12th International Conference on Harmonisation within Atmospheric Dispersion Modelling for Regulatory Purposes

6th-9th October 2008, Cavtat, Croatia

ADMS-Airport: Model Inter-Comparisons and Model Validation

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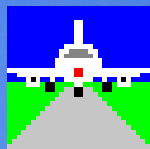

Introduction

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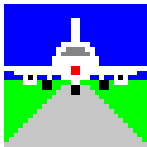
- Development of ADMS-Airport previously presented at Harmo11
- This presentation focuses on further evaluation of ADMS-Airport
- Overview of presentation
  - Brief description of ADMS-Airport
  - Comparison of ADMS-Airport predictions with monitored data at Heathrow Airport
  - Assessment of ADMS-Airport's ability to be used for CAEP (ICAO's Committee on Environmental Aviation Protection) local air quality assessments, including comparisons with other candidate models



ADMS-Airport

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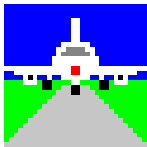
- ADMS-Airport is an air quality model designed to model pollutant concentrations in the vicinity of an airport.
- ADMS-Airport is an extension of the well-known ADMS-Urban system for modelling urban air quality
- Distinguishing feature is treatment of jet engine emissions during take-off and landing as moving jet sources, not as volume sources as is the case in some other models.



Heathrow Airport Study:
Introduction

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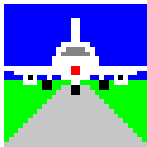
- ADMS-Airport was used in the assessment of the air quality impacts of the possible development of Heathrow Airport to allow for runway operation in ‘mixed mode’ or the operation of a third runway
- Study comprised 2002 Base Case study and nine future scenarios
- Full report published in CERC (2007): ‘Air Quality Studies for Heathrow: Base Case, Segregated Mode, Mixed Mode and Third Runway Scenarios modelled using ADMS-Airport’. DfT Publications 78APD02904CERC and http://www.dft.gov.uk/consultations/closed/heathrowconsultation/technicalreports/airquality.pdf
- Here we present some examples of validation of the model from the base case study



Heathrow Airport Study:
Summary of emission data and model set-up

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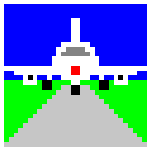
- Airport source emission data supplied by AEA Technology
- Traffic data for major roads supplied by Hyder Consulting
- Other inventory data taken from London Atmospheric Emissions Inventory (GLA, 2005) and the National Atmospheric Emissions Inventory (NAEI) for the area to the west of Heathrow
- Meteorological data (standard hourly sequential data) from the measuring site at the airport
- Background concentrations of NO_X, NO_2, PM_{10} and O_3 obtained from the relevant upstream rural monitoring sites for the prevailing meteorological conditions



2002: Modelled total NO_x concentration (µg/m³)

