Air Quality Forecasting and Related Services

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Contents

- Principles of air quality forecasting
- The Met Office tools
- Applications
- Problems

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Air Quality Management

- Emissions Inventory / Assessment
- Measurements, monitoring
- Modelling
- Mitigation
  - AQ Forecasts - useful tool

Emissions

The weather

Cannot control the weather!

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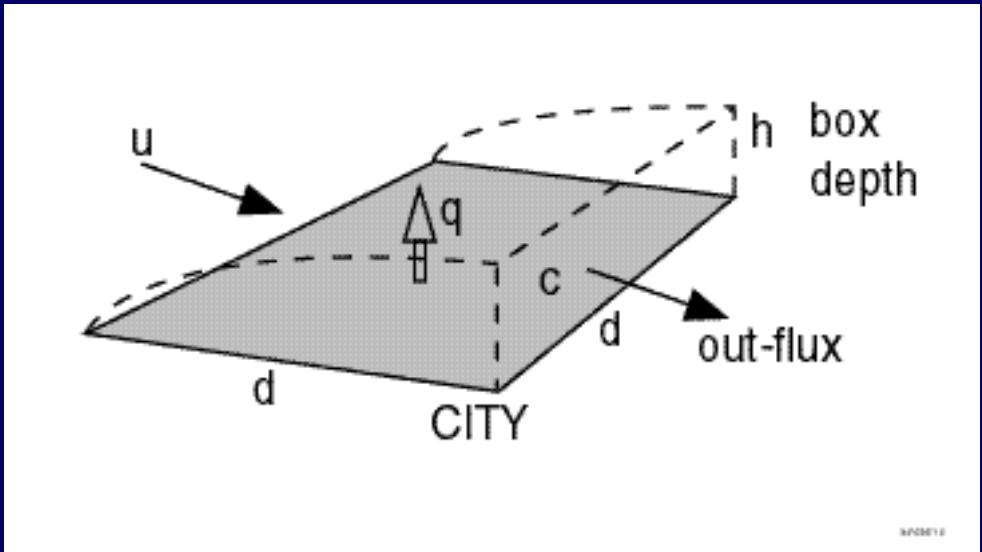
Forecasting Air Quality

- Knowledgeable weather forecaster
  - Synoptic situation
  - Emissions
  - Monitored data i.e. current pollution levels
  - Local met forcing due to coastal or topographic features.
- Little infrastructure and/or low labour costs.
- Other tools - stability, back trajectories, dispersion indices.

Forecasting Air Quality

- Modelling
  - simple box model approach
  - esp. useful if emissions are known but not well defined.
  - Does not incorporate chemistry

Box model (mass balance)



$$C = \frac{qd}{hu} x$$

Inputs = forecast/synoptic

wind speed/cloud:– diagnose stability

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Forecasting Air Quality

- Short Range Dispersion Modelling
- 3rd Gen Models i.e. ADMS, AERMOD
- Handle local pollutants
  - NOx, CO, Local PM10
- Emission details must be well defined
- Cannot accommodate imported pollution

