Propagation of Uncertainty through a Hazard Chain

Initial problem statement for Maths-in-Industry Study Group, UEA, 16-20 April 2012**.**

Dr Mike Redwood , Dr Joe Gillard, Dr Veronica Bowman.
Physical Sciences Department, DSTL Porton Down.

Toxic substances released into the environment pose both an immediate and delayed risk to human health. When this release is in the form of a gas or vapour it is necessary to predict where the substance will disperse and deposit in the environment as this will allow a first responder to undertake appropriate mitigation strategies. To this end many organisations have worked to produce models which predict parts of this process. However, in order to produce an estimate of casualties that may result from exposure to the substance these disparate models must be tied together. Importantly, it is not only necessary to predict a casualty estimate but also to have an associated uncertainty with this value. At a high level this modelling chain includes a meteorological estimate, a second order closure dispersion model, and a casualty model.

We are looking to establish a methodology for propagating uncertainty through this modelling chain in order to undertake a casualty estimate. However, there are several key problems within this propagation chain which we would like to address.

A dispersion model predicts mean concentration and variance at particular locations through time, however, the casualty estimate is undertaken with actual concentrations and the mean is used as an estimate. The mean is then integrated through time (ignoring population movement, laydown through the plume and variation in breathing rates along with many other possibly relevant factors), to give a received dosage. This dosage is then passed through a probit slope model with unknown uncertainty to produce a casualty estimate.

Suggestions for improvements to this modelling process are sought to allow more accurate casualty prediction and better understanding of the effect of these modelling steps on the uncertainties involved.

DSTL staff at the Study Group will have a full information pack, with details of the dispersion, dosage and response models, and will be able to run computer implementations of the models.