NAME – Numerical Atmospheric-dispersion Modelling Environment

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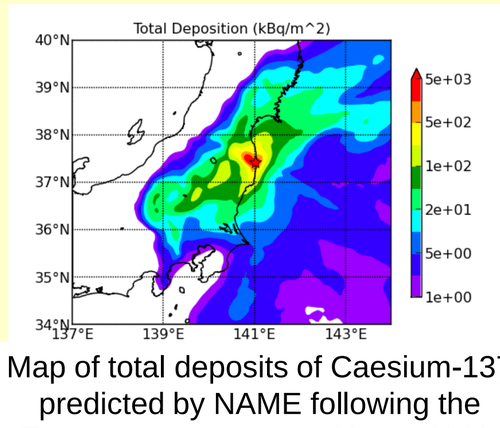
Introduction

NAME (the *N*umerical *A*tmospheric dispersion *M*odelling *E*nvironment), the Met Office's Lagrangian dispersion model was originally developed as a nuclear accident model after the Chernobyl incident in 1986. Since then its capabilities have been extended to include a large number of physical processes and deal with a wide range of scales (Jones et al., 2007).

The main application of the model is in operational emergency response where it is used to aid the assessment of health impacts caused by the accidental release of pollutants during industrial fires, nuclear accidents or volcanic eruptions. Recently the model was used to model the transport and deposition of radioactive material released from the accident at the Fukushima Dai-ichi nuclear power plant..

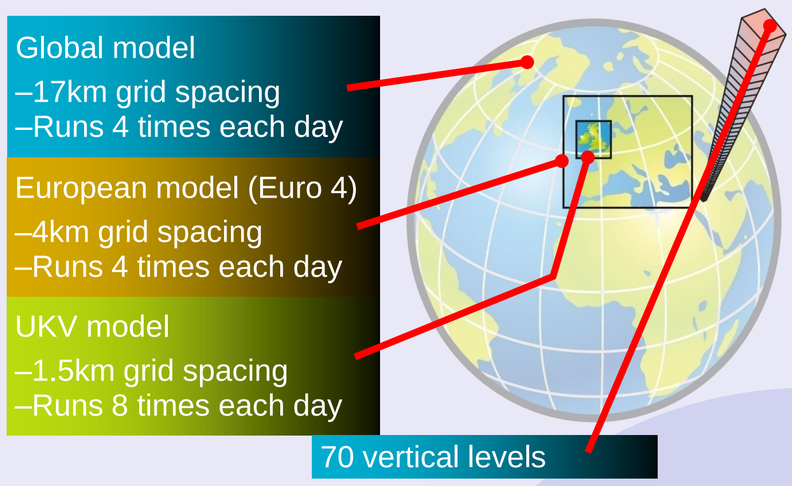
In addition NAME is used as a research tool both within the Met Office and by external collaborators in applications such as air quality predictions, spread of diseases by airborne midges, long range transport of pollutants and source back-attribution for regulatory bodies.



Map of total deposits of Caesium-137 predicted by NAME following the Fukushima accident in March 2011.

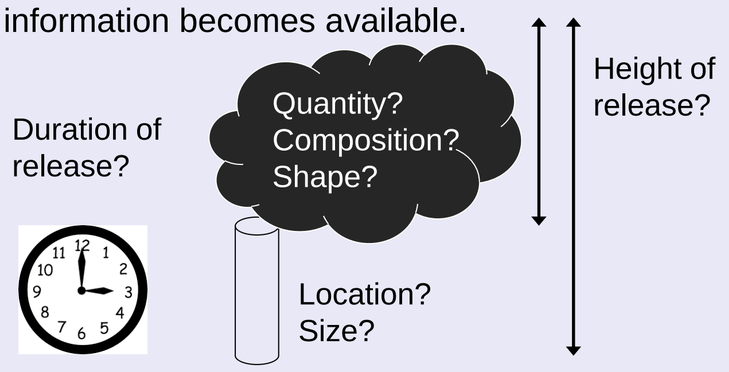
Meteorology

NAME can use meteorological data from a variety of NWP models including the Met Office Unified Model (UM) global and limited area models (see right), ECMWF and surface observations.



