Presentation 5 Mechanisms of dispersion in urban areas revealed by the DAPPLE experiments

Stephen Belcher, The University of Reading

The DAPPLE measurements in central London, and the corresponding wind tunnel measurements, provide a wealth of new measurements of the short range dispersion in urban areas. They suggest that the dispersion can be usefully thought of in 3 distinct regions: a very near field, where the concentrations are unpredictable, a neighbourhood scale where the street network provides a strong mechanism for spreading the plume, and a far field, where most of the material is above roof level and follows a Gaussian plume. This division has implications for modelling that will be discussed. We are just beginning to develop inverse methods for locating the plume source and strength in urban areas, when only concentration measurements are known.

Presentation 6

Joe Egan (HPA CEPR), ADMLC: Estimating the location and spatial extent of a covert anthrax release

Releasing highly pathogenic organisms into an urban population is a form of bioterrorism that could result in a large number of casualties. The first indication that a covert open-air release has occurred is quite likely to be individuals reporting for medical attention. If such an attack is suspected, then public health authorities would attempt to identify those individuals who have been infected in order to provide rapid treatment with the aim of reducing the possibility of disease and potential death. Aiming treatment at too small an area might miss individuals infected further down and/or up wind, whereas issues surrounding both treatment resources and serious side effects may rule out mass treatment campaigns of large sections of the population. Our work provides scientific robustness to firstly estimate where and when an aerosolized release has occurred and secondly identify the most critically affected geographic areas. In order to use this statistical tool during an outbreak, public health workers would only need to collect the time of symptomatic onset and the home and work locations of early cases; recent weather information would also be required. Although the accuracy of the estimates is likely to improve as more cases appear, treating individuals based on early estimates might prove more beneficial since time would be of the essence.

Presentation 7

Nils Mole, The University of Sheffield: Modelling large concentrations of dispersing hazardous gases

The assessment of hazards associated with dispersing toxic gases (or of nuisance from malodorous gases) requires knowledge of the probability distribution of large concentrations. Statistical extreme value theory provides a framework for modelling of this distribution based on data, but predictive modelling based on these ideas is currently not well advanced. Some initial ideas on this will be presented, but it is an area in need of further work.

Presentation 8

Tim Fletcher, The University of Glasgow: Interaction of an Eulerian flue gas plume with wind turbines – a computational study

The number of onshore wind farms within the UK is increasing at a considerable rate. The scale of the demand for clean energy along with the relatively small land area within the UK is leading developers to locate wind farms increasingly close to urban or industrialised areas. A key environmental concern that results from this trend is the effect of nearby wind turbines in modifying the dispersal of pollutants from industrial sites, and plumes from flue gas stacks in particular. The presentation will describe how a computational model that is able to simulate the wake dynamics of wind turbines to a high fidelity has been modified and to simulate the interaction of such turbines with smoke plumes. Simulations of several representative plume-turbine configurations will be demonstrated. The emphasis, however, will be on the potential of the model to yield insight into the, at present largely unknown, fluid mechanics of turbine-plume interactions.

Presentation 9

Roger Timmis (EA), ADMLC (& The University of Lancaster): The *AirTrack* Project: Tracking the performance of air pollution sources from ambient data

Ambient air-quality monitoring has grown markedly in the past decade, driven by concerns over human health and the environment. However, the monitoring data are mostly used to compute just a few routine concentration statistics - for comparison with standards, and extra information in the data on the performance of particular sources, sectors and policies is generally under-exploited. New developments in air-quality management, like exposure reduction and the need to scrutinise source performance at industrial and transport sites (e.g. steelworks, airports), mean that the extra information is now needed. Considerable technical knowledge for extracting extra information exists in the specialist scientific community, and *AirTrack* is a NERC-funded Knowledge Exchange project (lead by Lancaster University and the Environment Agency) that aims to share this knowledge with the wider community of air-quality practitioners, and to feedback practitioner experience to the scientists. Many of the new extraction methods are based on the same principles and processes as atmospheric dispersion modelling, and the methods can be used with modelling to give more robust air-quality assessments. In particular, they can show if a model is getting "the right answer for the right reasons (of emissions & dispersion)". The AirTrack project will be introduced, and some examples given of improved data exploitation and source attribution.

Presentation 10

Alan Robins, The University of Surrey: General overview of the future for dispersion modelling

The preceding presentations provide good examples of some recent developments in dispersion modelling. The aim of the final presentation is to complete that picture and, in so doing, discuss some of the areas where further development work is needed, either in terms of the modelling techniques themselves or their application. The review will be restricted to the physics of short/medium range dispersion in a regulatory context.

Appendix

Current and future work to be undertaken by other Universities represented at the ADMLC Forum.

1. Siegfried Gonzi, The University of Edinburgh

   We are working on a number of projects that may be of interest to the meeting, many of which use a global 3-D chemistry transport model driven by assimilated meteorology. We have developed an efficient and modular ensemble Kalman Filter that is currently being used to infer sources and sinks of CO2 and CH4 from new satellite observations, aircraft and ground-based data. Palmer is a science team member on the Japanese GOSAT instrument that measures CO2 and CH4 and on the NASA Atmospheric CO2 Observations from Space team. We currently resolve these fluxes on sub-continental spatial scales. We are also developing inverse methods to infer sources of reactive gases that are tracers of anthropogenic, pyrogenic and biogenic activity, and to interpret changes in land cover. In past work, we have used Bayesian inference techniques to infer gases related to international emission treaties.

2. David Beddows & Vivien Bright, The University of Birmingham

   Atmospheric composition affects air quality, weather, climate and the spread of pollution, amongst other factors. In urban environments, many pollutants are emitted from vehicles, and then undergo dispersion, mixing and chemical reactions; the latter can lead to the formation of ozone (a pollutant at low altitude, with negative impacts upon human health, crop yields and certain materials).

   The composition of the atmosphere in urban environments, particularly in the "street canyons" formed from roads running between rows of buildings in towns and cities, arises from the combined influences of background air mixed in from above, emissions (typically from vehicle exhausts at the roadside), and the mixing and chemical interactions between the two. At Birmingham a Large Eddy Simulation model has been developed, which can accurately simulate the atmospheric motion and mixing which result from background air flowing over a street canyon, and the chemical interactions between various species present. This project will involve an extension of this model, to include a more detailed chemical reaction scheme, and its use to investigate the combined effects of mixing and chemical reactions upon urban air quality.

   The completed model will provide a unique tool to look at the combined effects of mixing and chemical processing, and will be used to investigate a number of questions relating to atmospheric composition, for example: How different is the air quality within the street canyon from the overlying, background atmosphere? How does this depend upon the dynamics, i.e. the weather? To what extent are pollutants processed within street canyons before they escape to the wider atmosphere? What variability in pollutant levels is expected across a street canyon, and with time, and how does this relate to measurements performed by (for example) local authorities?

3. Damien Martin, The University of Bristol

   The atmospheric chemistry group's work at the University of Bristol is centred on the use of both passive and reactive tracers for characterising dispersion at a variety of scales. Recently work has been carried out in central London as part of both the BOC and REPARTEE projects looking at dispersion at relatively short scales. Our latest work focuses on the development of reactive tracers which can be deployed in conjunction with passive tracers in order to determine atmospherically reactive species under a variety of conditions.