

NordRisk: Practical risk assessment for long-range atmospheric transport of radionuclides

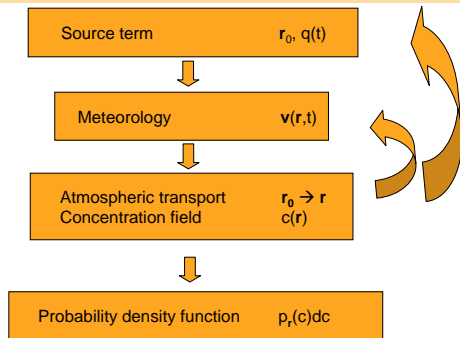
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Risø DTU

Presented at the NSFS meeting 26-30 May, Ålesund, Norway

Outline

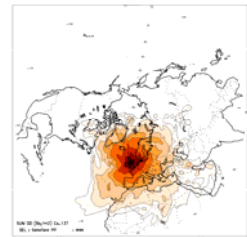
- Probabilistic Risk Assessment for long-range atmospheric transport
- Why you shouldn't do it
- How we did it (NordRisk Project)
- How we can avoid doing it again

Numerical Probabilistic Risk Assessment

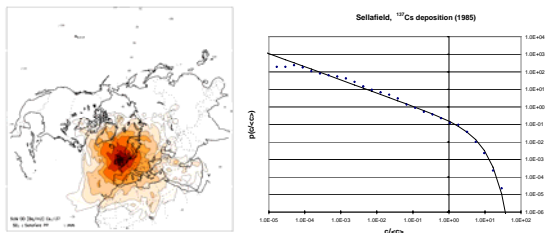


Numerical PRA for atmospheric dispersion

- Ensemble of meteorological data
- Atmospheric dispersion model
- Risk indicators:
 - Dry, wet deposition
 - Transport time
 - Dose estimate
- Ensemble averages/fluctuations



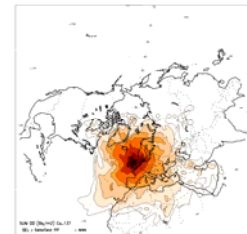
Numerical PRA for atmospheric dispersion



Numerical PRA for atmospheric dispersion

Why you shouldn't do it for long-range atmospheric transport

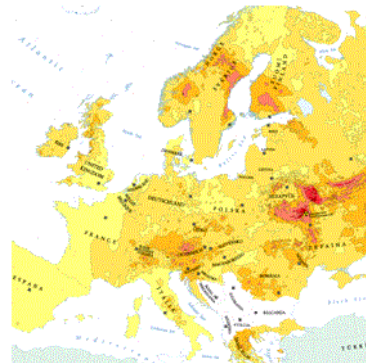
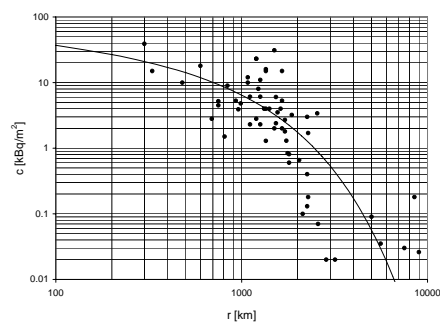
- Large numerical weather prediction model ensemble
- Complicated, time-demanding calculations
- Difficult to interpret
- Separation of ensemble mean value from fluctuations
- Non-generic (specific to release characteristics, weather ensemble)



Simplified Probabilistic Risk Assessment

Model-independent PRA

- Use historical data
 - Chernobyl
 - Kuwait Oil Fires
 - Volcano eruptions
- Analyze data, find statistical description
 - mean value
 - fluctuations

Chernobyl ^{137}Cs falloutChernobyl ^{137}Cs fallout

Nordic Nuclear Safety Research (NKS)

How we did it

- NordRisk (2005-6)
- NordRisk II (2008-9)
- Risø DTU (B. Lauritzen, T. Mikkelsen)
- DMI (A. Baklanov, A. Mahura, and J. Havskov Sørensen)
- NRPA (Ø. Selnæs)
- SSI (R. Finck)

NordRisk Plan

Objectives:

1. To provide a practical method for assessing and comparing nuclear risks due to atmospheric transport and deposition
2. to build an atlas of long-range atmospheric dispersion and deposition following a number of release scenarios in Northern Europe
3. to supplement this atlas with practical tools for rapid risk assessment for other (user defined) release scenarios

Meteorological Data

Analysed Numerical Weather Prediction (NWP) model data obtained for years 1983 and 1985 from the ECMWF re-analysis (ERA-40) archive.

