Cloud gamma modelling in the UK Met Office's NAME III model

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(with thanks to Joseph Wellings and Stephanie Haywood of HPA, and Matt Hort of the Met Office)

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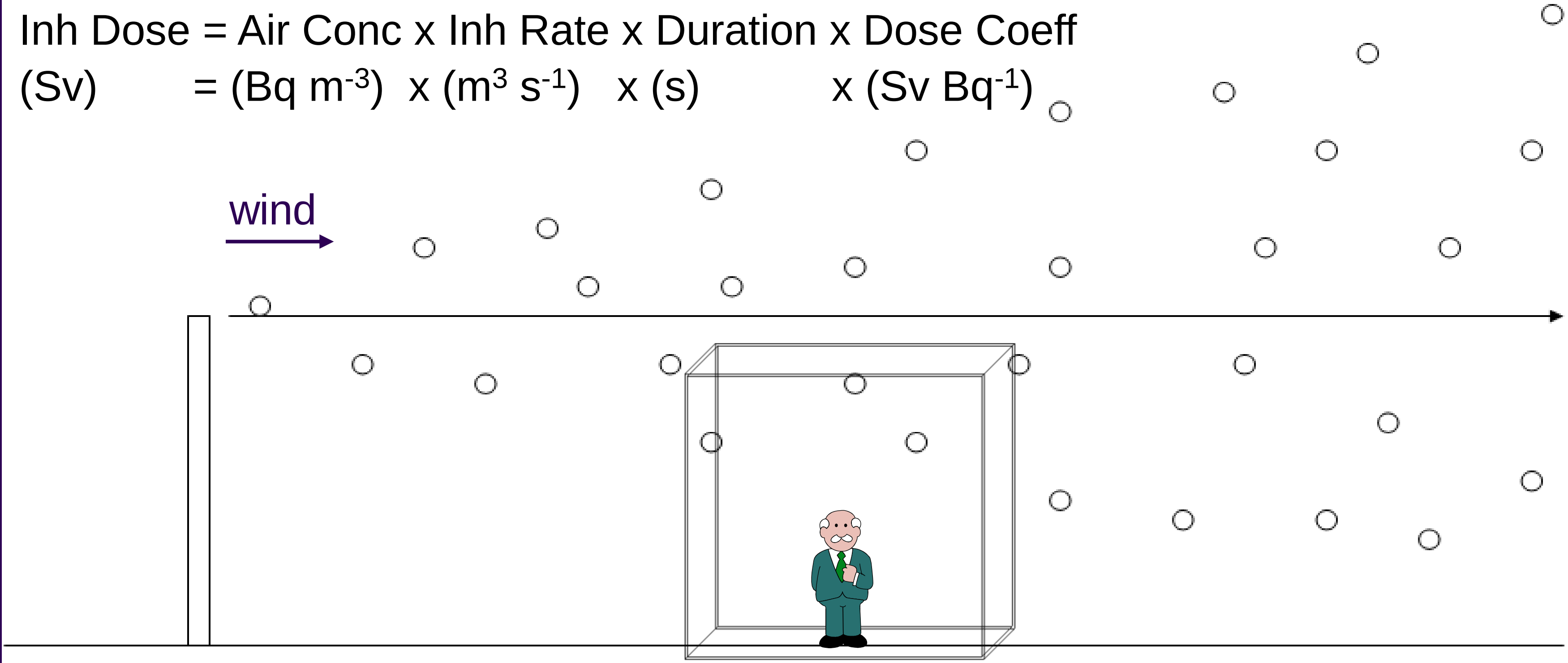
Introduction

Why integrate gamma ray exposures into a dispersion model?

