Uncertainties in dispersion modelling in DE

Foto: Räddningstjänsten Storgöteborg

Robert Sigg
Håkan Grahn, Jan Burman, Niklas Brännström, Oscar Björnham
Petter Lindgren, Leif Å Persson, Pontus Von Schoenberg, Lennart Thaning

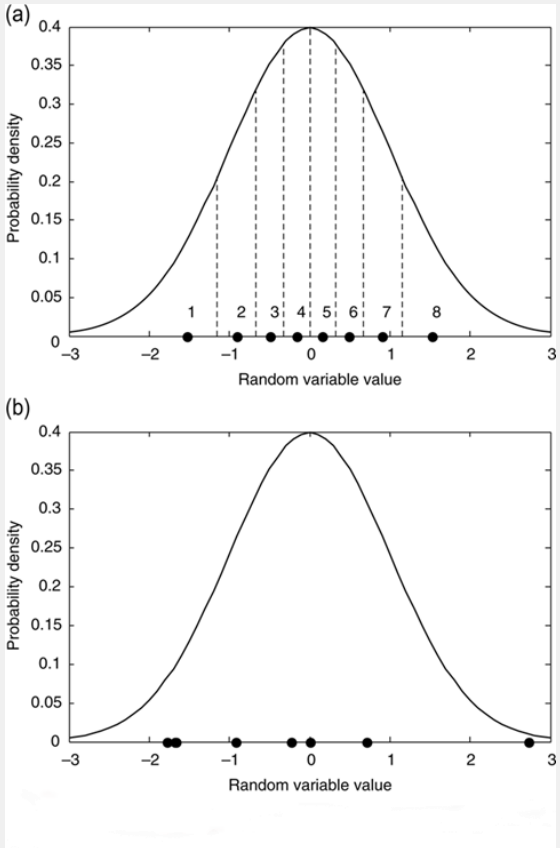
FOI

Background

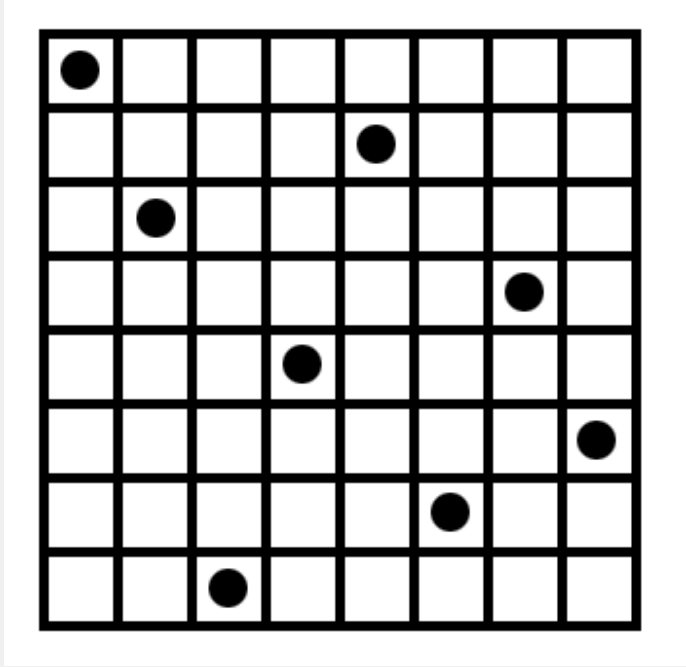
- An accident occurs with a potential release of a toxic gas (local scale):
  - Now? In an hour? In three days?
- Hypothesis:
  - Ensemble weather together with estimated uncertainties in parameters controlling the local dispersion of a release may lead to better decisions in handling the situation
- Goal:
  - Automated and fast solutions for the rescue services

LHS (Latin Hypercube Sampling) concept

1) Stratification, N=8



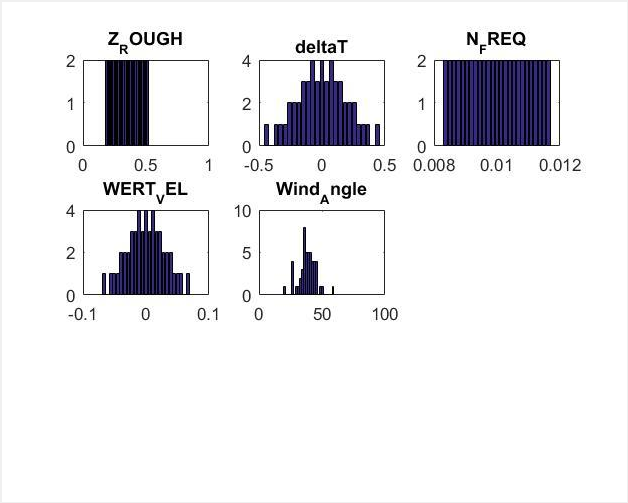
2) Never use the same interval twice!

