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STATISTICAL ELEMENTS OF PREDICTING THE IMPACT OF A VARIETY OF ODOUR SOURCES

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Summary

Two key elements in predicting odour response are the estimation of peak (few seconds) ground-level concentrations and the evaluation of the likelihood of a consequent adverse response. Peak rather than ensemble-average concentrations are not easily predicted by current dispersion models. The required peak-to-mean ratios depend on source characteristics, downwind distance and atmospheric stability. Using recent wind tunnel simulations for four types of sources and two atmospheric stabilities and various measures of intermittency and non-stationarity, different regimes of behaviour are resolvable. A set of peak-to-mean ratios for a specified probability of exceedance is recommended and their practicality discussed.

Keywords: Peak-to-mean ratio, intermittency, odour assessment.

1. Introduction

There is increasing interest in evaluating the odour impact of various industrial and agricultural enterprises. Recent tribunal proceedings in Australia have involved disputes over the methods of estimating odour emissions and variability, the criteria for annoyance due to odours and the methods of predicting likely odour impact. These issues affect the siting of industry and the choice of odour control technology and suitable buffer zones.

Short-term concentrations of odorous compounds are usually characterised by an intermittent time series of high peaks and periods of low concentrations. Previous field tests using trained observers have demonstrated strong intermittency for a tall stack, with odour recognition occurring sporadically in space and time. For an area source the odour was detected more regularly with a much lower centreline intermittency. Concentration time series for wind tunnel simulations of an area and point source in neutral conditions demonstrate the different structures of concentration bursts and gaps for the two source structures (Figure 1).

Odour response is not just tied to mean concentration and intermittency of component concentrations but depends on the overall intensity (strength) of the odour (usually measured in odour units (OU/m^3)), the frequency and duration of occurrence of various odour levels, the specific annoyance (offensiveness) of the constituent compounds of an odour and the composition, tolerance and past odour experience of the local population. Odour intensity and frequency are traditionally evaluated by a combination of emission and dispersion modelling. Duration and offensiveness are usually only known from experience or intensive odour surveys. Community annoyance can be evaluated at various levels of complexity and involves a wide variety of physiological, psychological and sociological factors.

Various experiments (see Woodfield and Hall 1994) have shown that the perceived odour response is <u>not</u> linearly related to the concentrations C(r,t) of the odorous compound. Odour response may be more related to the general characteristics of fluctuations of concentrations away from the mean value, rather than just the value of the peak concentration. A variation of odour response with ln C or $C^{0.5}$ could reduce the importance of very high concentrations compared to the evaluation of toxic or inflammable releases.

There are several general methods of assessing likely nuisance, annoyance and complaints due to odour exposure. Community surveys are particularly useful for existing sources but relatively expensive to perform well. The results from extensive European studies may not be readily transferred to the exposure patterns in the more open-air Australian environment. Industry codes of practice are particularly useful as screening techniques for likely odour impact. Semi-empirical descriptions also have considerable utility, especially for estimating the influence of individual sources within complex configurations. The Warren Springs relationship between maximum distance d_{max} for odour complaints from a low-level source of strength E OU/s ($d_{max} = (kE)^{0.6}$) can be extended to zones for perception, continuous perception, annoyance and complaint. The value of k varies by an order of magnitude between perception and complaint generation (with a resultant factor of 5 in d_{max}). Exercising this simple formula on a long-term meteorological database and including weather-dependent emissions can give an effective statistical analysis of likely community response.