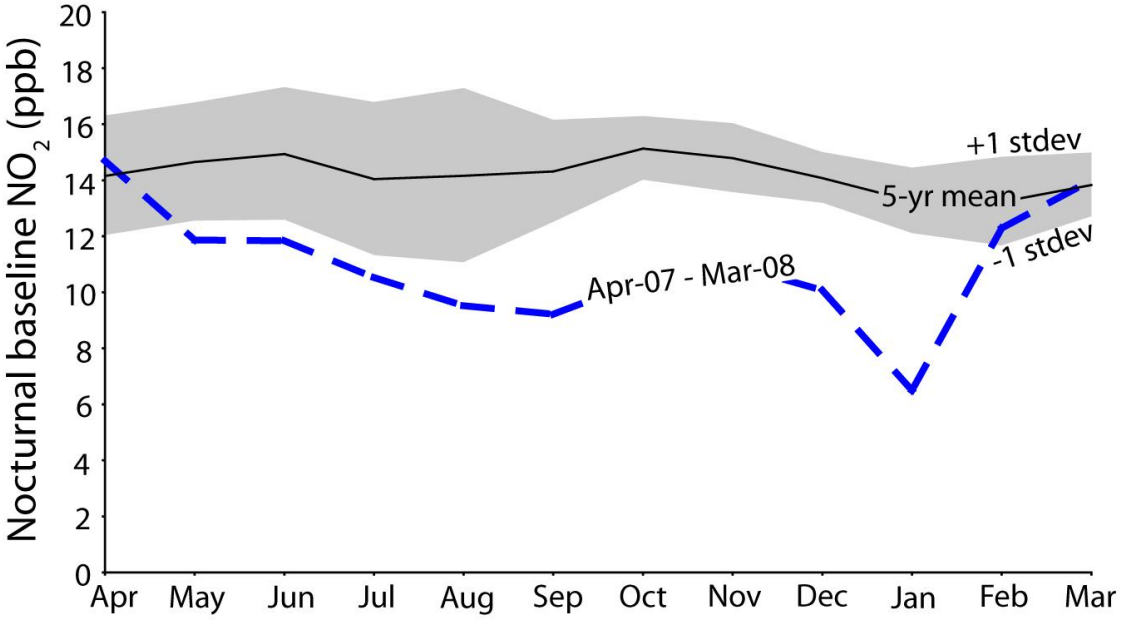
NO_2: Monthly Surveillance (Nocturnal base-line)



Trends in nocturnal baseline NO_2, NOx & NO_2:NOx



Monthly variation and performance tracking of NO_2

2007-08 cleaner than previous 5-years. Effective **regional** pollution management?

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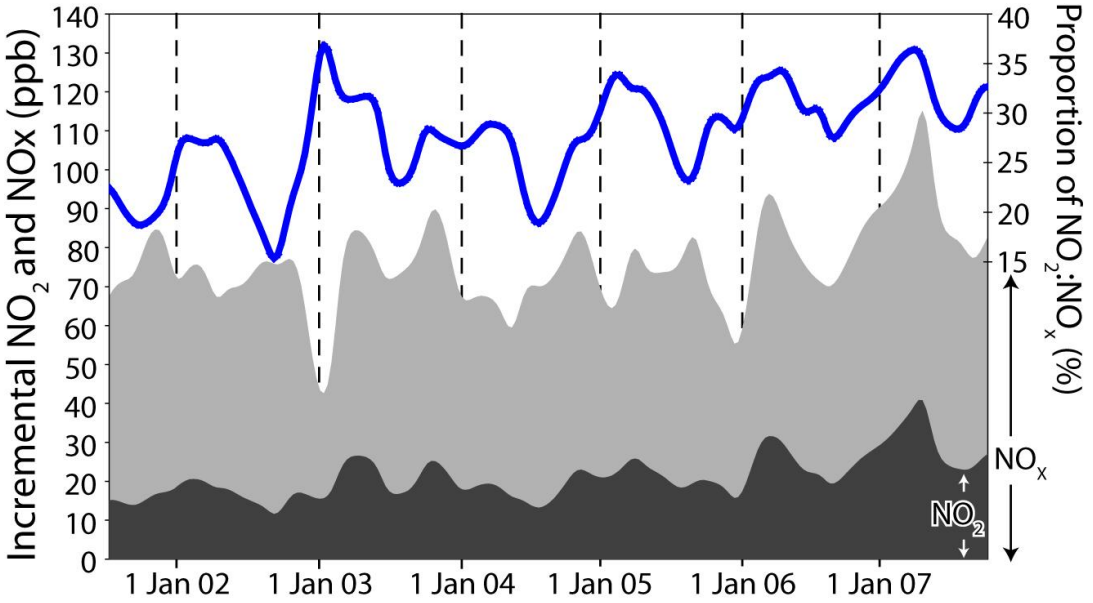
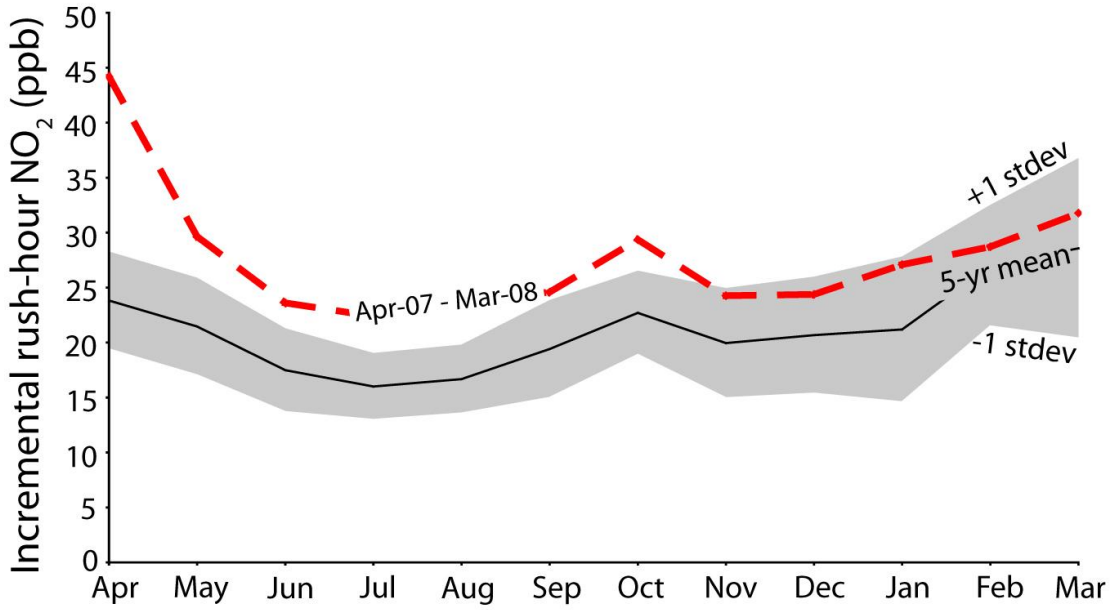
NO_2: Monthly Surveillance (Morning rush-hour)





