Federal Office for Radiation Protection

PREDICT

The PREDICT Project

ImPRovements in atmospheric dispErsion moDellIng and proteCTive action strategies in case of nuclear detonations

C. Woda (on behalf of the PREDICT consortium)

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NERIS Workshop, London, 29 September 2025

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Introduction

- PREDICT aims to enable the major internationally used decision support systems JRODOS and ARGOS and other nationally used atmospheric dispersion and transport codes and follow-on foodchain models to simulate and predict consequences due to the fallout of a nuclear detonation in Europe or worldwide.
- Duration: 01 February 2024 – 31 January 2027
- 12 partners from seven European countries

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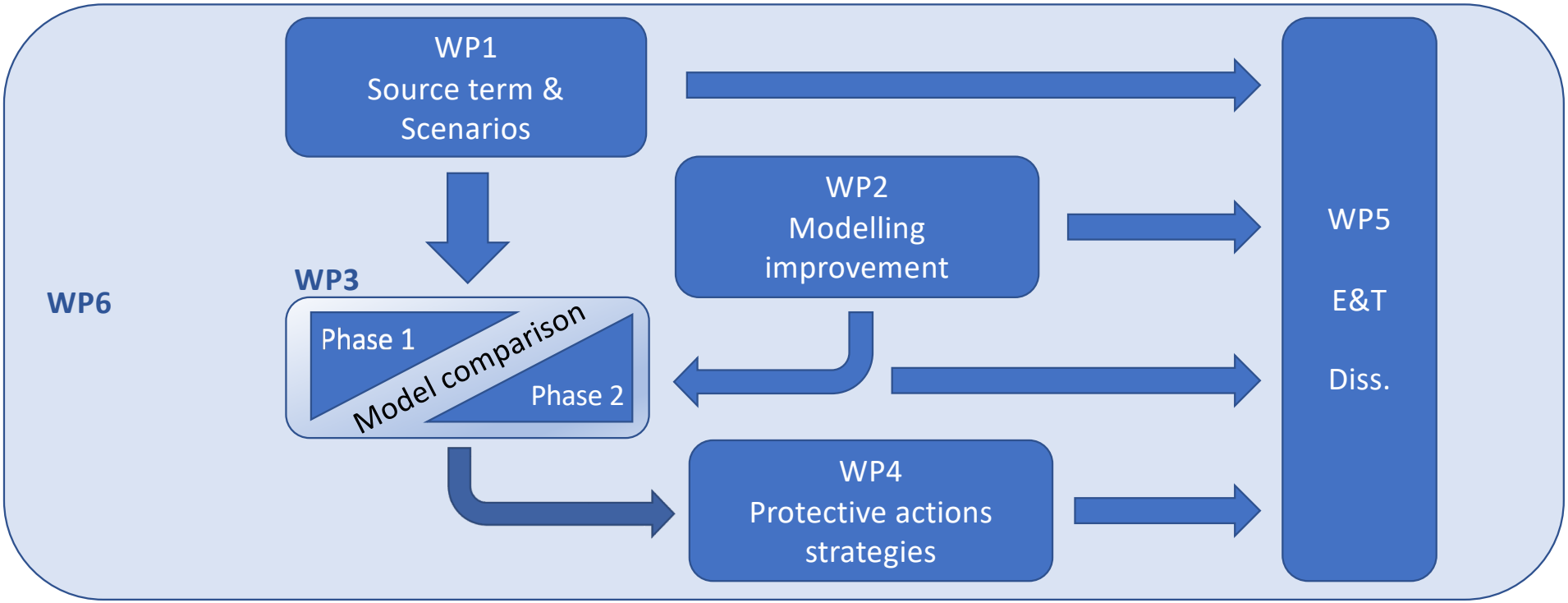
Project structure