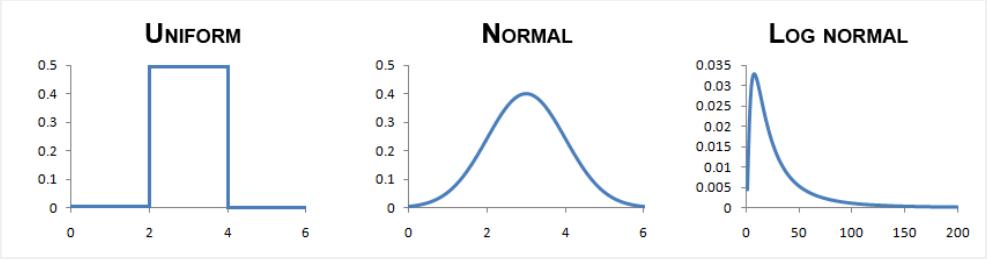


Example: N=8, p=2 → 8 combinations

Local scale dispersion modelling

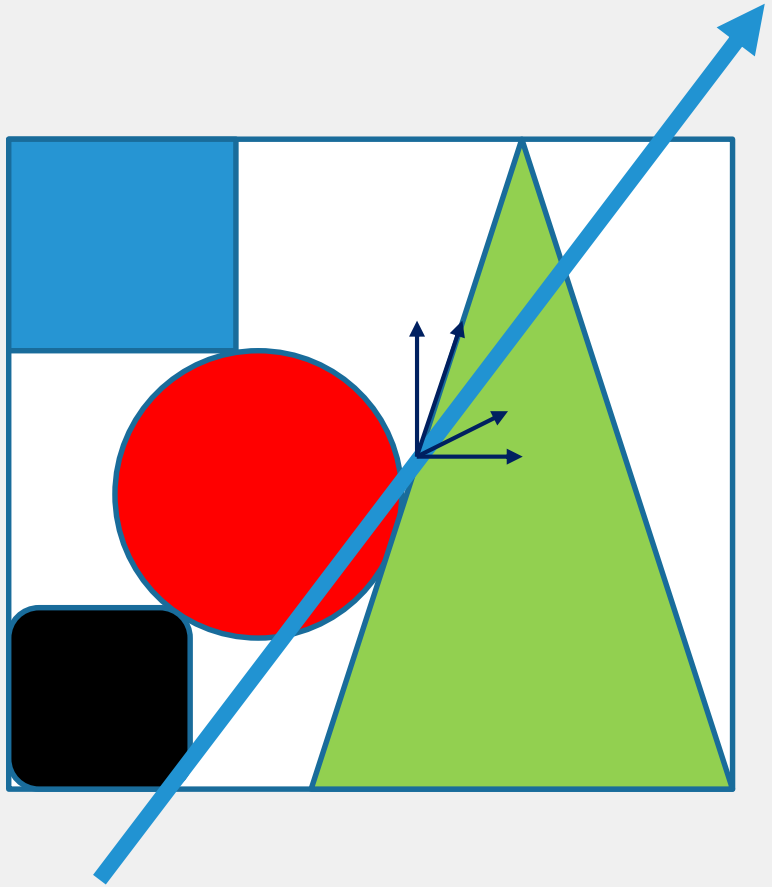
- Input
  - Wind speed and direction (from ensemble)
  - M-L corresponding to neutral stratification
- Uncertainty distributions:
  - Stability at the boundary layer height
  - Vertical velocity at the boundary layer height
  - Momentum flux at the surface
  - Roughness parameter
  - Wind direction forecast errors