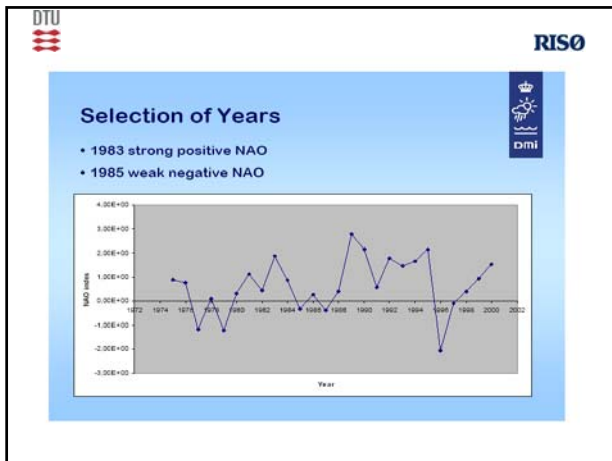
Horizontal resolution 1.125° latitude-longitude for northern hemisphere.

Analysed states each 6 hours.

Time resolution 3 hours.

28 vertical levels.





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DMI

Nuclear Risk Sites and Isotopes

Seven nuclear risk sites covering a wide range of climates in the Northern Hemisphere:

- Chernobyl
- Kola
- Leningrad
- Novaya Zemlya
- Sellafield
- Sinpo
- Savannah River

Three (forms of) isotopes:

- Cs-137
- I-131, aerosol
- I-131, elementary (gas)