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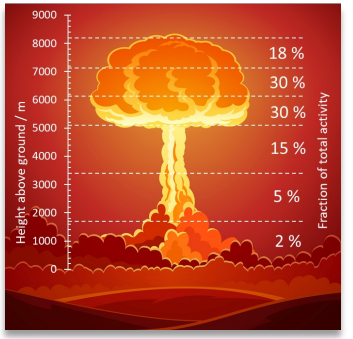
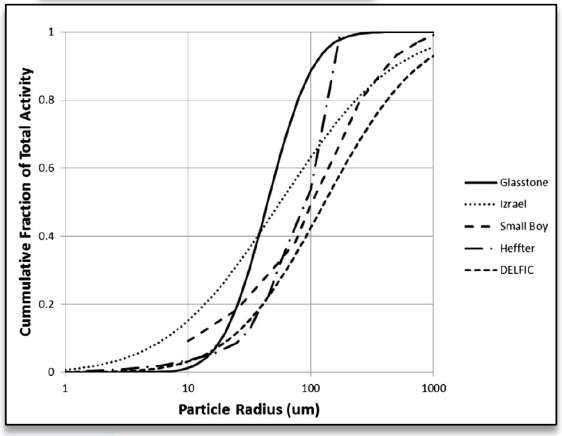
WP 1 – Characterization of airborne radiocontaminants (DTU)

- Research into datasets, relevant for atmospheric dispersion modelling for airburst and ground detonation
- What are the main dose-delivering radionuclides, activity-height and particle size distributions?
- Reduce computing time and develop relevant scenarios to be used in other WPs





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WP 1 – Characterization of airborne radiocontaminants (DTU)

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WP completed:

- "Predict Nuclide vector": 359 radionuclides with max activity from fission of U-235, U-238 and Pu-239 after 10 min, ranked according to either dose from ground or cloud shine or ingestion dose; corresponding analysis for activation and unconsumed fuel residues
- Parameterization of cloud dimensions and review of different activity –height and activity- particle size distribution achieved
- Four scenarios (two yields, two HOB); combinations of cloud geometry and parameter distributions for sensitivity analysis

Table 2: Radionuclides accounting for 95 % of external exposure from the ground in three early time windows: 1) first 6 hours; 2) 6 hours - 24 hours, and; 3) 24 hours – 30 days after the explosion. All times are relative to t + 10 minutes.

Window 1: 0 - 6 hours		
Nuclide	Share of dose (%)	Cumulative share (%)
I-134	11.78	11.78
Cs-138	8.31	20.09
La-142	7.00	27.09
Tc-104	5.94	33.04
Rb-89	4.21	
Mo-101	3.36	
Sr-92	3.33	

Window 2: 6 - 24 hours		
Nuclide	Share of dose (%)	Cumulative share (%)
I-135	15.37	15.37
Zr-97	8.08	23.45
I-133	6.62	30.07
Nb-97	6.57	36.64
Sr-91	6.53	43.17
I-132	5.82	48.99
Kr-88	5.74	54.73

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WP2 – Modelling Improvement (UKHSA)

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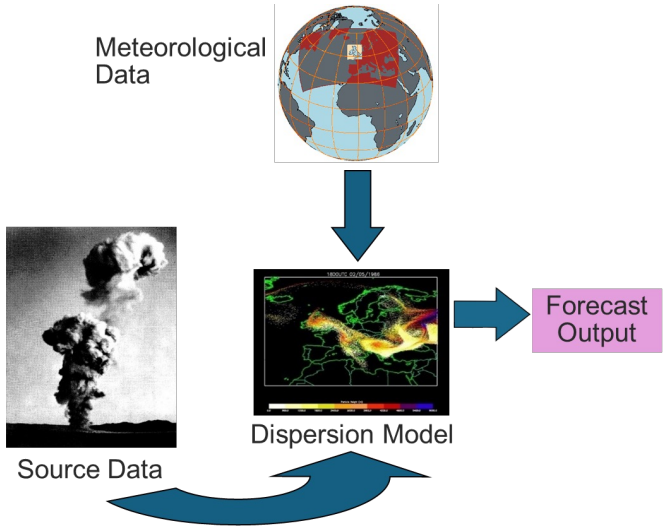
- Develop scientifically based recommendations for future improvements of atmospheric dispersion and radiological dose assessment models applied to nuclear detonation scenarios
- Determine the current (baseline) modelling capability
- Task 2.1 Improvements in dispersion modelling
  - Source term description
  - Input meteorological data (Resolution, meteorological fields)
  - Atmospheric dispersion model setup and parameterisations (wet & dry deposition, sedimentation, turbulence, convection, radioactive decay)
  - Output produced