Trends in morning rush-hour NO_2, NOx & NO_2:NOx

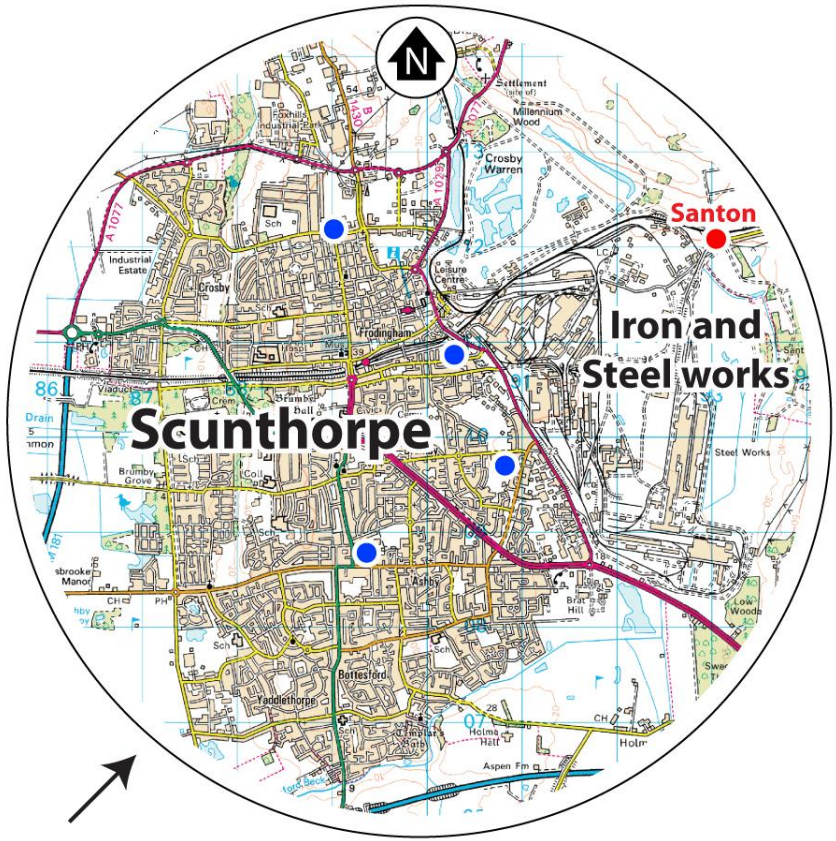
Monthly variation and performance tracking of 'rush-hour' NO_2

2007-08 dirtier than previous 5-years. Less effective **local** (traffic) pollution management? BUT...

"congestion in the UK has dropped by almost a third in two years because of the recession..."

7 September 2009, BBC News

Case Study 2: PM_{10} in Scunthorpe



Air Quality Management Area for PM_{10} declared in 2005.

In 2006 the daily PM_{10} objective (50µgm^{-3}) was exceeded on **158 days** and in 2007 on **133 days** - ***35 days per year are permitted under the NAQS***