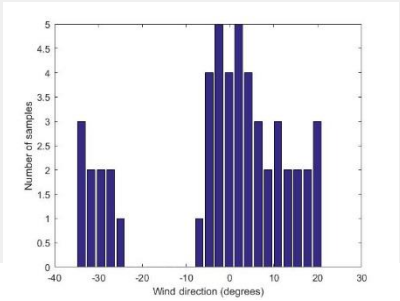


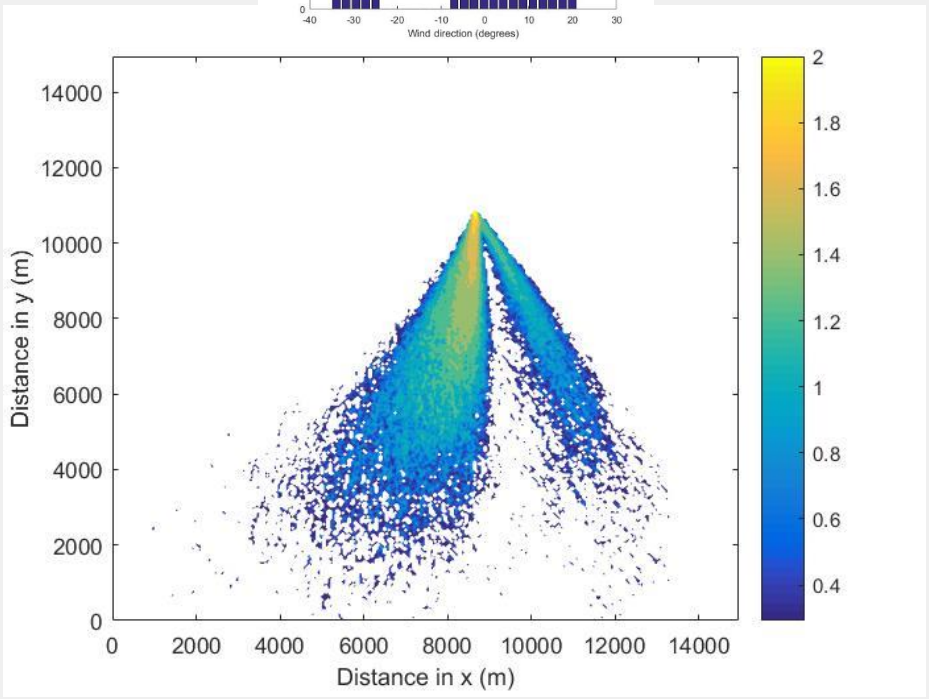
Ensemble weather

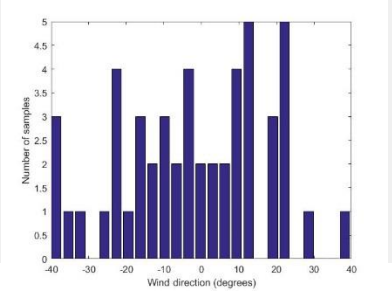
- Concept:
  - Each ensemble member is used ones in combination with other LHS generated uncertainties
  - Each ensemble member is added with a ”sub-grid” scale contribution
  - Uncertainty distributions reflect the ”sub-grid” scale variations