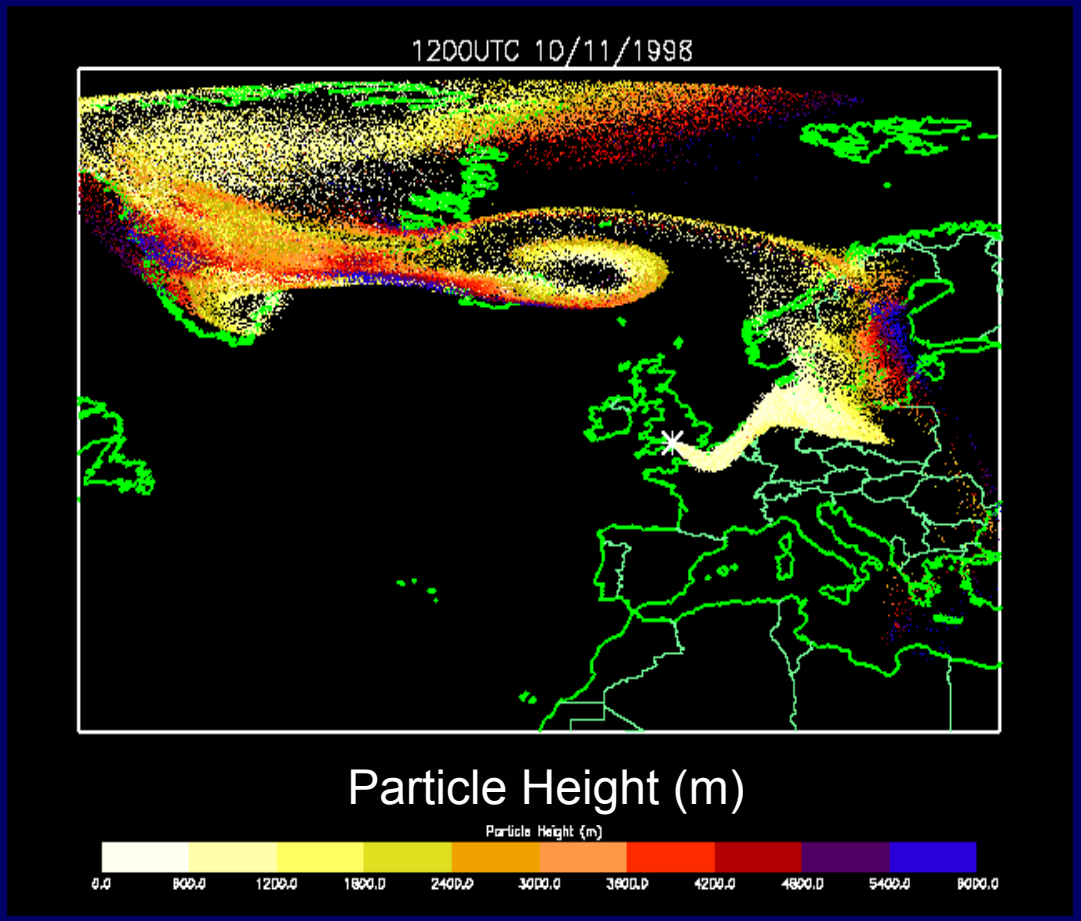
Forecasting Air Quality

- Long Range Dispersion Modelling
  - 3D Numerical Models e.g. Models 3, NAME
  - Lagrangian / Eulerian
  - Provides analysis of
    - » 3D Mesoscale to global transport of airborne material
    - » atmospheric dispersion - incl. calm conditions
    - » atmospheric loss processes - wet and dry
    - » can represent chemical transformations, radioactive decay and biological hazards