Inhalation dose calculated using activity concentrations in air after dispersion modelling

Inh Dose = Air Conc x Inh Rate x Duration x Dose Coeff

(Sv) = ($Bq\ m^{-3}$) x ($m^3\ s^{-1}$) x (s) x ($Sv\ Bq^{-1}$)



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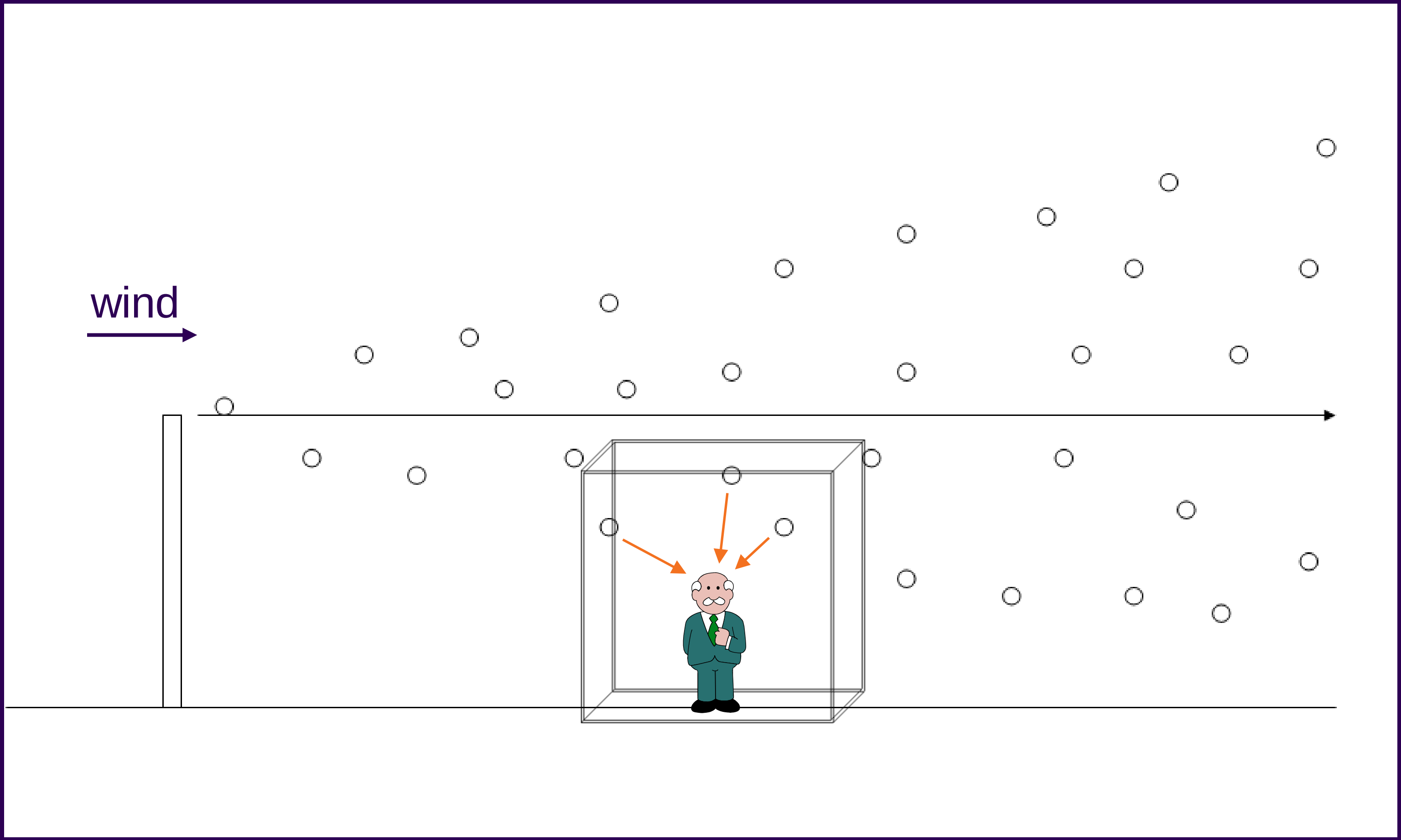