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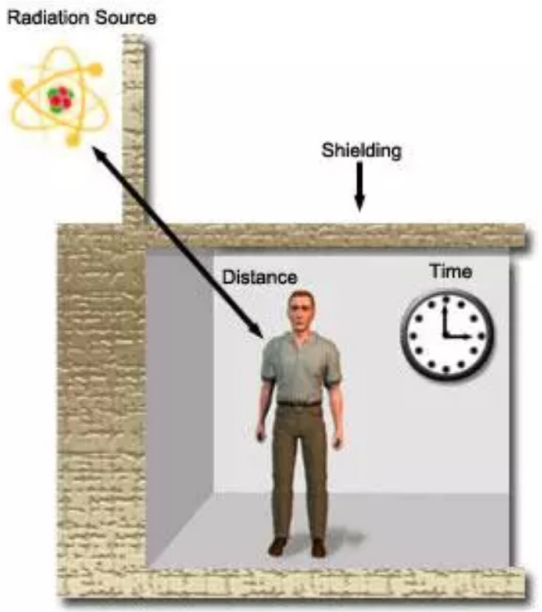
- Task 2.2. Improvements in external dose and dose rate modelling
  - External dose from deposition
  - Review of the applicability of location factors
  - Modelling tissue reaction effects
  - Recovery options in inhabited areas
- Task 2.3 Application of food chain transfer models
  - Ranking of radionuclides by accounting for radioecological factors



https://www.radiation-therapy-review.com/Radiation_Protection.html

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WP2 – Modelling Improvement (UKHSA)

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- Task 2.3 Ap
  - Ranking
    factors

More Details at ERPW Parallel Session 5 5 - Emergency Preparedness, Resilience and Response (EPRR) for nuclear detonation (Tuesday, 30th September, 15:00-17:30)

- David Igewsi: "Improving the modelling of radionuclides and their progeny in the assessment of external dose following a nuclear detonation"
- Justin Brown: „An approach to ranking radionuclides in terms of their contribution to ingestion dose following a nuclear detonation"

review.com/Radiation_Protection.html

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WP3 – Model Comparison (KIT)

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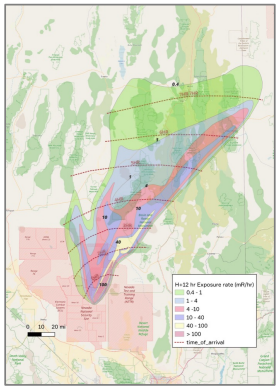
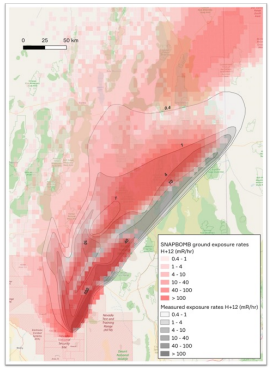
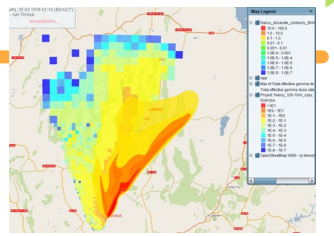
3.1 Model validation with historical contamination data from 1950s weapon tests (accuracy of the prediction)

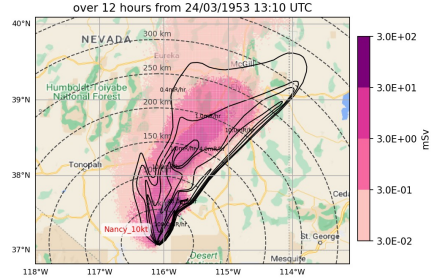
To date:

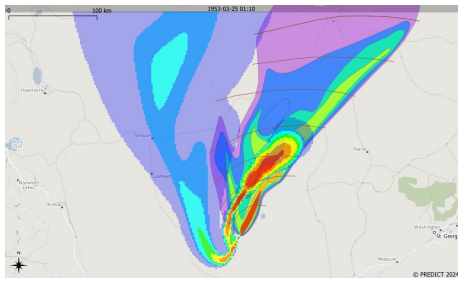
- Five usable tests identified:
  - "Trinity" (25 kT, 16 July 1945)
  - "Upshot Knothole – Nancy" (24 kT, 24 March 1953)
  - "Upshot Knothole – Harry" (32 kT, 19 May 1953)
  - "Operation Plumbbob – Smoky" (44 kT, 31 August 1957)
  - "Operation Dominic II – Small Boy" (< 20kT, 14 July 1962)
- Data sets for all tests digitized (Fallout dose rate and time of cloud arrival patterns)











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WP3 – Model Comparison (KIT)

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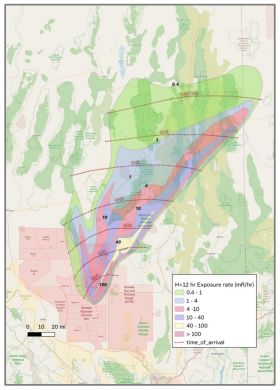
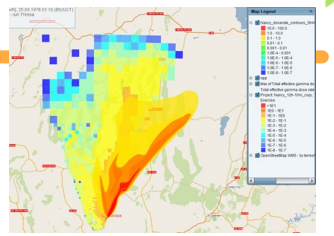
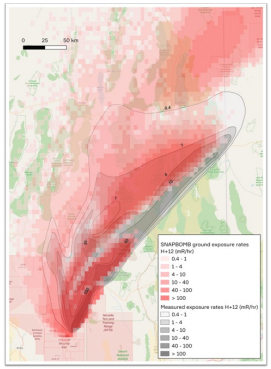
3.1 Model validation with historical contamination data from 1950s weapon tests (accuracy of the prediction)

To date:

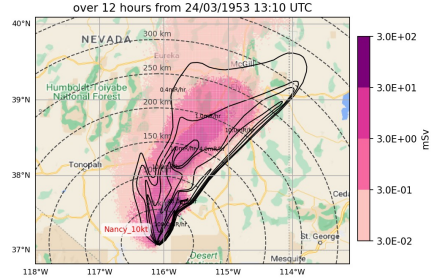
- Full comparison with all project partners carried out for the first test site data set ("Upshot Knothole – Nancy"); work in progress for the remaining four
- Each modelling group used their initial setup and parametrizations
- All used ECMWF's ERA-5 data
- Exercise will be repeated towards the end of the project with improved input parameters

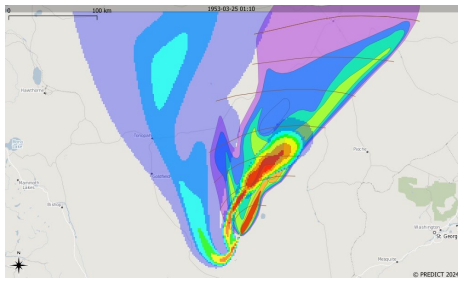






Effective external ground dose for an adult over 12 hours from 24/03/1953 13:10 UTC