Annual mean objective for PM_{10} (40µgm^{-3}) also exceeded in 2006 & 2007

Time-extension required to comply with EU air-quality targets

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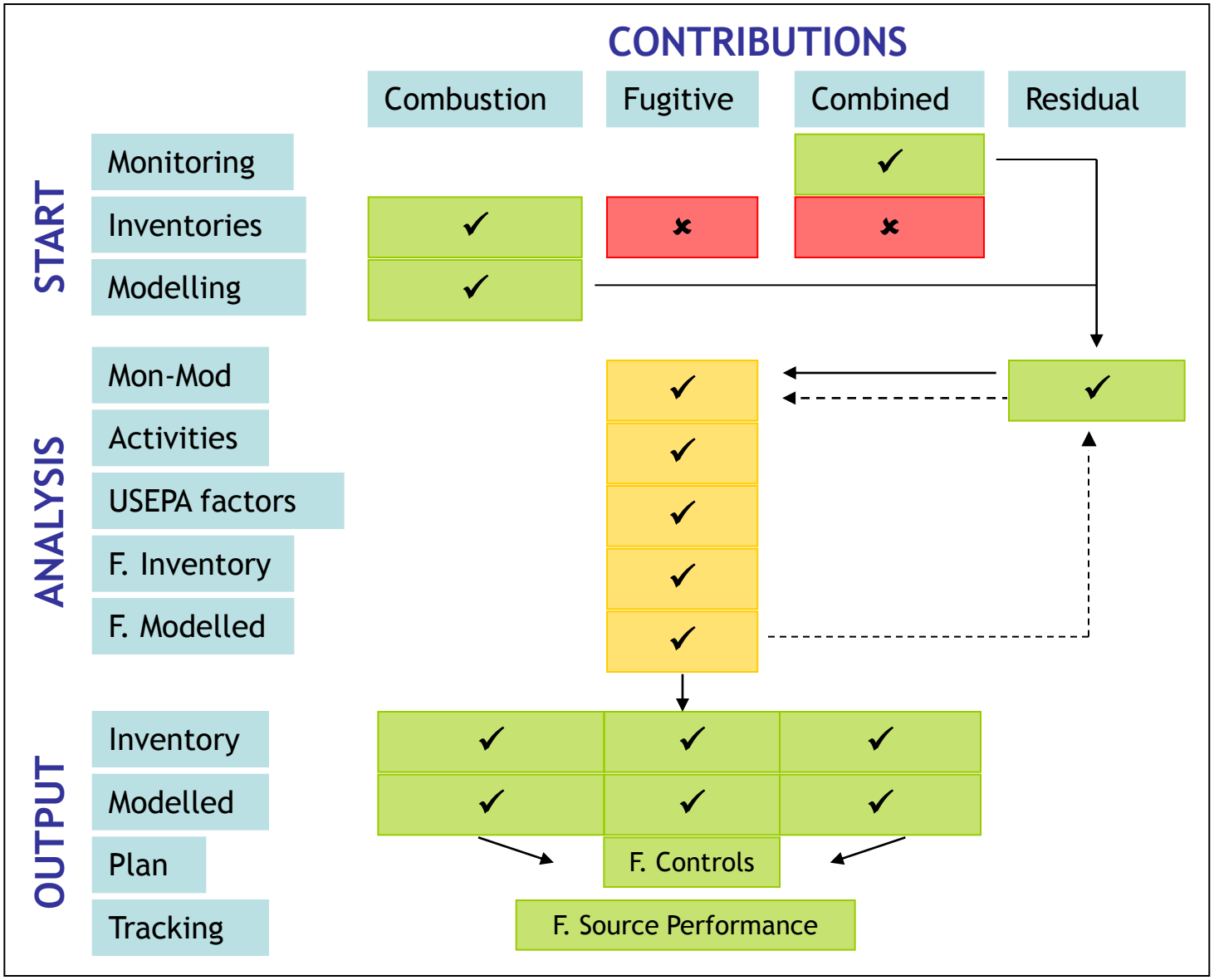
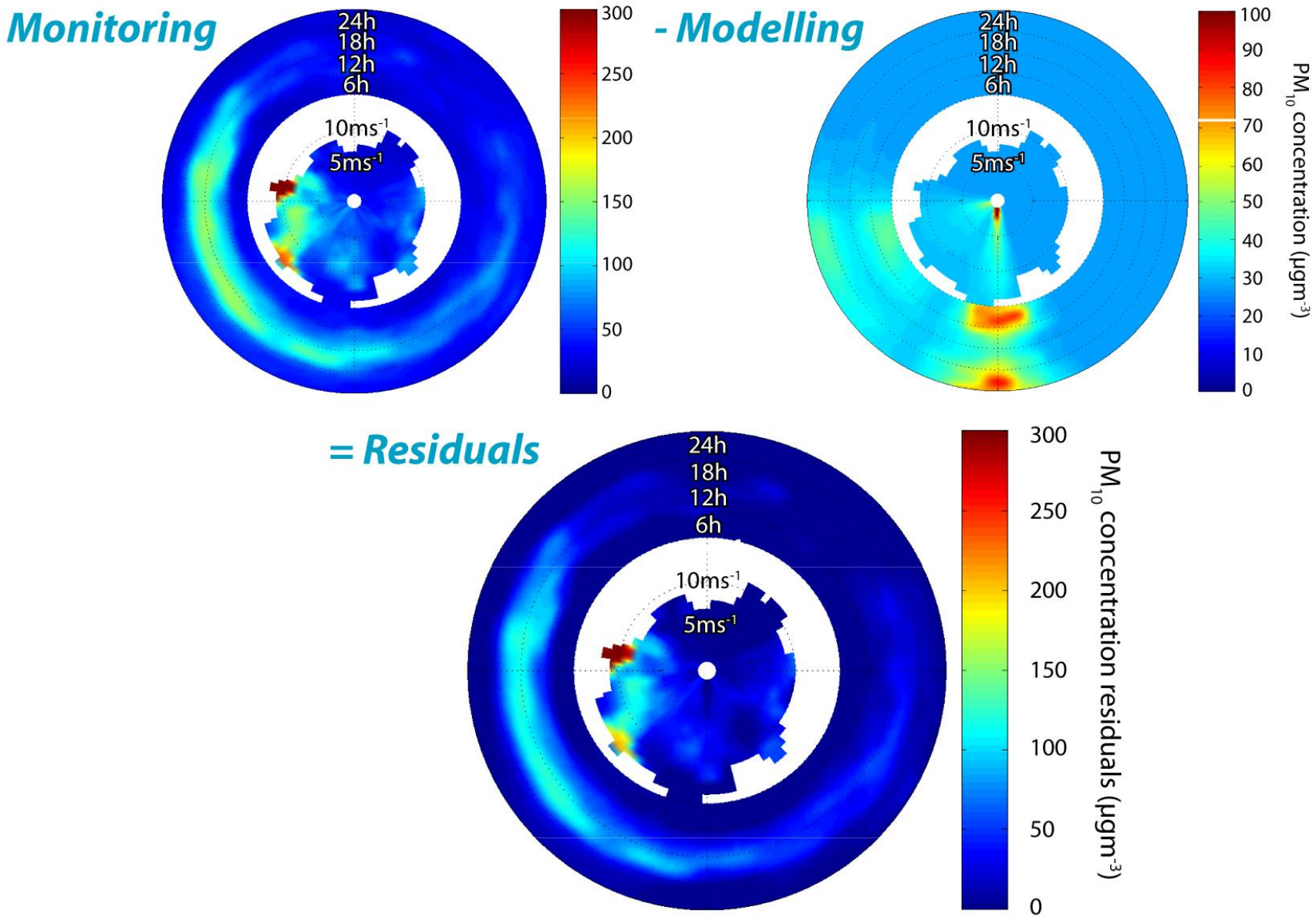
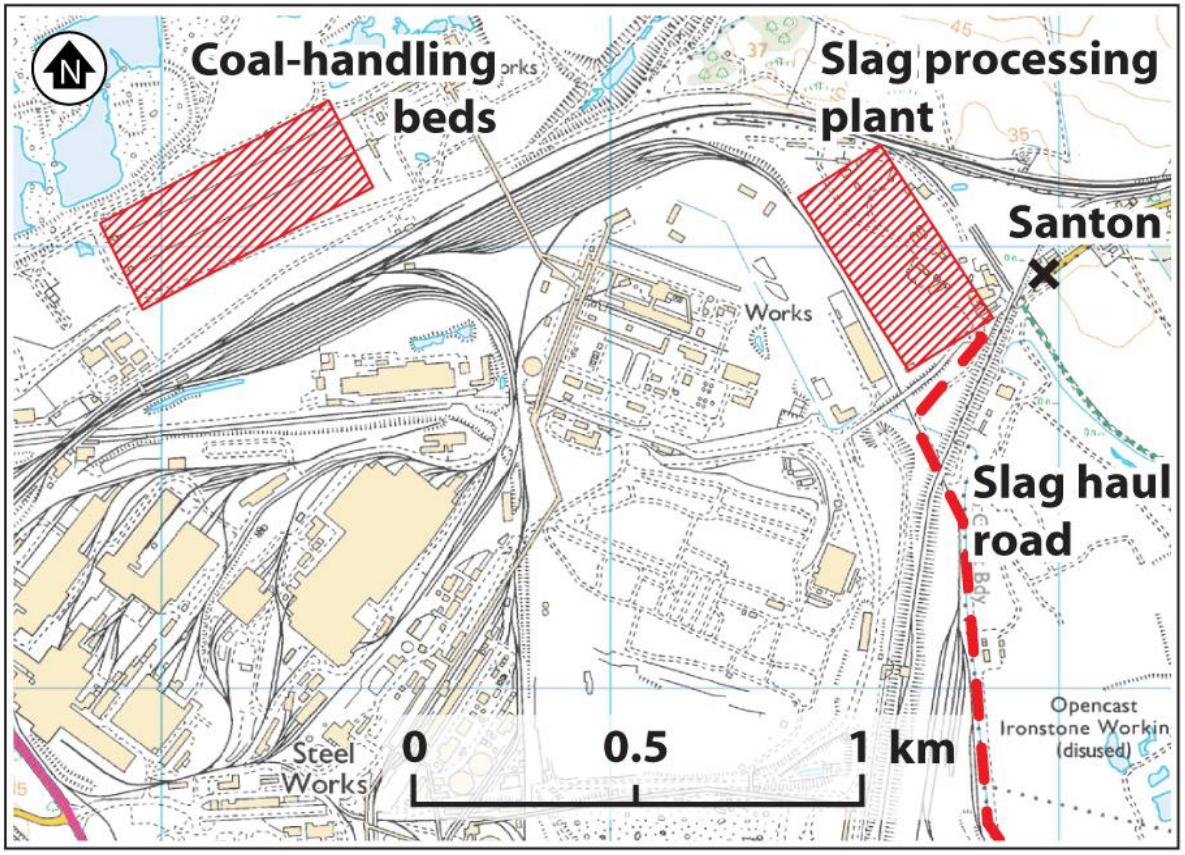
PM_{10} Analysis for Scunthorpe (Santon)



Concentration Residuals: Inferred Fugitive Contribution



Fugitive Sources: Assessment of Emitting Activities from Site maps / Aerial photos / Visit