The NAME dispersion model

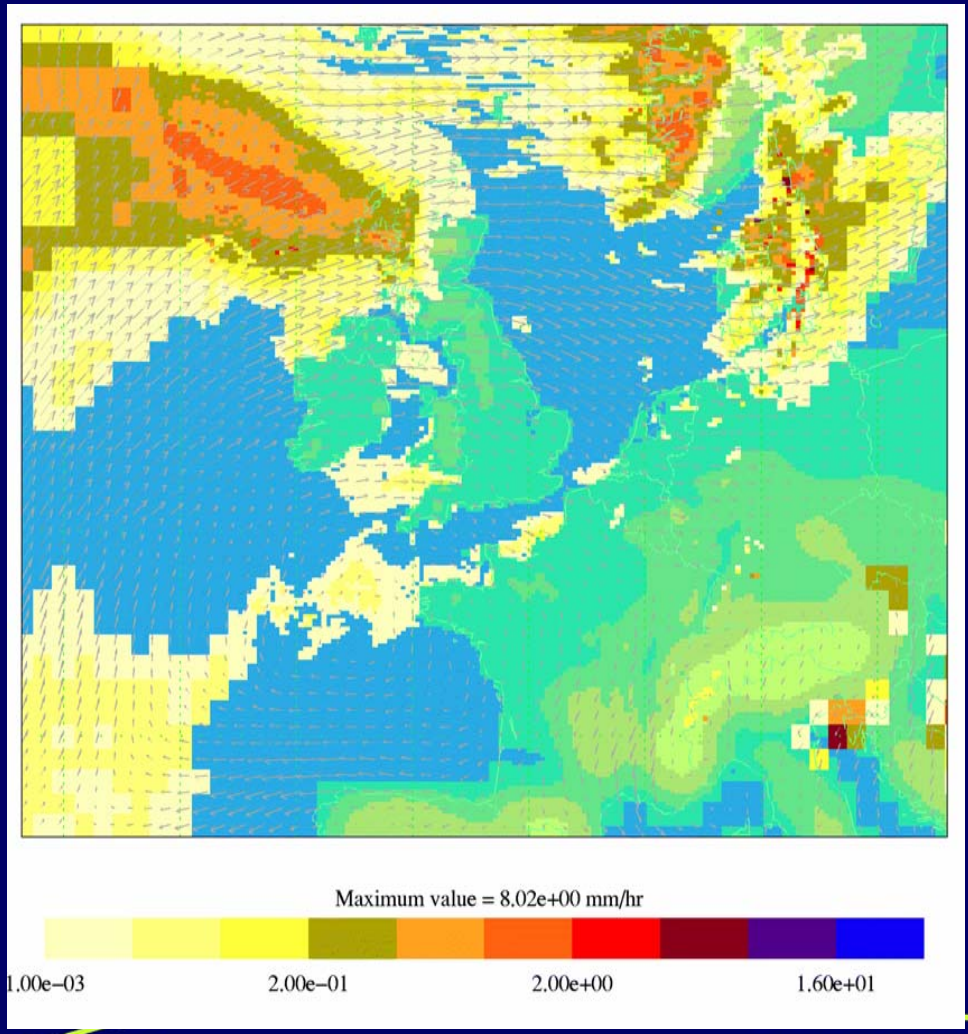
- Lagrangian particle model
  - Air concentrations and deposition
  - 1-10000km, hours-days
  - 3D met data from Unified Model
- Emergency response
- Air Quality
- Estimating source strengths

  verify greenhouse and ozone depleting gas inventories



NAME - Met Data

- Met data from Unified Model
- Global - 60km, 34 levels
  - 3 hourly fields to T+72
    6 hourly to T+144
- Mesoscale 12km, 34 levels
  - hourly fields to T+48
- Updated four times daily
  - 00Z, 06Z, 12Z and 18Z
- Nested structure
  (spatially and temporally)
- 6 year analyses archive
  (Europe)
- Can use ECMWF data



NAME - verification

- Limited data available to test long range dispersion models - no ‘ideal’ datasets
- Confidence derived from range of applications
- Case studies
  - Chernobyl, Petrol plume (1997), ETEX experiment, Volcanic plumes, Saharan dust
- Mace Head
  - Estimating source strengths and comparing with inventories
  - Model vs observations at Mace Head given UK/European emissions
- Air Quality
  - Forecast skill
  - Episode studies (eg high SO2)

