The NAME project

Numerical

Atmospheric dispersion

Modelling

Environment

History, Current Position and Future Plans

Origin of the NAME model

- Developed following the Chernobyl accident to give long range (>100km) emergency response dispersion predictions for nuclear incidents

  (originally NAME stood for Nuclear Accident ModEl)
- Lagrangian particle model
- Uses 3-D flow field from Numerical Weather Prediction Models

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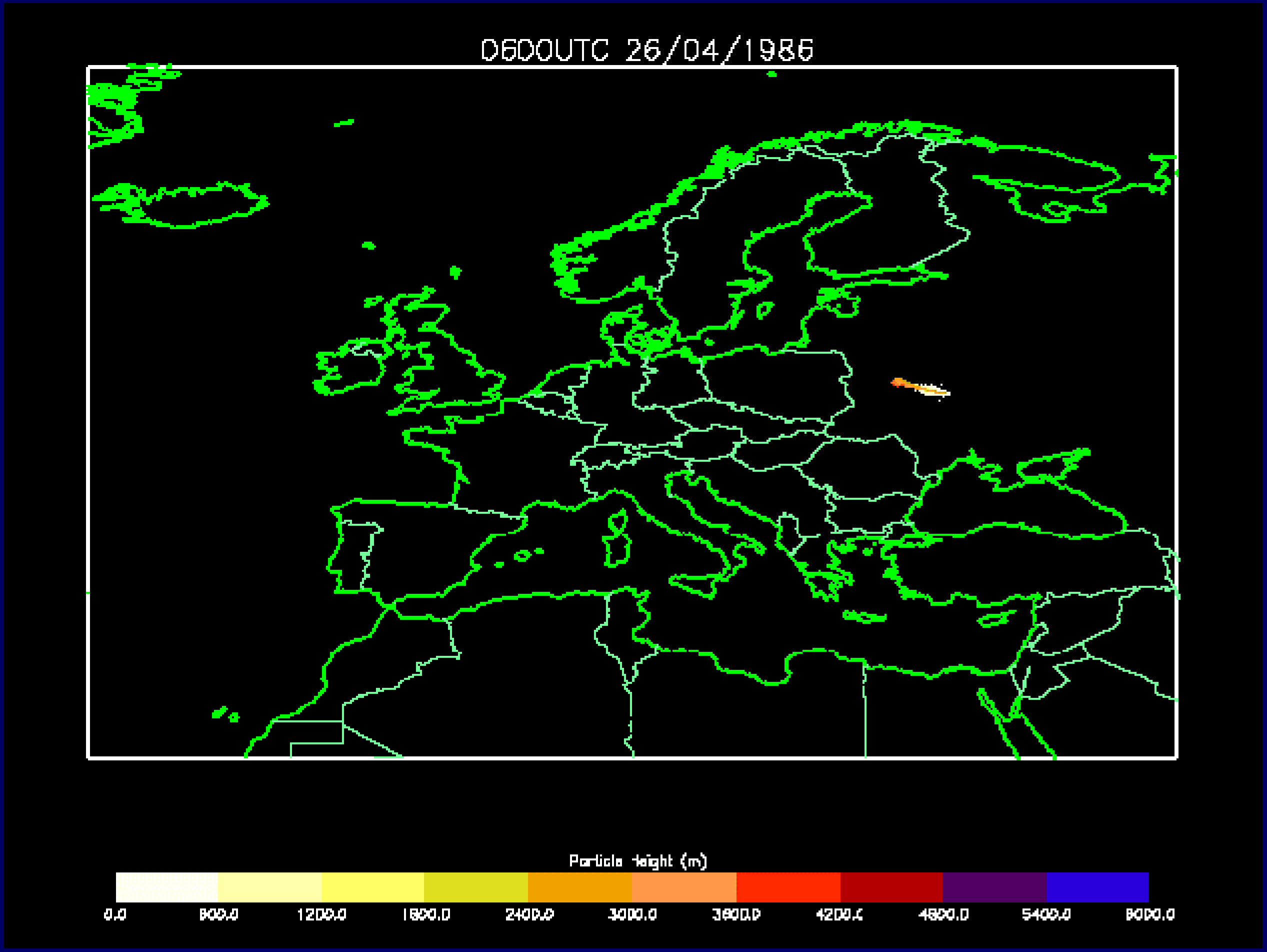
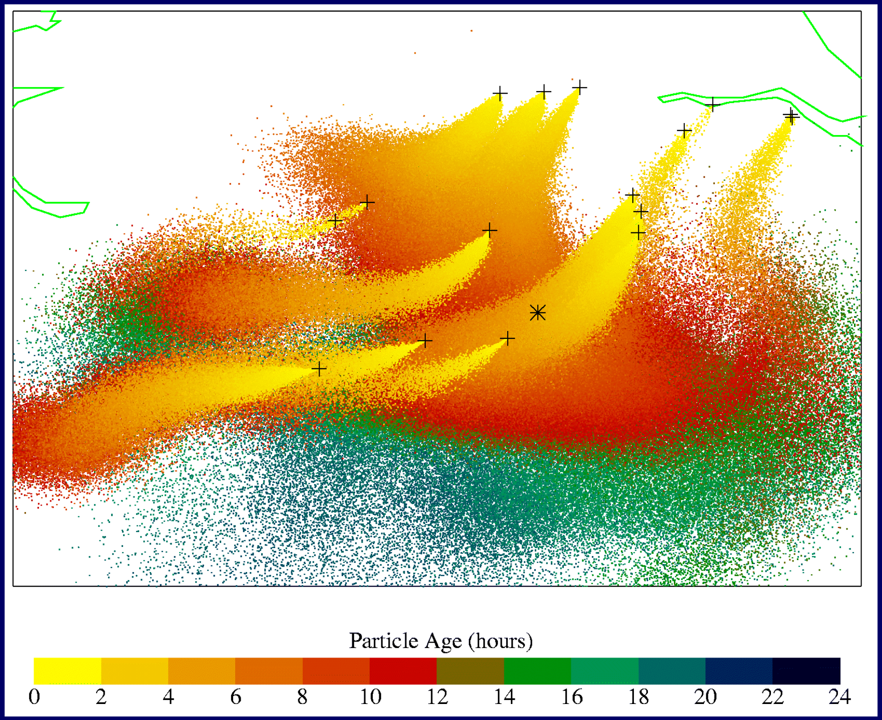
Chernobyl simulation



Current applications

- Model now extended to treat much wider range of dispersion problems:
  - wide range of airborne pollutants (nuclear, chemical, particulates, viruses)
  - 1-1000's km, hours - days
  - emergency response (nuclear, volcanoes, oil fires, foot and mouth)
  - air pollution (episode studies, air quality forecasts, policy support)
  - source attribution