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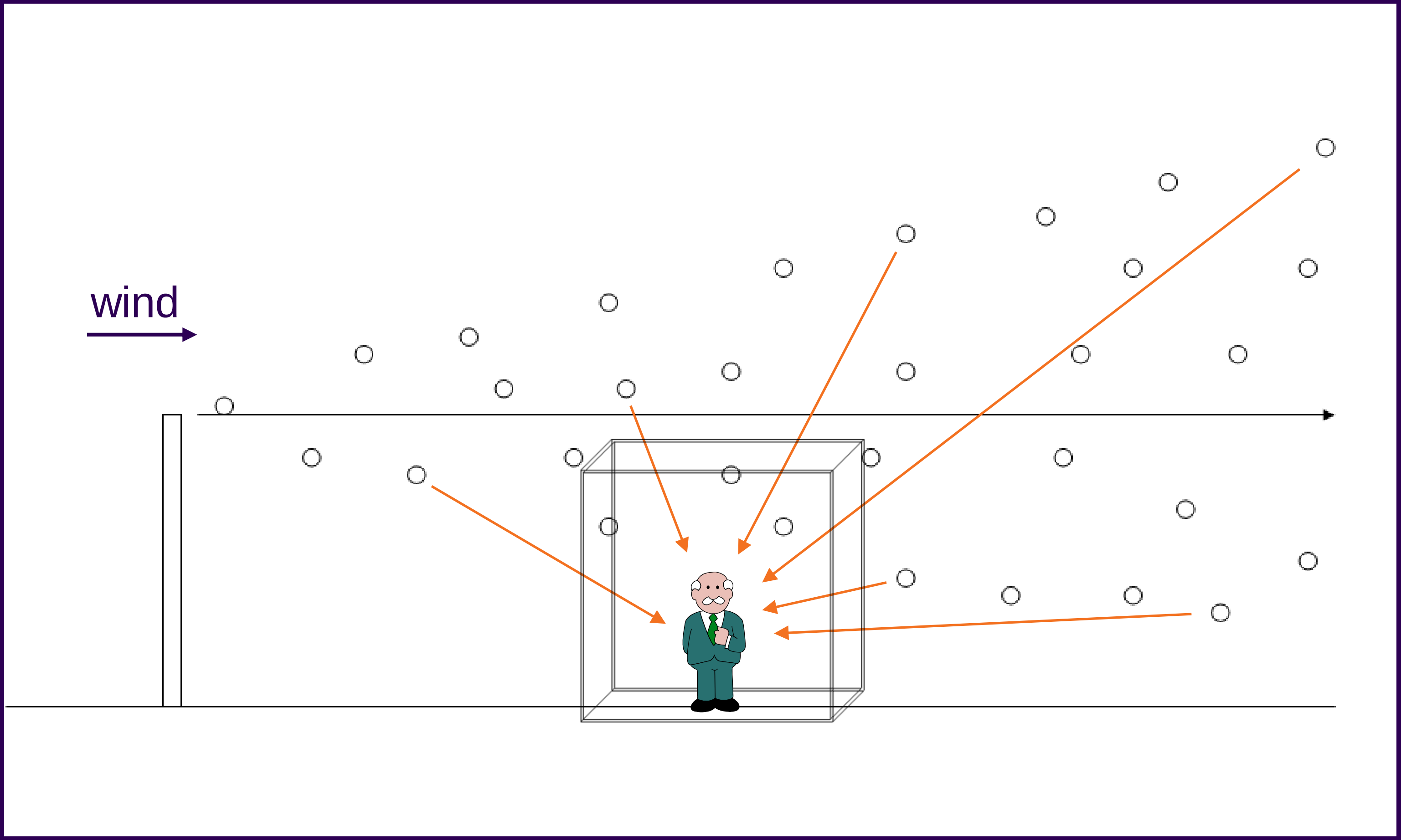


NAME III model description

- Lagrangian particle-trajectory model designed to predict the atmospheric dispersion and deposition of gases and particulates

- Advanced operational modelling approach combined with capability to utilise NWP met data

NAME III model description

- Advection-diffusion equation:

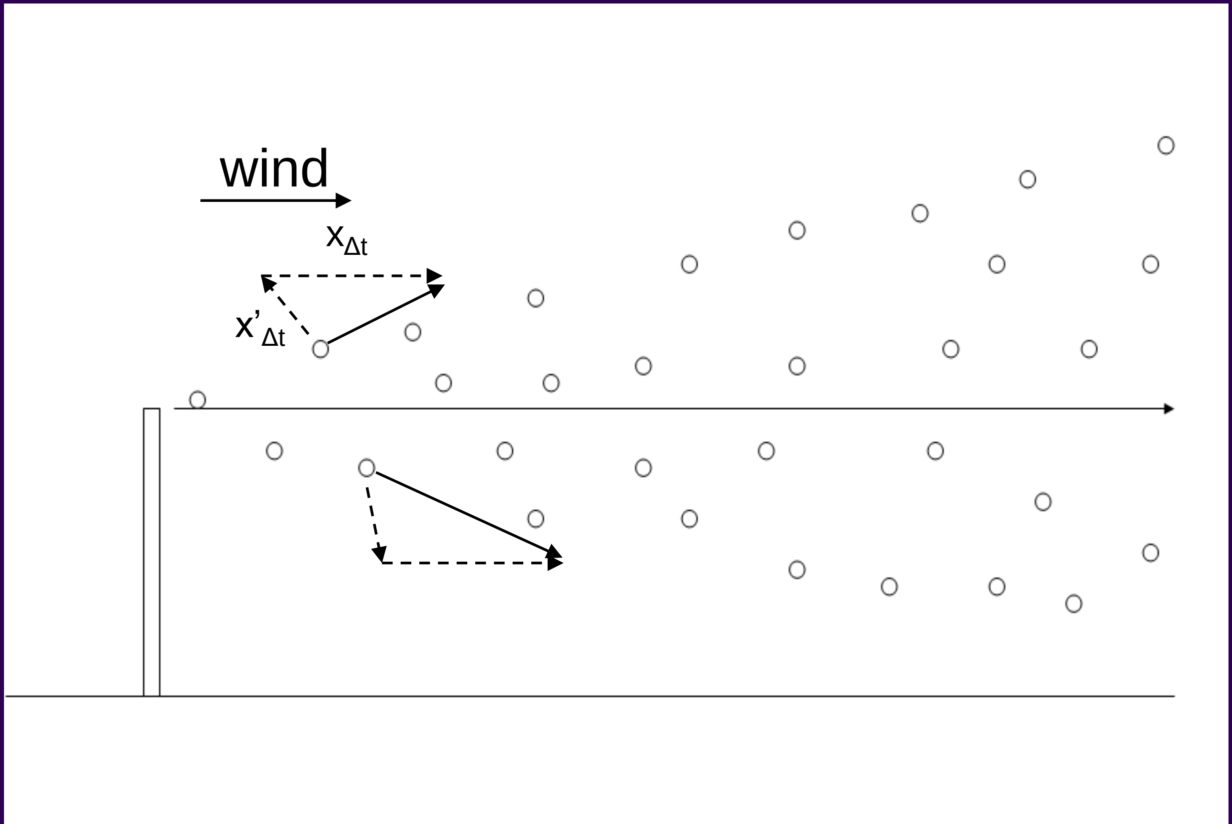
$x_{t+\Delta t} = x_t + [u(x_t) + u'(x_t)]\Delta t$