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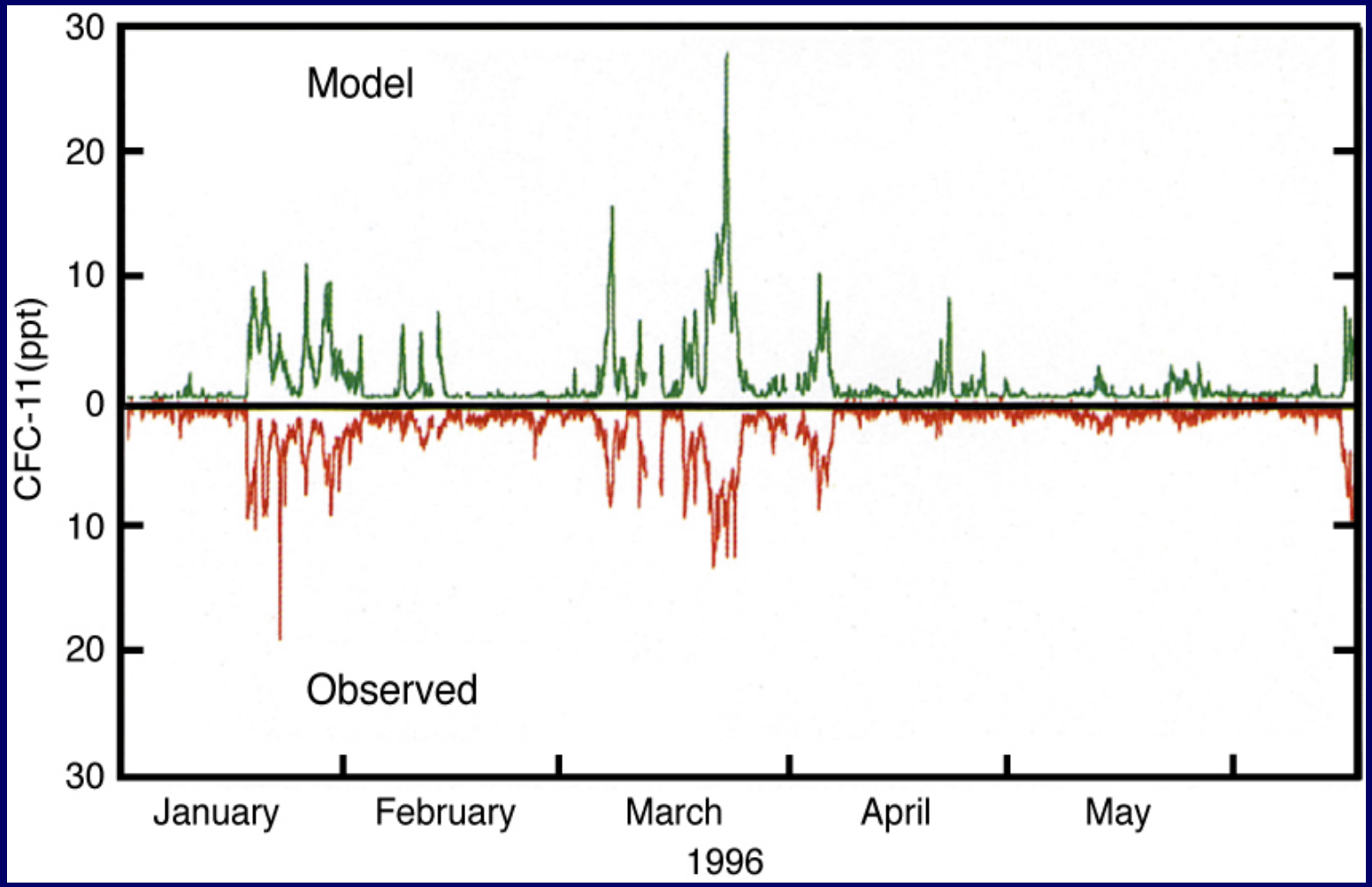
Mace Head CFC Comparison



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Applications

- Emergency Response
- National + Local A.Q. Forecasts
- Impact Assessments
- Events Analysis
- Research

Emergency Response

- Nuclear Releases
- Chemical Releases
- Foot and Mouth spread
- Volcanic Ash Advisory Service

Air Quality Forecasts

- National
  - Forecasts on regional basis
  - All pollution species
- Local
  - Hourly pollution forecasts
  - 3-5 days ahead
  - All major pollution species
  - Client specific locations