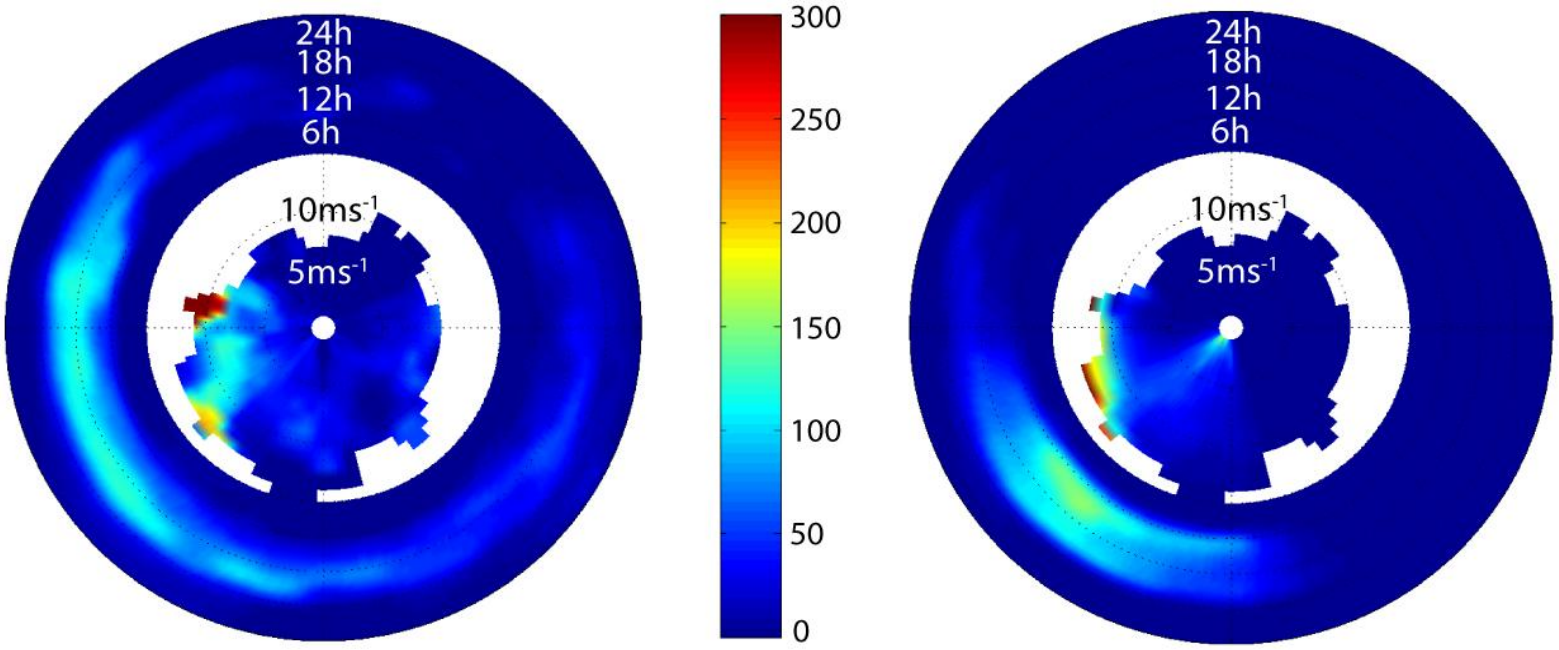
- 2 Area sources (hatched areas)

- 1 Line source (dashed line)

Modelled as sources of fugitive PM_{10} based on emissions estimated using US EPA emission factors.

Initial Verification: Inferred vs. Modelled
FUGITIVE SOURCES

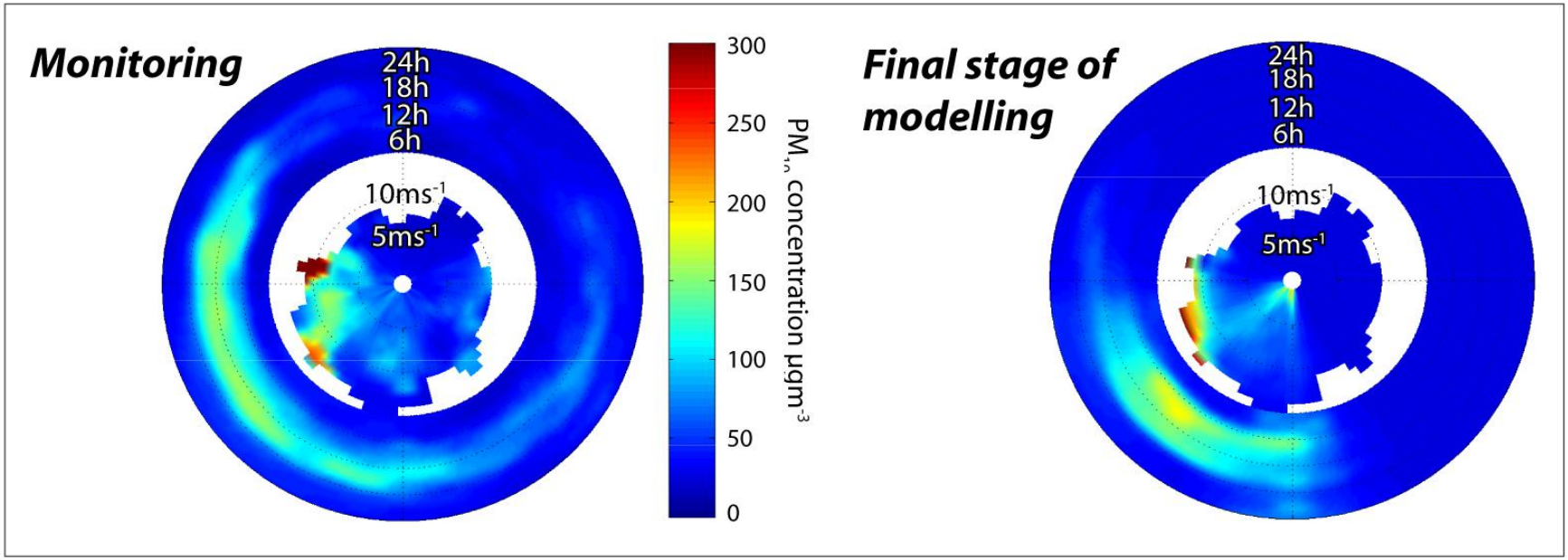
Inferred fugitive contribution (Concentration residuals)	Modelled fugitive contribution



Discrepancy between peak fugitive contributions (inferred - modelled)

100th percentile	99th percentile	90th percentile
22.4 %	***-7.9 %***	***2.5 %***

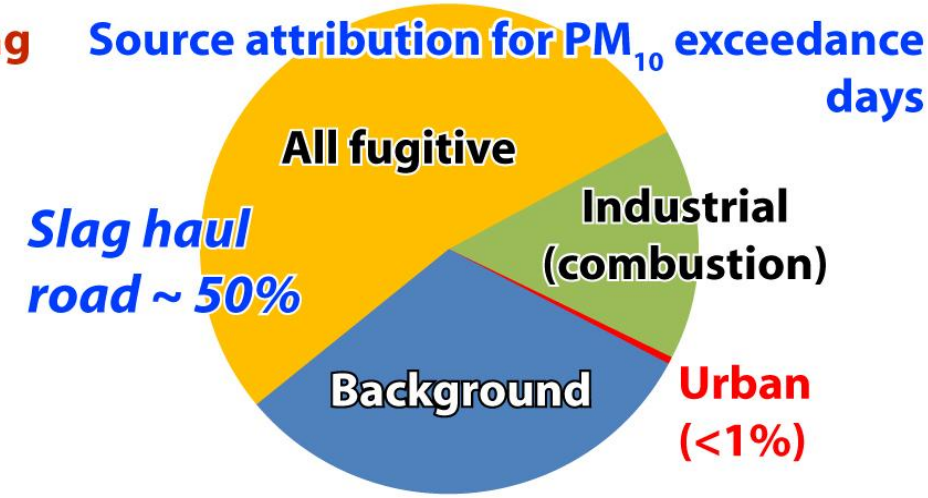
Final Verification: Monitoring vs. Modelled PM_{10}
ALL SOURCES