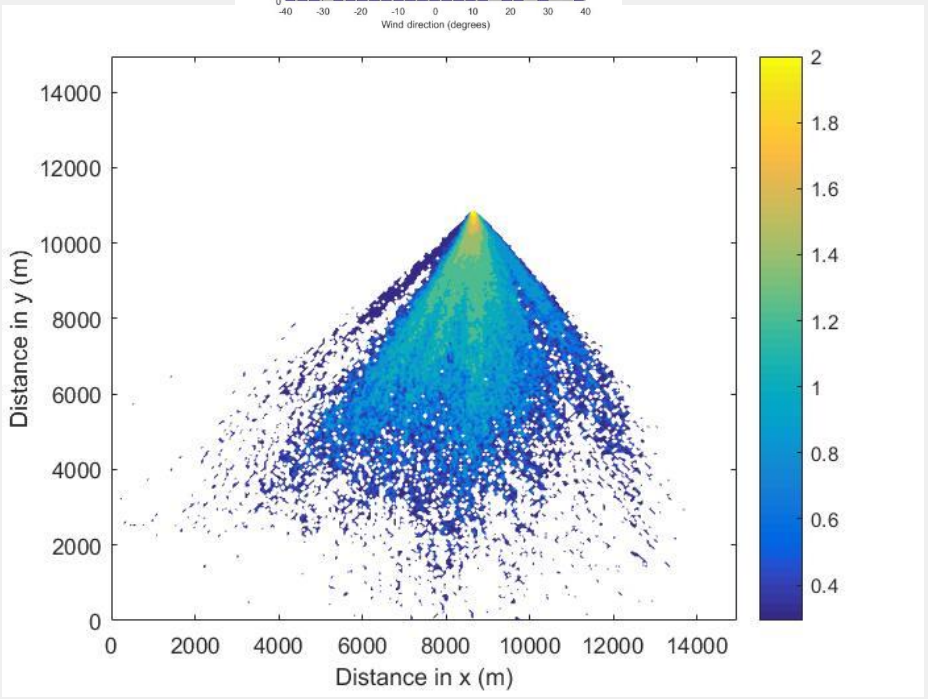


Academic ensembles – two modal distribution



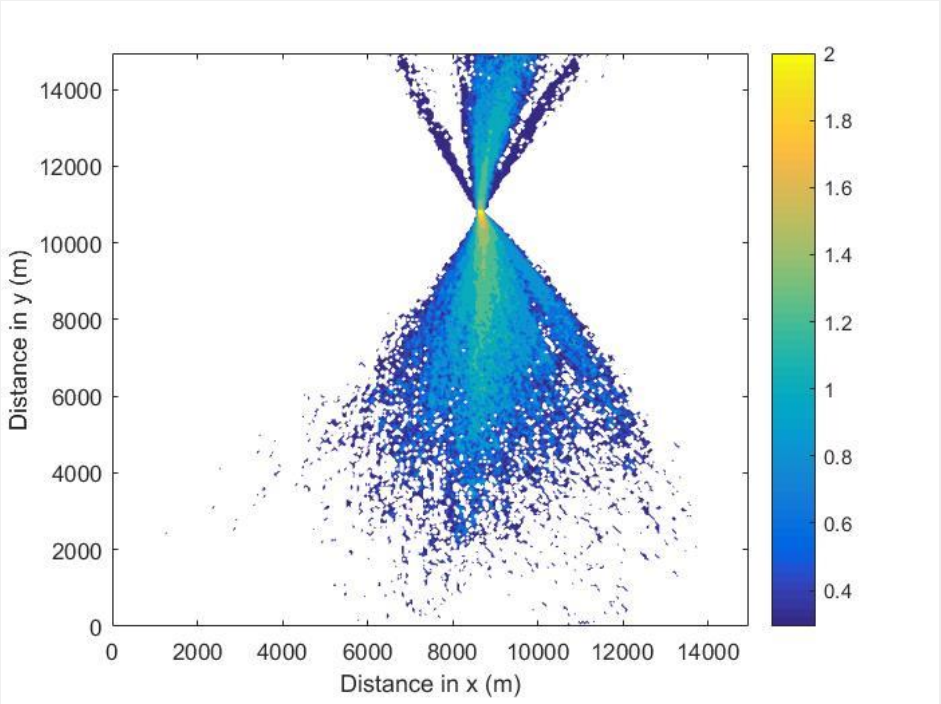




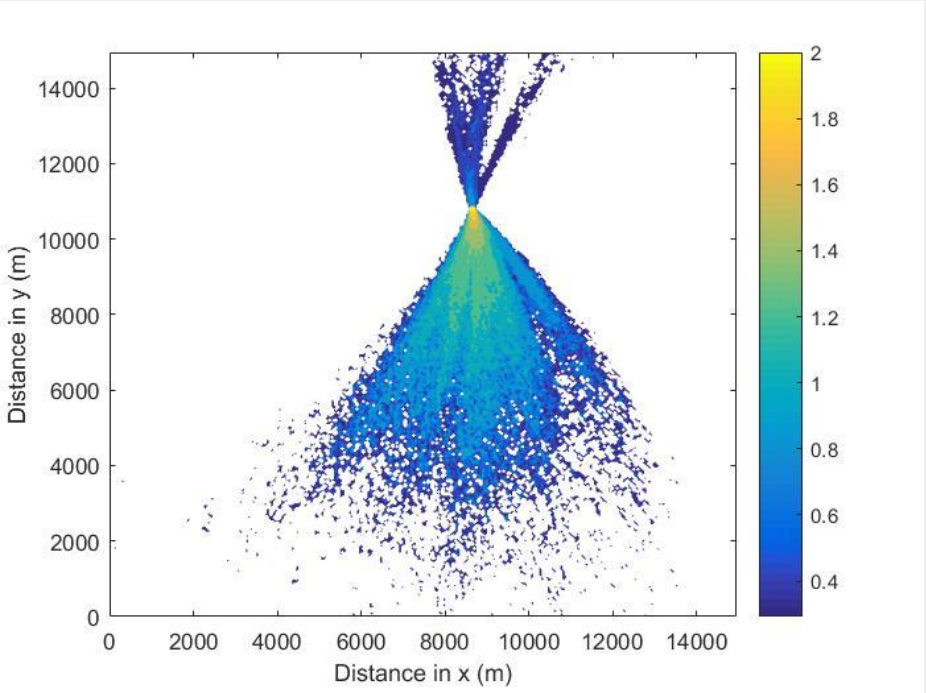