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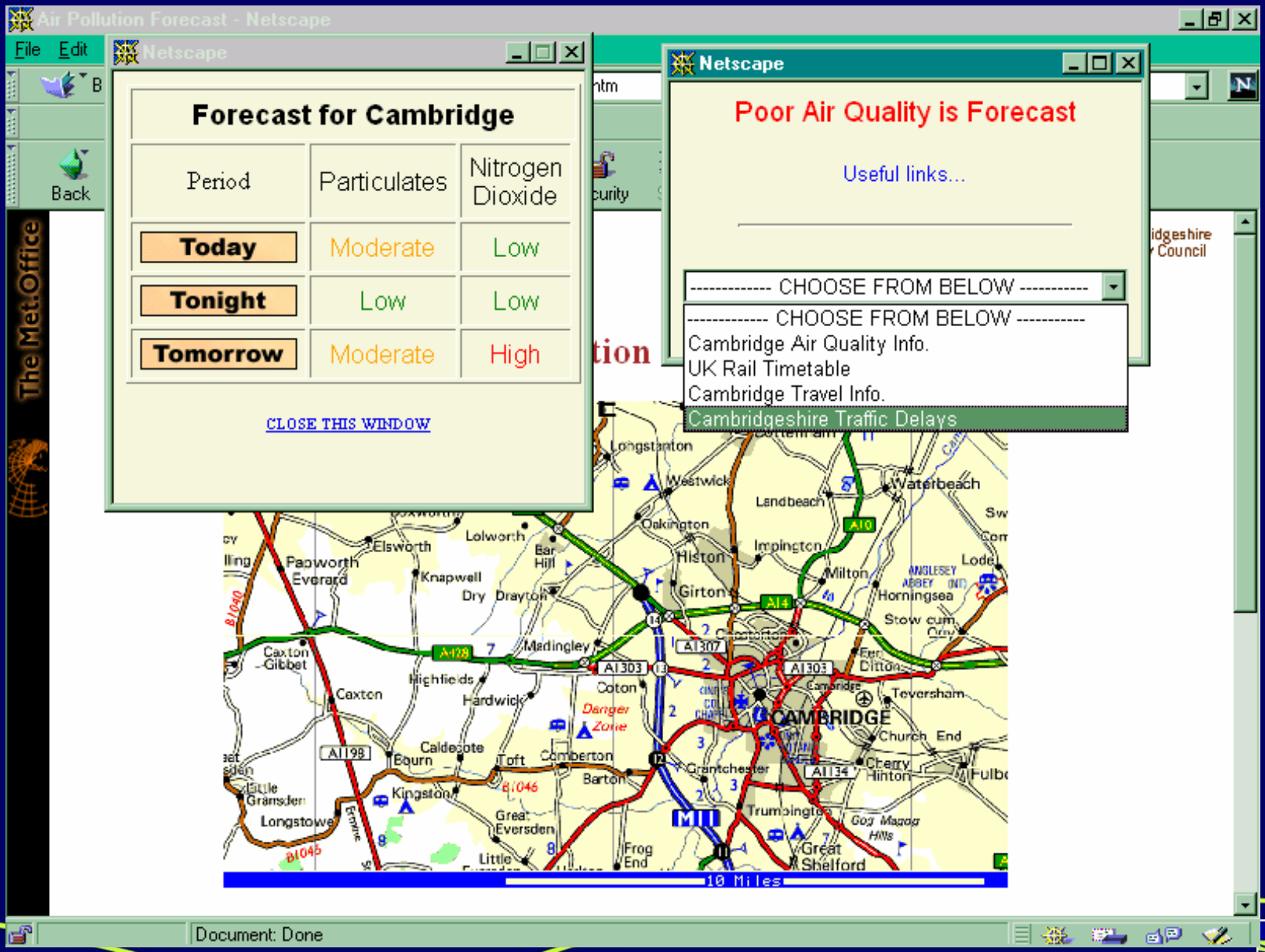
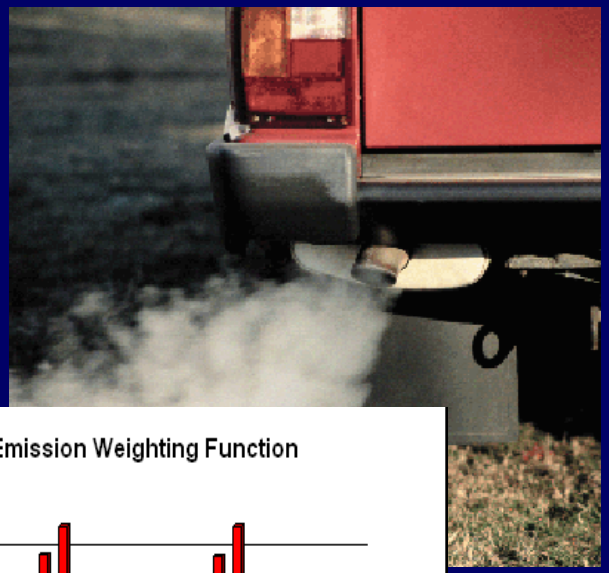
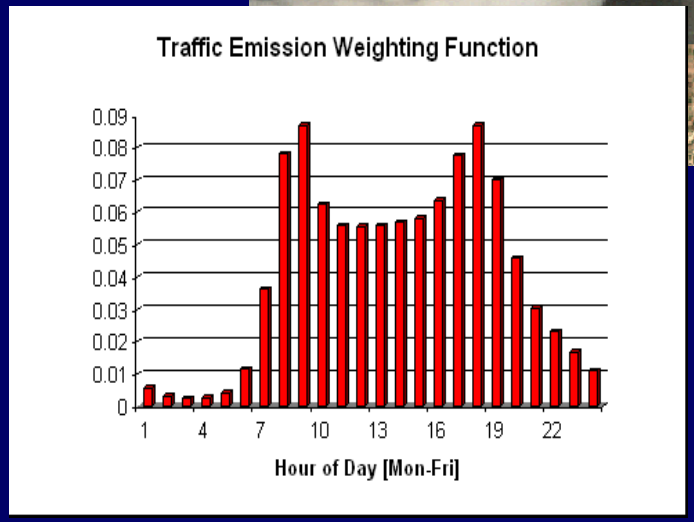

