ADMLC
UK Atmospheric Dispersion Modelling Liaison Committee

Uncertainty

Wednesday 3rd May 2017
European Space Agency (ESA), Fermi Avenue, Harwell Campus, Didcot, OX11 0FD

9.30 – 9.55 – Coffee on arrival

9.55 – 10.00 Welcome, Intro to ECSAT & H&S briefing – Alan Brunstrom
And brief introduction from the ADMLC Chair – Matt Hort

10.00 - 10.10 – Pres 1	**Stephanie Haywood, PHE:** Impact of uncertainties on early health protection decisions in radiation emergencies and applicability to other fields
10.10 - 10.40 – Pres 2	**Jeremy Oakley, University of Sheffield:** Uncertainty and Sensitivity Analysis for Complex Simulation Models
10.40 - 11.10 – Pres 3	**Helen Dacre, University of Reading:** Quantifying the uncertainty in volcanic ash forecasts
11.10 - 11.30 – Break	
11.30 - 12.00 – Pres 4	**Jonathan Rougier, University of Bristol:** Quantifying confidence in probability assessments
12.00 - 12.30 – Pres 5	**Ken Mylne, Met Office:** Ensemble modelling to better understand the impact / significance of uncertainty
12.30 - 13.00 – Discussion:	**led by Jim Smith on quantifying and reducing uncertainty**
13.00 - 14.00 – Lunch	
14.00 - 14.30 – Pres 6	**Shannon Fox, US Dept of Homeland Security:** Jack Rabbit II field-scale chlorine experiments – using measurements to reduce model uncertainty
14.30 - 15.00 – Pres 7	**Wendy Parker, University of Durham:** False Precision, Surprise and Improved Uncertainty Assessment
15.00 - 15.20 – Break	
15.20 - 15.40 – Pres 8	**Simon French, University of Warwick:** Presenting & communicating uncertain information
15.40 - 16.10 – Pres 9	**Catrinel Turcanu, Belgian Nuclear Research Centre:** Risk, uncertainty and decision support
16.10 - 16.30 – Discussion:	**led by Jim Smith on presenting and communicating uncertainty to decision makers**

Stephanie Haywood, PHE: Impact of uncertainties on early health protection decisions in radiation emergencies and applicability to other fields

A short introduction to the impact of uncertainty on the advice for public health protection in an emergency situation. In the UK, work has been undertaken to explore the best way of presenting uncertain information in the early hours of a radiological emergency to decision makers who have to make decisions on public health protection measures. Understanding of the situation will be very uncertain at this stage but decisions on protective actions must be taken in spite of a lack of knowledge. It is especially important to counterbalance the uncertainty in estimated health risks with the risks from the early countermeasures themselves, in particular evacuation. The information presented needs to consider not only available data but also what significant information is not yet known and this leads to a range of different predictions which need to be presented together with an estimate of the confidence associated with them. Some aspects of this are likely to be applicable to other situations. For example, how should the uncertainty presented be tailored to the audience? Will the information be welcomed?

Jeremy Oakley, University of Sheffield: Uncertainty and Sensitivity Analysis for Complex Simulation Models

Complex simulation models of physical systems invariably have uncertain input quantities or parameters. This input uncertainty induces uncertainty in the model outputs. We use the term "uncertainty analysis" to mean the process of quantifying input uncertainty and propagating this through the model to quantify the model output uncertainty. I will briefly describe this process, before moving onto the problem of "sensitivity analysis", by which we the mean the process of investigating which uncertain inputs are most influential in driving the output uncertainty. I will describe two approaches to sensitivity analysis: one that considers how uncertain inputs contribute to output variance, and one that considers the effect of uncertain inputs on decisions informed by the model.

Helen Dacre, University of Reading: Quantifying the uncertainty in volcanic ash forecasts

Volcanic ash poses a significant hazard to aircraft: it can cause both temporary engine failure and permanent damage. Flights are therefore restricted in ash-contaminated airspace, disrupting air traffic with the potential for large financial losses. For example, the 2010 Eyjafjallajökull eruption grounded over 95,000 flights, costing the airline industry over £1billion. To ensure safe and optimised flight operations during volcanic eruptions, accurate forecasts of ash location and concentration are needed. Current forecast models are, however, susceptible to many uncertainties, for example due to the imperfect representation of atmospheric processes and to incomplete knowledge of the volcano's eruption characteristics. At present, these uncertainties are not explicitly recognised in the operational forecast system: the challenge is to incorporate them to provide users (airline operators, regulators and air traffic managers) with more robust information to support decision-making during an eruption.