x is the particle position vector

t is time

$u(x_t)$ is the wind velocity

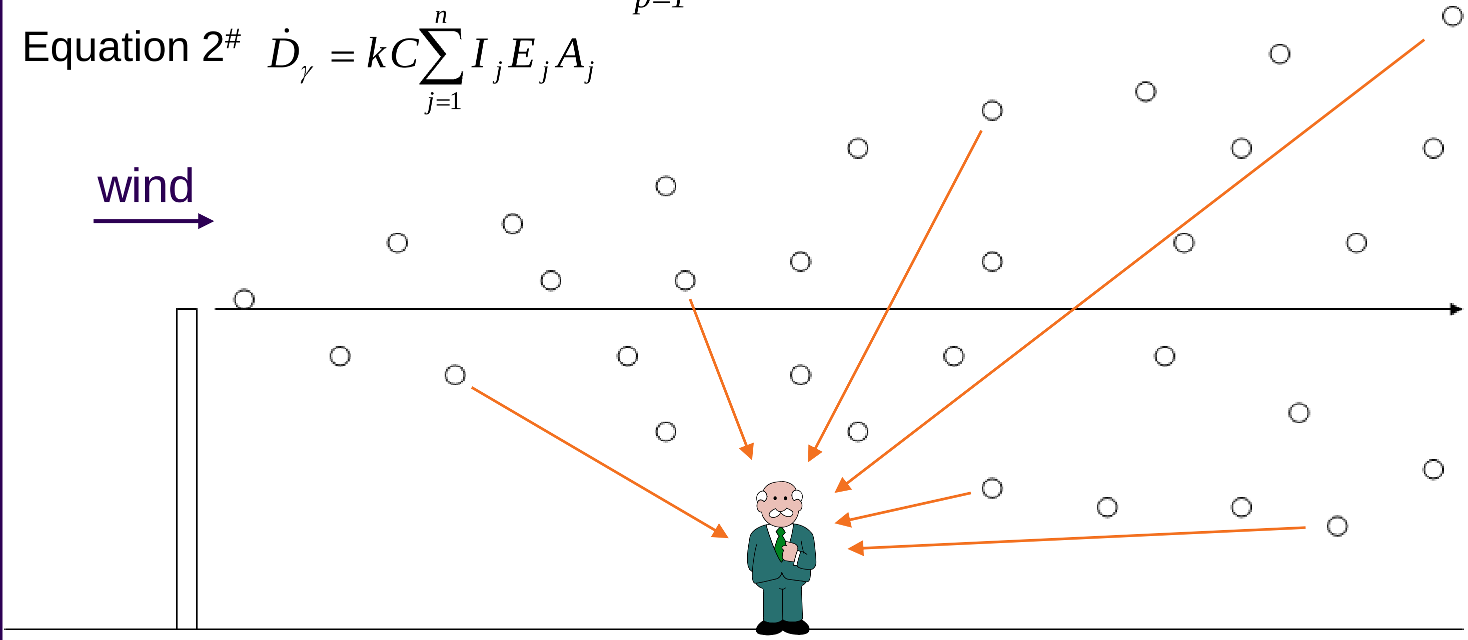
$u'(x_t)$ is the turbulent velocity



Cloud Gamma Modelling in NAME III

Equation 1* $\dot{D}_\gamma(x_0, y_0, z_0) = Ak \sum_{p=1}^{N} \frac{fB(E_\gamma, \mu r)\exp(-\mu r) q(x', y', z')}{4\pi r^2}$

Equation 2# $\dot{D}_\gamma = kC \sum_{j=1}^{n} I_j E_j A_j$



*Raza, S. and R. Avila (2001)

#Simmonds, J. R. *et al*, 1995

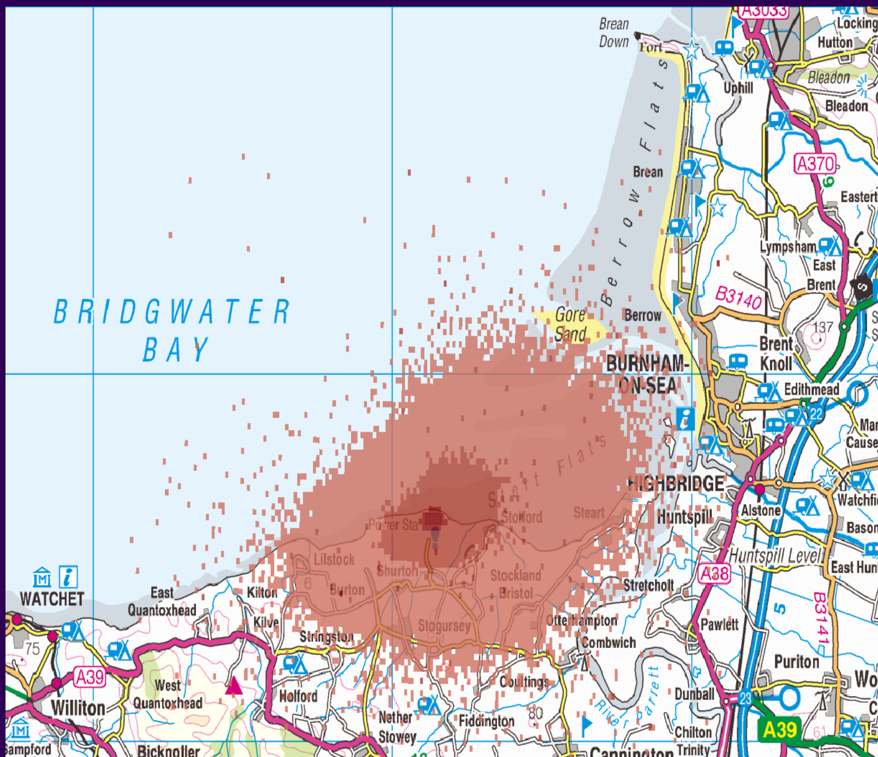
Results

Model inter-comparison of adult effective cloud gamma dose rate ($mSv\ s^{-1}$) at 3 receptors along the plume centre line*