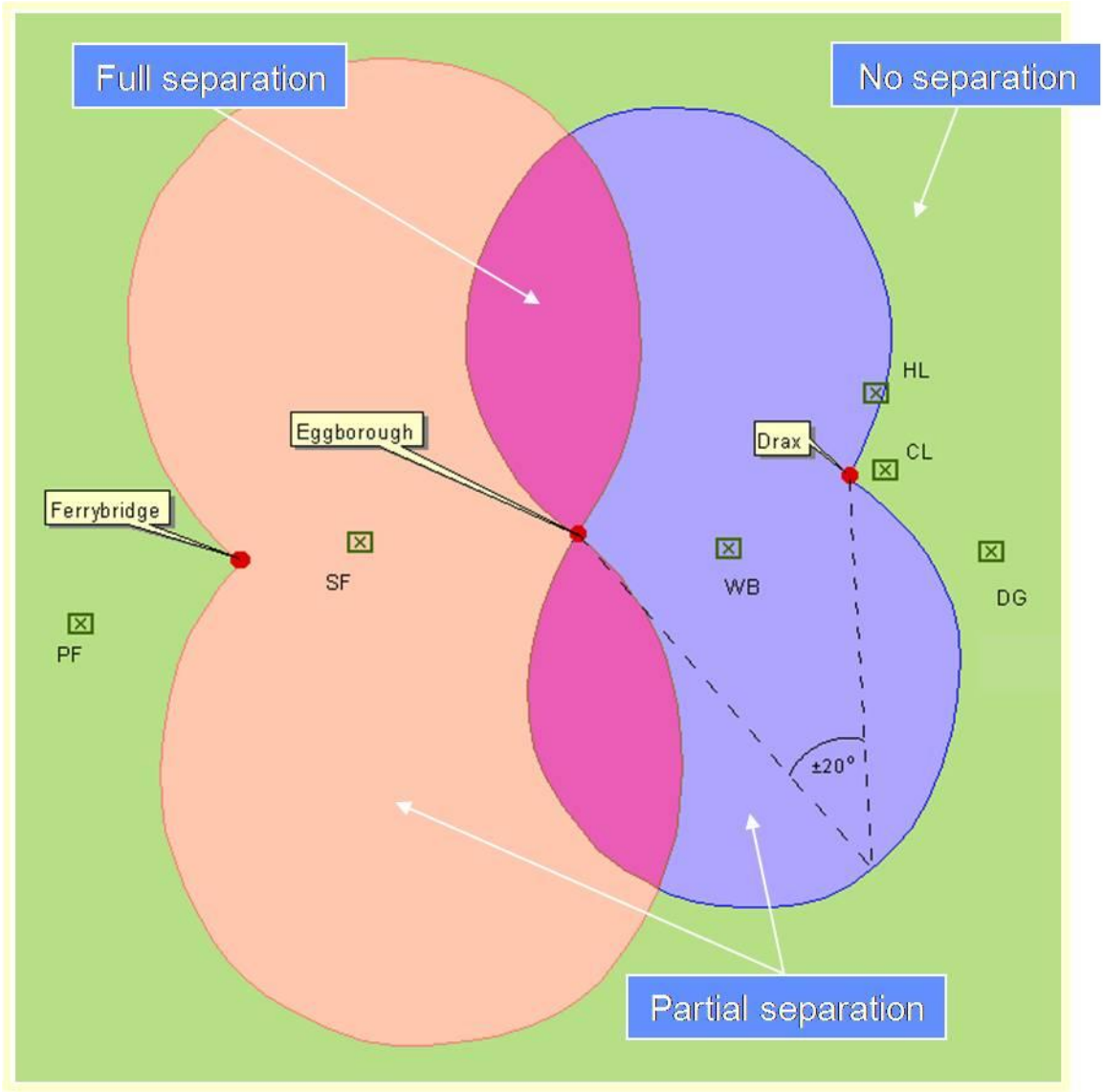
Discrepancy between peak monitoring and modelling (mon - mod)

100th percentile	*15 %*
99th percentile	*-6.1 %*
90th percentile	*1.7 %*

Source attribution for PM_{10} exceedance days



Optimal Network Design (1)



F separate from E & D

D separate from E & F

D, E & F separate

Power station

Monitoring site

10 km

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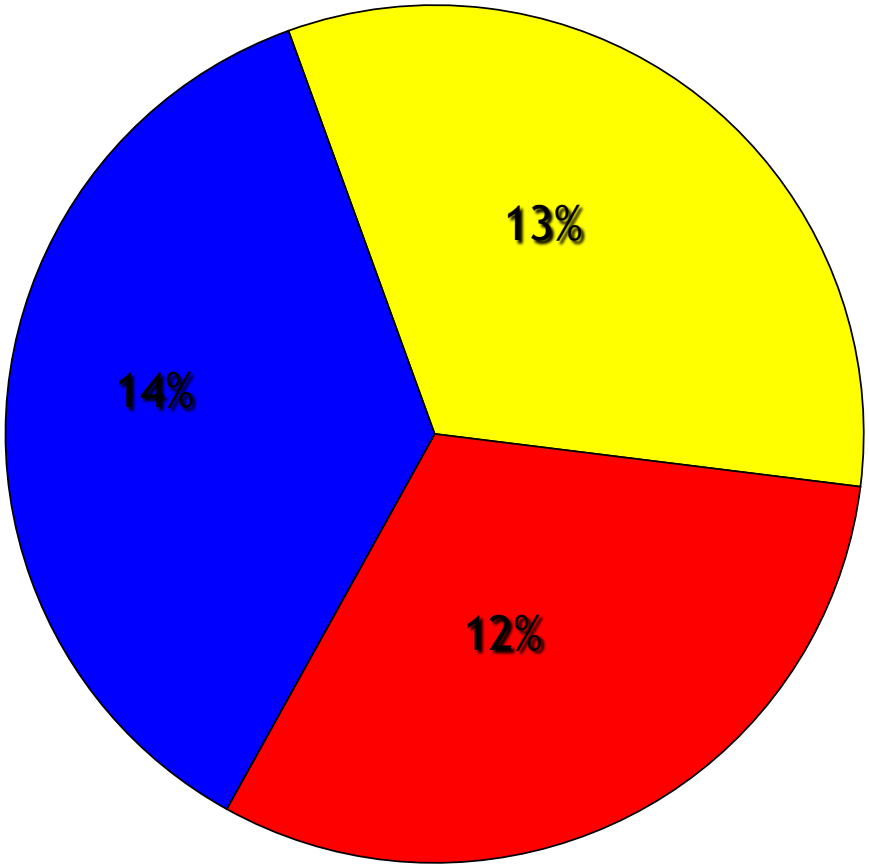
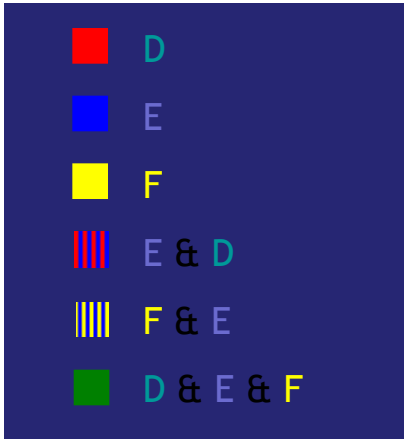
Optimal Network Design (2)



Annual mean % hours in 2001-2003 when site is downwind of:



NB The total size of pie is scaled according to the sum of annual mean % hours when site is downwind of a power station.