NAME example - power station plumes

Numerical weather prediction

- Solves basic dynamic and thermodynamic equations on a 3-D grid to predict flow, temperature, humidity, turbulence, cloud, rain etc.
- Run regularly using latest observations (surface, radiosondes, satellites, aircraft) for initial conditions
- Several domains and resolutions (nested)
  - Global model (~60km resolution)
  - Mesoscale model (UK at ~12km resolution)
  - Plans to cover wider area at ~12km and introduce finer scale models (e.g. to resolve urban areas)

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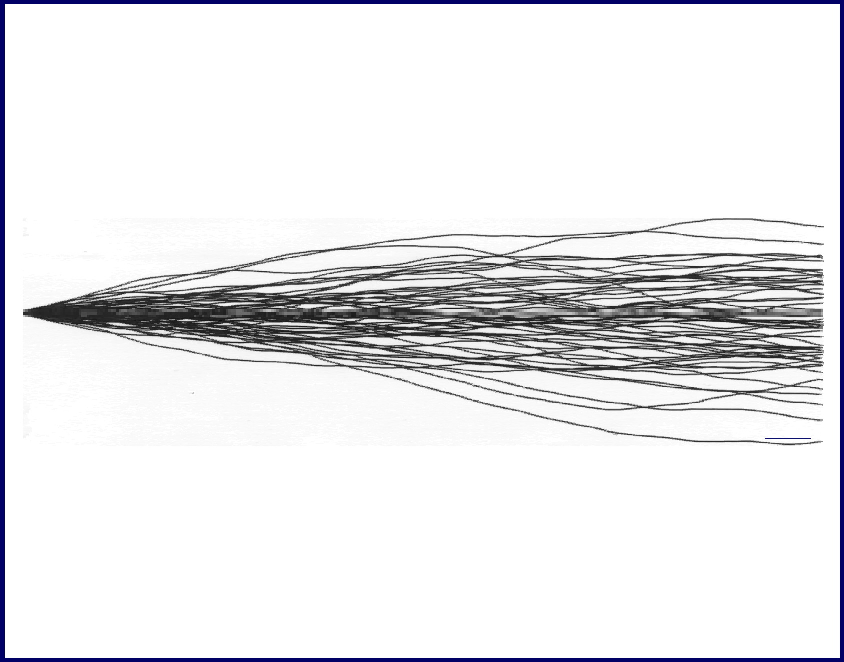
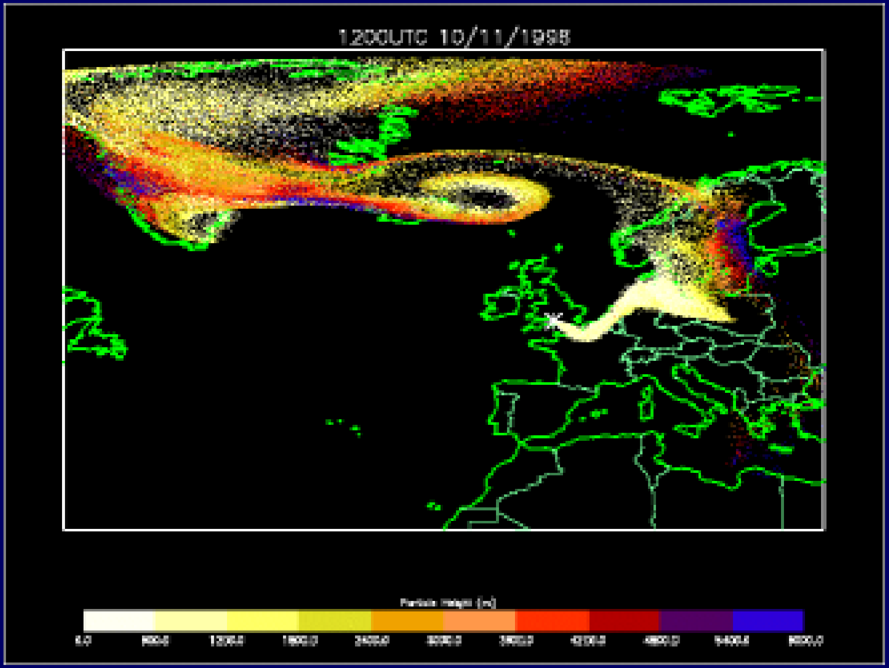
Particle Models

– Use knowledge of mean flow and statistics of turbulence to construct an ensemble of stochastic trajectories

