

ADMS-Urban model evaluation summary

December 2015

1 Introduction

Since [ADMS-Urban](#) was first developed and commercially released in 2002, concentrations predicted by the model have been compared to measurements, and the results of these comparisons have been published in various ways. For example:

- Peer-reviewed and conference proceedings papers
- Model intercomparison exercises
- CERC validation papers
- CERC and non-CERC project reports
- CERC presentations
- Guidance documents

Examples of these are given in the sections below.

There are a number of other models in the ADMS software suite, for example:

- [ADMS-Roads](#) is a reduced version of ADMS-Urban;
- [ADMS-Airport](#) has the same features as ADMS-Urban, but aircraft sources may also be modelled; and
- [ADMS 5](#) is an industrial model, which has some features in common with ADMS-Urban, but has additional modules including the ability to model plume visibility, radioactive releases and short term releases of pollutants.

In the following sections, references will be given to validation papers and documents that relate to other models in the suite of software, in the cases where the model results would be identical.

2 Peer-reviewed and conference proceedings papers

Results from the ADMS-Urban model have been presented in a number of papers by CERC authors, but also many papers by non-CERC authors. The CERC papers are listed on the [CERC website](#); a selection of papers by non-CERC authors is also given.

Specific papers are discussed below.

2.1 Road source model inter-comparison

The paper entitled ‘Estimating near-road pollutant dispersion: A model inter-comparison’¹ is

¹ Heist D, Isakov V, Perry S, Snyder M, Venkatram A, Hood C, Stocker J, Carruthers D, Arunachalam S and Owen RC, 2013: Estimating near-road pollutant dispersion: A model inter-comparison. Transportation Research Part D: Transport and Environment, vol. 25, pp. 93 – 105

a paper jointly written by a group at the US EPA and CERC that presents validation results from two studies. One study uses data collected during a field campaign involving releases of a tracer from a line source used to represent a road; the other study involves measurements from a Highway outside Sacramento, US. ADMS-Urban performs well in comparison to the other models (refer to Figures 5 and 9, noting that the tracer experiment dataset was used in the formulation of the RLINE model).

2.2 Evaluation of the use of ADMS-Urban at street scale

ADMS-Urban has been developed to accurately model the characteristics of urban areas that directly and indirectly influence the dispersion of emissions from road traffic. For instance, the wind speed reduction due to building density in urban areas and the channelling and recirculation of flows within street canyons. The paper entitled ‘Urban canopy flow field and advanced street canyon modelling in ADMS-Urban’² describes some of these model features and summarises validation results relating to a model configuration for London. Concentrations predicted by ADMS-Urban compare well with measurements when complex urban features are accounted for in the modelling.

2.3 ADMS-Urban coupled to a regional model

The ADMS-Urban dispersion model requires hourly meteorological data to drive the dispersion calculations. These data may be measured, or else output from a mesoscale model such as WRF. Further, ADMS-Urban requires data relating to the levels of long-range pollutant transport; these are usually hourly values, and again may be measured or modelled data. An automated system has been developed where ADMS-Urban is coupled to a regional model – the [ADMS-Urban Regional Model Link](#). The paper entitled ‘The development and evaluation of an automated system for nesting ADMS-Urban in regional photochemical models’³ describes the validation of such a system configured for the Hong Kong SAR. Despite the relatively poor quality emissions inventory used in this study, the model predictions show good performance. Since this work has been completed, CERC have developed a road emissions-related tool for the Hong Kong Environmental Protection Agency that will facilitate the compilation of their emissions inventory.

3 Model intercomparison exercises

Results from the ADMS models have been included in a number of model intercomparison exercises, for instance as part of the initiative on ‘[Harmonisation within Atmospheric Dispersion Modelling for Regulatory Purposes](#)’⁴. A road source model intercomparison paper is described in Section 2.1 above; details of two reports that present results from model intercomparison exercises involving ADMS are described below.

² Hood C, Carruthers D, Seaton M, Stocker J and Johnson K 2014: Urban canopy flow field and advanced street canyon modelling in ADMS-Urban. 16th International Conference on Harmonisation, Varna, Bulgaria, September 2014

³ Stocker J, Hood C, Carruthers D, Seaton M, Johnson K and Fung J, 2014: The development and evaluation of an automated system for nesting ADMS-Urban in regional photochemical models. 13th Annual CMAS Conference, Chapel Hill, NC, USA, October 2014

⁴ CERC Director Dr David Carruthers is on the scientific steering committee of the series of conferences relating to this initiative, which take place in Europe every 18 months

3.1 UK government-funded road source model intercomparison exercise

CERC took part in the UK Department of Food and Rural Affairs (Defra) funded urban model evaluation exercise, which attempted to assess the accuracy of a range of air dispersion models. The models were configured to represent London (2008). The model results were evaluated and compared during Phase 1⁵ of the exercise. During Phase 2⁶, various model scenarios were analysed, source apportionment results were assessed, and, for the two models that were able to model chemical reactions⁷, hourly NO₂ results were evaluated.