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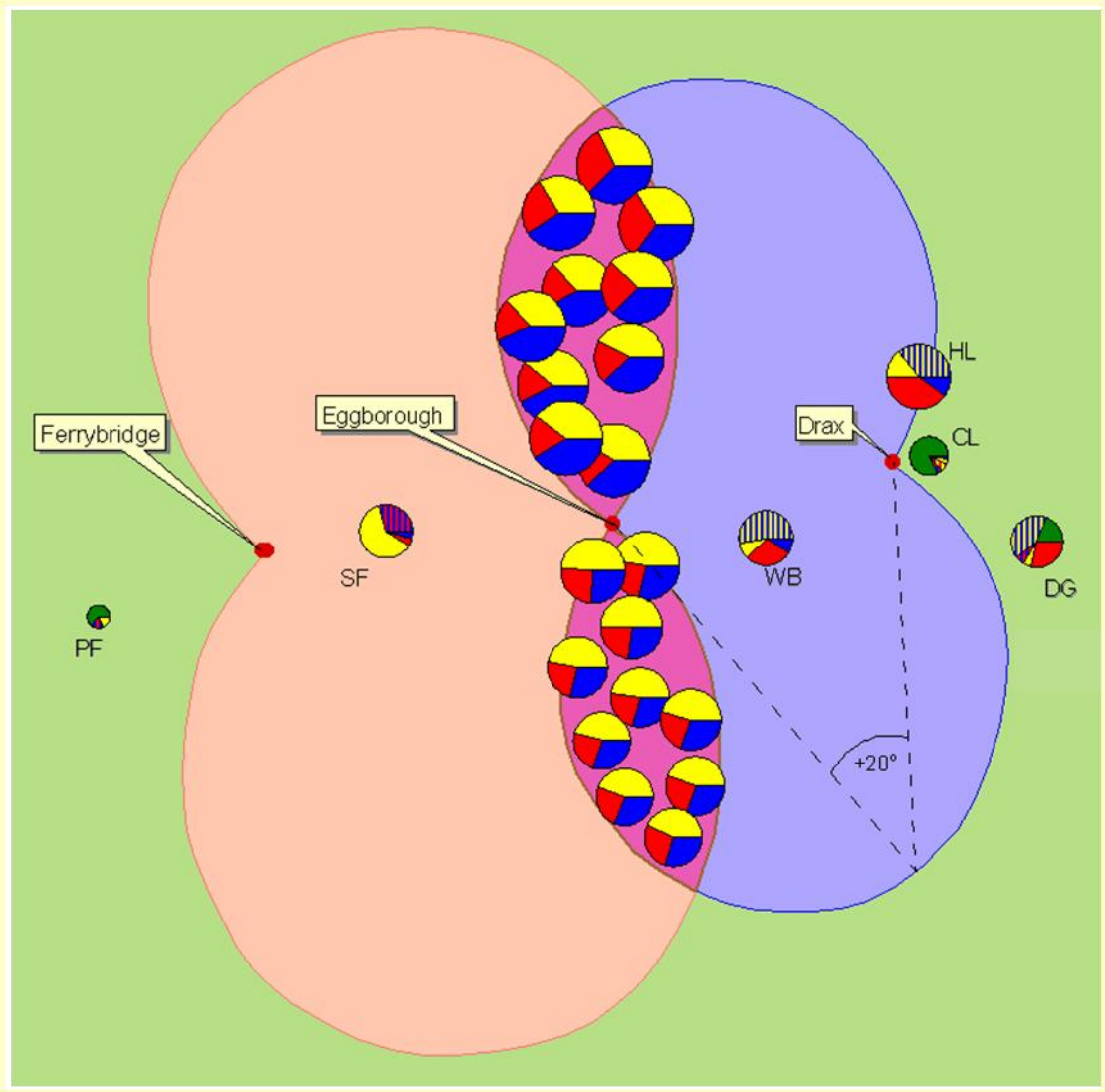
Optimal Network Design (3)



Hours downwind of:

- D
- E
- F
- E & D
- F & E
- D & F
- D & E & F
- Power station
- Total pie size = 30% of year

10 km

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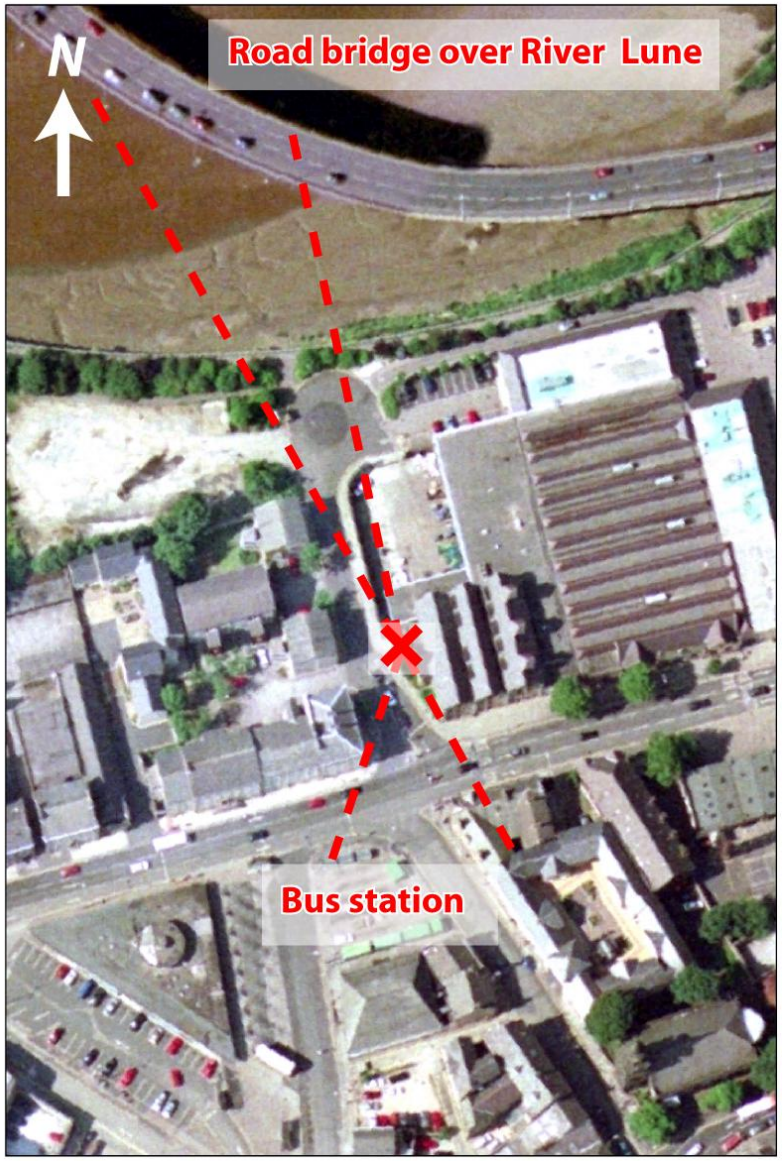
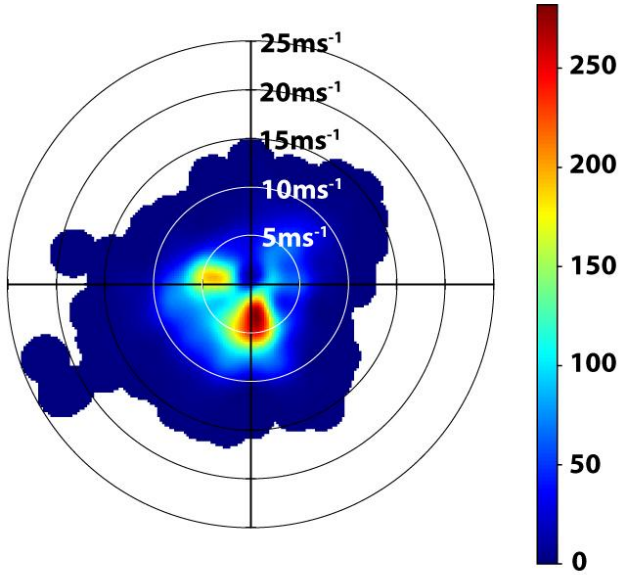
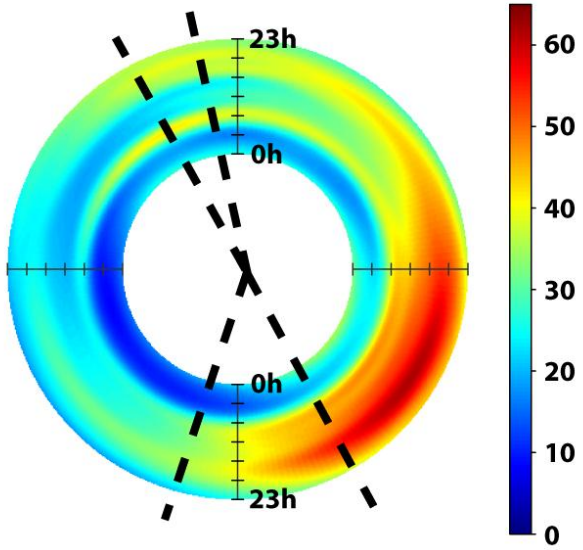
Monitor Siting and Meteorology