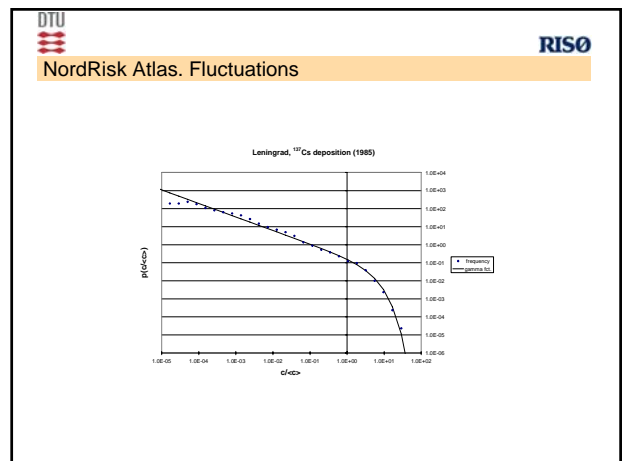
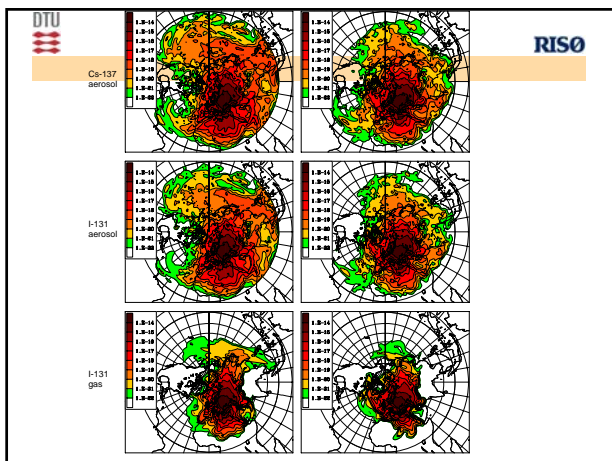
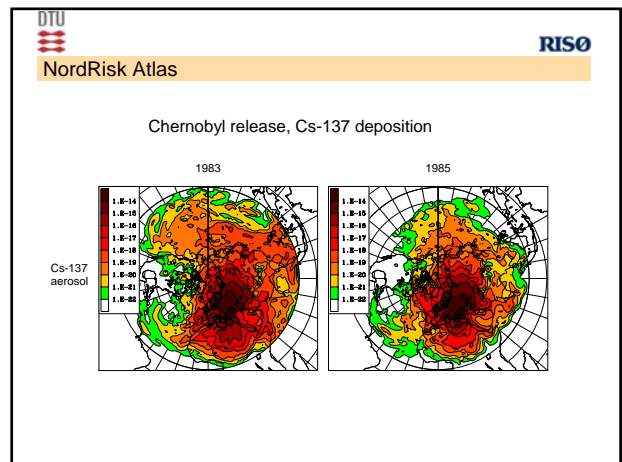
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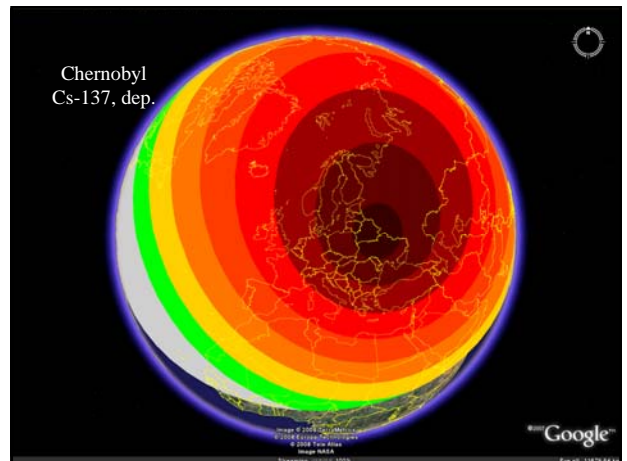
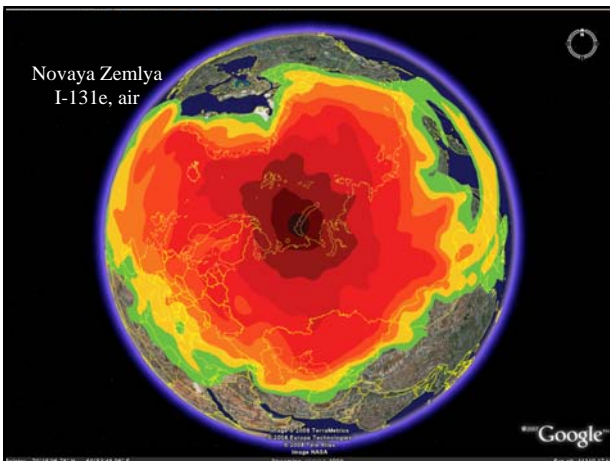
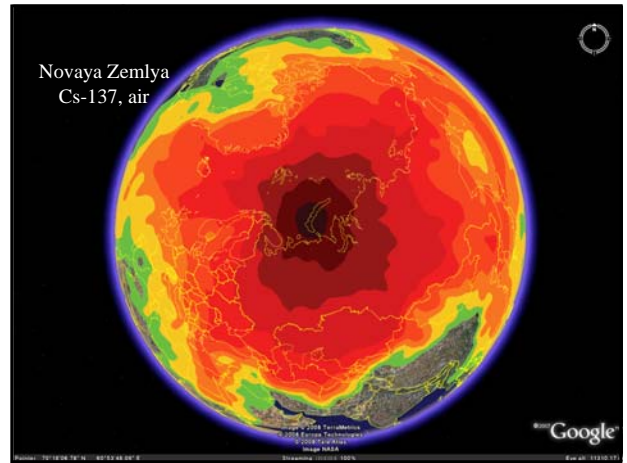
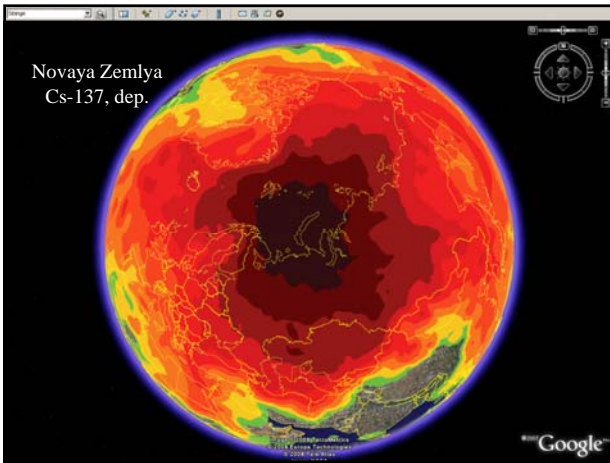
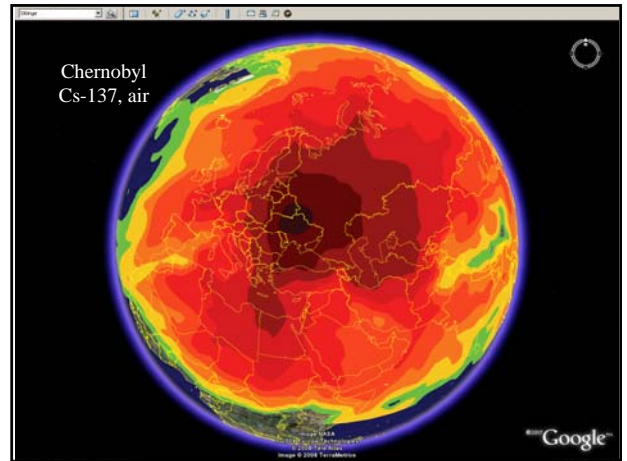
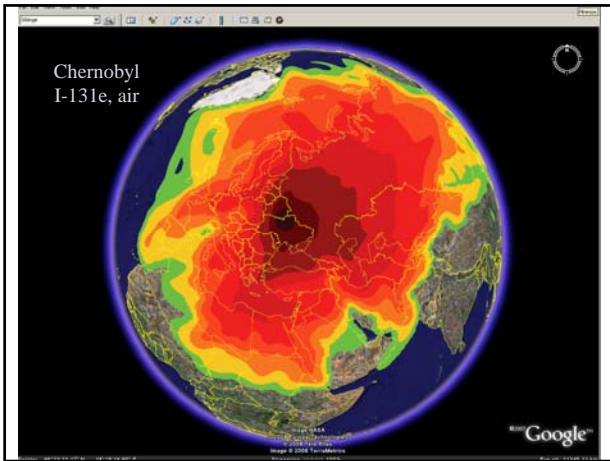
DMI