Air Pollution Forecast - Netscape
File Edit
Back
The Met.Office
Netscape
Forecast for Cambridge
Period
Particulates
Nitrogen Dioxide
Today
Moderate
Low
Tonight
Low
Low
Tomorrow
Moderate
High
CLOSE THIS WINDOW
Netscape
Poor Air Quality is Forecast
Useful links...
---------- CHOOSE FROM BELOW ----------
---------- CHOOSE FROM BELOW ----------
Cambridge Air Quality Info.
UK Rail Timetable
Cambridge Travel Info.
Cambridgeshire Traffic Delays
CAMBRIDGE
Danger Zone
10 Miles
Document: Done

Emissions

- National Emissions Inventory
- Detailed Local Emissions
- European Emissions





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Applications contd

- Impact Assessments
  - Offered to Industry to help meet regulatory requirements.
  - Forecasts sometimes offered as management tool.
- Events Analysis
  - Investigations of specific pollution episodes.
- Research
  - Models used as research tools and are continually being improved.

Air Quality Challenges

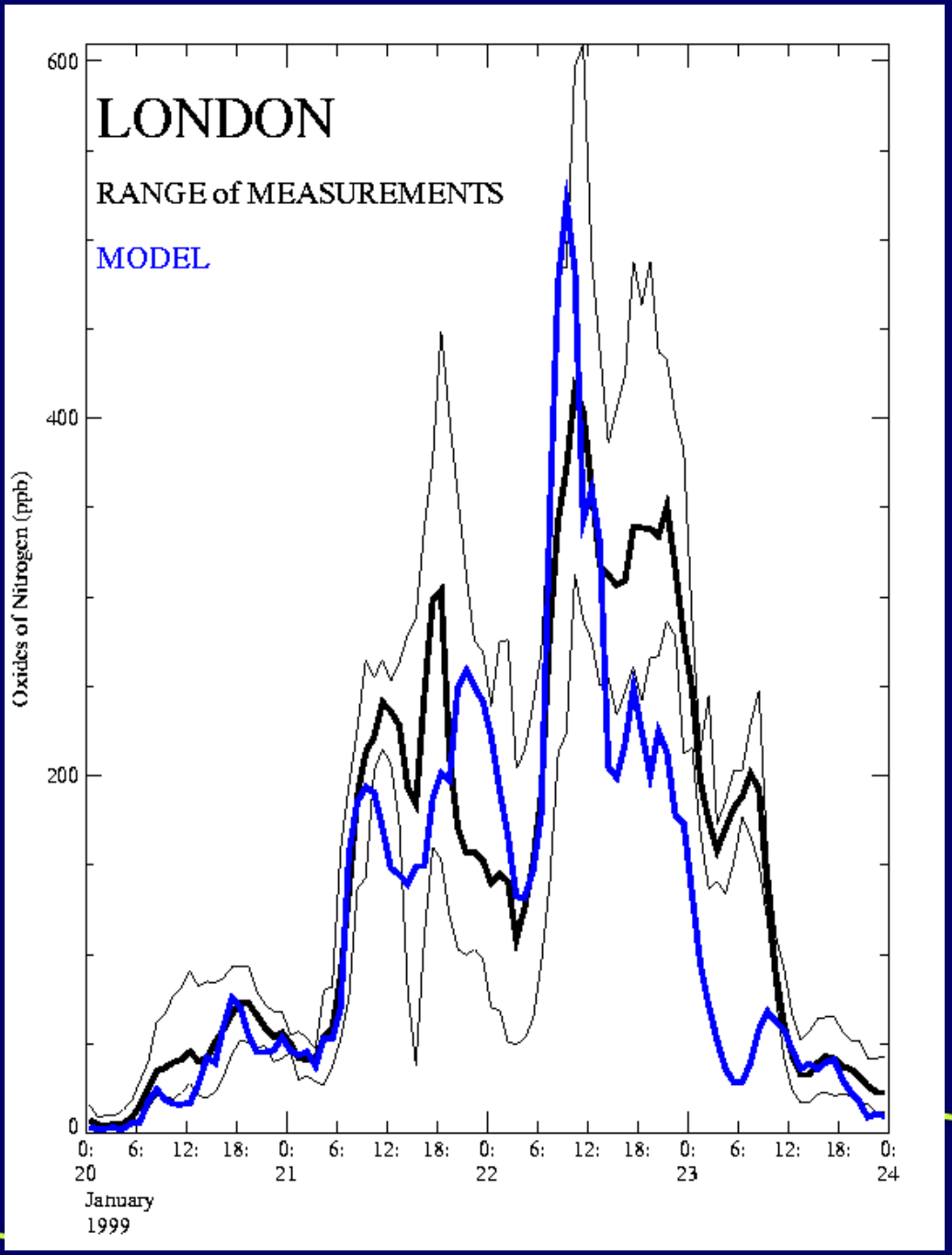
- Emissions
- Measurements
- Meteorology + Dispersion
- Chemistry

Emissions

- Pollution emitted from a wide range of activities
- Spatial resolution
- Spatial coverage
- Current emission data
- Temporal resolution

Measurements

- How good is the air quality model?
  - Need to compare with observations
- Observations: single point in space and time - averaged
- Modelled data: Volume and time averaged
- NOT a comparison of like with like values
  - Obs could be effected by local feature or source