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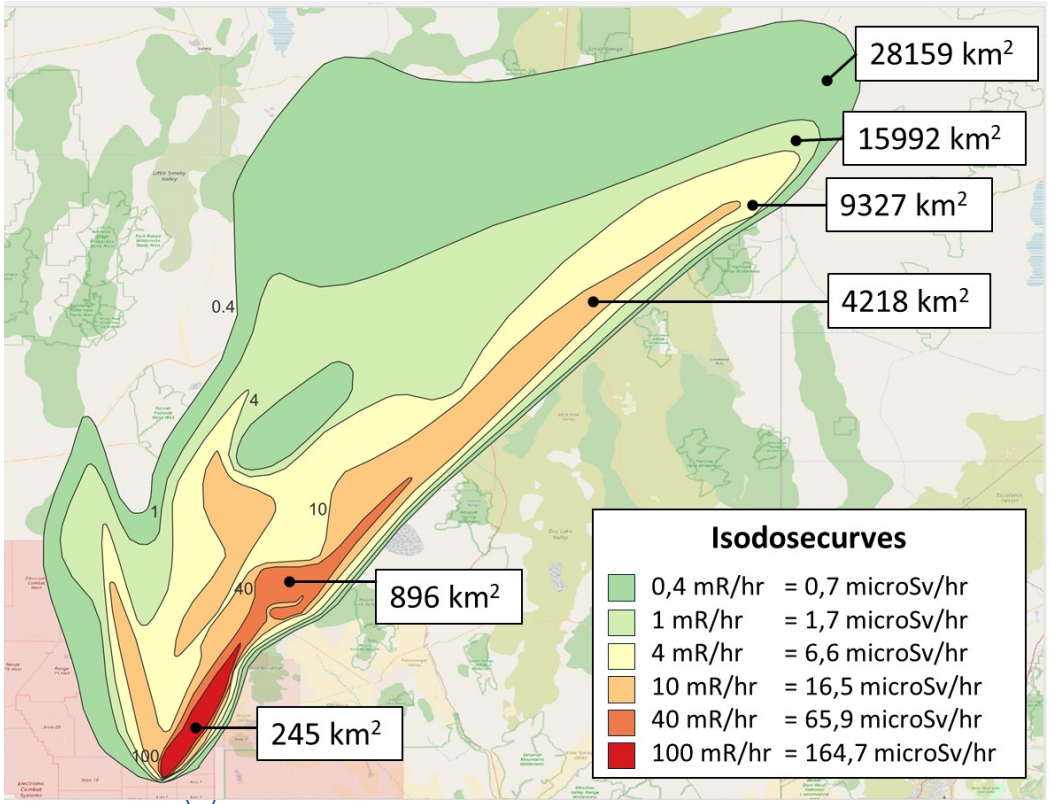
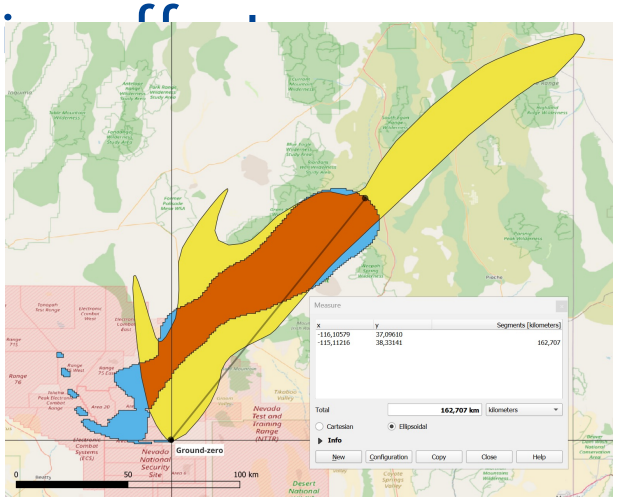