– Each particle responds to local flow and turbulence





Example - Convective Boundary Layer

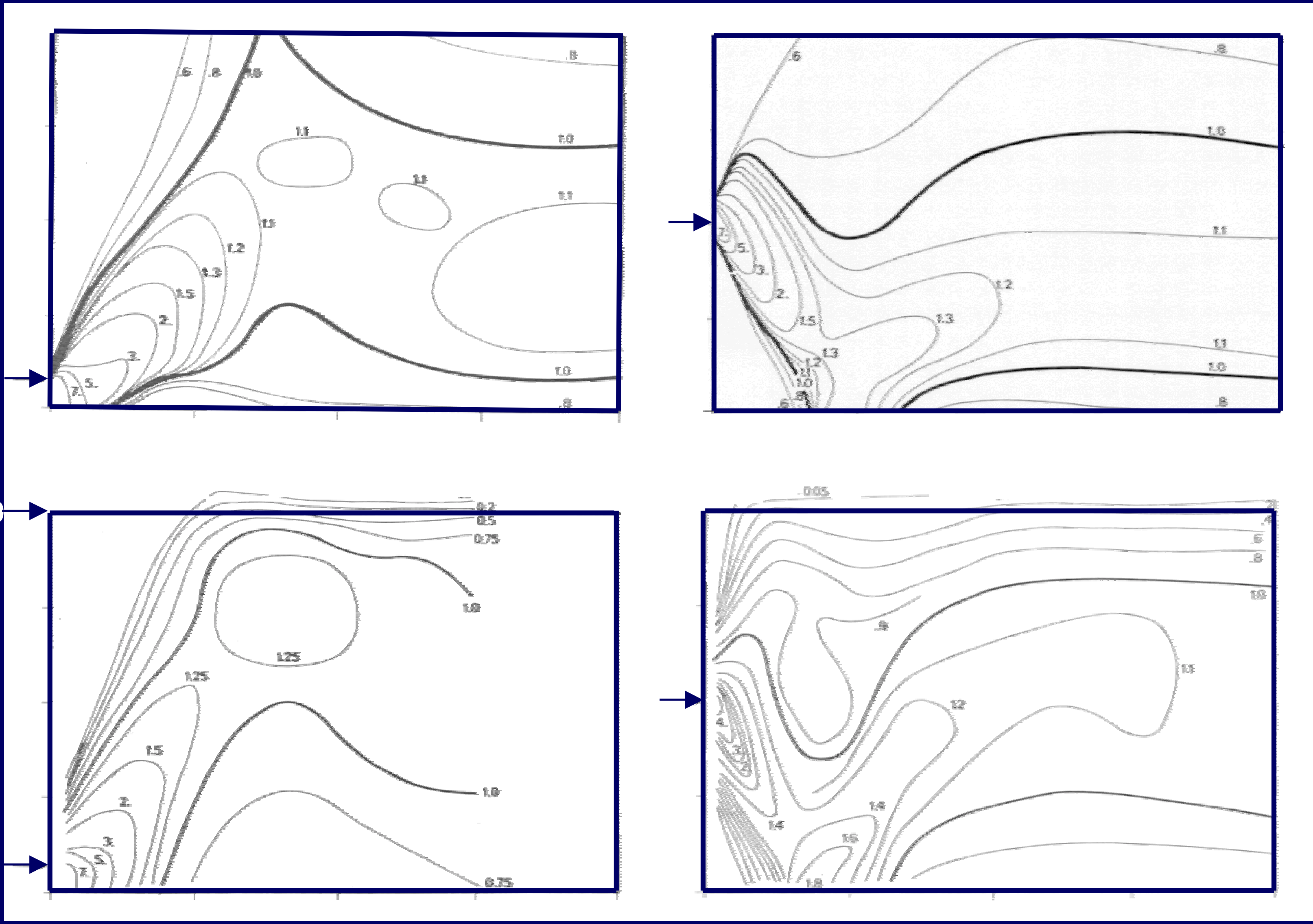
Height

Particle Model (de Baas et al)

B L top

Experiments (Deardorff + Willis)

Source height



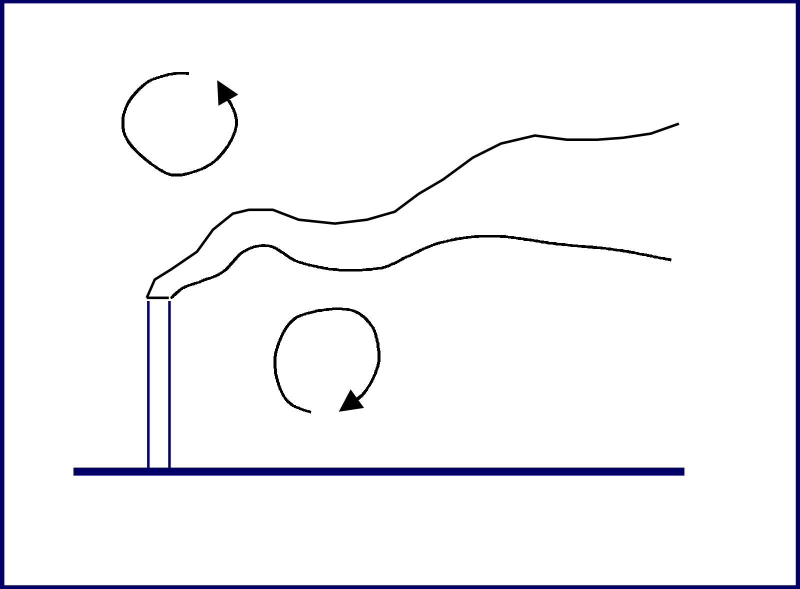
Downwind distance

Latest version – NAME III

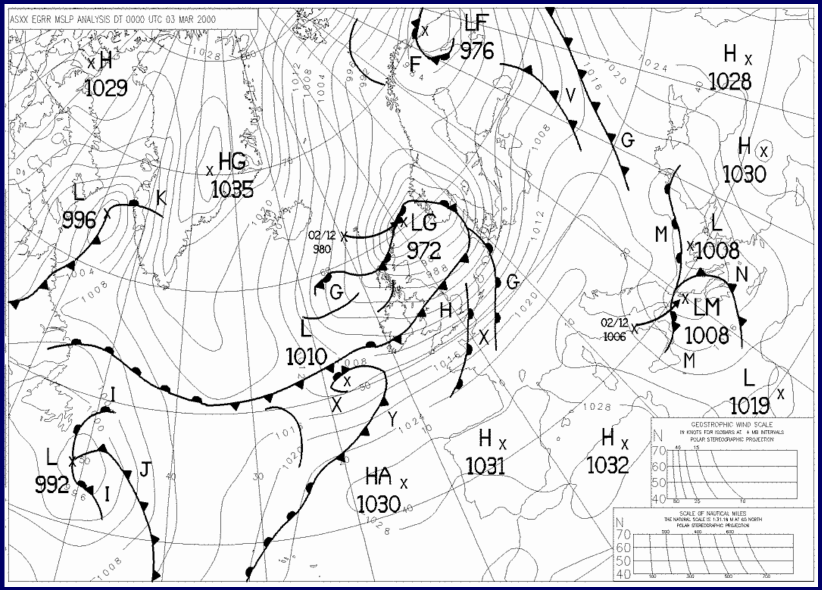
- A single model applicable to all ranges
- Use of puffs (as well as, or instead of, particles) to reduce statistical noise and/or computational cost
- Redesigned from ground up to provide increased flexibility, including:
  - Ability to add sub-models (e.g. building effects, small scale terrain, fluctuation predictions)
  - Flexible choice of coordinates (e.g. lat-long, national grid, stereographic projections, height above ground, pressure)

A single model for all ranges

Boundary Layer Turbulence



Changes in 'meteorology'



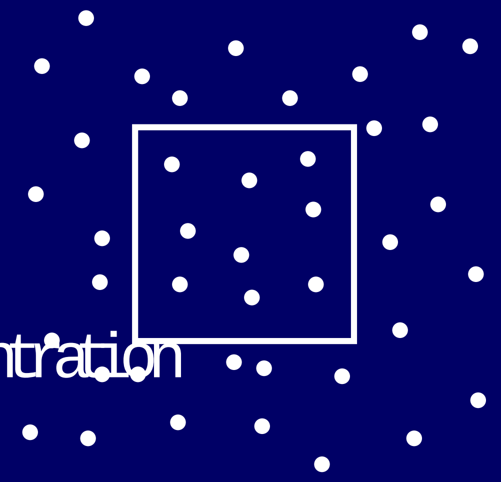
- In many dispersion problems, boundary layer turbulence and changes in meteorology are both important
- Lagrangian particle/puff models can provide a seemless treatment of all scales