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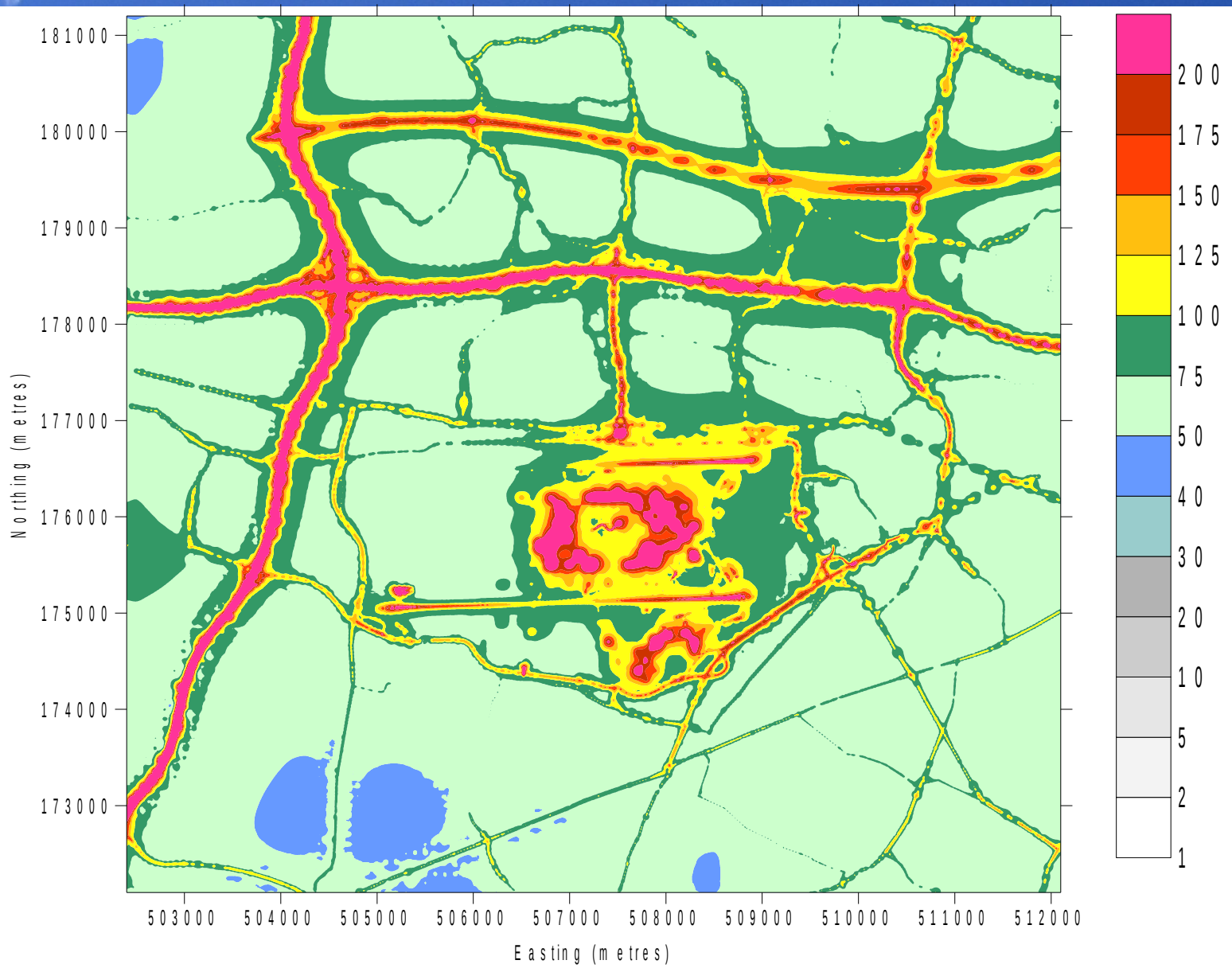

Heathrow Airport Study:
Comparison of model predictions with monitored data

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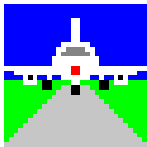
- Hourly model predictions of NO_X and NO_2 compared with hourly measured data from 9 automatic monitoring sites
- Hours were excluded where either modelled or monitoring data were missing

	Correlation (Monitored=1)	Fraction within a factor of 2 (Monitored=1)	Fractional bias (Monitored=0)
NO_X (averaged over all 9 sites)	0.61	0.77	+0.013
NO_2 (averaged over all 9 sites)	0.68	0.84	+0.018