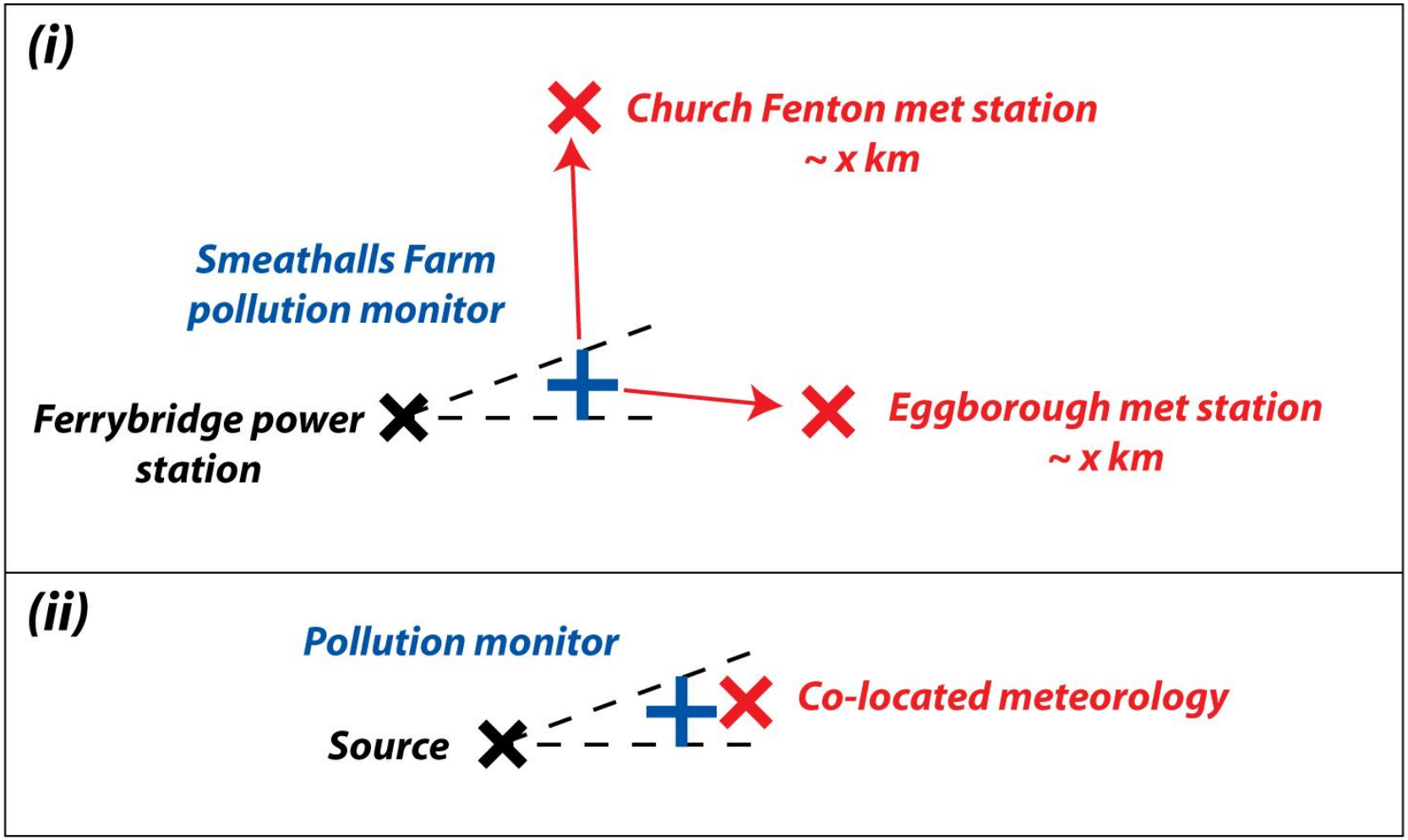


Wind frequency (hours), 2006-08 at Manchester Ringway (~ 80 km SE)



The dependence of NO_2 (μgm^{-3}) on time-of-day & direction at Lancaster Water Street

Location of Pollution Monitors and Met Stations



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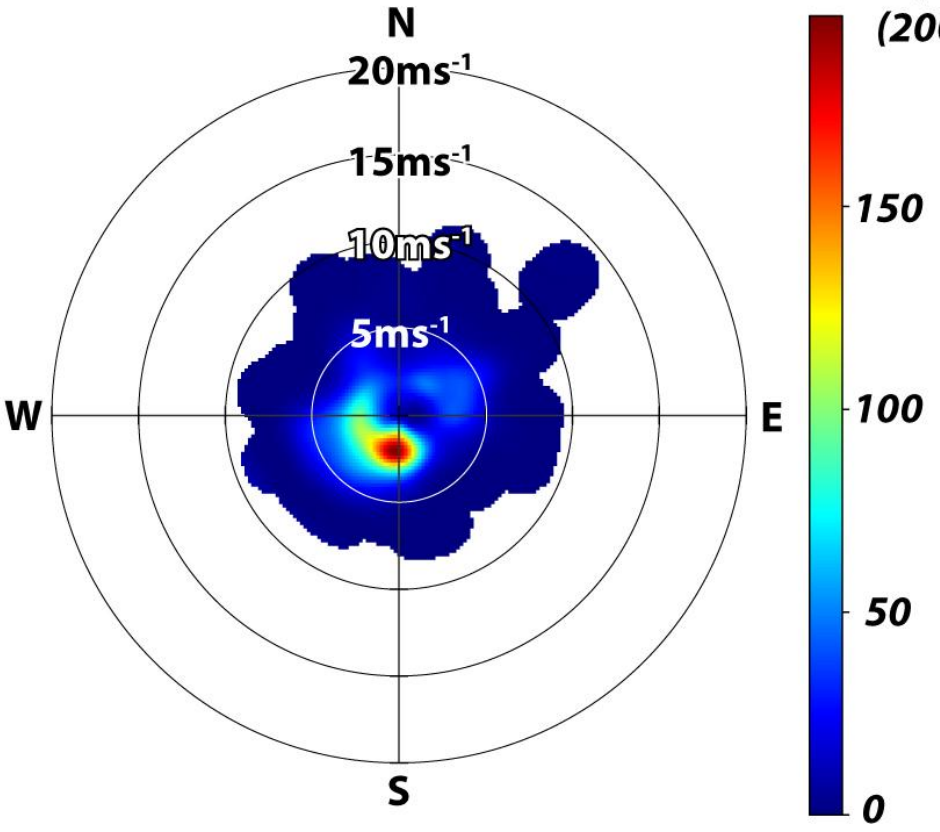
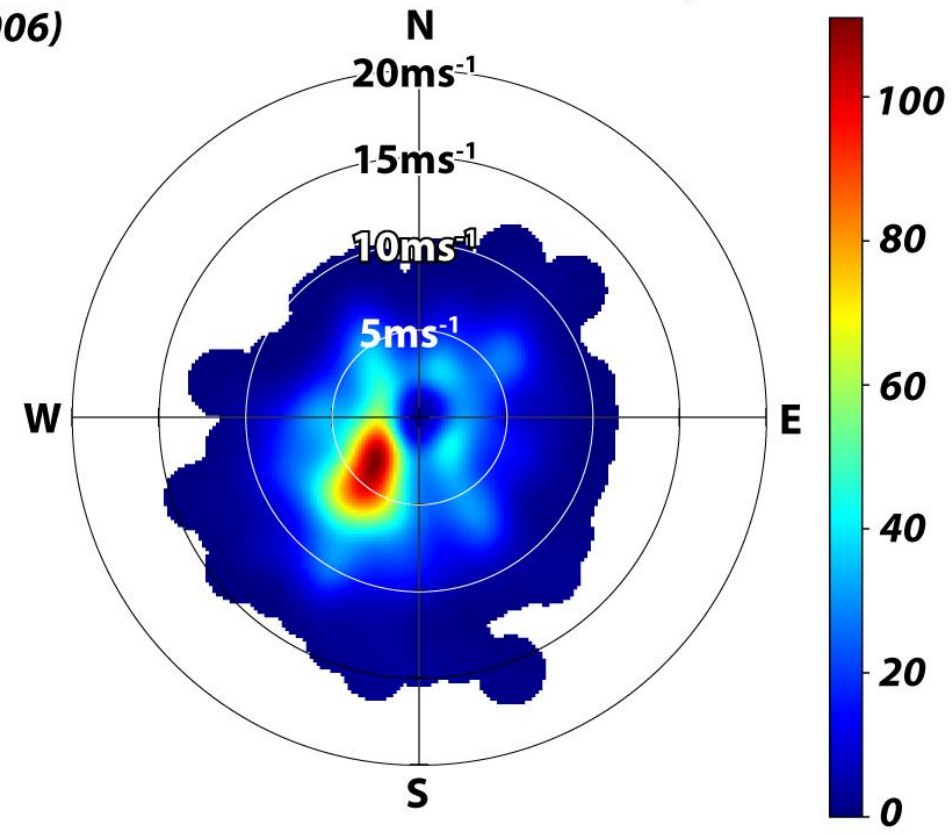
Meteorological Uncertainty (1): Wind Frequency