Puff model

- Particle models calculate concentrations by counting particles in boxes
  - Lots of particles and so expensive

    or

  - Noisy and hard to resolve detail of concentration field

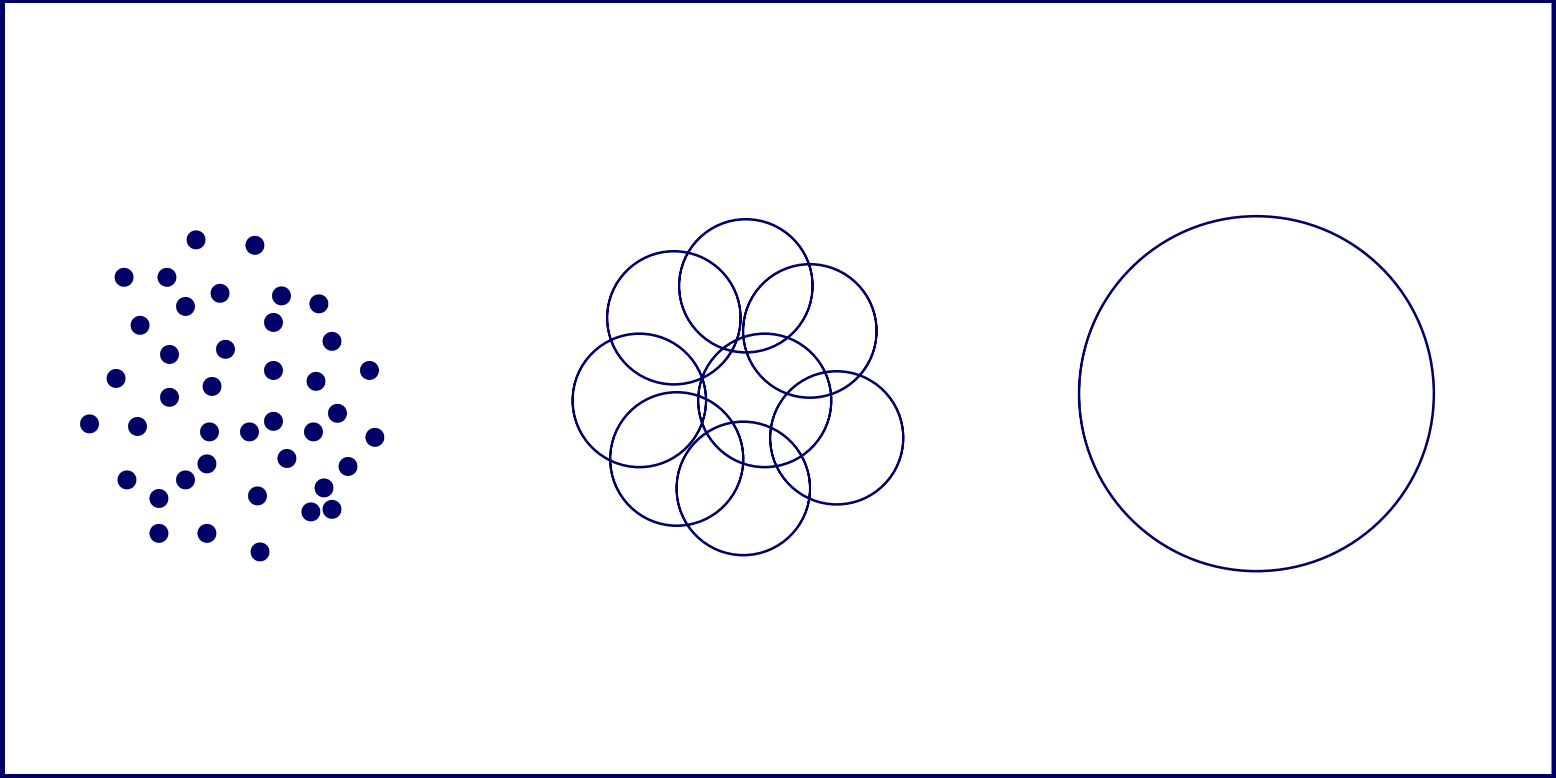


- Fractional Standard Error ~ $1/N^{1/2}$

Idea:

Represent

- some spread by random motion of particles
- some spread by spreading particles into puffs



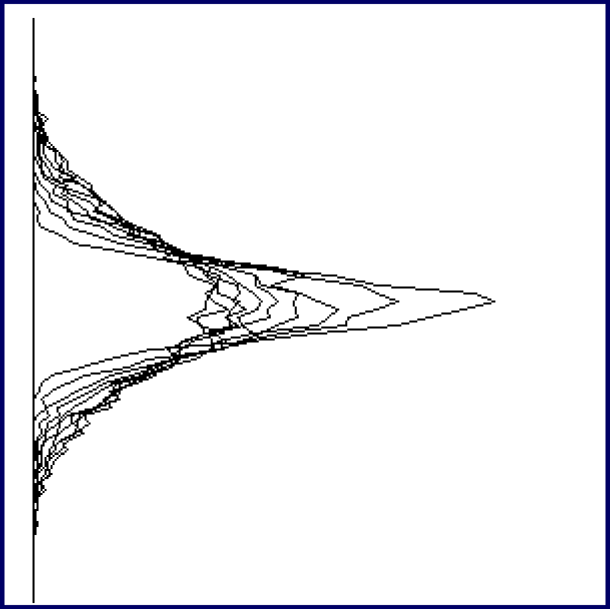
Enables cost-accuracy trade-off:

- Post accident analysis - best possible accuracy
- Emergency response - good accuracy but fast model
- Environmental Impact Assessment - concentration levels of the right magnitude, but model fast enough to run many different met scenarios

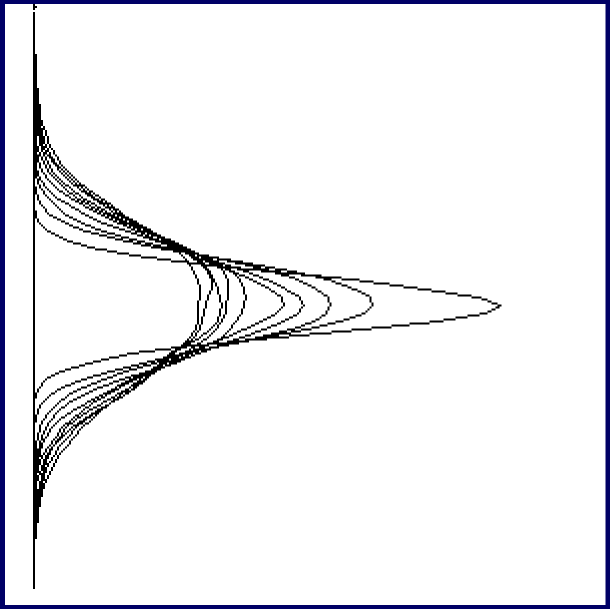
Some particle-puff examples

- *(i)* Vertical concentration profiles - homogeneous turbulence

Particle Model:

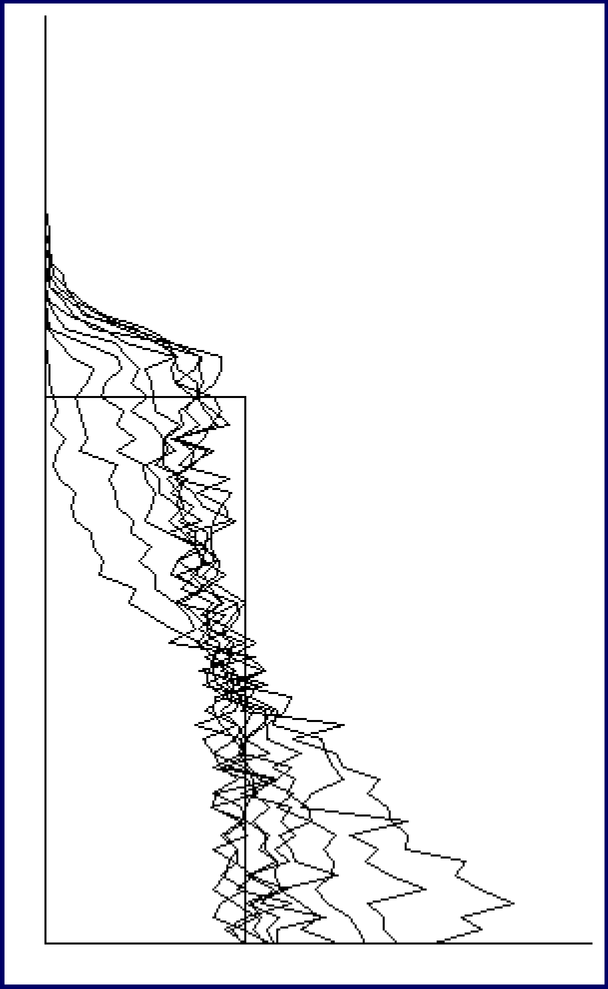


Puff Model:

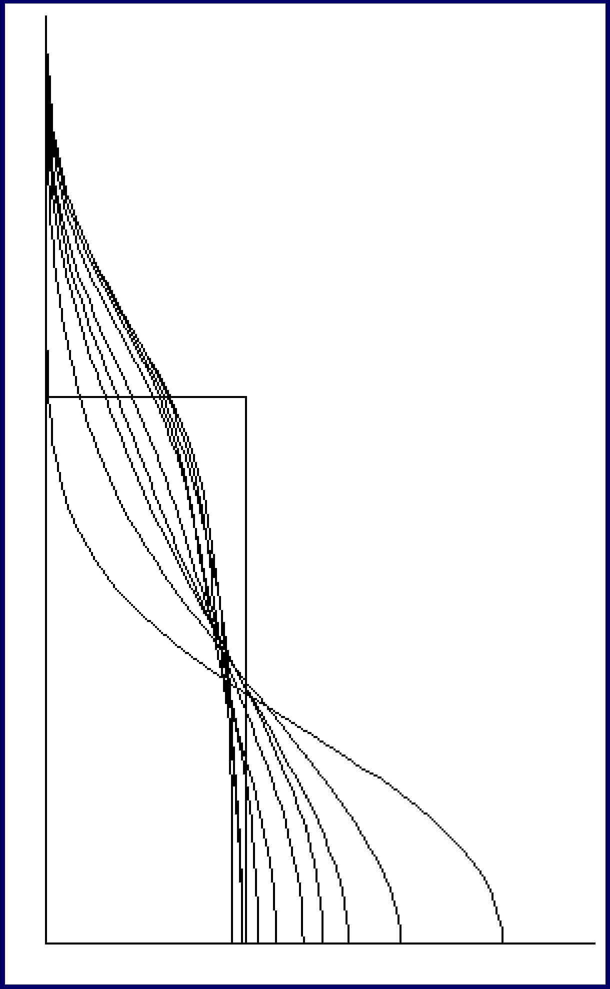


- *(ii)* Vertical concentration profiles - ground level source in boundary layer

Particle Model:

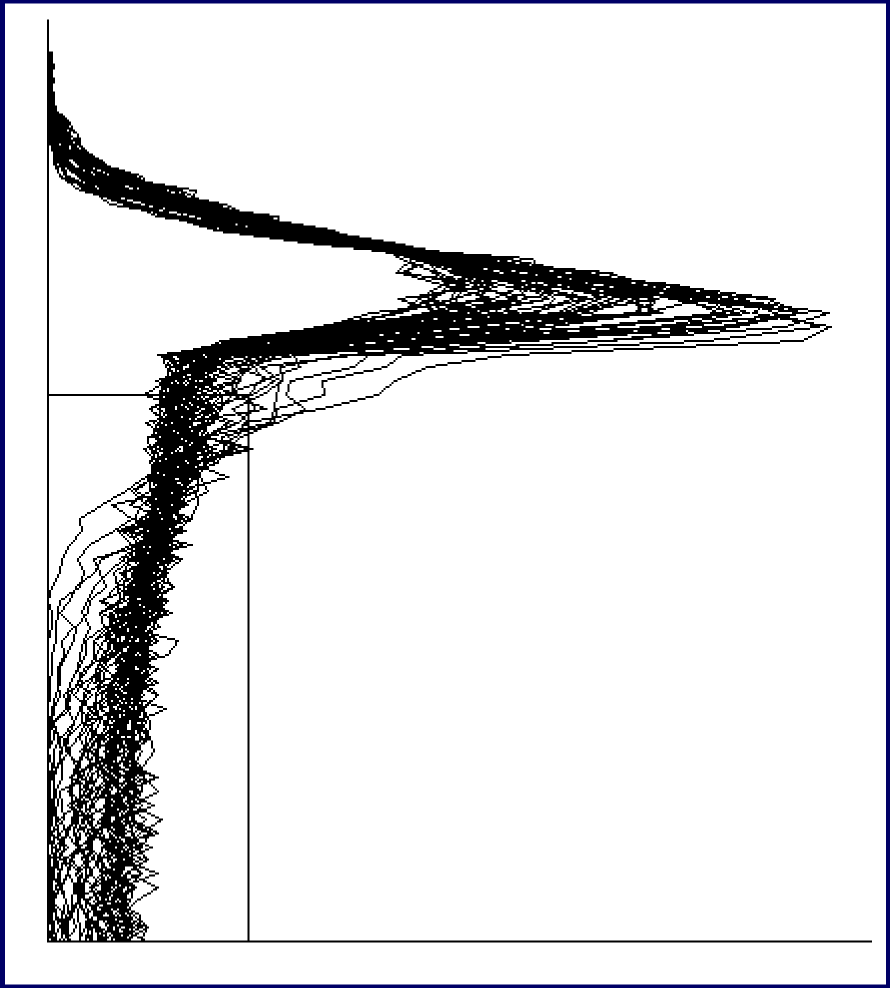


Puff Model:

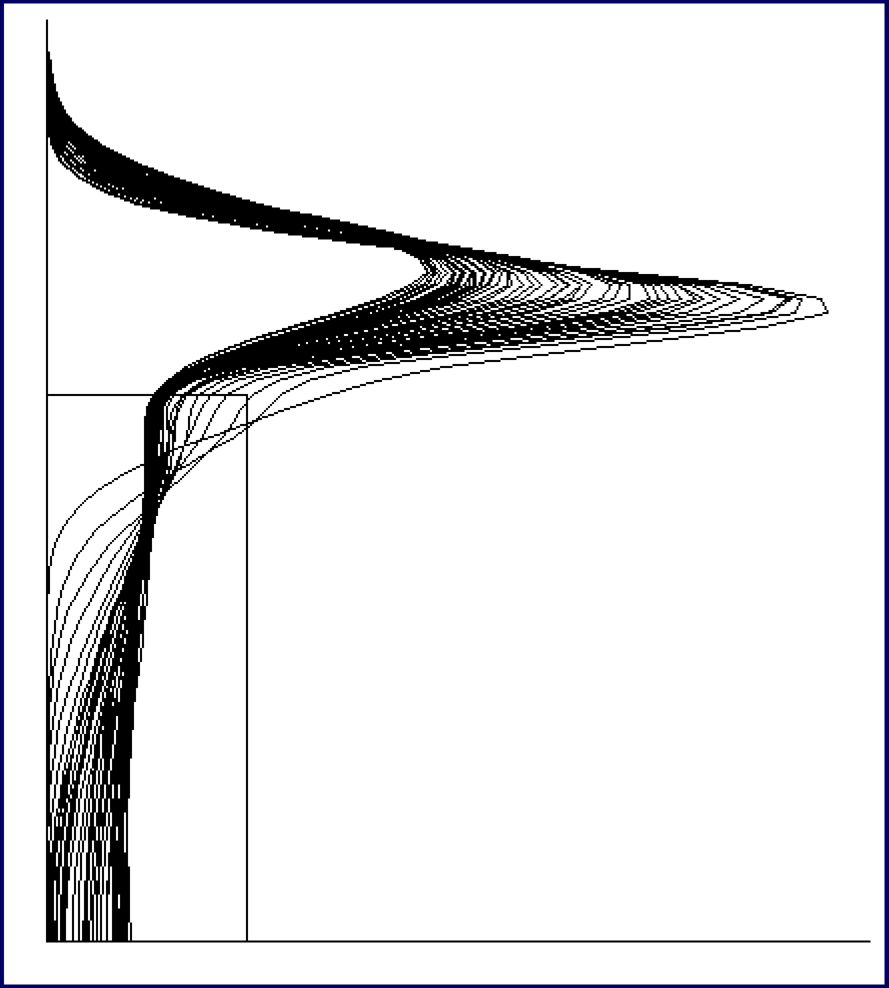


- *(iii)* Vertical concentration profiles - source above boundary layer

Particle Model:

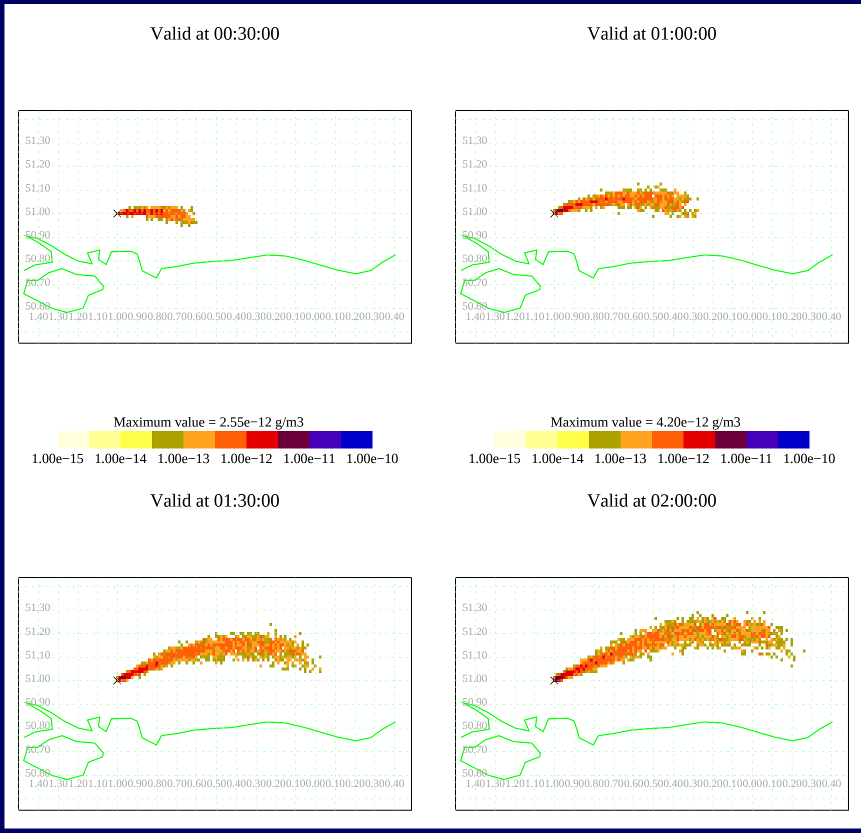


Puff Model:

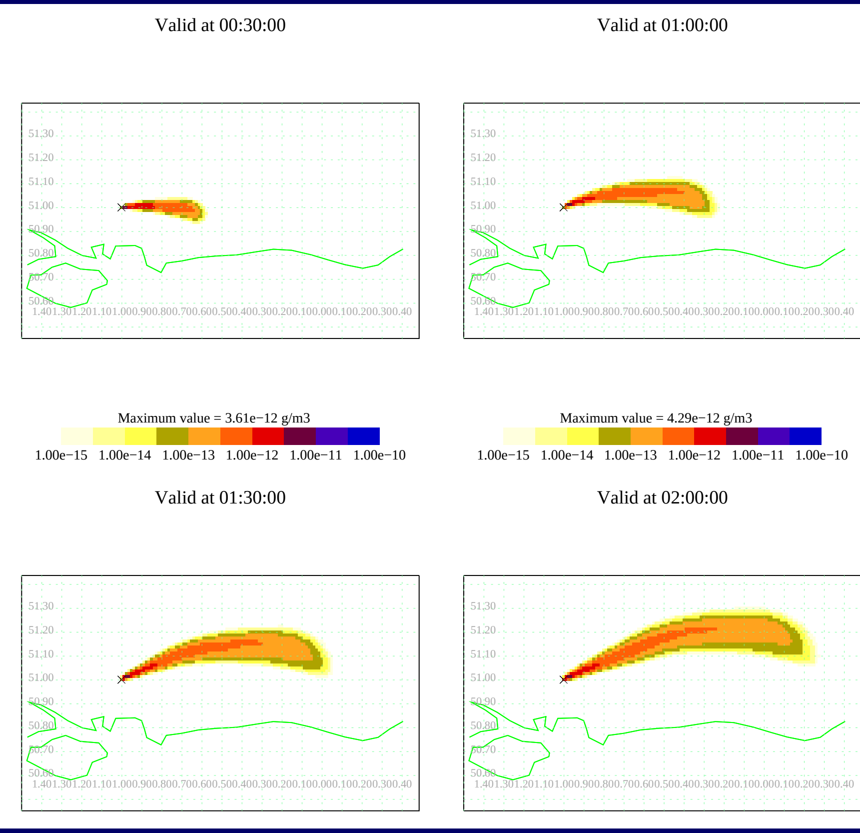


- *(iv)* Ground level concentrations for a release starting at 00:00

Particle Model:

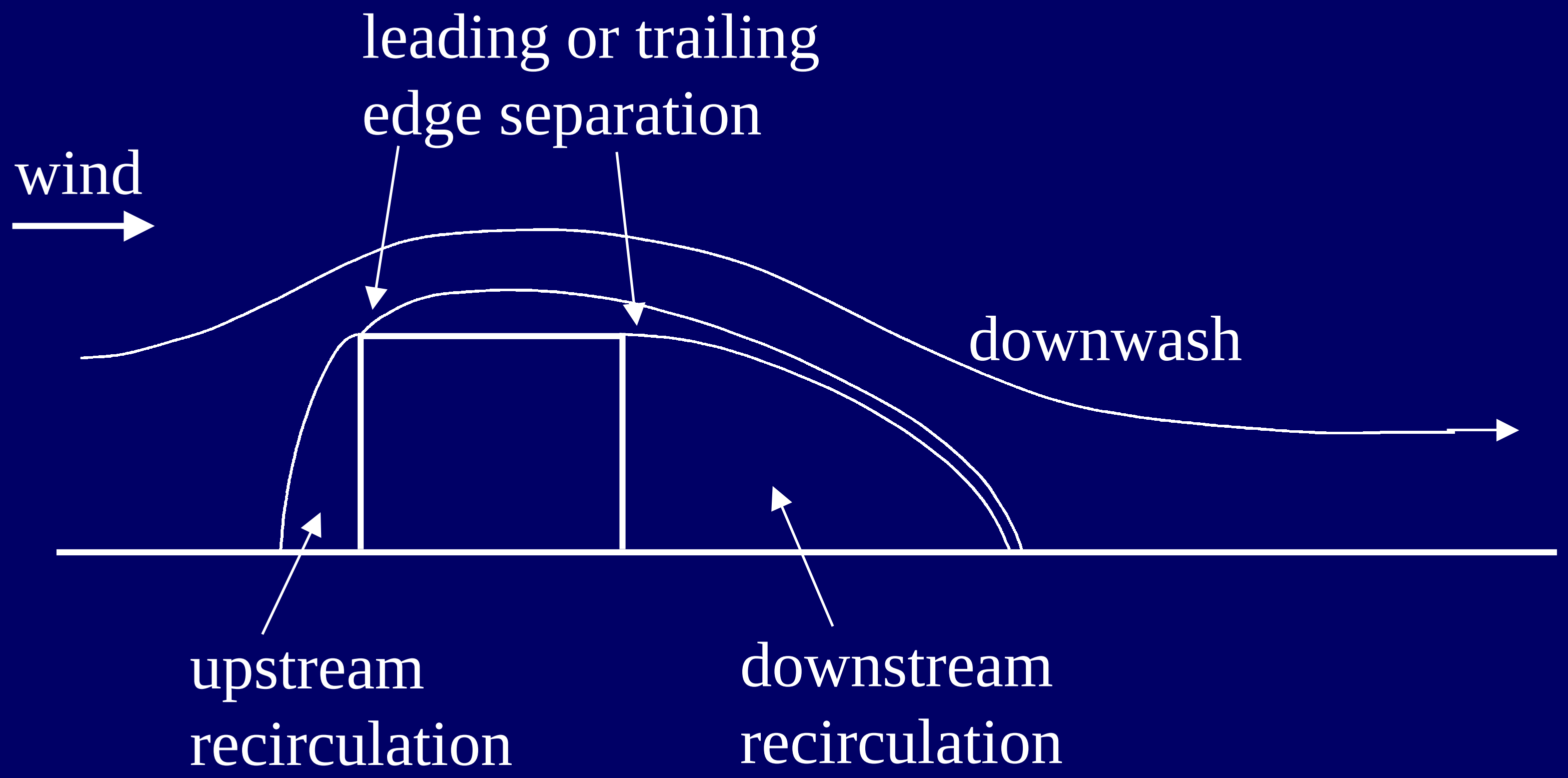


Puff Model:



The building-effects sub-model

- A flow is constructed which is incompressible and has the properties observed in flow round buildings



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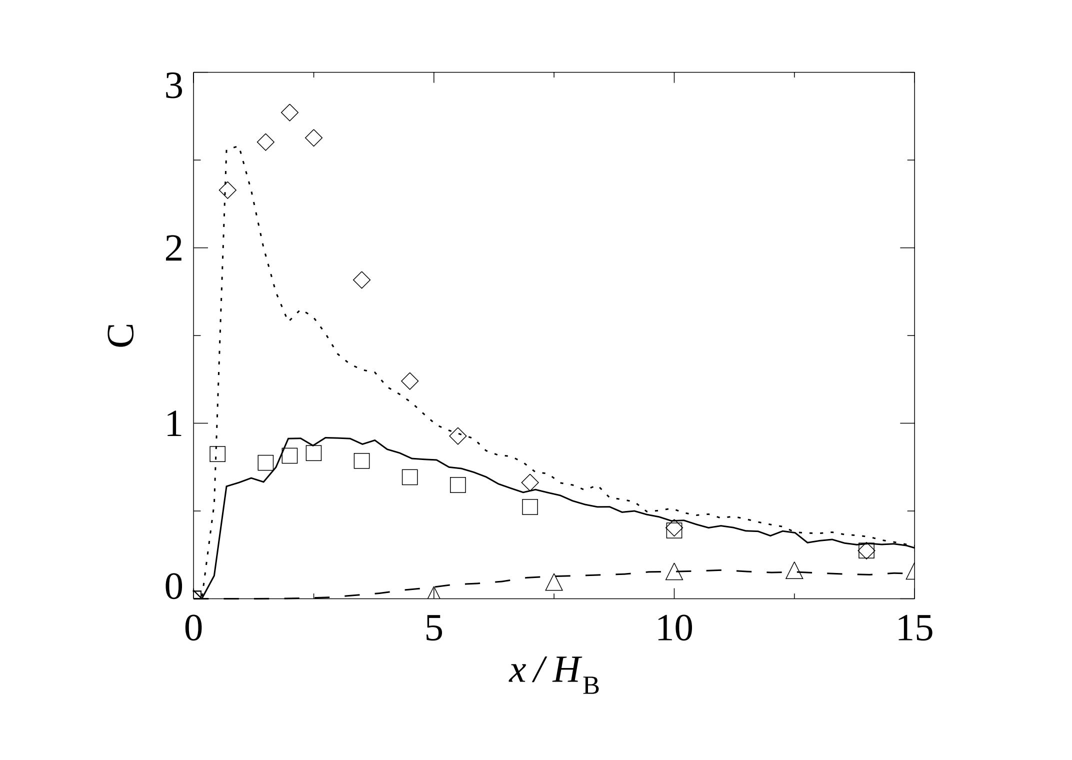
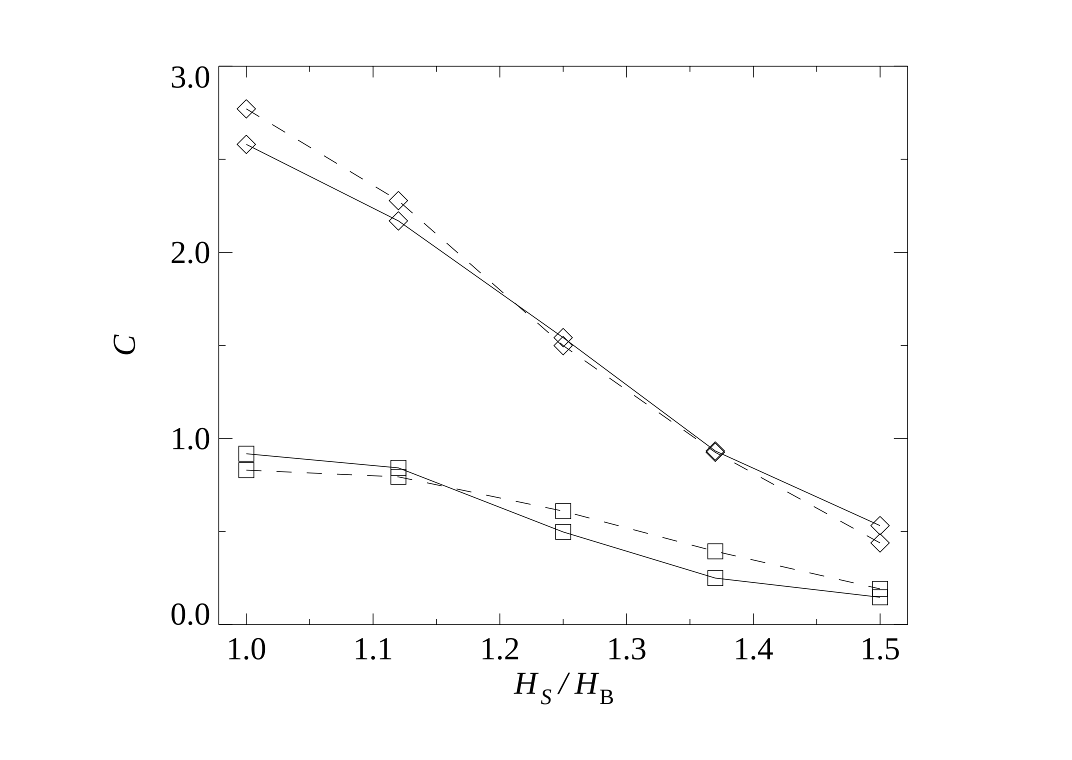
Ground level centre-line concentrations for roof top release – comparison with wind tunnel experiments