Academic ensembles – distribution with two modal outliers

15 ensemble members at opposite direction



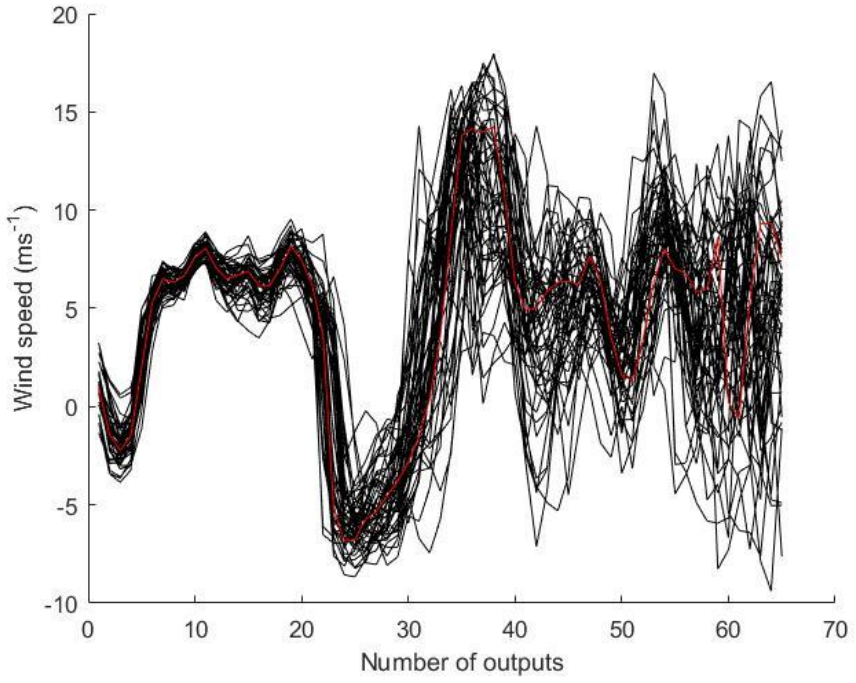
5 ensemble members at opposite direction



