AGGREGATION OF SOURCE EMISSIONS ONTO A GRID

CERC

In this document 'ADMS' refers to ADMS-Urban 5.1 and ADMS-Airport 5.1. Where information refers to a subset of the listed models, the model name is given in full.

1. INTRODUCTION

Urban areas include emissions from a number of different types of source, for example, major and minor roads, industrial sources, commercial buildings, domestic dwellings, sewage plants and landfill sites. In a modelling run it is important to consider the emissions from all these sources of pollution. However, treating all sources explicitly is computationally intensive and, in most cases, unnecessary.

ADMS has a **grid** source type that provides a fast way to model poorly-defined or diffuse emissions by obviating the need to model each source explicitly. A grid source consists of a matrix of identically sized cells (horizontally; cell depths may differ per layer if using a 3D grid source) and must be defined over an area encompassing all sources in the model run. The emission rates for the grid source are obtained by summing or **aggregating** the emissions of *all pollutants* from *all sources* in the modelling area, i.e. emissions from sources that may be specified explicitly, such as major roads and industrial sources, as well as those from any poorly-defined or diffuse sources in the area, such as minor roads or domestic heating sources. Although the grid source cells all have the same footprint area, each one will in general have its own emission rates according to the sources or parts of sources it contains.

Before calculating the dispersion of grid source emissions, the model subtracts the explicitly defined source emissions from the grid source emission rates, leaving only the residual emissions. In other words, the emissions of any specified industrial and road sources defined in the model file are subtracted from the grid source totals. This procedure is known as **disaggregation** and is clearly necessary to prevent double-counting of the emissions from explicit sources.

A standard grid source can be added to an ADMS modelling scenario in one of three ways:

- Created by hand in the ADMS model interface;
- Imported from an .spt file, for instance created in EMIT; or
- Generated from industrial and road source emissions using the Emissions Inventory extension in ArcGIS or MapInfo.

A 3D grid source must be added via the relevant additional input file option.

Sources that are usually considered explicitly in an ADMS modelling run are:

- Major roads, for example motorways, A, B and C roads; and
- Industrial sources with significant emissions, for example Part A and Part B sources.

Sources that are generally not treated explicitly in the model run, and would therefore form part of the residual emissions in a grid source, are:

- Minor roads, for example unclassified roads and roads in residential areas;
- Industrial sources with small emissions, for example small boilers or vents;
- Minor emissions defined via a GIS: polygon sources, defined over some polygonal area; or grid square sources, defined over a separate grid of squares, e.g. defined on a postcode district basis;
- Domestic properties; and
- Landfill sites.

The main advantage of setting up a grid source to include all emissions is that the grid source emission totals remain unchanged no matter which sources are considered explicitly in the model run. That is, various explicit source combinations can be investigated, without users having to recreate the grid source emissions each time (containing any non-explicitly defined sources).

However, an option exists to specify individual sources which will not be disaggregated from the grid source when source disaggregation is undertaken. This option can be useful when modelling scenarios where the proposed new sources are not already present in the grid source. Without this option, the emissions from these sources would have to be added onto the existing grid source totals to ensure they were correctly disaggregated.

Note that the residual emissions included within the grid source are *not* the same as background concentrations. The latter are the concentrations of pollutants that are advected from a rural area upstream of the modelling domain. Note that if a large urban area is being modelled, use of the Trajectory Model option allows changes in 'background' concentrations due to local emissions to be taken into account (please refer to Technical Specification paper P18/03 for further details).

In the rest of this paper, Section 2 gives details of how sources should be aggregated to create a grid source. The method used to carry out dispersion calculations for a grid source is described in Section 3.

2. AGGREGATION OF SOURCES

When disaggregating the explicitly-modelled sources from the grid source, ADMS makes certain assumptions about how the sources have been aggregated. It is therefore important that when a user creates a grid source, the guidelines in Table 1 are followed.

Source type	Source location	Treatment
Point	Point source inside grid source cell	Emissions allocated to the containing grid source cell*
	Point source lies on the edge between two grid source cells	All emissions are allocated to the most northern or eastern of those grid source cells*
	Point source lies on the vertex between four grid source cells	All emissions are allocated to the north-eastern grid source cell*
Road/ Line	Road contained entirely within one grid source cell	Emissions allocated to the containing grid source cell†
	Road crosses more than one grid source cell	Emissions are divided between grid source cells crossed in proportion to the length of the road source lying within each grid source cell†
	Road lies on the edge between grid source cells	Emissions are divided between the northern or eastern grid source cells in proportion to the length of road lying along the edge of that cell†
Area/ Volume	Source contained entirely within one grid source cell	Emissions allocated to the containing grid source cell
	Source covers more than one grid source cell	Emissions are divided between grid source cells covered in proportion to the area or volume of the source lying within each grid source cell

***Table 1** – Summary of how road, point, line, area and volume sources should be aggregated when creating an ADMS grid source. * If using a 3D grid source, there is an option (on by default) to distribute emissions vertically using an estimate of initial plume rise and spread. † If using a 3D grid source, there is an option (off by default) to treat all road sources as being within the lowest grid layer regardless of their height.*

3. DISPERSION CALCULATION

Grid sources are an efficient way to model the dispersion of diffuse or poorly-defined emissions because the dispersion of the residual emissions of a given pollutant only needs to be modelled once, for one grid cell, as an individual volume source: results for the other grid cells can be obtained by scaling these results according to their emission rates. This is achieved by taking conditions for the grid source to be uniform over the modelling area, i.e. terrain and roughness changes are ignored. Furthermore, the dispersion is simplified by modelling the grid cell as a passive source (i.e. with no

plume rise), as the effects of plume rise are unlikely to be important for this type of source.

For each grid cell, concentrations are calculated on a series of grids of 121 by 121 points, at a defined series of internal calculation heights. Each grid is centred on the centre of the grid cell, with spacing equal to the width of the grid cell. Concentrations at a given receptor point are then calculated by firstly linearly interpolating in the x- and y-directions, from the nearest 4 points on this grid of concentrations (here receptor points less than half a grid cell width outside this grid are assigned the concentration at the nearest point; the concentration at receptors more than half a grid cell width outside this grid is assumed to be zero), then secondly linearly interpolating in the vertical from the nearest 2 internal calculation heights. The calculation heights are 0, 1, 2, 4, 7, 10, 20, 40, 70, 100, 200, 400, 700 and 1000 metres above ground level, plus additional heights at H and H+1 m, where H is the boundary layer height, and at the maximum user-specified output height, if this is greater than 1000 m.