CALCULATION OF LONG TERM STATISTICS

CERC[1]

1. Calculation Methodology

Long term means of concentration, deposition and activity (radioactive isotopes), long term percentiles of concentration and activity, and the expected number of exceedences of threshold concentration/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 *fr*. For large sector sizes, m=*n* and the *n* wind directions are assumed to be equally likely. Otherwise, m=1.

[1] CERC authors: C A McHugh and S J Dyster

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

where $f_{total} = \sum_{i=1}^{metlines} fr(i)$ is the total frequency of all the met conditions.

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. 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 two methods of storing the concentrations and the appropriate method is chosen according to the type of calculation.

1.2.1 Linked List

For calculation of high percentiles from hourly sequential data 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, which is why the method is not used for lower percentiles.

1.2.2 Concentration file

For calculation of low percentiles from hourly sequential data and all percentiles from statistically analysed met data all the concentrations and frequencies are stored. This method requires more time after the calculation of the hourly concentrations to calculate the percentiles as the values must be read from file and then ordered.

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:

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

where A(i,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.