Rowland Road, Scunthorpe
~ 3km distance (SW)



RAF Waddington
~ 40 km distance (SSE)

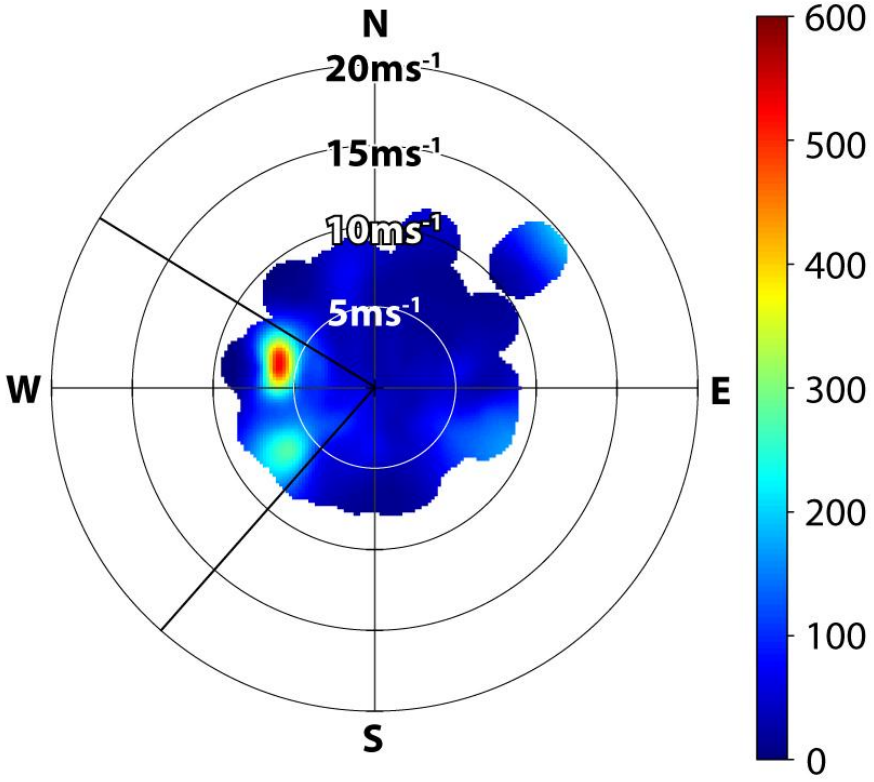


5^{th} percentile = $1.1ms^{-1}$
95^{th} percentile = $5.1ms^{-1}$

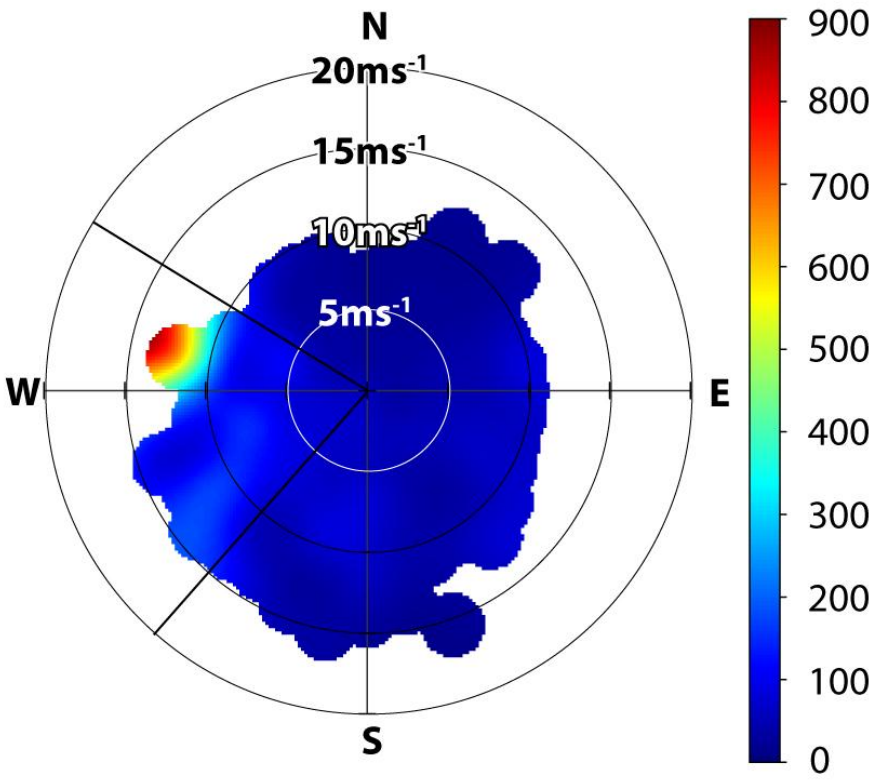
5^{th} percentile = $1.6ms^{-1}$
95^{th} percentile = $9.3ms^{-1}$

Meteorological Uncertainty (2): Pollution Impacts

Rowland Road, Scunthorpe
~ 3 km distance (SW)



RAF Waddington
~ 40 km distance (SSE)



PM_{10} concentration (μgm^{-3}), 2006

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Future Case Studies

- Disseminate outcomes of 6 case studies over project lifetime
- Focus on different source types & pollutants using combinations of monitored and/or modelled data, e.g.
  - BT Tower – platform surveillance
  - Landfills – inferred emissions
  - Shipping – air quality in ports
  - CMAQ – conditional validation of new 'one-atmosphere' models
  - ADMS smarter verification against field data, e.g. Kincaid
- Opportunities for the user community to engage with project team, contribute to and comment on future case studies

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Measures of Success

- Practioners aware
- Example archive
- Explanatory documentation
- Professional bodies engaged
- Systematic informatics
- Users take ownership

- Services under development
- Routine adoption
- Optimised networks
- Disseminated to user-communities
- Embedded into ‘best-practise’ guidance
- Extension to EU

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