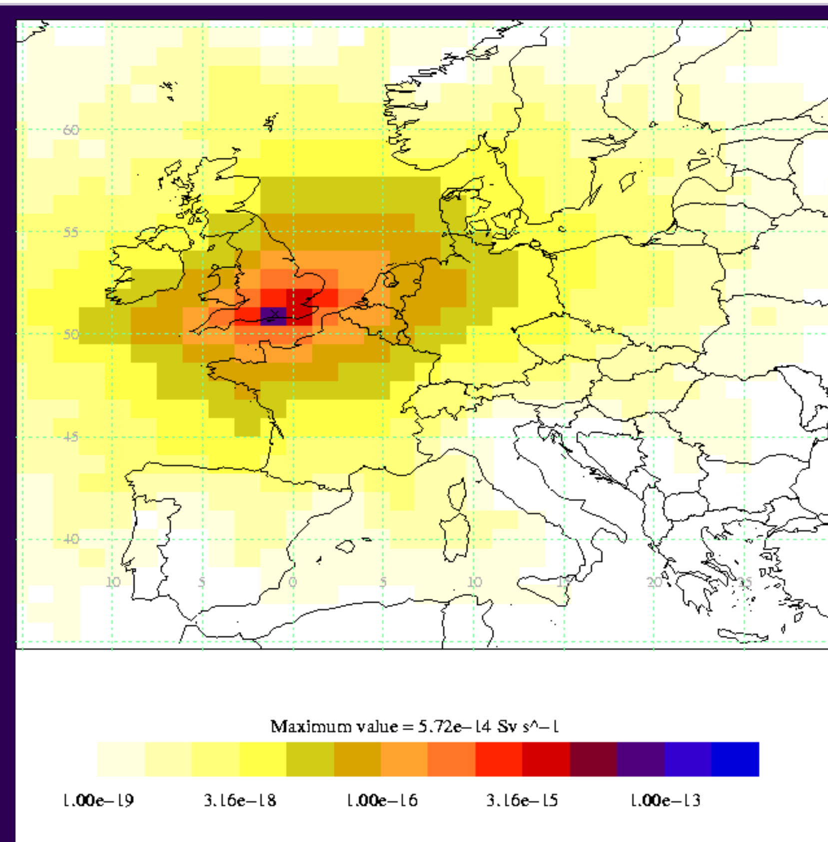
	NAME	ADMS	PC CREAM
1 km downwind	$2.3\ 10^{-09}$	$2.1\ 10^{-09}$	$3.2\ 10^{-09}$
2 km downwind	$1.1\ 10^{-09}$	$8.2\ 10^{-10}$	$1.3\ 10^{-09}$
5 km downwind	$5.1\ 10^{-10}$	$2.2\ 10^{-10}$	$3.5\ 10^{-10}$