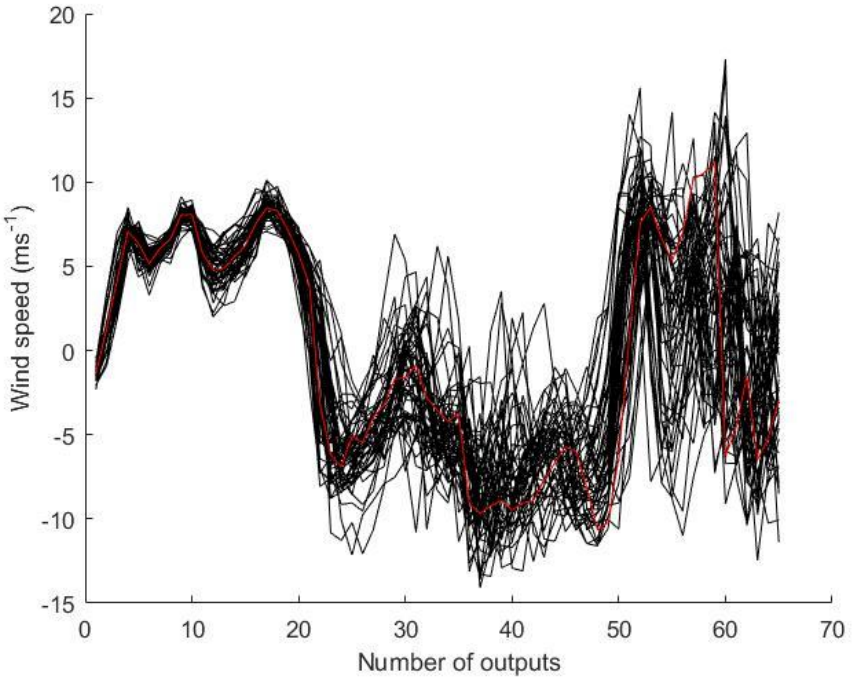
FOI

Ensemble output for an arbitrary point

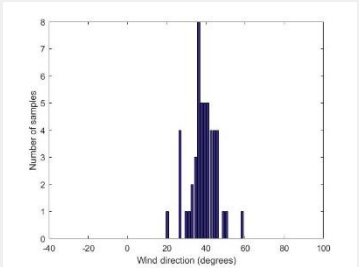
u10

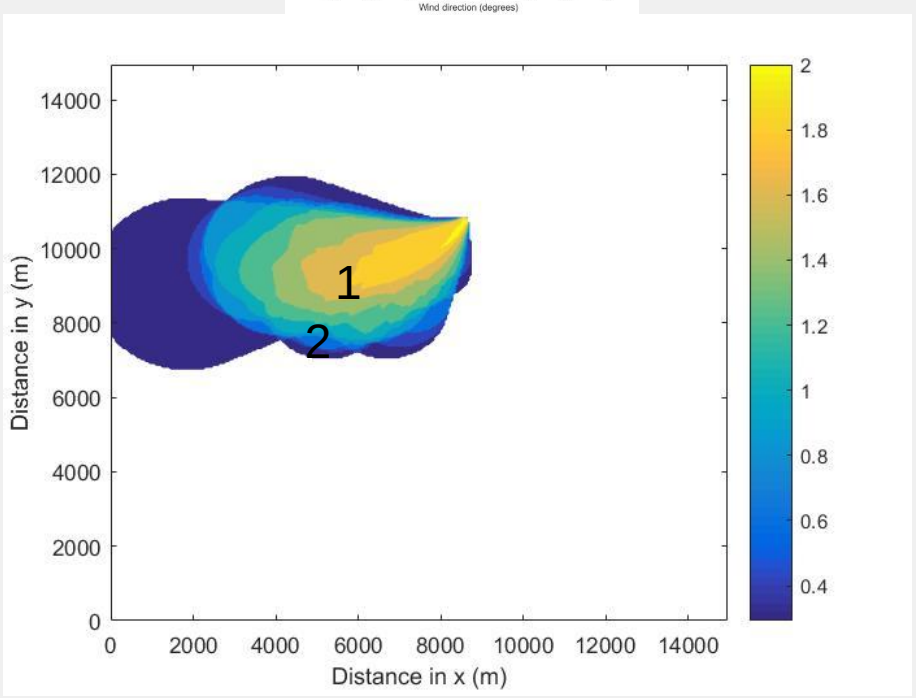


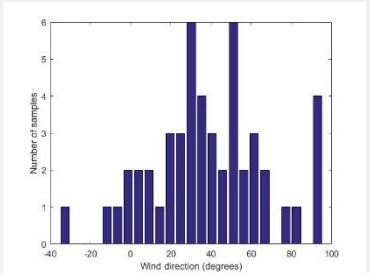
v10

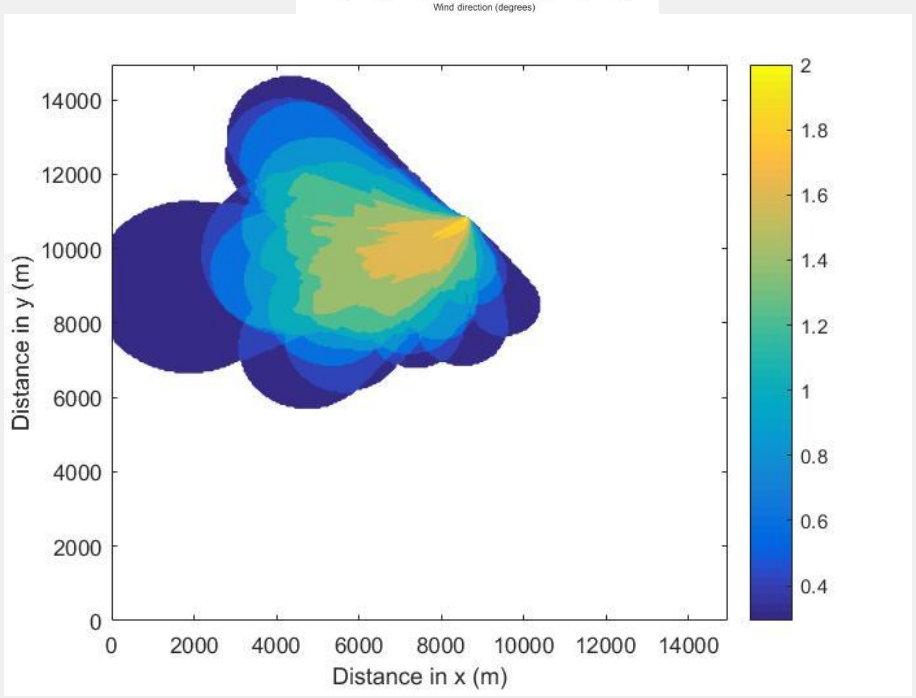


Case study

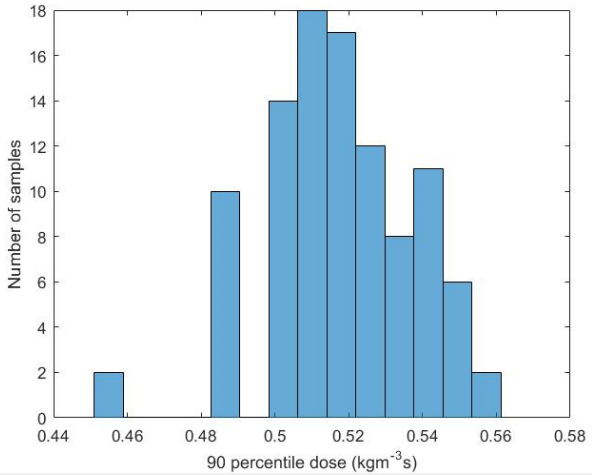

Number of samples
Wind direction (degrees)


1
2
Distance in y (m)
Distance in x (m)


Number of samples
Wind direction (degrees)


Distance in y (m)
Distance in x (m)

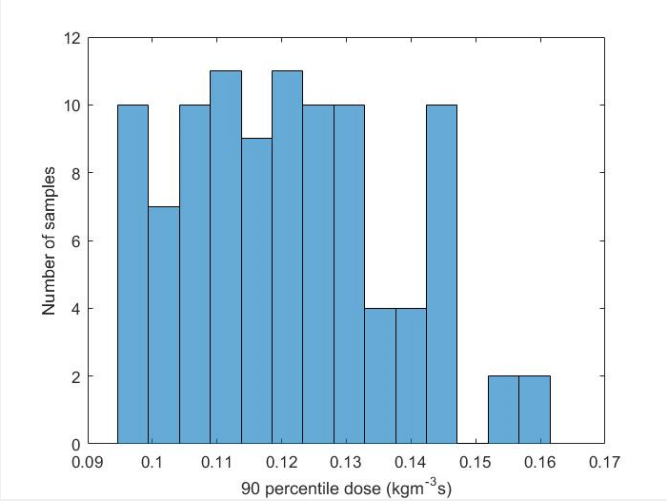
LHS stability properties



1

- Repeat every LHS run enough amount of times
- For every LHS run a new LHS combination is generated
- Compute the 90 percentile for every LHS run
- Analyze the stability

2



FOI

Conclusions and ongoing work

- Conclusions
  - Weather ensembles are easily implemented in the LHS concept
  - Local scale wind angle perturbations increase the risk area and may reflect local scale dispersion better
  - One LHS run is representative and the LHS sampling method is regarded as stable for our purposes
  - Fast
- Ongoing work
  - A better understanding of the uncertainty distributions
  - A better understanding of the ensemble forecast error
  - More analysis of real weather ensembles

FOI

FOI Dispersion Engine (DE)