CALCULATION OF LONG-TERM STATISTICS

CERC

In this document 'ADMS' refers to ADMS 6.0, ADMS-Roads 5.1, 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.

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1. Calculation Methodology

Long-term means of concentration, odours, deposition and activity (radioactive isotopes), long-term percentiles of concentration, odours and activity, and the expected number of exceedences of threshold concentration, odour or activity levels may be calculated using hourly sequential met data or statistically analysed met data.

Met data are often supplied with the wind direction in sectors (e.g. to the nearest 10°). In this case, the method of calculation is to resolve each wind direction into n wind directions equally distributed across the sector.

If the sector size is large (>15°), then n =5. Concentrations are calculated for each of the 5 wind directions, and each wind direction is assumed to be equally likely. For example, if the data are in 30° sectors and the given wind direction is ϕ_1, the values of ϕ used by the model will be ϕ_1, ϕ_1 +6°, ϕ_1-6°, ϕ_1 +12°, ϕ_1-12°.

If the sector size is small (<15°), then n =3. The 3 wind directions are used in turn as each sector appears in the met data. For example, if the data are in 10° sectors, and the first 6 values of ϕ are 30°, 30°, 20°, 30°, 10°, 20°, the values of ϕ used by the model will be 30°, 33.3°, 20°, 26.7°, 10°, 23.3°.

If the wind direction data are not in sectors, the wind direction is used as given. In the UK, hourly sequential met data are typically in 10° sectors and statistically analysed data are typically in 30° sectors.

1.1 Long-term means

The long-term mean at a point, $C_{ann}(x,y,z)$ is the mean of the contributions from the *metlines* met conditions, each of which occurs with frequency f. For large sector sizes, $m = n$ and the n wind directions are assumed to be equally likely. Otherwise, m =1.

$$C_{ann}(x,y,z) = \frac{1}{f_{total}} \sum_{i=1}^{metlines} \sum_{j=1}^{m} C_i\,(x,y,z)\,\frac{f(i)}{m}$$

where the total frequency of all the met conditions is given by

$$f_{total} = \sum_{i=1}^{metlines} f\,(i)$$

1.2 Long-term percentiles

The basic method of calculating the long-term percentiles of concentration (or activity) is to store the concentrations, C_i, calculated at each point and the associated frequency of occurrence, f_i, of each value. Note that for large sector sizes, for n_{met} lines of met data there will be n^*n_{met} values for each output point, where n is the number of wind directions per sector. The concentrations are sorted into descending order i.e. highest at the beginning and lowest at the end, to form a probability distribution function (PDF). The highest value corresponds to the 100th percentile value, and the lowest to the 0th percentile value. Intermediate percentiles are selected according to the cumulative frequency.

There are three methods of storing the concentrations and the appropriate method is chosen according to the quantity of working memory (RAM) available.

1.2.1 Concentration array

If sufficient working memory is available to store all the concentrations and frequencies in an array during the run and calculate percentiles from the array at the end of the run, this is the most efficient method. The quantity of memory required can be large, especially if there are many met. lines in the run. If insufficient memory is available, the model will use the linked list or concentration file methods described below.

1.2.2 Linked List

For hourly sequential met data only, if there is insufficient memory to store all the concentrations in an array during the run, the model will attempt the linked list method in which the highest concentrations are stored in a linked list so that they are ordered from the highest to the lowest values as they are stored. For instance, for the 98th percentile from one year's met data (8760 hours) only the top 2% of values (176 hours) need to be stored. There is a trade-off between storing fewer concentrations and the time required to order the values after each calculation. For low percentiles, this method can also require a large quantity of available working memory, and if there is also insufficient memory for this method, the model will use the concentration file method described below.

1.2.3 Concentration file

If there is insufficient memory to store all the concentrations in an array during the run, then for statistically analysed met data (or for hourly sequential met data if there is also insufficient memory for the linked list method), the surplus concentrations and frequencies that cannot be stored in the concentration array are stored in a temporary file on the hard drive. This method is typically the slowest as the surplus values must be written to and read from disk.

1.3 Long-term exceedences

Exceedences of threshold concentration are output at each output point as the number of T-hour periods per annum for which the T-hour concentration at that output point is expected to exceed the threshold value, where T is the averaging time in hours (which may be less than 1.0). Note that the number of exceedeences is always calculated as a *per-annum* value, even if the met data cover a period shorter or longer than a year.

The number of exceedences E is therefore calculated as follows:

$$E(C > C_0) = \frac{(365 \times 24)}{T \times f_{total}} \sum_{\mathrm{i}=1}^{metlines} \sum_{j=1}^{m} A\,(i,j) \times (f(i)/m)$$

where $A(\mathrm{i},\mathrm{j}) = 1$ if the calculated concentration for met line i and wind direction j exceeds the threshold value, and 0 otherwise.

2. Limitations

Percentiles and exceedences of deposition flux and gamma dose are not calculated.