Source Term

NAME requires information about the characteristics of the material released. In response to an emergency a unit source (1Bq) is used as it can easily be scaled when more information becomes available.



Inputs: Meteorology and Source Term

Random walk models

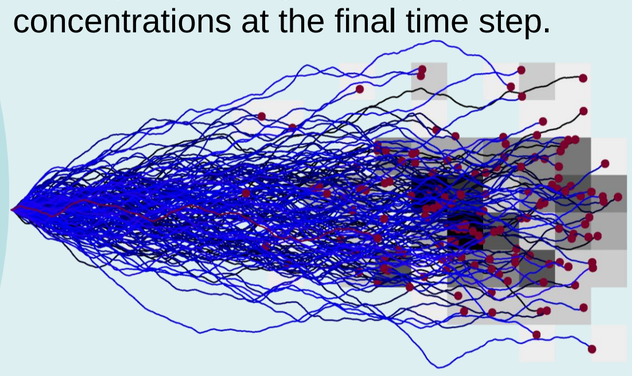
The atmosphere contains velocity fluctuations at all orders of scales. Turbulent eddies which are smaller than the grid size of the atmospheric flow model (e.g. the Unified Model) while not resolved are still vital for predicting the spread of the plume. These unresolved motions are simulated using random walk techniques of various levels of sophistication. The general form of the equation of motion in NAME is given by

$$x_{t+\Delta t} = x_t + \Delta t(\bar{u}(x_t) + u'(x_t) + u_l'(x_t)) \quad (1)$$

Where $\bar{u}$ is the mean wind at the particle position (x) and u' and u_l' are turbulent velocities for eddies and mesoscale motions. Δt is the time interval.

Transport and Dispersion

The figure below shows the trajectories of 150 model particles together with gridded concentrations at the final time step.



Sinks: Wet and Dry Deposition Radioactive Decay

Dry Deposition

Dry deposition is modelled in NAME using the concept of the deposition velocity, v_d. The flux of pollutant to the ground, F, is proportional to the concentration, C, of pollutant and is given by

$$F = v_d C \quad (2)$$

where v_d is the constant of proportionality.

Particles may also travel to the ground through gravitational settling.

Radioactive Decay

NAME is able to model the loss of radionuclides through radioactive decay. In addition NAME can model more complex radioactive processes such as the activity associated with the daughter products of radionuclides and cloud gamma doses.

Wet Deposition

The removal of material from the atmosphere by wet deposition is based on the depletion equation (3) where C is the air concentration and Λ is the scavenging coefficient. The scavenging coefficient is given by equation (4) where r is the precipitation rate (in mm hr^{-1}) and A and B are parameters which vary for different types of precipitation and for different wet deposition processes (Webster, 2014).

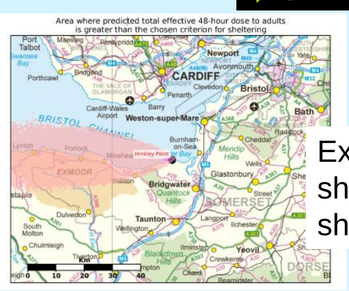
$$\frac{dC}{dt} = -\Lambda C \quad (3) \qquad \Lambda = Ar^B \quad (4)$$

A Joint Agency Response to Nuclear Accidents

During Fukushima a multi-agency response was activated to provide information to the UK government.

- The quantity of each radionuclides released was estimated by the Office of Nuclear Regulation (ONR)
- The dispersion and deposition modelling was carried out by the Met Office
- Dose calculations were performed by Public Health England
- Information was collated by the Radioactive Incident Monitoring NETwork (RIMNET)

Following Fukushima a standardised form for presenting the information was developed.



Example map from the new form showing region where sheltering should be considered.

References: Jones , Thomson, Hort and Devenish *The U.K. Met Office's next-generation atmospheric dispersion model, NAME III ,* in Air Pollution Modeling and its Application XVII, 2007;
Leadbetter, Hort, Jones, Webster and Draxler, 2014, *J. Env. Rad.;* Webster and Thomson., 2014, *Forecasting Research Technical Report 584*, Met Office, UK;

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