Heathrow Airport Study:
Scatter plots of annual average NO_X and NO_2

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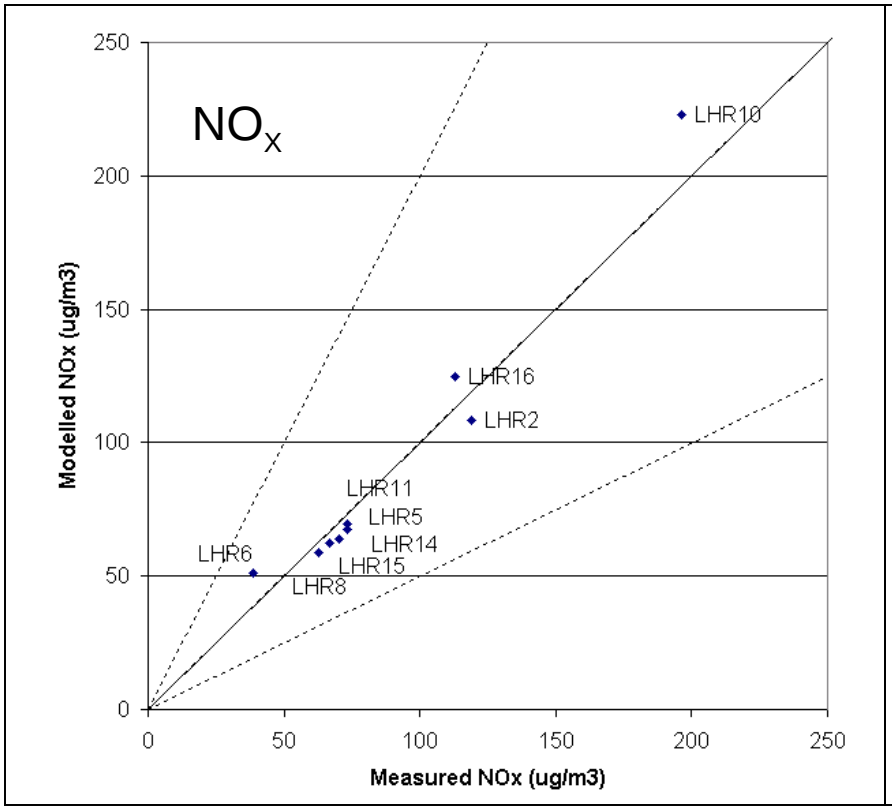
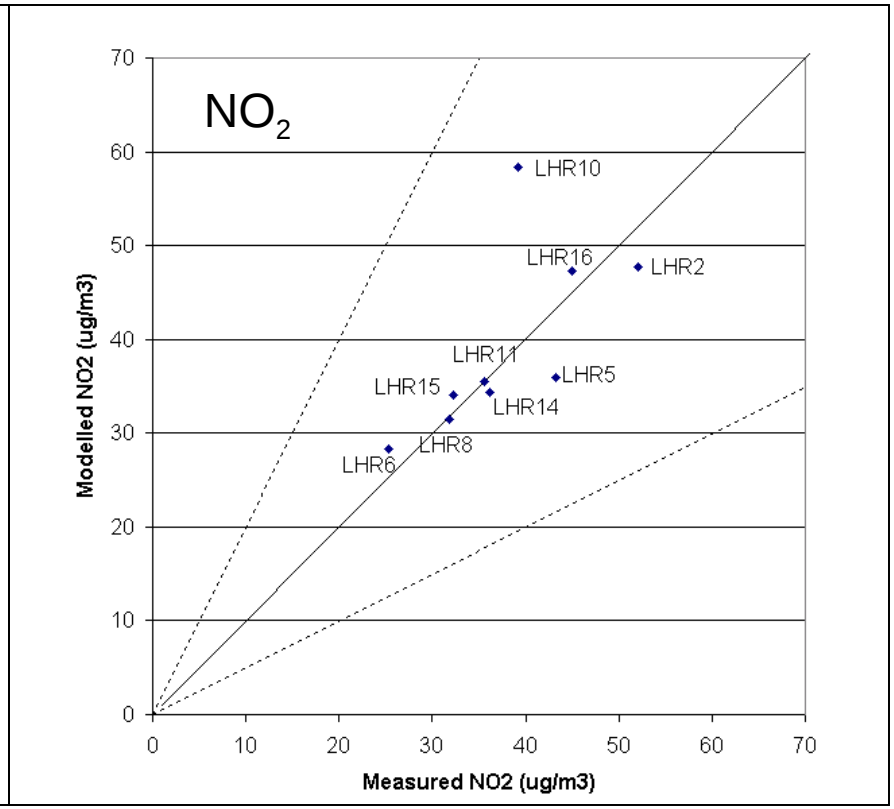
- Modelled and monitored annual average NO_X and NO_2 calculated from hourly values:





Heathrow Airport Study:
Detailed analysis of monitoring site LHR2

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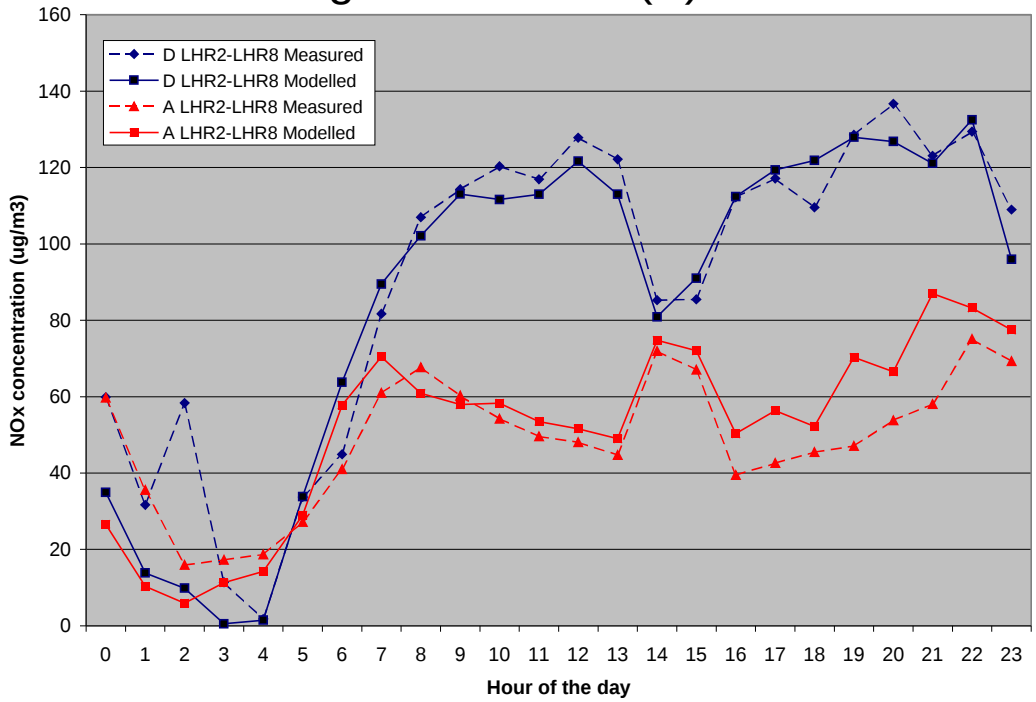
- Monitoring site LHR2 is located just north of the eastern end of the northern runway
- LHR2 records a strong signature from aircraft take-off when the northern runway is operational with take-off to the west
- Chart compares modelled and measured NO_X concentrations at LHR2 for hours when there are take-offs to the west (D) on the northern runway and hours when there are landings to the west (A) on the northern runway



- Diurnal variation as well as the difference between departures and arrivals is well-captured by ADMS-Airport

CAEP model inter-comparison study:
Introduction

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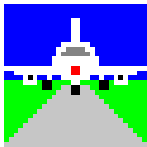
- Purpose of study: to provide CAEP with side-by-side comparison of the 4 local air quality models (ADMS-Airport, AEDT/EDMS, ALAQS and LASPORT) currently being proposed for CAEP assessments of emissions and pollutant concentrations in the vicinity of airports, **NOT** a validation exercise
- CAEP requires a generic approach applicable to all airports, therefore a mock airport ‘CAEPport’ was designed to test the candidate models regarding basic functionality of
  - Emission source characterisation
  - Pollutant dispersion modelling according to a common set of parameters, a shared set of meteorological data and a uniform array of downwind receptors
- Emissions sources considered:
  - Aircraft main engines (LTO cycle and start-up)
  - Auxiliary power units (APU)
  - Ground support equipment (GSE)
  - Landside surface transportation equipment and parking facilities
  - Stationary sources
  - Fuel storage and handling activities
  - Training fires