3 cases: Cubic building at 45° to wind
Cubic building at 0° to wind
No building

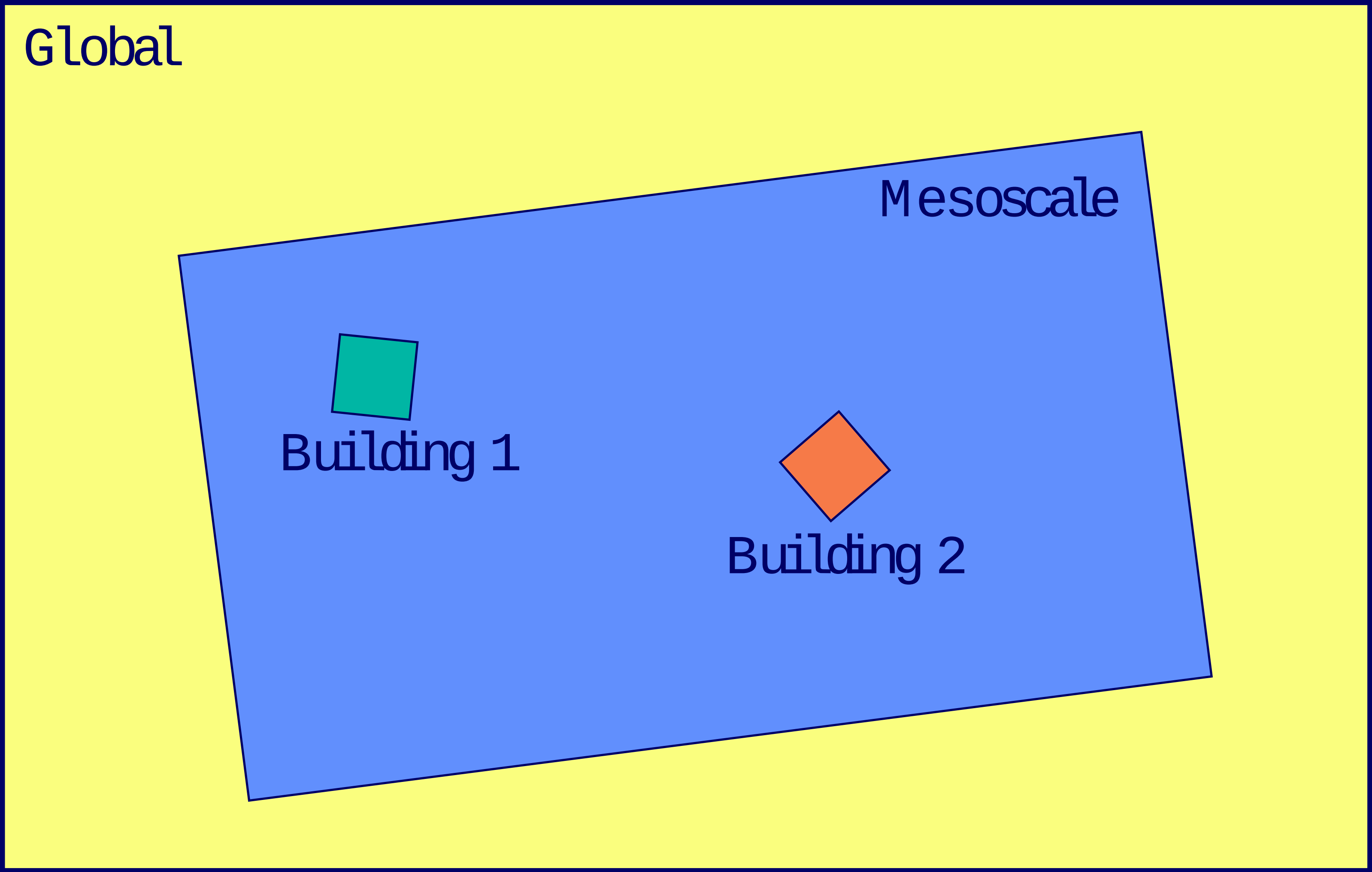
x = downwind distance
H_B = building height

Max Ground level centre-line concentration as function of source height / building height



H_S = source height
H_B = building height

Example of how NAME might be configured:



Summary of current capabilities:

- Met input as 3-D fields or, for short range problems, single site observations
- Use of radar rainfall data when available
- Dispersion and deposition using particles or puffs
- Building effects
- Small scale terrain effects (linear flow model)
- Fluctuations
- Radioactive decay
- Virus decay due to UV and humidity
- Chemistry

Possibilities for future development:

- Statistics/percentiles over many met cases or NWP ensembles
- Full radioactive decay chains
- Improved treatment of cloud induced turbulence/free troposphere dispersion
- Street Canyons

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