Jonathan Rougier, University of Bristol: Quantifying confidence in probability assessments

It is common for experts to be asked to assess the confidence in their probabilistic assessments, often on a five-point scale running from "not very confident" to "very confident", perhaps with some additional statement about the evidence base and the stability/maturity of the science. I am not sure how helpful this is in practice, and propose an alternative approach which leads directly to a quantification based on a judgement of the relevance of historical observations to the near future.

Ken Mylne, Met Office: Ensemble modelling to better understand the impact / significance of uncertainty

Ensemble forecasting has become the standard method for estimating uncertainty in weather and climate forecasts, particularly designed to address the impacts of chaos in non-linear model evolution. A model forecast is run multiple times with perturbed initial states, and often also perturbed physics parameterizations, and the range of forecast solutions provides a sampling of forecast uncertainty and a rough estimate of the probability of various events. Ensembles can be particularly useful in estimating the risk of high-impact weather events such as severe gales. In order to support effective decision-making under uncertainty, ensembles are increasingly used in conjunction with models of weather impact, so that the forecast uncertainty is propagated into uncertainty in the impact of the weather, and hence into risk management tools. Examples include coupling with a storm surge model to estimate the risk of coastal flooding and a vehicle-overturning model for the risk of travel disruption due to strong winds on the road network. Atmospheric dispersion is an example of where the impact can, under some circumstances, be strongly dependent on the forecast evolution, and hence a probabilistic approach using ensembles could aid better risk estimation and management. However it also presents a difficult challenge due to the very large uncertainties in many aspects of the system beyond the underlying meteorological uncertainty.

Shannon Fox, US Dept of Homeland Security: Jack Rabbit II field-scale chlorine experiments – using measurements to reduce model uncertainty

Due to the continuing risk of large-scale chemical release incidents involving chlorine and other toxic inhalation hazard (TIH) chemicals such as ammonia, accurate modelling of such an incident is of critical importance to DHS and private sector industries. The uncertainty existing in hazard prediction and atmospheric dispersion modelling has broad impacts on emergency planning, response, and risk mitigation, and is a product of many variables and the lack of empirical data for modelling input and validation. In September of 2016 the DHS Chemical Security Analysis Center (CSAC) completed a series of 9 outdoor chlorine release experiments to address these critical knowledge, data, and capability gaps in a field testing campaign called Jack Rabbit II. Sponsored by DHS CSAC, the U.S. Defense Threat Reduction Agency (DTRA), and Transport Canada, these 5 to 20-ton release experiments yielded unprecedented amounts of data from hundreds of instruments, sensors, and detectors tracking the chemical clouds' movement and behaviour 11 km downwind. Preliminary analyses of these data and high-definition video footage will be presented, and new and ongoing efforts to reduce uncertainty in modelling will be described.

Wendy Parker, University of Durham: False Precision, Surprise and Improved Uncertainty Assessment

We identify two basic requirements for uncertainty reports, called *faithfulness* and *completeness*. We then discuss two common pitfalls of uncertainty assessment that often result in reports that fail to meet these basic requirements: (i) adopting a one-size-fits-all approach to the representation of uncertainty and (ii) ignoring the risk of surprise. Finally, we outline some steps and strategies for avoiding these pitfalls and improving uncertainty assessment. (This is joint work with James Risbey)

Simon French, University of Warwick: Presenting & communicating uncertain information

After a brief discussion of the various meanings of uncertainty, I will reflect on some results from a recent project run for ADMLC on presenting the potential risks during the early phase of a nuclear accident. How do we convey the possible spatial distributions of contamination and its consequences to the UK's Scientific Advisory Group for Emergencies and thence to COBR, the UK's national crisis management group?

Catrinel Turcanu, Belgian Nuclear Research Centre: Risk, uncertainty and decision support

The first part of the talk draws on insights from social and decision sciences; it discusses underlying rationales for communicating risk, uncertainty and variability to decision-makers and lay publics, and their implications on subsequent decision-making processes. The second part of the talk departs from the traditional risk analysis approach to explore an alternative paradigm that, interestingly, appears as a point of convergence for operations research (multi-criteria decision aid), science and technology studies (vulnerability analysis) and recent approaches to nuclear risk governance (post-Fukushima stress tests).