    - » subject to turbulent fluctuations
    - » ideally requires many obs in the modelled volume


LONDON
RANGE of MEASUREMENTS
MODEL
Oxides of Nitrogen (ppb)
600
400
200
0
0: 6: 12: 18: 0: 6: 12: 18: 0: 6: 12: 18: 0: 6: 12: 18: 0:
20 21 22 23 24
January
1999

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Meteorology and Dispersion

- Spatial and temporal resolution of 3D meteorology
  - Are local (to source or receptor) features captured? (terrain, urbanisation, coastal)
  - How well resolved is the Day to Night transition?
  - Long range transport of pollutants requires accurate modelling of evolving synoptic picture
- Features important to atmospheric dispersion
  - 3D wind (mean flow)
  - Boundary Layer Depth
  - Atmospheric Stability and Surface Roughness (turbulence)

Chemistry

- Atmospheric Chemistry
  - non-linear and complex
  - Some reactions occur in the aqueous phase (requires cloud information)
  - All primary species and their products need to be modelled (formation of sulphate and nitrate, components of secondary PM_{10}, requires the primary species SO_2, NO and NH_3 to be modelled)

Useful Websites

- Air Quality Forecasts:

http://www.metoffice.com/environment/aq/index.html

- Boxurb (Box Model):

http://www.metoffice.com/environment/boxurb/index.html

Aeolius (Street Canyon):

http://www.metoffice.com/environment/aeolius1.html

UV Forecasts:

http://www.metoffice.com/weather/gsuvi.html

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