3.2 UK government-funded airport source model intercomparison exercise

ADMS-Airport was used to model air quality at London's Heathrow airport as part of the UK Department for Transport's (DfT) 'Project for Sustainable Development of Heathrow (PSDH) - Adding Capacity at Heathrow'⁸. This followed the PSDH Model Inter-comparison Study and the recommendations of the DfT's expert panel on modelling which was in 'full agreement in the recommendation of the CERC model ADMS-Airport for future modelling work at Heathrow'. ADMS-Airport continues to be used for air quality assessments at Heathrow and other airports in the UK and worldwide.

4 CERC validation papers

CERC have compiled a number of ADMS validation papers that demonstrate the models' ability to predict pollutant concentrations measurements in various urban and industrial situations. The majority of the studies involve data from field campaigns and wind tunnel experiments. Particular features of the model are evaluated, for example there are a set of papers relating to dispersion close to buildings, and also the impact of complex terrain on flow and pollutant concentrations.

Whilst some of these have been submitted to journals, the majority are available from the [CERC website](#) as non-peer reviewed documents. These ADMS 'validation papers' are updated when new versions of the model are released.

5 CERC and non-CERC project reports

There are many hundreds of users of the ADMS suite of software. The majority of work undertaken using the model is legislation-driven; for example, using the model to predict air quality concentrations relating to planning applications, or investigating the impact of low-emission scenarios. The users of the model are usually required to present results of their model evaluation in a project report; these reports often become publicly available. Examples of such reports are described below.

5.1 Air quality modelling for the City of London Corporation (UK)

CERC were contracted by the City of London Corporation UK to perform base case air

⁵ Carslaw, D.,2011: Defra urban model evaluation analysis – Phase 1

⁶ Carslaw, D. *et al.*, 2013: Defra Phase 2 urban model evaluation

⁷ The models were ADMS-Urban, and a King's College London research model that uses ADMS as a kernel

⁸ Air Quality Studies for Heathrow: Base Case, Segregated Mode, Mixed Mode and Third Runway Scenarios modelled using ADMS-Airport

quality modelling⁹. This work involved model verification of NO_x, NO₂ and PM₁₀ at the three monitoring sites within the borough, in addition to the creation of air quality maps in of the area. As exceedences of the air quality objective values were predicted, source apportionment analyses were undertaken¹⁰. The results of these analyses informed the range of emission-reduction scenarios¹¹ that were investigated.

5.2 Transport for Scotland – Environment statement for dual carriageway

Transport for Scotland used ADMS-Roads to assess the impact of widening a section of road to become a [dual carriageway](#)¹². This is a typical application of the model which involves base year (2012) model verification and future year (2019) modelling with and without the proposed scheme. For this study, a NO_x ‘model adjustment factor’ of 1.3 was derived from the base year model verification. This is a standard approach often applied by users of the model to allow for the [underestimation in the published diesel vehicle NO_x emission factors](#).

6 CERC presentations

CERC present at scientific conferences and technical meetings. Many of these presentations include model evaluation results. CERC also host and present at annual [User Group Meetings](#), which are free to attend for ADMS licence holders with valid support contracts.

A selection of CERC presentations is available for [download](#).

7 Guidance documents

There is no provision to specify regulatory air quality models in the UK, instead any model may be used if it can be shown to be fit for purpose. However, ADMS is prominent in the Local Air Quality Management Technical Guidance¹³ document, which has been written to support Local Authorities in their role of managing air quality.

In the US, where the regulatory models are developed by the US EPA, ADMS is mentioned in the list of ‘Alternative Models’ that can be used for regulatory applications with case-by-case justification to the Reviewing Authority.

CERC participate in the ‘[Forum for air quality modelling in Europe](#)’ (FAIRMODE) initiative. The focus of this work has been to develop metric(s) (and an associated tool) that are suitable for evaluating air quality models. CERC have contributed to this work; for instance, CERC are co-authors on the ‘Guidance Document on Model Quality Objectives and Benchmarking’¹⁴ document – ADMS-Urban results are presented as a case study in this document.

⁹ Air Quality Modelling for the City of London Corporation: Model Verification & Air Quality Maps, CERC

¹⁰ Source Apportionment for the City of London Corporation, CERC

¹¹ Emissions Reductions Scenarios for the City of London Corporation, CERC

¹² A9 Dualling: Luncarty to Pass of Birnam. DMRB Stage 3 Environmental Statement. Appendix A14.2: Dispersion Model Set Up, Model Verification and Traffic Data

¹³ Part IV of the Environment Act 1995 Environment (Northern Ireland) Order 2002 Part III Local Air Quality Management Technical Guidance LAQM.TG(09) February 2009

¹⁴ Guidance Document on Model Quality Objectives and Benchmarking, Viaene, P. et al. 2015