***for a release of 1 10^{10} Bq s^{-1} of ^{85}Kr over 24 hours from 10 m above ground level**

Results

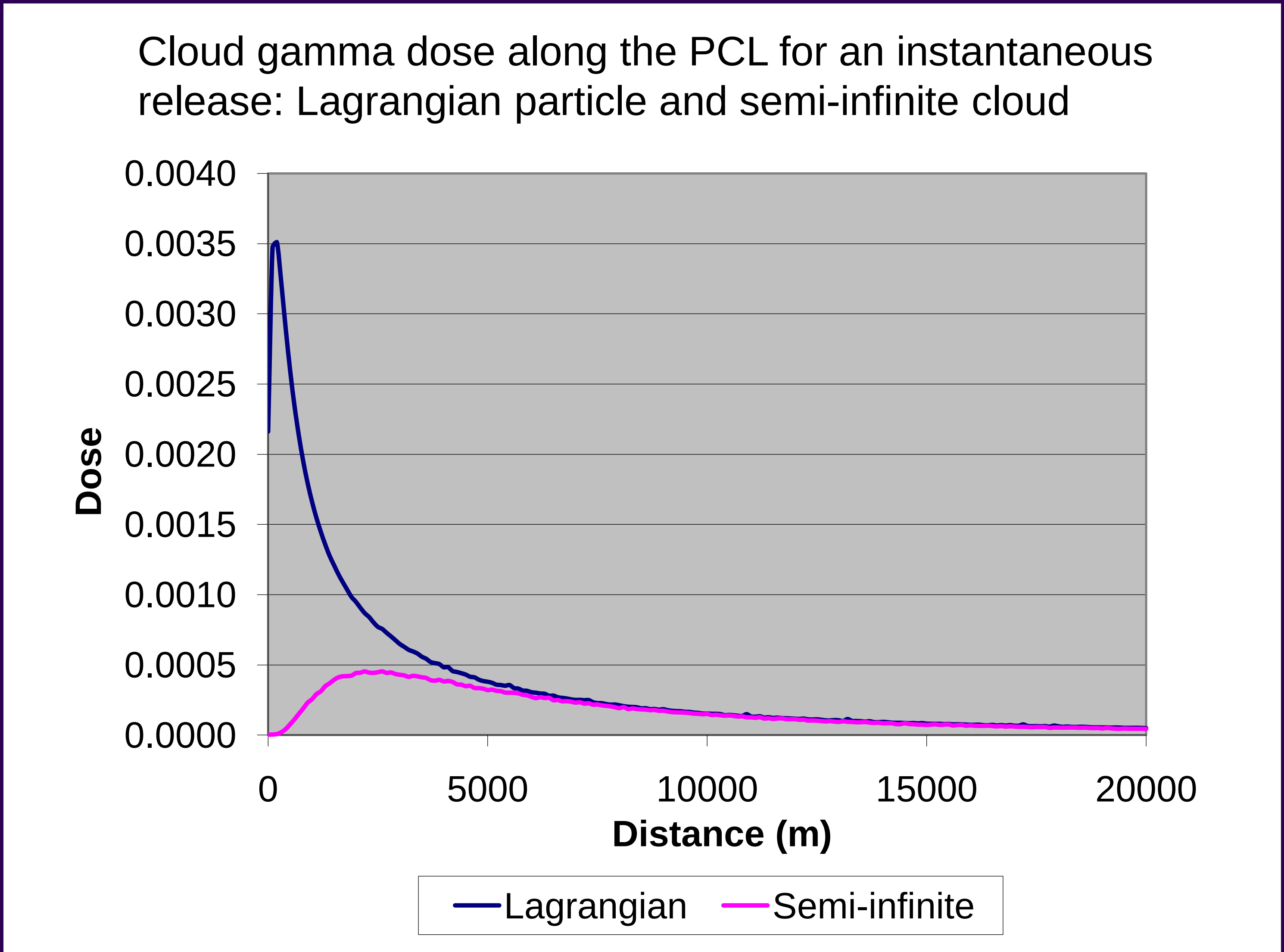


Cloud gamma dose rate (Sv s^{-1}), averaged over 1 year, from 1 10^3 Bq s^{-1} continuous release of ^{135}I using NWP met data, on a 100 x 100 m grid (Lagrangian particle approach)



Cloud gamma dose rate (Sv s^{-1}), averaged over 1 year, from 1 10^3 Bq s^{-1} continuous release of ^{135}I using NWP met data, on a 100 x 100 km grid (semi-infinite cloud approach)

Results


Cloud gamma dose along the PCL for an instantaneous release: Lagrangian particle and semi-infinite cloud
Dose
0.0040
0.0035
0.0030
0.0025
0.0020
0.0015
0.0010
0.0005
0.0000
0
5000
10000
15000
20000
Distance (m)
Lagrangian
Semi-infinite

Conclusions & future work

Two methods of calculating cloud gamma dose have been implemented in the UK Met Office's NAME model:

- Lagrangian particle approach
- Semi-infinite cloud approach

Future work:

- Development and implementation of a method to integrate the two approaches
- Comparison of model results with an observational dataset obtained from a tracer field study

Future applications:

- PC-CREAM, PACE, TAPIR