CAEP model inter-comparison study:
CAEPport

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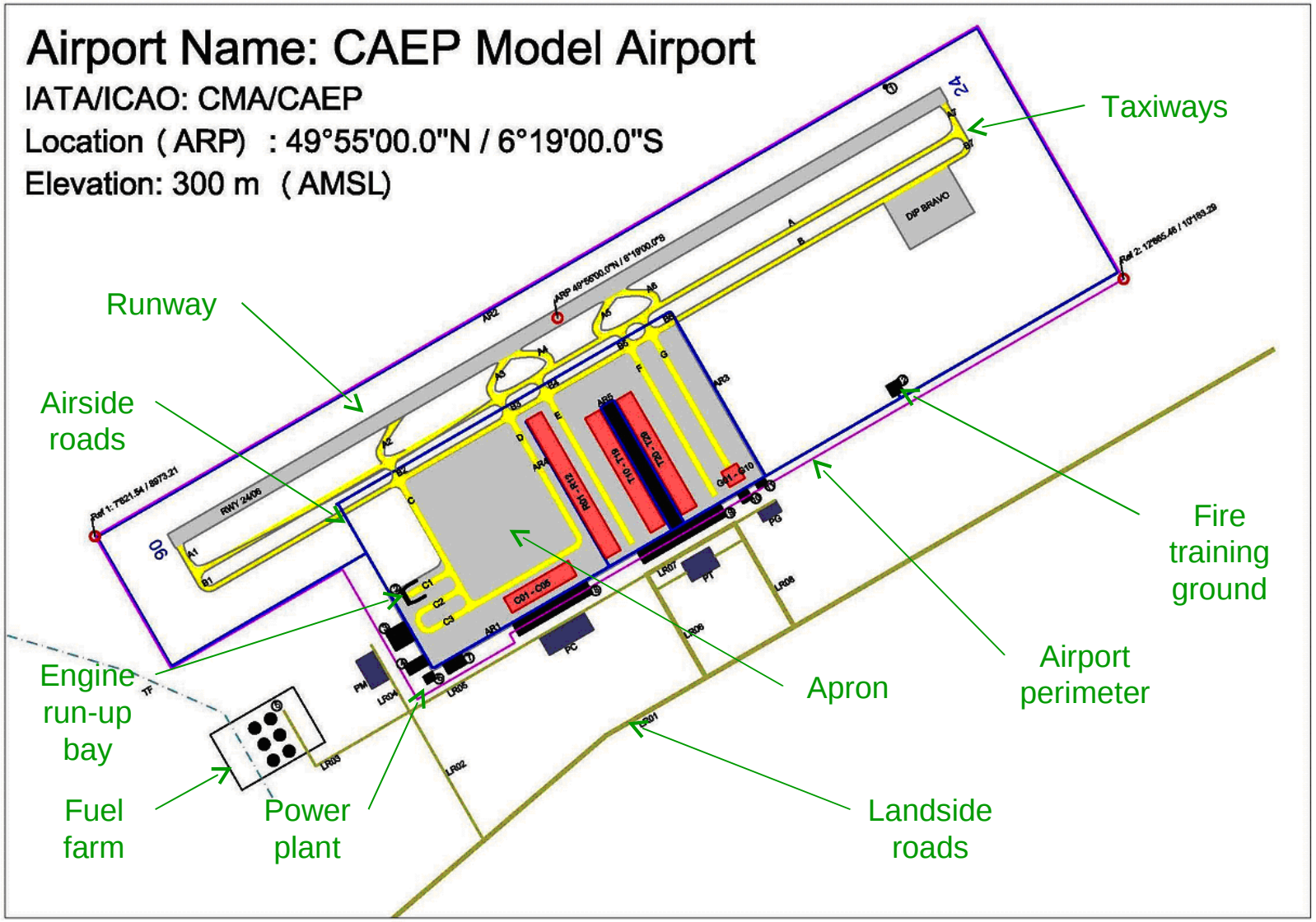