- Figure of Merit in Space (FMS)
- Maximum effect distance
- Si… ff…



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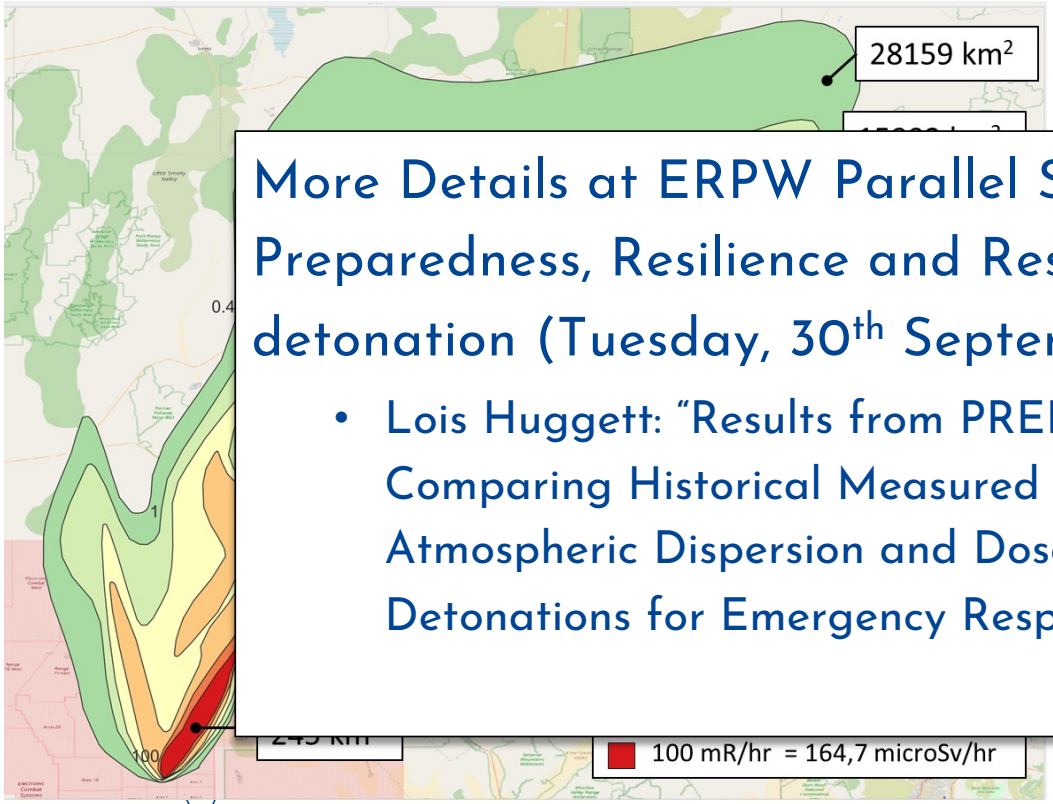

- Figure of Merit in Space (FMS)

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More Details at ERPW Parallel Session 5 5 - Emergency Preparedness, Resilience and Response (EPRR) for nuclear detonation (Tuesday, 30th September, 15:00-17:30)

- Lois Huggett: "Results from PREDICT Work Package 3.1 Phase 1: Comparing Historical Measured Nuclear Fallout with Modern Atmospheric Dispersion and Dose Model Output for Nuclear Detonations for Emergency Response Applications"

WP3 – Model Comparison (KIT)

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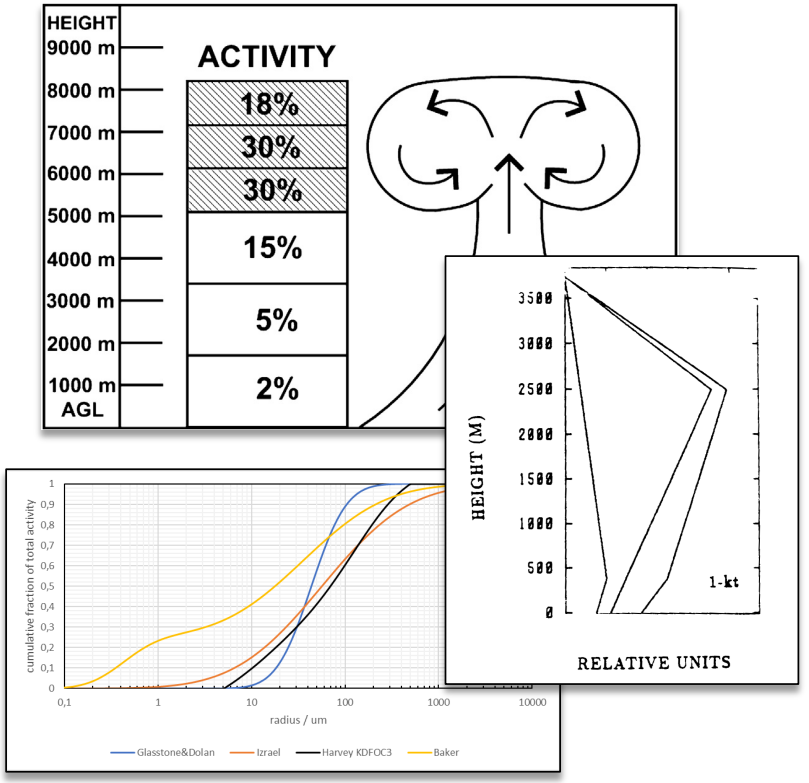
3.2 Sensitivity analysis for key source term model parameters:

- Plume height
- Activity-height distribution
- Activity-particle size distribution
- Particle density

- Statistical analysis on calculations for one meteorological year (2019) with fixed model parameters -> subset of 20-30 representative weather conditions for subsequent parameter variation



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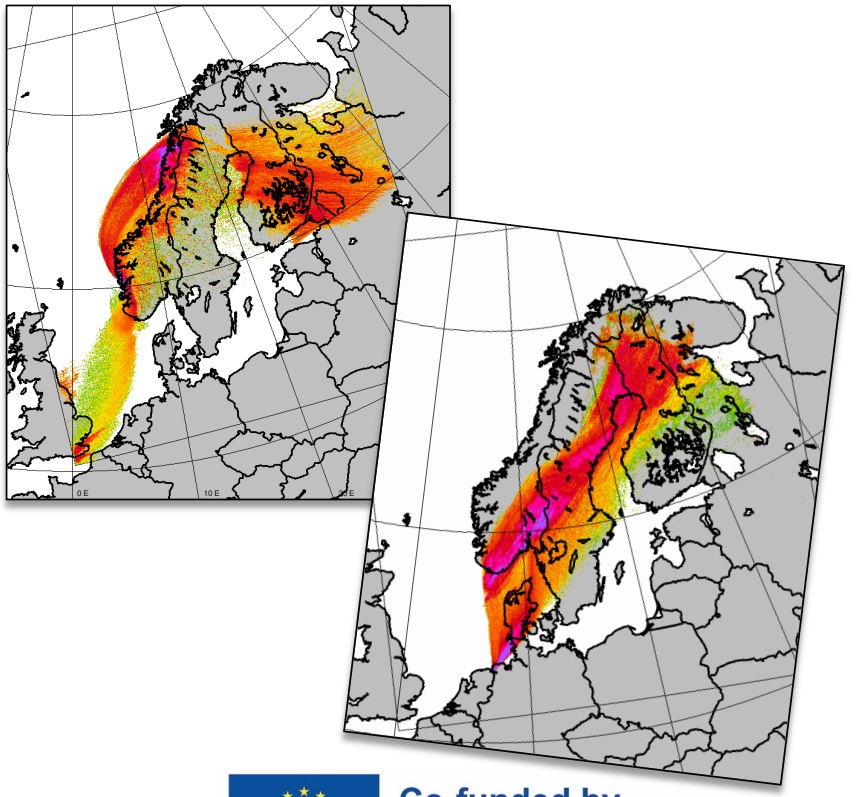
3.3 Sensitivity analysis for key weather conditions:

- Explore the sensitivity and uncertainty of model results related to variable weather conditions :
  - simple or complex weather,
  - changing wind directions,
  - situations with or without precipitation
- To date:
  - Eight weather conditions selected
  - Two locations (Bergen (NO) and Emden (DE))



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WPs 4 & 5

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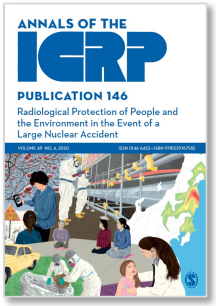
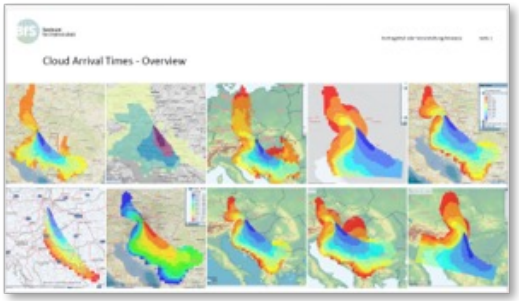
WP4 – Protective actions strategies (BfS, NMBU):

- Develop harmonized protective action strategies, based on the unified source terms of WP1 and specific endpoints of the uncertainty analysis in WP3
- Develop effective ways of communicating protective measures to the public, taking into account psychological, social and ethical consideration and utilizing results of a workshop with key players in emergency response. It will be co-organized with the final workshop of RRADEW (May 2026), to mutualize stakeholders and have opportunities to discuss transversal topics.