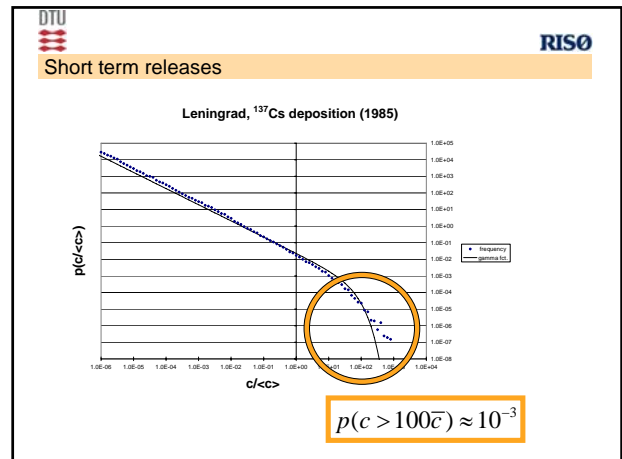
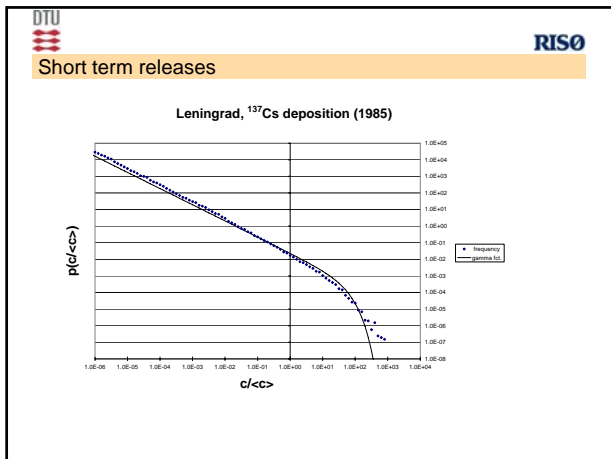
Atmospheric Dispersion Modelling

- Use of the DERMA model.
- For each site, each isotope and each day, a 24-hour constant release at a rate of 1×10^{11} Bq/s is assumed.
- The released material is followed for three weeks.
- Output fields:
 - Ground-level time-integrated concentration ($Bq \cdot h/m^3$)
 - Total deposition (Bq/m^2)
 - Dry deposition (Bq/m^2)
 - Wet deposition (Bq/m^2)

Output data: 300 GB.
CPU time: 28 days (on 7 CPUs)







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- Short term releases
- Fluctuations depend on ...**
- Modelling assumptions
 - source term
 - release duration
 - Risk indicator
 - spatial averaging scale
 - Add uncertainty

- DTU RISØ
- NordRisk II
- How to avoid doing it again**
- Statistical analysis of previous data
 - mean field: K-model
 - fluctuations: gamma model
 - Default / user-defined parameters
 - simplified PRA
without dispersion model calculations!
 - NordRisk II project

- DTU RISØ
- Conclusions**
- NordRisk
 - Atlas
 - simplified model
 - NordRisk II
 - Statistical description: examine variability
 - Models for mean value and fluctuations
- Thanks !