CAEP model inter-comparison study:
Emissions inventory variations

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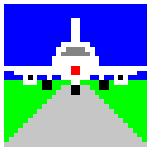
- The intention of the CAEPport model inter-comparison study was to provide a common set of data inputs to all models, leaving each model the freedom to make use of its particular functionality and ability to apply these data
- Models used different emissions calculators, resulting in different total emissions
- For example, below are the standard deviations of the average **aircraft** result from all four candidate models for NO_X:

Pollutant	Take Off	Climb Out	TO+CO	AP+Taxi In	Approach	Taxi In	Taxi Out	Total Taxi	Total
NO_X	42%	51%	8%	31%	67%	67%	11%	35%	11%



CAEP model inter-comparison study:
NO_x annual mean concentration

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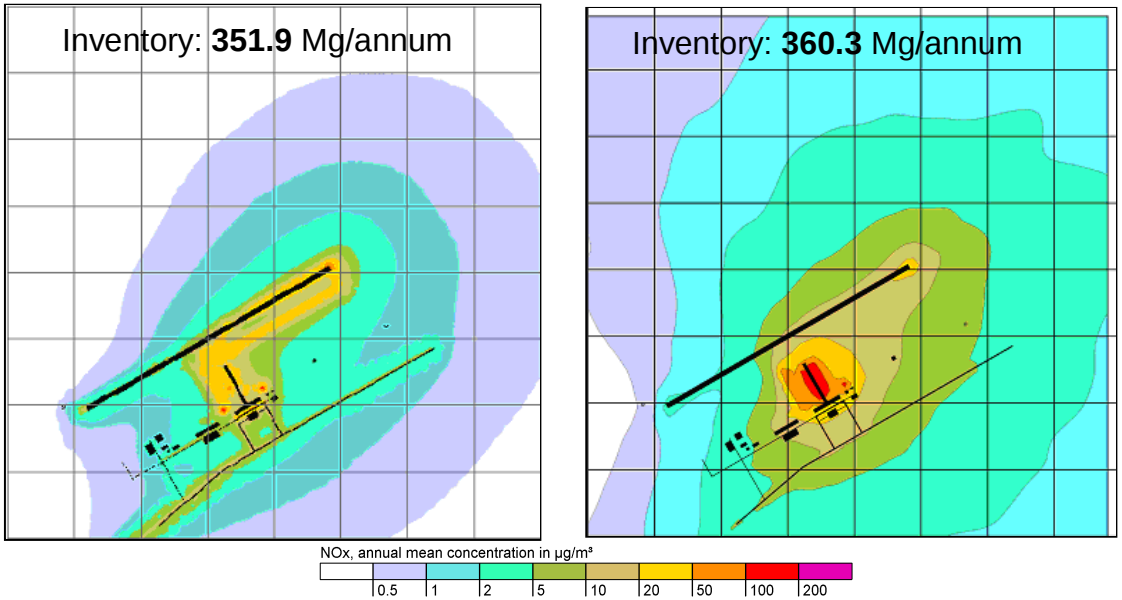
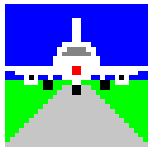


- Plots demonstrate differences/similarities in model performance, **not** absolute accuracy
- Extent to which dispersion model affects concentrations and spatial distribution can broadly be determined
- Significant differences are apparent between 4 models



Summary and Conclusions

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- Modelling air quality around airports is important to
  - those assessing local developments, and
  - international bodies such as CAEP, who require tools for source apportionment and assessment of relative impacts
- This requires tools for modelling air quality around airports to be ‘fit for purpose’ as judged against different criteria
- ADMS-Airport has recently been involved in evaluation exercises for both purposes:
  - In assessing a model for use studying local impacts against EU air quality standards, comparison with monitored data is important; ADMS-Airport predictions have been compared with monitored data at Heathrow.
  - CAEPport exercise not concerned with monitored data or air quality standards. Models have been judged on their ability to use input data in the given format, to calculate emissions, and to output air quality in a given format. Results give insight into the fitness for purpose of models put forward for use in the CAEP/8 Work Programme.