Advice for the Public on Protection in Case of a Nuclear Detonation





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WPs 4 & 5

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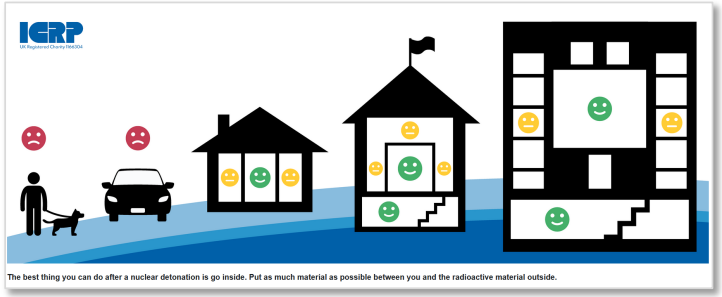
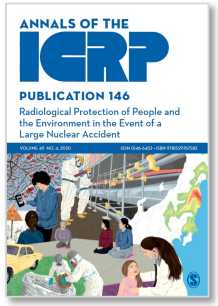
WP 5 – Education, training and dissemination (NMBU) :

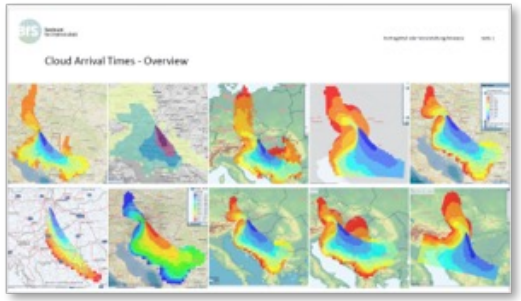
Disseminate project results to the European EPR community and worldwide using:

- MEENAS, International bodies such as IAEA, OECD NEA, ICRP, HERCA (WGE-TG Ukraine-Subgroup on Nuclear Weapons)
- Regular international exercises of the RODOS and ARGOS user groups (planned for late 2026 or 2027)
- International conferences (ERPW 2024, 2025, RICOMET 2024, MARC XIII, 2025) & Training courses (at NMBU)

Advice for the Public on Protection in Case of a Nuclear Detonation







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Data Management and Dissemination

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- All project deliverables will be openly accessible through the PIANOFORTE website. These include:
  1. Available parametrization (WP 1, January & April 2025)
  2. Recommendations for future research (WP 2, July 2026)
  3. Results from model comparison and testing (WP 3, December 2026)
  4. Recommendations for protective actions and crisis communication (WP 4, July & December 2026)
  5. Training materials (WP 5, April 2026)
- Publications, that will focus more on the methodological aspects of the derived data in the deliverables, will be made open access either through 'Gold' or 'Green' routes.
- Data generated within PREDICT will be made publicly available by deposition in the STORE^{DB} platform.


PIANOFORTE Partnership
European Partnership for Radiation Protection Research
D6.1 - Establishing of the management structure and data management plan of the PREDICT project

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Project Results & Impact

- Updated simulation models, which will be state-of-the-art at the end of the project
- Recommendations for protective actions & strategies to disseminate them to the population, based on the updated models
- Implementation in national and supra-national DSS (e.g. ARGOS, JRODOS, JAM (UK), SNAP (Norway), IRIS (Netherlands))
- Harmonized models potentially lead to a harmonized cross-border transnational emergency response
- Recommendations for future research for further improvement in modelling and dose assessment


Image: Glasstone and Dolan, 1977

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Thank you for your attention

The PREDICT Consortium:

Anderson, Kasper; Bedwell, Peter; Raskob, Wolfgang; Tomkiv, Yevgeniya; Pölzl-Viol, Christiane; Skipperud, Lindis; Mertes, Florian; Hamburger, Thomas; Jones, Kelly; Lind, Ole Christian; Hac-Heimburg, Agnieszka; Senstius, Elias Pagh; Brown, Justin; Selnæs, Øyvind; Berge, Erik; Ryan, Robert; Pehrsson, Jan; Kloosterman, Astrid; de Bode, Michiel; Axelsson, Anders; Blixt Buhr, Anna Maria; Johannsen, Jan; Kock, Peder; Lindgren, Jonas; Millington, Sarah; Huggett, Lois; Woda, Clemens

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